14th International Conference of the East and Southeast Asia Federation of Soil Science Societies

National Taiwan University, Taipei, Taiwan. November 3-8, 2019

Smart Soil Management for Sustainable Agriculture

ESAFS TAIWAN 2019

CONFERENCE ABSTRACTS

Organized by

ESAFS EAST AND SOUTHEAST ASIA FEDERATION OF SOIL SCIENCE SOCIETIES

Sponsored by

MOST 科技部 Ministry of Science and Technology

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Contents

PREFACE

Soil is not only important for sustainable agriculture, but also crucial to environmental quality. The negative impacts of civilization development on our environment are rapidly growing due to the increase of global population, yet humans are getting dependent on the high quality of soil resources for surviving on the earth. The East and Southeast Asia Federation of Soil Science Societies (ESAFS) is dedicated to the exchange of recent advances in soil science in the East and Southeast Asian regions, providing the better understanding of the attributes of soil quality and the way of improving soil and associated environmental quality for sustainable food security and healthy life of East and Southeast Asia as well as world population.

This international conference, ESAFS 2019, is an integrated platform for interaction among scientists, consultants, and policy makers, who are responsible for the research and technology transfer of soil science, fertilizer management, and plant nutrition in order to cope with the rapid industrial development globally. ESAFS 2019 is hosted by National Taiwan University (NTU) and Chinese Society of Soil and Fertilizer Sciences (Taiwan) and is held at GIS Convention Center of NTU in Taipei, Taiwan. It aims to emphasize the multidisciplinary collaboration for the development of smart soil management for sustainable agriculture. The presentations of ESAFS 2019 are focus on soil education and public awareness, emerging contaminant elements in soil-plant systems, pedogenesis and soil information, soil fertility and plant nutrition, soil ecology, paddy soil remediation and food safety, soil management and climate change, soil and water management, and forest soils. There is also an education trip of post conference for the visit of landscape, ecology, and culture of soils in central Taiwan.

The organization committee of ESAFS 2019 would like to appreciate a number of people helped us to achieve our aims and we would like to thank all of them: all the committees of ESAFS 2019 and staffs and students in my lab (Soil Survey and Remediation Laboratory, Department of Agricultural chemistry, NTU). In addition, we would like to thank the Ministry of Science and Technology, Taiwan and Apollo Technology Co., LTD. for financially supporting the conference.

Zeng-Yei Hseu

Zeng-Yei Hseu
Chairman, ESAFS 2019
President, Chinese Society of Soil and Fertilizer Sciences (Taiwan)
Professor, Department of Agricultural Chemistry, National Taiwan University
3 November 2019

Conference Program

Monday Nov. 04, 2019

Room	Forum Hall
08:00-09:00	**Registration**
Room	Forum Hall
Moderator	Zeng-Yei HSEU
09:00-09:20	Opening Ceremony Opening Remarks: Zeng-Yei HSEU, Chairman Welcome Address: Chia-Pei CHOU, Vice President, National Taiwan University Huu-Sheng LUR, Dean of College of Bioresources and Agriculture, National Taiwan University
Moderator	Dar-Yuan LEE
09:20-10:00	**Keynote Speech 1:** Biochar application modulates soil health and fertility: a meta-analysis Nanthi BOLAN
10:00-10:30	**Morning Tea and Coffee**
Moderator	Zueng-Sang CHEN
10:30-11:10	**Keynote Speech 2:** Development and prospect of a smart farming–based rice production system for sustainable agriculture in Taiwan Huu-Sheng LUR
Moderator	Yuan SHEN
11:10-11:50	**Keynote Speech 3:** Soil microbial ecology and organic matter application for sustainable agriculture Chiu-Chung YOUNG

Monday Nov. 04, 2019

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<tr><td>11:50-13:00</td><td colspan="3">Lunch</td><td rowspan="2">12:00-14:00
Council meeting
(11th Floor, Just Sleep Hotel)</td></tr>
<tr><td>13:00-14:00</td><td colspan="3">Poster Session----Plato Hall (Odd poster number only)</td></tr>
<tr><td>Room</td><td>Socrates Hall</td><td>Locke Hall</td><td>Alexander Hall</td><td>Archimedes Hall</td></tr>
<tr><td></td><td>Session 1: Soil education for pre- and elementary-school children: current issues towards setting an international standard</td><td>Session 2: Emerging contaminant elements in soil-plant systems (I)</td><td>Session 3: Soil information and digital soil mapping</td><td>Society Report</td></tr>
<tr><td>Moderators</td><td>Hideaki HIRAI
Heng TSAI</td><td>Dar-Yuan LEE
Tomoyuki MAKINO</td><td>Budiman MINASNY
Kai-Wei JUANG</td><td>Zeng-Yei HSEU
Shih-Hao JIEN</td></tr>
<tr><td>14:00-14:10</td><td>Demonstration functions, specific characteristics and high impression of soil museums of the world
Zueng-Sang CHEN</td><td>Effects of emerging contaminant elements on aquatic food chains in irrigation-pond wetlands
Rita YAM</td><td>Convolution neural network for mapping heavy metals in the topsoil of New South Wales, Australia
Yuxin MA</td><td>Soil Science Society of Bangladesh
S.M. Imamul HUQ</td></tr>
<tr><td>14:10-14:20</td><td>Soil education in the Philippines for pre-elementary and elementary school children
Edna D. SAMAR</td><td>The effects of emerging contaminant elements on soil bacteria
Nai-Chun LIN</td><td>Soil carbon and other nutrient conditions under different land use in Tamil Nadu, South India
Soh SUGIHARA</td><td>Soil Science Society of China
Renfang SHEN</td></tr>
<tr><td>14:20-14:30</td><td>Soil taxonomy of the municipality of Maasim in Saranggani Province, Mindanao, Philippines
Adeflor GARCIA</td><td>Bioavailability of chromium (Cr) from tannery waste for caisim growed on contrasted textural soil
Eko HANUDIN</td><td>Sensitive soil layers at landslide prone areas of the transitional volcanic landscapes between quaternary and tertiary systems in Java - Indonesia
Junun SARTOHADI</td><td>Indonesian Soil Science Society
Budi MULYANTO</td></tr>
<tr><td>14:30-14:40</td><td>Making shiny soil balls is popular with children, but what kind of soil balls should we make to link to soil education?
Haruo TANAKA</td><td>Nonexchangeable K threshold to screen radiocesium transfer risk to brown rice for paddy soils in Fukushima
Kohei KUROKAWA</td><td>Spatial variation of soil chemical properties in paddy fields of Kurunegala District In Sri Lanka
W. M. U. K. RATHNAYAKE</td><td>Japanese Society of Soil Science and Plant Nutrition
Ryusuke HATANO</td></tr>
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	Session 1: Soil education for pre- and elementary-school children: current issues towards setting an international standard	Session 2: Emerging contaminant elements in soil-plant systems (I)	Session 3: Soil information and digital soil mapping	Society Report
Moderators	Hideaki HIRAI Heng TSAI	Dar-Yuan LEE Tomoyuki MAKINO	Budiman MINASNY Kai-Wei JUANG	Zeng-Yei HSEU Shih-Hao JIEN
14:40-14:50	Development and implement of an soil curriculum in the senior high school in Taiwan Wen-Shu HUANG	Effect of antibiotics on germination rate, root length and chlorophyll content of four different crops Hyeon-Ji CHOE	Soil characteristics in urban area under different land use : A case study of Fuchu in Tokyo, Japan Chiaki MURAKAMI	Korean Society of Soil Science and Fertilizer Jwakyung SUNG
14:50-15:00	General discussion	The distribution of gallium, indium and thallium in different type of arable soils in Taiwan Yu-Hsi LIU	Cadmium and lead concentrations in surface soils of tropical Ultisol: spatial variability in-relation to land use, soil associations and topography A. G. K. S. KODIKARA	Malaysian Society of Soil Science Rosazlin ABDULLAH
15:00-15:10		Vanadium extractability, speciation, and bioavailability in agricultural soils Cho-Yin WU	Digital soil mapping of soil fertility for Thai Jasmine Rice using remote sensing and terrain parameters employing machine learning in Thung Kula Rong-Hai region, Thailand Sasirin SRISOMKIEW	Nepalese Society of Soil Science Keshav R ADHIKARI
15:10-15:20		Efficient utilization mechanism of crop water and nutrients and regulation mode under alternate partial root-zone irrigation Fusheng LI	Digital soil mapping, assessment and contribution to digital agriculture Budiman MINASNY	Philippine Society of Soil Science and Technology Edna D. SAMAR

15:20-15:50	**Afternoon Tea and Coffee**			
Room	Socrates Hall	Locke Hall	Alexander Hall	Archimedes Hall
	Session 4: Soil Fertility and plant nutrition (I)	Session 5: Soil Ecology	Session 6: Recent advances in paddy soil science: toward establishments of sustainable rice production, environmentally-friendly managements and food safety (I)	Society Report
Moderators	Tetsuhiro WATANABE Pi-Hui CHANG	Ryusuke HATANO Hung-Yu LAI	Mizuhiko NISHIDA Yu-Min TZOU	Zeng-Yei HSEU Shih-Hao JIEN
15:50-16:00	Relationship of soil color to soil fertility parameters of major soil series grown to sugarcane C. A. E. VALLEJERA-CORSIGA	Comparison of nutrient utilization strategies of traditional shifting agriculture under different climatic and soil conditions in Zambia, Thailand, Indonesia, and Cameroon Shinya FUNAKAWA	Phylogenetically distinct methanotrophs modulate methane oxidation in rice paddies and mangrove soils Chih-Yu CHIU	Soil Science Society of Sri Lanka M.G.T.S. AMARASEKARA
16:00-16:10	Silicon availability and its relation to other properties of soils in Taiwan Yin-Chung HUANG	From Effective Microorganisms (EM) Theory to examine soil microbial ecology Lo TSUI	Involvement of microaerophilic iron-oxidizing bacteria in the iron-oxidizing process at the surface oxidized layer of flooded paddy field soil Takeshi WATANABE	Chinese Society of Soil and Fertilizer Sciences (Taiwan) Shih-Hao JIEN
16:10-16:20	Enhancement in phosphorus uptake by rhizosphere effect in soil with combined application of chemical fertilizer and cattle manure compost Masahiko KATOH	Elemental and mineralogical diversity of serpentine soils in East Asia Atsushi NAKAO	Degree of saturation, availability and dynamics of phosphorus in paddy growing Alfisols of Sri Lanka and response of rice (Oryza sativa L.) plants to added P Fertilizers R.S. DHARMAKEERTHI	Soil and Fertilizer Society of Thailand Pitayakon LIMTONG

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16:20-16:30	Introduction of FFTC's proficiency testing program of soil and plant tissue analysis Yu-Wen LIN	Evaluating soil properties of serpentine soils between island arc and mainland area in Asia Chia-Yu YANG	Investigation of the effect of inter-tillage weeding on the distribution of nitrogen-fixing microorganisms in natural farming rice paddies Jin-Feng LIN	Vietnam Society of Soil Science Minh Tien TRAN
16:30-16:40	Effect of FertiGroe®N nanofertilizer on culturable bacterial population, microbial biomass, and enzyme activities in two soil types Carlito Jr Polo BASAY	Plant growth promoting endophytic bacteria confer growth promoting effect and different metabolite profiling in host plant Ryota KATAOKA	Role of biochar and manure combination on chemical properties of paddy soil polluted by mine tailing and the effect on rice (*Oryza sativa*) production Yulnafatmawita	General discussion
16:40-16:50	Effects of irrigation of livestock wastewater on soil quality and forage agronomic traits Hsin-Jung LEE	Cutting-edge arbuscular mycorrhizal fungal technology for sustainable agriculture Masanori SAITO	Effects of different iron amendments in paddy soil on arsenic accumulation in rice plants Han-Ting HSU	
16:50-17:00	Use of urine and excreta could improve vegetable production and soil fertility in Central Nepal Sharda KC	Isolation of endophytic fungi from forest soils in Indonesia Keitaro TAWARAYA	Effect of pelletized urea biochar composite on growth and N response of rice plant D.K.R.P.L. DISSANAYAKE	

Room	Socrates Hall	Locke Hall	Alexander Hall
	Session 4: Soil Fertility and plant nutrition (I)	Session 5: Soil Ecology	Session 6: Recent advances in paddy soil science: toward establishments of sustainable rice production, environmentally-friendly managements and food safety (I)
Moderators	Tetsuhiro WATANABE Pi-Hui CHANG	Ryusuke HATANO Hung-Yu LAI	Mizuhiko NISHIDA Yu-Min TZOU
17:00-17:10	Determination of base saturation percentage in agricultural soils via portable X-ray fluorescence spectrometer Ashmita RAWAL	Characteristics of soil morphology of high mountain belt in Khuvsgul mountain region, Mongolia Saruul NARANGEREL	General discussion
18:00-21:00	Puppetry show and welcome banquet at La Marée Restaurant (Foreign participants & invited guests only)		

Tuesday Nov. 5, 2019

Room	Forum Hall			
08:00-08:30	**Registration**			
Room	Socrates Hall	Locke Hall	Alexander Hall	Archimedes Hall
	Session 7: Soil Fertility and plant nutrition (II)	Session 8: Recent advances in paddy soil science: toward establishments of sustainable rice production, environmentally-friendly managements and food safety (II)	Session 9: Soil management and climate change (I)	Session 10: Soil and water management
Moderators	Edna D. SAMAR Ya-hui CHUANG	Mizuhiko NISHIDA Shan-Li WANG	Shinya FUNAKAWA Chi-Ling CHEN	Ki-In KIM Yu-Ting LIU
08:30-08:40	Mobility characteristics of inorganic nutrients from soil fertilized with sewage sludge compost Riko SAMATA	Fertility re-evaluation of paddy soils after 50 years of the Green Revolution (FREPS 50) ~ A case study in the Philippines ~ Fukiko MASAI	Evaluation of practices for soil organic carbon sequestration to mitigate climate change in Taiwan Chi-Ling CHEN	Policy framework for soil and water conservation integrating soil erosion and ecosystem services Jae E. YANG
08:40-08:50	The effects of biochar, poultry manure and their mixture on soil properties, growth and yield of cocoyam grown on a severely degraded sandy soil of Southwestern Nigeria Michael-Taiwo AGBEDE	Effects of the Green Revolution on long-term changes of fertility status of paddy soils in tropical Asia Junta YANAI	The ultimative loss of soil: coastal and river bank erosion – the example of Camau Peninsula, Vietnam Stefan NORRA	Ammonium and nitrate contamination of shallow groundwater under vegetable fields in the downstream areas of the Huong River, Central Vietnam Morihiro MAEDA

Room	Socrates Hall	Locke Hall	Alexander Hall	Archimedes Hall
	Session 7: Soil Fertility and plant nutrition (II)	Session 8: Recent advances in paddy soil science: toward establishments of sustainable rice production, environmentally-friendly managements and food safety (II)	Session 9: Soil management and climate change (I)	Session 10: Soil and water management
Moderators	Edna D. SAMAR Ya-hui CHUANG	Mizuhiko NISHIDA Shan-Li WANG	Shinya FUNAKAWA Chi-Ling CHEN	Ki-In KIM Yu-Ting LIU
08:50-09:00	Microbial immobilization of 15N labeled ammonium and nitrate following addition of polysaccharide with different quality Qian MA	The effects of N application methods on N recovery and grain yield of dry direct-seeded rice in north-east Japan Mari NAMIKAWA	Effect of continuous application of livestock manure compost on soil carbon accumulation and GHG emissions from a rice paddy field in a cool-temperate region, Japan Fumiaki TAKAKAI	Assessment of the nitrate-N leaching in the upland soils using the undisturbed monolith gravimatric lysimeter YeJin LEE
09:10-09:10	Effects of combined organic-inorganic fertilization to rice productivity and nitrogen use efficiency Edna D. SAMAR	Digital assessment of soil physical quality in the central region of Taiwan Chien-Hui SYU	Soil spectral library for cocoasoil of Papua New Guinea Kanika SINGH	Sorption and exchange of potassium on montmorillonitic soil clay mineral Zuldadan NASPENDRA
09:10-09:20	Role of plant growth promoting bacteria Brevibacterium linens RS16 in rice (*Oryza sativa L.*) cultivars to ameliorate salt stress by accumulation of proline and glycine betaine Jeongyun CHOI	Alleviating soil compaction under rice-upland crop rotations with deep tillage leads to increased nutrient availability and rice yield in a long-term experiment Tran Ba LINH	Gross nitrogen transformation rates during shifting cultivation cycle in Northern Thailand Makoto SHIBATA	Modelling organic carbon stocks in croplands of China: the past and the future Yongqiang YU

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Moderators	Edna D. SAMAR Ya-hui CHUANG	Mizuhiko NISHIDA Shan-Li WANG	Shinya FUNAKAWA Chi-Ling CHEN	Ki-In KIM Yu-Ting LIU
09:20-09:30	Response of paddy (*Oryza sativa L.*) under spatially varying levels of soil phosphorus and potassium H. P. G. T. N. KULASINGHE	An evaluation of quantity-intensity relationship of potassium on some low land rice growing soils Kar SANJIB	Assessment of soil health using simple tools and its application Ching-Hua MA	Effects of drip fertigation on soil carbon sequestration and greenhouse gas emissions in sugarcane field Mengling NONG
09:30-09:40	Yield and N use efficiency of rice and peanut applied with different soil amendments in acid upland soil affected with periodic drought M.C.A. SALES	Impact of improving chemical properties of newly established acid sulphate soils for paddy growth Jelly-Amalia SANTRI	Distribution of soil organic carbon and its controlling factors in tropical volcanic regions Han LYU	Effect of rock fragment contents and sizes on saturated hydraulic conductivity in repacked soil columns Mina LEE
09:40-09:50	General discussion	Decomposition patterns of biochars derived from selected Satoyama biomass resources in soils Shin ABE	Early Impact Of cover crops on greenhouse gas emissions and soil microbial activities Artemio Jr MARTIN	General discussion
09:50-10:30	**Morning Tea and Coffee**			

Room	Socrates Hall	Locke Hall	Alexander Hall	Archimedes Hall
	Session 11: Soil management and climate change (II)	Session 12: Emerging contaminant elements in soil-plant systems (II)	Session 13: Soil Fertility and plant nutrition (III)	Session 14: Control, remediation and reclamation of soil degradation and soil contamination (I)
Moderators	Kye-Hoon KIM Chia-Hsing LEE	Hsi-Mei LAI Jin Hee PARK	Suphachai AMKHA Ian Auza NAVARRETE	Junta YANAI Stefan NORRA
10:30-10:40	Soil properties controlling accumulation of C from plant residue Tetsuhiro WATANABE	Assessing fate and toxicity of thallium in rice paddies and rice fish medaka Pei-Jen CHEN	Agricultural practices and soil properties controlling crop production in sandy soils under semiarid tropical climate Hitoshi SHINJO	Advanced countermeasures for cadmium and arsenic contamination in rice under recent international situation Tomoyuki MAKINO
10:40-10:50	Optimization of nitrogen fertilization to minimize yield-scaled nitrous oxide emission in maize cropping field Muhammad Ashraful ALAM	Accumulation and distribution of ECEs in domestic growth rice in Taiwan Hsi-Mei LAI	Alternative nutrient management for sugarcane plantation in the central region adopted from tailor-made fertilizer technology for sugarcane in the Northeast (SimCane), Thailand Napaporn PHANKAMOLSIL	Elution characteristics of various silica materials and their effect on the mitigation of arsenic and cadmium in rice plant Hiroshi TAKENAKA
10:50-11:00	Deposition and metal content of particulate matter on the surface of shrub and tree leaves Seon Ju KWON	Physiological and molecular characterizations of rice in response to gallium and indium Ya-Fen LIN	Production of compost by means of eradicating invasive water hyacinth (*Eichhornia crassipes*) S. R. AMARASINGHE	Evaluation of adsorptions of cadmium and chromium on the biochars pyrolized form different feedstocks Che-Yu CHIH
11:00-11:10	Interactive effects of mycorrhization, daytime and/or nighttime eCO_2 on plant performance are host-species (N_2-fixing vs. non-N_2-fixing) or cropping pattern (mono-culture vs. intercropping) dependent Xinhua HE	Mitigation of manganese toxicity using various soil amendments in chromium contaminated soils Jin Hee PARK	Selection of appropriate methods to determine soil Mn availability for low-cadmium rice cultivar Rei SAITO	Chemical speciation and solubility of soil lead and arsenic by thermal treatments Kent SONODA

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11:10-11:20	Estimation of soil carbon stock change by liming in maize cropping upland soil Song Rae CHO	Effects of thallium on growth and ultrastructure of rice seedlings Chwan-Yang HONG	Sodium selenate application in soil on growth and yield quality in lettuce Suphachai AMKHA	Effect of conservation practices using various materials of mulching in Cameron Highlands Agrosystems, Malaysia Wan Yusoff Wan ABDULLAH
11:20-11:30	Changes in paprika internal electrical conductivity affected by manganese and chromium exposure Seung Ju CHA	General discussion	Use of nano-fertilizer to minimize nutrient losses from sandy regosols H.M.I.K. HERATH	Vertical migration of Fukushima Accident–derived radiocesium-137 in orchard soils under different land use and fertilizer management Kaori MATSUKA
11:30-11:40	General discussion		Soil testing kits as an alternative to laboratory soil testing for soil pH, exchangeable K and available P in Sri Lankan soils Dinaratne-Nihal SIRISENA	Radioactive cesium uptake ability of lupin Takuro SHINANO
11:40-11:50			Effects of calcium and magnesium treatments in acid soil on cadmium absorption by rice plant Bo-Jiun YANG	Blocking the diffusion of gasoline plume in groundwater using a permeable reactive barrier making up of waste distillery sludge Cheng-Chung LIU
11:50-13:00	**Lunch**			
13:00-14:00	**Poster Session----Plato Hall (Even poster number only)**			

Room	Socrates Hall	Locke Hall	Alexander Hall	Archimedes Hall
	Session 15: Soil management and climate change (III)	Session 16: Control, remediation and reclamation of soil degradation and soil contamination (II)	Session 17: Soil Fertility and plant nutrition (IV)	Session 18: Forest soils
Moderators	Dang Van MINH Hsing-Cheng HSI	Junta YANAI Stefan NORRA	Minh Tien TRAN Chien-Hui SYU	Chih-Hsin CHENG Rosazlin ABDULLAH
14:00-14:10	Nitrous oxide emission with different type of animal manure and region in South Korea ChangOh HONG	Soil erosion accelerated by deer overgrazing or clear-cutting deteriorates phosphorus availability in forest ecosystems Nanami MURASHITA	Fractionation of phosphorus in soils with different soil types of sugarcane cropland in Okinawa, south Japan Eito NONOMURA	The aeolian additions of the Podzolic soils on the high-altitude mountains in central Taiwan Heng TSAI
14:10-14:20	Mitigation of global warming gas with bottom ash in radish-maize rotation field DoYoung HEO	Plant microbial fuel cells for soil remediation, waste valorization and fate of pollutions Chung-Yu GUAN	Saving irrigating water and fertilizer P to adapt with water scarcity and soil P enrichment in intensive rice production in the Mekong delta-Vietnam Khoi-Minh CHAU	Specific features in soil processes of the reclaimed soils in Japan Masayuki KAWAHIGASHI
14:20-14:30	Green manuring effect on net ecosystem carbon budget and global warming potential in maize field Hae Ri HAN	Anthropogenic disturbance on geopedogenetic processes at the Lower slope of Ungaran Volcano, Central Java - Indonesia Elok-Surya PRATIWI	Livestock holdings control the soil fertility of the homegardens in the Kilimanjaro highlands, Tanzania Yuri ICHINOSE	Roles of typhoon disturbances on seasonal and interannual patterns of litterfall for coniferous and broadleaf plantations in Xitou, Central Taiwan Chih-Hsin CHENG
14:30-14:40	Significant variations in arbuscular mycorrhizal fungal communities between subsoil and topsoil layers under 15-year long-term fertilizer amendments in an intensively managed arable purple soil Xinhua HE	Accumulation of chromium in cyanidiales Yen-Lin CHO	Inhibition of soil amidase activity by pyroligneous acid to control the release of soil nitrogen Joo Kyung LEE	Genesis and classification of various andic soils in the hills of central Miyagi Prefecture, northeastern Japan: evaluating the effect of volcanic ash using cryptotephra identification Sahoko ONUMA

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Moderators	Dang Van MINH Hsing-Cheng HSI	Junta YANAI Stefan NORRA	Minh Tien TRAN Chien-Hui SYU	Chih-Hsin CHENG Rosazlin ABDULLAH
14:40-14:50	Modeling sediment yield response to land use change using SWAT model in Hiso basin, Fukushima, Japan Shilei PENG	Arsenic sequestration by framboidal pyrite in naturally contaminated soils: chemical extraction, SEM and micro-XRF/XAFS investigation Yohey HASHIMOTO	Salinity effects on soil characteristics, nitrogen recovery and rice growth on two paddy soils in the Mekong Delta Duy-Minh DANG	The phosphorus accumulation and distribution in larch plantation ecosystem at different stand ages Xin CHEN
14:50-15:00	Land suitability for citrus on new sediment soils in Segara Anakan, Cilacap, Indonesia Makruf NURUDIN	Role of organic matter associated with temporal change of radiocesium forms in soil Hirofumi TSUKADA	Response of paddy rice to gypsum topdressing in soils with different level of available sulfur and soluble metals Ayano SUZUKI	Alteration of water soluble organic inorganic matters by converting of land use of tropical peat soil in Malaysia Kensuke MIZUKI
15:00-15:10	Global cropland NPP increase due to agricultural Green Revolution Pengfei HAN	General discussion	Unexpected effect of plastic film mulching: increase soil carbon stock in maize cropping land, due to higher net primary production than respired carbon loss Ho Gyeong CHAE	Soil fauna distribution on various land use type in super wet tropical rain forest West Sumatra Indonesia Herman HERMANSA
15:10-15:20	General discussion		An evaluation on the effects of humic acid and organic manures on the point of zero charge Sourav Kumar KHAN	Measures to reduce soil erosion on cassava farms in Central Highlands, Vietnam Trinh Cong TU
15:20-15:40	**Afternoon Tea and Coffee**			
Moderator	Zeng-Yei HSEU (Chairman)			Room Socrates Hall
15:40-16:00	**Closing ceremony**			

Keynote Speakers

Keynote Speech 1:
Monday, Nov. 4, 09:20-10:00
Professor **Nanthi BOLAN**
University of Newcastle, Australia
Biochar application modulates soil health and fertility: a meta-analysis

Keynote Speech 2:
Monday, Nov. 4, 10:30-11:10
Professor **Huu-Sheng LUR**
National Taiwan University, Taiwan
Development and prospect of a smart farming–based rice production system for sustainable agriculture in Taiwan

Keynote Speech 3:
Monday, Nov. 4, 11:10-11:50
Professor **Chiu-Chung YOUNG**
National Chung Hsing University, Taiwan
Soil microbial ecology and organic matter application for sustainable agriculture

Biochar application modulates soil health and fertility: a meta-analysis

N. S. Bolan[1], H. Wijesekara[2], Md.Z. Hossain[3] and Y. S Ok[4]

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[3]Global Centre for Environmental Remediation, University of Newcastle, NSW, Australia, **Md.Zahangir.Hossain@uon.edu.au**
[4]Korea Biochar Research Center & Division of Environmental Science and Ecological Engineering, Korea University, Seoul 02841, Korea, **yongsikok@korea.ac.kr**

Abstract
With increasing human population and decreasing available land for cultivation, food security is becoming a critical issue in many countries. Climate change and the decline in freshwater supply for irrigation also contribute to the lack of food security, resulting in malnutrition and human death. Food security can be achieved by increasing the yield potential of crops, and by improving the soil health and productivity. Soil health and fertility continue to decline in many parts of the world mainly because of nutrient and carbon mining, poor water management and soil erosion. Soil health, as measured by the physical, chemical, and biological characteristics of soil, determines the yield potential of many crops and other ecosystem services. Soil can act both as a source and sink for greenhouse gas emission. As a source, the microbial decomposition of soil organic matter can lead to the release of carbon-di-oxide (CO_2). As a sink, soil can be used to store carbon in the form of soil organic matter and also by improving soil health and biomass production.

Biochar, which is resistant to decomposition, is used to store carbon in soil. Biochar application also improves soil health, thereby increasing biomass production and carbon sequestration. This paper will review the literature for the influence of biochar application on soil physical, chemical, and biological fertility, and present the results of a meta-analysis of these data from publications. Statistical meta-analytical methods have been developed for quantitative analysis of research results from multiple independent experiments. They have been used successfully with ecological and environmental data, and provide advantages over narrative or qualitative reviews that lack robust statistical methods.

A treatment effect size estimator commonly employed in meta-analysis is the magnitude of an experimental treatment (i.e., with biochar application) mean, relative to the control treatment (i.e., without biochar application) mean. A typical effect size metric is the response ratio or the relative impact on a measured parameter (e.g., soil bulk density) following biochar application compared to that in control treatment without biochar application. Preliminary meta-analysis indicated that biochar application modulate many physical, chemical, and biological properties of soils, and the extent of biochar-induced changes depend on the nature and level of biochar application, and soil type. This paper will also cover a number of variables (i.e., biochar and soil properties, and climatic factors) on soil properties, thereby developing a generalised model for the utilization of biochar to enhance soil fertility and sustainability.

Keywords: Biochar; Nutrient source, Physical fertility; Chemical fertility; Biological fertility; Meta-analysis; Soil health

Development and prospect of a smart farming–based rice production system for sustainable agriculture in Taiwan

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Abstract

Cadmium has been found in rice in Taiwan since the 1980s. This cadmium accumulation in rice was caused by illegally discharged chemical factory wastewater that was further transported through irrigation canal networks into paddy fields. Hence, the cadmium-rice events led us to highly concern with soil quality and agricultural sustainability in Taiwan. The paddy soil contamination and water limitation because of climate change engendered food safety problems in agricultural production, which had a critical influence on human health. Consequently, systematic soil surveys were conducted in Taiwan to identify potentially polluted paddy fields. In addition to these surveys, a conceptual model containing irrigation water groups and pollution prevention strategies was developed for preventing rice contamination in Taiwan. Through smart farming tools, such as remote sensing for identifying soil information, and other autointelligence facilities, such as time-lapse resin capsules combined with portable X-ray fluorescence devices, a continuous monitoring and real-time bulletin systems for monitoring soil and irrigation water quality have been established in this decade. Different crop simulation models to determine soil environment quality and food safety should be studied continuously for improving smart soil management to achieve sustainable agriculture.

Keywords: Environment quality, food safety, irrigation, smart agriculture, soil information

Soil Microbial Ecology and Organic Matter Application for Sustainable Agriculture

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Abstract

Taiwan is located in the subtropical- tropical zone that range from rainy to dry weather and hot to cool temperatures, depending on altitude and latitude. The intensive farming cause many diseases and insect pests. Taiwan's average annual rainfall is 2,515 mm. The soil is congenitally degraded due to the high temperature to accelerate the decomposition of soil organic matter. The lack of organic matter in the agricultural land in higher mineralization cause the low ability to retain water and fertilizer, and soil erosion. In order to ensure the crop production, farmers use a large number of chemical fertilizers and pesticides. The problem soils such as the accumulation of chemical salts, the death of a large number of roots, and the poor crop growth the soil needs to be emphasized to strengthen long-term conservation. The development direction of sustainable agriculture needs to be promoted from the agricultural point of view to the social point of view, and strengthen the application of microorganisms and organic fertilizers to achieve the health of increasing soil microbial ecological environment.

The farm management of sustainable agriculture is to establish an agricultural production system that does not rely on a large number of chemical fertilizers and chemical pesticides. The production should save energy and reduce carbon and reduce costs, and can reduce the density of field pests and diseases, stabilize production, increase income and reduce the impact of environmental ecology. The method of agricultural production that does not rely on a large number of chemical fertilizers and pesticides is to replace some chemical fertilizers and pesticides with microbial fertilizers and microbial pesticides. It is the development opportunity of microbial fertilizers and pesticides, and it is an agricultural "biotechnology" worthy of attention. Healthy soil microbes are the gateway to sustainable agriculture. Healthy soils have healthy crops, healthy crops have healthy foods, and healthy foods have healthy humans.

Microbial Fertilizers Act have established management regulations in the Fertilizer Act of the Council of Agriculture in Taiwan. They refer to microbial products whose active ingredients are used in crop production to provide plant nutrients or promote nutrient utilization. In recent years, the development of soil microbes has the effect of promoting crop growth, competing and inducing reduction of pests and diseases, and further discovering that soil microbes can promote plant drought resistance, heat resistance, salt resistance and iron and sulfur absorption, under extreme climate change. We have established new microbial-enzymes technology to accelerate the production of organic fertilizers within 3 hours instead of 3 months composting method.

Society Reports

Archimedes Hall
Monday Nov. 04, 2019

Activities of the Soil Science Society of Bangladesh (SSSB) During 2017-2018

SSSB celebrated World Soil Day 2017and 2018 in a befitting manner. It organized different events/programs independently and also in collaboration with Public Universities, Soil Resource Development Institute (SRDI) and Food and Agricultural Organization (FAO) of the UN. A former President of SSSB Dr. Zahurul Karim presented a key note paper on 'Global and Bangladesh Soil - Present Status and Future Potential' on the World Soil Day 2017 organized by SRDI, FAO and Practical Action Bangladesh. A 'Soil Care Award' 2017 giving ceremony, first ever in Bangladesh, was held where SRDI and Practical Action Bangladesh, provided three 'Soil Care Award- 2017' in the categories of academician, scientist and farmer for their outstanding contribution on soil health improvement in Bangladesh. Among the recipients was a former SSSB President late Professor Emeritus Aminul Islam. The SSSB celebrated WSD 2017 jointly with the Department of Soil and Environmental Sciences of the University of Barisal on the theme "Caring for planet starts from the ground'. A rally with the students and teachers in the morning, poster exhibition by the students and a seminar were held. The President of the SSSB and the then Vice Chancellor Professor Dr. S. M. Imamul Huq was the chief guest. Several papers on soil contamination were presented. Awards were given to the top three posters.

On the 2018 WSD a rally for awareness building was organized jointly by the SSSB, SRDI, FAO and Practical Action Bangladesh. About more than five hundred people participated in the rally. High officials from Ministry of Agriculture, SRDI, Department of Agricultural Extension (DAE), Department of Environment (DoE), SSSB members and scientists from institutes under National Agricultural Research System (NARS), professors from different universities and representatives from different National and International Organizations and students participated actively in the rally. On the day, the final round of Soil Olympiad was held at the SRDI, jointly organized jointly by SSSB and 'Team Soil'- a forum of students studying Soil Science in different universities and colleges. SRDI, FAO and Practical Action Bangladesh sponsored this event. Out of 30finalists 03 were awarded with a crest and a certificate. A seminar jointly organized by SSSB, SRDI, FAO and sponsored by Practical Action Bangladesh on the theme of WSD 2018 "Be the Solution to Soil Pollution" was held. Honorable Secretary, Ministry of Agriculture attended the seminar as the chief guest. Three scientific papers including the key note paper titled 'Status of Soil Health in Bangladesh: Solution to Pollution' were presented in the seminar. The SSSB President and the then Vice Chancellor of Barisal University Professor Dr. S. M. Imamul Huq presented the key note paper. FAO Representative in Bangladesh and the Country Director, Practical Action Bangladesh attended as special guest and guest of honor. Like the previous year, 'Soil Care Award' was provided to SSSB members, Professor Dr. M. Jahiruddin and Dr. M. Idris Ali for their outstanding contribution on soil health improvement in Bangladesh.

SSSB Secretary General Mr. Jalal Uddin Md. Shoaib has been involved in teaching as an adjunct faculty member of the department of Soil and Environmental Sciences of Barisal University. He is also involved as the National Project Coordinator of a UNEP funded project 'Establishing National Land Use and Land Degradation Profile towards Mainstreaming Sustainable Land Management in Sector Policies (ENALULDEP/SLM)'. The SSSB Treasurer Mr. S. M. Mozammel Haque is also involved in this project as Land Degradation Specialist. Three SSSB members including SSSB Joint Secretary Mr. A. F. M. Manzurul Hoque are team members in the preparation of the Soil Atlas of Asia. Mr. Manzurul Hoque is preparing the National Soil Classification Map of Bangladesh based on World Reference Base WRB) approach. SSSB Executive member Mr. Nazmul Hasan is involved as one of the technical consultants of the BARC (Bangladesh Agriculture Research Council) funded project ' Development of Land Suitability Assessment and Crop Zoning System of Bangladesh'. During the period seven EC meetings have been held and the SSSB has published the journal- Bangladesh Journal of Soil Science regularly.

Activity summary of SSSC in 2018-2019

The Soil Science Society of China (SSSC) is a legally registered, trans-industrial, trans-departmental and non-profit mass academic group which has been affiliated to the Institute of Soil Science, Chinese Academy of Sciences. Its current council has 21 specialty/working committees, 2 working groups, 5 editorial boards and an office of secretariat dealing with routine work.

As a national level professional society, SSSC is actively engaged in domestic academic activities and international collaboration and exchanges. During June 2018 to August 2019, the SSSC has organized more than 20 academic events domestically which attracted approximately 8000 participants. The number of abstracts received exceeded 1700, among which approximately 1900 were presented on the podium. Until the end of 2019, our society will also hold tens of academic symposiums nationally. At the same time, leaders of SSSC pay a great attention to international exchanges in this field and actively organize our members to participate in international activities. Almost 300 people attended the 21st World Congress of Soil Science in Rio de Janeiro, Brazil in August 12-17, 2018. Professor Shen Renfang, the president of SSSC, led our delegation, applied and won the right to host the 23rd World Congress of Soil Science which is planned to be held in June 2026 in Nanjing. The successful bid significantly enhance China's academic status and influence, also promote rapid development of soil science and related fields. Besides, our society has organized 6 international conferences with a total of 1700 participants in the past two years.

In addition, SSSC also emphasize on organizational construction, personnel recognition and award, education training and public science. The Soil health working group was approved and the "Soil Science Society of China Measures for the Implementation and Management of Young Elite Scientists Sponsorship Program by CAST" was revised and improved in 2018. Recommended by our society, Dr. Yang Fei of Institution of Soil Science, Chinese Academy of Science won the first "Yaalon young scientist medal", Professor Shen Qirong of Nanjing Agricultural University won the honorary title of "Representative of old scientists". Journal of "Acta Pedologica Sinica" was re-elected as "Excellent International Impact Academic Journals of China" and awarded "Top 100 Journal Impact Numbers", "Pedosphere" (English version) won "The highest international influential impact academic journal of China" (Top 1% nationally), "Excellent journal award of Jiangsu province" and "Top 10 boutique journals award".

Our society has organized three education training in 2018 with more than 350 participants. On the World Soil Day of 2018, our society posted pictures which shows topic of "Be the solution to soil pollution", provided free explanation of soil science knowledge and publicized booklet of "Healthy soil brings healthy life" to the public. SSSC also hosted the first national Soil remediation conference and 2018 World Soil Day China event on "Soil pollution prevention". A total of 1,800 people from hundreds of research institutes, universities and related companies participated, including more than 10 academicians of the Chinese Academy of Sciences and the Chinese Academy of Engineering.

COUNTRY REPORT OF
THE INDONESIAN SOIL SCIENCES SOCIETY (ISSS)

By:
Budi Mulyanto
The President of The Indonesian Soil Sciences Society (ISSS)
2019-2023

1. INTRODUCTION

We compile this report based on the implementation of programs and activities carried out by the The Indonesian Soil Science Society (ISSS) Central Board for the 2017-2019 Period. In carrying out activities, we always refer to the program, ISSS Statutes and by laws, Recommendations, Formulations of the XI ISSS National Congress in Malang and the recent development of soil science.

ISSS is a professional organization that houses experts who work in fields related to the dimensions and values of soil science. Therefore, its role has become real and is needed to deal with various issues related to land and land issues which are increasingly in number, distribution and intensity.

Life challenges related to land resources are increasing now as indicated by the increasing intensity and distribution of forest and land fires in the current dry season, climate change and greenhouse gas emissions, floods and landslides during the rainy season, thunder-storms in the transition season, etc. All of which lead to associated problems such as crop failure, vulnerability to food and energy security, disease outbreaks, damage to infrastructures etc. All of these challenges are aligned with life's challenges throughout the world. Therefore, it is very relevant that the United Nations has launched Sustainable Development Goals (SDGs).

In this connection, ISSS always strives to build commitment and strive at every opportunity to achieve SDGs, especially those related to Soil Science. Following are some achievements and activities carried out by ISSS in 2017-2019.

2. SOME ACHIEVEMENT AND ACTIVITIES

2.1. SOME CONVENTION

a) Definition of land in a set of soil sciences is land in the broad sense which includes the understanding of soil and land. The ISSS is a group of professionals who are experts in fields related to land in a broad sense which includes the relationship of land with natural resources for the sustainability of life.

b) The relationships between land and other resources are very close, so is the relationship between land and life. Therefore land is the key to the sustainability of life. Competencies of the soil science profession include sciences of land, water, flora, fauna, atmosphere, and humans, and their interrelations in the dimensions of space and time as set in the environmental system. Based on these considerations, the theme of the XII ISSS Congress was *Land Resources Management And Agriculture Innovation Toward Sustainable Environment And Food Security.*

c) This theme is based on the number of important issues both nationally and internationally on land related to the people of Indonesia such as:
- Synergy of Technology Innovation and Fertilizer Policy in Indonesia,
- Sustainable Management of Palm Plantation Oil
- Agrarian Reform for Increasing Land Productivity and Prosperity

These problems ere rooted in the management of the use and control of land resources that have not fully followed the rules of soil science that form the basis of professionalism in land management.

d. In connection with that, the ISSS XII Congress confirms the following matters:
- Food sovereignty must be implemented by developing national agriculture based on the nation's resources. Achievement of food sovereignty is done by increasing productivity and expansion of agricultural areas that are harmonized with the protection, prevention of degradation and improving the sustainability of land. Sustainable Food Agriculture Land must be maintained and included in the Regional Spatial Plan (RTRW) of each Regency / City on the basis of the carrying capacity of the existing land.
- Development of estate crops oriented to the production of renewable energy materials from various types of plants must be strengthened to develop environmentally friendly renewable energy sources.
- To anticipate the growing need for water for life, and in order not to experience a water crisis in the future, groundwater-based water management innovation must be developed that is oriented towards changing people's behavior towards efficient water use.
- Sustainability of the environment for life must be maintained, so development must consider land-supporting capacity by prioritizing the sustainability of land resource productivity.
- To achieve this, the management of all land resources and other natural resources must be optimized taking into account the balance sheet of land use and control based on national consensus placed into the Regional Spatial Planning (RTRW) system.

2.2. WORK PROGRAM

Based on the 2017-2019 ISSS work program, the ISSS activities are grouped into 3 programs, namely:

a. Development and Implementation of Soil Sciences.
b. Encouragement of Member Participation.
c. Institutional Development.

Each program has been implemented as follows.

2.2.1. DEVELOPMENT AND IMPLEMENTATION OF SOIL SCIENCES

This program is carried out through activities driven by divisions and commissions within ISSS and is carried out through seminars, workshops, special meetings, and meetings with other government and private agencies. The results that have been achieved are as follows:

a) Formulate soil technologies by utilizing various soil ameliorants that are needed to improve soil quality on problem soils. With these technologies, the intensity of land use and land utilization will increase with always considering the preservation of the soil functions as a pillar of life support systems.

b) Formulate a policy of sustainable use of peat-lands through the application of water regulation technology and selection of adaptive plant species. Utilization of peat-lands for cultivation and conservation needs to be done in a balanced manner by considering economic, socio-cultural, and nature preservation functions in the same time maintaining low greenhouse gas emissions.

c) Providing enlightenment to members of the Indonesian Parliament especially Commission IV in charge of Agriculture and Forestry regarding the characteristics of peat soils, peat subsidence, fire, greenhouse gas emissions, as well as the use and preservation of peat-lands.

d) Actively participation in formulating development policies relating to natural resources, especially natural resources that related to land (land policy), including in the drafting of legislation such as the Law on Spatial Planning, Government Regulations on National Spatial Planning, Land Difficulties, Sustainable Agriculture Land Laws, Laws on Peat-land Management, etc.

e) Play an active role in assisting the stakeholders of the government and the private sector in formulating and setting land use and utilization in accordance with the principles of soil science and of sustainable management.

f) ISSS encourages and assists some universities all over Indonesia in terms of accreditation of the Soil Science Study Program.

2.2.2. ENCOURAGEMENT OF MEMBER PARTICIPATION.

The activities that foster the participation of members are carried out in various Regional Commissaries which include various activities as follows:

a) Organizing symposiums, seminars, workshops and colloquia for the exchange (sharing) of knowledge and experience in the development and application of soil sciences in the National seminar. During the 2015-2019 ISSS management period, ISSS had conducted many National Meetings relating to various solutions to the problems of soils.

- National Seminar "The Landformation 2018" with the theme "Spatial Coalition, Land Engineering and Environmental Management to Achieve Sustainable Agriculture" which was held on 7-10 September 2018 at the UNPAD Campus, Bandung. In this Seminar activity, the composition of the management of the Central ISSS and West Java ISSS Regional Commissariat has just been formed.

- National Seminar and Inauguration of East Java ISSS Regional Commissariat on November 16, 2018.

- Review of ISSS Work Agenda Meeting 2017-2019 on July 20, 2018 at the Soil Museum, Jl Ir. H. Juanda No 98 Bogor. The agenda of the meeting is as follows: Discussion of the Soil Science Study Program (SSSP), ISSS suggestions/input for the Construction of the Soil Museum.

- Journal and News Letter of ISSS, Member Card Progress completion, Election and Inauguration of the Bogor-Jakarta ISSS Regional Commissariat in Bogor

- National Seminar with the theme: End-Year Reflections on Wetlands Management

Policies in Indonesia. In the context of "World Soil Day" on 7 December 2018 at the Bogor Soil Museum Building.

- In addition to the seminars conducted above, the Bengkulu Regional Commission, Lampung Regional Commission, and the NTB Regional Commission, the Papua Regional Commission, the West Kalimantan Regional Commission and the Southeast Sulawesi Regional Commission also conducted a National Seminar which was held in conjunction with the inauguration of the formation of each Regional Commission by the ISSS Central Board.

b). Participation in the International Seminar and Meeting

- ISSS participated in ESAFS in 2017. The 13th ESAFS conference was held on 12-15 December 2017 in Pattaya, Thailand. As many as 30 participants from Indonesia attended the conference.

- ISSS Attended the G20-Meeting of Agricultural Chief Scientist Forum (G20 MACS) in Japan on April 25-26, 2019 represented by Dr. Husnain with the Minister of Agriculture.

2.2.3. INSTITUTIONAL DEVELOPMENT

Considering the Republic of Indonesia is a fairly large archipelagic country, consisting of more than 17000 islands, and administratively divided into 34 provinces, ISSS institutional development is very important and strategic. For this reason, the development and activation of the ISSS Regional Commissariat in various provinces are very important. To date there are 22 ISSS Regional Commissariats throughout the Republic of Indonesia. Some activities are as follows:

a) In 2017-2019, the Central ISSS Board of Management confirmed the management of ISSS Regional Commissariats update of East Java, West Java, Bogor & Jakarta, Bengkulu, Lampung, West Nusa Tenggara, West Kalimantan, Papua and formation of ISSS Regional Commissariat of Southeast Sulawesi.

b) In line with the development of the scope of ISSS, it has revised Statute and has been discussed in the pre-ISSS congress on August 4, 2019.

c) Building a ISSS Website www.hiti.or.id and Whatsapp Group ISSS which has been used as a medium for information and communication among ISSS members and other stakeholders.

d) Conducting meetings in the framework of curriculum development discussion and the establishment of the Soil Science Study Program Communication Forum (APSITI), Up to now there are 20 Soil Science Study Program set in some Universities, spread over Indonesia, therefore the development of Soil Science education could be intensively conducted in Indonesia that relevant with the challenges of every region.

e) Publish the ISSS Issue 1 newsletter, Volume 1, which contains a variety of unique facts, expert opinions, upcoming events, the latest news and issues, world soil day, and all of the regional commissions.

f) Membership card printing, especially for members who have sent data.

g) Organizing the International Seminar and the XII ISSS National Congress in Bandung on 5-7 August 2019 based on the mandate of the XI ISSS National Congress in Malang.

h) Along with the XII National Congress and International Seminar, Symposia Fertilizers and Fertility Policies, Symposia Sustainable Management of Palm Plantation Oil, and Symposia Agrarian Reform to Improve People Prosperity.

3. CLOSING

The ISSS is a professional organization that houses experts who work in fields related to the dimensions and values of soil science. The ISSS has 22 Regional Commissariats spread over the Indonesian Archipelago.

There has been many activities carried out by ISSS includes Development and Implementation of Soil Sciences, Encouragement of Member Participation, Institutional Development.

Related to soil science education development there are 20 Soil Science Study Program set in some Universities, spread over Indonesia, therefore the development of Soil Science education could be intensively. In the framework of curriculum development discussion and the implementation of education development and cooperation the Soil Science Study Program Communication Forum (APSITI) was established.

We hope this report useful for sharing in the ESAFS 2019 Meeting.

Activities and recent progress of Japanese Society of Soil Science and Plant Nutrition

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Abstract

Japanese Society of Soil Science and Plant Nutrition (JSSSPN) was established in 1927. The number of the members of JSSSPN is about 2100 in 2019. JSSSPN has published "Japanese Journal of Soil Science and Plant Nutrition (JJSSPN)" in Japanese since 1934, and also "Soil Science and Plant Nutrition (SSPN)" in English since 1955. SSPN is one of the partner journals of International Union of Soil Science (IUSS) (**https://www.tandfonline.com/loi/tssp20**). JSSSPN holds the annual meeting in August or September. Around 500 papers are presented every year. Around 1000 people participate and discuss for the scientific progresses in soil science and plant nutrition. In each annual meeting, we celebrate the members awarded JSSSPN Award, JSSSPN Technical Award, Young Scientist Award, Technical Promotion Award, Best Paper Award for JJSSPN and Best Paper Award for SSPN. As for education of soil science and plant nutrition, we invite high school students for poster presentation, and award the Best Poster Award.

We sometimes invite special guest in the annual meeting to hear the worldwide progress of soil science and plant nutrition. In 2019, Prof. Rattan Lal, the former-president of IUSS, was awarded 35th Japan Prize, so we invited him to give a special lecture to general citizens at the annual meeting held in Shizuoka city, on 4 September 2019. The title of his lecture was "Managing Soils for a Negative Feedback to Global Carbon Cycle and a Positive Impact on Food and Nutritional Security". Also, Prof. Takashi Kosaki, the president of IUSS (2019-2020) and a member of JSSSPN, gave us the special lecture entitled "Prof. R. Lal was awarded the 35th Japan Prize - What should domestic and international soil science and plant nutrition communities do now?". Those lectures let us aware that soil science and plant nutrition should be in the wide range contribution to the society. We will positively conduct this kind of work as an outreach activity in "International Decade of Soils 2015-2024" (**https://www.21wcss.org/index.php**).

JSSSPN has six branches from northern to southern Japan of Hokkaido, Tohoku, Kanto, Chubu, Kansai and Kyushu/Okinawa. Japan is in wide range of climate zones from sub boreal to sub tropical and each region is characterized by fresh parent materials such as volcanic tephra or ejecta or eroded or deposited materials in various landscapes from mountain terrain to alluvial plains. Since the soil classification system in Japan was newly developed in 2017, we have written a book "Soils of Japan" for the publication in a book series of "Soil" of Springer. Total 178 members of JSSSPN contributed to writing the book. "Soils of Japan" consists of 9 chapters including overview, Japanese soil classification system, Japanese soil characteristics, and regional land use and good soil management practices in six regions. The book will be published at early 2020.

However, there is a big issue to be addressed: the decrease of the members of JSSPN, especially full members. Total number of members decreased from 2,814 (2,096 full members) in April 2010 to 2,111 (1,609 full members) in April 2019. On the other hand, number of annual citation of SSPN increased from 1,488 at the end of 2009 to 3,023 at the end of 2018. This phenomenon indicates that the internationalization of the society does not always directly lead to the increase of the motivation to study soil science and plant nutrition. We need to increase our activities to gain more recognition on our scientific outcomes and contribution to the society through the outcomes, especially for the 100th Anniversary Celebration of JSSSPN in 2027.

***Key words*: Japanese Society of Soil Science and Plant Nutrition, Soils of Japan, SSPN, IUSS**.

Country Report of the Korean Society of Soil Science and Fertilizer

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Abstract

The Korean Society of Soil Science and Fertilizer (KSSSF) was founded in 1968 with 127 founding members, and has intensively contributed to develop the academy and distribute useful technologies for farmers, public and private sectors. The Journal of KSSSF publishes several types of articles: original research articles, reviews, and short communications, and has consistently published landmark papers in soil science and plant nutrition. The journal of KSSSF published bimonthly 78 articles in 2017, since 2018, has been published quarterly, and published 77 and 21 articles in 2018 and 2019, respectively.

Besides publication of research papers, with great efforts, the KSSSF successfully held 20th WCSS (World Congress of Soil Science) in 2014. On the basis of an experience of international meeting, our society has been organizing domestic and international symposiums which are closely related with member's interest and are able to elevate the status of our society.

We briefly introduce domestic and international meetings organized by the KSSSF for last two years (2018~2019), and upcoming event (2020). In 2018, we held two annual meetings (spring and fall). The 1st meeting was held in Rural Development Administration (RDA) on 17 to 18, May with a theme "Agri-Environment Conservation of Korean Peninsular", and, in order to commemorate the 50th anniversary of the KSSSF, the 2nd meeting was held as an international academic symposium with a theme "Soil Health-Challenges and Opportunities" delivered by invited speakers from 10 nations (Korea, USA, Japan, China, Taiwan, UK, Italy, Australia, Canada, Denmark) in The K hotel located in Gyeongju, Gyeongsangnam-do, on 25 to 26, Oct. In 2019, with co-organization with RDA and The University of Seoul, we held an international symposium, SUITMA 10 (Soils of Urban, Industrial, Traffic, Mining and Military Areas), with a theme "SUITMA +20" including 13 subtopics addressed by plenary and invited speakers from more than 20 countries including Korea, USA and EU in The University of Seoul on 16 to 21, June. Our society decided to hold two annual meetings together from 2019, and held in Gyeongsang National University on 21-23, Aus. This meeting was also implemented as an international symposium with support by East-Asia Nitrogen Committee and RDA with a theme "Nitrogen Cycling and Its Environmental Impacts in East Asia" delivered by invited speakers from Korea, Japan, China, Australia and Panama. The KSSSF has a plan to organize an international symposium entitled "4th Global Soil Security: Beyond the Soil to Action Plans (www.globalsoilsecurity2020.org)" in Lotte World Tower, Seoul from 31, May to 4, June, 2020.

The KSSSF has also worked "Soil Judging Contest for Undergraduates" to raise young soil scientists leading future soil science since 2015 with making a motive "World Soil Judging Contest" held during the 20th WCSS, 2014, in Jeju, Republic of Korea. The contest is growing up with a big response from attendee and soil scientists, and this year (5th contest) competed 14 teams (52 undergraduates) from research institute and university.

The KSSSF welcomes all of you not only to submit your high-quality research results, but also to attend many events including academic symposium organized by our society.

Malaysian Society of Soil Science: Country Report

Malaysian Society of Soil Science (MSSS), a non-governmental organization (NGO) in Malaysia, was established to promote the study of soil science, specifically within context of agriculture and to champion environmental stewardship. Inaugurated on April 2, 1971 with 26 founding members, the society has grown into a full-fledged professional entity, having a membership of over 600. Members of the society include professionals working in both the public and private sectors, within and outside Malaysia. This year, 2019, MSSS celebrates its 48th year as a professional body representing the interest and aspirations of the soil scientists in Malaysia. The objectives of the society are to promote the study of soil science and to create public awareness on the importance of soil conservation within the context of sustainable land management, to review areas of soil study relevant for national development, and to disburse small grants to needy students and to members attending scientific meetings related to soil. The International Union of Soil Sciences (IUSS) has identified the key roles played by soils in addressing the major resource, environmental, health and social problems which humanity is currently facing. MSSS, as part of the global soil scientist network, is committed to actively support IUSS initiatives and is working towards increasing public awareness on soil matters in Malaysia. The society actively organizes activities to promote science and technology advancement in the area of soil research, to reach out to the public through conference, workshop, public talk, soil familiarization tour, fun run, community engagement programs, soil education programs, and participates in Malaysia International Agriculture Technology Exhibition. Every year, MSSS celebrates the World Soil Day on 5th December, with the aim of raising public awareness on the importance of soil as part of the ecosystem and food security with emphasis on the importance of soil for the well-being of humanity. MSSS, in collaboration with the Department of Agriculture of Malaysia, is actively involved in Asian Soil Partnership coordinating pillar's reporting to FAO. MSSS is also affiliated to Malaysian Professional Centre which serve as the umbrella body for all professional bodies from different fields and provides a platform for exchange of information and ideas between different professions in helping the development agenda of Malaysia. The society future activity is to provide thesis award to recognise outstanding post graduate student majoring in soil science and soil-related disciplines. With regard to publication, Malaysian Journal of Soil Science (MJSS) continues to be the main scientific and technical knowledge dissemination platform, with issues indexed under Scopus. The society produces three Newsletters annually to update members on the activities of the society as well as promotional platform for the society which is available on both MSSS and IUSS website. The society is currently actively involved in the organization of its annual Soil Conference of Malaysia which will be held on 7-8 April 2020 in Johor Bahru, Malaysia.

Soil is Life. A nation that destroys its soil destroys itself.

Malaysian Society of Soil Science

Nepalese Society of Soil Science: Activities and Progress

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Abstract

The Nepalese Society of Soil Science (NSSS) was established in 1991 with the aim of institutionalization of research and publication efforts in order to advance the knowledge of soil science in the country. The society currently performs under two patrons, two advisors, and nine members in the executive committee chaired by Professor Dr. Keshav Raj Adhikari. With increased activities and campaign, NSSS has increased the membership from less than thirty to over 100 in the last five years. The society revised its bylaws last year and held general committee meetings regularly. Recognizing the global challenges of soil degradation and reduced attraction towards Soil Science, NSSS has made a number of initiatives to increase awareness about soil and execute policies that are relevant and important in national as well as regional contexts.

In the last two years, the society involved post-graduate soil science students in excursion visits, classify soils making profiles in relation to best utilization and organize quiz-contest events while celebrating World Soil Day each year. We organized these events in collaboration with: i) Soil Management Directorate of Ministry of Agriculture and Development and ii) Soil Science Division of National Agricultural Research Council under Ministry of Agriculture and Development. Besides, a number of talk programs were also arranged from the soil scientists visiting from USA, Australia and professionals from other institutions of Nepal. Last year, representatives from diverse institutions (developmental, research and extension fields) joined to celebrate Soil Science Day in Kathmandu where participants also made paper presentations which included areas of organic farming, climate change, promotion of bio-fertilizers, soil pollution, application of biochar, and so on. The society also worked with National level Farmers Commission to help them framing eco-friendly sustainable soil development policies.

NSSS is also actively working in association with FAO and Asian Soil Partnership (ASP) programs of different pillars for advancing soils technologies, and soils education. For this, we also joined the 3rd ASP meeting in Bangkok back in 2016. Our team works for promoting sustainable soil management in Nepal and to identify appropriate technologies for protection and utilization of soil.

In this year, NSSS co-organized two International conferences in Kathmandu. The first was on May 27-28, in which the delegates discussed on "Food Security through agriculture and allied sciences." It was followed by another conference in June 16-18, in Tribhuvan University Kathmandu which was on "Global Initiative in Agriculture and Applied Sciences for Eco-friendly Environment (GIASE-2019). Several Indian Academic Institutions such as ATDS (Gajiabad), NGT (Jammu), and AAETDS (Uttarakhand) participated actively. These conferences identified some key areas of research on collaboration in the region. They covered a wide range of subjects including irrigation management; advances made in the field of biotechnology, innovations on disease and insect control, horticulture, and policies on economics of agricultural development. In the last year (Aug. 2018), the president of NSSS attended the World Congress of Soil Science to present the paper on increasing role of GIS and RS in the field of Agriculture taking a case study of Nepal.

While NSSS is making progress with time, it is still far from target of maximizing the membership count in the society, and to help government especially for effective penetration of soil science education into the elementary level school education system in the country. This effort will certainly be successful while working with ESAFS.

***Key words*: Nepalese Society of Soil Science, soil education, food security, society membership**

Country Report: Philippine Society of Soil Science and Technology

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Abstract
The Philippine Society of Soil Science and Technology, Inc. (PSSST) conducted its 22nd Annual Meeting and Scientific Conference at Baguio City, Philippines on May 6-9, 2019. Attended by 169 professional members and students, the theme of the scientific conference is “Conserving Soil Biodiversity Towards Sustained Ecosystem Services”. The Conference covered two plenary sessions, 13 technical papers for oral presentation under the Senior Category and nine (9) under the Junior Category, plus 18 papers under the Poster Category. During its Annual meeting, the PSSST was declared an Accredited Service Provider for Continuing Professional Development (CPD) by the CPD Council for Agriculture of the Philippine Regulatory Commission.

With dwindling enrollment and graduates in Soil Science, PSSST is pursuing Career Orientation Program to encourage 2nd year students to take up Bachelor of Science in Agriculture (BSA) to major in soil science. The orientation highlights the essential role of soil resources to human life and the ecosystem services. For SY 2018-2019, two universities were visited. Additionally, PSSST provides a Thesis Grant financial support to Bachelor of Science in Agriculture (BSA) students majoring in soil science after evaluation of submitted thesis proposals anchored on the PSSST’s Research and Development priorities. For SY 2018-2019, PSSST approved four soils major students from three state colleges and universities.

The PSSST joined the BSWM in the Philippine celebration of the World Soils Day on December 5, 2018. The celebration highlighted the pledge of commitment for the partnership of PSSST and other institutions towards Philippine Soil Partnership for the promotion and advocacy towards Sustainable Soil Management.

The PSSST in partnership with BSWM participated in the 21st World Congress of Soil Science (WCSS) held August 12-17, 2018 at Rio de Janeiro, Brazil, with technical paper entitled “Soil Microbial Community Assessment of Highland Vegetable Production Systems in La Trinidad, Benguet, Philippines” qualified for presentation under the poster session “Soil Microbiological Processes and Nutrient Cycling under Crop Rotation”.

Keywords: *Philippines, country report, soil science society*

Soil Science Society of Sri Lanka

Amarasekara, M.G.T.S., President - Soil Science Society of Sri Lanka

Introduction

Soil Science Society of Sri Lanka (SSSSL) which was established in 1969 marks its 50th anniversary in 2019. The founder president of the society was Dr. A.W.R. Joachim who is referred to as the Father of Soil Science in Sri Lanka. At present SSSSL has more than 350 life members who are affiliated with the academia and other government and private sector organizations. The vision of the SSSSL is to provide scientific knowledge, new technologies, and promote beneficial management practices to sustain the Sri Lankan soil resource for the provision of food, income and a quality environment for the nation. Mission of the society is to foster the wise use and stewardship of soil, water and other land resources by integrating diverse disciplines and principles of soil science with excellence in the acquisition and application of knowledge, the training and professional development of Soil Scientists, and the education and communication to a diverse citizenry.

Achievements of the society during past 50 years

- Soil Science Society of Sri Lanka successfully hosted the 10th International Conference of the East and South East Asia Federation of Soil Science Societies (ESAFS) from 10-13 October, 2011. The theme of the ESAFS10 was "Soil, a Precious Natural Resource: Agricultural Ecosystems, Environmental Health & Climate Change".

- The Soil Science of Sri Lanka (SSSSL) and the Canadian Society of Soil Science (CSSS) successfully completed a collaborative Project (SRICANSOL project) to update information on soils of Sri Lanka. The SRICANSOL project proceeded in three phases, beginning with soils in the wet zone, moving to the transitional, intermediate zone and finally to the dry zone. The new updated classification has already begun to enhance and facilitate the application and transfer of new technologies for land management of the county.

- The SRICANSOL project work was awarded the second and third prize of the National Award for Excellence in Agricultural Research by the Sri Lankan Ministry of Agriculture on 2004 and 2011.#

Upcoming Events

September 2019 - Midterm technical session and field trip of the society

December 2019 - Fertilizer day event and the Symposium to celebrate 50th anniversary of the SSSSL.

March 2020 - Annual General Meeting

Society report
The Chinese Society of Soil and Fertilizer Sciences (Taiwan)

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The Chinese society of Soil and Fertilizer Sciences (CSSFS) was founded in 1984, which member number is currently about 310 including professors and postgraduate students at university, governmental officers and researchers, and industrial technicians. The annual meeting of CSSFS will be held in December of the year, which program includes 7-10 oral presentations by invited speakers and about 30-40 voluntary poster presentations. During the annual meeting, prizes of CSSFS include Society Award, Research/Extending Paper Award, Poster Presentation Award, Shuang-Guai Soil Science Award, and Scholarship of Prof. Guo, Kuai-Shih. Additionally, Newsletter of Soil and Fertilizer is irregularly published every year. Monographs have been published for technique transfer to farmers in soil management and fertilizer knowledge, such as bio-fertilizer and organic farming. Three workshops and two conferences were organized for the research need and application of soil and fertilizer by the CSSFS every year. Additionally, our society organized summer training of soil survey for graduate student and undergraduate student every year from 2015, because the CSSFS plays a crucial medium for soil education, interaction among members particularly for students, and sharing experiences in soil science. Our society also organized the cross-strait conference of soil and fertilizer every two years, and we just finished the 12th cross-strait conference of soil and fertilizer in 2018 in Taiwan. The CSSFS became IUSS member since 1998 and member of East and South Asia Federation of Soil Science Societies (ESAFS) since 1990. The CSSFS is facing a cross-road, because of major reasons as below: the number of active member is decreasing, there are about 20 soil scientists at universities but much lower than before, and most postgraduate students shifted their interest to find their jobs on soil pollution prevention, soil remediation, soil analysis or monitoring of pollutants from last decade in Taiwan. However, the CSSFS continues to serve for society in soil science and plant nutrition in support global environmental sustainability and food safety.

Country Report: Soil and Fertilizer Society of Thailand

Pitayakon Limtong, President of SFST
Soil and Fertilizer Society of Thailand

The Soil and Fertilizer Society of Thailand (SFST) has been established since 1981 with the main objective is a core agency of multi-stakeholders in soil and fertilizer technology in both national and international level. SFST is focusing on providing technical information and knowledge about soil and fertilizer, including disseminate, support and encourage such knowledge to policy makers, executive and academic persons and land users to use the land correctly according to academic principles and to achieve sustainability. Currently, the members of SFST are consisting of technical and researchers from the government and private sectors, lecturers and students in university and fertilizer companies including land users. The SFST mandate is to carry out annually seminar and workshop to promote and disseminate academic knowledge 2 times a year. Moreover SFST has organized and supported national conference of soil and fertilizer in every 2 years since 2008. Due to the UN's stipulation established the 5th December 5 in 2015 as the World Soil Day. Therefore, SFST has held the more importance activity in celebration event of World Soil Day since the beginning to disseminate knowledge and awareness raising in the soil resource on annual basis by cooperating with Department of Land Development (LDD) and Kasetsart University (KU) as well as supporting activities to disseminate the main theme specified by the Food and Agriculture Organization (FAO) each year which this year is defined as Stop soil erosion, Save our future. In the matter of Asia Soil Partnership (ASP), SFST has also worked and communicated closely with GSP/ASP-FAO project together with LDD, which SFST acts as national focal point. And the achievement is SFST and LDD organized workshop and training on the preparation of the Soil Organic Carbon Mapping under the GSP framework. Another important event that SFST organized the 13 th International Conference of the East and Southeast Asia Federation of Soil Science Societies (ESAFS 2017) on December 2017. In addition, the SFST encourage and promote the 6th National Conference of Soil and Fertilizer is held every 2 years for the last time in July 2019, Kasetsart University is the main organizer and theme is Soils: where nutrition starts for health and environment. For knowledge distribution, SFST establish national journals of soil and fertilizer 2 volumes per year and will lunch into an e-journal in the near future.

Current Activity and Development of Soil Science in Vietnam

(Dec 2017 – Sept 2019)

Dr. Tran Minh Tien

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1. Fact of Vietnam Society of Soil Science (VSSS)

- Date of foundation: June 8th, 1991
- The past president **Dr. Tran Khai** (since 1991-2011)
- President of the 5 th (2011-2016) and 6th term (2016-2021): Prof. **Dr Vu Nang Dzung**
- Office address: 61 Hang Chuoi, Hanoi, Vietnam
- Tel: 84 4 3 821 0374; Fax: 84 4 3 9724757; Email: hoikhoahocdatvn@yahoo.com
- The membership of the Society up to Sept 1st, 2019 is 720 including 35 branches and centers at different institution and locations in Vietnam.
- President, board executive is elective by the General Assembly for 5 years term.

2. Organization and Activities

VSSS have four divisions for covering its activities

1) Information and publication including Vietnam Journal of Soil Sciences
2) International collaboration
3) Development of Soil Sciences and Technology
4) Award and Administrative Assistance

3. Current development

- The main activities of VSSS in the past two years are to organize the workshops to collect information from VSSS members which contributed to establish new policies in land, soil, water and fertilizer management in Vietnam (organized two workshops annually).
- Participating in teaching at graduate and postgraduate's level, especially taking part in the different committees of PhD. defense and nomination of the professors.
- The journal "Vietnam soil science" was published quarterly. This journal is of high academic level in the field of soil science of Vietnam. The VSSS also publishes books, handbooks, special reports, textbook and proceedings to disseminate the knowledge and experiences of local experts.
- Hundreds projects and scientific themes have been established and conducted in this period by the VSSS members, are soil fertility limitations and plant nutrition, improvement of problematic soils and rational utilization, land degradation assessment for the whole country and agro-economical zones, provinces, land use planning adapting to the climate change, formulation of soil resources information.
- Different themes of soil science should be focused in Vietnam in near future: Soil information; soils and community health; soil nutrition cycle and plant growth and development; soil degradation and restoration; soil resources and climate change; and soil borne diseases.

Oral sessions

Demonstration Functions, Specific Characteristics and High Impression of Soil Museums of the World

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Abstract
Some countries have developed the national or regional soil museums to extent the soil science education to the students of primary school, high school and general people including farmers, scientists and policy makers in last two decades, especially in the European countries and Asian countries. This reports included the national soil museums of Brazil, China, France, Japan, Korea, New Zealand, Netherlands, Philippines, Russia, Thailand, Taiwan, United States of America, and Vietnam. The authors have visited the National soil museum and collected the pictures, introduction, demonstration types, functions and specific characteristics on different sizes of soil monoliths and posters during they attended the different international conferences or workshops since 1986.
The demonstration functions of old soil museums almost focus on soil morphological characteristics, soil characters and limitation for crop production, soil classification taxa and their distribution, and soil management of major soil groups of the regions or whole country created in 1995 to 2010. But the demonstration functions of new created soil museum almost change to focus on the effects of human activity, urban development and climate changes on the soil quality, food safety and human health, and also focus on the soil science education on how to protect soil resources, environmental quality and ecosystem, and biodiversity conservation in last decade of 2010 to 2019.
The specific characteristics and highly impressions of the soil museums of the world should be Dokuchaev Central Soil Museum of Russia and World Soil Museum of Netherlands. The specific characters of these two soil museum are whole building for different soil education types including elementary school and high school student's interaction activities, academic workshop, information and digital soil mapping system now. The other more important functions is focus on the biodiversity and ecosystem conservation of the soil museums of New Zealand at Waikato University, United States of America, and World soil museum of ISRIC at Wageningen University. The very high impressions soil museums of Taiwan Agricultural Research Institute (TARI) located at Central Taiwan are many extra big size of soil monoliths (3 m width by 2 m depth and 30 cm thick) and very thin and big (3 mm thick by 3 m width by 2 m depth) soil monoliths which are very difficult to be sampled from field and prepared in the laboratory.

***Key words*:** National soil museum, demonstration functions, specific characters, high impressions of soil museums, environmental quality, ecosystem and biodiversity conservation

Reference website of the national or regional soil museum of the world.

1. Taiwan: National Taiwan University; http://Lab.ac.ntu.edu.tw/soilsc/
2. Taiwan: Taiwan Agricultural Research Institute (TARI) https://www.tari.gov.tw/sub/links/index.asp?Parser=11,27,279
3. China: (1). Institute of Soil Science, Chinese Academy of Sciences, Nanjing. http://www.issas.cas.cn/kxcb/kptp/. (2). Guangdong Museum of Soil Science, http://www.soil.gd.cn/channel.action?chnlid=3813
4. Japan: National Institute for Environmental Studies. http://www.nies.go.jp/rslist/index_e.html
5. USA, Tacoma, Washington, USA. https://www.pugetsound.edu/academics/academic-resources/collins-memorial-library/about-collins/artwork-exhibits-in-the-library/dirt/
6. Netherlands: World Soil Museum of International Soil Resources and Information Center (ISRIC). https://www.isric.org/
7. Brazil: Solos de Minas; http://www.fao.org/fileadmin/user_upload/soils-2015/events-doc/Invitation%20Exhibition_%20Solos%20de%20Minas_FAO.pdf
8. Russia: Dokuchaev Central Soil Museum. http://www.saint-petersburg.com/museums/museum-of-soil-science/

Soil Education in the Philippines for Pre-Elementary and Elementary School Children

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Abstract
The implementation of the Republic Act 10533 or the Enhanced Basic Education Act of 2013 saw a massive change in the educational landscape of the Philippines. The K to 12 Basic Education Curriculum had been designed following the spiral progression approach. It is relevant, responsive and contextualized. In the pre-elementary and elementary grades, learning standards for soil education had been incorporated in various learning areas. In kindergarten, there are no learning competencies that directly addresses soil education. The closest concepts for soil education are found in the Physical and Natural Environment Domain and discuss plant habitats, needs of plants, and taking care of the environment. In the elementary grades, soil concepts are found in the learning areas of Science and "Edukasyong Pantahanan at Pangkabuhayan" (Technology and Livelihood Education or TLE). Particularly for Science, concepts directly and indirectly related to soil appear in Grades 4 and 5. The TLE soil concepts involves skills in land tilling and plant propagation, that are embodied in TLE learning modules available online as resource for teachers. The STEM education through problem-based learning in real-life contexts can provide an opportunity for enhancing soil education in the country. However, tThe accessibility to media resources in rural areas, and the limited open space in schools located in highly urbanized areas are constraints to practical soil education. An evaluation study of soil education in the K-12 Basic Education Curriculum is wanting.

Keywords: soil education, curriculum, learning standards, learning competencies

Table 1: Summary of learning competencies for soil concepts in Pre-elementary and Elementary Grades in the Philippine K to 12 Basic Education Curriculum

Kindergarten	Science (Elementary)	TLE (Elementary)
a. Group plants according to certain characteristics, e.g., parts, kind, habitat b. Identify needs of plants and ways to care for plants c. Identify simple ways of taking care of the environment	a. conduct investigation on the specialized structures of plants given varying environmental conditions: light, water, temperature, and soil type b. compare and contrast the characteristics of different types of soil c. describe how rocks turn into soil d. investigate extent of soil erosion in the community and its effects on living things and the environment	a. performs systematic and scientific ways of caring plants and seedlings such as watering, cultivating soil, preparing, and applying organic fertilizer b. uses different ways of preparing organic fertilizer and pesticides

Soil Taxonomy of the Municipality of Maasim in Saranggani Province, Mindanao, Philippines

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ABSTRACT

The study entitled Soil Classification of Maasim, Sarangani Province was conducted in Maasim, Sarangani Province and in University of Southern Mindanao, Kabacan, Cotabato. In this study, we intend to properly classify the soils in Maasim, Saranggani Province being a strategic location for the agricultural expansion for export quality fruit crops. The Keys to Soil Taxonomy 12th edition (2014) was used in the classification of soils included in the study. Four orders were identified in the area: the Orders *Entisols, Inceptisols, Alfisols and Andisols. Entisols* was identified in Sitio Mati, Kanalo, Maasim (Pedon 3). This was consequently classified as *clayey-skeletal, montmorillonitic, superactive, non-acid, isohyperthermic, Typic Udorthents*. *Inceptisols* were identified in Dampilan , Lumatil (Pedon 1), Bales (Pedon 4), Seven Hills (Pedon 5), Colon (Pedon 6) Lumasal (Pedon 8) and in Kamanga (Pedon 9) all of Maasim municipality, Saranggani Province, Mindanao Philippines. Pedon 1 and pedon 6 situated at 30 masl and 434 masl, respectively were classified as *fine, montmorillonitic, superactive, isohyperthermic, Typic Eutrodepts*. Pedon 4 at 83 masl was classified as *fine-silty, vermiculitic, supractive, isohyperthermic, Typic Eutrudepts*. Pedon 5 was distinguished to be *fine-loamy, vermiculitic, superactive, isohyperthermic, Humic Eutrudepts* while pedon 8 at 39 masl was classified as *fine-silty, vermiculitic, superactive, isohyperthermic, Humic Eutrudepts*. Pedon 9 was catergorized as *loamy, carbonatic, superactive, isohyperthermic, Humic Eutrudepts*.

Alfisols was classified in Purok 4, Nomoh, Maasim (Pedon 2) at 153 masl. This alfisols was identified as *fine-loamy, mixed, active, isohyperthermic, Typic Hapludalfs*.

The order Andisols were categorically found in Pananag (pedon 7) and in Bulok-sawa, Amsipit, Maasim (pedon 10). The former was classified as *ashy-skeletal, mixed, superactive, isohyperthermic, Typic Hapludands* while the later was *ashy, mixed, superactive, isohyperthermic, Eutric Hapludands.*

Keywords: Soil taxonomy, Maasim, Saranggani Province

Making Shiny Soil Balls is Popular with Children, but What Kind of Soil Balls Should We Make to Link to Soil Education?

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Abstract

According to the previous questionnaire research, it is known that “interest in the soil" becomes higher as the children who have many opportunities to touch the soil, so it is better to have many opportunities to touch the soil from an early age children such as pre- and elementary school children. Events that make shiny soil balls are very popular with children in Japan. I think it is important for soil education to encourage children to become interested in the soil by making shiny soil balls. So, what kinds of soils should we use to make soil balls, and how to link to soil education?

The familiar soils are suitable to make soil balls. In Japan, the major upland soils such as Andosols and major paddy soils such as Fluvisols are considered to be suitable. Also, these soils can be purchased from gardening store even in urban area where it is difficult to obtain. There are some processes to make shiny soil ball, (1) collecting of soil, (2) air-drying, (3) crushing, (4) adding water, knead and round to form soil ball core, and (5) polishing to make shiny soil ball. Although it is most educative to make soil ball from the process of soil sampling, it is very laborious and time-consuming to perform all the processes. Therefore, it is good for children to start from the process of polishing the soil ball core which is the final stage, and to have them become interested. And for children who are strongly interested, it is good to perform experience from soil collection.

Making of soil ball is considered to be the beginning of soil education, and children can understand that the characteristic value differs depending on the soil by using and comparing multiple soils. An example is shown in Fig. 1.

There are more educational effects to carry out with other experiment, such as mud dyed, observation of soil particles, adsorption experiments, soil respiration experiments, etc. together with soil balls making.

Key words**:** Shiny soil balls, soil education, pre and elementary school children

Let's compare the nature of various soil balls!

Soil Type		Ease of making	How to light	Weight (specific gravity)	Hardness (Broken height when dropped)	Water content
Arakida tsuchi (Paddy soils)		◎	◎	No.1!! (Heaviest) (2.1 Mg m^{-3})	No.1!! (Hardest) (80 cm)	No.4 (little water) (0.04 kg kg^{-1})
Kuro tsuchi (Andosols)		✖	○	No.3 (1.5 Mg m^{-3})	No.4 (45 cm)	No.2 (0.27 kg kg^{-1})
Akadama tsuchi (Red Andosols)		✖	✖	No.2 (1.7 Mg m^{-3})	No.2 (57 cm)	No.1!! (Most water) (0.34 kg kg^{-1})
Kanuma tsuchi (Yellow Andosols)		✖	✖	No.4 (Lightest) (1.3 Mg m^{-3})	No.3 (47 cm)	No.3 (0.18 kg kg^{-1})

Fig. 1. Figure of the nature of various soil balls for children.

Development and implement of an soil curriculum in the senior high school in Taiwan

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Abstract
Few examples of teaching soils in the schools under K-12 have been proposed in Taiwan for the past several decades. The difficulties of developing and implementing a soil curriculum for the teachers in the schools under K-12 are not revealed in Taiwan. Therefore, a curriculum of soil concepts for the students in a senior high school, Yunlin county, Taiwan, have been designed and practiced. The pedagogic action study was adopted to investigate the difficulties of developing a soil surriculum and assess the effects of teaching the curriculum and the students' learning in the senior high school. The results suggest that at first it is necessary to get the financial supports from the school adminstration in order to purchase the equiments of soil analysis and sampling. Secondly, before developing and practicing the soil curriculum, most teachers in the school under K-12 in Taiwan are supposed to be trained in knowledge of soil science. This is because the teachers in the school under K-12 in Taiwan have not ever taken any soil courses . Thirdly, after attending the soil class, students' learing shows that students recognize the soil knowledge well and also have positive attitudes to learning soil science. Moreover, increasing time for students to practice the soil sampling and analyses is key to enchance students' recognition of soil knowledge.

Effects of Emerging Contaminant Elements on Aquatic Food Chains in Irrigation-pond Wetlands

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Abstract

Emerging contaminant elements (ECEs) are widely distributed across the environmental matrices because of extensive industrial development and various anthropogenic discharges. Despite ECEs could possess serious ecological threats and potential risk to human health and aquatic biota even at low concentrations, knowledge of hazard effects at different trophic levels along the food chains in aquatic ecosystems is lacking. Irrigation ponds are artificial ponds, widely built in Taiwan >200 years ago, serving a primary function for agricultural irrigation in particular paddy fields. In Taoyuen county, total area of irrigation ponds (~26.7 km^2) makes up of 4% of total land area Taoyuen Plateau (758 km^2). There are >2000 irrigation ponds which were connected by extensive irrigation channels, forming a complicated network of wetland ecosystems providing important habitats for wildlife and many ecological functions such as water supply, farming and fishery supporting, water purification, climate regulation. Extensive industrial development in Taoyuen county have aroused the public concern of potential ecological impacts to wildlife inhabiting in the irrigation-pond wetlands. In this study, we conducted field survey and carried out elemental analysis with stable C and N isotope analysis on biota from different trophic levels in laboratory to assess the ecological responses (i.e. wetland assimilative capacity, food-web structure, bioaccumulative potential of ECEs) in four categories of irrigation ponds of different levels of anthropogenic disturbances. Results on the evaluation of the ecological effects of ECEs from different sources along aquatic food chains in irrigation-pond wetland ecosystems will be further discussed.

Key words**:** ECE, irrigation ponds, food chains, trophic transfer, ecological risks.

The effects of emerging contaminant elements on soil bacteria

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Abstract

Gallium (Ga) and indium (In) are metal elements belonging to the group IIIA in the periodic table, and present in trace amount in the Earth's crust. Due to their utilization in high-tech industries in Taiwan, occasional higher background of Ga or In in ground water near Hsinchu Science Park, where many semiconductor companies/factories are located, was reported, indicating their potential risk to our environment and human health. Soil microorganisms usually provide good resources to ameliorate impacts on the environment with metal contamination. However, the effects of those emerging contaminant elements (ECEs) on microbial community in soil have never been evaluated although they are detrimental to animals and plants even at low levels. When 100 mg L^{-1} of Ga, In or thallium (Tl) were amended in three different soils and incubated at room temperature for one day, we found that bacterial numbers were reduced dramatically in all thallium-treated soils whereas Ga has no negative effect on the bacterial number recovered on nutrient agar. On the other hand, bacterial number was decreased after treatment of In only in soils with lower pH value. Changes in composition of microbial community were then evaluated using 16S metagenomic sequencing with three soil types experimentally contaminated with different concentrations of Ga or In. The results showed that even no strong effect on bacterial numbers after treatment with gallium, the composition of bacterial species still changed a lot after one-month incubation, especially in the presence of higher concentration of Ga. Consistent with the culture-based method, even low amount of In has huge influence on bacterial composition regardless of soil properties. Using a culture-based method, we isolated 6 and 18 bacterial strains from the consortia which can survive in the presence of Ga and In, respectively. Further investigation confirmed that 11 isolates were resistant to high level of Ga (200mg L^{-1}), but only 2 isolates could survive in 100mg L^{-1} of In. Surprisingly, these two In-resistant isolates also showed moderate and high degree of resistance to Ga and Tl. Bacteria tolerant to ECEs isolated in this study provides not only potential agents for bioremediation, but also materials for further study of the mechanism underlying metal tolerance as a base to develop better strategies for treatment or detection of Ga or In contamination in the future.

***Key words*:** Emerging contaminant element; soil bacteria; metagenomics; metal resistance.

BIOAVAILABILITY OF CHROMIUM (CR) FROM TANNERY WASTE FOR CAISIM GROWED ON CONTRASTED TEXTURAL SOIL

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Abstract

This research aims to determine the availability and uptake of chromium (Cr) by caisim on contrasted textural soil as affected by tannery waste application. The research using a completely randomized design with 2 factors: 1) soil type (vertisols-clay soil) and inceptisols-sandy loam) and 2). tannery waste (0, 0.67, 5, 10, 15, 20, 25 mgL^{-1}), with three replications. Agronomic observations was subjected for plant height, leaf number, fresh weight and dry weight of roots and shoot. Chemical analysis was subjected for soil, waste and plant tissue. The results showed that Cr availability increased with increasing the concentration of base cations such as Ca, Mg, K, and Na, but decreased with increasing pH, C-org, humic acid, and fulvic acid in the both soils. Vertisols with high content in clay and organic matter had higher capacity in adsorbing Cr than inceptisols. All of agronomic parameters indicated that caisim growed on inceptisols better than vertisols. Chromium content in the plant increased with increasing the dose of waste. The amount of Cr uptaken by caisim growed on vertisols was lower than inceptisols, and Cr which accumulates in the shoot part was five times the root part. Base cations and Cr absorbed by plant had a positive correlation, this indicated that Cr and base cations had a synergetic properties. Whereas, Cr uptaken was suppressed by increasing the soil pH, C-org, humic acid and fulvic acid.

Keywords: tannery waste, Cr, inceptisol, vertisol, caisim, synergetic.

Nonexchangeable K threshold to screen radiocesium transfer risk to brown rice for paddy soils in Fukushima

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Abstract
Soil-to-plant transfer of radiocesium (RCs) is known to decrease considerably with increasing phytoavailable K (including exchangeable K (Ex-K) and nonexchangeable K (Nex-K)) content in soil because of high competition of Cs^+ with K^+ at the ionic channel on plant root. While Ex-K content in soil more than 25 mg K_2O/100g before the usual fertilization was recommended in Japan as a threshold value to reduce RCs transfer from soil to brown rice, any threshold has never been determined for Nex-K content in soil. Therefore, the object of this study was to determine the sufficient amount of Nex-K in soil to reduce the RCs transfer. Soil samples (0–15 cm depth) were collected before planting and after harvest of rice in 2017 from 34 paddy fields where supplemental K to reduce RCs transfer was not applied in Fukushima, Japan. Brown rice harvested in 2017 were also collected from these paddy fields. The concentrations of RCs in soils and brown rice were determined by Ge semiconductor detector. The transfer factor of RCs from soil to brown rice (TF) was determined as follows: TF = RCs concentrations of oven-dried brown rice (Bq/kg) / RCs concentrations of oven-dried soil after harvest (Bq/kg). Ex-K in soils was extracted with 1 M CH_3COONH_4, whereas phytoavailable K was extracted with 1 M HNO_3 for 15 min (soil:extractant = 1:10). Nex-K content was obtained by subtracting Ex-K content from phytoavailable K content. The radiocesium interception potential (RIP) was measured as an index of the RCs retention ability of soils. The mica content was quantified by selective dissolution analysis. Both the Ex-K and the Nex-K content in soils before planting showed significant negative correlation with TF (r_s = −0.58, $p < 0.01$; r_s = −0.44, $p < 0.05$), although there was no significant correlation between Ex-K and Nex-K (r_p = 0.18). This result indicated that not only Ex-K but also Nex-K effectively reduced the RCs transfer. Considerably low TF values (< 0.005) were shown for soils with either Ex-K content before planting more than 25 mg K_2O/100g or Nex-K content before planting more than 50 mg K_2O/100g (Fig. 1). The other soils deficient for phytoavailable K, namely those with both Ex-K less than 25 mg K_2O/100g and Nex-K less than 50 mg K_2O/100g showed relatively high TF values up to 0.09. Similar trends were obtained for soils after harvest. The Nex-K content in soils showed a significant positive correlation with the mica content in soils (r_p = 0.91, $p < 0.01$), which indicated that Nex-K was mainly controlled by the amount of mica in soils because the interlayer of mica can be a reservoir of Nex-K. In conclusion, a threshold value of Nex-K is helpful to predict transfer risk of RCs more precisely, especially for Ex-K deficient soils.

Key words: Fukushima; K; mica; nonexchangeable K; radiocesium; RIP.

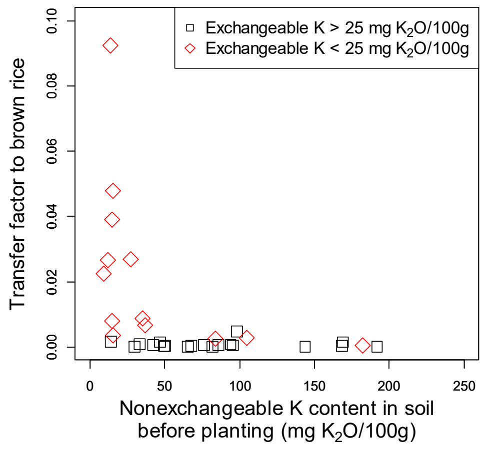

Fig. 1 Relationship between the nonexchangeable K content in soils before planting and TF. The square and rhombus plots indicate the soils with exchangeable K content before planting more than 25 mg K_2O/100g and less than 25 mg K_2O/100g, respectively.

Effect of Antibiotics on Germination Rate, Root Length and Chlorophyll Content of Four Different Crops

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Abstract
Recently, as the use of antibiotics increases, we are concerned about the impact of antibiotics on crops. So the purpose of this study is to determine the impact of tetracyclines on the early growth stage of four different crops. In this study, lettuce (*Lactuca sativa*), chinese cabbage (*Brassica rapa var. glabra Regel*), chonggak radish (*Raphanus sativus*), and lentil bean (*Lens culinaris Med.*) were used. Crop seeds were sown on agar plates with no antibiotics (control), tetracycline 5, 10, 20ppm (TC5, TC10, TC20), chlorotetracycline 5, 10, 20ppm (CT5, CT10, CT20) and oxytetracycline 5, 20ppm (OT5, OT20), respectively. And Crops were incubated in growth chamber (23ºC, 6 days). The germination rate and root length were measured and shoots were harvested at 6 days after sowing. Chlorophyll content was analyzed by uv-spectrometer at 665 nm and 649 nm. There was no significant difference in the germination rate of antibiotics for each crop. The germination rate of lettuce, chinese cabbage and chonggak radish was over 90% in all treatments. However, germination rate of lentil bean was 80~93%. Root length was most inhibited in TC20 compared to control in all crops. The root length of lettuce, chinese cabbage, chonggak radish, and lentil bean was 2.15, 3.78, 4.00, and 1.17 cm in control, respectively. The lowest root length of lettuce, chinese cabbage, chonggak radish and lentil bean was found in TC20 as 0.38, 0.73, 1.10, and 0.86 cm, respectively. The Chlorophyll content of cabbage and chonggak radish decreased as the concentration of antibiotics increased. In conclusion, there was no effect of tetracyclines on the germination rate of crops except lentil bean. In terms of root length and chlorophyll content, TC had the highest impact, followed by CT and OT.

***Key words*:** Antibiotics, Tetracyclines, chlorophyll, crop

The Distribution of Gallium, Indium and Thallium in Different Type of Arable Soils in Taiwan

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Abstract

As emerging contamination elements, Gallium (Ga), Indium (In) and Thallium (Tl) have raised interests in multiple studying fields, such as their distribution in soils, anthropogenic sources and bio-toxic effects. Industries of semi-conductors, liquid crystal displays (LCDs) and light-emitting diode (LEDs) are potential contamination sources in Taiwan. However, the detail of their distribution, or their natural background value, in arable soils in Taiwan are still unknown. Thus, the aims of this study were to investigate the background concentration of gallium in Taiwanese arable soils derived from different parent materials and to establish baseline of soil Ga, In and Tl for pollution prevention. Samples derived from different parent materials like aged alluvium of quaternary, serpentine, alkaline alluvium from sandstone, volcanic ash, and basalt. Ga in soils investigated ranges from 3.98 to 36.47 mg kg^{-1}. A special case which shows Ga more than 200 mg kg^{-1} is from MianTian Mountain, whose parent materials are volcanic ash. In ranges from 5.6 to 81 ug kg^{-1} and Tl ranges from 6 to 210 ug kg-1. These values are obtained by aqua regia extraction and measured by ICP-MS. In addition, the experimental results indicated that Ga level was the highest in the aged alluvial soils from quaternary (red soils; Ultisols), while In and Tl shows no similar behavior.

Key words: Emerging contamination element, gallium, indium, thallium, pedogenesis

Vanadium extractability, speciation, and bioavailability in agricultural soils

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Abstract
The global vanadium (V) demand in industry increased over 100% from 2001 to 2017, thus the burgeoning V demand leads to potential risks to environment quality and human health. However, the evaluation of metal bioavailability based merely on the total soil content is insufficient to determine the actual environmental impact. This study attempted to explore the fractionation, chemical speciation, and bioavailability of V from 17 soil pedons with 94 horizon samples in Taiwan. The Commission of the European Communities Bureau of Reference selective sequential extraction method indicated V was primarily fixed in the mineral lattices. However, the Fe/Mn-oxide-bound fraction was remarkably observed. The siderophilic affinity of V in derived soils was further confirmed by the element mapping conducted with electron probe X-ray microanalyzer (EPMA). V(IV) (VO^{2+}) and V(V) ($H_2VO_4^-$) were the dominant species of V in the soils demonstrated by the V K-edge X-ray absorption near edge structure (XANES) spectra, while both can be efficiently extracted by $NaHCO_3$ extraction to predict a better bioavailability of V than $CaCl_2$, HCl, and EDTA. The plant assay conducted with Chinese cabbage (*Brassica rapa* var. chinensis) revealed the soil $NaHCO_3$ extractable V positively and significantly correlated with the plant shoot uptake of V, supporting the potentially bioavailable V can be computed by using multivariate regression equation considering the soil total V and pH.

***Key words*:** Bioavailability; EPMA; parent material; sequential extraction; XANES.

Efficient utilization mechanism of crop water and nutrients and regulation mode under alternate partial root-zone irrigation

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Controlling irrigation water and reducing fertilizer application, efficient utilization of water and fertilizer, the enhancement of crop quality and soil quality and the environment improvement are important guarantees for green and sustainable development of agriculture. Traditional management of water and fertilizer takes less account of crop quality and does not fully consider the effects of crop physiological activities on water and fertilizer utilization, so the efficient utilization of water and fertilizer is low. The effects of different irrigation and fertilization methods on water and nutrient uptake by crop roots, the efficient utilization mechanism of crop water and nutrients and the optimal irrigation and fertilization mode are important scientific problems facing farmland water and fertilizer management, which need to be clarified. 1. The efficient utilization mechanism of water and fertilizer under alternate partial root-zone irrigation is revealed, which provides a theoretical basis for field application. 2. The water-nutrient-dry matter accumulation-yield relationship and the response of crop quality to water and nutrient supply were revealed under alternate partial root-zone irrigation, and the feasible ways to improve crop water and nitrogen use efficiency and regulate farmland water and nutrient precisely were explored. 3. Established a water and fertilizer regulation scheme which comprehensively considered the physiological regulation function of crops and the water- nutrient- yield- quality response relationship, which provides theoretical support and mode reference for modern agriculture to control irrigation water, reduce fertilizer application, improve crop and soil quality and increase utilization efficiency of water and fertilizer. The results can provide a new theory for crop quality improvement, soil quality improvement and efficient utilization of water and fertilizer in farmland, and have important application value for water and fertilizer management in modern agricultural production.

Key words: irrigation method; optimal irrigation and fertilization mode

Convolution neural network for mapping heavy metals in the topsoil of New South Wales, Australia

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Abstract

Soil security raises the issue on the maintenance and improvement of the world's soil resource to produce food, fibre and fresh water. Heavy metals contamination in soil is one of the greatest threats to soil security. The knowledge on the spatial distribution of heavy metals over a region is important to understand the background concentration of heavy metals and also to identify possible area of contamination. This paper aims to map concentration of selected heavy metals in the topsoil in New South Wales (NSW), Australia (area of 809,444 km^2) at a fine resolution (100 m) using an emerging deep learning method. The convolutional neural network (CNN) is the type of deep learning method used in this study. CNN is commonly used in image recognition as it is able to take an image as input.

In most Digital Soil Mapping (DSM) studies, environmental covariate values are extracted at the location where soil records have been sampled and these point data are used as predictor variables to predict soil classes and properties using machine learning techniques. However, soil properties in larger neighbourhoods might be different because of local geomorphic processes even if all other state factors are identical. It is necessary therefore to incorporate local and regional geomorphic context by incorporating information not only from the specific point but also from its surrounding environment.

The recent development of a deep learning approach for image classification, such as the convolution neural network (CNN) could be useful for extracting information on covariates from images and using these features from images as input to the model in DSM studies.

In this study 490,000 observations of heavy metal concentration from the topsoil (i.e. Cu, Pb, and Zn) were used to train a CNN model. Topography derived from the SRTM DEM, soil and vegetation cover derived from Landsat 8 images, climate, and the abundances of potassium (^{40}K), thorium (^{232}Th) and uranium (^{238}U) gamma-ray radiation of the earth surfaces were used as covariates. This study produced a series of maps on the concentrations of heavy metal in NSW. Background heavy metals concentration can be observed via the spatial trend in the data. Hotspots can also be identified. Then the priority areas where the potential threat from heavy metals are high can be further assessed.

Key words: soil security; heavy metal contamination, convolution neural network (CNN), contextual spatial information

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Soil carbon and other nutrient conditions under different land use in Tamil Nadu, South India

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Abstract:

Soil information is critically important to develop the adequate land management for sustainable agriculture, especially in infertile tropical soil. In dry tropical India, there were some reports about the soil degradation due to soil organic carbon depletion or salt accumulation, though these current conditions were still limited especially in Tamil Nadu state, South India. The objectives of this study were (1) to evaluate the current soil physico-chemical properties under different land use, such as cropland, paddy field, natural vegetation, and (2) to evaluate the soil carbon and salt condition including its controlling factors of each land use, in Tamil Nadu state of south India. We collected the surface and subsurface soil samples from 48 sites from different land use in the whole Tamil Nadu state (Cropland=29, Paddy=13, Natural vegetation=4, and others=2). Most soil were classified as Alfisols or Inceptisols, though there were also Vertisols, according to Soil taxonomy. Soil pH, EC, soil texture, total C (TC) and N, exchangeable cation, CEC were determined, and analyzed the correlation between the values. Soil pH was generally alkaline, i.e., 8.1±0.2 in cropland and 8.2±0.2 in paddy, though it was relatively neutral in natural vegetation (6.8±0.6). EC in paddy (18.9±3.5 mS m^{-1}) was clearly higher than that in cropland (12.1±1.7) or natural vegetation (3.5±1.9). We also found that Na_e and Mg_e were accumulated in subsurface layer in paddy, though Ca_e was accumulated in cropland. In case of paddy, the ratio of Na_e to CEC, such as exchangeable sodium percentage (ESP), were relatively high (8.6 in surface and 12.5 in subsurface). These results indicate the salt (esp. sodium) accumulation by irrigation in paddy field. In addition, TC of soil were also surprisingly small both in cropland (4.8±0.4 g C kg^{-1}) and paddy (7.6±1.1 g C kg^{-1}), though we could not separately measure the organic and inorganic C. We also found that the TC were clearly correlated with Mg_e and Ca_e, but not with clay contents, indicating the most TC might be inorganic C. Considering of the not small clay contents, such as18.9±4.0 and 26.4±4.6 % in cropland and paddy, respectively, the depletion of soil organic C must be critically occurred in this state, especially in cropland. We will separately measure the organic and inorganic C before the conference, and will discuss more about the soil organic C condition in this state. Thus, to achieve the sustainable land management in this state, organic management with conservation agriculture practice should be improved to increase the soil organic C especially in cropland, while adequate irrigation management should be necessary in paddy field.

Sensitive Soil Layers at Landslide Prone Areas of the Transitional Volcanic Landscapes between Quaternary and Tertiary Systems in Java - Indonesia

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Java is one of the main volcanic island in Indonesia. There are more than 27 Quaternary volcanoes in Java Island where most of them lies at the adjacent area of Tertiary Volcanoes. The transitional volcanic landscape between Quaternary and Tertiary systems become interesting since it has high soil resources and high landslide susceptibility. The expansion of settlement and agriculture land use toward volcanic slopes had occupied some areas with high landslide susceptibility. The soil management often reach the sub-soil layers that had specific physical characteristics of the landslide sensitive soil. The physical soil resources information is usually limited at the soil surface horizons and quite rare to cover the sub-soil layers.

Observation of the spatial distribution of landslide events recorded at national and district level in Java becomes the first step in establishing the field sampling locations. The field soil sampling were carried out at the deep soil profiles that depicted several soil layers covering soil surface horizon and sub-soil layers. Every soil horizon and layer were sampled and measured for their soil physical characteristics. Soil sensitivity indices were calculated from several soil characteristics data such as liquid limit, maximum water content, soil texture, and bulk density.

The soil profile in the area of study have developed from a series of volcanic materials with different degree of weathering and soil development. The soil profile have some sensitive soil horizons and layers. The sensitive soil layer may occur in the near surface and/or deep layers. The deeper from the surface of the sensitive soil layer is the higher potential to initiate the landslide. Removal of the soil surface layer that expose the sensitive sub-soil layer have increased the landslide susceptibility. Built up environment both for agriculture and non-agriculture have a tendency to increase the run off that create deep incision exposing the sub surface sensitive layers. Seasonal wetting - drying due to both irrigation and drainage water have created deep-seated and flow-type landslides.

Keywords: Sensitive, Landslide, Transitional, Landscape, Volcanic

SPATIAL VARIATION OF SOIL CHEMICAL PROPERTIES IN PADDY FIELDS OF KURUNEGALA DISTRICT IN SRI LANKA

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Abstract
Identification of spatial variation of soil chemical properties in paddy fields and adoption of remedial measures are needed to maintain soil health. Thematic maps of soil properties assist to identify the variations and to introduce soil test based fertilizer recommendations for optimum rice yield while conserving the environment. Therefore, this study was conducted to prepare thematic map of soil parameters in Kurunegala district. Soil samples to depth of 0-15 cm were collected from 2.5 km by 2.5 km grids. Sampling points were demarcated by Global Positioning System (GPS). Collected soil samples were analyzed for available soil P by Olsen's method, exchangeable-K by 1N NH_4OAc (pH 7) extraction method, exchangeable Zn by EDTA extraction, soil pH by 1 soil: 2.5 water, Electrical Conductivity by 1 soil: 5 water and soil organic carbon contents by Walkley-Black method. Tested values were mapped using ArcGIS 10.5 and legends were prepared based on the optimum and critical values of each parameter. Available soil Phosphorous maps of Kurunegala district showed that 55% of lands are having optimum P content and no need to apply P fertilizer to obtain optimum yield. Soil exchangeable K is low (< 80 mg/ kg) in 73% of the area and need to apply K fertilizer for a better yield. Soil pH and soil salinity are not critical factors in the district but attention should be paid to Zn and organic matter content.

Key Words: Rice; Soil chemical properties; Spatial variation

Table 1. Percentage land extent of rice growing soils in paddy field of the Kurunegala District for different soil parameters

Soil Parameter	Value	Land extent (%)	Area(ha)
Available P content (mg/kg)	< 5	37	39,471
	5 – 10	55	58,113
	> 10	8	8,450
Exchangeable soil K (mg/kg)	< 40	13	13,379
	40 - 80	60	63,296
	80 - 160	27	28,993
	> 160	-	366
Soil pH (1:5 soil : water)	4.5 - 5.5	5	4,993
	5.5 - 6.5	37	39,255
	6.5 - 7.5	57	60,376
	> 7.5	1	1,410
Soil EC (dS/m)	< 0.15	95	100,810
	0.15 - 0.4	5	5,095
	0.4 - 0.8	-	129
Soil Zn (mg/kg)	< 1	97	102,828
	1 - 4	3	3,206
Soil Organic Matter (%)	< 2	32	33,884
	2 - 3	67	71,455
	>3	1	695

Soil Characteristics in Urban Area under Different Land Use : A Case Study of Fuchu in Tokyo, Japan

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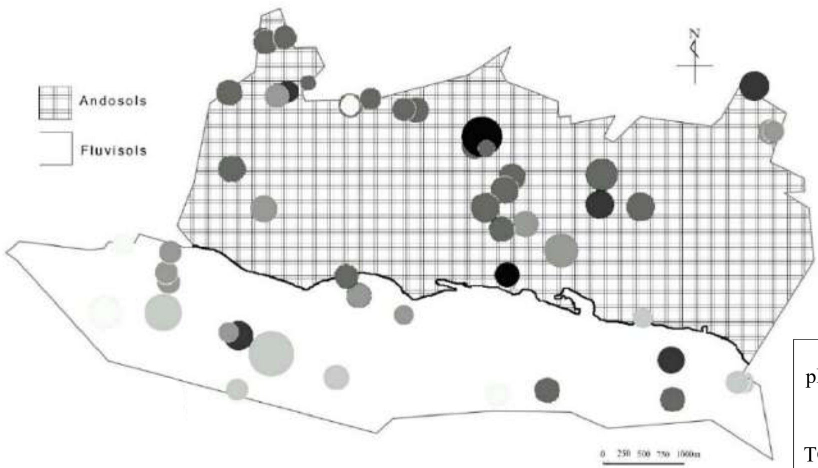
Abstract

The objective of this study is to elucidate the soil characteristics in urban soil affected by human impacts. The site is located in Fuchu, Tokyo, Japan. Mean annual temperature is 15.0℃ and mean annual precipitation is 1530 mm. Andosols were distributed in Musashuino and Tachikawa upland plateau, and Fluvisols were distributed in Tamagawa lowland. Thirty three pit samples were collected from upland and 23 pit samples were from lowland. Land uses were park, agriculture land, vacant lot, orchard, woods and others. We measured soil properties such as bulk density, hydraulic conductivity, phosphate absorption coefficient, cation exchange capacity (CEC), total carbon (TC), pH(H_2O), β-glucosidase activity and so on. From the principal component analysis, we found factors characterizing soils are CEC, TC, total nitrogen, pH(H_2O), pH(KCl) and base saturation percentage. CEC, TC and TN represented soil organic matter: an indicator of soil fertility. pH(H_2O), pH(KCl) and base saturation percentage represented pH: an indicator of human impacts. Pit samples could be divided according to phosphate absorption coefficient that represented parent materials, but they weren't characterized. Pit samples also weren't characterized by β-glucosidase activity although its sensitivity for change of land management. Therefore, soil properties in Fuchu were characterized by soil fertility and human impacts. Fig.1 shows soil characterization map using TC and pH(H_2O).

***Key words*:** human impacts; land use; soil fertility; soil map; urban soil



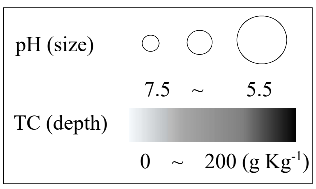


Fig.1 Soil characterization map of Fuchu using pH(H_2O) and TC

Cadmium and Lead Concentrations in Surface Soils of Tropical Ultisol: Spatial Variability in-relation to Land Use, Soil Associations and Topography

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Abstract

Accumulation of trace elements in soils has become an environmental concern. Understanding spatial variability of trace elements in relation to point and non-point sources is an important to identify threats and monitoring mechanisms. Objectives of this study were to explore the spatial variability of cadmium (Cd) and lead (Pb) in relation to the land-use and topography. We collected 137 surface soil (0–15 cm) samples from a tropical Ultisol soil scape in up-and mid-country in Wet Zone in Sri Lanka, representing tea, forest, and urban land uses. Total Cd and Pb concentrations were determined by digesting the soils using aqua regia (Trace-metal grade) and analyzed using Graphite Furnace Atomic Absorption Spectrophotometer, following USEPA method 7010. Extractable concentrations of Cd and Pb were determined using Mehlich 3 extraction. Soil pH, EC, CEC, Available P, total P, Amorphous Fe, total Fe and Mn were determined. Total and Mehlich 3 concentrations of trace elements showed positively skewed data distributions. Across all the land uses, the total Cd and Pb concentrations ranged from 0.05 to 0.4 mg kg^{-1} (median: Tea=16, Urban=13, Forest=19) and 3 to 37 mg kg^{-1} (median: Tea=0.13, Urban=0.14, Forest=0.16) respectively. Mehlich 3 Cd and Pb concentrations were low and ranged from 0.01 to 0.62 mg kg^{-1} and 1 to 26 mg kg^{-1}, respectively. Potential bioavailability of Cd in tea, urban and forest land uses was 40%, 32% and 32% respectively, meanwhile for Pb it was 40%,60% and 40% respectively. Regression analysis explained that the relationship of total Pb and Mehlich 3 extractable Pb concentrations with elevation was significant ($P<0.05$); However, only about 4-7 % of variation of them was explained by elevation. Cd concentration was not significantly related to elevation. Variability of concentrations of Cd and Pb were not related to land use, suggesting the concentrations of Cd and Pb observed were background levels influenced by human interventions at minimal. Soil associations were also not related to spatial variability of total concentrations of Cd and Pb in soils. Spatial variability of total concentrations of Cd and Pb will be presented with maps including land use, soil association and elevation distribution.

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Keywords: Potential bioavailability, Spatial variability, Topography, Trace elements,

Acknowledgement: This study was funded by the National Research Council of Sri Lanka (NRC/17-025).

Digital Soil Mapping of Soil Fertility for Thai Jasmine Rice using Remote Sensing and Terrain Parameters employing Machine Learning in Thung Kula Rong-Hai region, Thailand

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Abstract
Accurate and detailed spatial soil fertility information is an important factor for sustainable food production, land use management as well as conservation of the environment. The use of remote sensing (RS) satellite data as secondary sources of information to establish digital soil mapping (DSM) has been found to be cost effective and less time consuming compared to traditional soil mapping approaches. Machine learning (ML) techniques have been used by various researchers for the prediction as well as mapping of various soil properties including both physical and chemical properties. This research explicates the method in digital soil mapping and shows the application for mapping & monitoring soil fertility in Thung Kula Rong-Hai (TKR) region located in Northeast Thailand that covers a total area of approximately 337,230 hectares. TKR region produces good quality of Thai Jasmine Rice which has the quality of aroma more than any other areas of the country and was registered to Thai Geographical Indication (GI) in 2010. In this research, we established digital soil map using remote sensing data from Landsat 8 OLI, terrain data and conventionally analyzed data of 186 soil samples which have been collected by Land Development Department (LDD) in Thailand during March-May 2016. The digital soil maps of soil properties were released using machine learning technique. The released DSM of each soil property has been used to evaluate soil fertility from the relationship between soil properties with respect to rice productivity in TKR. Since a correlation analysis between the predictor variables has a statistically significant relationship, a predictive model can be generated by machine learning technique using each soil property. The shortwave infrared and near-infrared channels of Landsat 8, as well as soil specific indices of saturation (SI), normalized difference vegetation (NDVI), normalized difference water (NDWI), soil moisture (SM) and terrain index (DEM), were prominent predictors in digital soil mapping. The machine learning algorithms using multiple linear regression model (MLR) performed well to predict soil properties at unsampled locations. The prediction accuracies from MLR model are 94.87% for pH, 76.19% for EC, 74.93% for OM, 96.02% for P, 77.42% for K, 85.57% for Ca, 74.30% for Mg, 91.75 for Fe, 98.56% for Cu, 95.45% for Mn and 93.52% for Zn. The development of DSM from the research will help to demonstrate the distribution of soil fertility for jasmine rice in TKR region, which reduces time and cost consuming processes as compared with the traditional soil mapping approaches. The DSM established using those soil information with soil productivity can help farmers to determine the extent of the crop nutrients deficiency and come up with remedies that would increase nutrient efficiency for the rice production hence to enhance quality and quantity of jasmine rice in Thung Kula Rong-Hai.

***Keywords*:** Digital soil mapping (DSM), Remote sensing (RS), Machine learning (ML), Soil fertility, Thai Jasmine Rice, Thung Kula Rong-Hai

Digital Soil Mapping, Assessment and Contribution to Digital Agriculture

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Abstract
Digital soil mapping (DSM) has been established as a cost-effective method to provide a range of soil properties to support soil function, mainly in crop production. DSM involves collection of field samples using representative sampling methods, development of spatial prediction functions and mapping of soil properties. The outputs of digital soil maps can quantify spatial variation of key soil properties at multiple depths. Digital soil maps can be integrated with other biophysical data such as climate, vegetation, and terrain for quantitative decision making and supporting the development of digital agriculture. This presentation will illustrate two examples on the role of soil information in developing digital agriculture. The first example is the use of DSM products for designing agricultural development in the State of Tasmania, Australia. DSM products were used for the establishment of Enterprise Suitability Assessment for 20 different crops. Digital soil maps are also used in producing agricultural versatility and spatial gross margins. The second example demonstrates to the development of soil moisture maps for rice fields mapping in Indonesia and Malaysia. We used time series Sentinel-1 images, which are collected by the synthetic-aperture radar satellite. The backscatter data provides information about the soil moisture status which can be used to map rice area and its growing stages. We used classification methods to learn how to recognise different rice growth stages from time series information. We compared its predictions with field-survey data. And found that the method could measure rice extent with 96.5% accuracy. The method could also forecast areas planted to rice for up to two months. This study demonstrates the potential of microwave indices for vegetation monitoring and phenology. Soil information through digital technology is required to support digital agriculture.

***Key words*:** Digital agriculture, precision agriculture, soil mapping, pedometrics.

Relationship of Soil Color to Soil Fertility Parameters of Major Soil Series Grown to Sugarcane

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Abstract
Soil color can be a useful indicator of some general properties of a soil as well as the chemical processes that are occurring beneath the surface such as the amount and state of decomposition of organic matter, presence of specific mineral like iron or manganese, moisture availability, and texture of a soil. This study was conducted to correlate and interpret soil color using Munsell notation with soil fertility parameters. Soil samples collected at 0-30 cm and 30-60 cm depth from five major soil series that were planted to sugarcane namely Guimbalaon (*Andic Haplustept*), Isabela (*Aquic Hapludalf*), Luisiana (*Ustic Palehumult*), San Manuel (*Fluventic Eutropept*), and Silay (*Aquic Tropudalf*) in Negros Occidental, Philippines were utilized and soil color notations (value and chroma) were correlated to the different soil fertility parameters (percent Organic Carbon; soil pH; total Nitrogen; available Phosphorus; exchangeable Potassium, Sodium, Calcium, Magnesium, and Aluminum; extractable Iron; cation exchange capacity; and percent sand, silt, and clay) using Correlation and Regression Analysis.

Soil fertility parameters found to be significantly correlated with Soil Color Value at the topsoil (0 – 30 cm depth) were percent Organic Carbon, exchangeable Magnesium and Potassium while for subsoil (30 – 60 cm depth) were soil pH, exchangeable Magnesium and Potassium, and extractable Iron.

Moreover, soil fertility parameters found to be significantly correlated with Soil Color Chroma at the topsoil (0 – 30 cm depth) were percent Organic Carbon, exchangeable Magnesium and Sodium, percent clay, percent sand, and soil pH while for subsoil (30 – 60 cm depth) were percent Organic Carbon, exchangeable Magnesium, Sodium, and Calcium, total Nitrogen, Cation Exchange Capacity, and percent clay and sand.

Keywords: soil color, soil fertility parameters, correlation and regression, soil series, sugarcane

Silicon availability and its relation to other properties of soils in Taiwan

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Abstract#
Silicon (Si) is the second most abundant element of Earth's crust, and recent studies generally regarded Si as a beneficial element for plant growth, especially for graminaceous plants. With abundant Si existing in soils, however, Si fertilization is often a necessary agricultural practice in Taiwan. This indicated that the bioavailability of Si could not be inferred directly from the total Si concentration. This study determined the available Si content by using an acetate buffer (1M, pH 4.0) under five-hour water bath to extract plant-available Si. The samples selected are composed of 20 soil pedons (forest and agricultural soils) with 111 horizons, and were classified as Spodosols, Oxisols, Ultisols, and Inceptisols in the U.S. classification system (Soil Taxonomy). The available Si content significantly ($p < 0.05$) correlated positively with the pH, clay content, dithionite-citrate bicarbonate extractable iron (Fe_d) and aluminum ($Al_{d)}$, while significantly negative correlation with organic carbon (OC) was observed. Additionally, the available Si showed no significant correlation with acid oxalate extractable iron (Fe_o) and aluminum (Al_o). Multiple regression analysis implied that pH, clay content, and content of crystalline iron (Fed-Feo) were major factors controlling soil available Si. On practical use, the regression model considering pH and soil texture gave a sufficient prediction of available Si content, serving as a suggestion for Si fertilization.

Key words: bioavailability, silicon, acetate buffer extraction, fertilization.

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Enhancement in Phosphorus Uptake by Rhizosphere Effect in Soil with Combined Application of Chemical Fertilizer and Cattle Manure Compost

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Abstract
Appropriate fertilization by combined application of chemical fertilizer and animal manure compost is important for resource cycle and nutrient balance in soil. Their combined application alters nutrient behavior, particularly phosphorus, by their chemical interaction. The aims of this study was to understand the phosphorus behavior and uptake by the rhizosphere effect in the soil with the combined application of fertilizer and compost comparing with the single application of chemical fertilizer. Two rhizo-box tests with and without the plant were conducted; the water-uptake flow of plant was simulated in the box without the plant. The amounts of available phosphorus from fertilizer in the rhizosphere soil 3 mm apart from the root were higher in the combined application than in the single application of fertilizer despite the plant growth. The phosphorus was uptaken from the rhizosphere soil within 1 mm from the root. In the box without the plant, the amounts of phosphorus from fertilizer migrated with the water flow was slightly higher in the combined application than in the single application, but those were corresponded to less than 1% to phosphorus added to the rhizosphere soil as fertilizer. In the box with the plant, 15% of phosphorus from fertilizer to added in the rhizosphere soil was uptaken by the plant in the single application. On the contrary, 56% of phosphorus was uptaken in the combined application. These results indicate that the combined application of fertilizer and compost suppress the phosphorus immobilization in the rhizosphere soil, and the rhizosphere effect greatly enhance the phosphorus uptake in the combined application compared with the single application of fertilizer.

Key words**:** Animal manure compost; combined application; phosphorus immobilization; phosphorus uptake.

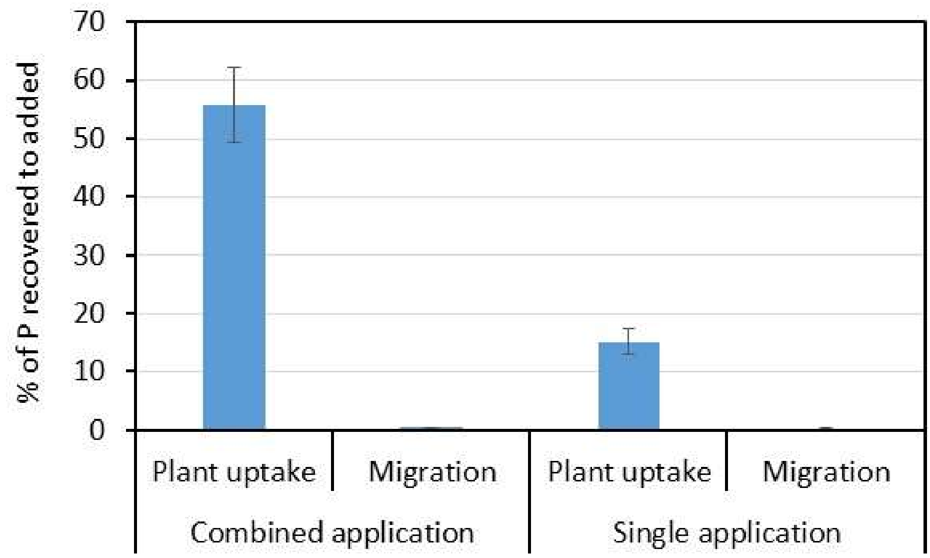

Fig. 1. Phosphorus recovery ratio in combined application of fertilizer and compost and single application of fertilizer. Plant uptake and migration indicates the value from the rhizo-box with and without the plant, respectively.

Introduction of FFTC's Proficiency Testing Program of Soil and Plant Tissue Analysis

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Abstract

In order to maintain and improve the quality of soil/plant testing laboratories in Asia and the Pacific, Food and Fertilizer Technology Center (FFTC) and Taiwan Agricultural Research Institute (TARI) collaborated on the "Proficiency Testing Program of Soil and Plant Tissue Analysis" in 2018 and 2019. This program is designed to provide participating laboratories with an opportunity to compare their analytical results with other laboratories. In 2018, 21 laboratories from Taiwan, the Philippines, Vietnam, Malaysia, Thailand and Indonesia participated in the PT program. In 2019, in addition to the aforementioned countries, participants from Japan and South Korea were added, and a total of 47 laboratories participated in this program. In this PT program, the procedures of the preparation, homogeneity and stability testing of PT samples, and statistical analysis were followed according to the International Organization of Standardization (ISO) related principles and requirements. The results of homogeneity and stability testing indicated that the homogeneity and stability of PT samples corresponded to the requirements of ISO Guide 35. The results of 2018 PT program indicated that the z scores of most of participants fell inside the range of -2 to 2 (satisfactory results) for most of PT items. It revealed that the capability of soil and plant testing for most PT participants were satisfactory. However, it also found that the high deviation degree and coefficient of variation of measured values for a few PT items, which mainly resulted from the use of different analytical methods and instruments. In summary, it suggests that the participation in the PT program regularly will help to maintain the soil/plant testing quality of laboratory, and further to elevate the accuracy of the fertilizer recommendations and plant nutritional diagnosis.

***Key words*:** proficiency test, soil testing, plant analysis, interlaboratory comparison.

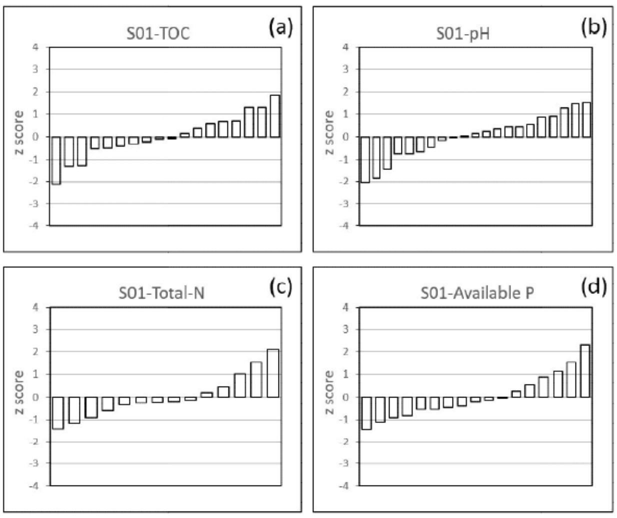

Fig. 1. The z score distribution of some proficiency testing items (soil samples, S01) calculated from data submitted by participants in 2018.

Effect of FertiGroe®N Nanofertilizer on Culturable Bacterial Population, Microbial Biomass, and Enzyme Activities in Two Soil Types

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Abstract
Nanomaterials have many beneficial applications, however, there is a need to assess their effects on the environment. Microorganisms are considered the most sensitive indicators of environmental stresses. This study assessed the effects of nanofertilizer (FertiGroe®N) on the culturable soil bacterial population, dehydrogenase (DHA) and urease (UA) activities, and microbial biomass (MCB) in Lipa clay loam (LCL) and Sariaya sandy loam (SSL) over 75 days incubation period in the laboratory. The treatments included, commercial fertilizer, urea, nanocarrier, and unamended control. FertiGroe®N, urea, and the nanocarrier had no significant effect on the culturable bacterial population and DHA. At 1 day after amendment (DAA), FertiGroe®N significantly increased UA in LCL but was reduced in SSL. Urease activity in SSL was significantly reduced by urea up to 75 DAA. FertiGroe®N had no adverse effect on the microbial biomass of both soil types. On the other hand, urea significantly reduced MCB in both soil types at 35 DAA. The effect of FertiGroe®N and the non-nanomaterials on the parameters measured was influenced by soil type. FertiGroe®N seems to be less detrimental to the microbial biomass than urea. Results show that FertiGroe®N can be safely used in crop production.

Key Words**:** nanotechnology, nanofertilizer, FertiGroe®N, dehydrogenase, urease, microbial biomass

Effects of Irrigation of Livestock Wastewater on Soil Quality and Forage Agronomic Traits

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Abstract
The experiment was conducted to monitor the soil and groundwater qualities of the Pangola grassland which was irrigated the anaerobic wastewater from cattle farm in Livestock Research Institute. The results showed that the total nitrogen content of the cattle anaerobic wastewater during 2013-2018 did not change much, with an average of about 825 mg/L. After 5 years of sprinkler irrigation, there is no significant difference in pH and EC value of the groundwater, no meter in low-flow and dry period. The NH_4-N and NO_3-N contents of the groundwater were lower than the regulatory standard, and the Cu and Zn of the groundwater in the three monitoring wells were below the regulatory standards. In the soil monitoring data, the EC value (soil:water=1:5) has been increasing year by year after five consecutive years of irrigation, but it was still lower than the stop-irrigation standard. The Cu and Zn content of the soil were also increase slowly year by year, but still lower the the soil pollution monitoring standard (Cu 120 mg/kg, Zn 260 mg/kg). The construction area is about 0.75 hectares of farming and animal husbandry circulation irrigation area, planting the Napiergrass No. 8, and the agronomic traits were measured. The treatment group includes 1.2 times nitrogen fertilizer application of cattle anaerobic wastewater (A zone), irrigation without fertilizer control (B Zone), and application of chemical fertilizer (C zone). The fresh weight of the Napiergrass in the irrigation wastewater treatment (A Zone) was 1.8 times to the fertilizer application group (C Zone) and more than twice times to the B Zone. Measuring the traits of the Napiergrass, the leaf height (101 cm), leaf tip height (198 cm), stem nodes number (8.4 nodes), internode length (61 cm) and leaf length (95 cm) of the A zone were significantly higher than C Zone. In summary, There is no harm to the soil and groundwater quality of the livestock wastewater irrigated grassland after 5 years irrigation. The yield, growth traits and nutrient contents of the Napiergrass were higher than the chemical fertilizer group and the benefits were obvious. It is recommended to continue the long-term monitoring as a supporting evidence for the environmental impact of the livestock wastewater reuse.

***Key words*:** Livestock wastewater; agriculture and animal husbandry circular; irrigation.

Use of Urine and Excreta Could Improve Vegetable Production and Soil Fertility in Central Nepal

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Abstract
Ecological sanitation (Ecosan) is defined as water conserving and nutrient recycling system for the use of human urine and excreta in agriculture and is seen as a potential strategy to enhance soil fertility in small holder systems and to address sanitation challenges (Langergraber and Muellegger, 2005). It is the closed loop nutrient cycle in which one eats food, uses toilet for excretion but the urine and excreta are no more treated as wastes. Those human waste is regarded as a resource to use as a fertilizer. It would help smallholder farmers to improve the livelihood via improved sanitation and improved production. The objectives of the study are to understand the feasibility of ecosan toilet in the study area and to understand the effect of human urine and excreta on crop productivity and soil fertility. To meet the objective of research, field experiments were conducted in three sites (Angare, Bhot Khoriya and Deurali) with five treatments (Control, Chemical Fertilizer, Urine, Excreta + Urine, and Excreta) in farmers' fields in Palung village of Makawanpur district in Central Nepal in year 2017 and 2018. Cauliflower was grown to understand the effects of the treatments on cauliflower productivity. The soil samples were collected before and after the treatments to analyze the nutrient variation in soil due to the different types of application. The biomass of plant in three weeks and after harvest was calculated from the three sites to analyze the role of treatment in productivity. Plant samples were also analyzed to understand the nutrient present. Questionnaire survey was conducted to understand the feasibility of ecosan toilet where villagers were asked about socio-economic parameters, farming practices, awareness of ecological sanitation and fertilizer value of urine.

Eighty three percent respondents were found engaged in agriculture growing mainly vegetables, which may raise the feasibility of ecological sanitation. In the study area, water deficiencies in dry season, high demand of chemical fertilizer, lack of sanitation awareness were found to be solved. The soil texture of the Angare, Bhot Khoriya and Deurali is sandy loam, loam and silty loam respectively. The soil of the Angare had high pH and low mineral N compared to Bhot Khoriya and Deurali. The results from the field experiments in both years showed no significant difference in dry weight of leaves and flower in Angare, while the significant differences were observed in Bhot Khoriya and Deurali. In Angare as the soil is sandy loam with high pH, there is high chance of leaching and volatilization in urine treatment leading to less availability of N for plants. It might result in the less dry weight of cauliflower in urine treatment leading to no significant difference. The cauliflower with urine and excreta treatments resulted in yield better than the control treatment and comparable to the chemical fertilizer treatment. The positive correlation between N uptake and applied was found in year 2017 but not in 2018. It might be the reason that nitrogen applied in 2018 was not fully taken by plants and could not contribute to growth although larger amount of N was applied in 2018. From the questionnaire survey, it was understood that respondents have known about the fertilizer value of human urine and excreta. After the installation and demonstration of ecosan toilet in the village, the willingness to construct ecosan toilet was increased. Ecological sanitation is feasible in the area with similar socio-economic conditions especially for the marginal farmers with less land holding capacity and where availability of chemical fertilizer on time is a constraint. Less land holding size reflects to the smaller number of livestock hence lacking availability of livestock manure to use in the field. In this case, ecosan could be a good option to fulfill fertilizer requirement. The study showed the positive effect of urine and excreta from ecosan toilet in cauliflower production. When urine and excreta is utilized as a fertilizer, the productivity could be increased and the time and money to buy chemical fertilizer would be utilized in other livelihood activities.

Key words: Cauliflower, Chemical fertilizer, Ecological sanitation, Nepal, Urine, Excreta#

Determination of base saturation percentage in agricultural soils via portable X-ray fluorescence spectrometer

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Abstract
Soil base saturation percentage (BSP) plays an important role in the assessment of soil taxonomic classification and soil fertility. Conventionally, soil BSP measurement methods are fraught with many drawbacks such as being time consumptive, laborious, and destructive to the samples. Recently, proximal sensors such as portable X-ray fluorescence (PXRF) spectrometry have proven to be effective for rapid physicochemical analysis of soils. In this study, we proposed and examined a PXRF-based method to predict BSP using 300 soil samples from agricultural lands across six states in the USA; Colorado, California, Minnesota, Nebraska, Oklahoma, and Texas. An Olympus Vanta series PXRF analyzer was employed to measure Mg, Ca, and K for BSP prediction. Predicted BSP was validated against measured BSP using four different multivariate models [generalized additive model (GAM), multiple linear regression (MLR), random forest (RF), and regression tree (RT)] via R 3.5.1. Predictive model performance was assessed via root mean squared error (RMSE), coefficient of determination (R^2), residual prediction deviation (RPD), and the ratio of performance to interquartile (RPIQ) range. While predicting BSP, models exhibited validation R^2 and RPDs as follows: GAM = 0.58, 1.6; MLR = 0.45, 1.4; RF = 0.62, 1.6; RT = 0.68, 1.8, respectively. Soil CEC was also predicted using a similar approach, with similar and moderate predictive performance; GAM produced R^2 and RPD of 0.69, 1.8, respectively, relative to laboratory data. This study demonstrated that PXRF elements can be used to predict BSP with fair accuracy for the range of agricultural soils examined. Therefore, PXRF could offer advantages for faster and in-situ analysis of base elements and soil classification. As such, further study and enhancement of the approach outlined herein on a wider array of soils is warranted to establish the wider applicability of this technique.

Key words: PXRF; base saturation percentage; soil classification; cation exchange capacity; proximal sensors

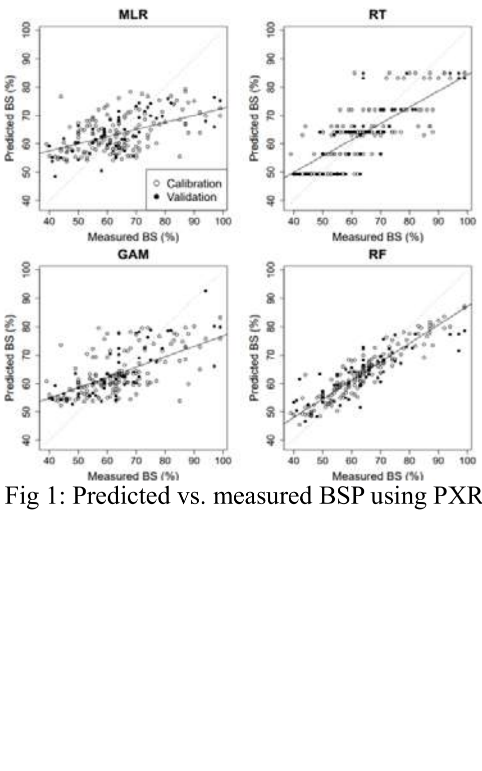

Fig 1: Predicted vs. measured BSP using PXRF measured Ca, Mg and K for agricultural soils from the USA

Comparison of nutrient utilization strategies of traditional shifting agriculture under different climatic and soil conditions in Zambia, Thailand, Indonesia, and Cameroon

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Based on the field studies in different regions of the tropics, land management strategies using shifting cultivation under different bio-climatic and soil conditions are comparatively analyzed. Four regions are included in this study: eastern Zambia, northern Thailand, East Indonesian Kalimantan, and eastern Cameroon. An increase in N mineralization and resulting increase in N flux, after the original vegetation was removed for cropping, were the highest for the eastern Cameroon forest, followed by northern Thailand, eastern Cameroon savanna, Indonesian East Kalimantan, and eastern Zambia. This trend, however, was considered to coincide with mineral nutrient loss due to leaching. This loss would be more detrimental for the strong-weathered soils, such as Oxisols in Cameroon. The function of the fallow phase was the most clearly observed in shifting cultivation in northern Thailand; the soil fertility was reinstated in the later stage of the young fallow, around 8 years. A similar trend was also found for the soils in eastern Cameroon, in which the soil fertility was the highest in the young fallow forest. Such improvement in soil fertility during the fallow stage was not observed for the plots in East Kalimantan, Indonesia, and eastern Zambia, presumably due to the specific climatic conditions. Generally, the farmers' practices and land uses during shifting cultivation in Southeast Asia were well adapted to the respective soil and climatic conditions. However, the present pattern of land use in eastern Cameroon has not been controlled solely by natural conditions; human factors, such as activities of neighboring agro-pastoralists, have a greater impact on these dynamics. In the case of eastern Zambia, limited and fluctuating precipitation may be the most important factor in agricultural production, and because primary production and soil organic matter decomposition rate are regulated by this, soil fertility status would not change considerably under the present land use practices. Therefore, the classical interpretation of slash-and-burn agriculture is not applicable to the agricultural practices in the latter two African cases.

***Key words*:** climatic condition; land management; nitrogen flux; shifting agriculture; soil properties.

From Effective Microorganisms (EM) theory to Examine Soil Microbial Ecology

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Abstract
Biofertilizer is essential to maintain agricultural productivity while effectively reduce the external input of chemical fertilizer. Much research has focused on the relationship between applying pure strain microorganism and crop yield, but effective microorganisms (EM) theory suggested that using mixed culture of microorganisms would have better effect on plant growth. EM consists of mixed culture of beneficial microorganisms, including lactic acid bacteria, yeast, photosynthetic bacteria, and actinomycetes in a carbohydrate-rich liquid. The efficacy of using EM on agricultural production, however, has shown contradict results. EM generally showed positive results when applied on soil with high quality of organic matter, but some studies suggested there were no significant effect, or even sometimes negative effect, on crop growth when applied on soil with much agrochemical. According to Professor Teruo Higa, the founder of EM technology, the soil microorganisms could be classified into three groups: "positive microorganisms", "negative microorganisms", and "opportunist microorganisms". Depending on the dominant species of microorganisms, soil could be categorized into four types: disease-inducing, disease suppressing, zymogenic, and synthetic soils. Some possible mechanisms that EM technology did not show optimal results would be discussed. In addition, the importance of using "bokashi", the fermented organic matter produced by EM microorganisms, would be emphasized. It might be useful to enhance biofertilizer efficiency by understanding EM theory properly.

***Key words*:** Biofertilizer; effective microorganism; bokasi; organic farming.

Fig. 1. The comparison result of rice root by using EM or without EM application

Elemental and mineralogical diversity of serpentine soils in East and Southeast Asia

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Abstract

Serpentinite is an ultrabasic rock composed of ferromagnesian minerals with extremely high concentration of Mg and transition metals. Mainly due to the elemental anomalies, special vegetation communities called serpentine endemic flora can be developed above geo-surface of the serpentinite bedrocks. Because serpentine minerals are weatherable in soil conditions, transformation or neoformation into secondary silicates or oxides of these minerals proceeds much faster than felsic minerals. In East and Southeast Asia, where it has high temperature and much precipitation, minerals in serpentine soils are weathered easier than those in soils from other regions. Thus, mineral diversity of serpentine soils is our interest along with the climosequence in this region. Samples were collected from Japan (Hokkaido, Kyoto, Kochi), Malaysia (Mt. Kinabalu's 4 sites with different elevation) and Indonesia (Kuaro). Soil samples were collected from horizons of each profile, whereas rock samples were collected from near respective soil sampling sites. The elemental compositions of the samples were determined by spectrophotometry, AAS, ICP-AES, and EDXRF. Mineral composition of rocks and clays fractionated from each soil sample was identified by XRD. Principal component analysis (PCA) was used to obtain basic information on difference of elemental concentrations in the samples. All rock samples showed similar SiO2-MgO-Fe2O3 ratio of 8: 5: 1. The Fe^{2+}/Fe_t ratio was >0.3 and the Fe_{dcb} contents were very small for these rock samples. In contrast, serpentine soils showed considerably different elemental composition depending on sampling regions. PCA revealed that Si and Mg contents had high positive loadings and those of Fe, Ni, Cr, and Mn had high negative loadings to PC1, indicating that PC1 associates with degree of mineral weathering. Negative loadings of Na, K, Al, and Ti contents to PC2 was obtained, inferring an incorporation of exotic minerals, probably Asian dust materials (Table 1, Fig. 1). Thus, serpentine soils in East and Southeast Asia have highly variable elemental and mineralogical composition, caused by variable pedogenic factors. Such information of elemental and mineralogical diversity would be helpful to establish land management strategies in serpentine areas.

***Key words*: Desilication; Serpentine geochemistry; X-ray fluorescence; X-ray diffraction analysis.**

Table 1. The result of PCA for total elements

	PC1	PC2	PC3
SiO_2	-0.93	0.25	0.05
MgO	-0.88	-0.32	-0.06
Fe_2O_3	0.96	-0.16	0.19
Al_2O_3	0.03	0.88	-0.25
CaO	-0.16	0.05	-0.94
Cr_2O_3	0.94	-0.02	-0.07
MnO	0.92	-0.15	0.25
NiO_2	0.61	-0.28	0.36
TiO_2	0.03	0.96	-0.2
K_2O	-0.2	0.94	0.16
Na_2O	-0.21	0.92	0.09
Eigen value	4.8	3.7	1.3
Varience explained (%)	43	34	11

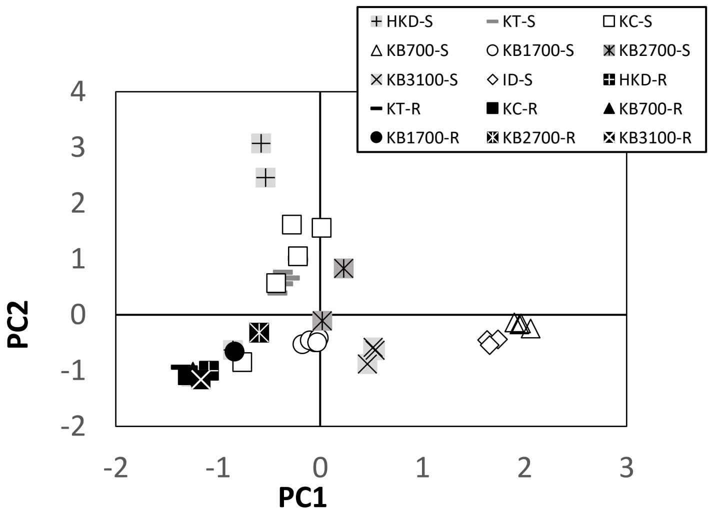

Fig. 1. The PC1 and PC2 scores for total elements of the rocks and soils collected from serpentinitic regions in East and Southeast Asia. HKD = Hokkaido, KT = Kyoto, KC = Kochi, KB = Kinabalu, Malaysia, ID = Indonesia, S = soil, and R = rock

Evaluating soil properties of serpentine soils between island arc and mainland area in Asia

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Abstract

Serpentine soils are characterized with high trace element (i.e., Cr, Ni, Co) concentrations and low Ca and P for plant growth. Serpentine soils are widely distributed worldwide, and the soil properties can differ a lot between sites. In Asia, serpentine soils located in both island arc and mainland countries. To evaluate the characteristics of serpentine soils with different tectonic backgrounds, we collected five serpentine pedons with 25 horizon samples from eastern Taiwan (TS), northern Philippines (ZB) and northern Vietnam (NN) in this study. The TS and ZB samples represent the serpentine soils from island arc, and the NN soils represents the mainland source. Physical and chemical properties were characterized by pH, organic carbon, and particle size distribution, as well as elemental analysis with portable x-ray fluorescence (pXRF). In all samples, the NN soils had the highest pH around 6.6 to 7.6, whilst other soils have pH around 6.0 to 7.3. Organic carbon content was highest in the TS soils. The TS soils also contained the highest clay fraction with 40-60%, however, the clay content only ranged from 24 to 40% in the ZB and NN soils. The principal component analysis (PCA) was used to distinguish these soils, indicating PC1 has positive correlation with all NN soils except for NN3 and that PC1 factor had high variance between island arc soils. It appears that the NN soils contained high levels of nickel and chromium. However, the ZB and TS soils had larger variance of Cr and Ni. These PCA data supported that parent material was the main factor to distinguish serpentine soils from island arc and mainland area in Asia.

***Key words*:** serpentine soils, physical chemistry, principal component analysis (PCA).

Plant growth promoting endophytic bacteria confer growth promoting effect and different metabolite profiling in host plant

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Endophytic bacteria are possible option for sustainable production of commercial crops and a lot of research has been carried out in their isolation, characterization and application. However, study of metabolomic response of plants towards application of such potential microbes remains primitive, and particularly in Cucurbitaceae, especially cucumber, not much has been explored. The aims of this study were to find the cucumber growth promoting endophytic bacteria and documenting the metabolome response of the host plant after application of potential endophytic bacteria. For this, lowest healthy leaf-stalk was sampled from 4 different-sourced cucumber plants, and endophytic bacteria were isolated after surface sterilization. Five strains (Strain No.: 4, 72, 167, 193 and 227) were selected based on their contribution to root growth compared with control. The selected strains were further evaluated in pot experiments, axenic PGP traits assays, and metabolomic approach was also conducted using the plants grown in pot experiment. Results revealed that selected isolates possessed indole-3-acetic acid and siderophore production, phosphate solubilization, 1-aminocyclopropane-1-carboxylate (ACC) deaminase and *nif*H genes, and all the isolates significantly enhanced plant growth in the pot experiments when compared with control and fertilizer control. The metabolomic profiling in strains 4 and 227 showed the metabolome of the host plant changed when compared with control. Around 50% of the metabolites explored were observed higher in either or both the bacteria-applied plants against control. Differences were observed in both strains' regulation of metabolites within the plant, although both enhanced plant growth at similar levels. Overall, endophytic bacteria significantly enhanced plant growth, tended to produce or induced the release of certain metabolites within the plant endosphere.

Keywords: plant growth promoting endophytic bacteria, cucumber, plant metabolomics

Cutting-Edge Arbuscular Mycorrhizal Fungal Technology for Sustainable Agriculture

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Abstract
Arbuscular mycorrhizal (AM) fungi have a symbiotic relationship with approximately 80% of terrestrial plants, and have attracted considerable attention as a microbial inoculant for sustainable agriculture. However, their obligate symbiotic nature poses technical challenges in the development of its inoculum production technology. In addition to the inoculum production, the environmental conditions under which the application of AM fungi is effective remain essentially unknown. Combining the benefits of advances in cutting-edge genome and field research, we have ventured into the area of developing a new culture technique for AM fungi, along with a diagnostic system for mycorrhizal fungus utilization for effective saving of phosphorus fertilizers.

The first part of the study involved sequencing of the genomes of AM fungi *Rhizophagus irregularis* and *Rhizophagus clarus* with considerably higher precision than in previous studies. Unusual characteristics of the genome were identified, which included presence of only 10 or 11 copies of rDNA in *R. irregularis,* in addition to their lack of tandem repeat structure (Maeda et al., 2018). The absence of several genes associated with primary metabolic pathways was also observed from the genomes of AM fungi, which implies the existence of a higher dependency of AM fungi on the host plant (Kobayashi et al., 2018). Furthermore, some fatty acids were found to facilitate asymbiotic growth of *R. irregularis* (Kameoka et al., 2019), implicating the potential use of this knowledge in bringing about a revolutionary change in culture of AM fungi.

In the subsequent part of the study, a new molecular tool was developed to analyze fungal and bacterial flora in plant roots based on the MiSeq sequencing platform. This tool facilitates dissection of interactions between the inoculum and indigenous AM fungi. To identify biotic and abiotic factors that determine crop responses to AM fungal inoculation, we conducted field inoculation experiments to evaluate the efficacy of a commercial AM fungal inoculum (Hayashi et al., 2018; Niwa et al., 2018; Sato et al., 2018). In the field trials with soybean, the abundance of the inoculum fungus was the most significant factor that determined yield responses to the inoculation (Niwa et al., 2018). Interactions among inoculated AM fungi, indigenous AM fungi, and bacteria were analyzed using the molecular tool (Akiyol et al., 2018). Based on these findings, we propose to develop a diagnostic system for effective use of AM fungi in cultivation of Welsh onion.

***Key words*:** field experiment, genome sequence, inoculation, mycorrhizal fungi, phosphorus

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Isolation of endophytic fungi from forest soils in Indonesia

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Abstract
Endophytic fungi (EPF) are an important contributor to fungal community. It is surmised that EPF colonizing roots have high diversity. There are few studies of root EPF in tropical forests, particularly in Indonesia. The purpose of this study was to isolate and identify EPF from forest soils in Indonesia. Soils were collected from five forests: (1) *Tectona grandis* monoculture; (2) *Swietenia macrophylla* monoculture; (3) *Gmelina* sp., *Artocarpus champeden*, Dipterocarp mixed; (4) Dipterocarp primary; (5) *Macaranga* sp. secondary. Four trees (*Calliandra calothyrsus*, *Paraserianthes falcataria*, *Sesbania grandiflora*, and *Cassia siamea*) and three plants *(Sorghum bicolor*, *Allium fistulosum*, and *Trifolium repens*) were grown in the soils to trap EPF. EPF were isolated from roots and isolation rates were calculated. Based on the isolation rates, *P. falcataria* and *S. bicolor* were chosen and grown again in forest soils. EPF were isolated and identified by their rDNA ITS1 region. Twelve and 21 EPF were isolated from 250 roots of *P. falcataria* and 300 roots of *S. bicolor*, respectively. Identified EPF were from genera *Acrocalymma*, *Fusarium*, *Tolypocladium*, *Penicillium*, *Talaromyces*, *Exophiala*, *Dictyosporium*, *Pseudochaetosphaeronema*, *Mariannaea*, *Trichoderma,* and *Mycoleptodiscus*. *Acrocalymma*, *Tolypocladium*, *Penicillium*, *Exophiala*, *Pseudochaetosphaeronema*, *Mariannaea,* and *Mycoleptodiscus* spp. were isolated from only one forest. *Fusarium*, *Talaromyces,* and *Trichoderma* spp. were isolated from more than one forest. The numbers of EPF isolated from *Gmelina* sp., *Artocarpus champeden*, Dipterocarp mixed forest, and *Macaranga* sp. secondary forest were higher than those from other forests, suggesting that different plant species in forests affect the root EPF community.

Key words**:** endophytic fungi, *Paraserianthes falcataria*, *Sorghum bicolor*, tropical forest

Characteristics of soil morphology of high mountain belt in Khuvsgul mountain region, Mongolia

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Abstract
Khuvsgul mountain region is one of the most beautiful places of Mongolia with its natural beauty, wilderness and historical sites. Many types of endangered plant species and wildlife of Mongolia were distributed in high mountain, mountain taiga and mountain forest steppe belts in Khuvsgul region. In the recent years, human activities and climate changes have altered Khuvsgul mountain area, significantly. Mountain soils are particularly susceptible to climate change and intense land use. Thus, prediction and precautions against the land degradation are essential. The basic data of Mongolian soils were insufficient and especially there is very few research on soils from high mountain. Also, the investigations of mountain soils were done not systematically. Morphological characteristics of soil are not enough to distinguish mountain soils from steppe soils, due to distribution of many kinds of soils both in mountain and steppe. In this study, our aim was to provide basic information of the soil morphology of high mountain belt in the Tsotsuul mountain of Khuvsgul region in northern Mongolia.

The study took place at Mt. Tsotsuul which belongs to Khoridol Saridag mountain range. All of study sites were in high mountain steppe. First study site (TSO1) was located on the top of mountain, gentle slope (2407masl.) and second study site (TSO2) was located in upper part gentle mountain side slope (2356masl.). *Dryas-oxyodonta Carex high mountain Steppe* vegetation type was distributed in TSO1 and *Fescue-forb high mountain Steppe (alpine steppe)* vegetation type was distributed in TSO2 study site. The parent materials were limestone in TSO1 and metamorphic rock in TSO2. We did soil profile survey according to the FAO (1990) and soil sampling from each horizons.

The soil depths were only ca. 35cm with gravels in both sites. The A horizons were thin with ca. 19cm depth in TSO1 and with ca. 7cm depth in TSO2. Soil colors were brownish black to dark brown in A horizon and dark greysh yellow to olive brown in B horizon of TSO1. In case of TSO2, the soil colors were brownish black in A horizon and dark brown to brownish black in B horizon. The field texture classes ranged from silty clay to silt loam in TSO1 and silt loam in TSO2. The crumb structure at A horizon had strongly developed in TSO1 in comparison with that in TSO2. And subangular blocky structures at B horizon had developed moderately in TSO1 and weakly in TSO2. As a feature of high mountain steppe soil, the soil horizons were fragile. Plant roots were densely distributed in the surface horizon, gradually decreasing to the lower horizons in both sites. The most prominent feature of the soil profile morphology was found in the lower part of B horizons which were calcic horizons. Accumulation of calcium carbonate ($CaCO_3$) was high at B horizons of both sites as a feature of steppe soil. It is suggested that the difference of the soil chemical properties was caused by the soil parent materials.

Key words: High mountain steppe; soil morphology; Khuvsgul

Phylogenetically distinct methanotrophs modulate methane oxidation in rice paddies and mangrove soils

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Methanotrophs can oxidize methane before it is emitted to atmosphere. However, the biogeographic distribution of active methanotrophs in rice paddies and mangrove soils across Taiwan was poorly understood. We used DNA-based stable isotope probing (DNA-SIP) to show that phylogenetically distinct type I and type II methanotrophs dominated methane oxidation in geographically different paddy and mangrove soils. High-throughput sequencing of soil 16S rRNA and *pmoA* genes under field conditions revealed that a type II methanotroph, *Methylocystis*, was predominant in rice paddy soils. In addition, an uncultured novel type I methanotroph cluster (Rice Paddy Clusters) was detected with the closest relatedness to *Methylocaldum* 16S ribosomal RNA (rRNA) genes in all rice field soils was tested. High-throughput sequencing of ^{13}C-*pmoA* genes indicated the presence of novel methanotrophs that are phylogenetically distantly related to the type I methanotrophs *Methylosarcina* in four out of five non-acidic paddy soils studied, and the high proportions in the ^{13}C-DNA suggested that these uncultured methanotrophs play an important role in methane oxidation. These results provide strong evidence for the environmental selection of phylogenetically distinct methanotrophs under field conditions. Moreover, community shifts in active methanotrophs likely occurred in response to environmental variations with fluctuating methane concentrations. Methanotrophs affiliated with the cluster Deep-sea-5 belonging to Type Ib methanotrophs were the most dominant methanotrophs in the fresh mangrove soils, whereas Type II methanotrophs also appeared in the fresh mangrove soils. High-throughput sequencing of the 16S rRNA gene also confirmed similar differences in methanotrophic communities at the different locations. However, several unclassified methanotrophic bacteria were found by 16S rRNA MiSeq sequencing in both fresh and incubated mangrove soils, implying that methanotrophic communities in mangrove forests may significantly differ from the methanotrophic communities documented in rice paddies.

Key words: DNA-SIP, mangrove, methanotrophs, rice paddy, soil.

Involvement of Microaerophilic Iron-Oxidizing Bacteria in the Iron-Oxidizing Process at the Surface Oxidized Layer of Flooded Paddy Field Soil

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Abstract

Redox cycle of iron (Fe) is the central process in the biogeochemistry of paddy field soil and mediated via biotic and abiotic reactions. Although microorganisms involved in the biotic Fe(II)-oxidizing process and their contributions have not been well clarified yet, a novel microaerophilic Fe(II)-oxidizing bacterium (FeOB), *Ferrigenium kumadai* An22 in the family *Gallionellaceae*, was recently isolated from a paddy field soil (Khalifa *et al*., 2018; Watanabe *et al*., 2013). The present study investigated 1) O_2 profile in the strain A22-grown tubes and 2) community structure of *Gallionella*-related microaerophilic FeOB in the surface thin layer of a flooded paddy field soil microcosm to reveal the optimal O_2 conditions for the growth of microaerophilic FeOB and their involvement in the Fe(II)-oxidizing process at the redox interface of the surface thin layer of flooded paddy field soil.

The gel-stabilized gradient tube method was used for the cultivation of strain An22. In the gradient tubes, modified Wolfe's mineral medium with 0.15% Noble agar was layered on FeS, resulting that opposing gradients of O_2 and Fe(II) were formed. A sharp growth band with deposition of Fe oxides was formed at the optimal position for the growth within 6 days after the inoculation in the tubes, at which the O_2 concentration was ca. 3–4 μM. Compared with the O_2 profile above the growth band, steep decrease in the O_2 concentration was observed at the growth band. The concentration below the growth band was nearly zero. These findings indicated that the active O_2 consumption by *F. kumadai* An22 in the vicinity of the oxic-anoxic interfaces.

In the microcosm experiment, the soil was mixed with pulverized rice straw and incubated under dark and flooded conditions at 25°C for a month. Steep redox gradients were formed at the surface thin layer (0–10 mm in soil depth) of the soil during the incubation: O_2 is rapidly depleted within 2.5 mm in the soil depth, while the amounts of acetate-extractable Fe(II) increased with the soil depth. Quantitative PCR and PCR-denaturing gradient gel electrophoresis (DGGE) analyses of the microaerophilic FeOB 16S rRNA genes suggested active proliferation of the microaerophilic FeOB at the surface thin layer. The copy number of 16S rRNA genes was the highest at the top surface layer (0–2 mm in the soil depth) of the soil. Most of the observed DGGE bands were derived from '*Sideroxydans*' and *Ferriphaselus* in the FeOB cluster of *Gallionellaceae*.

The present study indicated that *Gallionella*-related microaerophilic FeOB were involved in the Fe(II)-oxidizing process at the redox interface of the surface thin layer of flooded paddy field soil.

***Key words*:** Fe(II) oxidation; microaerophilic Fe(II)-oxidizing bacteria; paddy field soil.

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Degree of Saturation, Availability and Dynamics of Phosphorus in Paddy Growing Alfisols of Sri Lanka and Response of Rice (*Oryza Sativa* L.) Plants to Added P Fertilizers

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Abstract
Predicting the response of rice (Oryza sativa L.) plants to added phosphorus (P) fertilizers in many paddy growing Alfisols of Sri Lanka using common soil test methods is difficult because of the complexity in P dynamics in flooded soils. This study examined the variability of different P indices in paddy growing soils of Sri Lanka and response of rice plants to added P fertilizers in soils with contrasting P status. Forty soil samples representing major paddy growing soils of Sri Lanka were analyzed for Olsen-P (O-P), Mehlich 3-P (M3-P), single point P fixation capacity (P_{150}) and degree of P saturation (DPS). Using four soils with contrasting P status, a greenhouse pot experiment was conducted over two months to determine the P nutrition status and growth of rice plants (*var* Bg 250) with and without added triple supper phosphate (TSP). Other nutrients, N, K, and Zn, were supplied at recommended levels. Soil solution was extracted at weekly intervals and analyzed for dissolved reactive P (DRP), pH and cations. A large variation in soil P indices was observed among paddy growing soils with mean ± SD values of O-P: 11.6±10.9 mg kg^{-1}; M3-P: 11.9±13.0 mg kg^{-1}; P_{150}: 414±177 mg kg^{-1}; DPS:3.7±4.8%. The P_{150} did not correlate with P availability indices while DPS was significantly and positively correlated ($r = 0.75$; $p<0.01$). Despite contrasting P availability in the selected four soils (O-P: 6.6 to 54.8 mg kg^{-1}; DRP: 0.008 to 0.631 mg L^{-1}), shoot P concentration was not affected by soil type or TSP application (Fig. 1a). Responses in shoot dry matter contents to TSP application (Fig. 1b) observed were not related to measured P indices or soil solution P dynamics. Growth response of rice plants to added P in flooded Alfisols of Sri Lanka appears to be controlled more by other soil factors than P status of the soil.

Key words: Alfisol, Degree of phosphorus saturation, Dissolved reactive P, Growth response, Rice Phosphorus sorption capacity.

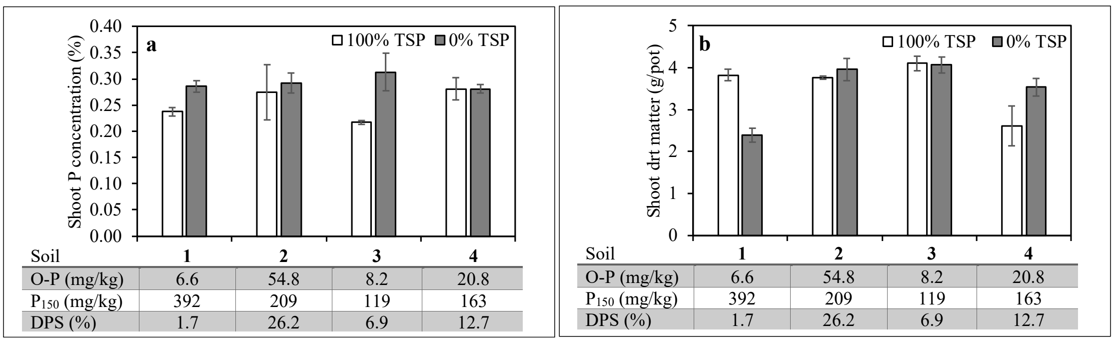

Fig. 1. Shoot P concentration (a) and dry matter content (b) of rice plants grown in four soils with application of 0 and 100% TSP. Different P indices of the soils used are given in the x-axis.

Acknowledgement: This study was funded by National Research Council of Sri Lanka under a target oriented research grant (NRC/TO/16-07).

Investigation of the effect of inter-tillage weeding and no-tillage on the distribution of nitrogen-fixing microorganisms in natural farming rice paddies

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Abstract
Both inter-tillage and no-tillage systems are conducted by “natural farming” rice farmers. Inter-tillage systems are able to improve the physical environment and can minimize weeds. However, several studies indicate that performing tillage every year decreases soil microbial activity. Therefore, most of the natural farming farmers adopt no-tillage to less disturb the soil microorganisms. With no-tillage it is difficult to manage weeds which can inhibit rice growth. “Natural farming” systems do not use any synthetic chemicals and therefore rely on nitrogen-fixing soil microorganisms. Nitrogen- fixing in rice paddies was previously reported to occur in soil surfaces and root zones. This research aims to analyze the effect of weeding on the distribution of nitrogen-fixing microorganisms by investigating the abundance of functional genes and the 16S rRNA gene. Soils were sampled from no-tillage plots and 5-times inter-tillage plots from rice paddies of the Field Science Centre of Hokkaido University. Preliminarily measurements were conducted on soil pH and ammonium (NH_4^+). PH is significant for microbial activity and soil health and rice tends to preferably assimilate ammonium as nitrate. The results indicated that pH varies slightly before and after weeding. Furthermore, soils from 10 cm depth (pH 6.05~6.51) were more acidic than soils from the surface root area (pH 6.33~7.13). Ammonium had higher concentrations in 10 cm depth soils (1.09 ppm) of 5-times inter-tillage plots compared to no-tillage plots. On the soil surface the amount of ammonium in 5-times inter-tillage (0.66~0.68 ppm) is lower than no-tillage (0.70~0.84ppm). Further detailed comparison will be done to connect the preliminary data.

Key words: Rice paddy; Nitrogen-fixing; Inter-tillage and No-tillage; Soil microorganisms

ROLE OF BIOCHAR AND MANURE COMBINATION ON CHEMICAL PROPERTIES OF PADDY SOIL POLLUTED BY MINE TAILING AND THE EFFECT ON RICE (*Oryza sativa*) PRODUCTION

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Yulnafatmawita, S.Yasin, L.Maira, and Adrinal

Rice is still the main food crop for Indonesian. However, some of the rice field was polluted due to use of polluted irrigation from gold main tailing. This research was in form of pot trial in which the soil was taken from polluted rice field in Dharmasraya, a rice production center for West Sumatra, Indonesia. This study was aimed to determine the role of biochar derived from rice husk and manure on reducing heavy metal concentration as well as improving the growth and yield of rice. Combination of biochar (6, 8, and 10 t ha^{-1}) and manure (6, 8, and 10 t ha^{-1}) was applied to soil, and incubated for 15 days prior to rice seedling transpanting. The results showed that application of biochar combined with manure decreased the heavy metals found in the soil by 17.8-59.1%(Ag), 22.2-58.7% (Fe), 17.4-66.7% (Mn), 44.5-53.9% (Al), and 11.9-72.3% (Zn) compared to the soil before being treated. Decreasing heavy metals concentration benefits to the growth of rice crops. Application of biochar and manure was also able to improve soil properties, especially soil OM up to 166%, pH up to 204%, and yield up to 198% compared to withoud biochar and manure addition. Application of biochar and manure was positively correlated to crop growth and yield. Increasing application of biochar and manure was able to increase the root biomass (R^2=0.756), above ground biomass (R^2=0.922) and therefore yield (R^2=0.871) of rice. It is suggested to apply 8 t biochar and 10 t manure per ha to optimally improve soil chemical properties and yield of rice.

Keywords: polluted rice field, biochar, manure, heavy metal,

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Effects of Different Iron Amendments in Paddy Soil on Arsenic Accumulation in Rice Plants

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Abstract

In paddy fields during a period of flooding, topsoils could be possessed of an anaerobic condition, which would promote arsenic (As) absorption by rice plant and enhance As accumulation in grains. The purpose of this study was to evaluate the effectiveness of different iron (Fe) amendments on reducing As concentrations in rice plant. A pot experiment was conducted to simulate rice cultivation in As contaminated soil with different Fe amendments. Soils used in the pot experiment were drawn from a potentially contaminated paddy in Chiayi, Taiwan. Arsenic concentration in the soils was higher than 60 mg kg^{-1}, that is the threshold used in Taiwan to declare soil being As contaminated. Two major Taiwan rice cultivars, TN11 and TCS10, were used for assessing the genotypic variation; TN11 is japonica and TCS10 is indica. The soils were treated with Fe-amendments of ferric oxide and chloride (Fe_2O_3 and $FeCl_3$), respectively. Effects of organic matter (OM) on Fe and As sequestrations in rhizosphere were simultaneously investigated with the pot experiment for the soils combined OM-addition and Fe-amendment. The rice plants were grown in the pots with the variously treated soils for about 150 days until they entering the maturity stage. The plants in each pot were harvested and the rhizosphere soil was simultaneously sampled. Rice plant was divided into root, shoot, and grain. Root samples were washed with sodium dithionite-citrate-bicarbonate (DCB) solution to extract iron plaque on roots surface. All parts of plant samples were then dried, grind, and digested for determining Fe and As concentrations. Iron plaque on rhizosphere soil was also extracted by using DCB solution. Then, the concentrations of Fe and As in DCB extracts and the concentration of As in plant digests were determined by the atomic absorption spectrometry (AAS) and inductively coupled plasma mass spectrometry (ICP-MS). The results showed that the concentrations of As in rice plants were decreased by both Fe_2O_3 and $FeCl_3$ amendments. Nevertheless, the decrease of As accumulation in rice plant was more significant with $FeCl_3$ amendment than with Fe_2O_3 amendment. This could be referred to that the decreased pH by $FeCl_3$ amendment resulted in more poor mobility of As in soil. Moreover, $FeCl_3$ amendment made more iron plaque deposits on root surface, which would be a barrier against As absorption by root. Under the Fe-amendments combined with OM-addition, there was a great variation in the sequestrations of As by iron oxides on root surface and rhizosphere. The As concentrations in grain were reduced by the combined OM-addition which changed the partition of As sequestered by iron oxides between on root surface and on rhizosphere soil. Overall, the correlations of As concentrations in rice plant between As sequestered by iron oxides on root surface were positive, but those on rhizosphere soil were negative. That is, if Fe-amendments and OM-addition could promote more As sequestered on rhizosphere soil rather than on root surface, reductions of As concentrations in rice plant would be found. Nevertheless, it is worth to note that the As concentrations in grain of TN11 were relatively higher than those of TCS10.

***Key words*:** Paddy soil, arsenate, arsenite, iron plaque, radial oxygen loss (ROL).

Effect of Pelletized Urea Biochar Composite on Growth and N Response of Rice Plant

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Abstract

Fertilizer use efficiency (FUE) of urea in paddy cultivation is often less than 30% in Sri Lanka. The excess application of urea losses through volatilization, leaching, denitrification and runoff causing low profits and multitude of environment issues. This study attempted to increase FUE in paddy cultivation through a pelletized urea - rice husk biochar composite (UBC). A pot experiment was conducted to study the effect of produced UBC on growth, N uptake and Fertilizer use efficiency of rice plant (var Bg 251). Treatments consisted: no N fertilizer control; 100%, 75% and 50% of the recommended N level as urea or UBC. The seven treatments were replicated thrice in RCBD experimental design. Greenness of leaves were measured periodically and plant dry weight and total N uptake were measured 60 days after seed germination, grain yield at 14% moisture content and FUE were also calculated. Soil solution was extracted by installing RhizonFlex® pore water samplers and NH_4^+-N- and NO_3^--N contents were measured colorimetrically. Significant (p<0.05) treatment effects were observed in all measured parameters except soil solution N contents. A higher greenness in leaves was observed after 45 days of germination in treatments with 75% and 100% UBC compared to plants in 100% urea treatment (Fig. 1a) probably due to slow release of N from UBC and/or less loss. Application of 75% N and 50% N in the form of UBC produced a dry matter content comparable to that of 100% Urea treatment. Shoot N uptake in 75% UBC treatment was significantly higher than the 75% urea treatment and comparable with 100% urea treatment. Although 10 to 20% of yield increment, when compared to 100% Urea treatment, was observed with 75% UBC and 100% UBC, respectively, they were not statistically significant (Fig. 1b). FUE has improved from 37 - 51% (with urea) to 52 - 61% (with UBC) under conditions of this pot experiment. This study suggests that 25% of the conventional urea application in paddy cultivation could be reduced when N is supplied as UBC. Repeated application of UBC could also enhance the fertility levels of paddy lands in the long run and needs to be investigated in future studies.

Key words: Biochar, Fertilizer use efficiency, Paddy, Slow release fertilizer, Urea

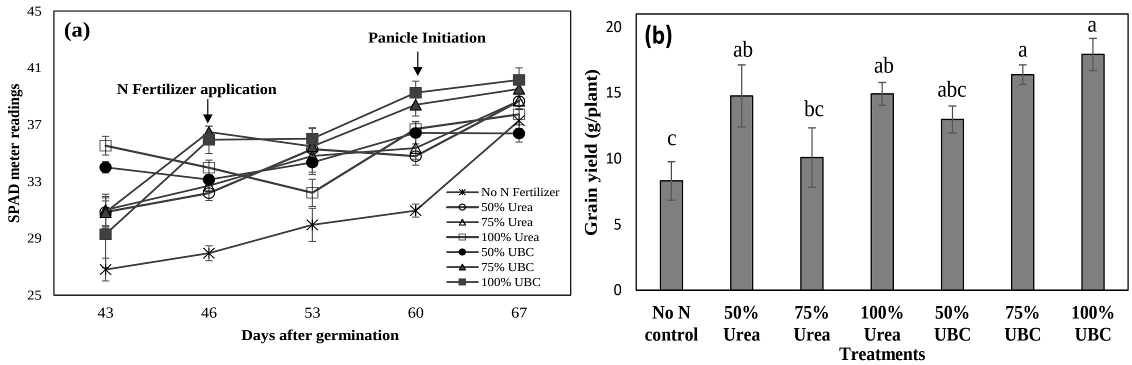

Fig. 1. Variation in the mean greenness of the flag leaves with days after seed germination (a) and grain yield (b) in plants received 0, 50, 75 and 100 % of recommended levels of N as urea or UBC. Error bars at each data point is the SE (n=6 for greenness and n= 3 for grain yield). Bars with the same letter are not significantly different at P<0.05.

Acknowledgment: This study was funded by the National Research Council of Sri Lanka (NRC TO 16-07)

Mobility Characteristics of Inorganic Nutrients from Soil Fertilized with Sewage Sludge Compost

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Abstract

A use of un-used resources such as sewage sludge and animal manure as fertilizer is expected for regional recycling agriculture. However, mechanisms of available nutrient supply from sewage sludge compost to plant has not been deeply understood compared with animal manure compost. This study carried out a column leaching test to determine the mobility characteristics of inorganic nutrients from the sewage sludge compost comparing with the swine manure compost, and to correlate the mobility characteristics with the chemical properties in the sewage sludge compost. Two sewage sludge composts derived from dewatered sludge and residue of methane fermentation were collected and used for an up-flow column leaching test (hereinafter referred to Sewage A and Sewage B, respectively). The soil sample was prepared mixing andosols and silica sand at a weight ratio of 25:75. The compost was mixed with the soil sample at 200 mg-P_2O_5/kg. These were packed in a glass column (inner diameter 2.0 cm and height 10 cm). The treatments of swine manure compost (Swine) and non-amendment (Blank) were prepared. Ultra-pure-water was up-flowed at a rate of 0.2 ml/min using a constant flow pomp, and the leachate was collected every 2 pore volume (PV: cm^3). After measurement of leachate weight, values of pH and EC, and concentrations of inorganic nutrients and water-soluble organic carbon (WSOC) were analyzed. The total phosphorus (P) content and P phases by sequential extraction in the compost were determined for evaluation of chemical properties of composts. The P concentrations in the leachate were low throughout the column test. Within these, the P concentrations in Swine were relatively higher than in Sewage A and Sewage B where those were compatible with each other. This would be because the ratio of readily soluble P which is defined as the sum of fractions 1+2 obtained by the sequential extraction, to the total P content in the compost was low in Swine A (31.5%) and Swine B (24.4%). In contrast, this ratio was high at 63% in Swine. Also, the lower P concentration in the leachate from the soil with the sewage sludge composts would explanted by the higher ratio of fraction 3 (relatively insoluble) to total P at 34% and 34.5% for Sewage A and Sewage B, respectively. This ratio in Swine was 10.6%. The higher ratio of fraction 3 in Sewage A and Sewage B would result from the higher total Fe and Al contents. The positive liner relationships between the contents of fraction 3 and the total Fe content as well as total Al content, respectively, in the sewage sludge composts were observed, which suggests that the Fe and Al in the sewage sludge compost retained the P, resulting in the relatively low P mobility in the soil.

Key words: available nutrient; column leaching test; migration; phosphorus; sewage sludge compost.

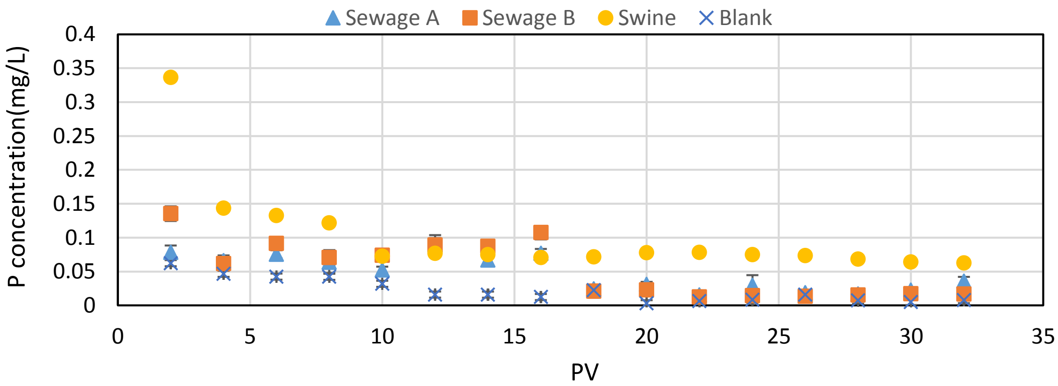

Fig. 1. Phosphorus concentration in leachate from soil with sewage sludge compost

The Effects of Biochar, Poultry Manure and their Mixture on Soil Properties, Growth and Yield of Cocoyam Grown on a Severely Degraded Sandy Soil of Southwestern Nigeria

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Abstract
Field experiments were conducted over two years, 2017 and 2018, to evaluate the effects of biochar (B) and poultry manure (PM) on soil physical and chemical properties, growth and cormel yield of cocoyam. The experiment each year consisted of 4 x 2 factorial combinations of biochar (0, 10, 20 and 30 t ha^{-1}) and poultry manure (0 and 7.5 t ha^{-1}). Results of the study indicated that application of biochar and poultry manure alone, and in combination, improved soil physical and chemical properties, growth and cormel yield of cocoyam. In both years, the application of biochar and poultry manure alone or their combination significantly increased the soil pH, and concentrations of organic carbon (OC), N, P, K, Ca and Mg, as well as plant height, number of leaves, leaf area and cormel yield of cocoyam compared with the control. In both years, there was a significant interaction effect of biochar and poultry manure (B x PM) and this was attributed to the ability of the biochar to increase the efficiency of the utilization of the nutrients in the poultry manure. It was found that combination of 30 t ha^{-1} biochar and 7.5 t ha^{-1} poultry manure (B_{30} + $PM_{7.5}$) gave the highest cormel yield of cocoyam. Averaged over the two years, application of biochar at 30 t ha^{-1} and poultry manure at 7.5 t ha^{-1} (B_{30} + $PM_{7.5}$) significantly increased cormel yield of cocoyam by 51, 64, 80 and 104% as compared with biochar alone at 30 t ha^{-1}, biochar alone at 20 t ha^{-1}, biochar alone at 10 t ha^{-1} and no application of B or PM (control) respectively. The combination of 30 t ha^{-1} biochar and 7.5 t ha^{-1} poultry manure (B_{30} + $PM_{7.5}$) exhibited the highest impact and is therefore recommended for soil sustainability and cocoyam productivity on sandy soil.

***Keywords*:** Biochar; cocoyam; cormel; poultry manure; soil physical and chemical properties;

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Microbial immobilization of ^{15}N labeled ammonium and nitrate following addition of polysaccharide with different quality

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Abstract

Plant residues as a carbon (C) source is often applied in combination with inorganic nitrogen (N) fertilizer in the cropping systems; N loss may potentially be lowered as fertilizer-N could be temporarily immobilized due to the microbial decomposition of plant residue. Various crop residues applied to soil often result in different N immobilization-mineralization turnover, but little attention has been given to different N forms, leaving their potential interactions unevaluated. In this study, starch and cellulose were used to represent different polysaccharide-C quality in crop residue, and their effects on the immobilization of fertilizer-N in two forms (NH_4^+-N and NO_3^--N) were investigated. Application rates of the polysaccharides and N were 0.5%(w/w) and 100 mg N kg^{-1} soil, respectively. During a 48-day soil incubation at 25°C, soil respiration was measured to indicate microbial activity, and labeled ^{15}N was used and quantified to trace fertilizer-N dynamics. In the starch treatment, maximum fertilizer-N immobilization occurred at 3 and 7 days after incubation for NH_4^+-N and NO_3^--N addition, respectively, which was earlier than that in the cellulose treatment (28 days for both NH_4^+-N and NO_3^--N additions). Magnitudes of the maximum fertilizer-N immobilization was significantly ($P < 0.01$) higher with NH_4^+-N than NO_3^--N addition in the cellulose treatment (60.0% vs. 36.0% of added N), but did not differ between N forms in the starch treatment (53.6% vs. 54.3% of added N). The earlier occurrence of the maximum N immobilization in the starch treatment was due to its faster decomposition, as evidenced by the higher cumulative soil respiration during the early incubation period, compared to the cellulose treatment. The different maximum N immobilization between N forms in the cellulose treatment suggested that NH_4^+-N was preferentially assimilated to microbes compared to NO_3^--N, but no difference was found in starch treatment. Our results showed that exogenous C quality and fertilizer-N form interactively affected fertilizer-N immobilization, and no preferential N assimilation (i.e., NH_4^+-N over NO_3^--N) occurred when more labile C (e.g., starch) was the dominant C source. Our findings also have important implications for managing inputs of different crop residue quality and fertilizer type to improve N synchrony in the cropping systems.

Key words: Exogenous C quality; ^{15}N-labeled fertilizer; nitrogen form; nitrogen immobilization.

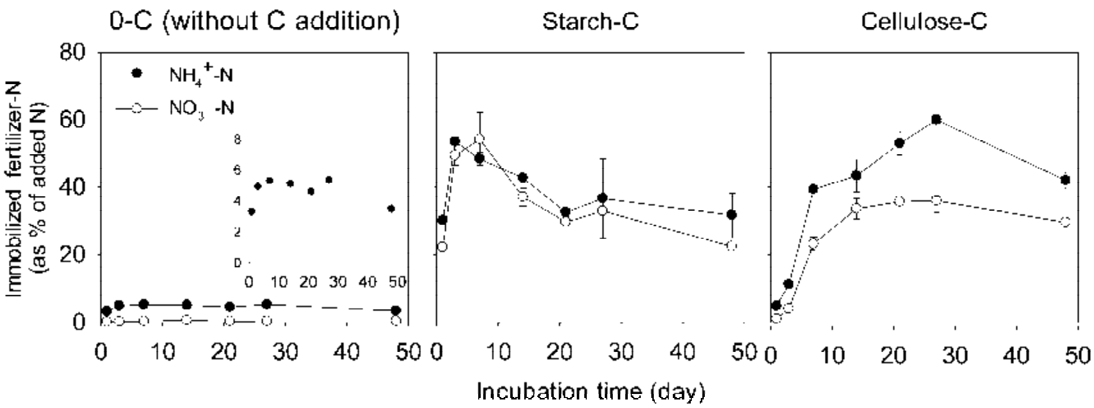

Fig. 1. Immobilized fertilizer-N (as % of added N) vs. time under different C source for NH_4^+-N and NO_3^--N. Error bar represents standard error of the mean.

Effects of Combined Organic-Inorganic Fertilization to Rice Productivity and Nitrogen Use Efficiency

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Abstract
The global rice production systems face the challenge of meeting the increasing demand in a manner that is sustainable. An integral part of this challenge is fertilizer application coupled with the adoption of science-based management practices to achieve sufficient rice production while reducing the economic and environmental costs. This study aimed to determine the effects of using organic and inorganic fertilizers in increasing hybrid rice production and nitrogen use efficiency (NUE). A paddy field measuring about 350-m^2 was prepared for the study. Rice seedlings were transplanted after the first basal fertilizer application, and all required phosphorus (P) and potassium (K) were applied uniformly in all treatments. N was applied using ^{15}N labelled urea in varying amounts equivalent to 0, 45, 90, and 135 kg N/ha and supplemented with 0.3t/ha organic fertilizer. Agronomic data were gathered accordingly, nitrogen derived from organic fertilizer (NDFO) was calculated based on control treatments while inorganic fertilizer nitrogen use efficiency (%FNUE) was quantified using ^{15}N tracer measured through isotope ratio mass spectrometry. The results show that the application of 135 kg N/ha resulted in the highest amount of biomass, averaging at 29.12 t/ha. However, this was not significantly different ($p > 0.05$) from biomass obtained from the application of 45 and 90 kg N/ha. On the average, the application of 45 kg N/ha resulted in the highest amount of grain yield among all treatments. Subsequent increase in fertilizer application did not have a significant effect ($p > 0.05$) on grain yield across all experiments. Generally, N derived from fertilizer (NDFF) was significantly highest ($p < 0.05$) with 135 kg N/ha fertilizer application, but FNUE were statistically the same ($p > 0.05$) across all treatments. N derived from organic fertilizer (NDFO) and soil (NDFS) also did not have significant differences ($p > 0.05$). These results indicate that the use of organic fertilizer considerably reduced the amount of nitrogenous inorganic fertilizer needed (45 kg N/ha) to achieve optimum yield, while maintaining FNUE. Thus, organic fertilizer can be an effective amendment for sufficiently and sustainably meeting the increasing demand for rice while also improving the soil physico-chemical condition.
Keywords: Inorganic fertilizer, organic fertilizer, isotope tracer, nitrogen use efficiency, rice production.

Table 1. Grain yield, NDFF, NDFO, NDFS, and FNUE of hybrid rice as affected by N fertilization and across seasons in Vertisol of Bulacan, Philippines.

Season	N Levels (kg/ha)	Grain Yield (t/ha)	±SD	Sig	NDFF (%	±SD	Sig	NDFO (%)	±SD	Sig	NDFS (%)	±SD	FNUE (%)	±SD	Sig
Wet Season	0	2.80	0.75	b	-	-	-	-	-	-	-	-	-	-	-
2016	45	4.43	0.73	a	17.57	0.52	b	36.60	7.89	a	45.84	7.85	35.81	5.61	a
	90	4.73	0.59	a	28.33	6.64	ab	24.02	8.49	a	47.65	11.28	29.34	14.09	a
	135	5.05	0.13	a	37.18	5.41	a	26.24	7.87	a	36.58	2.62	31.01	2.54	a
2017	0	9.37	0.32		-	-	-	-	-	-	-	-	-	-	-
	45	11.76	0.87		7.66	3.30	b	49.41	7.11	a	42.93	5.14	32.07	13.29	a
	90	9.70	1.61		14.70	3.51	b	47.22	3.60	a	38.08	2.16	35.06	9.12	a
	135	9.87	1.29		24.25	2.13	a	41.85	4.74	a	33.90	6.44	44.77	13.09	a
Dry Season	0	5.71	0.70		-	-	-	-	-	-	-	-	-	-	-
2016	45	8.44	0.87		23.23	3.49	c	4.08	5.18	a	72.69	3.14	81.31	13.19	a
	90	7.18	1.89		33.87	3.51	b	6.39	8.51	a	59.75	5.09	70.56	6.07	a
	135	8.35	1.19		43.42	2.13	a	2.07	3.59	a	54.51	4.42	59.48	13.96	a
2017	0	8.25	3.29		-	-	-	-	-	-	-	-	-	-	-
	45	9.84	2.71		25.68	3.12	b	18.92	9.26	a	55.39	9.23	62.78	14.50	a
	90	9.27	0.90		37.02	1.35	a	16.32	9.09	a	46.65	7.87	53.42	8.14	a
	135	8.70	0.77		42.09	1.63	a	17.52	4.64	a	40.39	3.91	46.21	4.11	a

Means with the same letter are not significantly different from each other at P>0.05

Role of plant growth promoting bacteria *Brevibacterium linens* RS16 in rice (*Oryza sativa* L.) cultivars to ameliorate salt stress by accumulation of proline and glycine betaine

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Rice (*Oryza sativa* L.) is one of the major staple food crop in the world, but highly sensitive to salinity. Under salt stress, rice plants are affected by oxidative stress, ionic imbalance and osmotic stress, all of which results in the overall reduction of plant growth and grain yield. Many studies showed proline and glycine betaine to be mitigating factors preventing salt-stress injury in rice plants, but very few studies were conducted to evaluate the inoculation effect of plant growth promoting bacteria to regulate the accumulation of proline and glycine betaine in plant. This study mainly focused on proline and glycine betaine accumulation under salt stress as part of plant defense mechanisms, and their regulation by inoculation of *Brevibacterium linens* RS16 in rice plant. The interaction of four major factors including effects of inoculation, length of salt stress exposure, level of salt stress and rice cultivar types were explored in this study. Results of the study clearly showed the debilitating effects of salt stress on both the salt-sensitive cultivar (IR29) and the moderately salt-tolerant cultivar (FL478) in terms of reduction of plant growth parameters especially total dry weight. The significant decrease of plant biomass in the salt-sensitive cultivar compared to the moderately salt-tolerantly cultivar were alleviated significantly by *B. linens* RS16 inoculation under salt-stress conditions. Proline and glycine betaine accumulation in the whole plant were consistently higher in the moderately salt-tolerant cultivar but inoculation of *B. linens* RS16 significantly increased the proline and glycine betaine accumulation only in the salt-sensitive cultivar (IR29) after 10 days under 50 mM (35.7% and 38.54%, respectively) and 150 mM (37.7% and 39.55%, respectively) salt stress conditions. In conjunction with ameliorating salt stress, high levels of proline and glycine betaine synthesis in the inoculated salt-sensitive cultivar (IR29) compensate deleterious effect of salt stress through increasing total length and dry weight of plant which indicated that the intracellular osmotic potential, oxidative and ionic stress may balance. Overall, this study will be useful to explore novel characteristics of plant growth promoting rhizobacteria (PGPR) under salt stress conditions and further outline the feasibility of *B. linens* RS16 inoculation to alleviate salt stress in realistic biological settings in field conditions as a cost effective strategy to cope with salt-stress.

Key words: Salinity; Proline; Glycine betaine; *Brevibacterium linens* RS16; plant growth promoting rhizobacteria (PGPR).

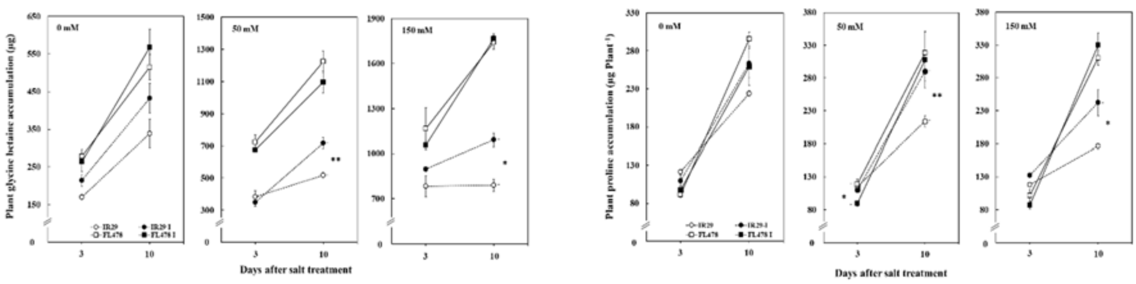

Fig. 1. The total proline and glycine betaine accumulation (µg) of the salt-sensitive cultivar (IR29) and the moderately salt-tolerant cultivar (FL478) at 3 and 10 under 0, 50 and 150 mM salt stress. ** is significant at p< 0.01; * is significant at p<0.05

Response of Paddy (*Oryza Sativa* L.) under Spatially Varying Levels of Soil Phosphorus and Potassium

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Abstract

Site specific nutrient management (SSNM) decisions lead to sustainable management of phosphorus (P) and potassium (K), resulting in economic and environmental benefits. Assessment of the crop responses under spatially variable soil P and K levels is important to develop site-specific fertilizer recommendations. The objective of this study was to investigate the yield response of paddy under spatially varying levels of available soil P and K. At the onset of the growing season, surface (0-15 cm) soil samples were obtained from 71 paddy fields distributed over 15544 km^2 area of Sri Lanka. These samples were analyzed for Olsen-P and Mehlich 3-K. Three experiment plots (3×6 m) were established at each site comprising of N, P and K applied, and P and K omission treatments. Other nutrients were supplied for omission treatments at recommended levels and the total yield of each plot was recorded at the end of the growing season. The coefficient of variance (CV) of the initial P and K levels (78% and 41%, respectively) indicated a considerable spatial variability of available P and K contents of paddy growing soils. The results showed that 17% of fields had P levels higher than the recommended level (> 10 mg kg^{-1}) and 52% and 31% of fields were medium (5 – 10 mg kg^{-1}) and low (< 5 mg kg^{-1}) levels of P, respectively. Soil K level was higher than the recommended level (80 – 160 mg kg^{-1}) in 70% of sites, whereas 24% and 6% of sites showed low (< 40 mg kg^{-1}) and medium (40 – 80 mg kg^{-1}) levels of K, respectively. The Fig. 1 shows weak responses of yield for applied P and K. The average yield of nutrient applied fields (5.5 Mg/ha, *SE*=0.2 Mg/ha) was slightly higher than the average yield of P (5.3 Mg/ha, *SE*=0.2 Mg/ha) and K (5.3 Mg/ha, SE=0.2 Mg/ha) omission fields. Further, paired samples *t*-test revealed that these differences of average yields were not statistically significant (P>0.05). Our results indicated that spatial variability of soil P and K levels do not effect on the yield response of paddy possibly due to short term availability of nutrients from soil reserves built up due to long-term application of P and K, and nutrient supply from other inputs.

Key words**:** Phosphorus, Potassium, Site-specific nutrient management, Paddy.

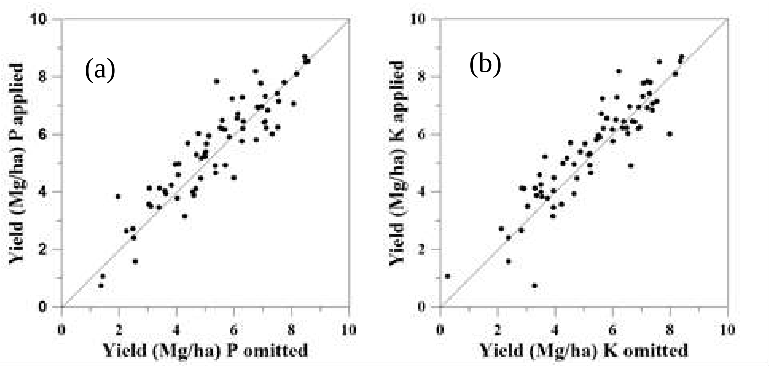

Fig. 1. Yield response of paddy for (a) P and (b) K.

Acknowledgement: This study was funded by the National Research Council of Sri Lanka under a target oriented research grant (NRC/TO/16-07).

Yield and N use efficiency of Rice and Peanut applied with Different Soil Amendments in Acid Upland Soil Affected with Periodic Drought

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Abstract

The study was conducted to assess the yield and nutrient use efficiency of rice and peanut in acid upland soil exposed to periodic drought condition applied with lime, organic materials and microbial inoculants. Two types of organic amendments (vermicompost and farmyard manure) added alone or in combination with microbial inoculants (BioGroe™ and Formula 4) were applied in upland rice. NitroPlus was the microbial inoculant used in peanut. Addition of organic materials alone or in combination with microbial inoculants significantly increased grain yield over the control with and without lime. Without lime, higher yield and total NPK uptake were obtained from the combined application of microbial inoculants and organic amendments particularly farmyard manure + BioGroe™. Agronomic use and recovery efficiencies of N were improved with the combined application of organic amendments and microbial inoculants particularly vermicompost + BioGroe™.

Key words: N uptake; agronomic efficiency; recovery efficiency; organic amendments, microbial inoculants

Table 1. Grain yield of rice under lime and soil amendments*

SOIL AMENDMENTS	**GRAIN YIELD (t ha^{-1})** *	
	Without lime	With lime
Control (Farmers Practice)	0.83 b	1.02 b
Inorganic Fertilizer	1.18 ab	1.65 a
Vermicompost	1.44 a	1.45 ab
Vermicompost + BioGroe™	1.50 a	1.68 a
Vermicompost + Formula 4	1.46 a	1.52 ab
Farmyard Manure	1.33 ab	1.79 a
Farmyard Manure + BioGroe™	1.60 a	1.69 a
Farmyard Manure + Formula 4	1.56 a	1.60 a

*In a column, means followed by the same letter(s) are not significantly different at P<0.05 according to Tukey's HSD test.

Fertility Re-Evaluation of Paddy Soils after 50 Years of the Green Revolution (FREPS 50) ~ A Case Study in the Philippines ~

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Abstract

The "Green Revolution (GR)" was initiated in tropical Asian countries in the late 1960s and has contributed to improving food production and self-sufficiency in those countries. In those days, Kawaguchi & Kyuma (1977) investigated physicochemical properties of 410 paddy soils in 9 tropical Asian countries. Owing to the GR, the rice yield in the Philippines increased from 1.2 t ha^{-1} in 1964 to 4.0 t ha^{-1} in 2014. The objective of our research was to examine the changes in paddy soil fertility over the last 50 years in the Philippines, so that we speculate the impact of the GR. We collected 37 soil samples from the plow layers of paddy fields in Luzon, Leyte, Panay and Mindanao in the Philippines in 2016 and 2017 (named as 2010s). These sampling sites were located at the same or close to the original sampling sites in 1969 (named as 1960s) as reported in Kawaguchi & Kyuma (1977). We analyzed physicochemical properties of the soils in 2010s, using the same analytical procedures adopted in 1960s. By using the equations obtained by the factor analysis of the data set from 9 tropical Asian countries in 1960s, three factor scores, i.e., inherent potentiality (IP), organic matter and nitrogen status (OM) and available phosphorus status (AP), were calculated for the soils in 2010s. The mean values of soil properties and the factor scores in 2010s are compared to those in 1960s (Table 1). The levels of total P (TP), available P (Av-P) and exchangeable Ca (Ex-Ca) in 2010s were significantly higher than those in 1960s. These differences were probably attributed to high input of P fertilizers (e.g., monocalcium phosphate) under the GR. However, about one third of the soils in 2010s still had the deficient levels of Av-P for rice production. The significant increase in available Si (Av-Si) was also observed in the same period, which may be caused by the supply of Si through irrigation water. With respect to the factor scores, AP significantly increased, whereas IP and OM tended to increase and decrease without statistical significance, respectively. The increase of AP reflected the improvement of Av-P. Increasing trend of IP may be due to the increase of Av-Si. Decreasing trend of OM may reflect the decrease of total carbon (TC) and available nitrogen (NH_4-N), and indicated the decrease of the organic matter. In 1960s, the soils of the Philippines were relatively higher in IP and OM but intermediate in AP among the 9 countries, which could be ascribed to their nature as derived mostly from volcanic ejecta. So, it is suggested that the significant increase of Av-P and Av-Si are factors to increase the rice yield. Thus, we concluded that the soil fertility of paddy fields in the Philippines had been improved during 50 years of the GR implementation. On the other hand, the further input of phosphorus fertilizer in accordance with plant requirement and continuous application of organic matter is recommended for sustainable enhancement of rice production.

***Key words*:** Factor analysis; Green revolution; Paddy fields; Philippines; Soil fertility.

Table 1. Changes in physicochemical properties and three fertility-related scores of paddy soils in the Philippines from 1960s to 2010s (data of 1960s cited from Kawaguchi & Kyuma 1977)

		Mean		t-test
		1960s	2010s	
pH		6.39	6.62	ns
TC	g kg^{-1}	20.6	18.5	ns
TN	g kg^{-1}	1.71	1.81	ns
NH_4-N	mg N kg^{-1}	205	144	ns
TP	g P_2O_5 kg^{-1}	1.13	1.64	**
Av-P	mg P_2O_5 kg^{-1}	25.2	149	**
HCl-P	mg P_2O_5 kg^{-1}	126	199	ns
Ex-Ca	$cmol_c$ kg^{-1}	13.6	18.9	**
Ex-Mg	$cmol_c$ kg^{-1}	8.20	8.62	ns
Ex-Na	$cmol_c$ kg^{-1}	1.86	0.57	**
Ex-K	$cmol_c$ kg^{-1}	0.46	0.40	ns
CEC	$cmol_c$ kg^{-1}	24.9	30.9	*
Av-Si	mg Si kg^{-1}	208	295	**
Sand	%	28.7	22.3	ns
Silt	%	31.4	44.3	**
Clay	%	39.9	33.4	ns
IP[1)]		0.478	0.615	ns
OM[2)]		0.427	0.145	ns
AP[3)]		0.090	1.210	**

Paired t-test; *: $p<0.05$, **: $p<0.01$,
ns: not significant between 1960s and 2010s.
[1)] Inherent potentiality, [2)] Organic matter and nitrogen status, [3)] Available phosphorus status.

Table 2. The factor loading matrix of factor analysis

	IP	OM	AP
TC	0.29	0.91	0.12
TN	0.17	0.97	0.15
NH_4-N	0.11	0.67	0.05
TP	0.48	0.41	0.53
Av-P	0.09	0.10	0.94
HCl-P	0.18	0.04	0.88
Ex-Ca+Mg	0.94	0.05	0.15
Ex-K	0.78	0.25	0.30
CEC	0.94	0.28	0.11
Av-Si	0.80	0.12	0.22
Sand	−0.49	−0.32	0.09

Effects of the Green Revolution on long-term changes of fertility status of paddy soils in tropical Asia

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Abstract
Understanding of the long-term trend of soil fertility status would be essential to deduce the cumulative impacts of agricultural management on soils and to establish rational soil management for the future. For example, positive effects of the Green Revolution (GR) on rice yield has been clearly demonstrated in tropical Asia during the last 50 years, but the long-term effect of the GR on fertility status of paddy soils is not fully understood. The objective of this research was, therefore, to evaluate the effect of the GR on the changes of soil fertility status in the last 50 years, as case studies in Thailand, Philippines and Malaysia. These countries were selected because Thailand had very low soil fertility level as represented by the northeast region (Khorat), Philippines was the center of the GR as headquartered by IRRI and had high soil fertility level reflecting volcanic activities, and Malaysia introduced the GR technologies intensively based on rapid economic growth to improve widely-distributed peaty marsh soils.
In 2015-2017 (named as 2010s), 65, 37 and 40 soil samples were collected from the plow layers of paddy fields in Thailand, Philippines and Malaysia, respectively. The sampling sites were placed at the same or close locations of the original sampling during 1964 to 1972 (named as 1960s) reported in Kawaguchi & Kyuma (1977). Fertility-related physico-chemical properties of the 2010s samples were analyzed: pH, EC, total carbon (TC), total nitrogen (TN), available N, available phosphorus (P) (Bray No.2 method), 0.2 mol/L HCl extractable P (HCl-P), total P, exchangeable bases (Ca, Mg, K, Na), CEC, particle size distribution, available silicon (Si) and clay mineral composition. Factor scores of the soils in 2010s were calculated based on the equations obtained using the overall soil data from 9 tropical Asian countries collected in 1960s. The soil properties and factor scores in 2010s were then compared with those in 1960s.
In Thailand, pH, TC, TN, available N, available P, HCl-P and exchangeable K in 2010s were significantly higher and exchangeable Mg and clay contents in 2010s were significantly lower than those in 1960s. Regionally, soil fertility levels in the northeast region were still significantly lower than other regions in the 2010s. In the Philippines, available P, exchangeable Ca, available Si and CEC increased significantly and exchangeable Na and C/N ratio decreased significantly. In Malaysia, significant increase was observed for pH, available P, HCl-P, Total P, CEC and exchangeable Ca and K and significant decrease was observed for TC and exchangeable Mg and Na. In relation to factor scores, available phosphorus status (AP) increased drastically in all the countries, whereas organic matter and nitrogen status (OM) tended to decrease except the increase in Thailand, and inherent potentiality (IP) remained relatively constant (Table 1). These would be due to high input of chemical fertilizers (N, P and K) and increased cropping times due to irrigation. Based on these results, availability of P of the paddy soils in these three countries was improved drastically during the last 50 years of the GR while the trend of organic matter content was variable suggesting the importance of careful maintenance under intensive agriculture. In conclusion, region-specific rational soil management needs to be established for sustainable agricultural production and environmental conservation in accordance with variable fertility levels among countries and among regions in each country.
***Key words*:** Available phosphorus, fertility status; Green Revolution; paddy soils, tropical Asia.

Table 1 Changes of fertility-related factor scores of the 3 countries during the last 50 years

Country	IP-2010s	IP-1960s	OM-2010s	OM-1960s	AP-2010s	AP-1960s
Thailand	-0.63**	-0.37	0.10**	-0.38	0.91**	-0.68
Philippines	0.61	0.48	0.14	0.43	1.21**	0.09
Malaysia	-0.33	-0.55	1.10	1.41	1.45**	0.05
All	-0.22	-0.20	0.39	0.33	1.14**	-0.27

Factor score 0 represents the overall average of soil samples from 9 tropical Asian countries in 1960s.

The effects of N application methods on N recovery and grain yield of dry direct-seeded rice in north-east Japan

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Abstract

Dry direct-seeded rice (DSR) is becoming an important option for rice farmers in Japan because of its lower cost and labor demands compared with conventional transplanted rice cultivation (TPR). One of the disadvantages of DSR, however, is low nitrogen use efficiency (NUE), so the use of controlled-release fertilizer (coated urea, CU) is commonly recommended in Japan. However, CU is about five times as expensive as normal urea (NU) per g-N, which decreases the low-cost advantage of DSR. Split-application of NU is an alternative, but its efficacy has not been examined for DSR in northeast Japan located in a cool temperate zone. In this study, we therefore compared the growth, N uptake, and yield of DSR grown in different N fertilizers regimes such as CU application and split application of NU in addition to no N application, to explore efficient N management for DSR.

A field experiment was conducted in Morioka City, Iwate Prefecture, Japan, during the 2018 growing season. The soil was andosol. The experiment had three N treatments (0N, coated urea, and split application of normal urea) with a combination of two cultivars (‘Akitakomachi’, AK, and ‘Yumiazusa’, YA). Nitrogen was applied at the rate of 12 g-N/m^2 in the coated urea treatment (as basal) and 15 g-N/m^2 in the split-application of normal urea treatment (at 41: 6 g-N/m^2, DAS 67: 3 g-N/m^2, DAS 83: 3g-N/m^2 and DAS 95: 3 g-N/m^2). AK is a major cultivar in northeast Japan, whereas YA is a recently released high-yielding cultivar with high eating quality.

Apparent N recovery rate, defined as the difference in N uptake between fertilized and non-fertilized plots measured at the heading stage, was generally low ranging from 21% for AK-CU to 29 % YA-NU, but the treatment effects were not significant (Table 1). Brown rice yield of YA was significantly higher than that of AK (P < 0.001) , whereas no significant difference was observed between CU and NU (Table 1). The interaction between N treatment and cultivars was not significant in apparent N recovery, N uptake, and brown rice yield. These results suggest that split-application of NU can be an alternative to expensive CU application and that higher yielding ability of YA at all N treatments will help to reduce the cost per product. However, N recovery is still generally low with the current application method, which needs significant improvement.

Key words**:** dry direct-seeded rice; N recovery; coted urea; split application.

Table 1. N uptake, apparent N recovery, and brown rice yield of different N treatments in DSR.

	N uptake at heading stage(g-N/m^2)		Appearent N recovery rate at heading stage(%)		brown rice yield(g/m2)	
	‘Akitakomachi’	‘Yumiazusa’	‘Akitakomachi’	‘Yumiazusa’	Akitakomachi	‘Yumiazusa’
0N	4.84	4.95	-	-	317	367
coated urea	7.86	7.88	26.3	25.5	467	497
normal urea	7.88	9.08	21.2	28.8	395	498
ANOVA						
cultivars	n.s.		n.s.		**	
N treatments	***		n.s.		***	
cultivars*N treatments	n.s.		n.s.		n.s.	

Brown rice yield is expressed on the 15% moisture content basis. ***, P < 0.001; **, P < 0.01; n.s. not significant (P > 0.10).

Digital assessment of soil physical quality in the central region of Taiwan

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Abstract
Soil physical quality is important for plant growth, which related to the root elongation and respiration, water supply, and nutrient balance. There are many indicators used to evaluate the physical quality of soils, but an integrated method to assess the soil physical quality based on different measurable parameters is still limited. In addition, detailed spatial information on soil physical properties are also limited. The objective of this study is to model and map integrated soil physical index for plant growth based using digital soil mapping and assessment techniques. The study area is in central Taiwan, and four soil physical observations: bulk density (BD), aggregate stability in water (AS), available water content (AWC), and saturated hydraulic conductivity (Ksat) were used in this study. A machine learning model (Random forest, RF) and Regression kriging (RK) approach were used for modeling and mapping the four physical properties with the help of several covariates (i.e., DEM, Sentinel-1, Sentinel-2, land use, and soil type data). The resulting maps are at 20 m resolution with uncertainty of prediction. The prediction values were transformed into a soil physical quality index using membership functions and inference rules. The results showed that the prediction accuracy of RK approach was higher than RF model, and the prediction accuracy of BD was higher than the other soil properties. The results of physical quality index indicated that the topsoils of central Taiwan has a good structure (in terms of BD and AS) and the limiting factors are AWC and Ksat. The most limiting physical quality is the relatively high values of Ksat, which contributed to be the lowest quality index for most of the study area. According to these results, it suggests that the plant growth could be improved by appropriate water management in the study area to increase water storage and prevent leaching.

***Key words*:** soil physical quality; soil quality; digital soil mapping; plant growth.

Alleviating soil compaction under rice-upland crop rotations with deep tillage leads to increased nutrient availability and rice yield in a long-term experiment

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Abstract

In the Mekong Delta, farmers are currently confronted with problems of declining soil productivity. A declining trend in rice yield has been exhibited over recent years, despite the efforts of farmers to increase rice yield by applying chemical fertilizer even above recommended rates. Therefore, the objectives of this study were to (i) compare concentrations of nutrients in soil depth intervals that are penetrated by roots under monoculture rice and rice-upland rotations, (ii) identify factors confounding rice yield by assessing relationships between these soil nutrient stocks and rice yield and (iii) evaluate the effect of rotating rice with upland crops on rice yield and economic benefit sequence in a long-term experiment. A field experiment was conducted for 10 years using a randomized complete block design with four treatments and four replications: (i) rice–rice–rice (control – conventional system as farmers' practice), (ii) rice–maize–rice, (iii) rice–mung bean–rice, and (iv) rice–mung bean–maize. Our study indicated that the increases in rice rooting depth and root mass density in upland-rice rotations relative to the rice monoculture were strongly associated with a decrease in bulk density and penetration resistance, and an increase in porosity, macro-porosity and aggregate stability index at 20–30 cm depth. Rooting zone stocks of almost all nutrients were higher in rice-upland crop rotation systems compared with rice monoculture system from 1.11 to 1.94 times. It thus appears that there exists a correlation between rice growth, rice yields and available nutrient stocks through enhanced rooting depth and both are indirectly linked via strongly mutually correlated physical soil traits in the subsoil.

Key words: clayey soil; crop rotation; root biomass; nutrient availability.

An evaluation of Quantity-Intensity Relationship of Potassium on some low land rice growing soils.

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Abstract

Potassium (K) supplying capacity of some low land rice growing soils was investigated by employing the quantity-intensity (Q/I) approach. The values of potential buffering capacity (PBC^K), labile (K_L), Specific K (K_O), specific K sites (K_X), equilibrium activity ratio (AR^K) and free energy change ($-\Delta G$) were estimated from the quantity-intensity curve. Non-specific K values changes with clay mineralogy and organic matter content. Higher cation exchange capacity and organic carbon favours labile K pool. Low equilibrium activity ratio indicates that bulk of K was preferentially held at edge position of the clay crystals. Higher potential buffering capacity (PBC^K) indicates excellent K-status. PBC^K is directly proportional to the free energy change of potassium. The changes of Q/I parameters is associated with the contents of clay, organic matter and clay mineralogy of the soil. Higher exchangeable cations in soil matrix favours labile K, specific K and specific K sites.

Keywords; quantity-intensity relationship, labile K, specific K, specific K sites, free energy change, equilibrium activity ratio.

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IMPACT OF IMPROVING CHEMICAL PROPERTIES OF NEWLY ESTABLISHED ACID SULPHATE SOILS FOR PADDY GROWTH

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This research aims to determine the effect of leaching on soil characteristics, water quality, and the benefit of inorganic fertilizer and local organic matter to support a new established filed of rice growth on actual sulfuric acid soil. The research began with composting in the Belandean experimental field, pot experiments in greenhouse and soil, water and plant analysis in laboratory of Balittra, Banjarbaru, Kalimantan Selatan from February to May 2019. Randomized complete design was set on experimental field with two factors and three replications. The first factor is leaching by system, there are (1) DO = unreturned leaching water and (2) D1 = returned leaching water. The second factor is fertilization, there are (1) P0 = no additional fertilizer, (2) P1 = 50% of recommended NPK fertilizers, (3) P2 = 50% of recommended NPK fertilizers + Compost, (4) P3 = 100% of recommended NPK fertilizers + amount of compost nutrient which is substituted by inorganic fertilizer, and (5) P4 = 100% recommended NPK fertilizers. The results showed that by unreturned leaching water had the value of Eh, EC and soil Fe and SO4 content lower than other treatments. However, the lowest Al-dd and H-dd values were found in the treatment of returning water from washing and fertilizing NPK 50% recommended dosage by adding compost to inorganic organic matter. This treatment also has the highest biomass production value when compared to other treatments.

Key words: Acid sulphate soil, Ameliorant, Leaching water quality, Paddy growth

Decomposition patterns of biochars derived from selected Satoyama biomass resources in soils

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Abstract
Biochars are believed to be resistant against biological decomposition and thus to be persistent in the soil for millennia. However, decomposition patterns of biochars in the soil in relation to feedstock nature and preparation methods as well as to environmental settings in which biochars are placed have not been fully understood. Moreover, such patterns of decomposition have been hardly observed under field conditions, which makes difficult to estimate the residence time of biochar-associated carbon in the soil with accuracy. In the present study, we conducted a one-year field experiment in a Satoyama forest (34°40’19”N, 135°43’57”E), Nara, Japan, using a burying method (at 5–10 cm in depth) of litter bags made of a glass microfiber filter (Whatman® GF/A: particle filtration size = 1.6 μm) to examine decomposition patterns of biochars produced from three different types of plant biomass, i.e., leaves of *Pleioblastus fortune* (a broadleaf dwarf bamboo), *Chamaecyparis obtuse* (a coniferous tree), and *Quercus serrata* (a deciduous broadleaf tree), which are widely seen in Satoyama landscapes of Japan and under two different temperatures of hydrolysis, i.e., 250°C and 400°C. In the study period, the masses of all types of feedstock (dried at 80°C) got rapidly decreased and only 30–50% (w/w) of the initial mass remained at the end of the experiment due to their inherently low resistibility against microbial decomposition. In contrast, all three types of biochars showed a little loss of the mass (<10%, w/w) during the same period, irrespective of the feedstock type, pyrolysis temperature and soil moisture regime. These results clearly demonstrated that the hydrolysis had all types of plant tissues gain high resistibility against microbial decomposition irrespective of plant species, hydrolysis temperature, and soil moisture regime.

***Key words*:** Carbon sequestration; *Chamaecyparis obtuse*; litter bag; pyrolysis; *Pleioblastus fortunei*; *Quercus serrata*

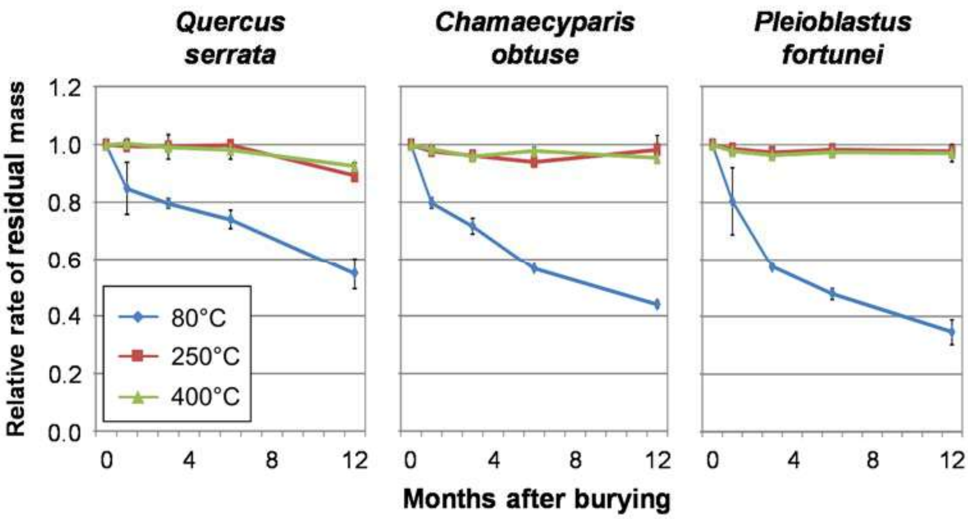

Fig. 1. Changes in the masses of biochars prepared from different types of feedstock and under different pyrolysis temperatures in the soil over the one-year period of the field experiment. a) *Pleioblastus fortune* (a broadleaf dwarf bamboo leaves), b) *Chamaecyparis obtuse* (a coniferous tree leaves), and c) *Quercus serrata* (a deciduous broadleaf tree leaves).

Evaluation of Practices for Soil organic Carbon Sequestration to mitigate Climate Change in Taiwan

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Abstract

Increasing soil organic carbon (SOC) has been proposed to mitigate climate change with an additional benefit of improving soil structure and conditions. The “4 per 1000 Initiative: soils for food security and climate” aspires to increase global soil organic matter stocks by 0.4 % per year as a compensation for the global emissions of greenhouse gases by anthropogenic sources. The initiative aims to show that food security and combating climate change are mutually complementary and to ensure that agriculture is a source of solutions. The action also present as a major contributor to the greenhouse effect, climate change and food security. Taiwan has signed the joint declaration as a response to the action. This study is to assess the possibility to achieve the goal of increasing 4‰ of SOC every year in Taiwan. First, the SOC in Taiwan has been estimated by the sum of content of SOC in different soil groups. Second, the carbon sequestration potential of different agricultural practices has been estimated by long term experiment. Many practices assessed have involved livestock manure and bio-char application on farmlands, organic farming, orchard grass cultivation, and afforestation in the plain area. The bio-char application has the highest potential carbon sequestration among all the practices. However, the total of the potential carbon sequestration cannot achieve the goal of the initiative with any of the practices. Moreover, the total carbon sequestration of current practices is much lower than the target. In the future, some other practices, such as intercropping, restore the degraded land, land use change, minimum tillage and humification of organic matter etc., might be adopted and improved as approaches to the goal of the initiative.

Keywords: 4 per 1000 initiative, soil carbon sequestration, agricultural practice

The ultimate loss of soil: coastal and river bank erosion – the example of Camau Peninsula, Vietnam

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Abstract
The most southern part of Vietnam, the Camau peninsula, was formed by deposition of sediments from Mekong under the influence of a north-eastern ocean current during the last 10,000 years. But due to recent intensive overexploitation of groundwater resources in the confined aquifers for shrimp and rice farming but also for drinking water use in combination with fewer annual inundations, which brought particles to build-up the Delta, land is subsidizing now of up to 3 cm each year (Erban et al., 2014). The missing inundations are not compensating anymore the constant compaction of the sediment layers. Concurrently, global warming causes an average sea level rise of 3 mm per annum. Both processes, land subsidence and sea level rise result in coastal erosion and support river bank destabilization. In addition to that, land use change such as the extension of shrimp farming intensively harms the Mangrove, which is more and more dying on the peninsula. Thus, a natural protection shield against soil erosion vanishes. Annually, several decameter of coast can be lost to the sea. The lost soil can be found as part of the particulate phase in the ocean. Samples of the particulate phase in rivers and in the ocean as well as sediment cores have been taken during two field campaigns in 2018 and 2019. Additionally, the turbidity along the coast was monitored by means of the BIOFISH, an in-situ and online recording multi-sensorsystem. Mineral and chemical composition of those sediments and the spatial distribution of turbidity with respect to the loss of soil will be presented. Furthermore, counter measures will be discussed to protect the soil against erosion.

Key words: coastal erosion, soil loss, Mangrove, groundwater overexploitation, land subsidence, climate change

Fig. 1: Loss of soil with dying Mangrove along the west coast of Camau Peninsula, Vietnam

Fig. 2: Loss of soil due to river bank erosion in Camau Peninsula, Vietnam

Erban, L. E., Gorelick, S. M., & Zebker, H. A. (2014). Groundwater extraction, land subsidence, and sea-level rise in the Mekong Delta, Vietnam. Environmental Research Letters, 9(8), 084010

Effect of Continuous Application of Livestock Manure Compost on Soil Carbon Accumulation and GHG Emissions from a Rice Paddy Field in a Cool-Temperate Region, Japan

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Abstract

Recently, there is concern about the depletion of available soil nitrogen of paddy fields due to global warming, and the application of organic matter such as livestock manure compost could be an efficient practice as a countermeasure. The continuous application of organic matter to paddy fields has the effect of suppressing global warming due to soil carbon accumulation, but there is a concern that methane (CH_4) and nitrous oxide (N_2O) emissions could be increase. Thus, this study was conducted to evaluate the effect of continuous application (around 10 years) of organic matter to paddy fields on soil carbon accumulation and CH_4 and N_2O emissions.

This study was conducted at the continuous rice paddy fields of the Daisen Research Station, TARC/NARO located in northern Japan (39°29' N, 140°30'E) for two years (2017 and 2018). The soils of studied fields were classified as fine-textured gray lowland soil (Typic Fluvaquents). The varieties of rice are Hitomebore and Moeminori. Three experimental plots were used in this study: a plot without application of organic matter (removal of rice straw after harvesting, no application plot), a plot with application of livestock manure compost (cow: poultry = 9: 1, continuous application of 3.6 kg FW m^{-2} in each spring for 12 years before the start of the experiment, application of 2.0 kg FW m^{-2} during the experiment period, removal of rice straw after harvesting) and a plot with application of rice straw (incorporation of residue after combine harvesting in autumn for 8 years before the start of the experiment). Each plot had four replicates (two replicates per rice variety). CH_4 and N_2O emissions were measured using a closed-chamber method almost once a week during the rice growing period (late May–late September). Soil carbon storage (0–15 cm in depth) was measured at the start of this experiment. The soil carbon sequestration rate derived from the organic matter application was calculated by the difference between the continuous organic matter application and no application plots. To compare them, net greenhouse gas (GHG) balance was calculated by subtracting soil carbon sequestration rate by increment in CH_4 and N_2O emissions (converted into CO_2 equivalent).

The CH_4 emission from the livestock manure compost plot tended to be higher in the earlier growing season from the transplanting to the mid-season drainage than in the no application plot, but the effect of continuous application of livestock manure compost on the Che emission was not clear in the later growing season after the mid-season drainage. The cumulative CH_4 emissions from the rice straw plot were 2.7 to 5.2 times higher than those of the other two plots. Soil carbon sequestration rate by continuous application of livestock manure compost was 6 times higher than that by the continuous application of rice straw. When the two were integrated and evaluated, continuous application of rice straw showed an increase in net GHG emission as increment in the CH_4 emission exceeded the soil carbon sequestration rate. While, in the continuous application of livestock manure compost, the two was almost balanced, and the net GHG emission was suppressed. Compared with the previous reports of the ratio of soil carbon sequestration and increment in CH_4 emission to carbon application in long-term organic matter application fields (30 to 40 years), application of livestock manure compost in this study (12 years) had high soil carbon sequestration effect (60%), but did not increase CH_4 emission (-1%), and was considered to have high mitigation effect on GHG emission.

Key words**:** Methane; nitrous oxide; rice straw; livestock manure compost; soil carbon sequestration

Soil spectral library for Cocoasoil of Papua New Guinea

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Abstract
Cocoa is amongst the most sustainable crops in the world. Comprehensive soil testing is needed to intensively and sustainably manage smallholder cocoa farms in Papua New Guinea (PNG) for reaching an ambitious production goal of 310,000 tonnes by 2030. Can we predict soil nutrients (Figure 1) with spectral data and make Fertliser recommendations using predictions from a spectral library created on soil under cocoa trees of PNG? We bring in this paper soil characterisation on four major cocoa growing provinces of PNG and a simple methodology to create spectral library to predict soil properties.

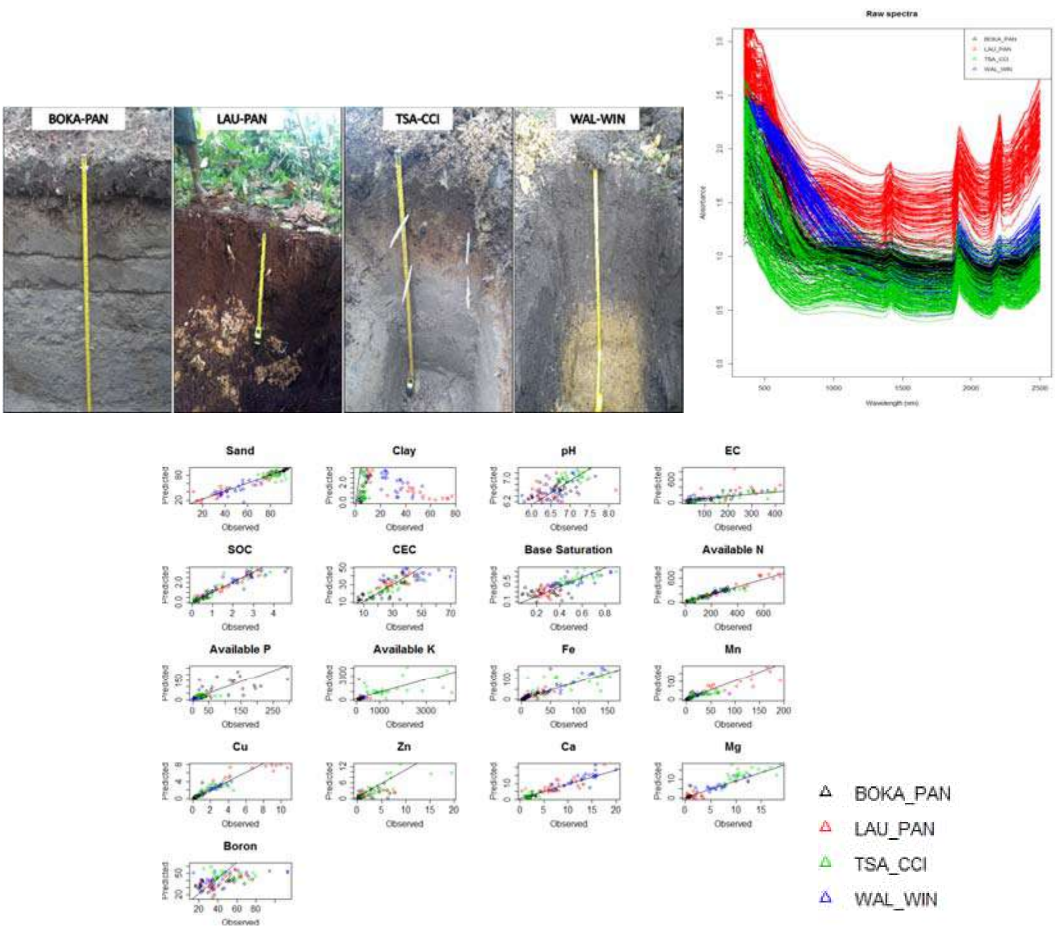

Fig.1: Soil catena of four sites, soil spectral variability and predictions.

Key Words: Diffuse reflectance spectroscopy, Cocoa, Soil assessment

Gross Nitrogen Transformation Rates during Shifting Cultivation Cycle in Northern Thailand

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Abstract

Shifting cultivation affects soil nitrogen (N) transformation processes, which plays an important role for plants and soil microbes. The previous studies well documented the temporal fluctuations of soil inorganic N (NH_4^+ and NO_3^-) pool after fire. However, the production and consumption rates of inorganic N pool (gross N transformation rates), which regulates soil inorganic N pool, during the shifting cultivation cycle are still unclear. Thus, the objective of this study was set to elucidate the controlling factor of soil inorganic N pool under different land use stages of shifting cultivation by measuring gross N transformation rates. Soil samples were collected from an agricultural village in Northern Thailand, where the local farmers conduct shifting cultivation. The cycle of shifting cultivation was 7 years: 1 year of cropping and 6 years of fallow. The samples were collected in the cropland just after burning (0 year after burning; AB0) and the fallow areas (1, 4, 6 and 7 years after burning; AB1, AB4, AB6 and AB7, respectively) as well as natural forest (NF) at 0-10 cm soil depth in 2015. Laboratory incubation (24h, 25°C) was conducted to measure gross N transformation rates by using ^{15}N pool dilution method. The NO_3^- pool increased following slash-and-burn. Then, it started to decline as time passed until AB7. The NH_4^+ pool, on the other hand, slightly declined following slash-and-burn. At AB6 and AB7 it increased. The gross nitrification rates (GNR) did not change significantly from AB7 to AB0 (almost 0 mg kg^{-1} d^{-1}), and it increased at AB1. Then, it started to decline until AB7. The gross ammonification rates (GAR) did not fluctuate significantly during the shifting cultivation cycle. The GAR were positively correlated with total soil N concentration (r = 0.78, p < 0.01), while the GNR were weakly negatively correlated with C/N ratio (r = –0.60, p = 0.052) and weakly positively correlated with base saturation (r = 0.53, p < 0.10). Moreover, the NO_3^- immobilization rates were positively correlated with the GNR (r = 0.83, p < 0.01). Therefore, it can be concluded that the GAR were constant under different land use stage of shifting cultivation because soil organic matter content did not fluctuate during the cycle. On the other hand, the GNR were increased by lower C/N ratio and higher base saturation. C/N ratio was higher in the beginning, decreased in the middle, and increased in the end of the cycle while, base saturation was lower in the beginning, increased in the middle, and decreased in the end of the cycle. In sum, the main controlling factor of soil inorganic N pool was the GNR, which were regulated by C/N ratio and base saturation under different land use stage of shifting cultivation in Northern Thailand.

***Key words*:** Gross nitrification rate; ammonification; nitrification; immobilization; shifting cultivation.

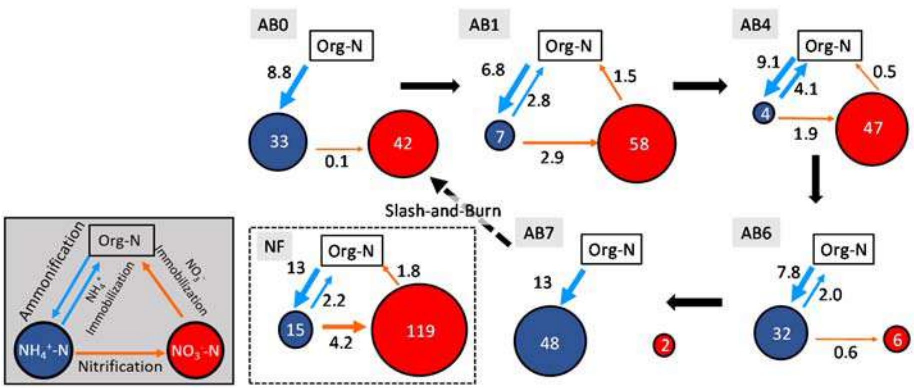

Fig. 1. Temporal variation of inorganic nitrogen pool and gross nitrogen transformation rates under the different land use stages of shifting cultivation.

Assessment of Soil Health using Simple Tools and its Application

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Abstract

The temperature increase, sea level rise, floods and droughts caused by climate change have imposed tremendous hazards on soils which have greatly increased risks of soil erosion and degradation, consequently, will impact on soil health. Easy and fast soil tests are of critical important to manage and improve soil health. Traditional soil laboratory measurements focus mostly on chemical properties, not paying sufficient attention on physical and biological properties. There are many soil quality or soil health test kits/manuals published, however they have not been popularly utilized by growers or farmers.

This study assembled a soil health assessment kit with a minimum data set of soil indicators, including five physical, three biological and three chemical soil indicators. All the indicators could be tested using simple tools or modified easy methods, so they could be self-diagnosed and applied by extension staffs or farmers to assess their soil health status. A three grade system was developed for its easiness to interpret soil health survey results.

A soil health package was sent to researcher in Fiji. Fifteen farm sites in major vegetable production areas of Viti Levu Island, Fiji were selected, and soil health assessments were examined in each farm by extension staff and technicians. In the meanwhile, another group of staffs conducted farm to farm surveys regarding with farmers' land use, crop grown, fertilizer management, cultivation practices, etc. Soil health survey results indicated that all farms had the "Moderate" soil health level. Judging from the scores of each indicator, it was clear that all farms surveyed had less concerns on soil physical indicators. However, low soil fertility and organic matter that resulted in low scores of EC, nitrate and earthworm tests were common constraints. Results of some soil indicators were verified with the farm survey data, indicating simple soil health assessment kit could still provide reliable soil management information. Based on tested results, recommendations of soil management practices relevant to each soil constraint were provided to all farmers for improving soil health status of their farms.

The application has shown that "Soil health assessment kit" can provide fast soil health information in places where soil laboratory is not available or not accessible. Easy and rapid assessment of soil health is as a mean to evaluate soil health/degradation status following different land changes and management practices. It is applicable for smallholder farmers to monitor and improve soil health condition in their fields. Moreover, it can also serve as a convenient soil education tool for the publics.

***Key words*:** Soil health, soil health assessment kit, soil physical indicator, soil chemical indicator, soil biological indicator.

Distribution of soil organic carbon and its controlling factors in tropical volcanic regions

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Abstract

The elucidation of the soil organic carbon (SOC) pools and its controlling factors is an urgent issue of the global climate problems. The secondary minerals in soil stabilize SOC, and formation of secondary minerals, in turn, is strongly affected by climatic condition. The study objective is to figure out the controlling factors of SOC distribution in tropical volcanic regions. The study sites were in the southeast slope (6 sites) and the northwest slope of Mt. Kilimanjaro (8 sites), Tanzania; and Mt. Sibyak of Sumatra (7 sites) and Mt. Tengger of Java (6 sites), Indonesia. All the soils were sampled along the elevation gradient under the natural or secondary forest vegetation. The soils of the surface (0-15 cm) and subsurface (20-40 cm) were used for the experiments. The total carbon (TC), ammonium oxalate extractable Al, Fe and Si (Al_o, Fe_o and Si_o), pH, soil texture, and exchangeable cations were measured. Climatic data was obtained from the WorldClim database (www.worldclim.org). The excess precipitation (EP: precipitation – potential evapotranspiration), which represents the soil moisture, was calculated.

Positive correlation was found between TC and Al_o+1/2Fe_o that represents nanocrystalline minerals for the subsurface soils of both Tanzania ($r = 0.88^{**}$) and Indonesia ($r = 0.90^{**}$) (Fig.1). The TC also had a positive correlation with Al_o+1/2Fe_o in the surface soils at all the sites ($r = 0.62^{**}$). The correlation indicates that nanocrystalline minerals stabilize the SOC in both surface and subsurface horizons. The ratio of TC to Al_o+1/2Fe_o in the subsurface soils in Indonesia was lower than that of Tanzania, shown by the low slope in Fig. 1 (left). Furthermore, the subsurface soils in Indonesia had high Si_o. The Al_o would associate with Si_o in the subsoils in Indonesia instead of SOC, probably because the Indonesia soils are younger with less time for accumulating SOC.

For the factors affecting the distribution of Al_o+1/2Fe_o, the temperature came first. Al_o+1/2Fe_o contents were negatively correlated with MAT for the soils of Tanzania ($r = -0.82^{**}$) and Indonesia ($r = -0.60^{**}$). The low MAT at high elevation sites would retard the crystallization of nanocrystalline Al and Fe. Besides temperature, at the sites which have a clear dry period with the ustic moisture regime, the contents of Al_o+1/2Fe_o had a positive correlation with EP in Tanzania ($r = 0.81^{**}$) and Java, Indonesia ($r = 0.89^{**}$), where correlation between EP and MAT was lower in Tanzania ($r = -0.75^{**}$) and not significant in Java, Indonesia. Meanwhile, the correlation between Al_o+1/2Fe_o and EP is not significant in the udic soils in Sumatra, Indonesia (Fig. 1 (right)). The drier condition would results in the formation of crystalline minerals such as kaolinite which has the weaker ability to stabilize SOC. In conclusion, low temperature and humid condition contribute to nanocrystalline mineral formation, which stabilize SOC in the tropical volcanic soils.

***Key words*:** Soil organic carbon, Nanocrystalline minerals, Volcano, Temperature, Excess precipitation

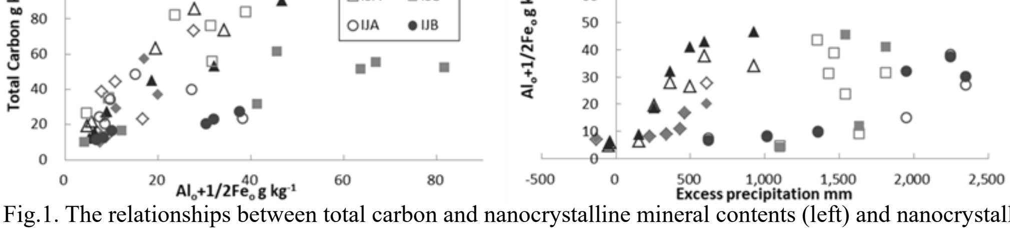

Fig.1. The relationships between total carbon and nanocrystalline mineral contents (left) and nanocrystalline mineral content and excess precipitation (right) in each region. TE: Tanzania East slope, TW: Tanzania West slope, IS: Indonesia, Sumatra, IJ: Indonesia Java; A: surface B: subsurface

EARLY IMPACT OF COVER CROPS ON GREENHOUSE GAS EMISSIONS AND SOIL MICROBIAL ACTIVITIES

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ABSTRACT

The effect of cover crops (ryegrass, hairy vetch, and oilseed radish) in terms of microbial biomass carbon (MBC), C and N mineralization, and enzymatic activities in a corn-wheat-soybean cropping systems under a Mollisol was evaluated. The distributions of total organic C (TOC), total Kjeldahl N (TKN), microbial biomass C (MBC), readily mineralizable C and N, and five enzyme activities (*β-glucosidase, β-glucosamidase, acid phosphatase, arylamidase, and fluorescein diacetate hydrolysis*) involved in the cycling of C, N, P and S were studied in three soil depths (0-5. 5-10, 10-20 cm) while soil surface fluxes of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) were estimated.

Rye grass showed higher activity in acid phosphatase, β-glucosidase and β-glucosaminidase. Rye grass and hairy vetch significantly increased organic C and N, and MBC. Level of mineralized C and N were the same in rye grass and hairy vetch. There was no clear variation in CO_2, N_2O and CH_4 fluxes from the cover crop treatments. N_2O fluxes increased with an increase in soil moisture. The negative CH_4 fluxes manifest the soil as CH_4 sink. No significant differences among cover crop treatments in terms of CO_2-C, N_2O-N and CH_4-C emissions, a reflection that their emissions are highly variable.

Empirical data on carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) fluxes are important in management systems to evaluate mitigation strategies, while microbial biomass and enzyme activities can be used as sensitive indicators of ecological stability.

KEYWORDS: Carbon sequestration, Soil Quality, Microbial Activity, Greenhouse Emission

Policy Framework for Soil and Water Conservation Integrating Soil Erosion and Ecosystem Services

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Abstract
Soils are the finite and non-renewable natural resources that are responsible for hosting goods and services vital to ecosystem and human life. The UN Sustainable Soil Management and Sustainable Development Goals target to optimize soil ecosystem services and minimize the soil threats through the site-specific management practices. This presentation will introduce the decision supporting framework for the planning, assessment and policy of soil and water conservation, by integrating both soil erosion and ecosystem services. The WEB GIS-based portal system was developed as a tool for soil management using big datasets (Fig. 1). The portal system predicts soil erosion and quality, and assesses the soil ecosystem services based on soil functions. This allows to designate the priority areas for soil conservation and the planning for soil and water conservation can be formulated using the specific best management practices at designated areas, followed by the assessment of BMP effects on soil erosion and ecosystem services. The system provides the framework to develop a strategy and policy for soil and water conservation to enhance soil ecosystem services and minimize soil erosion.
***Key words*:** Soil erosion; Ecosystem services; Web-GIS soil management system; Conservation policy

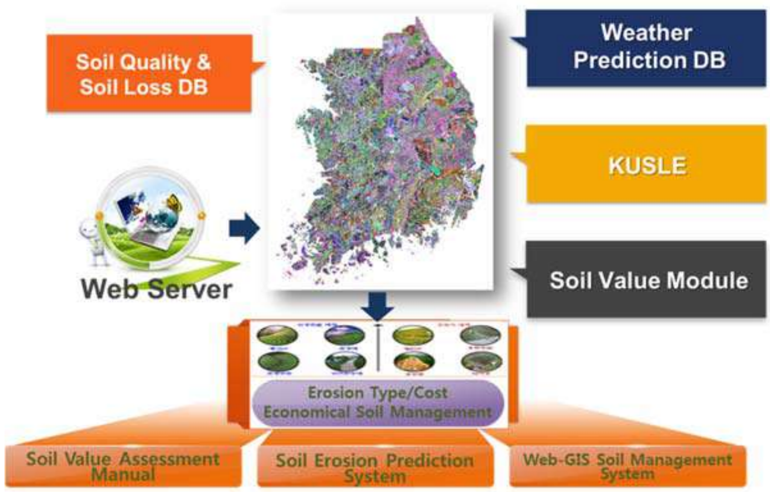

Fig. 1 Basic concept of the WEB-GIS soil portal system for soil and water management.

Ammonium and Nitrate Contamination of Shallow Groundwater under Vegetable Fields in the Downstream Areas of the Huong River, Central Vietnam

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Abstract

High concentrations of ammonium- (NH_4-N) and/or nitrate- nitrogen (NO_3-N) were found in shallow wells in vegetable fields in the downstream areas of the Huong River, Central Vietnam. The objective of the study was to determine the contamination mechanisms of inorganic nitrogen (N) in groundwater with high concentration via ^{15}N natural abundance ($\delta^{15}N$) measurement by a modified sequential diffusion method to collect NH_4-N, NO_3-N, and organic N from water samples.

Two vegetable production areas (QA and QB) in Quang Thang commune, and one vegetable-flower production areas (PM) in Phu Mau commune, in downstream areas of the Huong River were selected for the study sites. Groundwater was sampled in 4 fields in QA, 3 fields in QB, and 3 fields in PM in June (dry season) and November (rainy season) from 2014 to 2016. Deepsoil up to 2.4 m was collected in these fields in both seasons of 2016 and 2017. Vegetable fields in QA were several hundred meters away from the residential area while those in QB and PM were adjacent to the houses.

In QA, NH_4-N was a dominant form of N in both dry and rainy seasons. In QB, NO_3-N was mainly found in the rainy season while NH_4-N in two fields and NO_3-N in a field were more dominant in the dry season. In PM, high concentrations of NO_3-N (1.5–48 mg N L^{-1}) was detected and that of NH_4-N was less than 0.5 mg N L^{-1} regardless of seasons. In QA, $\delta^{15}N$ values in NH_4-N (+3.9 to +8.0‰) were similar to those in soil as deep as groundwater. In this area, groundwater was more reductive than in QB and PM, which was suggested by lower ORP and soil Eh. Ammonium-N released from the deep soil by N mineralization probably flowed into groundwater. In QB, $\delta^{15}N$ values in NH_4-N (+5.5 to +21‰) was much greater than in QA and large numbers of *E. coli* and total coliforms were detected, indicating that groundwater was unintendedly polluted by livestock wastes and/or domestic wastewater. Also in PM, livestock wastes and/or domestic wastewater may have flowed into groundwater, which is inferred from unchanged high $\delta^{15}N$ values in dry and rainy seasons and detection of *E. coli* and total coliforms. In conclusion, high concentrations of NH_4-N and NO_3-N in groundwater of QB and PM sites were attributed to unintended inflow of livestock wastes and/or domestic wastewater while NH_4-N in QA likely resulted from N mineralization of deep soil.

Keywords: Ammonium, *E. coli*, groundwater, natural abundance, nitrate, Vietnam

Assessment of the Nitrate-N Leaching in the Upland Soils Using the Undisturbed Monolith Gravimatric Lysimeter

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Abstract
Nitrate leaching in arable land is monitored to preserve groundwater and manage non-point source pollution. Unsaturated soil condition in upland soils should be considered soil physical properties because the movement of rainwater accompanied by nitrate is influenced by soil structure such as pore size and texture. The undisturbed cylindrical soil monoliths from two upland soils, Songjung series (clay loam) and Sangju series (sandy loam), were installed into the lysimeter of 1.1 x 1.5 m (diameter x height) dimension. At depths of 10, 30, 55, 85 and 125cm in the lysimeter, sampling ports were installed from which water samples were taken to analyze the nitrate ions. Changes of soil moisture contents were determined gravimetrically by the differences in lysimeter weight measured by sensors (10 g sensitivity) installed at the bottom of the lysimeter. In the lysimeters with the two soils, soybean, corn, and cabbages (spring and autumn) were cultivated from 2015 to 2018 under the various environmental conditions, such as irrigation, N fertilization. The impacts of water balance and N balance on the nitrate-N leaching were assessed. Drainage occurred by the differences in amounts of soil water and evapotranspiration during the crop cultivation periods. The amounts of nitrate-N leaching were proportional to those of the drainage. The higher soil N balance caused the higher level of N in the surface soil and increased the concentration of nitrate ions in the soil solution. The concentrations of the nitrate-N in top 30cm of soils in clay loam and sandy loam were increased up to 25 and 60 mg kg^{-1}, respectively. When corn and Chinese cabbage were cultivated, the respective nitrate-N leaching below 1.5m depth of soil profile were 2.3~4.6 kg ha^{-1} in clay loam soil and 4.1~6.6 kg ha^{-1} in sandy loam soil indicating that the concentration of nitrate-N in soil affected directly the amounts of nitrate-N leaching.

Key words**:** Upland soils, Nitrate, lysimeter, Drainage, Nitrogen balance

Sorption and exchange of potassium on montmorillonitic soil clay mineral

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Abstract

One of the main problems of montmorillonitic soils is that of high nutrient retention, especially of potassium. Understanding sorption and exchange processes is essential to predicting the retention of potassium on montmorillonitic soils because it can affects on deficiency for plants. Our research was designed to observe: (i) the dynamics of sorption and exchange of potassium on various fraction size of montmorillonitic soil clay minerals, and (ii) the effect of fraction size, abundance of montmorillonite, and ionic strength on the sorption and exchange of potassium. Soil samples were collected from four sites in western Java, Indonesia, namely Lebak (MS1), Karawang (MS2), Cianjur (MS3), and Cirebon (MS4). The samples were fractionated to obtain coarse clay (2-0.2 µm), medium clay (0.2-0.08 µm), and fine clay (< 0.08 µm). Sorption and exchange experiments of K^+ followed batch equilibrium method. Statistical analysis used pseudo 1st and 2nd order for kinetic sorption and used Freundlich and Langmuir equation for sorption isotherm. Kinetic sorption of K^+ was accurately described by the pseudo-second order model, indicating the sorption of K^+ was controlled by valency forces through sharing electron between adsorbent and K^+. In term of sorption isotherm, the process were best adjusted to the Freudlich models which demonstrated that at a given maximum concentration of K^+ (440 mg.L^{-1}), soil fraction, total clay, and all clay fractions had more capacity to adsorb K^+. Based on the particle size, the sorption of K^+ increased on the finer clay fraction which was linear to the abundance of montmorillonite in the finer clay fraction and CEC value. Sorption of K^+ was higher at ionic strength concentration 0.1 mol.L^{-1} NaCl than 0.01 mol.L^{-1}. However, amount of exchangable K^+ after adsorption expriments was only 42.38-37.75%, indicating that most K^+ was strongly adsorbed in montmorillonite. These results showed that a high affinity of K^+ to montmorillonitic soils impact on low availability of potassium for plants.

Key words: batch equilibrium, montmorillonite, potassium, sorption, Freundlich

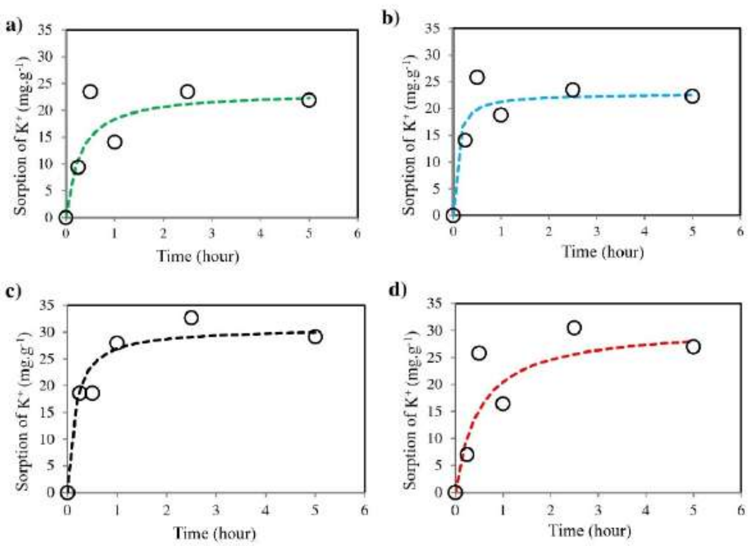

Fig 1: Kinetic adsorption of K^+ on clay < 2 µm with K^+ concentration by 0.17 g.L^{-1} and ionic strength of NaCl by 0.1 mol.L^{-1}, a) MS1, b) MS2, c) MS3, d) MS4.

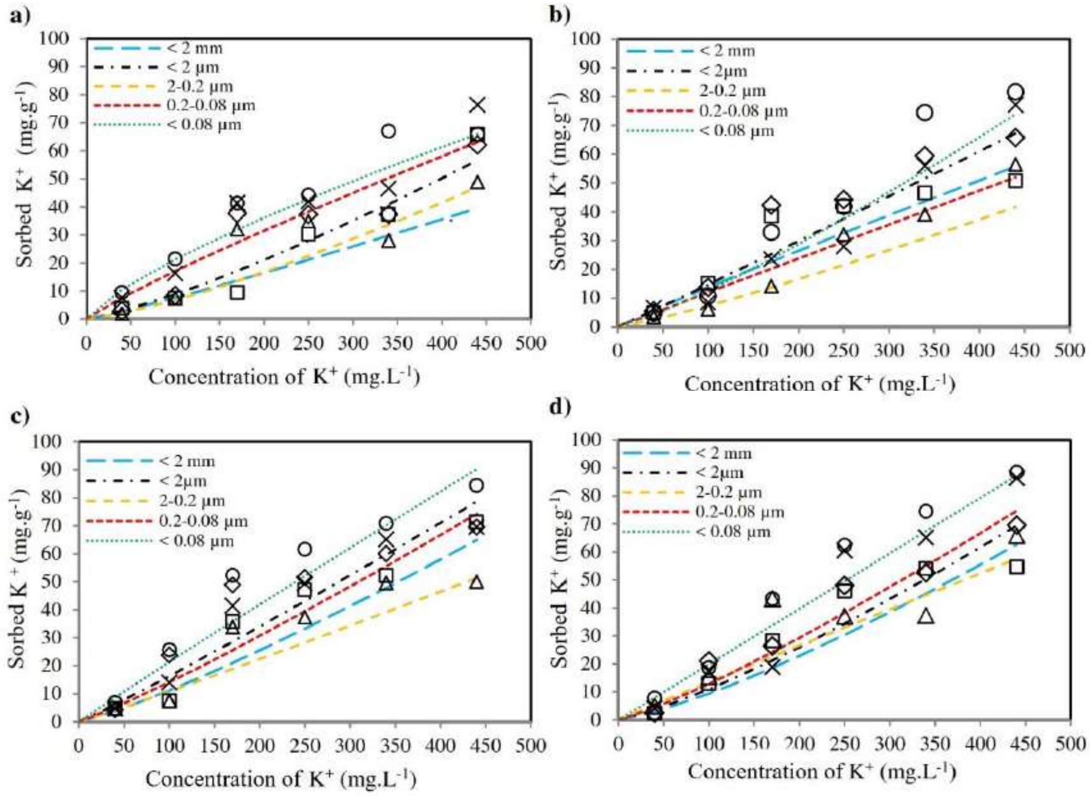

Fig 2. Sorption isotherm of K^+ on soil fraction and various clay fractions with ionic strength 0.1 mol. L^{-1} NaCl: a) MS1, b) MS2, c) MS3, d) MS4. (□) soil < 2 mm, (◊) total clay < 2 µm, (Δ) coarse clay 2-0.2 µm, (x) medium clay (0.2-0.08 µm), (○) fine clay (<0.08 µm).

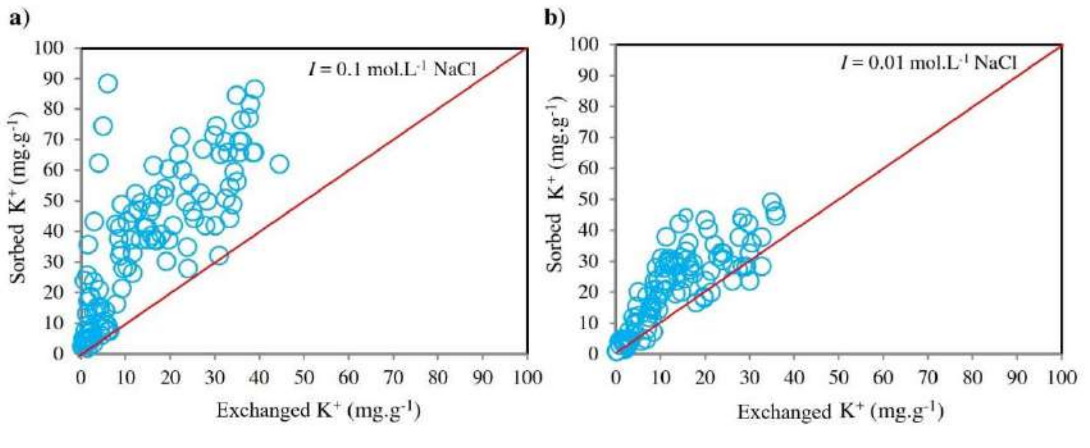

Fig 3. Relationship between sorption and exchange of K^+ on two different ionic strength. a) 0.1 mol. L^{-1} NaCl, b) 0.01 mol. L^{-1} NaCl.

Modelling organic carbon stocks in croplands of China: the past and the future

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Abstract
Recent spatiotemporal soil organic carbon (SOC) changes in croplands of China were estimated by using a modified and validated Agro-C model. Estimates revealed that SOC in approximately 81% of China's croplands increased from 1980 to 2009. Overall, we estimated that China's croplands covering an area of 130 million hectare sequestered 730 (329 to 1095) Tg C in the topsoil to 30 cm depth, during this period. Approximately 73% of the SOC sequestration occurred in east, central and south China. The carbon sequestration was attributed to the improvement of crop production and the decrease in the removal of crop residues. Soils rich in organic carbon that received relatively low carbon inputs during the same period, however, suffered net carbon losses in Heilongjiang Province.
Meanwhile, we also used the Agro-C model to simulate climate and agricultural management scenarios to investigate the combined impacts of climate change and management on future SOC stocks in China's croplands. The model was run for croplands on mineral soils in China, which make up a total of 130 M ha of cropland. The model used climate data (years 2011–2050) from the FGOALS and PRECIS climate models based on four Intergovernmental Panel on Climate Change (IPCC) emissions scenarios. Three equidistant agricultural management scenarios were used. S0 was a current scenario, and S2 was an optimal scenario. Under the S2 scenario, crop yields increased annually by 1%, the proportion of crop residue retained in the field reached 90% by 2050, and the area of no-tillage increased to 50% of the cultivated area by 2050. Across all croplands in China, the results suggest that SOC will increase under all combinations of climate and management and that the effect of climate change is much smaller than the effect of changes in agricultural management. Most croplands in China showed a significant increase in SOC stocks, and only few zones, mainly in northeastern China, showed a decline. The maximum carbon sequestration potential of the croplands of China was 2.39 Pg C under S2. Annual increases in SOC stocks could offset a maximum of 2.9% of the CO_2 emissions from fossil-fuel combustion in 2009.

***Key words*:** Agro-C model, Soil organic carbon, Climate change, Agricultural management, Croplands, Sequestration

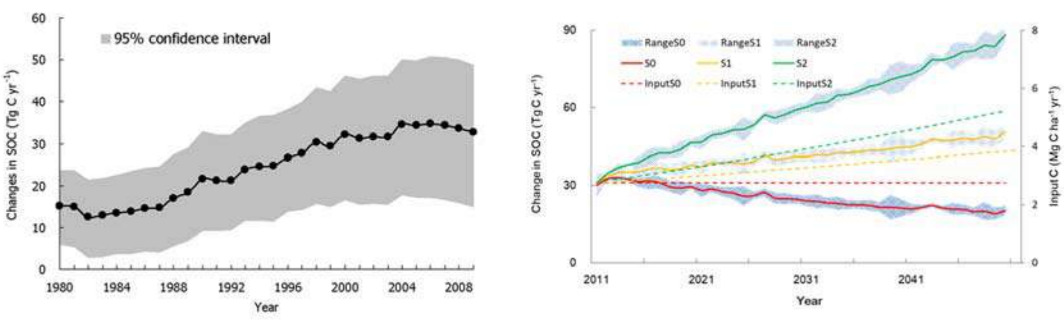

Fig. 1. Simulated changes in SOC of China's croplands from the past to the future

Effects of drip fertigation on soil carbon sequestration and greenhouse gas emissions in sugarcane field

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Irrigation and fertilization not only affect crop yield and quality, but also play important roles in soil organic carbon sequestration and greenhouse gas emissions. Drip fertigation, as an efficient technique of irrigation and fertilization management, is widely adopted in Guangxi and other regions of China. However, very limited information is available in terms of the effects of drip fertigation on soil organic carbon sequestration. So we investigated the effects of drip fertigation on soil carbon sequestration and greenhouse gas emissions in sugarcane field in Guangxi, where the planting area of sugarcane accounts for more than 60% of the national total. Firstly, we investigated the effect of drip fertigation on soil organic carbon pool dynamics and unravel the underlying mechanism in combination with soil organic carbon fractions and microbial indices, included soil microbial biomass carbon and nitrogen, soil microbial community structure and enzyme activities. In order to more fully assess the effect of drip fertilization on climate and environment, we also measured soil CO_2, CH_4 and N_2O fluxes. The underlie mechanisms of drip fertigation on greenhouse gas emission wound be assessed. The net global warming potential wound be determined by considering both soil organic carbon storage and the fluxes of greenhouse gases. In addition, we estimated the water and nutrient use efficiency under different water and fertilizer management. The results of the study contributed to understanding the carbon sequestration effect of sugarcane after implementation of drip fertigation in Guangxi, and provide scientific and technical support for planning irrigation and fertilization management schemes in Guangxi or China.

Effect of rock fragment contents and sizes on saturated hydraulic conductivity in repacked soil columns

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Abstract

Rock fragments are usually found in many soils as a result of natural processes and human activities. In addition, soils containing rock fragments represent a significant part of arable lands and are a component of this important resource for human beings. In spite of the significance of rock fragments, research experiments tend to remove or ignore them in soil studies. There is now an increased interest to identify the relationship between rock fragments and soil properties although the study of the rock fragments is still scarce. The effect of rock fragments on soil hydraulic properties is far from clear and has shown conflicting results. Thus, the effect of rock fragment content and sizes on saturated hydraulic conductivity (K_{sat}) in repacked soil columns was explored in this study.

Rock fragments and mineral soils were collected from Te Whenua Hou (Eyrewell forest) which is 7000 ha gravel plain near Christchurch, New Zealand. Rock fragments were divided into two size groups, gravel (2-76 mm) and stones (76-200 mm) following the FAO rock fragment classification. Collected materials were repacked in plastic soil columns with nine different rock fragment contents. Each treatment included different size groups of rock fragments or different ratios of gravel and stones. Repacked soil columns were saturated from the bottom and K_{sat} was measured.

The size of rock fragments was a critical factor for the K_{sat} at low rock fragment content (17-20 %) because the existence of rock-to-rock connections was closely related to the size of rock fragments. Where 3-4 pieces of stones were isolated, a large number of pieces of gravel was more likely to create rock-to-soil interfaces and continuous flow paths along surfaces of rock fragments. At intermediate rock contents (20-48 %), the K_{sat} was not influenced by the increasing content, size, and the ratios of gravel and stones. This was because the intermediate content was sufficient to create the rock-to-rock connections regardless of the size and the component ratios. Increasing rock fragment content not only decreased space available for water flow but also increased the large pores at rock-to-soil interfaces and the rock-to-rock connections. At a high rock fragment content (40-60%), the K_{sat} tended to increase gradually. When the rock fragments accounted for large space in the repacked soil, less-filled or unfilled voids were created between rock fragments. This may be a limitation of the repacking experiment and may or may not happen to the same degree in the field. Further study is necessary to explore the effect of rock fragments on water flow in field conditions.

This study has provided valuable knowledge of the significance of rock fragments to hydraulic properties in soils. An optimal range of rock fragment of 20-48 % regardless of sizes or component ratios, would restrict the leaching of water through the soils. Lack of rock fragments would enhance leaching depending on distribution and alignment of rock fragments.

***Key words*:** Rock fragments; saturated hydraulic conductivity; soil water flow.

Soil Properties Controlling Accumulation of C from Plant Residue

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Abstract

To clarify soil properties contributing to the accumulation of newly added organic matter is essential when we consider C sequestration in the soil. The possible soil properties include clay content, active Al and Fe (acid ammonium extractable Al and Fe) contents, pH, and degree of C saturation (the ratio of organic C to capacity for soil organic C storage). The objective of this study is to clarify soil properties that contribute to the accumulation of newly added organic matter using various types of soils. We used volcanic and highly weathered soils from Indonesia (12 samples, pH: 4.8–5.8, active Al plus Fe: 2–71g kg^{-1}, clay content: 24–78%), and soils from mountain to plain of Kazakhstan (18 samples, pH: 4.9–8.9, active Al plus Fe: 0.5–11g kg^{-1}, clay content: 17–40%). To investigate the remaining amount of newly added residue, we incubated ^{13}C labeled plant material with the soils. The plant material was maize shoot, milled to less than 2 mm, added to soil at the ratio of 1.2 mg:1.0 g, and incubated at 25℃ and 50% of water holding capacity. The remained C derived from the plant material after three, six, and 12 months of the incubation (C_{3m}, C_{6m}, and C_{12m}) was determined based on the ^{13}C atom% of the incubated soil. We defined the degree of C saturation as the ratio of organic C content to clay plus silt content or active Al plus Fe content. There was no difference between C_{6m} and C_{12m} in each soil, indicating C_{12m} was stabilized. The C_{12m} was positively correlated with active Al and Fe for all and Kazakhstan samples, and tend to be high in the soils with high active Al plus Fe content for the Indonesian samples (Fig. 1 left). The C_{12m} was negatively correlated with pH for all and Kazakhstan samples; this negative correlation is considered to reflect more active Al and Fe under lower pH conditions because C_{12m} is considered to be stabilized. The C_{12m} was also correlated with the degree of carbon saturation based on active Al and Fe (Fig. 1 right). On the other hand, clay plus silt content and the degree C saturation based on clay plus silt were not correlated with C_{12m}. Altogether, active Al and Fe, and the degree of C saturation based on active Al and Fe are important soil properties for the accumulation of newly added organic matter.

Keywords: C sequestration; ^{13}C tracer; active Al and Fe; pH; C saturation.

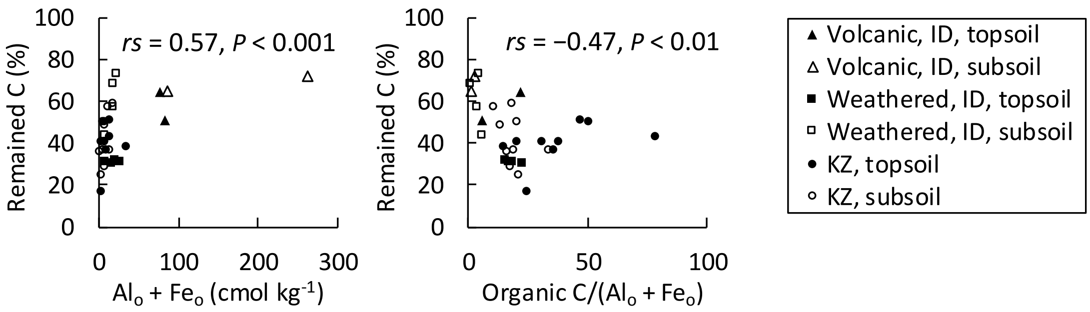

Fig. 1. Relationships between C derived from newly added plant residue remained after 12 months of incubation and active Al and Fe (left) and degree of carbon saturation based on active Al and Fe (right). ID: Indonesia; KZ: Kazakhstan

Optimization of nitrogen fertilization to minimize yield-scaled nitrous oxide emission in maize cropping field

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Abstract
Nitrogenous fertilizers play a vital role in the remarkable increase in global food production. However, excess N fertilization beyond crop requirement causes N loss to the environment. Among all forms of N loss, the most important form is N_2O, as it holds 265 times higher global warming potentials than CO_2. It also depletes the stratospheric ozone layer. To reduce N_2O emission without affecting crop productivity, it is necessary to optimize N fertilization level. The objective of this study was to investigate the optimization of N application level, which can produce lower yield-scaled N_2O flux. Four N fertilizer (urea) rates, such as 0%, 50%, 100% and 200% of the South Korean recommendation rate (186 kg N ha^{-1}) for maize were tested using a randomized complete block design with three replicates. Maize grain productivity increased with increasing N fertilization level up to 250 kg N ha^{-1} and thereafter decreased ($Y = - 0.000036X^2 + 0.018X + 2.383$, $R^2 = 0.958$***). The highest yield was estimated as 4.64 Mg ha^{-1} which was comparable to that (4.62 Mg ha^{-1}) for the 186 kg ha^{-1} of N application level. Total N_2O fluxes increased proportionally with increasing N fertilization level ($Y = 0.0056X + 1.444$, $R^2 = 0.927$***). Yield-scaled N_2O flux changed by following a quadratic relationship of $Y = 0.000006X^2 – 0.0015X + 0.616$ ($R^2 = 0.89$). The lowest yield-scaled N_2O emission was observed at 125 kg ha^{-1} of N application and that was 0.52 kg N_2O-N Mg^{-1} grain yield. At 125 kg N ha^{-1}, the estimated grain yield was 4.08 Mg ha^{-1}, and that was 12% lower than 186 kg ha^{-1} of N application level. Hence, the maximum yield was achieved at 250 kg N ha^{-1}, but 186 kg ha^{-1} of N fertilization could be recommended to minimize the impact of N_2O emission without yield decline.

Keywords: N fertilization; N_2O emission; Crop productivity; Yield-scaled N_2O flux.

Deposition and metal content of particulate matter on the surface of shrub and tree leaves

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Abstract
It is known that different plant species have the ability to deposit different amounts of particles on their leaves. Thus, particles matter on different plant species were fractionated and quantified by particle size (PM_{11}, $PM_{2.5}$, $PM_{0.2}$). The distribution of metals on leaves and concentration of metals in particles of different sizes were analyzed using μ-XRF fluorescence (μ-XRF) and inductively coupled plasma atomic emission spectroscopy (ICP-AES), respectively. Heavy metals in fine dust could affect plant growth if accumulated on leaves. In this study, the mass of PM_{11} deposited on the surface of the shrub leaves ranged from 0.0181 μg/cm² to 32.7 μg/cm², while the mass of $PM_{2.5}$ ranged from 0.00213 μg/cm² to 14.8 μg/cm². The $PM_{0.2}$ mass ranged from 0.00338 μg/cm2 to 8.17 μg/cm2. The Particulate matter contained cluster elements such as Al, Ca, Mg, and Si and heavy metals, including Cu and Zn. The concentration of cluster elements was higher in the coarser size, while the concentration of heavy metals was higher in the finer size fraction. Particles matter on pine leaves was observed under a stereoscopic microscope and the distribution of Cu and Pb on leaves was shown by μ-XRF.

***Key word*:** Particulate matter; metal; shrubs; leaves; PM size.

Interactive effects of mycorrhization, daytime and/or nighttime eCO_2 on plant performance are host-species (N_2-fixing vs. non-N_2-fixing) or cropping pattern (mono-culture vs. intercropping) dependent

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Abstract
Introduction: Almost all elevated atmospheric CO_2 (eCO_2) studies have focused on plant aboveground characteristics under mono-cultures, whereas limited considerations of interactions with arbuscular mycorrhizal fungi (AMF) under intercropping are available, let alone under the same, yet unrealistic, daytime/nighttime CO_2 concentrations. We thus addressed how auto-simulated field daytime and/or nighttime eCO_2, AMF and N_2-fixing/non-N_2-fixing intercropping could interactively affect plant biomass production and major physiological characteristics. Methods: Non-N_2-fixing winter wheat (*Triticum aestivum* cv. Yunmai) and N_2-fixing fababean (*Vicia faba* cv. 89-147) inoculated with AM fungus (*Funneliformis mosseae*) were grown in mono-cultures and intercropping in soil (Eutric Regosol) filled pots inside environmentally controlled glass-made chambers. Those chambers had the same growth conditions (nitrogen-fertilization, AMF inoculation, etc.), except CO_2 concentrations: ambient CO_2 (ACO_2, 400ppm daytime/450ppm nighttime), daytime elevated ($DeCO_2$, 550ppm/450ppm), nighttime elevated ($NeCO_2$, 400ppm/600ppm), and daytime/nighttime elevated ($D+NeCO_2$, 550ppm/600ppm). Plant physiological parameters were then examined. Results: Regardless AM-mycorrhization, root and shoot biomass and total soluble sugar were significantly increased, but tissue NPK, leaf gas exchange, total chlorophyll, soluble protein and free amino acids were significantly decreased under eCO_2 in mono-wheat, mono-fababean or wheat/fababean intercropping. Significantly different responses of plant growth parameters (tissue N, total chlorophyll, soluble protein and free amino acid) to eCO_2 patterned as: $DeCO_2$ > $D+NeCO_2$ > $NeCO_2$ > ACO_2, while to AM-mycorrhization as $D+NeCO_2$ > $DeCO_2$ > $NeCO_2$. Conclusions: Mycorrhization and/or eCO_2 have varied interactive effects on plant biomass production and physiological characteristics, no matter whether plants were grown in mono-cultures or intercropping. Such interactive effects are probably plant host-species or cropping pattern dependent.

***Key words*:** Elevated CO_2; fababean, intercropping; N_2-fixation, winter wheat.

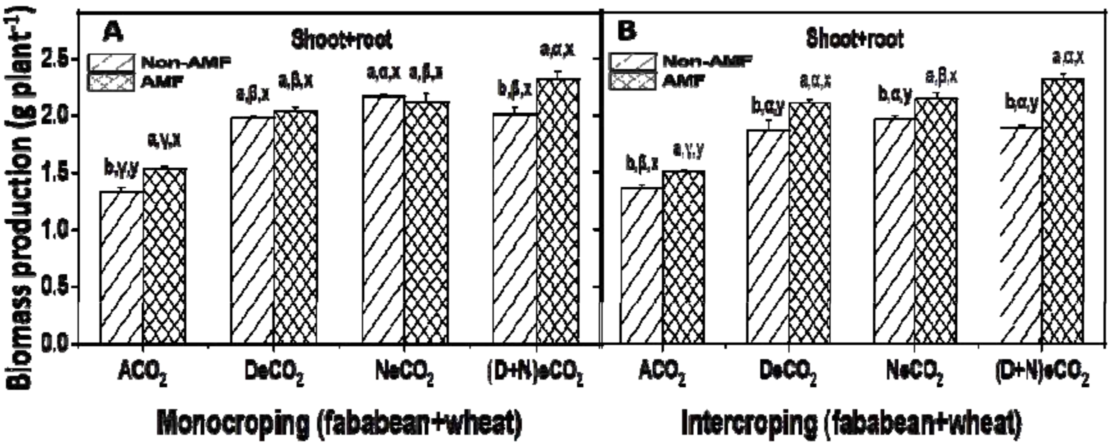

Fig. 1. Effects of mycorrhiza and CO_2 on biomass production of monocropping (A) and intercropping (B) (fababean+wheat). Abbreviations: ambient CO_2 (ACO_2), daytime CO_2 ($DeCO_2$, 07:30am-18:30pm), nighttime CO_2 ($NeCO_2$, 18:30pm-07:30am), and daytime + nighttime CO_2 ($(D+N)eCO_2$).

Estimation of soil carbon stock change by liming in maize cropping upland soil

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Agricultural liming is a common agricultural practice worldwide for improving crop productivity in acidic soils. Liming can increase soil pH and nutrient availability and reduce Al toxicity and toxic metal uptakes. The effect of liming practices on soil properties has been extensively studied, with mainly focusing soil pH, nutrient availability and crop productivity. However, the effects of lime application on soil carbon (C) stock changes still are poorly understood. The net effect on soil C stock can be the result of several factors. At the first, liming can increase microbial activity in soil via ameliorating pH condition. Thus, the improved biological activity can increase the mineralization of soil organic matter and decrease soil organic C stock. Secondly, calcium containing lime can ameliorate soil structure, increasing the stability of clay assemblages and clay-organic matter bonds, which can bring an increase in the physical and physicochemical protection of soil organic C. Finally, as liming improves soil conditions to plant growth, plant biomass returning as an organic C input source can increase soil C concentration. However, the net effect of these processes is not well understood yet. Still, some overall trends can be deduced from data currently available in the literature. In this field study, to evaluate the effect of liming on soil C stock changes, $CaCO_3$ was applied with the rates of 0 and 2 Mg ha^{-1} yr^{-1} before maize seeding, and soil C stock changes were estimated by analyzing net ecosystem C budget (NECB), which means the difference between C input and output. Liming application increased C input, mainly due to 80% increase of the net primary production (NPP) of maize in Control (no-liming). In comparison, lime application significantly increased mineralized-C loss (CO_2 emission) by 49.4~52.7%. The difference between NPP and Mineralized C loss, mineralized C loss's slope was bigger than NPP ($Y=9.29+2.75X-0.31X^2$, $Y=-7.35-3.27X+0.39X^2$). The NECB in the control treatment ranged within minus 4.27 Mg C ha^{-1} yr^{-1}, which means this C level might be depleted. Since local farmers removed maize residues for cattle feeding, this C removal was considered as a main C output source, which covered 36-39% of total C output. Therefore, more additional input of organic C sources such as crop residues and cover cropping are required in crop lands to sustain soil C stocks under liming.

key words: soil carbon stock, greenhouse gas, net ecosystem carbon budget

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Changes in paprika internal electrical conductivity affected by manganese and chromium exposure

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Abstract
Transport of ions and water in plant stem can be measured by electrical conductivity of the plant. Internal electrical conductivity (ECps) of the stem helps to understand plant physiological changes in relation to environmental stress [1]. Metal is one of environmental stresses affecting plants and metal toxicity causes various direct and indirect effects in plants resulting in disruption of water and ion transport [2]. Therefore, the effects of Cr^{3+}, Cr^{6+}, and Mn^{2+} on the water and ion transport of paprika was evaluated by monitoring of ECps. Mature paprika was exposed to 50 mg/L and 5 mg/L of Cr^{3+} and Cr^{6+}, respectively, and to 100 mg/L and 50 mg/L of Mn^{2+} in hydroponic solution. A metal-free hydroponic solution was used as a control. Electrodes to monitor ECps was inserted on both sides of the paprika stem and ECps data was collected every 1 h. Paprika's ECps under Mn and Cr stress was lower than that of the control, indicating that water and ion transport is disrupted by metal stress. Paprika ECps decreased slightly with Mn^{2+} treatment but was recovered after 2 days of Mn exposure. Although external symptoms of paprika with Cr were not observed, Cr^{3+} and Cr^{6+} disrupted water and the ion transport of paprika. Therefore, ECps monitoring can be used to diagnose physiological changes in plants under various environmental stress prior to the onset of symptoms.

Key word **:** Chromium; manganese; electrial conductivity; heavy metal stress.

Assessing Fate and Toxicity of Thallium in Rice Paddies and Rice Fish Medaka

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Abstract
Thallium (Tl) is classified as a technology critical element frequently used in the new or developing technologies including electronic, optical, semi-conductive and superconductive industries etc. The anthropic processes of Tl entering the aquatic environment and rice paddies include its mining, usage (e.g., coal combustion and cement production) and disposal (e.g., wastewater discharge from those high-tech manufactures). Tl is also classified as a priority pollutant by the U.S. EPA, as it has high toxicity to mammals. Tl exists in the environment as monovalent (Thallous, Tl(I)) or trivalent (Thallic, Tl(III)) state. Tl(I) is thought to be more thermodynamically stable than Tl(III); however, Tl(III) may be present in surface water, and it seems more toxic than Tl(I) to aquatic organisms. However, the environmental transformation between Tl(I) and Tl(III) in natural water matrices and their toxicities to higher tropic levels of aquatic organisms such as fish remain unclear. We have developed two analytical methods including high performance liquid chromatography inductively coupled plasma mass spectrometry (HPLC-ICP-MS) and anodic stripping voltammetry (ASV) for assessing Tl speciation and fate in environmental water samples. The cause effects and related toxic mechanisms of two Tl species have been assessed by using a rice fish medaka (*Oryzias latipes*) as a model organism coupled with analytical approaches and the transcriptome analyses with next generation sequencing (NGS) and qualitative gene expression. The correlation between Tl speciation and toxicity in medaka fish will be discussed in the lights of our results

***Key words*:** Thallium; rice paddies; fate; toxicity; medaka fish

Accumulation and Distribution of ECEs in Domestic Growth Rice in Taiwan

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Abstract

Rice (*Oryza sativa* L.) is an important staple food served as the main dishes and providing the energy for people in many areas of the world. Although the amount of rice consumption decreased to around 44 kg/person/year, the cooked rice and the rice processed products are still the major carbohydrate source of Taiwanese. The awareness of the emerging contamination elements (ECEs) used in highly developed high-tech industries, such as semiconductor manufacturing, are brought great attentions. The threaten of ECEs on the environments, including water, soil, and agriculture, should be monitored in advance to prevent from the disaster. The country having an overintensive agriculture like Taiwan, the survey of accumulation and distribution of ECEs in the domestic cultivated rice grains is the first task to evaluate the influence of ECEs on the rice fields currently. In this study, there are 24 rice samples, including 14 Japonica rice, 4 Indica rice, and 6 colored rice, collected from domestic farmers and agricultural research and extension stations. Within 24 rice samples, there are 23 paddy and 1 brown rice. The rice samples were dehulled and polished before determinations. The moisture and ash content of the husk, bran and polished rice of each rice sample were determined according to the AACC methods. The 6 elements, gallium (Ga), indium (In), thallium (Tl), arsenic (As), cadmium (Cd) and lead (Pb) were analyzed by using ICP-MS. The results show that the distribution of Ga in rice gain is husk > bran > polished rice, in all rice samples. Compared with other elements, the amount of Ga is much higher, and the colored rice has the highest content of Ga in husk (2.80 mg/kg dm) and in bran (1.52 mg/kg dm) among all rice samples. After dehulling and polishing, the content of Ga in 5 polished Tainan No. 11 (TN11) collected from different locations are all below 0.98 mg/kg dm (maximum) with the averaged value of 0.49 mg/kg dm. Generally speaking, the In is evenly distributed in the husk and bran in rice grain and there is no significant difference among the rice types (Japonica, Indica, and colored rice). The Tl cannot be detected in either husk, bran nor polished rice in rice samples. The distribution of As is rice grain is bran > husk > polished rice. Among three types of rice, the minimum, maximum, and averaged contents of bran are 0.45, 1.48 and 0.84 mg/kg dm in Japonica rice, 0.38, 0.77, 0.58 mg/kg dm in Indica rice, and 0.29, 1.44, 0.89 mg/kg dm in colored rice. The distribution of Cd in rice grain is husk > bran and polished rice. The Cd contents of polished rice from all of rice samples are all below the 0.4 mg/kg dm, which are all meet the Standard for the Tolerance of Heavy Metals in Rice (Ministry of Health and Welfare, Taiwan). More rice samples collected from rice fields with information of soil and water conditions are necessary for building the data bank of ECEs of rice grains. This data bank will provide valuable information for setting the standards of ECEs tolerance in rice and farmland irrigation water.

Key words**:** Husk; bran; polished rice; gallium (Ga); arsenic (As).

Physiological and Molecular Characterizations of Rice in Response to Gallium and Indium

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Abstract

Heavy use of gallium (Ga) and indium (In) compounds in the manufacturing of semiconductor materials has resulted in their increased concentrations in soils and groundwater. Information on how these heavy metals affect the growth of rice plants is still on a rudimentary level. This study aims to characterize the effect of Ga and In treatments on the physiology and molecular changes of a popular premium rice in Taiwan, Taikeng 9, at the seedling stage. Our result displayed that $GaCl_3$ treatment enhanced the growth of rice seedlings by slightly increasing root length and shoot dry weight, while $InCl_3$ inhibited the normal growing of seedlings. Even though the relative chlorophyll content (SPAD value) was not affected by both types of heavy metal treatments, 3,3'-Diaminobenzidine (DAB) and Nitro Blue Tetrazolium (NBT) staining generally showed an increased accumulation of hydrogen peroxide (H_2O_2) and superoxide (O_2^-) in the leaf and root tissues of $InCl_3$- and $GaCl_3$- treated plants, respectively. In conclusion, our preliminary results demonstrate a potentially interesting contrasting effect of $InCl_3$ and $GaCl_3$ on the growth of rice seedlings which warrants further studies. An ongoing experiment involves exploring the differential expressed genes in Ga promotion and In inhibition mechanisms by the use of transcriptomic methods and giving an overview of Ga- and In- regulatory mechanism, inclusive of transport and tolerance, in rice.

Key words: Gallium, indium, rice, abiotic stress.

Mitigation of Manganese Toxicity using Various Soil Amendments in Chromium Contaminated Soils

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Abstract

Contamination of soil with trivalent chromium [Cr(III)] caused manganese (Mn) toxicity. Manganese oxidized Cr(III) to Cr(VI) and Mn was reduced resulting in the increased bioavailable Mn concentration in soil. Oxidized Cr(III) was reduced again by soil organic matter. While soil contamination with Cr(III) was not toxic to plants, increase of bioavailable Mn induced by Cr(III) contamination was toxic to plants grown in the soil. Therefore, the objective of the study was to evaluate effect of soil amendments on the mitigation of Mn toxicity in Cr(III) contaminated soils. Three different soils were spiked with 1000 mg/kg of Cr(III) and incubated for 1.5 years. Incubated soils were treated with $CaSO_4$, $CaCO_3$, $CaNO_3$ and garlic stalk and incubated for 2 weeks. Bioavailable Mn concentration was analyzed using inductively coupled plasma atomic emission spectroscopy (ICP-AES) and Mn oxidation state of the soil was analyzed using X-ray absorption fine structure (XAFS). Among soil amendments, $CaCO_3$ reduced bioavailable Mn concentration extracted by 1 M sodium acetate and Mn in the soil was slightly oxidized by $CaCO_3$ and $CaNO_3$ treatment. However, oxidation state of Cr(III) was not affected by the soil amendments. The results indicate that Mn toxicity can be ameliorated by soil amendments such as $CaCO_3$ and $CaNO_3$ without affecting Cr toxicity in Cr(III) contaminated soils.

***Key words*:** chromium; manganese; toxicity; soil; amendment.

Effects of thallium on growth and ultrastructure of rice seedlings

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Thallium (Ta) is an emerging pollutant compound, which is widely used in the manufacture of electronic components, semiconductors, and optics, thereby have the risk led to environmental pollution. The aim of this study was to explore the toxic effect of Ta on rice seedlings. Growth of rice seedlings on hydroponics containing Ta higher than 1 μM significantly reduced plant height and root length. Histochemical analysis of transgenic rice containing auxin responsive promoter and GUS reporter gene indicating Ta inhibited auxin polar transportation consequently restricted root growth. Ultrastructure of 2-week-old rice seedlings was studied after 5 days culture treating with or without Ta by transmission electron microscopy (TEM). In mitochondria, treating rice seedlings with Ta higher than 10 μM caused swelling in leaves and roots, and 20 μM Ta treatment caused severe collapse of mitochondrial cristae and rupture of outer membrane. In chloroplast, with increasing Ta concentrations the number of plastoglobule increased. To further understand the mechanism of Ta-induced cell death in rice, transcriptomic profiles of roots and shoots response to Ta were analyzed and possible mechanisms will be discussed.

Key words: Auxin, Mitochondria, Rice, TEM, Thallium, Ultrastructure

Agricultural Practices and Soil Properties Controlling Crop Production in Sandy Soils under Semiarid Tropical Climate

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Abstract

In the semiarid tropics, where variable climatic conditions such as drought and flood are among the difficulties for smallholder farming, the mitigation of their impact on food security is of great significance. Taking an example from the north-central Namibia, where sandy soils are dominant, production of the pearl millet as staple crop is very low because of low soil fertility and variable rainfall. In addition, encroachment of the cultivated field due to population growth caused the invasion of the harmful weed, Bermuda grass (*Cynodon dactylon*, hereinafter referred to as CD) leading to serious decline in crop yield. Our research objectives were to identify soil properties controlling the crop production under variable rainfall conditions and to examine mitigation measures against impact of rainfall variability and CD on crop production.

To achieve this, we conducted two field experiments in north-central Namibia. Soils in Namibia were classified as Quartzipsamments with about 5% of clay content. In the first experiment, some parcels of fallow forest were cleared every year since 2012 and continuously cultivated for 4 years with 3 replicates. Treatments also included fertilization. Thus, we could distinguish the effects of climatic variability on crop production from those of cultivation periods and/or fertilization. We monitored soil parameters such as organic matter content and infiltration rate, crop yield and climatic variables. In the second experiment, all the combination of the two treatments, plowing and fertilization, were prepared in 2014 in two sites with CD and without CD with 3 replicates. Measured were soil water content, soil texture, soil hydraulic conductivity, soil water retention curve and crop production.

The rainfall in each cropping season ranged from 77 to 235 mm only despite 400 - 500 mm of long-term average values in this region. Findings from the first experiment could be summarized as follows. 1) Positive effect of fertilization was not consistent during the course of 4-year experiment, suggesting that fertilization will not mitigate climatic variations, 2) soil physical properties such as infiltration rate were crucial characteristics to mitigate climatic variations and 3) crop production in the 4 cropping seasons after land clearing declined so drastically partly due to rapid decomposition of soil organic matter in the sandy soils. The second experiment revealed that crop yield in the site with CD was one-tenth of that in the site without CD because CD outcompeted the crop for acquiring moisture at the depth of 0 - 20 cm. Although plowing and fertilization could increase crop production, these treatments did not mitigate the decline of crop production caused by CD. In conclusion, for mitigation of impact of rainfall variability and weed damage on crop production in sandy soils under semiarid tropical climate, maintenance or improvement of soil moisture is more crucial than fertilization.

***Key words*: *Cynodon dactylon*; Namibia; pearl millet; rainfall variability; sandy soils;**

Alternative Nutrient Management for Sugarcane Plantation in the Central Region Adopted from Tailor-made Fertilizer Technology for Sugarcane in the Northeast (SimCane), Thailand

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Abstract
The objective of this research was to find out the utilization possibility of Tailor-made fertilizer technology for sugarcane in the Northeast (SimCane) transfer to the Central region of Thailand comparing with other nutrient management techniques by considering growth and yield of sugarcane and soil resource sustainability. The Study site was located in Song Phi Nong district, Suphan Buri province, Central region of Thailand. Experimentally, a randomized complete block design (RCBD) has been used to conduct with 3 treatments and 3 replications comprising fertilizer application according to Department of Agriculture recommendation (T1), SimCane applying based on the similar properties of soil series (T2), and modern development of tailor-made fertilizer technology for sugarcane in the Western Central part of Thailand (T3). The results demonstrated that the sugarcane height of all treatments was not statistically significant difference at 4 months and 8 months after plantation. Nonetheless, there has shown a statistically significant difference at 12 months after plantation, namely T2 provided the highest sugarcane height. In term of the sugarcane yield and commercial cane sugar (CCS), all treatments were not statistically significant difference. However, T2 showed the highest of sugarcane yield with 17.89 ton/rai following by T3 and T1 with 17.00 ton/rai and 14.92 ton/rai, respectively. As far as the economic return was concerned, there has revealed that T2 was likely to be the highest of net income with 8,564.09 baht/rai following by T3 and T1 with 8,353.37 and 6,993.79 baht/rai, consecutively. In addition, the analysis of soil after the sugarcane harvest revealed that total nitrogen and exchangeable potassium of all treatments were not statistically significant difference while available phosphorus has exhibited a statistically significant difference. These results suggested that SimCane could be able to possibly apply for sugarcane cultivation in the central region of Thailand by using soil information to fine comparable soil series in SimCane.

Key words**:** Central region, nutrient management, sugarcane, tailor-made fertilizer technology, SimCane

Production of compost by means of eradicating invasive Water Hyacinth (*Eichhornia crassipes*)

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Abstract

Most of the water bodies in Sri Lanka have invaded and degraded due to the invasive growth of water hyacinth. This has diminished the water quality for irrigation purposes, bio-diversity, and aesthetic value. As water hyacinth absorbs nitrogen and phosphorous very rapidly from water, it has a good potential to prepare compost and can be practiced as a cost effective eradication method. The produced water hyacinth compost would be an excellent soil conditioner as well as a substitute for inorganic fertilizers. However, heavy metals may accumulate in water hyacinth plants due to the phyto-accumulation effect of these plants. The composition and the quality of compost essentially depend on the input sources occupied. Further, due to high moisture content of water hyacinth, it is vital to incorporate several materials to increase the volume and the quality when producing compost.

The present study was conducted to prepare different compost mixtures using water hyacinth and to determine the suitability of produced compost mixtures. The water hyacinth plants were collected from Moragoda canal, Galle. Six mixtures were prepared as; water hyacinth, cattle manure, Dry leaf litter (M1), water hyacinth, wood ash, dry leaf litter (M2), water hyacinth, cattle manure, wood ash, Eppawala rock phosphate [ERP], dry leaf litter (M3), water hyacinth, ERP, dry leaf litter (M4), water hyacinth, dry leaf litter (M5), water hyacinth, wood ash, ERP, Spent Poultry litter (M6). Compost prepared only by water hyacinth plants was kept as the control. The mixtures were digested aerobically for 12 weeks by mixing them weekly and maintaining 60% moisture content at the early stages of composting process. After fully decomposition, the final compost mixtures were analyzed for pH (pH meter), Total N (micro kjeldahl method), Organic C (Loss on ignition method), heavy metals including Cu, Cd, Pb, Zn, Fe, Ni, As (Inductively coupled plasma optical emission spectrometer). According to the results, it was revealed that, pH was within the permissible limit in M3, M5, M6, and in control. Highest Total N% and organic C% was reported in control compost mixture 3.07% and 32.58 % respectively. The highest C:N ratio was reported in M5 mixture with 17.8. All the heavy metals detected in prepared compost was within the permissible level for Sri Lanka Standards (SLS) except the control compost showing total Fe content as 17402.8 mg/Kg which was above the SLS standards (10000 mg/Kg). Comparing the C:N ratio, pH and heavy metal composition, M5 is the most suitable compost mixture with composition of water hyacinth and dry leaf litter.

Key words: water hyacinth; compost; heavy metals; C:N ratio; invasive

Selection of Appropriate Methods to Determine Soil Mn availability for Low-Cadmium Rice Cultivar

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Abstract

In previous research, we produced a japonica rice cultivar (Oryza sativa L. cv. Koshihikari Kan No.1 = KK1)) that is a mutant with nearly cadmium (Cd)-free grains. It also shows a relatively low absorptive ability for soil manganese (Mn) because of the inactivation of the transporter-encoding gene (OsNramp5) that transports Cd and Mn, and is susceptible to brown spot disease compared to Normal cultivar (Koshihikari =KK). Thus, the objectives of this study are to determine appropriate methods for soil-Mn availability for KK1 and to clarify the difference in Mn absorption property between KK1 and KK.

We collected 12 shoot sample sets of KK1 and KK with soils in Japan. Available Mn of the soils were determined by the extraction methods with ammonium acetate, calcium chloride, tannic acid, hydroquinone, EDTA and DTPA followed by ICP-OES analysis. The latter two extraction solvents are also used to analyze soil Fe availability. Shoots were decomposed by an acid digestion method, and Mn and Fe were measured by ICP-OES.

KK1 had linear correlations between available soil Mn and shoot Mn with the decreasing of determination coefficients as follows: calcium chloride, ammonium acetate, DTPA, EDTA ,tannic acid, hydroquinone. The top three solutions showed a high correlation significantly, suggesting the suitability of those methods to determine soil Mn availability for KK1 (Fig.1, $CaCl_2$).

On the other hand, the high correlations were not observed on KK in contrast to KK1 (Fig. 1). This difference could be attributed to the strong ability of KK to absorb soil Mn at low Mn concentration. As shown in Fig. 2, the transfer factor of Mn showed a great difference between KK1 and KK, especially in the range of low concentration of soil Mn. KK1 showed a constant value of the trance factor regardless of the soil Mn concentration, while KK showed a very high value at the low concentration and decreased exponentially with the increase of soil Mn concentration. These results suggest that the Mn transport-related gene are activated at low Mn concentration and the Mn absorption capacity increase rapidly.

***Key words*:** Manganese; Koshihikari Kan No.1; Koshihikari:

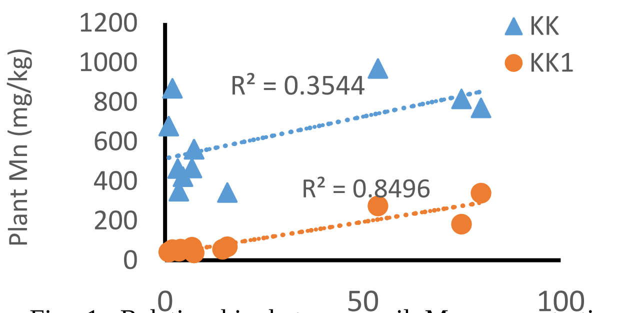

Fig. 1. Relationship between soil Mn concentration extracted with $CaCl_2$ and shoot Mn concentration in KK1 and KK.

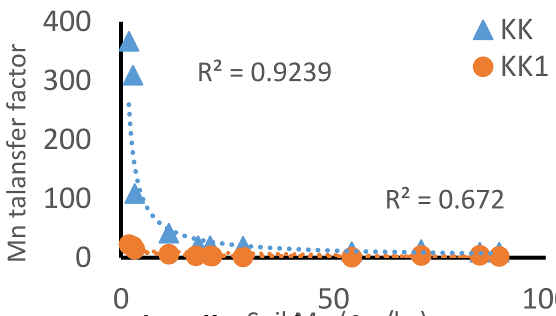

Fig. 2. The effects of Soil Mn concentration extracted with DTPA on Mn transfer factor of KK1 and KK.

Sodium selenate application in soil on growth and yield quality in lettuce

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Abstract
The objective of this experiment was conducted the effect of sodium selenate application on growth, yield quality and selenium accumulation in lettuce. The experiment used 2x5 Factorial in Completely Randomized Design (CRD) with 10 replications and 2 factors. Factor 1 is seedling preparation (sodium selenate and non-sodium selenate applied) and factor 2 is the concentration of sodium selenate solution at 0, 5, 10, 15 and 30 mg/L. The results found that seedling preparation was not significantly different the plant height, fresh weight and dry weight of lettuce. While, the secondary metabolic compounds in lettuce found that the seedling preparation with sodium selenate solution at 5 mg/L in soil gave the highest of total chlorophyll and carotenoid contents. In addition, the seedling preparation was not significantly different selenium accumulation in lettuce, but the sodium selenate solution at 30 mg/L in soil gave the selenium accumulation 2.57 µg/g in lettuce.

***Key words*: **Lettuce, secondary compound, seedling, selenium, soil

Table 1. Effects of seedling preparation with Na_2SeO_4 application in soil on selenium accumulation of lettuce (µg/g)

Seedling preparation (A)	Na_2SeO_4 application (mg/L) (B)					Average (A)
	0	5	10	15	30	
Non-Na_2SeO_4 application	0.15 c	0.26 c	0.47 bc	0.84 b	2.40 a	0.82
Na_2SeO_4 application	0.16 c	0.29 c	0.84 b	0.90 b	2.43 a	0.92
Average (B)	0.15 C	0.27 C	0.66 B	0.87 B	2.57 A	
F-test (A)	ns					
F-test (B)	**					
F-test (AxB)	*					
CV. (%)	15.53					

Mean by the same letter were not significantly different by LSD (n=10)
ns: non-significantly different at P >0.05
*: significantly different at P ≤0.05
**: significantly different at P ≤0.01

Use of Nano-Fertilizer to Minimize Nutrient Losses from Sandy Regosols

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Abstract

Fertilizers play a vital role in enhancing the crop productivity, especially with the introduction of high yielding fertilizer responsive varieties. The nutrients applied to sandy-textured well-drained soils are highly prone to leach with deleterious environmental consequences. Nano-structured fertilizer formulations have been identified as a possible option to minimize these losses. The aim of this study was to evaluate nutrient releasing pattern and leaching potential of two nano-fertilizers namely, hydroxyapatite urea (HAU) and K-MMT against conventionally used urea and muriate of potash (MOP). The experiment was conducted for 16 weeks on leaching column (25cm Diameter and 45cm height) with three replicates. The soil type used was well-drained sandy regosols which is a common coconut growing soil in the tropics. Fertilizer application rates were calculated based on soil mass used (15kg) in the column and the annual fertilizer application rate for adult coconut palm on its rootzone. Moisture levels were maintained at field capacity. Releasing pattern of nutrients from fertilizer was quantified using frequent soil sampling (two weeks intervals) and analysis. The columns were over-saturated and the drainage was collected once a month. The leachate was analysed to quantify the leaching losses. Results showed that Soil exchangeable potassium levels were significantly higher ($P<0.05$) in K-MMT fertilizer applied treatment compared to MOP treatment while control had the significantly lowest potassium levels throughout the experimental period. Available N (NO_3^- and NH_4^+) in soil did not show a consistent pattern between Urea treated and HAU treated columns. By 16 weeks after application, 31% of N from conventional urea and 27.8% of N from HAU had been leached and they were not significantly different.

The cumulative leached potassium showed that by 16 weeks after treatment application, 64.1 % of applied K from conventional fertlizer (MOP) had been leached while that of Nano-K fertilizer was 39.9%. This indicates that potassium supplied through K-MMT has lower leaching potential of leaching compared with potassium from conventionally used MOP. It highlights the potential of this nano-K fertilizer (K-MMT) for enhancing the environmental performance of agricultural production. Cost effectiveness of production and field level application and the impact of these nano-fertilizers on soil microbial community is being studied.

***Keywords*:** Nano fertilizers; Leaching; Contamination of groundwater

Soil testing kits as an alternative to laboratory soil testing for soil pH, exchangeable K and available P in Sri Lankan soils

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Abstract

The soil test based P and K fertilizer application for food crops was initiated in 1993 by the Department of Agriculture (DOA), Sri Lanka to prevent unwise application of fertilizer to crop lands. Since laboratory testing take 3- 4 weeks- to issue soil test, experiments were conducted at the major soil testing laboratories of the Department of Agriculture to find out an easy and quick method to test soil samples at farmers' field itself. Numbers of soil samples collected from cultivated fields of different locations were tested by the Transchem soil testing kit and by the laboratory methods for pH, available P and exchangeable K. Correlations between soil test kit results and laboratory analysis results were estimated. Soil samples having pH between pH 4 to pH 8 were selected for pH testing. Soil test based P and K recommendations has been prepared by taking available P contents as <20, 20-30 and > 30 mg P/kg soil and exchangeable K content as < 40, 40- 80, 80 -160 and > 160 mg K/kg soil. As such soil samples having soil available P between 5 and 30 mg P/kg soil and exchangeable soil K between 20 and 200 mg K/kg soil were studied by both methods. Substantial variations in intensity of brown to blue colours were obtained for pH below 5, 5-7 and above 7. Clear variation of intensity in blue colours was obtained for available soil P below 5, 5-20 and above 20 mg P/kg soil. Similarly, clear variation of intensity in yellow colours was obtained for exchangeable K below 100, 100 – 200 and above 200 mg K/kg soil. Correlations between soil test kit values and laboratory values for pH and available P and exchangeable K were always positive. It is suggested form these results that Tanschem soil testing kits is a suitable alternative to laboratory testing of soils for pH, available P and exchangeable K contents of the agricultural fields. These test kit results can be used to formulate soil test based fertilizer recommendation at a cost of 1 $ per sample. This soil test kits can be used to test soils at the farmers' field itself and as such it will be helpful for farmers to decide the level of lime, P and K application as quickly as they need.

Key words: Available P, Exchangeable K, Laboratory soil analysis, Soil pH, Testing Kits,

Effects of Calcium and Magnesium Treatments in Acid Soil on Cadmium Absorption by Rice Plant

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Abstract
According to the previous hydroponic test, the cations of the essential elements (e.g. calcium (Ca), magnesium (Mg), etc.) will reduce the absorption of cadmium (Cd) ions in the soil and alleviate the Cd toxicity to crops. The objective of this study was to evaluate the effects of Ca and Mg applications in a potentially contaminated soil on rice plant growth and Cd distributions in plant. In this study, the Taiwan acid soil, Pinchen, was used, that was sampled from Tea Research and Extension Station, Taoyuan, Taiwan. Artificially Cd-contaminated soil sample was obtained by Cd spike of 0.33 mg kg^{-1} in Pinchen soil. The contaminated soil sample was further treated by two application levels of 1600 and 800 mg kg^{-1} of Ca and 400 and 200 mg kg^{-1} of Mg, respectively. A control was set without Ca and Mg treatments. Then, a pot experiment was carried out for assessing the influences of Ca and Mg applications to the soil on rice plant growth and Cd absorption. Two rice cultivars, Taiken 9 (TK9) which is japonica and Taichung sen10 (TCS10) which is indica, were used in the pot experiment for illustration of the genotypic variation. In Table 1, the results showed that the Cd absorptions by root for both TK9 and TCS10 were significantly decreased by Ca treatments. However, simultaneously the soil pH was reduced obviously and the soluble aluminum (Al) in soil was increased dramatically. And there was a great reduction in root dry weight due to the Ca treatments. This revealed addition of Ca in soil would enhance desorption of Al from solid phases into solution and then result in low pH and reduction of plant growth. Nevertheless, the decreases of Cd in rice plant would be due to not only the competition of Ca and Cd for absorption by root but also the Al stress induced by Ca treatment to reduce plant growth. In addition, the Mg treatments but resulted in an increase of Cd absorption by rice root. This could be referred to that the available Cd in soil was significantly increased by Mg treatment. The soluble Al in soil increased slightly with the Mg treatments, and thus there was not severe Al stress on rice plant. One even found the plant growth was promoted by Mg treatment according to the increases of root dry weight.

***Key words*:** Heavy metals; soil pollution; paddy rice; phytotoxicity; aluminum.

Table 1. Available cadmium, pH, and soluble aluminum in soil and the root dry weight and cadmium absorption for the rice cultivars, TK9 and TCS10, growing on the cadmium contaminated soils with the calcium and magnesium treatments, respectively.

		TK9				TCS10			
Treatment	Available cadmium[a] (μg kg^{-1})	pH	Soluble aluminum[b] (mg kg^{-1})	Root dry weight (mg plt^{-1})	Cadmium absorption (μg plt^{-1})	pH	Soluble aluminum[b] (mg kg^{-1})	Root dry weight (mg plt^{-1})	Cadmium absorption (μg plt^{-1})
Control	10.93	5.81	0.00	0.147	0.261	5.67	0.00	0.323	0.625
Ca /1600	11.57	4.45	2.66	0.071	0.047	4.96	1.27	0.111	0.001
Ca /800	18.83	5.05	1.60	0.078	0.005	4.64	1.20	0.106	0.058
Mg /400	24.50	6.10	0.22	0.113	0.256	7.58	0.07	0.543	1.517
Mg /200	19.33	6.71	0.03	0.271	2.259	6.18	0.09	0.437	2.381

a. Available cadmium was extracted by 0.1N HCl.
b. Saturated extraction.

Advanced countermeasures for Cadmium and Arsenic Contamination in Rice under Recent International Situation

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Abstract
The Codex Alimentarius Commission has recently adopted maximum permissible levels for cadmium (Cd) of 0.4 mg kg^{-1} in polished rice, and inorganic arsenic (iAs) of 0.2 mg kg-^{1} and 0.35 mg kg^{-1} in polished and husked rice, respectively. The Codex committee has elaborated code of rractice for the prevention and reduction of Arsenic contamination in rice. Given that 34–50% of Cd intake and 62% of iAs intake by Japanese people comes from rice, reducing the concentrations of Cd and As in rice grains is a high priority in Japan and Asian countries in which rice is eaten as a staple crop. Here, the advanced countermeasures for Cd and As mitigation of rice in Japan are summarized.
Chemical remediation of Cd-polluted soil by soil-washing. Various chemicals were tested for their Cd extraction efficiency by using three paddy soils, selecting ferric chloride ($FeCl_3$) as a promising chemical for on-site soil washing. The comparison of $FeCl_3$ extraction ability to that of various iron, manganese, and zinc salts revealed the primary extraction mechanism of $FeCl_3$ to be proton release coupled with hydroxide generation (hydrolysis). Washing with $FeCl_3$ led to the formation of Cd–chloride complexes, enhancing Cd extraction from the soils. The developed in situ three-step washing method for Cd-contaminated paddy fields will be introduce in the presentation.
Phytoremediation for Cd-contaminated paddy soil by rice plant. An effective-phytoextraction has been developed by using the high-Cd indica rice cultivars, “Chokoukoku” for 2-years without irrigation after drainage to enhance availability of soil Cd to rice plant in fields. They demonstrated that the phytoextraction effectively decreased soil Cd content and the grain Cd concentration. In order to achieve commercialization of phytoextraction technology, they have established an integrated mechanized system of harvesting, on-site drying, and packing of Cd-containing rice plants, and developed an efficient system for collecting Cd involving the incineration of the harvesting rice plants. In an effort to improve the phytoextraction, new rice cultivars have been bred, which have some advantages in some agronomic traits such as shattering and lodging susceptibility.
Breeding of low Cd absorptive cultivar. Practical rice cultivars showing low-Cd characteristic have been develop by using the mutant breeding. “Koshihikari”, the most popular Japanese japonica cultivar, were irradiated with accelerated carbon ions from an azimuthally varying field cyclotron. Three mutants (lcd-kmt) were screened and The Cd concentrations of shoots and roots in all lcd-kmt were significantly lower than that in normal Koshihikari (KK). Plant morphology, grain yield, and eating quality for lcd-kmt mutants were as good as those of KK. The gene responsible for low-Cd trait was identified based on gene mapping and the DNA marker was developed for efficient breeding of new rice cultivars.
Promising methods simultaneously decrease concentrations of As and Cd in rice grains. Under anaerobic conditions, Cd precipitates as the barely-soluble sulfide, resulting in a low Cd availability for rice plants. Field experiments showed that flooded cultivation during the entire rice growing period or the latter part of it significantly decreased Cd in rice grains by more than 80%. Flooded cultivation, however, increases As solubility through the reduction of As(V) to As(III) and the reductive dissolution of As-bearing Fe-oxides in soils. As expected, flooded cultivation increased As in rice grains, whereas aerobic cultivation increased Cd. The strategies for the simultaneous decrease of As and Cd are; 1) optimal water management to simultaneously decrease, 2) water saving cultivation with low Cd rice cultivar and 3) flooding cultivation with soil amendments for As uptake by rice plant.

***Key words*:** Arsenic, cadmium, paddy soil, rice.

Elution Characteristics of Various Silica Materials and Their Effects on the Mitigation of Arsenic and Cadmium in Rice Plant

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Abstract

In recent years, Codex Alimentarius Commission has instituted the maximum level of arsenic (As) and cadmium (Cd) in rice, so we have to reduce both of them simultaneously. While silica materials applying to soils can be concerned for the answer, the comprehensive research on a wide variety of the materials, sold commercially in Japan, is insufficient. It should be clarified how successive years application of the materials effects on Si in soil solution, and As/Cd mitigation and healthy growth of rice plant. The purposes of this study are to analyze elution characteristics of the commercially available materials and to elucidate the relationship between the elution characteristics and As, and Cd concentrations in rice plant.

The amount of available silica in 31 materials was determined by an extraction method with a weakly acidic cation exchange resin in water, followed by the selection of 14 materials, covering the different levels of the available silica, for pot cultivation test under continuous flooding condition. The 0.02 m^2 Wagner pot was used with 2.5 kg of medium coarse gray lowland soil (1 mol L^{-1} HCl extracted As: 2.0 mg kg^{-1}, 0.1 mol L^{-1} HCl extracted Cd: 0.3 mg kg^{-1}) and 5 g of the materials. We started the pot test with japonica rice (*Oryza sativa*. L. cv. Hitomebore) after the transplanting of rice seedling on Jun. 1, 2018. The concentration of Si in soil solution at heading stage was measured by ICP-OES. Si in shoots was determined by a weight method. Total As and Cd in shoots and brown rice were measured by acid digestion followed by ICP-MS. Inorganic As in brown rice was determined by HPLC-ICP-MS.

Available silica of materials is 17.3 to 340.3 mg SiO_2 g^{-1}, showing a wide range of Si content in the materials. The Si concentration in soil solution positively correlated with the available silica, which indicates the determination method of available Si is useful and the elution characteristics is various in Japanese silica materials. The Si concentration in shoots was positively correlated with that in soil solution, so it is speculated that the eluted silica was effectively taken into the plant. Besides, the total As concentration in shoots significantly decreased along with the increase of Si concentration in soil solution, while it shows similar tendency with a relatively low mitigation for the total and inorganic As concentration in rice grain. These results suggest that the mitigating effects, thought to be a competitive absorption between silicate and arsenite, have diminished during the transportation/distribution process of As in rice plant. On the other hand, Cd concentration in brown rice was at low level sufficiently, probably due to the flooding condition. A further mitigation was observed with the application of the materials, which could be attributed to the increase of the soil solution pH due to the alkali component of the materials.

The results obtained here are from the first year of successive materials application. In the future, we would like to advance analysis of the accumulation effect by successive application of materials.

***Key words*:** Silica, arsenic, cadmium, paddy soils, rice.

Evaluation of Adsorptions of Cadmium and Chromium on the Biochars Pyrolized form Different Feedstocks

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Abstract
Biochar is increasingly used for heavy metal adsorbent in pollution remediation. The deposits on biochar surface which are mainly made up of mineral oxides or salts would influence adsorption behavior of biochar, and so does biochar surface charge. Pollution of agricultural land is a global issue for safe food production. Soil amendment of biochar (BC) is reported to reduce the bioavailability of heavy metal contaminants. Sugarcane biochar (SB), coffee biochar (CB), and tea biochar (TB) were used in study for characterization of the adsorptions of cadmium (Cd) and chromium (Cr) on the biochars (i.e. SB, CB, and TB). The biochars of SB, CB, and TB were torrefied at temperature of 350°C for 90 min. The points of zero charge (PZC) for SB, CB, and TB were measured and about 2.4, 7.2, and 6.60, respectively. Their cation exchangeable capacities (CEC) were determined of 151, 73.2, and 38.5 cmol (+) kg^{-1}. According to the determination of functional groups by Boehm titration, the SB surface was rich in acidic groups, but the TB surface was relatively rich in basic groups. And abundant acidic and basic groups could be simultaneously found in CB. The biochar surface morphology was investigated with the images of scanning electron microscope (SEM). The porous structure of SB was regular strip arranged and those of CB and TB were seemingly irregular and tightly hierarchical. According to the adsorption isotherms for Cd and Cr on the biochars, CB has the superior capacity to adsorb Cd and Cr, and TB adsorbed more Cd than did SB. Nevertheless, SB absorbed much more Cr than TB did. The results revealed that the adsorptions of Cd and Cr by biochar would be in relation to the functional groups on biochar surface.

Key words**:** biochar; surface morphology; sorption; cadmium; chromium.

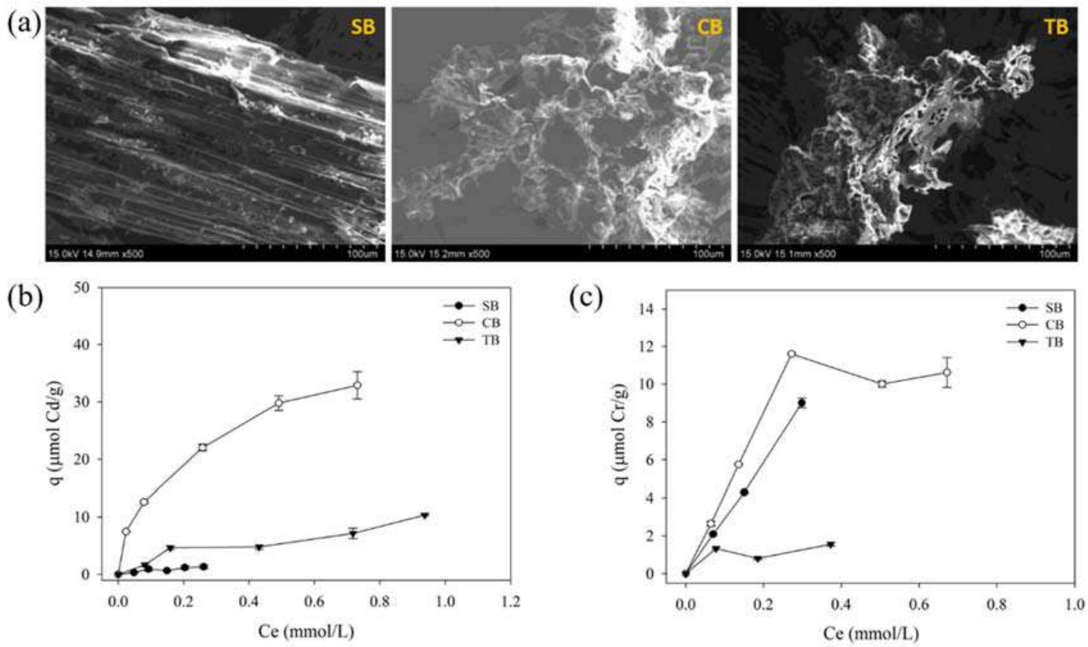

Fig. 1. (a) Surface images of sugarcane biochar (SB), coffee biochar (CB) and tea biochar (TB) by scanning electron microscope (SEM) and the adsorption isotherms of (b) Cd and (c) Cr on SB, CB and TB, respectively.

Chemical speciation and solubility of soil lead and arsenic by thermal treatments

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Abstract

Thermal treatment is an effective technique for soils contaminated with relatively volatile heavy metals such as mercury. Due to a relatively high temperature for volatilization, this technique has little been studied for the treatment of contaminated soils with lead (Pb) and arsenic (As). It has been unknown how the solubility and chemical species of Pb and As are changed during the thermal treatment process. The objective of this study was to investigate the solubility and chemical species of Pb and As in soils applied for thermal treatments.

Three types of soils (IS, TJ, and HS) contaminated with Pb and As were subjected to the thermal treatment at 300, 600, and 900 ^{o}C using an electric furnace. An aliquot of soil samples were weighted in an alumina boat and heated in a tubular electric furnace for 6 hours (n = 3). After the thermal treatment, Pb and As in the soils were extracted with water and 1 M HCl, and total concentration of these elements was measured by acid digestion method with HNO_3 and HF. The concentrations of these elements were determined by ICP-AES and ICP-MS.

Total soil Pb concentrations were 10489, 22568, and 13622 mg kg^{-1} for IS, TJ and HS soils, respectively. In IS soil, the HCl extractable Pb concentrations were not changed after the 300 ^{o}C treatment (4723 mg kg^{-1}), and increased rapidly after the 600 ^{o}C treatment (9444 mg kg^{-1}). On the other hand, the HCl extractable Pb in TJ and HS soils decreased rapidly when the soils were treated at 600 and 900 ^{o}C. In TJ soil, for example, the HCl extractable Pb concentrations were about 22000 – 23800 mg kg^{-1} up to 300 ^{o}C, but decreased to 17592 mg kg^{-1} at 600 ^{o}C and further to 2478 mg kg^{-1} at 900 ^{o}C. Total soil As concentrations were 5690, 226, and 70 mg kg^{-1} for IS, TJ and HS soils, respectively. The HCl extractable As as a function of temperature of thermal treatment was similar with Pb, which the trend of IS soil was different from TJ and HS soils. In IS soil, the HCl extractable As concentrations were not changed after the 300 ^{o}C treatment (874 mg kg^{-1}), and increased rapidly after the 600 ^{o}C treatment (3275 mg kg^{-1}). On the other hand, the HCl extractable As in TJ and HS soils was not remarkably changed by the temperature of thermal treatment. Our study found that the solubility of Pb and As in soils was dependent on the temperature of thermal treatment and soil types.

key words: thermal treatment, lead, arsenic

Effect of Conservation Practices Using Various Materials of Mulching in Cameron Highlands Agrosystems, Malaysia

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Abstract

Vegetable cultivation on the slopeland farm usually involves a few types of erosion control method. Apart from terracing, the land should be covered by some kinds of mulching. In Cameron Highlands, farmers normally used two types of mulching; plastic cover mulching and living mulching. Therefore, this study aims to compare and quantify the amount of soil erosion for both types of cover under Cameron Highlands agrosystem. Erosion study plot in MARDI Cameron Highlands was used to compare the amount of erosion produced from both mulching types. Soil loss and surface runoff data were quantified using the stilling basin and tipping bucket system. Sampling were done for every ten days interval throughout four months of cabbage cultivation. Three treatments, including control were evaluated; plastic cover mulching (T1), living mulching – liverworts (T2) and control – bare plot (T3). Throughout the first season of cabbage cultivation, the amount of rainfall and irrigation recorded was 284 mm. Based on the result of season 1 cabbage cultivation, 654 g/27.5 m^2 of soil was eroded under the living mulching treatment compared to 711 g/27.5 m^2 under plastic mulching. As for surface runoff, living mulching plot (T2) generate 12.1 mm runoff compared to plastic mulching plot (T1), 17.7 mm. Therefore, the use of natural mulching significantly reduces surface runoff, and effective in controlling soil erosion by water in Cameron Highlands agrosystems.

***Keywords*:** Soil loss; surface runoff; mulching.

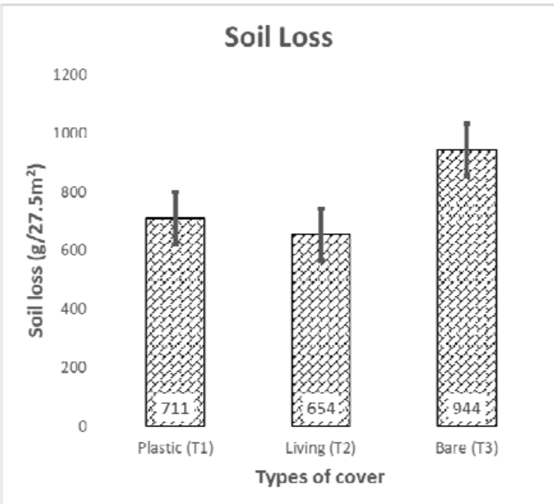

Fig. 1. Soil loss is highest from bare plot, followed by plastic covered plot and lowest soil loss is from plot with natural cover in cabbage farm, Cameron Highlands.

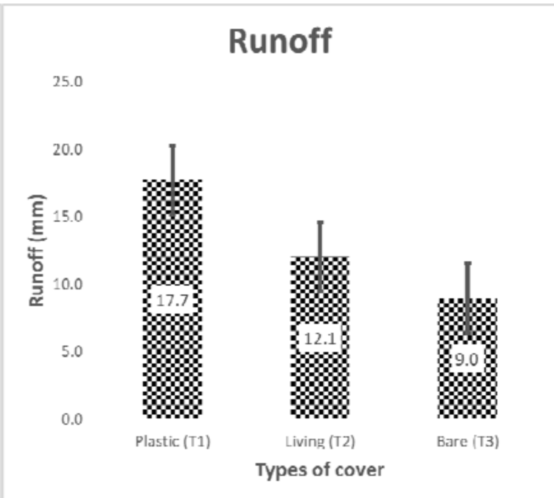

Fig. 2. Runoff is highest under plastic cover, followed by liverworts and lowest on bare plot in cabbage farm, Cameron Highlands.

Vertical Migration of Fukushima Accident–Derived Radiocesium-137 in Orchard Soils under Different Land Use and Fertilizer Management

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Abstract
Our monitoring survey since the Fukushima accident in 2011 indicated that the vertical distribution of accident-derived radiocesium-137 (^{137}Cs) in orchard soils differed significantly among five orchards in 2015, 4 years after the accident. The objective of this study was to evaluate the effects of land use (peach or apple orchard) and nitrogen (N) fertilization on the vertical migration of ^{137}Cs in orchard soils in Fukushima Prefecture. At two peach orchards and three apple orchards, soil samples were collected every 3 cm to 30 cm in 2015. At one apple orchard with a fertilized plot (20 g N m^{-2} y^{-1}) and an unfertilized plot in a long-term N fertilizer trial, soil samples were collected every 1 cm to 15 cm in 2016. The concentration of ^{137}Cs in the samples was analyzed. In 2015, ^{137}Cs migrated significantly further in the 'Akatsuki' peach orchard (4.7 cm) than in the 'Kougyoku' apple orchard (2.6 cm) **(Fig. 1)**. The greater migration in the 'Akatsuki' peach orchard was probably due to the significantly lower bulk density of the soil at 3–30 cm. We evaluated the effects of the application of N fertilizer in the 'Kougyoku' apple orchard on the average migration distance in 2016. ^{137}Cs migrated significantly less distance in the fertilized plot (1.5 cm) than in the unfertilized plot (3.3 cm) **(Fig. 2)**. The slower migration in the N fertilized plot may be ascribed to the harder soil (greater soil hardness) in that plot. In conclusion, land use and fertilizer management affected the vertical migration of ^{137}Cs in orchards: ^{137}Cs moved further in peach orchards than in apple orchards, and N fertilization retarded this migration.

Key words: Nitrogen fertilization; orchard field; Fukushima Daiichi Nuclear Power Plant accident; ^{137}Cs.

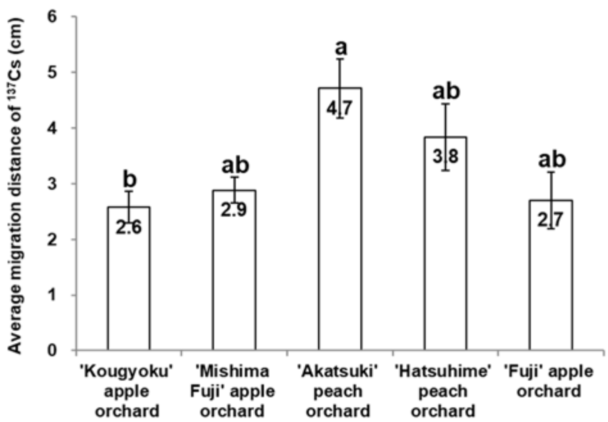

Fig. 1. Effects of land use on the average migration distance of ^{137}Cs within the top 30 cm of the soil profile in 5 orchards in 2015. Error bars represent SEM (n = 3). Bars with the same letter do not significantly differ (ANOVA followed by Tukey's test: $P < 0.05$; $n = 3$).

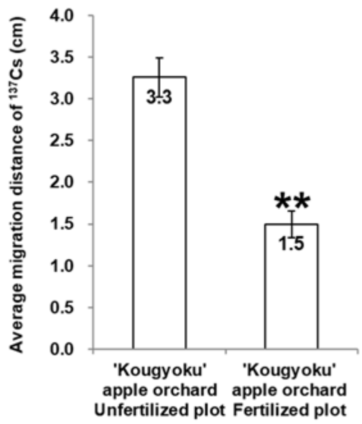

Fig. 2. N fertilizer-induced changes in the average migration distance of ^{137}Cs within the top 15 cm of the soil profile in a 'Kougyoku' apple orchard in 2016. Error bars represent SEM (n = 3). Significant difference between unfertilized and fertilized plots at $^{**}P < 0.01$ (t-test).

Radioactive Cesium Uptake Ability of Lupin

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Abstract

Eight years after TEPCO's FDNPP accident, radioactive cesium (RCs) transfer from soil to plant has been sufficiently regulated mainly by the application of potassium fertilizer to maintain the soil available potassium level high throughout the growth. This countermeasure is useful but it forces to apply additional cost for fertilizer (or resources for potassium) and labor of farmers. Furthermore, the RCs concentration of soybean and other Fabaceae crops tend to be high when compared to rice and the effect of available potassium on the mitigation of RCs transfer is low. One of the most important parameter to evaluate RCs uptake from soil is transfer factor (or concentration ratio), which is designated as RCs concentration in the seed (or any target organ) to RCs concentration in the soil, and this value is generally high in soybean and higher in lupin. The higher ability to absorb Cs in lupin is confirmed by stable cesium uptake and mix-cropping of soybean with lupin enhances the uptake of stable Cs of soybean. These information indicate that lupin increases the availability of Cs in the rhizosphere through root exudates by directly and/or indirectly. We have applied positron-emitting tracer imaging system (PETIS) to visualize the active rhizosphere area in soil (Fig. 1) then investigate the biological and chemical characteristics between rhizosphere and bulk soil.

Key words: radioactive Cs, lupin, potassium, mix-cropping, root exudates, PETIS

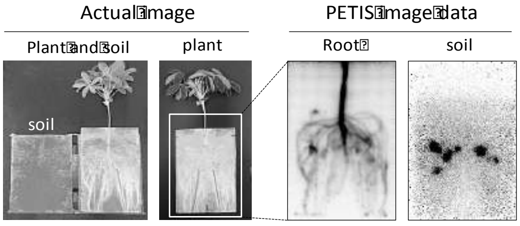

Fig. 1 Visualization of lupin rhizosphere by using PETIS

Blocking the Diffusion of Gasoline plume in Groundwater Using a Permeable Reactive Barrier Making up of Waste Distillery Sludge

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Distillery sludge has been known that it has an excellent ability of removal of high-molecular-weight dyes by its high organic content. This revealed that the sludge can trap non-polar molecules into its structure by partition. In this study the sludge was employed as an absorbent in a permeable reactive barrier (PRB) for simulation of blocking the migration of gasoline plume. Sludge particles with 50-100 mesh were used to make the barrier, which had a size of 4 cm (L) ×28 cm (W) ×28 cm (H). A contaminated region was built with a range of 10 cm (L) ×14 cm (W) ×7 cm (H) beside the PRB by mixing river sands and enough gasoline. The flow of pore water passing the PRB was maintained at 50 ml min^{-1}. The PRB experiment was conducted over a 10-day period, and the concentrations of BTEX (benzene, toluene, ethylbenzene, and xylene) and methyl tert-butyl ether (MTBE) behind the PRB in pore water were determined every day. Toluene broke through the barrier on the first day but MTBE also did until the second day. The highest concentrations for toluene and MTBE appearing on the third day were 650 ppb and 217 ppb, respectively. All monitored toluene concentrations met the standard level of groundwater for drinking water (1.0 mg L^{-1}) during the 10-day period. However, the MTBE concentrations almost met the level (0.1 mg L^{-1}) exclusive the concentration from the third day. Only tiny amount of xylene was detected just on the third day, but both benzene and ethylbenzene were not found all the way. The PRB fixed about 43% of gasoline as the experiment was finished on 10^{th} day; meanwhile, about 86%, 11%, 26%, 85%, and 18% of benzene, toluene, ethylbezene, xylene, and MTBE were still remained in the contaminated area.

Keywords : BTEX, MTBE, distillery sludge, gasoline, permeable reactive barrier

Nitrous Oxide Emission with Different Type of Animal Manure and Region in South Korea

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Abstract

Nitrous oxide (N_2O) emission from manure amended soil is affected by type of animal manure account for management of the manure and diet that attribute to difference in characteristic of manure such as nitrogen (N) and carbon (C) content. The pattern and total amount of N_2O emission is also affected by changes of chemical and physical properties of soil, especially change of water filled pore space (WFPS). The objectives of this study were to determine the effect of 1) type of animal manure, 2) climate, and 3) soil physical and chemical properties on N_2O emission from upland soil. To do this, we conducted this study in different type of animal manures amended upland soils at geographically different two regions of South Korea. Field trials were established at two locations (Miryang, and Yesan) in South Korea. Relationships between N_2O emission and several environmental factors were determined. The cumulative N_2O emission increased with increasing of the manure application rate in both years and locations. Mean value of cumulative N_2O emission across application rates was greatest with pig manure at Miryang in 2017 and 2018 (7.05 and 13.6 kg ha^{-1} year^{-1}, respectively) and Yesan in 2018 with emission rate of 4.04 kg ha^{-1} year^{-1}. This might be attributed to higher NH_4^+-N concentrations in pig manure than other animal manure. However, mean value of cumulative N_2O emission across application rates was greatest with chicken manure (1.69 kg ha^{-1} year^{-1}) at Yesan in 2017. The mean value of cumulative N_2O emission across manure type and application rates increased with increasing of year in both locations. Location significantly affect cumulative N_2O emission, greater mean value of cumulative N_2O emission across manure type and application rates was observed at Miryang where initial soil N was higher than Yesan. Precipitation was highest in 2017 at Yesan, it was likely to elevate mean value of WFPS up to 65.9% whereas Miryang showed 32.0% WFPS. Additionally, mean value of WFPS in Miryang and Yesan in 2018 was 42.3 and 28.1% WFPS, respectively. Cumulative N_2O emission was mainly governed by nitrification at Miryang in both years, whereas N_2O might be mainly produced from denitrification at Yesan in 2017. Furthermore, the majority of N_2O emission was governed by nitrification at Yesan in 2018. To mitigate N_2O emission from cropping system, soil management for animal manure type, application rate, precipitation, and %WFPS of soil should be considered.

Key word: N_2O emission, water filled pore space, animal manure, climate

Mitigation of Global Warming Gas with Bottom Ash in Radish-maize Rotation field

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Abstract
Bottom ash (BA), by-product of coal combustion from electricity power plant, with a very porous surface texture and high carbon might affect physical and chemical properties of soil associated with greenhouse gas emission from arable soil. The objective of this study was to evaluate effect of BA as soil amendment in mitigating greenhouse gas and global warming potential (GWP) from upland soil. In a field experiment, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emitted from the soil was periodically monitored using closed chamber. BA was applied to an arable soil at rates of 0, 200, and 400 Mg ha^{-1}. Radish (Raphanus sativa L.) and Maize (Zea mays L.) were cultivated from March 30th to May 28th and July 5th to Oct 1th in 2018, respectively. Emission of CO_2, CH_4, and N_2O decreased with increasing application rate of BA. Cumulative CO_2 emissions were 41.5, 37.6, and 29.9 Mg ha^{-1} year^{-1} at the rate of 0, 200, and 400 Mg ha^{-1} of BA. Cumulative CH_4 emissions were 15.1, 13.2, 11.5, and kg ha^{-1} year^{-1} at the rate of 0, 200, and 400 Mg ha^{-1} of BA. Cumulative CO_2 and CH_4 emissions decreased with 400 Mg ha^{-1} of BA by 27% and 31% compared with the control, respectively. Cumulative N_2O emissions were 44.9, 28.7, and 14.5 kg ha^{-1} year^{-1} at the rate of 0, 200, and 400 Mg ha^{-1} of BA. Cumulative N_2O emissions decreased with 400 Mg ha^{-1} by 67% compared with the control. Net GWPs were 45.5, 39.5, and 27.1 Mg CO_2 eq. ha^{-1} year^{-1} at the rate of 0, 200, and 400 Mg ha^{-1} of BA. Net GWP decreased with 400 Mg ha^{-1} by 40% compared with the control. Mitigation of CO_2 and CH_4 emission might be mainly attributed to non-degradable property of BA used in our experiment and decrease of soil carbon mineralization. Mitigation of N_2O emission with BA might be due to decrease in water filled pore space (WFPS) of soil. There was no visual toxicity symptoms on radish and maize with application of all of BA treatment during growing seasons. BA did not decrease biomass yields of radish and maize. Based on the above results, BA might be a good soil amendment to mitigate greenhouse gas and net GWP from arable soil without adverse effect on crop productivity.

Key words: Bottom ash, Nitrous oxide, Carbon dioxide, Methane,

Green Manuring Effect on Net Ecosystem Carbon Budget and Global Warming Potential in Maize Field

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Abstract

Green manuring is one of agricultural management strategies to sequestrate atmospheric carbon (C) into soil and mitigate greenhouse gas (GHG) emissions. So far, the effect of mixture of green manure on carbon budget and net global warming potential (GWP) has been evaluated only in paddy soil. Therefore, this study was conducted to examine changes of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions and evaluate net ecosystem carbon budget (NECB) and net GWP with different combination of green manuring in upland soil. Barley (B), hairy vetch (HV), and mixture of B and HV (B+HV) were sown to an upland soil with conventional tillage on November 4th in 2017. The aboveground biomass of these green manures were incorporated into soil on May 25th in 2018. In addition, conventional treatment (NPK fertilizer) was installed as the comparison. Maize was transplanted as the subsequent crop on July 24th in 2018. A closed chamber method was used to examine GHG emissions from the soil, and gas samples were collected once every week during growing seasons of green manure and maize. The gas fluxes were measured with gas chromatograph mass spectrometer and used to calculate NECB, net GWP, and greenhouse gas intensity (GHGI). Cumulative CO_2 emission was lowest in B+HV and it was 35.6 Mg CO_2 ha^{-1} yr^{-1}. All green manuring treatments were effective in mitigating cumulative N_2O emission, which was ranged from 5.2 to 5.9 kg N_2O ha^{-1} yr^{-1}) compared with conventional treatment (7.4 kg N_2O ha^{-1} yr^{-1}). Mean value of NECB was positive only in B+HV, because biomass yield of green manure was greatest and cumulative CO_2 emission was lowest, implying atmospheric carbon was sequestrated into soil. The net GWP was lowest in B+HV (-132 kg CO_2 eq. ha^{-1}), followed by HV, NPK, and B (2,414 kg CO_2 eq. ha^{-1}, 2,608 kg CO_2 eq. ha^{-1}, and 4,019 kg CO_2 eq. ha^{-1}, respectively) in order. Mean value of grain yield of maize was not significantly different among treatments, however the GHGI was lowest in B+HV. Based on the above results, B+HV under the conventional tillage might be the best way of green manure management to increase soil organic carbon stock and to mitigate GHG emissions in arable soil.

Key words: tillage; green manure; Greenhouse gas; NECB; GWP.

Significant variations in arbuscular mycorrhizal fungal communities between subsoil and topsoil layers under 15-year long-term fertilizer amendments in an intensively managed arable purple soil

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Abstract
Introduction: Arbuscular mycorrhizal fungi (AMF) can maintain soil fertility and increase crop yields due to enhanced uptake of soil nutrients and stimulated crop growth. However, how AMF communities along soil layers in managed arable soils could actively respond to long-term fertilization with different amendments are still unknown. Methods: Next generation sequencing was applied to profile soil AMF communities in both 0-15cm topsoil and 15-30cm subsoil from a typical arable purple soil (Eutric Regosol) in the Sichuan Base, China. Soils were collected at four times/year after crop's heading and harvesting from an annual winter wheat (*Triticum aestivum*) – summer maize (*Zea mays*) rotation under four 15-years long-term fertilizations (same nitrogen but different carbon inputs): no-fertilization control, chemical fertilizers (NPK), NPK plus crop straw return (NPKCR), and NPK plus pig manure (NPKOM). Results: Compared to no-fertilization control, AMF Shannon-Wiener index, not Sobs and Chao indices, significantly decreased at 0-15cm topsoil, but increased at 15-30cm subsoil, for both heading and harvesting samples of wheat and maize under NPK, NPKCR and NPKOM. Meanwhile, AMF community composition shifted between contrasting fertilizations in both topsoil and subsoil. The mantel analyses demonstrated that AMF community were significantly changed by fertilization and soil available phosphorus for wheat and maize samplings, while related to soil organic carbon (SOC) in topsoil, but to available potassium in subsoil. Conclusions: Fertilizer amendments and SOC are important factors in shaping AMF community composition and diversity in intensively fertilized arable soils. Our results promote better understandings of changes in AMF communities for intensively managed agro-ecosystems.

***Key words*:** Eutric Regosol, mantel analyses, next generation sequencing, manure, straw carbon input.

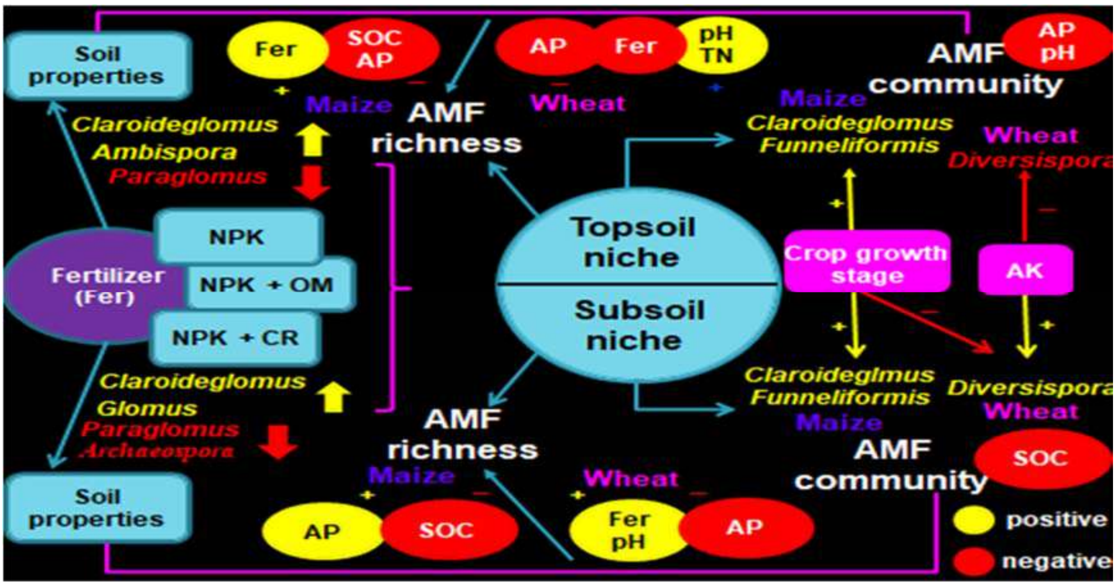

Fig. 1. Conceptional diagrams that showing distinctive soil properties as positive and negative factors in shaping AMF community composition and diversity in intensively 15-years long-term fertilized arable soils and their differences between topsoil and subsoil.

Modeling sediment yield response to land use change using SWAT model in Hiso basin, Fukushima, Japan

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Abstract
Land use change has a great influence on sediment characteristics in the basin scale. Application of models to identify soil erosion processes, estimate sediment yield monitor and evaluate different land use scenarios. This study aims to use the well-calibrated Soil and Water Assessment Tool (SWAT) to assess the response of sediment yields under different land use scenarios in the Hiso basin in Fukushima, Japan. Land use change analysis showed that agricultural and rice areas have changed into barren and range areas since 2011. The data from 2013 to 2014 were used for calibration of the model, while the data from 2015 to 2017 were used for validation. The sensitivity analysis of the model parameters was performed using the SUIF-2 method in the SWAT-CUP model. Multi-objective function statistics, for the monthly comparison, Nash–Sutcliffe efficiency, NSE (0.68, 0.77), Coefficient of determination, R^2 (0.83, 0.82) and Relative error, Re (43%, 26%), and for the daily comparison, NSE (0.73, 0.73), R^2 (0.83, 0.82) and Re (43%, 26%), for calibration and validation, respectively, were obtained. During both calibration and validation periods the sediment yield were accurately predicted. However, the sediment yield was underestimated during several heavy rainfall events. The average annual sediment contribution from the individual HRU (hydrological response unit) and sub-basin shows that steep areas in sub-basins in the forest, pasture and agricultural lands had the highest sediment yield (100 to 300 tons ha^{-1} y^{-1}). SWAT model successfully simulated sediment yields during the land use change and scenario analysis showed that increasing the rangeland, especially the barren land resulted in the increase in the sediment. Changing rice, agricultural and pasture land have the most significant impact on sediment.

***Key words*:** Hiso basin; land use change; sediment; SWAT model.

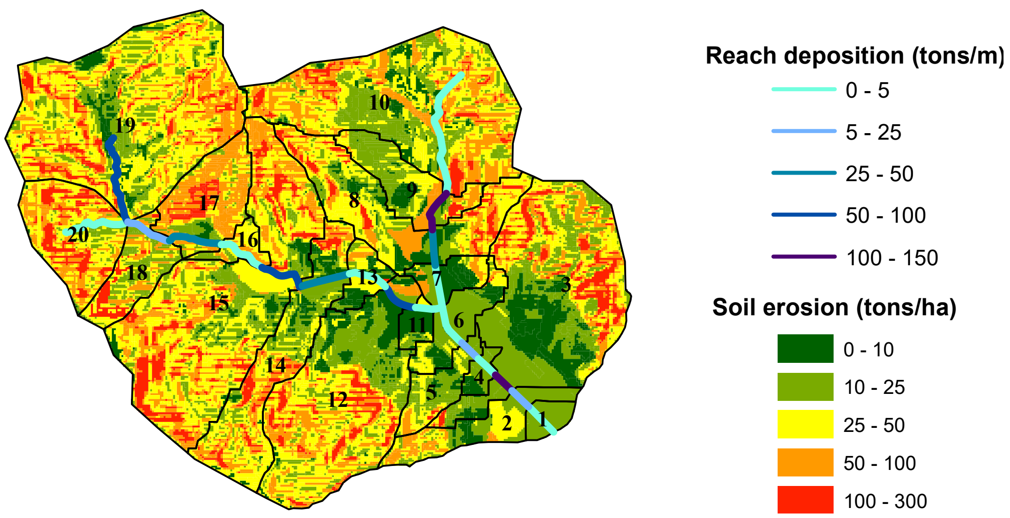

Figure 1 Annual land surface erosion and channel deposition (numbers show location of the subbasins)

Land suitability for citrus on new sedimen soils in Segara Anakan, Cilacap, Indonesia

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Abstract
This research aims to determine the land suitability for citrus on the new sediment soils at Segara Anakan, Cilacap Regency. This research is located in three villages at Kampung Laut Subdistrict, which are Panikel, Ujunggagak and Klaces Villages. Based on the results of the overlaying risk inundation area, land use, and the age of sediment maps, it becomes 19 land map units. Soil samples were taken at each land map units by considering a rapid soil test on a full grid system (1: 50000). Furthermore, the sample is analyzed by land morphology, physical and chemical properties, and the process to determine land suitability for citrus and soil productivity index. The results of land suitability for citrus are dominated by marginally suitable (S3) and unsuitable (N1) classes. The limiting factors are water availability (dry month), root media (drainage, texture and effective depth), nutrient retention (actual soil pH), toxicity (sodicity and depth of sulfidic material) and nutrients available (total nitrogen and phosphorus available). Then, the land suitability used to make land use directives in Segara Anakan about a citrus plant, paddy field, and 'surjan' system after improving the limiting factor.

Key words: citrus, land suitability, limiting factor, new sediment, Segara Anakan
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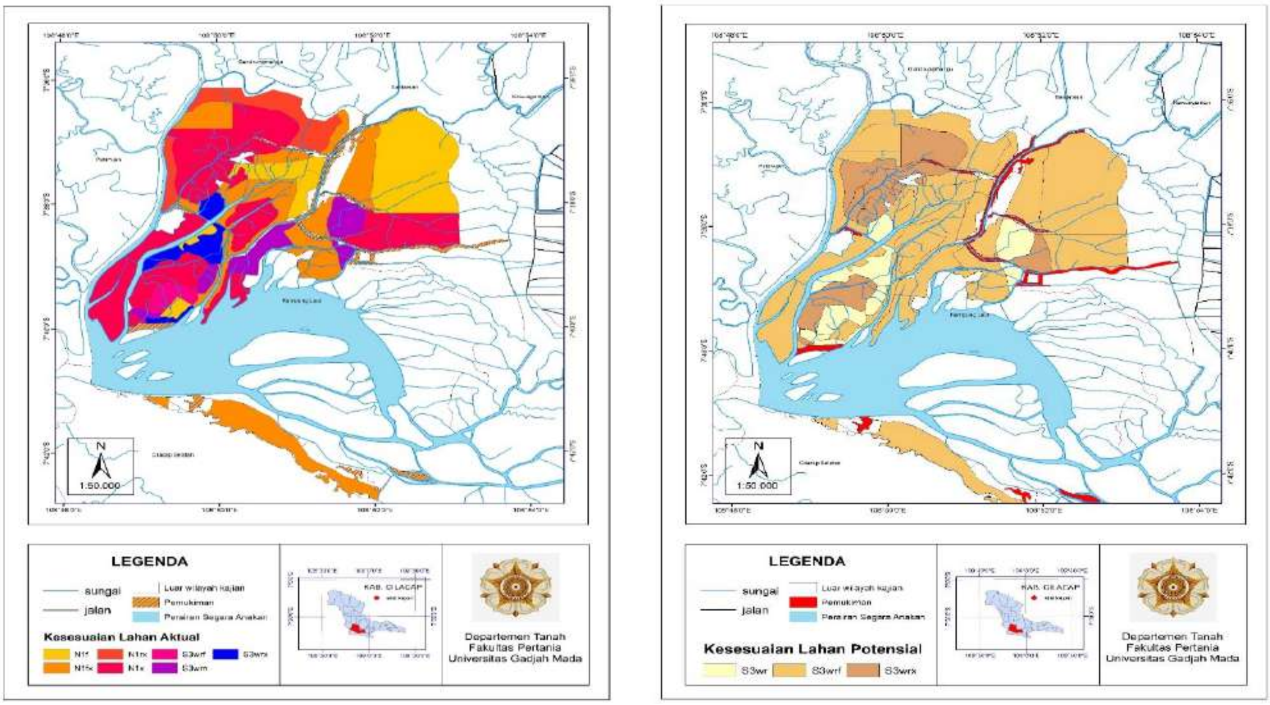

Figue 1. Land Suitability for citrus (actual and potential) in Segara Anakan, Cilacap

Global cropland NPP increase due to agricultural Green Revolution

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Abstract
Global cropland net primary production (NPP) has tripled over the last 60 years due mainly to the agricultural Green Revolution, contributing largely to the increase in atmospheric CO_2 seasonal amplitude. Although many regional-scale comparisons have been conducted between yield-derived data and simulating results, long-term national scale evaluations are difficult and rare because of the shortage of high resolution spatiotemporal management data. Here, we conducted a modeling study of global cropland NPP using a process-based model called Vegetation–Global Atmosphere–Soil (VEGAS) and calibrated the results with Food and Agriculture Organization of the United Nations (FAO) statistical data for major agricultural countries. The VEGAS model captured the increasing trends on national scales except for Russia. The NPP increased most notably in the North China Plain, the US Midwest and Western Europe. We modified the default values of management intensity associated with the agricultural Green Revolution differences across various countries to better match the FAO statistical data. Across all the selected countries, the updated results reduced the root mean square error (RMSE) by 45%. The results suggest that these differences in model parameterization are due to differences in socioeconomic development. To better predict the future cropland NPP trends under represented concentration pathways (RCPs), it is important to incorporate management processes in models, calibrate key management parameters on major agricultural regions and develop historical management data sets.
Key words**:** global cropland; Green Revolution; net primary production modeling

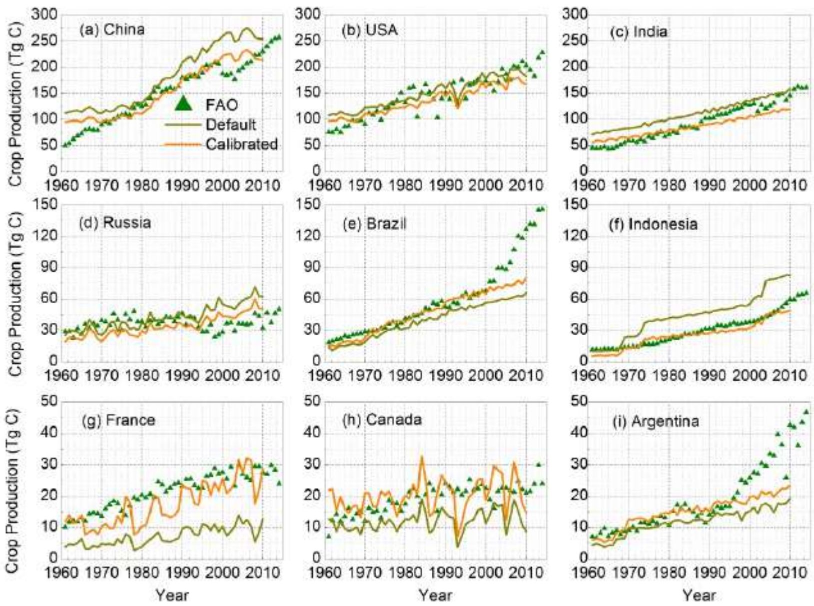

Fig. 1. Annual crop production from 1961 to 2010 on a country scale. Note that the scales are different for each row.

Soil erosion accelerated by deer overgrazing or clear-cutting deteriorates phosphorus availability in forest ecosystems

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Abstract
Soil erosion can be intensive in forested slope areas when understory vegetation is overgrazed by deer or trees are clear-cutting to prevent spread of oak wilt diseases. However, few studies have shown how these disturbances affect on erosion-associated nutrient losses or soil deterioration. In this study, we focused on P, which tends to be deficient in forests, and aimed to evaluate the effects of deer overgrazing and clear-cutting on the soil erosion and P availability in forest ecosystem. We set three adjacent experimental plots of 30 m × 10 m on the west-facing slope in Takaragaike Park (Kyoto, Japan) in December 2015; fenced to protect vegetation from deer (F), not fenced (NF), and fenced plus clear-cutted (F+C). A soil erosion monitoring plot (2 m × 1.5 m) was set up in each treatment area in December 2016. Eroded soils were collected and weighted approximately every two weeks in the first year, and every month in the second year. Total P content in the eroded soil, litter, aeolian dust (2-20 μm) and precipitation were determined by XRF, ICP-OES or spectrophotometry. Soil cores (100 cm^3) were sampled from 9 points outside of the erosion plot in F, NF, and F+C. Triplicate samples were prepared by mixing 3 of 9 soils into a composite, which were subjected to P fractionation (Hedley et al., 1982) and the analysis of root phosphatase activity and microbial biomass P. The amount of eroded soil (t ha^{-1} yr^{-1}) increased in the order of F (1st year, 2nd year; 1.81, 1.06) < F+C (5.09, 2.97) < NF (7.71, 7.48) (Figure 1). Amount of eroded soil for plot F+C was largely reduced in 2nd year, probably because regenerated vegetation after clear-cutting protected soil surface against erosion. In addition, P losses with soil erosion in plot NF and F+C were also much greater than plot F. The efflux of P to the influx of P in plot NF and F+C increased considerably, compared with that of F. Soils of both NF and F+C plots had smaller $NaHCO_3$-Po, namely organic available form, compared with those of F (Figure 2). Microbial biomass-P contents and root phosphatase activity also tended to be lower in NF and F+C plots. This suggested that the increases of soil erosion by deer overgrazing or clear-cutting had serious impacts on P, especially the organic available P form in forest ecosystem. In conclusion, we should conserve the forest ecosystem through preventing the accelerated soil erosion by external factors because erosion control enables to maintain or ameliorate phosphorus availability in soil.

***Key words*:** Clear-cutting; Deer; Forest soil; Phosphorus flux; Soil erosion.

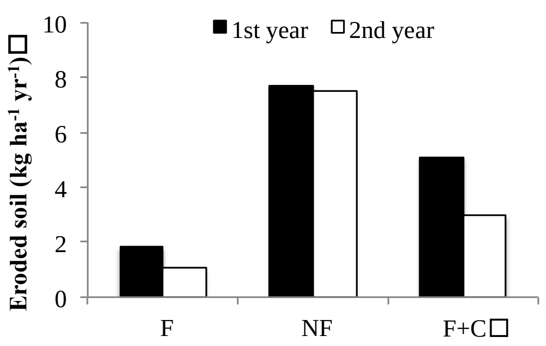

Figure 1. The annual amount of eroded soil.
F: fenced plot, NF: not fenced plot, N+C: fenced plus clear-cutted plot.

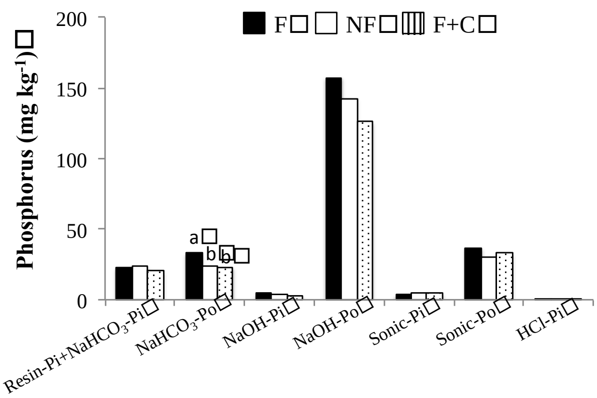

Figure 2. The P fractions of soils in each plot by Hedley method. Different letters are significantly different by Tukey's test (p<0.05).

Plant Microbial Fuel Cells for Soil Remediation, Waste Valorization and Fate of Pollutions

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Abstract

Plant microbial fuel cells (PMFCs) are novel technologies that integrate plants, microbes, and electrochemical systems to convert from solar energy to chemical energy. Different plants and electrode materials affected the efficiencies of electricity generation and soil remediation under different spiking Cr(VI) concentration soils. For three months, the pH of top soils was transformed from slightly acidic to neutral, and the electrical conductivity was reduced during operation. The removal efficiency of Cr(VI) in soils reached 99%, and the total Cr of soils could also be reduced. The closed circuit voltage of Chinese pennisetum PMFCs using graphite carbon felts as the electrodes could reach the daily average value of 469.21 mV. PMFCs have demonstrated the ability to remove Cr(VI) from soils collected from actual metal-contaminated sites.

For ten months of PMFC operations, pH and electrical conductivity of anode soils are lower and higher than cathode soils respectively. Furthermore, by plant uptake, total Cr concentrations of anode soils are higher than cathode soils. The difference between total concentrations of anode soils and cathode soils in PMFCs with closed circuit was higher than free plant microbial fuel soils and PMFCs with open circuit. Therefore, heavy metal distributions in PMFC systems are effected by electrokinetics in PMFC systems.

After harvesting of PMFCs for soil remediation, liquid acid could convert plant biomass waste to levulinic acid in microwave heating conditions. Increasing temperature to 180°C accelerated the yield of levulinic acid to over 15 C mol% in 60 min in H_2SO_4 solution. Furthermore, the acid solution with *gamma*-Valerolactone could improve levulinic acid yields. Therefore, organic solvent with liquid acid for plant biomass waste possess high efficiencies of conversion in microwave heating methods for waste valorization. Finally, heavy metals stay in solid residues after conversion work.

***Key words*:** Solar energy; electricity generation; soil remediation; actual metal-contaminated sites; waste valorization; solid residues.

Anthropogenic Disturbance on Geopedogenetic Processes at the Lower Slope of Ungaran Volcano, Central Java - Indonesia.

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Abstract
Andesite mining activities operated between 2005 and 2017 have gradually devastated the natural surface of the earth at the lower slope of northern flank of Ungaran Volcano. The removal and burial stages have created new geomorphic features leading to inevitably effects on soil characteristics. This study focuses on field observable geopedogenetic changes including land surface morphology, recent geomorphic processes and soil properties due to anthropogenic disturbance in the ex-mining area. We generated a digital terrain model from small format aerial photo acquired by Un-maned Aerial Vehicle (UAV) to identify the anthropogenic landforms. Some soil samplings were collected along effected and non-effected mining areas to analyze the soil properties changes. The mining activities has modified a single convex hill into a complex land surface morphology consisting of escarpment, small basin and flat area. These changes have triggered new geomorphic processes in the form of incision and deposition at the escarpment and basin respectively. Furthermore, there was a significant impact on the diminishing top soil in the area effected by mining activities. Two years after mining operation, the flat zone was covered by new parent material coming from tilling materials with high content of rock fragments, while basin zone was filled by finer deposit from the surrounding overland flow deposition. Soil laboratory data also demonstrated that both physical and chemical soil properties were altered into less favorable environment to support vegetation growth. Understanding these geopedogenetic changes are essential to perform proper land rehabilitation effort and ex-mining area management. Soil organic matter should be added to improve soil characteristics as well as organizing land surface morphology and geomorphic processes arrangement.

Key words: anthropogenic; geopedogenetic; mining; soil; UAV.

Accumulation of Chromium in Cyanidiales

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Abstract
The thermoacidophilic red microalgae Cyanidiales, separated from Yangmingshan National Park in Taiwan, could not only survive in extreme conditions with high temperature (25-56℃) and acidic environment (0.5-5.0), but in high concentration of heavy metals as their habitats. However, chromium (Cr) is one of the most toxic elements and is exists stably in trivalent [Cr(III)] and hexavalent [Cr(VI)] states in the environment. Due to the less toxicity and mobility of Cr(III), it is recommended to convert Cr(VI) to Cr(III) for protecting the ecology. In the study, we developed the potential biocomposite of Cyanidiales [Gp (*Galdieria partita*) and Cc (*Cyanidium caldarium*)] and iron hydroxide to reduce and removal Cr from the contaminated system. Besides, molecular identification was performed using synchrotron-based high resolution Fourier-transform infrared (FTIR), and Cr K-edge X-ray absorption (XAS) analyses. The highest Cr removal capacity of 152.1 and 135.1 mg g^{-1} were achieved at primitive states in Gp and Cc respectively. While Cr sorption capacities on algae were promoted significantly by Fe hydroxides modification. The interaction between biocomposites and Cr was also revealed in the change of secondary structure proteins; and further, the irrefutable evidence for Cr complexed with algae using the organic functional groups and precipitated as $Cr(OH)_3$ on the surface of algae were derived from XAS results. As discussed above, the study could certainly promote the application of the Cyanidiales in environmental remediation as an innovative green technology.

***Key words*:** Cyanidiales; thermoacidophilic; microalgae; chromium; secondary structure protein; XAS.

Arsenic sequestration by framboidal pyrite in naturally contaminated soils: chemical extraction, SEM and micro-XRF/XAFS investigation

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Abstract
Large-scale urban and underground construction projects being undertaken in many countries bring an unexpected consequence of exposing soils containing hazardous metal(loid)s. We face a lack of knowledge about the chemical species of As in civil construction soils in which the released As occasionally exceeds the regulation levels regardless of low total concentration. This study investigated the chemical speciation and extractability of As in naturally contaminated soils collected from civil construction sites (unaffected by anthropogenic pollution) in comparison to anthropogenically contaminated soils. The results of bulk X-ray absorption fine structure (XAFS) demonstrated that the sulfide As species was dominant in naturally contaminated soils derived from marine sediments (ave. 49%), which was significantly greater than the soils derived from non-marine deposits (ave. 1%) and anthropogenically contaminated soils (ave. 6%). According to micro-XRF combined with micro-XAFS investigation, the soils derived from marine sediments were characterized by the abundance in pyrite framboids (~20 μm in diameter) in which As occurred as multiple oxidation states ranging from As(-I) to As(V). In naturally contaminated soils derived from non-marine deposits and anthropogenically contaminated soil, framboidal pyrite was absent and As occurred mainly as As(V) in concomitant with Fe. An SEM micrograph illustrated that framboidal pyrite was intact in water but dissolved in part by exposing to hydrogen peroxide. The results of this study demonstrated that oxidation of framboidal pyrite controls As release in civil construction soils derived from marine sediments whereas reductive dissolution of Fe minerals may play an important role in the other soils.

***Key words*:** Arsenic; heavy metals; X-ray absorption spectroscopy

Role of Organic Matter Associated with Temporal Change of Radiocaesium Forms in Soil

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Abstract

A large inventory of radiocaesium was deposited across the landscape from TEPCO's Fukushima Daiichi Nuclear Plant accident. Caesium-137 (half-life 30 y) was the major radionuclide released from the accident and an important radionuclide for the assessment of long-term radiation exposure to the public. Internal radiation doses are estimated with intake of radionuclides from food and inhalation. Soil-to-plant transfer of radionuclides, which depends on the phytoavailable fraction of ^{137}Cs in soil, is an important process for radiation dose estimation. Previously reported exchangeable fraction of radiocaesium, which is the major component of the phytoavailable fraction, has decreased and the strongly fixed fraction has increased with time after deposition onto soils. Organic matter is known to adsorb radiocaesium into the strongly fixed fraction of clay minerals. However, changes in the distribution of radiocaesium in the organic matter fraction with aging is not clear. In the present study the aging of radiocaesium in organic matter in contaminated was determined.

Eleven contaminated soil samples were collected from paddy and upland fields in Fukushima Prefecture after the 2011 accident. The soil samples were air dried for several weeks and passed through a 2 mm sieve. The aging process of the soil samples was promoted by subjecting them to a wetting-and-drying treatment in a heated chamber (30℃) every week for 230 d. Activity concentrations of ^{137}Cs within three soil fractions were determined by sequential extraction as follows:

1) Exchangeable fraction: extracted with 1 M ammonium acetate solution
2) Organic matter associated fraction: decomposed with hydrogen peroxide and extracted 0.8 M ammonium acetate with 5 % nitric acid solution
3) Strongly fixed fraction: residue

Activity concentrations of ^{137}Cs were measured with Ge detector connected by multichannel analyzer.

Distributions of ^{137}Cs in exchangeable and organic matter fractions differed among the 11 soils before aging, 0.036-0.41 and 0.061-0.32, respectively. The distributions of exchangeable fraction decreased with time (Fig. 1). Percentage distribution of ^{137}Cs in the exchangeable fraction decreased by 51 ± 12 % after 230 days of aging. However, the distributions of ^{137}Cs in organic matter were relatively constant with aging; the percentage distribution of ^{137}Cs after 230 days was 82 ± 23 % of the initial amount in the organic matter before aging. These results show the organic matter has bound ^{137}Cs for a relatively long time without a transfer to the exchangeable fraction.

***Key words*:** Radiocaesium fractions; aging; wetting-and-drying; exchangeable; organic matter.

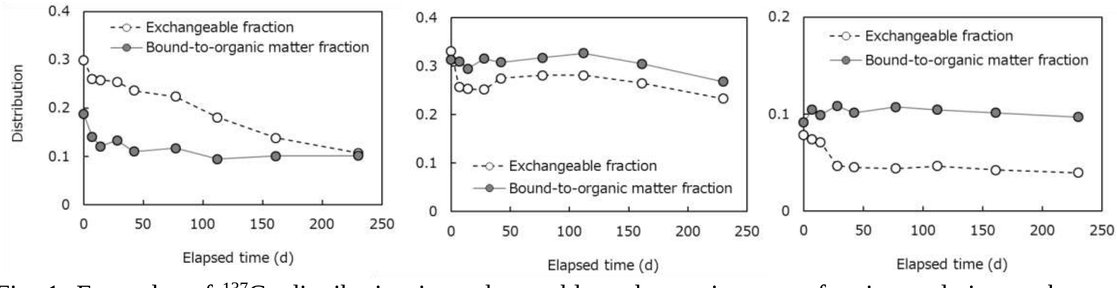

Fig. 1. Examples of ^{137}Cs distribution in exchangeable and organic matter fractions relative to the total content in soils. Analytical uncertainties are within the size of circles.

Fractionation of phosphorus in soils with different soil types of sugarcane cropland in Okinawa, south Japan

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Abstract:

Phosphorus (P) is an essential element for many crops including sugarcane, while most P fertilizer is easily converted to less labile P (Al-P, Fe-P, Ca-P) in soil. The dominant form of less labile P in soil was different, depending on the parent materials and soil chemical properties, such as pH, Al or Fe contents, and so on. To achieve the P efficient management, it is necessary to understand the P amounts in relation to its availability in soil, including its controlling factors. Sugarcane, which is the major crop in Okinawa of south Japan, is cultivated in three different soil types, i.e., Kunigami-mahji (KM, Red-yellow soil), Shimajiri-mahji (SM, Dark-red soil) and Jahgaru (JG, Gray-soil). There is little information about the amount and the forms of P in each soil type of sugarcane cropland, and therefore, the objectives of this study were (1) to investigate the amount and the form of P in each soil type, and (2) to identify the factors controlling the forms of P with different soil types in Okinawa. In a total, 82 surface soil samples (0-30 cm) (KM: 24 points, SM: 41 points, JG: 17 points) were collected from sugarcane fields in Okinawa, south Japan. Soil P is sequentially fractionated with resin, $NaHCO_3$, NaOH, HCl by using Hedley P method, while soil physicochemical properties, such as pH, soil texture, total C, N and P, available P, oxalate extractable Al (Al_o), and dithionite extractable Fe (Fe_d), were also measured. We analyzed the correlation between each P fraction and measured soil properties for each soil type, to evaluate the effect of soil physicochemical properties on P forms in soil. The averages of available P contents were 84 and 80 mg P kg^{-1} in KM and SM soil types, respectively, and these values were about two times higher than the recommend value, indicating the excess available P of soil in these soil groups. In KM group, NaOH-P_i (assumed as Al-P and Fe-P) was the dominant P fraction (454 mg P kg^{-1}, 31 % of total P), and total C and Fe_d were positively correlated with this fraction ($P<0.05$). In SM group, NaOH-P_i was the dominant P fraction (480 mg P kg^{-1}, 27 % of total P), and pH, Al_o, and Fe_d were positively correlated with this fraction. In addition, there was a negative correlation between Al_o and pH, NaOH-P_i and pH only in SM group, indicating that less labile P, which was associated with Al oxides, may become plant available by adjusting soil pH from acid to neutral condition, due to the decrease of Al_o in soil. In JG group, HCl-P (assumed as Ca-P) was the dominant P fraction (518 mg P kg^{-1}, 53 % of total P), and total C is correlated with this fraction. This might be because HCl-P fraction of JG group is considered to be adsorbed on $CaCO_3$ contained in marl, which is a major parent material of JG. These results indicate (1) the abundance and diversity of soil P forms varied greatly among soil types in Okinawa sugarcane croplands, and especially (2) in SM group, Al-P may become plant available by adjusting soil pH from acid to neutral condition, resulting in the better P use efficiency.

Keywords: P fractionation, soil fertility, sugarcane field, subtropical soil

Table Sequantially fractionated phosphorus of each soil types

soil type	Resin-P	$NaHCO_3$-P P_i	$NaHCO_3$-P P_o	NaOH-P P_i	NaOH-P P_o	HCl-P	Residual-P	Total P
	mg P kg^{-1}							
Kunigami-Mahji	132 a	171 a	23 a	454 a	96 a	97 b	503 b	1476 ab
(n=24)	(16)	(23)	(1)	(51)	(10)	(44)	(44)	(129)
Shimajiri-Mahji	76 b	121 a	21 a	480 a	120 a	129 b	860 a	1807 a
(n=41)	(10)	(22)	(3)	(57)	(21)	(26)	(97)	(154)
Jaagaru	21 c	30 b	11 b	43 b	15 b	518 a	338 b	976 b
(n=17)	(5)	(6)	(1)	(7)	(1)	(41)	(58)	(68)

Different letters indicate significant differences ($p < 0.05$) among soil types.
Values in parentheses indicate the standard errors of the mean.

Saving irrigating water and fertilizer P to adapt with water scarcity and soil P enrichment in intensive rice production in the Mekong delta-Vietnam

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Abstract
Increased rice cropping intensity has been in conjunction of increased uses of freshwater and fertilizer, which are limiting resources. Saving irrigating water, which becomes scared in the Mekong delta due to drought and hydropower dam construction in the river's upstream and saving fertilizer P, which increasingly accumulates in soil due to increased cropping intensity, are thus necessary. Long-term field experiments were established in the triple rice cropping area to aim at investigating to which extent saving irrigating water and fertilizer P could be applied without rice yield penalty and soil P pool decline. The field experiments were laid out in a completely randomized block with split-plot design: the main factor was saving irrigation management and the sub-factor was reduced P fertilization. There were three irrigation management practices: (NT+5) continuously flooded above 5cm; (NT-15) irrigated when the water level dropped to -15cm; and (-NT-30) irrigated when the water level dropped to -30cm below soil surface. Fertilizer P was applied with four rates 0, 20, 40 and 60 kg P_2O_5/ha/crop, of which the highest P application rate represented the common rate applied as farmer's practice in the study area. The diffusive gradient in thin films (DGT) technique was used as a process-based approach to estimate P availability under long-term reduced P fertilization. The experiment was run during six consecutive crops. The results showed that irrigating when the water level dropped to -15 cm resulted in no significant differences in soil total P and available P contents as well as rice yields. This could save up to 20% irrigating water. There were no significant differences in the P contents in rice straw and grain among the treatments applied with 0, 20, 40 and 60 kg P_2O_5/ha. The results also revealed that applying 40 kg P_2O_5/ha maintained the pool of P in soil and supplemented the P amount removed by rice uptake.

***Key words*:** Diffusive gradient in thin films (DGT) technique, long-term field experiment; saving irrigating water; saving fertilizer P; triple rice cropping.

Livestock holdings control the soil fertility of the homegardens in the Kilimanjaro highlands, Tanzania

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Abstract
The sustainability and function of homegardens in tropical countries are based on traditional land management such as agroforestry, fallow, and crop-livestock farming, which improves soil fertility through complex soil-plant interactions. In the Kilimanjaro highlands, homegardens with banana-coffee cultivation have been managed using livestock dung for more than 100 years. However, there are few studies which quantitatively evaluated the effect of smallholders' practice such as the application of livestock dung on soil fertility of homegardens in the mountainous area. The objective of this study was to evaluate the effect of livestock holdings on soil carbon and nutrient stock in soil profiles of the homegardens in the Kilimanjaro highlands. We surveyed 32 households in a village at 1600 m a.s.l. of the southeast slope of the Mt. Kilimanjaro. Livestock holdings were converted into tropical livestock unit (TLU), and livestock density was defined as TLU per hectare of each households homegarden. Soil samples at the surface layer (0–15-cm depth) were collected from the homegardens with banana cultivation of the above-mentioned 32 households for subsequent soil chemical analysis. In addition, soil samples from 5 layers (0–5, 5–20, 20–35, 35–50 and 50–65-cm depth) were collected from the homegardens with banana cultivation of 6 households of the previous 32 households. Our results showed that livestock density positively correlated with soil carbon (TC, $r = 0.38$), soil nitrogen (TN, $r = 0.59$), available phosphorus (AvP, $r = 0.63$), total exchangeable bases (TEB, $r = 0.59$), and cation exchange capacity (CEC, $r = 0.49$) at the surface layer (0–15-cm depth) of the 32 households ($p < 0.05$). These results indicated that the increase in livestock density caused the increase in soil carbon and nutrients at the surface layer of homegardens through livestock dung application. Similarly, livestock density positively correlated with TC and TN in the sub-surface layers, and with AvP, TEB, and CEC at the surface layer and the deeper layers below 20-cm depth of the 6 households (Table). The significant correlations between livestock density and soil fertility even in the deeper layers are attributable to the long-term application of livestock dung to both surface and deeper layers for banana cultivation in this area. Therefore, we conclude that the livestock holdings are a crucial aspect of land management to maintain the soil fertility throughout the soil profile of the homegardens in the Kilimanjaro highlands.

Key words: Africa, Agroforestry, Small-scale farming, Soil carbon, Soil nutrient, Sustainable agriculture.

Table.

Correlation coefficient of soil properties at each depth with livestock density in six households.

Soil depth (cm)	TC	TN	AvP	TEB	CEC
0–5	0.44	0.61	0.91*	0.95*	0.84*
5–20	0.92*	0.94*	0.93**	0.96**	0.96**
20–35	0.76	0.84*	0.92*	0.96**	0.91*
35–50	0.82*	0.84*	0.87*	0.98***	0.76
50–65	0.76	0.71	0.74	0.94**	0.62

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

Inhibition of soil amidase activity by pyroligneous acid to control the release of soil nitrogen

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Abstract
The most commonly used fertilizer in South Korea is nitrogen fertilizer including urea. Urea is decomposed into carbon dioxide and ammonium by the urease secreted by soil microorganisms and plants in soil and ammonium is taken up by plants. If urea is excessively applied in soil, ammonium produced can be leached or volatilized before plant uptake. Therefore, it is important to control release of nitrogen from the nitrogen fertilizer. Pyroligneous acid was selected as a soil amendment to control release of nitrogen from urea, which inhibited the urease activity resulting in the prevention of excessive ammonium release from urea by slow hydrolysis. Amidase is an enzyme that catalyzes the hydrolysis of the amide group. Amidase includes asparaginase and glutaminase. In this study, the effect of pyroligneous acid on amidase was evaluated. Amidase was added to the soil and pyroligneous acid was added to the soil and incubated for 24 h. After incubation, ammonium content was analyzed by indophenol blue method. Enzyme activity was estimated by measuring ammonium content. The results showed that pyroligneous acid inhibited the activity of amidase. Decomposition of C-N bonding was inhibited by pyroligneous acid.

Key words: Pyroligenous acid; amidase activity; indophenol blue method.

Salinity effects on soil characteristics, nitrogen recovery and rice growth on two paddy soils in the Mekong Delta

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Abstract
Future sea level rise will increase the area affected by salinity and threaten rice producing river deltas throughout Asia. Currently, salinity is one of the major biotic stresses on rice and affects rice production and in the future, this will challenge the world's food security. Acid sulfate soil (ASS) is a ubiquitous feature of many Asian river deltas and research on impacts of salinity on nitrogen (N) cycling and fertilizer efficiency in this soil type is limited. Improving N fertilizer efficiency in salt-affected soils is required to improve rice yield and increase farm profitability under future environmental conditions. The present pot experiment investigated changes in soil properties, the dynamics of N and effects of these changes on rice growth and yield under various salinity levels by using a ^{15}N label fertilizer technique. Differences in soil type and salinity significantly altered height and the number of rice tillers that developed in all treatments. A combination of acidity and high salinity (8 g L^{-1}) resulted in no rice yield. The high salinity (8 g L^{-1}) on the ASS resulted in significant loss of crop yield and significantly lowered the recovery of fertilizer N by due to increased N losses, most likely as denitrification. There was also a significant interaction effect of soil and salinity on the loss of fertilizer nitrogen. Rice production and N fertilizer application in a conventional cultivation may not be sustainable on the ASS inundated by saline water. Therefore, alternatives cropping systems and appropriate interventions should be noticed in the climate change context.

Key words: acid sulfate soil, climate change, nitrogen recovery, rice production, sea water intrusion and soil salinity.

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Response of paddy rice to gypsum topdressing in soils with different level of available sulfur and soluble metals

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Abstract

Sulfur (S) is an essential element for plants and absorbed as a sulfate ion (SO_4^{2-}, available S). Our study suggested that the reduced S solubility due to forming insoluble sulfides, as well as the shortage of available S in soil, might cause S deficiency of paddy rice (*Oryza sativa*). However, the precise mechanism of insoluble sulfide formation inducing the S deficiency of paddy rice still remains to be quantified. Here we show the soil properties for S availability with rice growth response to gypsum ($CaSO_4 \cdot 2H_2O$) topdressing. We used 6 lowland soils taken from western (A1--A4) and northeastern (B1, B2) Japan. We kept them under submerged conditions in 1/5000 Wagner pots and transplanted paddy rice to them at May 17th, 2018. At tillering stage, Jun 22nd, we topdressed gypsum at 0.0 or 0.45 g pot^{-1}. We reaped it at heading time, August 10th, and measured the dry weight and the concentration of various elements. We also measured available S in soil extracted by 0.01 M calcium dihydrogen phosphate (Ca (H_2PO_4)$_2$) and soluble zinc (Zn), lead (Pb), cadmium (Cd) and copper (Cu) in soil extracted by 0.1 M hydrochloric acid. The growth of rice was strongly inhibited in A1, A2, B1 and B2 without gypsum topdressing and all of them were recovered by gypsum treatment (Fig.). The amount of available S in soils was 6.1 to 32.4 mg kg^{-1} (A2, A3, A4 <A1 <B1 <B2) and it did not correspond to the inhibition of rice growth. On the other hand, soluble Zn in soils was rich in A1 and soluble Cu was rich in B1 and B2. The degree of inhibition was correlated to molar difference between the available S and the soluble metals. Therefore, we could confirm that the cause of the rice growth inhibition was not only the shortage of available S but also the insoluble sulfide forming with soluble Zn and Cu. It suggests that we can predict S deficiency of paddy rice by soil analysis.

Key words: Available sulfur, insoluble sulfides, sulfur deficienct of paddy rice, pot cultivation experiment

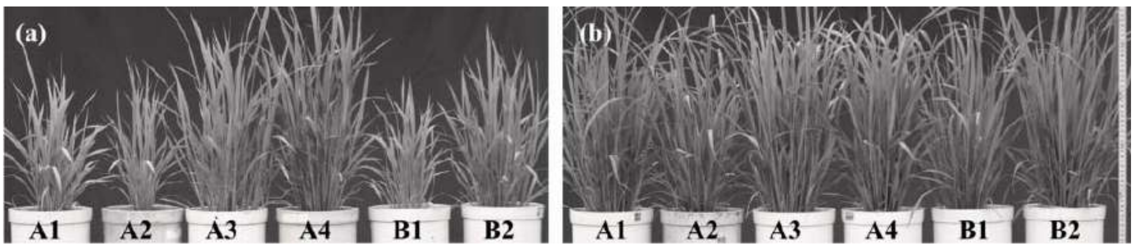

Fig. The difference of rice growth in soils (a) without and (b) with gypsum topdressing at 14d after treatment.

Unexpected effect of plastic film mulching: increase soil carbon stock in maize cropping land, due to higher net primary production than respired carbon loss

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Abstract

Plastic film mulching (PFM) is popularly utilized to increase crop productivity, via controlling weeds and improving soil properties. However, since PFM can improve soil moisture and temperature condition, PFM might not only increase the net primary production (NPP) as a C input source, but also soil organic matter decomposition. Therefore, the effect of PFM on soil C stock change is debating still. In this field study, to determine the effect of PFM on soil C stock changes, PFM and no-mulching were selected as the main treatment, and organic and chemical fertilization were installed as the sub-treatment. In all treatments, stover as organic matter source was recycled at the harvesting stage for two years. Soils were sampled at different depths after two years of stover recycling. PFM significantly increased maize biomass productivity by 10 and 26% in chemical and organic fertilization, respectively, comparing with no-mulching, and then increased soil C stock by 228 and 62%. In comparison, PFM decreased labile organic C fraction but clearly increased stable organic carbon fraction, irrespective with fertilization background. Different with the general knowledge, which PFM boosts soil microbial activity and then decreased soil C stock, PFM was very effective to increase soil C stock under stover recycling condition, due to higher biomass productivity increase than mineralized C loss increase.

Key words: Green manure; soil microbial activity; labile organic carbon; lability index

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An evaluation on the effects of humic acid and organic manures on the point of zero charge

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Abstract

To investigate the distribution of the electric charges, by the effects of humic acid, oil cake, vermicompost and farmyard manure in two different types of soil was made by potentiometric titration method by using electrolyte ion as a function of pH and electrolyte of net electric charge measurement. To assess the fertility of the soil in relation to surface charge both soil and clay incubated with added amendments at the rate of 1-2% with three treatments. Both forest (Haplaquept) and agricultural (Fluvaquent) soil bore net negative charge at their native pH. Variability in the magnitude of these charges was attributed to the effect of Al or Fe blocked exchanged sites or contribution from strongly acidic organic functional groups. The titration curves at different ionic strengths crossed the common point of intersection, the point of zero charge (PZC), or the pH at which the net electric charge is zero. PZC of forest soil is lower compare to agricultural soil, was attributed to the higher amount of organic carbon and exchangeable Al. Kaolinite and bentonite bears significant pH dependent positive charges between pH ranges 2 to 8. Surface properties of both soil and clay changes drastically when 1 to 2% humic acid and organic manure applied to research site. It was observed that PZC values reduce when humic acid and organic manures added with Kaolinite. Among these organic manures, vermicompost play minor role on the pH-dependent surface charge properties. PZC values increases maximum when humic acid incubated with bentonite. Oil cake fails to change the surface properties of bentonite. Among these organic manures oil cake influences more on the PZC value of agricultural soil whereas vermicompost influences more on the pH dependent surface charge properties of forest soil.

Key words: Distribution of electric charge, point of zero charge, humic acid, organic manure.

The aeolian additions of the Podzolic soils on the high-altitude mountains in central Taiwan

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The podzolic soils with characteristic eluvial horizon are widely distributed in the mountainous area of Taiwan where the altitude greater than 3000 meters above sea level where a cold and humid climate prevails. However, there are multiple-sequence horizons along the soil profile in some of the places. They may indicate the cycles of climatic or environmental changes in the past. In addition to identifying the soil origin and the following soil development, an attempt to investigate the paleoclimates/environments of the mountainous regions through soil properties, degree in pedogenesis, and isotopic analyses is conducted as well. Four soil profiles were sampled from Hohuanshan (HHM and HWS), Nanhuashan (NH), and Battonguan (BTG) of the alpine area in central Taiwan. After laboratory analysis, soil texture is silt and silty loam, high soil organic carbon, low cation exchange capacity, low base saturation percentage, and soil strontium isotope ratios ranges 0.70997~0.72214. Soil classification in accordance with the Soil Taxonomy is Typic Humicryepts. The bimodal pattern on the particle size distribution indicates a source of eolian material about 10 μm in size for these soils. It suggests these soils were developed by in-situ weathering with the addition of aeolian particles. The constant rate of aeolian addition shown little influence from the climate change since mid-Holocene. The index quantification for soil morphologies shows the extent of soil genesis fairly between profiles. However, the lower sequence of soil development index is higher than the upper sequence, indicating the changes in climate during soil genesis. The findings of this study not only help validate previous studies on the paleoenvironment of Taiwan but also inspire more aspects of the Taiwanese paleoclimate researches.

Keywords: podzolic soil, soil development index, strontium isotope, climate change

Specific Features in Soil Processes of the Reclaimed Soil in Japan

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Abstract
Despite of decrease in agricultural and forested areas in Japan, artificial greenery areas has increased with increasing urban areas accompanied by concentration of urban population. The managed greenery areas can be roughly separated into two types. One is developed on the artificial land filled with transported soils from the outside. The other greenery area is usually distributed on original grounds with less land transformation. The former greenery areas are still young, while the latter one has already had long history after their development. There are some historical greenery areas which have already reached to natural forest from the ecological point of view. However, the greenery area developed on the reclaimed areas have not been well studied. The properties of soils on artificial islands were evaluated depending on ages after the landform construction and seedling planting.
Soil physical properties were evaluated by soil hardness using a penetrometer and soil bulk density. Soil microbial biomass and available nutrients were determined. Biodegradation of bark chips buried in soil was evaluated by a spectral analysis. These parameters were evaluated according to the time after the planting. Soil reaction was alkaline over 8.0 in most of soil horizons except for the top horizons under the forest stand aged over 25 years. The pH values were relatively higher at deeper horizons, indicating that acidification has been occurred at the surface horizon mainly by infiltration of downward water brought by excessive precipitation compared to evapotranspiration. Relatively high pH can be attributed to buried materials such as concrete and asphalt debris. Those buried materials kept deeper soil horizons alkaline. Compaction of subsoil also prevent vertical water infiltration, resulting in alkaline soil reaction due to buried materials. However, acidification in shallower depth will reach to equilibrium with time. Carbonate was detected probably absorption of CO_2 under the alkaline soil reaction. Carbonate contents detected in soils seemed to be consumed by acidification with time. Applied bark materials increase their amino-N and decreased carbohydrate-C, indicating that microbial decomposition increases N content in soil. Biodegradation process increase content of nitrate and ammonium nitrogen in soil, resulting in rich in available N in soil with time. Rich in nutrients with neutralized soil reaction can be good for plant productivity. However, hard soil basement in subsoil can be adverse soil condition for plant growth. At the beginning, soil physical condition should be taken into account to construct the basement of the greenery area.

***Keywords*:** Green Infrastructure, Civil engineering, Soil hardness, Biodegradation, Soil Fertility

Roles of typhoon disturbances on seasonal and interannual patterns of litterfall for coniferous and broadleaf plantations in Xitou, Central Taiwan

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Abstract

Litterfall is an important component in forest function that can be linked to net primary production and the return of nutrients and organic matter from biomass to soils. In this study, we determined the role of typhoon disturbance on the seasonal and interannual patterns of litterfall between coniferous and broadleaf plantations in Xitou, central Taiwan. We collected litterfall monthly over a span of seven years from January 2012 to January 2018. In the years of 2012, 2013, 2015, and 2016, at least one severe typhoon was recorded, and were denoted as the years with typhoon disturbances. By contrast, slight or even no typhoon disturbances occurred in the years of 2014, 2017, and 2018, and were denoted as the years without typhoon disturbances. The results showed an extremely high peak driven by typhoon disturbances was obvious especially at the coniferous stands. The amounts of monthly litterfall at the coniferous stands may exceed 4000 kg ha^{-1} during typhoon disturbances, equivalent to 70% of total annual litterfall. However, in the years without typhoon disturbances, the amounts of monthly litterfall were more constant throughout the year and did not show a large seasonality. The amount of litterfall at the coniferous stands not only peaked in the month with typhoon disturbances, but also resulted in higher amounts of annual litterfall. In the years with typhoon disturbances, the amounts of annual litterfall were significantly higher than those years without typhoon disturbances (2500 kg ha^{-1} yr^{-1} vs 6000 kg ha^{-1} yr^{-1}). Due to the considerable year-to-year variation, the ratio between the maximum and minimum annual litterfall at the coniferous stands ranged from 1.95 to 6.58, and the mean interannual CV ranged from 29% to 65%. By contrast, the pattern of litterfall varied significantly with the coniferous and broadleaf tree species. The litterfall at the broadleaf stands was bimodal timing, one minor peak in summer and one major peak in the deciduous season from October to January. Seasonal variation was smaller than those at the coniferous sites, especially compared to the years with typhoon disturbances. The annual litterfall mass at the broadleaf stands also appeared to be less related to typhoon disturbances. There were no differences in the amount of litterfall between years ($P > 0.05$). Our results indicated the pattern of litterfall seasonality and interannual variability varied substantially between coniferous and broadleaf stands in Xitou.

Key words: Litterfall; typhoon, plantation, seasonality, interannual variation

Genesis and classification of various andic soils in the hills of central Miyagi Prefecture, northeastern Japan: evaluating the effect of volcanic ash using cryptotephra identification

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Abstruct
Andisols occupy about 31% of Japanese land area. Various andic soils, which is affected by volcanic ash has a specificity both physically and chemically. Understanding the characteristics and appropriate evaluation of distribution of such soils are significant for global soil resource management. In this study, we investigated the influence of volcanic ash on genesis and classification of soils in hills of central Miyagi Prefecture, northeastern Japan. The case study site was a cedar plantation forest in the Ohira hills and Kashimadai hills in this area. Five soil observation sites located on continuous ridge-valley in each hills. The effect of the volcanic ash was referenced to the analysis method of cryptotephra. Analysis of the grain ratio of the volcanic glass in the medium sand fraction (0.05 to 0.2 mm) and the elemental analysis of each volcanic glass particle were performed using SEM-EDS. According to chemical analysis results, we classified each pedons of Ohira hills (O5: Andic Dystrudepts, O1, O2, O3, O4: Typic Dystrudepts)and Kashimadai hills(K2, K3: Andic Dystrudepts, K1, K4, K5: Typic Dystrudepts). Based on comparison of the element composition of volcanic glass derived from soil samples with the previous tephra analysis data, we found the To-a (Eruption: AD 915), Hj-O (Eruption: 11-12 ka), however, there were some volcanic glasses not identified. To-a glasses tend to be present in the surface to subsurface layers, and Hj-O glasses are present in the subsurface to lower layers. In both of the observation sites, there was a correlation between the volcanic glass content and Al + 1/2 Fe (%) extracted with ammonium oxalate, which is one of the criteria of andic soil properties. These results show that volcanic glass identification provide tephrachronological information for soil genesis of various andic soils.
Key words: Andisols; Andic soils; soil genesis; volcanic glass; cryptotephra

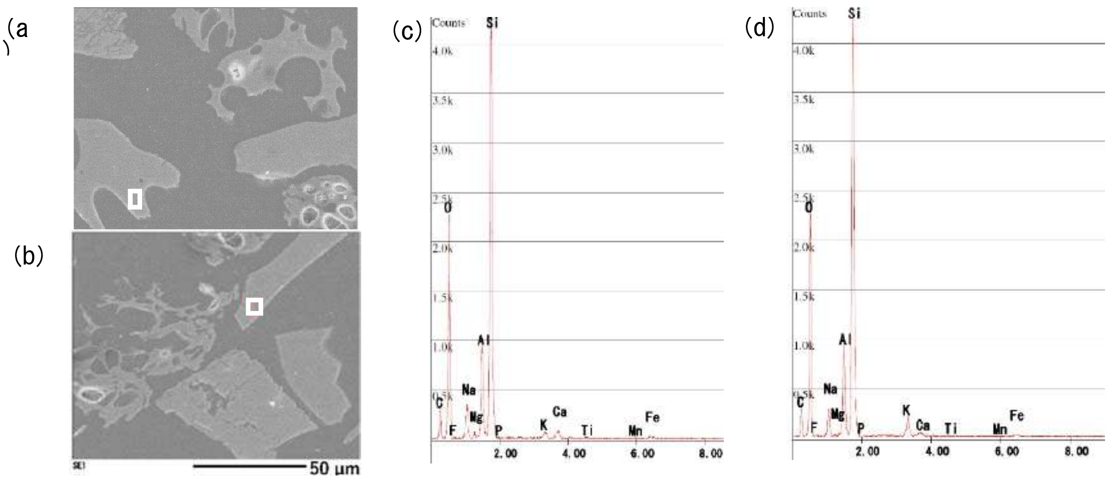

Fig.1. (a) Volcanic glass of To-a, (b)Volcanic glass of Hj-O, (c) EDX spectrum of volcanic glass dashed square in (a), (d) EDX spectrum of volcanic glass square in (b)

Thephosphous accumulation and distribution in larch plantation ecosystem at different stand ages

Abstract

Larch is one of the major coniferous timber forest species in northeast China. However, due to the limitations of plantation ecosystem and the local inappropriate managing methods, makingthe soil fertilityof larch plantation soil fertility declined. Phosphorus (P) becomes the main limiting factor of larch growth. In this study, the different stages (10-, 25- and 50-year-old) of larch plantation in mountainous region of eastern Liaoning Province, China were selected. Firstly, we analyzed the P content, accumulation and distribution characteristics in different plant organs (root, bark, branch, stem and leaf) of different age larch plantations, which aimed to explore the limit factor and the response of phosphorus accumulation of larch plantation to the soil P status by using the whole-wood analysis method. Secondly, we adopted the Hedley P classification technology and ^{31}P nuclear magnetic resonance (^{31}P NMR) method to study the accumulation and distribution characteristics of different soil phosphorus forms, and the change of soil organic P composition and content. Finally, the influence of litter decomposition to the forms and content of soil P were studied by combining outdoor and indoor experiments. The main conclusions of this study are as follows:

(1) **The characteristics of phosphorus accumulation and distribution of different age class of larch plantations:** The proportion of biomass in leaf and branch decreased, and the proportion of biomass in bark increased with the increase of stand age. The leaf N:P of 10-, 25- and 50-year-old larch which increased significantly with stand age were 13.9, 15.4, 18.8. With the increasing of stand age, the proportion of P accumulation in leaves and branches reduced significantly, and the proportion of P accumulation in root increased significantly. And the P accumulation in leaf, branch and root accounts for more than 80% of total P accumulation.

(2) **The characteristics of distribution and transformation of various soil phosphorus forms:** The P content order of different soil P form in 0-20 and 20-40 cm soil layer was: Resin-P < $NaHCO_3$-P < HCl-P < NaOH-P < Residual-P. The content of soil total P and soil labile P (Resin-P and $NaHCO_3$-Pi) decreased with the increasing stand age. The content of soil stable P (Residual-P) content increased with the increasing of stand age. The component of soil organic P were: orthophosphate, orthophosphate monoester, phytate, pyrophosphate. The content and kinds of soil organic P were reduced with the increasing of soil layer.

(3) **The influence of litter decomposition on the form and content of soil P:**Thelarch litter mass loss rate is about 30% within a year of natural decomposition. And the turnaround of 10- 25- 50-year-old of litter are: 6.62, 10.53, 8.01 years. The P release patterns of belongs to: Leaching--Enrichment--Release model. The litter P release rate was closely related to the initial litter C:P. Litter addition significantly influenced the content of soil Resin-P. Comparing with control group, the content of soil Resin-P for the 10-, 25- and 50-year-old litter content increased by 300%, 240% and 15% respectively after 180 days' room temperature cultivation.

According to our research, the suggestions of larch plantation in mountainous region of eastern Liaoning Province, China are as follows: (1) When harvesting the larch plantations, the leaf, branches and root should be crushed and left at the land, in order to improve the resilience soil fertility of larch plantations; (2) The appropriate phosphate fertilizer should be conducted at the middle and mature stage of the larch plantations to reduce the P limitation to the growth of larch plantation; (3) Litter should not be removed in order to maintain the sustainable development of larch plantations.

Key words: larch plantation,soil phosphorus fractions, phosphorus accumulation and distribution, litter decomposition

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Alteration of Water Soluble Organic Inorganic Matters by Converting of Land Use of Tropical Peat Soil in Malaysia

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Abstract
Plantation agriculture is an important and basic industry in Southeast Asia, including Malaysia; however, the deforestation of original forest is regarded as an environmental problem. In addition, farmland used for plantation may be abandoned in near future because of industrial structure changes as well as strengthening regulations. Therefore, regenerated forest is important to recover from loss of original forests. However, it is not understood alteration on the characteristic of soil properties with converting land use from original forest, plantation to regenerated forest. In this study, we focused on the behavior of water-soluble inorganic matter with water-soluble organic matter (WSOM). We collected the tropical peat soil from original forest (OF), plantation (PL) and secondary forest (SF) in Selangor, Malaysia. The aim of the present study was to understand the alteration of behavior of water-soluble organic and inorganic matters with converting land use of tropical peat soil. We collected the soil samples with 5-10 depth from three points (A, B, C) on each site. The amounts of water-soluble Ca, Mg, Fe, Mn, Al, K, P, As, Pb, NH_4^+, NO_3^- as well as water-soluble organic carbon (WSOC) were determined with water extraction. The amounts of inorganic elements complexed with WSOM and WSOC above MW1000 was evaluated by the dialysis method (MW1000). Exchangeable cations, amorphous Fe, pH, EC, moisture content, loss on ignition, CEC were evaluated. The amounts of WSOC was highest in OF, and lowest in PL (Fig. 1). The amounts of WSOC decreased with converting land use to PL, but these increased again by converting land use to SF. The same pattern was observed in the amounts of WSOC above MW1000. 33-99% of water-soluble inorganic elements such as Ca, Mg, Fe, and Mn was existed with WSOM-complexed, and the positive liner relationships between these amounts of inorganic elements complexed with WSOM and WSOC above MW1000 were observed (Table 1). Thus, the dialysis test indicates that the release of inorganic elements from the soil is enhanced with the complexation of WSOM. In contrast, potassium, phosphorus, and arsenic was not almost complexed with WSOM. The amounts of exchangeable cations were highest in OF, and lowest in PL. The amount of exchangeable magnesium was only positively correlated with the amounts of WSOC above MW1000. These results suggest that the release of WSOM from the soil causes the alteration of soil chemical properties with converting land use in the tropical peat soil in Malaysia.

Key words: plantation, tropical peat soil, water-soluble inorganic matter, water-soluble organic matter

Table 1 Correlation coefficient between WSOC above MW1000 and inorganic element complexed with WSOM

pH	WSOM-Mg	WSOM-Ca	WSOM-Fe	WSOM-Mn	WSOM-Al	WSOM-K	WSOM-P
0.315	0.929**	0.688*	0.713*	0.784*	-0.506	0.519	0.507

*$p<0.05$, **$p<0.01$

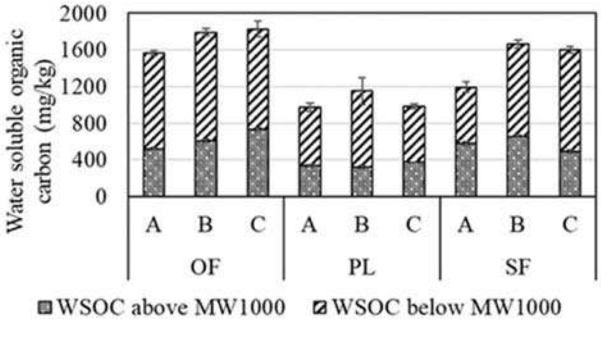

Fig. 1. Water-soluble organic carbon (WSOC) concentration extracted from tropical peat soil

SOIL FAUNA DISTRIBUTION ON VARIOUS LAND USE TYPE IN SUPER WET TROPICAL RAIN FOREST WEST SUMATRA INDONESIA

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Abstract

Changes in land use have an impact on the level of soil fertility both chemical and physical properties. The degradation of soil fertility raises the assumption that not only due to abiotic factor of the land experiencing but there are biotic components that are sensitive and affected by changes in land use. This study aims to assess the abundance and diversity of soil fauna on several land types and their relationship to soil fertility status. The study was conducted for four months in the Pinang-Pinang study site, West Sumatra, Indonesia. The sampling is based on purposive random sampling on each type of land use. The results showed that the highest of soil fertility status are found in Monoculture Garden. While the highest value of relative abundance and diversity index of soil fauna is found in the Forest. On the contrary, in monoculture garden and open land only found relative abundance and diversity index of soil fauna with low values. Based on the time, the relative abundance of soil fauna in the forest showed the highest consistency of values over four months of observation. The diversity of soil fauna showed a fluctuation values with downward trend in the forest at 4th month (3.134 at 1st, 3.313 at 2nd, 3.314 at 3rd and 2.891 at 4th). While in open land showed the increase trend of soil fauna diversity index at 4th month (2.631 at 1st, 2.998 at 2nd, 2.782 at 3rd and 3.084 at 4th). The correlation of chemical and physical properties of soil to the abundance and diversity index of soil fauna has no a significant relations. So that in this region, the diversity and distribution of soil fauna cannot be used as an indicator of soil fertility.

Key words: Diversity index, super wet tropical rain forest, soil fauna distribution, and soil fertility.

Table 1. Diversity index, evenness, relative abundance and dominance of soil fauna in several land types of super wet tropic rainforest areas

Month	Parameter	Land Use Type			
		Forest	Open Land	Mixed Garden	Monoculture Garden
November 2017	H’	3.134	2.631	2.728	2.527
	e	0.552	0.464	0.481	0.445
	KR	9.52%	5.89%	9.55%	7.84%
December 2017	H’	3.313	2.998	3.113	3.214
	e	0.584	0.528	0.549	0.566
	KR	6.05%	4.03%	4.22%	3.44%
January 2018	H’	3.314	2.782	2.870	2.935
	e	0.584	0.490	0.506	0.517
	KR	6.54%	6.20%	5.67%	4.03%
February 2018	H’	2.891	3.084	3.183	2.927
	e	0.509	0.544	0.561	0.516
	KR	10.39%	5.21%	7.04%	4.37%

Ket. H’: Diversity index of Shanon-Winner; e: Evenness index; KR: Relative abundance

Measures to reduce soil erosion on cassava farms in Central Highlands, Vietnam

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Abstracts

Cassava has become an important crop in developing countries. However, growing cassava on sloping land can result in serious erosion due to the wide spacing and thin canopy. This study discusses on measures to reduce soil erosion on cassava farms in Central Highlands, Vietnam. A field experiment on sowing direction (strip and contour) and intercropping (0, 1, 2 and 3 peanut rows between 2 cassava rows) was conducted on sloping land with a 15% grade during 2016-2017. The treatments were arranged in a split-plot design with 3 replications. The results showed that the contour growing and intercropping peanut among cassava techniques reduced the rate of soil loss in comparison with strip planting and monoculture. Intercropping reduced cassava productivity but produced peanuts, keeping the total income balanced. In addition, growing peanut fixed nitrogen and produced biomass that contained OM and minerals for better soil fertility. The treatment that had the highest economic and environmental effectiveness was contour sowing and intercropping 3 peanut rows between 2 cassava rows.

Keywords: cassava; contour; erosion; intercropping; productivity.

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"SOIL EXHIBITION TOUR " — The Soil Education for General Public and Elementary School Children in Taiwan

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Abstract
Soil is the foundation for animal life and human society. And it's the media for plant growth also. However, there are fewer people keeping their eyes on the "soil" nowadays. The main purpose of this program is hope to greatly improve the understanding and management of the soil resource to social human beings, especially for children-education. Three-parts of activities were prepared to convey the basic knowledge of soil. The exhibition board was shown first; In second part, describing the soil color via Munsell soil color charts and determining of textural class by feel method; Finally, the postcard, which has the soil acknowledgment, such as, textural triangle, six ecological functions of soil, and soil profile on the cover, was colored by the watercolors made of soil. These soils have different color and were collected from different regions in Taiwan. In this program, we can adjust the detail of the activities according to the age of the participants; hence it's suitable for elementary school children, general adults, and even the science educators. It is expected that this program will be held on a larger scale and in-depth in further days.

***Key words*:** Postcard; soil color; soil exhibition; soil texture; watercolors.

Funding
This program was funded by the Council of Agriculture of the R.O.C. and in part by the Ministry of Education, Taiwan, R.O.C., under the Higher Education Sprout Project.

Effects of Al on the uptake and accumulation of Ga and In in rice seedlings grown in Ga/In containing solution cultures

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Abstract

Gallium (Ga) and indium (In) are emerging contaminants and widely used in semiconductor manufacturing industry, wastewater containing Ga and In may be discharged into paddy fields by the irrigation system, further raising the exposure risk of Ga and In to humans through rice consumption. Our previous study indicates that the growth inhibition of rice seedlings grown in Ga/In-contaminated acidic soils is mainly caused by aluminum (Al) toxicity, but the effects of Al on the accumulation of Ga and In in rice plants is still unclear. Therefore, the objective of this study is to investigate the effects of Al on the uptake and accumulation of Ga/In in rice seedlings. Hydroponic experiment was conducted and the rice seedlings were treated with different levels of Ga (0, 2, 4, 8, 15 mg L^{-1}), In (0, 0.25, 0.5, 1, 2 mg L^{-1}) and Al (0, 5, 20 mg L^{-1}) in the nutrient solutions for 40 days. The results showed that the growth index (root length, shoot height and biomass) increased with Ga concentrations in culture solutions, but the growth inhibition was observed while the In concentrations higher than 0.25 mg L^{-1}. It also found that the growth index was decreased while the Al concentrations higher than 5 mg L^{-1} for Ga and In treatments. Plant analysis results indicated that the roots were the dominant sink of Ga, In and Al in rice seedlings, and it was also found that the accumulation of Ga and In in rice seedlings were inhibited by Al, which might be resulted from competitive absorption between Al and Ga/In in rice seedlings and Al phytotoxicity. This study suggests that Al plays an important role for Ga/In accumulation and plant growth of rice seedlings grown in Ga/In containing solution cultures.

Key words**:** gallium; indium; aluminum toxicity; paddy rice; hydroponic; emerging contaminants.

Sorption of gallium and indium on humic acid-ferrihydrite

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Abstract

Recent development of semiconductors and energy industries results in the release of trace elements such as gallium (Ga) and indium (In) into the environment. The contamination of Ga and In in soil and groundwater may lead the risk to human health via food chain. Hence, it is crucial to understand the fate of these trace metals in the environment. In soil environments, the adsorption and desorption reaction of metals by soil constituents play an important role in determines their mobility and bioavailability. The aim of this study is to investigate the sorption of Ga(III) and In(III) the binary HA-Ferrihydrite system and the transformation of sorbed Ga and In upon aging. The sorption experiments were carried out in different pH and aging time for (1) HA, (2) HA mixed with ferrihydrite and (2) HA coprecipitated with iron. The sorption of Ga(III) and In(III) on HA was found to inhibit the precipitation of Ga and In, which occurs in the system without HA at pH > 4. Different sorption capacities of Ga and In were determined for HA associated with ferrihydrite and coprecipitated with Fe(III). Upon aging, ferrihydrite transformed to crystalline Fe hydrous oxides, which resulted in the changes of bonding configurations of sorbed Ga and In. This study provides insights into the key reactions which control the mobility and bioavailability of Ga and IN in soils.

***Key words*:** Gallium; Indium; Humic acid; Ferrihydrite; Sorption

Evaluation of Chemical Properties and Heavy metals in Upland Soils in Korea.

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Abstract

In order to monitor the chemical properties and heavy metal contents for the long term change in soils of upland fields in 2017, a total of 1,770 soil samples (inland area 1,630, jeju area 140) at 15 cm of top layers all over the country were collected. Chemical properties in soil analyzed using korean standard method for soil chemical analysis(NIAS), and total heavy metal analyzed using acid digestion(HNO_3:HCl). The average chemical properties of upland soils were 6.4 for pH, 1.03 dS m^{-1}, for EC, 27.3 g kg^{-1} for organic matter, 657 mg kg^{-1} for available phosphate, 0.96 $cmol_c$ kg^{-1} for exchangeable potassium, 7.6 $cmol_c$ kg^{-1} for exchangeable calcium, and 2.07 $cmol_c$ kg^{-1} for exchangeable magnesium. The average concentrations(acid digestion, HNO_3:HCl) of total heavy metals in upland soils were 0.20 mg kg^{-1} for Cd, 23.9 mg kg^{-1} for Cu, 20.5 mg kg^{-1} for Pb, 84.1 mg kg^{-1} for Zn, 17.8 mg kg^{-1} for Ni, 0.29 mg kg^{-1} for Cr^{+6}, 4.29 mg kg^{-1} for As, and 0.028 mg kg^{-1} for Hg. Heavy metal contents of upland fields were lower than threshold values for soil contamination in Soil Environmental Conservation Act in Korea.

***Key words*:** Upland soils, Chemical properties, Heavy metal, Monitoring

Table 1. Chemical properties of upland soils in Korea.

Basic statistics	pH (1:5)	EC (dS m^{-1})	OM (g kg^{-1})	Av.P_2O_5 (mg kg^{-1})	Ex. Cations (Cmol$^+$ kg^{-1})		
					K	Ca	Mg
Mean	6.4	1.03	27.3	657	0.96	7.6	2.07
Max.	8.6	12.73	111.3	2464	7.66	30.4	8.96
Min.	4.0	0.03	1.7	4	0.07	0.7	0.14
Median	6.5	0.73	24.0	599	0.79	7.0	1.90
95%-P	7.6	2.72	54.9	1420	2.30	14.3	4.07
99%-P	8.0	4.83	77.0	1745	3.53	21.5	5.53
Jeju[1)]	6.2	0.72	66.8	320	1.11	8.7	2.14
Optimum[2)]	6.0~7.0	≤2.00	20~30	300~550	0.50~0.80	5.0~6.0	1.5~2.0

[1)] Chemical properties of upland soils in Jeju province(140 samples).

[2)] Optimum level of soil chemical properties in upland soils (RDA, 2008).

Reactive iron controls the dynamics of Ni and Cr in serpentine paddy soils

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Abstract
While the natural abundance of Ni and Cr in serpentine soils are well known, very few studies related the presence of reactive iron on the dynamics of Ni and Cr in paddy soils. The objective of this study is to elucidate the role of reactive iron in the stabilization of Ni and Cr in serpentine derived paddy soils in the Philippines. Twenty surface soils (0-20 cm) at each site were collected and characterized across three paddy areas in Luzon Island, Philippines. A citrate-bicarbonate-dithionite reduction procedure was employed to extract reactive iron from the soil and the concentrations of total Ni and Cr were quantified using the aqua regia method. In addition, Ni and Cr fractions (exchangeable, reducible, oxidizable, residual) in paddy soils were determined and quantified. The results revealed that: (1) Ni and Cr concentrations in paddy soils were significantly ($p<0.05$) higher in Sta Cruz compared to Candelaria and Masinloc; (2) Ni (R^2=0.54; p<0.0001) and Cr (R^2=0.44; p<0.0001) concentrations increases with increasing reactive iron concentration; and (3) reactive iron is strongly correlated (p<0.001) to the different Ni fractions, whereas the reactive iron is strongly (p<0.001) correlated with the reducible and residual fractions of Cr. Despite exceeding agricultural guidelines of Ni and Cr concentrations, with up to 57 folds for Ni and 9 folds in Cr, they have low availability since they are mostly bound to mineral structures, suggesting that reactive iron acts a giant rusty sponge for Ni and Cr in serpentine paddy soils.

Key words: metal speciation, paddy soils, reactive iron, rice, serpentine

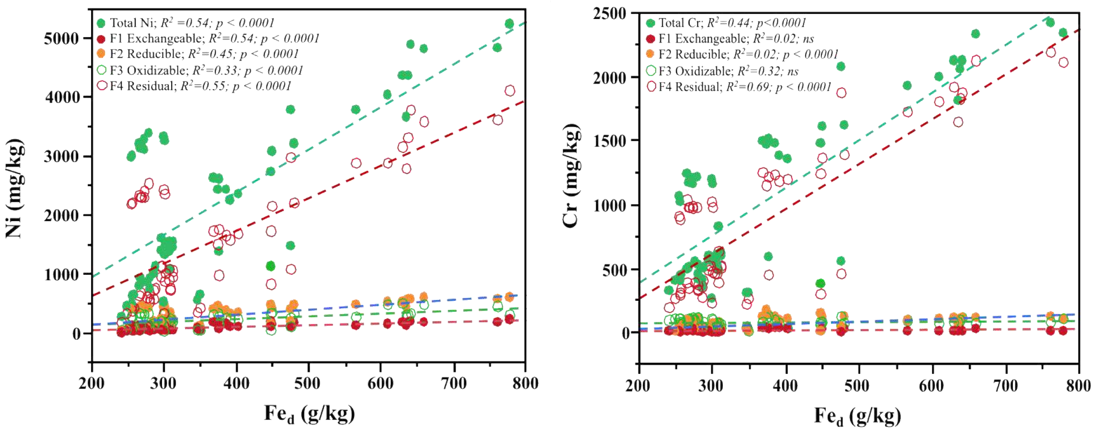

Figure 1. Relationship between Ni (mg/kg) and Cr (mg/kg) and dithionite extractable iron (Fed) concentrations in serpentine paddy soils.

A Distinctive Effect of High Ga and In on Rice Physiology and Molecular Regulation

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Abstract

The heavy use of gallium (Ga) and indium (In) elements coupled with their low processing efficiency have led to the contamination of soils in the industrial areas, e.g. the Ga concentration in the soil is 8ppm. To date, information on how rice plants cope with extremely high Ga and In contamination is still limited. To evaluate the possible effects of high concentration of Ga and In on rice growth, this study examined the physiological and molecular changes that take place in a popular premium rice (*Oryza Sativa* L.) variety in Taiwan, Taikeng 9, at the seedling stages upon exposure to 16-60 times higher Ga and In concentration than soil background values. As a result, rice shoot and root growth were evidently reduced by $InCl_3$ treatment whereas root growth was slightly stimulated by $GaCl_3$ treatment. Despite the relative chlorophyll content (SPAD value) was not affected by both the heavy metal treatments, 3,3'-Diaminobenzidine (DAB) and Nitro Blue Tetrazolium (NBT) staining generally showed the accumulation of hydrogen peroxide (H_2O_2) and superoxide (O_2^-) in the leaf and root tissues of $InCl_3$- and $GaCl_3$-treated plants, respectively. In conclusion, the physiological data indicates that the inhibitory effects of In treatment on rice seedling is more severe than that of Ga treatment. An ongoing experiment involves understanding the molecular regulations of Ga and In transport, accumulation and tolerance in rice in order to ensure a sustainable rice production, especially in terms of yield component and food safety for human consumption, when facing with the threats of emerging contamination elements, Ga and In.

Key words: Gallium, Indium, Taikeng No. 9, rice, abiotic stress.

Influence of Transpiration Stream on Lettuce Uptake of Antibiotics

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Poster presenter: Chia-Lin Lu

Abstract

Antibiotic medications have been widely used to treat human and animal diseases caused by bacteria. The practices of land application of biosolids and irrigation using reclaimed water from wastewater treatment plants have resulted in the dissemination of antibiotics in agricultural soils and waters followed by their uptake in crops. Understanding the magnitude of antibiotic accumulation and transport in crops under different environmental conditions (e.g., arid and humid climates) could provide information necessary for decision-making on legislation. In this study, the accumulation and transport of two antibiotics trimethoprim and lincomycin in hydroponically grown lettuce with different transpiration rates were examined through applying abscisic acid (ABA) to nutrient solution. The results revealed that both trimethoprim and lincomycin had higher root accumulation in lettuce than that in shoots, and the relative mass distribution of trimethoprim in lettuce roots was higher than that of lincomycin through 12 to 144 hours of uptake. A good positive linear relation was observed between transpired water and the mass of trimethoprim accumulated in both roots (R2 > 0.5) and shoots (R2 > 0.8). Though the transpired water had a good positive correlation with lincomycin accumulated in lettuce shoots (R2 > 0.6) but there was low correlation with its accumulation in roots (R2 < 0.3). This could be attributed to trimethoprim with relatively small size (MW = 290.3 g mol−1) had higher affinity to lettuce roots while lincomycin with relatively large size (MW = 406.5 g mol−1) was obstructed in entering lettuce roots via symplastic movement. The results of this study highlighted that chemical size and affinity to plant roots and transpiration rates collectively influenced the accumulation and transport of antibiotics in plants.

Key words: Antibiotics, plant uptake, transpiration stream, LC-MS/MS, symplastic movement

Funding

This study was supported in part by Agriculture and Food Research Initiative Competitive Grant 2016-67017-24514 from USDA National Institute of Food and Agriculture, MSU AgBioResearch, and Project GREEEN.

Laboratory and Field Measurement of Magnetic Susceptibility of Agricultural Surface Soil for Rapid Soil Assessment

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Abstract

Soil magnetic susceptibility can be measured rapidly and nondestructively as a proxy for the content of strongly magnetic Fe oxides in soil. However, it has been rarely utilized for agricultural purposes. In this study, we evaluated how much soil magnetic susceptibility can be useful for rapidly estimating the properties of agricultural surface soils.

A hand-held magnetic susceptibility meter (KT-10, Terraplus) was used in the laboratory and field conditions. In the laboratory conditions, agricultural surface soils collected throughout Japan (n = 164; Sano *et al*., 2004) were air-dried and 2-mm sieved, and more than 100 g of the sample was packed in a 500-mL plastic bottle. The magnetic susceptibility was measured from the bottom of the bottle 10 times per sample, with a sample mixture between measurements to renew the measurement surface. In the field conditions, contiguous paddy fields in Kumamoto Prefecture, southern Japan, were investigated. The magnetic susceptibility of the soil surface was measured at 792 sites in the study area of about 50 ha after stamping the feet on the ground to level the measurement spot. The measurement was repeated twice per site with a distance of less than 1 m. The data were subjected to the correlation analysis.

For the laboratory measurement, the average magnetic susceptibility of the nationwide samples was 1.77 x 10^{-3} SI with a large CV value (112%). The average was highest for the Silandic Andosols (4.18 x 10^{-3} SI, n = 39), which was followed by Aluandic Andosols (1.21 x 10^{-3} SI, n = 7) and other types of soils (1.00 x 10^{-3} SI, n = 118). The effect of land use on the magnetic susceptibility was smaller than that of soil type, when the data from 23 pairs of paddy and upland fields at the same site were compared. The CV value of the repeated measurement of the same sample was usually less than 10%, when the average was higher than 0.2 x 10^{-3} SI. Thus, the correlation analysis was carried out by using the soil data whose average values exceeded 0.2 x 10^{-3} SI (n = 132). The magnetic susceptibility showed significant positive correlations (r > 0.65) with the contents of structural Fe (total Fe minus Fe_d) and the andic soil property (Al_o+1/2Fe_o); those related to soil parent material, the degree of weathering and the fixation of soil P.

For the field measurement, the magnetic susceptibility was influenced mainly by the degree of contact between the sensor and the soil surface, and not so much by the fluctuation of soil moisture content. The average CV values of the duplicate measurements at the same site were about 5%. In the study area, soil magnetic susceptibility varied widely at two spatial scales; within-field scale (CV = 14% and 27% in two fields, each with an area of about 0.3 ha) and inter-field scale (CV = 44% across 128 fields). The variation of soil magnetic susceptibility could be detected even within an individual field. The variations were spatially dependent at both scales, which enabled to create a map of soil magnetic susceptibility in this area. Furthermore, the field measurements at 39 sites (8 fields) in the study area were strongly correlated (r = 0.98) with the laboratory measurements of the surface soil sampled at the same sites eight months before the field measurement. This would be probably due to the homogenization of the surface soil by puddling and plowing. The field measurements showed significant positive correlations with the contents of sand (r = 0.91) and nonexchangeable K (r = 0.61) in the surface soil; those related to soil texture and the slowly available K pool. Thus, the soil properties affecting the magnetic susceptibility varied with the type of samples collected at different spatial scales.

In conclusion, the laboratory and field measurement of magnetic susceptibility of agricultural surface soil can become useful for rapidly estimating the related properties and mapping them at a high spatial resolution, provided that the measurements are relatively constant for the same sample or at the same site.

Key words: Agricultural soil; Japan; magnetic susceptibility; mapping; nondestructive measurement

Comparison of adjacent soils formed different parent materials, Cache Valley, Utah, USA

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Abstract

Soils have an important role in the terrestrial carbon pool. In the soils of semiarid ecosystems, inorganic carbon typically has a greater contribution to carbon stocks than in soils of humid ecosystems.

Cache Valley is a semiarid, seasonally dry basin in the Great Basin, western USA. Cache Valley was inundated by Pleistocene pluvial Lake Bonneville about 20,000 years ago. About 17,400 years ago, the natural dam collapsed and the water level of Lake Bonneville dramatically dropped. Most soils in Cache Valley are formed in deposits of Lake Bonneville and have stages of carbonate accumulation of II or less. At Spring Hill in eastern Cache Valley, soils formed in calcareous alluvium (SH-W) with Stage II to IV carbonate accumulation occur adjacent to soils formed in dolostone (SH-E) with Stage I accumulation. The objective of this study was to determine the roles of parent material and landscape evolution in the development of these soils.

The morphology of the soils was described. Samples were taken by genetic horizons and sieved to separate <2-mm material from rock fragments. The pH, electrical conductivity, exchangeable/extractable cations, cation exchange capacity, and particle size distribution were measured on <2-mm soil. Total, inorganic, and organic C were determined on soil ground to <0.250 mm. Mineralogy of the very fine sand fraction (0.05-0.10 mm) was determined by petrographic microscopy. Optically stimulated luminescence (OSL) dating was conducted on soil sampled from 115-130 cm in SH-W.

SH-W was classified using USDA Soil Taxonomy as loamy-skeletal, carbonatic, mesic Typic Calcixerolls, whereas SH-E was classified as loamy-skeletal, carbonatic, mesic Cumulic Haploxerolls. The very fine sand of the lower horizons of both soils were dominated by carbonate minerals. The upper part of both soils were silt-rich and the very fine sand had mixed mineralogy and contained small amounts of volcanic glass, suggesting an eolian origin. In lower horizons, extractable Ca^{2+} was higher in SH-W, reflecting mixed alluvium, whereas SH-E had higher extractable Mg^{2+} reflecting dolostone residuum. Organic carbon content was higher in SH-E than that of SH-W. Inorganic carbon content was also higher in SH-E, whereas carbonate accumulation stage was more developed in SH-W. The difference of these carbon content difference would reflect the difference of parent materials. OSL dating showed the age of SH-W 115-130 cm at about 62.92±10.92 ka suggesting that the mixed alluvium was older than the Lake Bonneville deposits. This study revealed that the soil formed in alluvium was not significantly eroded during the transgression of Lake Bonneville. The silt-rich near-surface horizons indicate that loess was deposited across the landscape following the Lake Bonneville flood.

***Key words*: **Inorganic carbon; pedogenic carbonates; carbonate accumulation stages.

Chemical Properties of Representative Soil in Chungbuk Province

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Abstrac
Environmentally friendly agricultural system is a key element to pursue safe agricultural practices and preserve the environment through agricultural and environmental harmony. Soil testing is one of the major strategy for establishing this system as it gives consolidated information on levels of nutrient application and enhancing the soil fertility for sustainable agriculture. The present study evaluated the chemical properties in soil samples collected from 4,100 (paddy 52%, upland 26%, orchard 15%, plastic film house 7%) representative fields in Chungbuk province. Soil chemical properties such as pH, EC, organic matter, available P_2O_5, available SiO_2 (paddy) and exchangeable K, Ca, Mg were analyzed according to standard protocols designed by RDA (Rural Development Administration). The average values of different soil chemical parameters for paddy soils were as follows: pH-5.7, organic matter-21 g kg^{-1}, available phosphate -174 mg kg^{-1}, and available silicate-156 mg kg^{-1}. Exchangeable potassium, calcium and magnesium had the average values of 0.32, 5.5, 1.2 cmol$_c$/kg, respectively. Besides, the average values of different soil chemical parameters for upland soils were as follows: pH-6.5, soil organic matter- 22 g kg^{-1} and available phosphate- 488 mg kg^{-1}. Exchangeable potassium, calcium and magnesium for the upland soils had the average values of 0.32, 5.5, 1.2 cmol$_c$/kg, respectively. This data could be utilized in making agricultural policy which will lead to sustainable agriculture by improving soil fertility and soil safety for human health. These results indicated that nutrient management of paddy, upland, orchard and plastic film house are very important aspects for the concept of sustainable agriculture.

Key words: Soil chemical properties, Representative soil, Soil testing

Table 1. Soil chemical properties in arable land of Chungbuk Province (n=41,000)

Arable land	pH	OM	Av.P_2O_5	Ex. cation(cmol$_c$kg^{-1})			Av.SiO_2
	(1:5)	(g kg^{-1})	(mg kg^{-1})	K	Ca	Mg	(mg kg^{-1})
Paddy	5.7	21	174	0.32	5.5	1.2	156
Upland	6.5	22	488	0.64	6.8	2.0	-
Plastic film house	6.6	26	906	1.13	9.5	3.7	-
Orchard	5.9	36	168	0.26	5.3	1.2	-

Characteristics in Spatial Variability of Soil Organic Matter Under Different Land Uses in Northeast of Thailand

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Soil organic matter (SOM) is an important soil property contributing toward soil fertility and a key attribute in assessing soil quality. In general, this property in agricultural soils may reveal a large spatial variability depend on several factors including soil-forming factors, soil management, land cover, and agricultural system etc. The objective of the study is to describe the spatial variability of SOM in a different land uses (i.e. forest, rice paddy, sugarcane). Soil samples were taken at 0–20 cm depths. 143 Random soil samples were collected under different 3 land uses and analyzed SOM in the laboratory. The basic statistics and geostatistics were employed to describe the variability and characteristics in spatial variability of SOM, respectively. The results showed that the variability of SOM indicated by the CVs were low under different land uses. The forest contained the highest SOM, whereas the rice paddy the lowest (Table 1). The characteristics in spatial variability of all SOM indicated by the semivariogram, the spherical model was best fitted for all SOM under different land use. The nugget effect, sill and effective range were different between land uses. The SOM of sugarcane exhibited a moderate spatial dependence (Nugget/sill = 0.25) and a stronger spatial dependence was found in forest (Nugget/sill = 0.14) and rice paddy (Nugget/sill = 0.09), respectively. This information is very useful for site specific management and developing applicable land use plans on the soil system.

KEYWORDS: Soil Organic Matter, Geostatistics, Semivariogram, land use, spatial dependence

Table 1 variability of Soil Organic Matter under different land uses.

Land uses	Min (%)	Max (%)	Mean (%)	SD	CV
Forest	0.64	4.07	1.88	0.68	1.32%
Sugarcane	0.20	2.69	1.17	0.67	1.32%
Rice paddy	0.16	2.50	1.10	0.65	1.59%

Table 2 Characteristics in spatial variability of SOM under different land uses**.**

Land uses	Model	Nugget	Sill	Effective Range (km)	R^2	Nugget/Sill	Spatial dependence
Forest	Spherical	0.09	0.67	18.15	0.81	0.14	Strong
Sugarcane	Spherical	0.12	0.48	55.10	0.67	0.25	Moderate
Rice paddy	Spherical	0.07	0.73	5.60	0.70	0.09	Strong

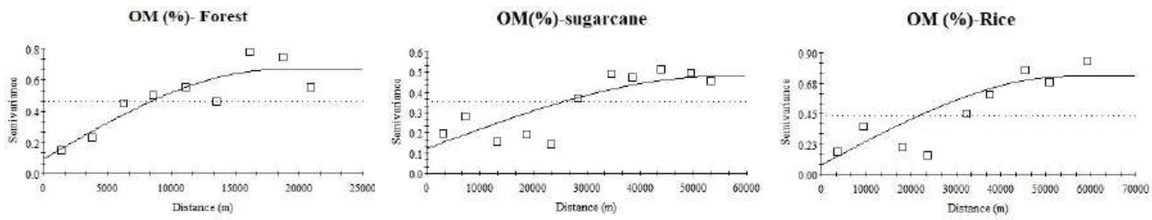

Figure 1. Semivariograms showing characteristics in spatial variability of SOM under different land uses.

Recycle barley bran into fertilizer and its influence on soil microorganisms

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The barley bran, barley skin generated by the processing, is produced as a by-product in the food company. The amount of barley bran reaches to 80,000 tons a year and few of them are used as feed, but most of them are disposed. If it is possible to use the barley bran as agricultural material, barley bran can be environmental friendly material. In this study, we tried to recycle the barley bran into fertilizer for sustainable agriculture. In order to evaluate the possibility of barley bran as fertilizer, analysis of the fertilizer component and temporal number of cultuable bacteria and fungi, when the barley bran was mixed into the soil, were checked. Moreover, temporal nitrogen mineralization in soil, and barley growth experiment was conducted. As a result, the total carbon and nitrogen were 42.9% and 1.8%, respectively, and phosphate and potassium were 1.0% and 0.91%, respectively. The number of bacteria and fungi using dilution plating method showed that fungi rapidly increased, whereas the bacteria gradually increased in the previously fermented barley bran compared with control. It is expected that the barley bran application will lead to the improvement of microbial diversity and of microbial activity. On the other hand, mineralization of barley bran incubated until 144 days was low at 11.2% and 5.9% in the fermentation barley bran and non-fermentation barley bran, respectively, whereas it was 33.5% in the oil cake. And non-fermented barley bran was immobilized till 108 days after application and turns to mineralization after 108 days, whereas the fermented barley bran maintained the mineralization after application. Therefore, the fermented barley bran can be used for growing barley when urea as a supplementary nitrogen source was added into fermented barley bran. The addition of urea gave good results equivalent to those of chemical fertilizers in the barley growing experiment. In conclusion, barley bran has low nitrogen content, and fermented barley bran alone has less fertilizer effect. However, barley bran + urea showed same growth of barley as that of chemical fertilizer. Moreover, the number of microorganisms increased, when barley bran was mixed with soil, as compared with the control. Thus the reduction of chemical fertilizers and the improvement of microbial diversity can be expected if the barley bran use as agricultural material.

Key words: Barley bran; soil microorganisms; Recycling-type sustainable agriculture; untouched natural resources

Production of CO_2, CH_4 and N_2O in differently disturbed tropical peat soils

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Abstract
Soil organic matter (SOM) quality would be changed by drainage, fire and land-use change in tropical peat, which might alter GHG emissions. The objective is to investigate the effect of SOM quality on the GHG emissions across the different levels of disturbance intensity.
Samples were taken from Indonesia (Palangka Raya) and Malaysia (Sarawak). Following the increase of disturbances intensity, samples were defined as: undrained forest (UFI and UFM), drained forest (DFI and DFM), oil palm (DOM), burnt forest (BFI), and cropland (CL). Samples were submerged and incubated with N_2 gas in the headspace (25^{0}C, 10 weeks). Headspace gas was taken every week to measure CO_2, N_2O, and CH_4 concentrations. Easily reducible iron (R-Fe) was extracted by sodium-citrate dithionite. Acid insoluble component (AIC) was analyzed by TAPPI method.
CO_2 and CH_2 emissions were highest in the undrained forest (*$P<0.05$).* CO_2/CH_4 was 1000 times higher in DOM, BFI, and CL than in the undrained forest. Because R-Fe, nitrate and sulfate contents were lower in the undrained forest, oxidation capacity might be lower. Furthermore, AIC was highest in CL (62%) and BFI (73%) where recurring peat burning have occured producing charcoal, which might increase oxidation capaity. On the other hand, N_2O emission was highest in CL due to highest nitrate content.
In conclusion, higher disturbance intensity could increase oxidation capacity of SOM, which would change to more CO_2 than CH_4 emission.

Key words: tropical peatland, peat disturbance, GHG emissions.

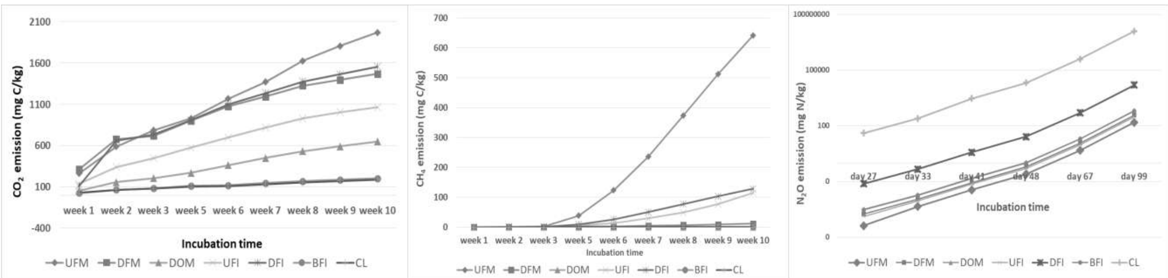

Fig. 1. CO_2, CH_4 and N_2O emissions (mg/kg) during 10 weeks incubation.

PHOSPHATE (P) ADSORPTION ABILITY OF CLAY FRACTION OF SEVERAL SOIL TYPES IN SOUTHERN SLOPE OF MOUNT UNGARAN, SEMARANG

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Abstract

Soil has different fertility rates for each type depending on the material, the type of mineral and the nutrient content. Generally, phosphate (P) in the soil is not available for plants because it is strongly adsorbed in the clay particles. This study aimed to determine the availability of nutrients P and compare the P uptake ability of four types of soil (Andisol, Inceptisol Alfisol Ploso and Alfisol Krajan) in southern slope of Mount Ungaran, Semarang Regency. This research was conducted at General Soil Laboratory, Faculty of Agriculture, Universitas Gadjah Mada. The clays of the four soil types were separated using insertion method. A total of 0.5 g of soil clay was added to 20 ml of KH2PO4 solution at concentration of 0, 15, 30, 45, 60, 75, 90 and 105 ppm at each. The soluble absorbent was measured using spectrophotometer with a wavelength of 889 nm. The readable absorbent was P that was not adsorbed by the clay. The amount of P adsorption was calculated using Langmuir and Freundlich equations. The result showed that P adsorption isotherm of the four soil types had L curve pattern. Phosphor adsorption was better described by the Langmuir equation. The maximum P adsorption from the highest to lowest was observed in andisol > alfisol Ploso > alfisol Krajan> anceptisol. The types of clay minerals mostly adsorb P are: amorphous (allophane) > kaolinite (1: 1)> haloysite (1: 1).

Keyword: Phosphate (P) adsorption, the Langmuir equation and Freundlich equation, andisols, alfisols and inceptisols.

Study of Genetic Diversity and Rice Breeding Mode for Low-Cd Acumination

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Abstract

Cadmium (Cd) accumulation in paddy soil is posing a high risk to food safety through the rice consumption, especially in Asia. Even though the rice grain was produced in low Cd level paddy field or remediated field, it still possible exceed the Cd safety criterion. To reduce the risk of Cd enters the food chain, it is necessary to select rice cultivars with lower Cd accumulation in grain. Various genes have an important influence on the Cd accumulation in grain. Therefore, identifying the genotypes of rice cultivars is an efficient strategy for safety rice cultivars screening. The major locus *qCDT7* is on the chromosome 7 of rice, including four Cd uptake-related and transport-related genes. OsNramp1 and *OsNramp5* are transporters for the uptake of Cd into rice root; *OsHMA3* sequesters Cd into vacuoles of root cells and reduce the xylem loading of Cd; *OsZIP8* regulates Zn and Cd translocation. In this study, we analyzed the haplotypes diversity of each gene in 3K rice panel from Rice SNP-Seek Database. In 3k rice germplasms, 95 % of *Indica* subgroup germplasms possessed the *OsNRAMP1* haplotype (Del.) that showed higher ability of Cd absorption. Conversely, *OsNRAMP1* haplotype (Complete) with lower ability of Cd absorption mainly exists in *Japonica* subgroup; *OsHMA3* possessed several haplotypes. However, the haplotype with lower translocation ability (80th, 380th aa and 826-878th InDel) did not exist; In *OsNRAMP5*, 66% of germplasms was identical to 'Nipponbare' haplotype (Complete). In addition, the haplotypes (InDel), which probably had potential to reduce Cd absorption, mainly existed in Indica subgroups and Tropical Japonica subgroups. The *OsZIP8* possessed highly conserved sequences. Based on these results and related literatures, we summarized the Cd mobile-type of each haplotype. Moreover, we designed markers to distinguish these haplotypes and applied these markers to screen Taiwan rice cultivars. In Taiwan, nearly all *Japonica* cultivars possessed *OsNRAMP1*-haplotype (Complete), *OsNRAMP5*-haplotype (Complete) and *OsHMA3*-haplotype (Complete) that showed low absorption and high translocation ability; Most of *Indica* cultivars possessed *OsNRAMP1*-haplotype (Del.), *OsNRAMP5*-haplotype (Del) and *OsHMA3*-haplotype (Complete) that showed high absorption and high translocation ability. It is worth noting that a few Indica cultivars possessed *OsNRAMP5*-haplotype (Del). These cultivars possessed a potential for low-Cd accumulation rice breeding; However, none of *OsHMA3*-haplotype (Del) existed in our experimental materials. In summary, this study provides an information about haplotype of each gene on *qCDT7* locus and also develops a rapidly genotyping method to identify low Cd accumulation rice cultivars.

***Key words*:** Cd-related genes, Low-Cd accumulation rice screening and breeding

Soil Properties Affecting the Quality of Special Local Tea Produced in Thai Nguyen Province, Northern Vietnam

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Abstract

In Vietnam, tea is one of the important agricultural crops both for local consumption and export. This study was conducted to investigate the relationships between soil properties and tea quality in Tan Cuong and Song Cau communes of Thai Nguyen province, a core area of tea production in the county.

In Tan Cuong, three transect lines were established perpendicularly to the Cong River (Fig. 1), based on the preliminary information that farm-gate shipping prices of tea products were higher at tea gardens close to the river, and nine gardens were selected on the lines (A1-2, B1-3, C1-4). Three gardens were in Song Cau commune (S1-3), marginal in tea production in a mountainous region. Surface (0-10 cm) and subsurface (20-30 cm) soils were collected at each garden in February 2017 for chemical analyses. Tea leaves (one bud and two adjacent leaves) of a cultivar "Trung Du" were sampled, and their mineral composition, antioxidative activity (AA), concentrations of total polyphenols (TPC), catechins (CATs) and theanine (THE) in the infusion (extracted at a tea-boiling water ratio of 1:90) were determined.

Compared with other sites, the THE concentrations in A1, B1 and C1 located on the riverside tended to be high while the AA, TPC and CATs levels were intermediate. The highest THE with the lowest AA, TPC and CATs was found in B2. The AA, TPC and CATs on average were significantly higher in Song Cau than in Tan Cuong, while the THE in Song Cau were lower. Thus, the trends of the THE concentration of the tea seem to correspond with tea quality as the farm-gate shipping prices.

A multiple regression analysis (the stepwise method) was performed to examine the influence of soil properties on the AA, TPC, and CATs in the tea infusion. Among the surface soil properties, EC and exchangeable Mg were commonly selected as explanatory variables for AA, TPC, and CATs (Table 1). Meanwhile, for the subsurface soils, DTPA-extractable Zn was selected as the variable (Table 2). It is suggested that a high Mg level through fertilization but a low Zn availability in the weathered soils exerted stress on tea plants, which in turn enhanced the biosynthesis of polyphenols as defense substances.

Our previous study (Huu Chien *et al.*, 2019) revealed that tea garden soils in the study area were strongly acidic but high in bases, P and N. To avoid excessive stress to tea plants as well as to reduce leaching loss of fertilized nutrients should be taken into consideration for safe, high-quality tea production.

Key words: catechins; Tan Cuong tea; tea garden soil; theanine; Vietnam.

Reference: H. Huu Chien, *et al.* 2019. Soil physicochemical properties in a high-quality tea production area of Thai Nguyen province in northern region, Vietnam. Soil Science and Plant Nutrition 65, 73-81.

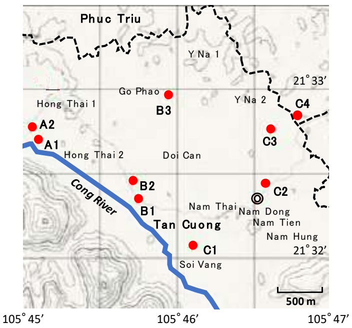

Fig. 1. Map of study sites in Tan Cuong commune.

Table 1. Multiple regression analysis of AA, TPC and CATs. for surface soils

Objective variables	Explanatory variables	Standardized partial regression coefficients
AA	Log [EC]	-0.545**
	Log [Ex-Mg]	1.156**
	Ex-H	0.436**
	Clay	-0.645**
	R^2	0.705**
TPC	pH (H_2O)	-0.460*
	Log [EC]	-0.673**
	Av-P	-0.449**
	Log [Ex-Mg]	1.036**
	R^2	0.592**
CATs	pH (H_2O)	-0.751**
	Log [EC]	-0.991**
	Log [Ex-Mg]	0.939**
	Log [DTPA-Mn]	0.311*
	R^2	0.560**

Table 2. Multiple regression analysis of AA, TPC, and CATs for subsurface soils.

Objective variables	Explanatory variables	Standardized partial regression coefficients
AA	T-N	0.382
	Log [Ex-Ca]	-0.628*
	Log [Ex-Mg]	0.517*
	Log [DTPA-Zn]	-0.465**
	R^2	0.410**
TPC	Ex-Al	-0.358*
	Log [DTPA-Cu]	-0.224
	Log [DTPA-Zn]	-0.635**
	R^2	0.474**
CATs	NH_4-N	0.287
	Log [DTPA-Zn]	-0.516**
	R^2	0.303**

Retention and Release of Soil Phosphorus from Various Aggregates in the Red Soil with Long-term Fertilization

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Abstract
Soil aggregate-associated retention and release of phosphorus (P)in the red soil affected by the long-term application of chemical fertilizers and/or combined with organic amendments were investigated. The long-term fertilization experiment was established in 1988 with four fertilization treatments: no P input (NK treatment), complete chemical fertilizer (NPK), NPK + crop straw (CS) and NPK + pig manure (PM). Soil aggregates with different sizes (> 2.0 mm, 2.0 -1.0 mm, 1.0 - 0.25 mm and 0.25 - 0.053 mm) were obtained by wet sieving method from samples collected from those treatments. Then total P (TP), Bray P, CaCl2-P, soil P sorption index (PSI), soil degree of P saturation (DPS) and the soil P storage capacity (SPSC) across various aggregate size fractions were analyzed, and the relationships among those tested parameters were investigated. Results showed that long-term no exogenous P input resulted in the lowest TP content, highest PSI and lowest DPS and the highest positive SPSC across various aggregates in the red soil. Compared with the NPK treatment, there was no significant effect of NPK + CS treatment on soil TP, PSI, DPS and SPSC in all aggregate size fractions; but NPK + PM treatment significantly decreased soil P retention capacity with the highest TP and lowest PSI value, and increased the release or loss potential of P from soils and various aggregates with the highest DPS, Bray P, CaCl2-P and negative SPSC values. All fertilizations irrespective of their nature and type, significantly increased the P enrichment in the > 2.0 mm aggregate fraction with PEC (P enrichment coefficient) >1, but only in NPK + PM treatment P was more easily enriched in macro-aggregates (> 0.25 mm). Correlation analysis indicated that the soil accumulated P poses a minimum threat to the safety of water quality when Bray P was lower than 264 to 300 mg kg-1 and DPS < 28% in the red soil; otherwise P loss from the soil was significant. Therefore, new strategies of using both commercial fertilizers and animal manures must be established and implemented to prevent P build up in the soils and to minimize the P loss to water bodies in the red soil region.

Key words: Soil Phosphorus Storage Capacity (SPSC), phosphorus sorption, degree of phosphate saturation(DPS), Ultisol, P fertilizers

Assessment of soil properties suitable for tea cultivation in Taiwan

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Abstract
Tea is one of the major commercial plant in Taiwan that was planting mostly in eastern, central, northern, and high mountain area. Many literatures have demonstrated that plant growth and plant production were affected by soil properties such as soil pH, electrical conductivity (EC) values, and contents of available nitrogen (N), available phosphorus (P), exchangeable potassium (K), and other nutrients. However, the relationship between soil physicochemical properties and tea's growth and quality were not well studied. Moreover, the suitable soil properties for tea cultivation soil in Taiwan were rarely discussed before. Hence, the objective of this research was to assess the soil properties that affected the growth and quality of tea in central Taiwan. Tea cultivation with good (GGE) and poor (PGE) growth exhibition were selected using aerial photographs. Soil depths of 0-20, 20-40, 40-60, and 60-80 cm below the soil surface were collected to analyze soil physicochemical properties mentioned above. Analyzing results show that some soil properties had influence on the growth exhibition of tea. Among these properties, pH, EC, and concentrations of exchangeable cations (Ca, Mg, Na, and K), total concentration of N, available P were significant different between GGE and PGE. In the case of soil pH, the GGE and PGE was in the levels of 3.2-6.0 and 3.3-5.4, respectively. The GGE has higher EC value (1.01±0.00 dS/m) compared with PGE (0.78±0.01 dS/m). The suitable soil properties data set of tea cultivation obtained in this study could be used and applied on tea cultivation for tea soil management and reliable recommendation on tea production.

***Key words*:** growth exhibition; nutrient management; sustainability; tea cultivation.

Funding
This program was funded by the Ministry of Science and Technology of the R.O.C. (Grant number MOST 107-2321-B-005-016) and in part by the Ministry of Education, Taiwan, R.O.C., under the Higher Education Sprout Project.

Seasonal Alleviation of Mn-induced Chlorosis in Sugarcane Seedlings Facilitated by Ammonium and Rainfall

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Abstract
We had previously reported that manganese (Mn)-induced chlorosis is a serious problem in ratoon sugarcane seedlings grown in acidic soils. To further monitor the progression of chlorosis and elucidate the corresponding mechanism, both plant growth and nutrient status of sugarcane plants and soils were investigated in the growth seasons of ratoon cane seedlings in 2016 and 2018. The impacts of rainfall and ammonium on chlorosis were also investigated hydroponically. The results showed that part of the chlorotic seedlings could green in mid-summer; Mn content in the first expanded leaf decreased significantly, whereas iron (Fe) content increased significantly during the progression of greening. The leaf Mn content in the greened seedlings decreased by up to 78.1% when compared with that in the initial chlorotic seedlings. The seedlings also showed a significant increase in seedling height and weight of the expanded leaves, accompanied by a decrease in plant Mn content during the progression of greening. Moreover, young seedlings with less Mn content showed earlier greening than older seedlings with more Mn content. The exchangeable ammonium content in the soils increased significantly during the progression of greening, and the addition of 1 mM ammonium to the chlorotic seedlings resulted in a decrease in leaf Mn content by up to 80%. Furthermore, leaf chlorophyll and Fe content increased by 2.0-fold and 1.4-fold, respectively, after rainwater was applied to the chlorotic seedling. These results indicate Mn-induced chlorotic can alleviate naturally, and downregulation of plant Mn content, rainfall in summer, and soil ammonium contribute to the greening of chlorotic seedlings.

Key words: Manganese; chlorosis; alleviation; soil; nutrition

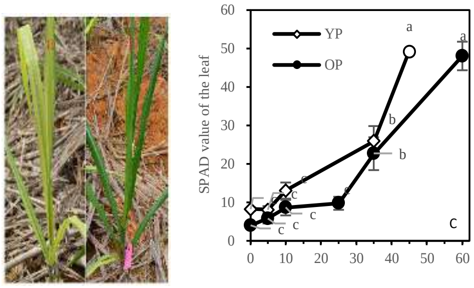

Fig 1. Chlorotic (a), greened seedling (b) and changes in chlorophyll concentration, as SPAD value, in the first expanded leaf of the seedlings during the progression of greening (c). The values were first measured at April 15, 2016 (day 0) and measured on the indicated days after the first measurement. YP, seedlings that bourgeoned in April; OP, seedlings that bourgeoned in February.

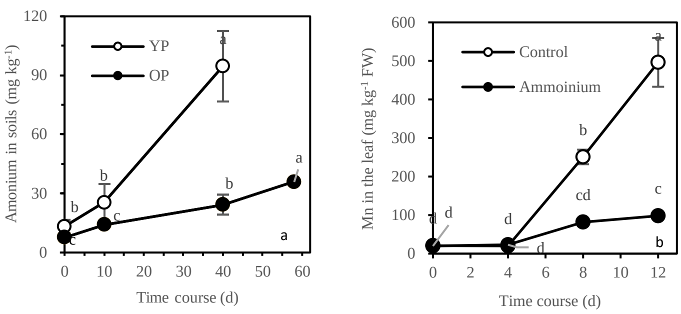

Fig 2. Ammonium contents in the soils (a) and effects of ammonium on Mn content in the first expanded leaf of the seedlings exposed to a nutrient solution with 0.5 mM $MnCl_2$ and 0 (Control) or 1.0 mM NH_4Cl (Ammonium) for 0, 4, 8, and 12 days (b).

Variation of Soil Potassium in Different Land Uses in Northeast of Thailand

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Abstract

In different land uses, soil nutrients are dynamic. It's can be changed at any time due to the uptake of plants. Soil potassium (K) is a crucial element for plant nutrition, have to be received appropriate potassium for growth. The objectives of the study were to (i) study the variation of K forms such as Extractable K and Total K in different land uses (forest, sugarcane and paddy) in Sakon Nakhon, Nakhon Phanom and Udon Thani province, Northeast of Thailand and (ii) compare the soil potassium content in a differences land uses using Basic statistics. Soil samples were collected randomly in areas of different 3 land uses at a depth of 0-20 cm and analyzed for Extractable K and Total K in laboratory. The basic statistics were employed to explain the variability of K forms in the soil and compare the differences of K form between different land uses. The results revealed that the variation of Extractable K and Total K in the soils is high in all different land uses. The Extractable K and Total K in the forest is the highest value and followed by sugarcane and paddy, respectively. The soil potassium in different land uses demonstrated statistical difference at 95% significance (Table 1). This information is very useful for the researcher and planner to improve soil quality and sustainable land management in the future.

Key words: Land Use; Variation; Soil Potassium; Northeast Thailand.

Table 1 Statistical analysis of Extractable K and Total K forms in different land uses.

Land use	Extractable K (mg/kg)	Total K (%)	%CV Extractable K	%CV Total K
Forest	92.47a	0.34a	50.70	58.58
Sugarcane	58.85b	0.24b	85.48	85.96
Paddy	49.95b	0.23b	114.63	101.22
p-value	0.001	0.0424		
F-test	*	*		
% CV	77.7	81.39		

* significantly different at $p < 0.05$

Optimizing nitrogen management to balance food and environmental objectives in two maize systems of the Tanzanian highlands

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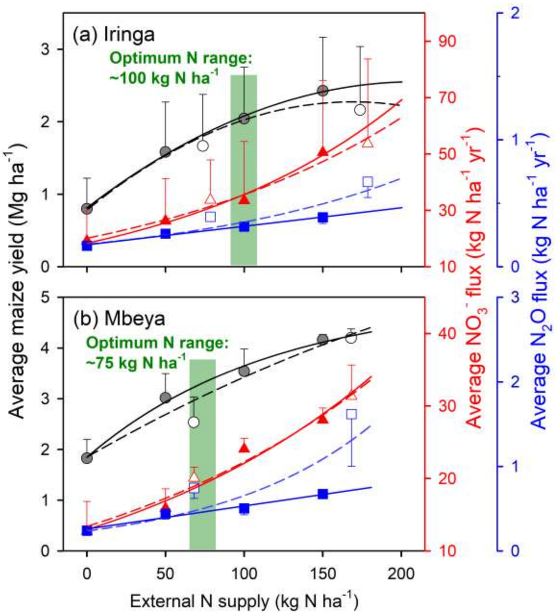
Abstract

In sub-Saharan Africa (SSA), cropland intensification with increasing fertilizer nitrogen (N) and organic input is needed to secure food production. However, integrated assessment of yield and N loss in response to different N management is lacking, largely constrained our ability to design an environmentally-friend crop production system. In two sites of the Tanzanian highlands (Iringa, sandy Alfisols; Mbeya, clayey Andisols), we quantified maize yield, NO_3^- leaching, and N_2O emission, for up to four years (2013–2017), under the treatments of increasing N rates (0–150 kg N ha^{-1}) and in combination with maize stover incorporation (~2 Mg C ha^{-1}). Iringa was lower in yield and N_2O emission, and higher in NO_3^- loss, as compared to Mbeya (0.8–2.4 vs. 1.8–4.2 Mg grain ha^{-1}, 0.16–0.67 vs. 0.24–1.6 kg N_2O-N ha^{-1}, and 19–54 vs. 13–31 kg NO_3^--N ha^{-1}). The responses of averaged yield, NO_3^- loss, and N_2O emission to only N input were well described by quadratic, exponential growth, and linear pattern, respectively, in both sites (R^2 = 0.963–0.998, P = 0.006–0.098). Despite the general well fittings, yield and NO_3^- leaching showed large inter-annual variations in Iringa but not Mbeya. When the combined inputs (fertilzier-N plus stover) were involved in describing the response patterns, yield tended to be slightly reduced, NO_3^- loss was negligibly affected, and N_2O emission was markedly raised. We therefore define the optimal N range based on the sole N input scenario, and at N rates where the difference between yield and NO_3^- loss (after normalized into a same scale) reached maximum, provided that the fertilizer-induced N_2O emissions were low across N rates and sites (0.15–0.40% vs. 1% of the IPCC Tier 1 estimate). Optimal N range occurred at ~100 kg N ha^{-1} in Iringa, higher than that (~75 kg N ha^{-1}) in Mbeya, but produced less grain (2 vs. 3.4 Mg ha^{-1}); such optimal N rate may not be practical for local farmers in Iringa. Lower yield and higher NO_3^- loss in Iringa, coupled with large inter-annual variations, suggest that the maize systems are "leaky and fragile" as compared to that of more "fertile and resilient" in Mbeya. Cropland intensification in SSA should prioritize regions with "fertile and resilient" maize systems like in Mbeya, and future research is needed to address the secondary constraints (e.g., micronutrients) on the yield in addition to N input; while for "leaky and fragile" systems like in Iringa, recovery of the soil health is needed before a satisfying response of yield to the N management can be obtained.

***Key words*:**.sub-Sahara Africa, soil type, maize yield, NO_3^- leaching, N_2O emission, stover incorporation



Yield vs. fertilizer-N
NO_3^- flux vs. fertilizer-N
N_2O flux vs. fertilizer-N
Yield vs. (fertilizer-N + stover)
NO_3^- flux vs. (fertilizer-N + stover)
N_2O flux vs. (fertilizer-N + stover)

Figure Average maize yield (Mg ha^{-1}), NO_3^- flux (kg N ha^{-1} yr^{-1}), and N_2O flux (kg N ha^{-1} yr^{-1}) in response to external N input (i.e., fertilizer-N or fertilizer-N plus straw) in Iringa (a) and Mbeya (b) sites of Tanzania. Solid lines are fitted for sole N input (four N rates), while dash lines are fitted for all external N input (six N rates). Optimum N rates were determined under the sole N input scenario, and as the N rates where the difference between yield and NO_3^- flux (after normalized into a same scale) reaches maximum.

The study of sauerkraut manufacture affecting soil salinity in Dapi Township

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Abstract

Dapi, a township in Yunlin County, is known for sauerkraut industry which supplies more than 80% of the consumption in Taiwan. However, the Xing'an village in Dapi contributes 65% of the production. There are abundant cement barrels for pickling built in the paddy field, because the wastewater of brine can be conveniently and carelessly discharged into the channels of the irrigation system without any treatment. The sauerkraut was made from the “Brassica juncea” by pickling. They were planted after the harvest season of the rice. It wasn’t until the recent years did the farmer found the poor growth and decreasing crop yields, probable due to the contamination of salts in the wastewater.

This study attempts to explore the spatial variation in salinity and electrical conductivity of the soils in the area, thus assess the relationship between soil salinity and the barrels of sauerkraut. A total of 60 soils were collected from grid sampling with depth of 0-30, 30-60, and 60-90 cm respectively in the paddy field of the Xing'an Village. The soil pH as well as the electrical conductivity were measured. The result shows these soils do not meet the classification of “saline soil”, “saline-sodic soils” or “sodic soils” defined by the US Department of Agriculture (USDA). However, such soil properties reach the maximum tolerance and hamper the growth of the Brassica juncea.

***Key words*:** salinity; electrical conductivity; maximum tolerance.

Speciation of Phosphorus in Acidic Paddy Soil as Affected by Rice-Straw Biochars

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Abstract

Acidic soils occur extensively worldwide and most of them are being used for paddy rice cultivation. However, due to strong acidity, high Fe/Al toxicity, and low P availability, the rice yield from these soils is usually limited. To investigate the effect of biochar amendment on the P availability in acidic paddy soils, this study added rice-straw biochars produced at two different temperatures (i.e. BC350 and BC600) to two soils with different textures. The content and speciation of P in soil and biochar during soil reduction and reoxidation were determined. The results indicated that adding biochar to acidic soil can increase soil pH and change soil Eh. During soil reduction, the dissolved Fe concentration increased in the acidic soil incorporated with biochar. The P of biochar was released to the soil solution in the first hour of soil reduction, and the amounts of soluble P in biochar gradually decreased. The soluble P in biochar was transformed into the labile-P associated with Fe and into the apatite-like P in BC350 and BC600, respectively. During soil reoxidation, the amounts of soluble P in biochar increased. The amounts of soluble P in biochar-amended soils showed a marked increase during soil reduction, and this result demonstrated that adding biochar to acidic soils can improve the P availability in the soils.

Keywords: acidic soils, redox, biochar, phosphorus availability, phosphorus speciation

Rice Yield, Nitrogen Use Efficiency and Greenhouse Gases Emission in Response to Controlled-release Fertilizer Combined with Wheat Straw Incorporation in a Paddy Field

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Abstract
Crop straw is increasingly recommended to return back to cropland mainly due to its advantage in improving soil fertility, while controlled release fertilizer application is effective to enhance nitrogen use efficiency (NUE) and crop yield. In rice-wheat rotation cropping system, lots of studies have focused on the effects of wheat straw incorporation or controlled release fertilizer application on rice grain yield (RY) and greenhouse gases (CH_4 and N_2O) emissions, however, the knowledge on the effect of controlled release fertilizer combined with wheat straw incorporation on RY and greenhouse gases emission is still lacking. In this study, four treatments, i.e. chemical fertilizer (CF), wheat straw incorporation combined with chemical fertilizer (SCF), wheat straw incorporation combined with controlled-release urea fertilizer (SCUF), and no fertilizer (CK), were designed to investigate the effects of straw returning and controlled-release urea fertilizer application on rice grain yield (RY) and greenhouse gases emission was investigated in five rice growing seasons (2012-2016).

SCF decreased RY by 0.4 % and 2.3 % in 2012 and 2013 seasons respectively, however, which increased RY in 2014-2016 seasons and the degrees of increase enhanced with time (2014: 2.3 %; 2015: 4.0 %; 2016: 9.3 %) relative to CF. SCUF significantly increased RY by 9.3-24.3 % ($P < 0.05$), and particularly enhanced NUE by 58.3-149.4 % ($P < 0.05$) relative to CF in all five seasons (Table 1). In addition, SCUF remarkably increased RY and NUE by 6.8-18.2 % and 42.0-150.5 % compared to SCF, respectively. It indicates that the strategy of straw incorporation combined with controlled-release urea fertilizer could effectively improve NUE and further enhance RY. Although the CH_4 emissions from SCUF were slightly lower than that from SCF in most rice growing seasons, which both significantly higher than that from CF. SCF tended to reduce N_2O emission, whereas SCUF significantly stimulated N_2O emission compared to CF. Finally, the greenhouse gas emission intensities (GHGIs) calculated by CH_4/N_2O emissions and RY in SCUF were slightly lower than that in SCF in most rice growing seasons.

In conclusion, SCF may have a positive effect on RY and tend to enhance NUE in a long run. SCUF greatly increased RY compared to CF due to the enhancement in NUE. In the paddy fields with straw incorporation, the application of controlled-release urea fertilizers, instead of conventional urea fertilizer, would be a promising way to enhance RY, improve NUE, and mitigate GHGI in rice growing seasons.

***Key words*:** Controlled-release urea; Methane; Nitrogen use efficiency; Nitrous oxide; Rice yield.

Table 1 Effect of different treatments on NUE (%) in rice growing seasons

Treatments	2012	2013	2014	2015	2016
CF	28.7 ± 0.1b	31.8 ± 0.7b	31.8 ± 0.4b	27.5 ± 2.1b	28.6 ± 1.9b
SCF	28.6 ± 0.4b	31.6 ± 2.2b	33.7 ± 2.9b	28.4 ± 1.4b	32.9 ± 2.1b
SCUF	71.6 ± 2.0a	63.3 ± 4.8a	50.3 ± 1.8a	48.5 ± 2.6a	46.7 ± 4.4a

Soil Fertility Status and Leaf Nutrient Concentrations of Robusta Coffee in the Multi-cropping System with Para Rubber

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Abstract

In the multi-cropping system, robusta coffee (*Coffea canephora*) was the minority plant, thus, fertilizer application was depended on the majority plant-para rubber. For properly management of robusta coffee, soil (0-20 cm) and leaf samples were collected (64 plants) from the 4 to 5 ha plot on the nearly flat to gently undulating terrain of Chumphon soil series (Cp: Clayey-skeletal, kaolinitic, isohyperthermic Typic Paleuduults) which located in Chumphon Province, Southern Thailand. Soil and leaf sampling together with evaluation of analytical data were done following the standard criterion. Soils revealed an imbalanced fertility with very strongly acid (4.44±0.41) and moderately high organic matter contents (2.97±0.49%). Extractable potassium and zinc were medium (62.33±23.39 mg K kg^{-1} and 2.26±1.88 mg Zn kg^{-1}). However, available phosphorus, extractable iron and manganese were very high whilst extractable magnesium and copper were low whereas very low for extractable calcium and sodium (49.08±37.84 mg P kg^{-1}; 82.60±28.39 mg Fe kg^{-1}; 88.67±39.28 mg Mn kg^{-1}; 71.94±35.03 mg Mg kg^{-1}; 0.73±0.36 mg Cu kg^{-1}; 198.86±128.75 mg Ca $^{kg-1}$ and 14.36±4.49 mg Na kg^{-1}, respectively). Nutrients in leaf also showed imbalance among them. Total nitrogen, copper and zinc were evaluated in "deficient" ranges (2.28±0.28% N; 7.21±3.98 mg Cu kg^{-1} and 10.57±2.62 mg Zn kg^{-1}). Contrarily, total calcium and manganese were high (2.20±0.63% Ca and 216.58±155.98 mg Mn kg^{-1}). Total phosphorus and potassium were rated as "adequate" ranges (0.14±0.04% P and 1.84±0.49% K). In case of leaf magnesium, though it had an adequate concentration (0.30±0.13%), however, more than half of the plants were in deficient range. For appropriately management for robusta coffee, at least, liming with dolomitic limestone should be recommended. More nitrogen fertilizer should be added together with copper and zinc foliation.

Key words**:** Robusta coffee, Multi-cropping system, Leaf analysis, Soil fertility, Chumphon Province

Growth and Yield Performance of Aromatic Rice Varieties in Response to Different Nitrogen Fertilization Treatments

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Abstract

Aromatic rice is the most highly valued rice commodity in Bangladesh agricultural trade markets. Grains of aromatic rice are relatively small and show soft texture with pleasant aroma upon cooking. Nitrogen is one of the major essential plant nutrients. Nitrogen fertilization is, therefore, a key farming practice to maximize rice production, while it has been found to be deficient in most agricultural soils in Bangladesh. The nitrogen requirement for growing coarse rice is available in Bangladesh; however, such information is lacking in case of aromatic rice. In this study, a field experiment was conducted with the aim to find out: (i) suitable aromatic rice varieties appropriately responding to nitrogen fertilizer application, and (ii) effect of nitrogen fertilization levels on growth and yield performances of aromatic rice.

The experiment consisted of three varieties, viz. Kalizira, Binadhan-13 and BRRI dhan34, and six different nitrogen fertilization treatments, viz. 0, 30, 60 and 90 kg N ha^{-1} of normal urea, and 55 and 80 kg N ha^{-1} (1.8 and 2.7 g per 4-hills, respectively) of urea super granule (USG). The experiment was laid out in a randomized complete block design with three replications. As a result, varieties, nitrogen fertilizations and their interaction significantly influenced the growth and yield of aromatic rice. The highest number of tillers per hill, total dry matter weight (TDM) and crop growth rate (CGR) were recorded in Binadhan-13, when fertilized with USG 55 kg N ha^{-1}. At harvest, the highest grain yield, 3.33 t ha^{-1}, was obtained from Binadhan-13, followed by BRRI dhan34 (3.16 t ha^{-1}). The lowest grain yield was found in Kalizira (2.11 t ha^{-1}). In view of the nitrogen fertilization treatments, the tallest plant (140.3 cm), the highest number of effective tillers per hill (11.40), grains per panicle (152.8) and grain yield (3.32 t ha^{-1}) were obtained when fertilized with USG 55 kg N ha^{-1}. The lowest values were found in the control treatment without nitrogen fertilizers (0 kg N ha^{-1}).

In conclusion, Binadhan-13 fertilized with USG 55 kg N ha^{-1} (1.8 g per 4-hills) appeared as the promising practice for the appreciable grain yield.

Key words: Aromatic rice, Nitrogen level, Variety, Yield

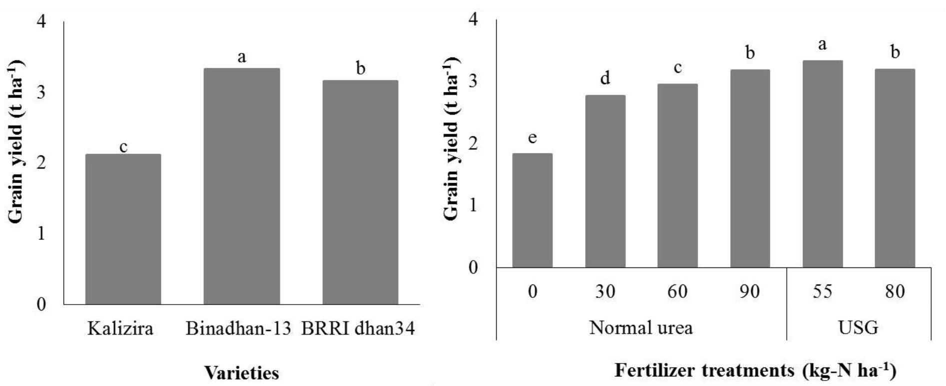

Fig. 1 Effect of varieties (left) and nitrogen fertilizer treatments (right) on grain yields of aromatic rice
USG: urea super granule

Introduction of On-site Diagnosis & Prescription built by Linking Soil Testing with On-site Diagnosis and its Application

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Abstract

The on-site diagnosis and prescription system established in mobile web of Korean soil information system is a program that provides soil management status, soil diagnosis, and prescription by inputting on-site soil analysis results and address only. The process of system was composed of five steps: 1) The results of soil testing at the address is retrieved from Korean soil information system. 2) It categorized soil as 8 types with soil pH and soil organic matter. 3) Combination of soil testing type and on-site analysis results shows soil management status. 4) Analyzing chemical properties(pH & Eh), nutritional properties(N, P) and osmotic properties(EC or NO_3^- & SO_4^{2-} & Cl^-), and diagnosing soil condition as one of 64 kinds of soil conditions(Kim et al., 2018). 5) Recommending the amount of minimum according to the soil condition and soil testing type and how to supply fertilizers by a series of pH buffer and fertilizer and water. According to data collected when normal osmotic pressure, pH 6.0 ~ 7.0 (16.3%) was the most common in chemical aspect and N deficiency (20.9%) was the most common in nutritional aspect. But, when high osmotic pressure, pH <5.9 (23.3%) was the most common in chemical aspect and N/P imbalance (20.9%) was the most common in nutritional aspect. This was thought to be the lack of P dissolved in soil solution due to lowering of pH and excessive fertilizer application. In this way, the system would provide a solution to soil chemical problems and analysis of the collected data could help to identify problems often encountered.

***Key words*:** Korean soil information system, on-site diagnosis, soil testing

Effect on Rice Yield and Content of Soil Carbon According to the Difference Types of Organic Matter in Paddy Soil

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Abstract

In agricultural land, organic matter is a major factor in determining the physical properties of soil and a necessary factor in enhancing fertility that contributes to crop productivity. When organic matter is returned to the soil, it is treated by soil microorganisms, it is decomposed by soil microorganisms, and supplied to the crops. Depending on the type of organic matter, the impact on the level of nutriments supply and the amount of soil organic matter varies. Therefore, to analyze the effects of organic material types on rice yield and soil carbon, different types of organic matter (oil cake compost, livestock manure compost, and hairy vetch) were used in paddy soil. After the use of organic materials, the early growth of rice was 34.6 ~ 37.9 cm in plant height and 11.3 ~ 14.9 in number of panicles per plant, which was not different between the types of organic matter. And the early growth of rice was not different between the organic matter application and the control. Rice growth and yield during harvest stage were higher in site of organic matter application than in that of chemical fertilizer application. Oil cake compost, livestock manure compost, and hairy vetch efficiency showed positive results. Rice yield and growth were much better in oil cake compost than in sites of other organic matter treatments. By item, culm length and panicles length were longer than other organic matter application. The number per m^2 was 591, which was 1.5 to 1.7 times higher than that of other organic matter, and about twice as high as that of the controls. However, the percent ripened grain (76.5 percent) and the 1000 weight of brown rice (21.0g) were lower than sites of other organic matter application and the amount of rice was 587 kg/10a. Hairy vetch had a significant rate of calm length, panicle length, and percent ripened grain, while the allowance for livestock manure compost was low, while oil cake compost was low in percentage of ripened grain were low. Soil carbon content increased in all organic matter application after the test (73.g/kg). T-C content was highest in livestock manure compost and hairy vetch, was lowest in oil cake compost. Carbon content in each form accounted for 59 to 67 percent of humin carbon, 13 to 23 percent of fulvic acid carbon content and 19 to 26 percent of humuc acid carbon.

Key words**:** organic matter type, paddy soil, soil carbon, rice yield

Effect of Nitrogen Fertilizer on Seed Yield and Growth Response for Italian ryegrass in the Saemangeum Reclaimed Tidal land

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Abstract
This study was conducted to investigate the effect of nitrogen fertilizer levels on seed yield and growth response for Italian ryegrass in the Saemangeum reclaimed tidal land. Nitrogen fertilizer was applied at the ratio of 0, 45, 90, 135, 180kg ha^{-1} and seed yield, growth characteristics and nitrogen use efficiency were evaluated. Fertilization with 180kg ha^{-1} of N slightly increased ear length by 5.1% compared with no fertilization but there was no significant difference. As fertilization level increased, seed yield of italian ryegrass increased up to 180kg ha^{-1} of N but from over 90kg ha^{-1} of N, there was no significant difference in seed yield. Dry weight of Italian ryegrass increased with increasing N fertilization. Nitrogen uptake amount of italian ryegrass straw at seed harvesting stage increased up to 22.7 kg ha^{-1} in 180kg ha^{-1} N treated plot which was 8.6 kg ha^{-1} higher than no fertilization plot. Further researches about N uptake and seed yield cultivation of italian ryegrass are necessary to increase N use efficiency and develop stable seed production techniques at reclaimed tidal land.

Key words**:** Reclaimed tidal land; Soil salinity; Italian ryegrass seed.

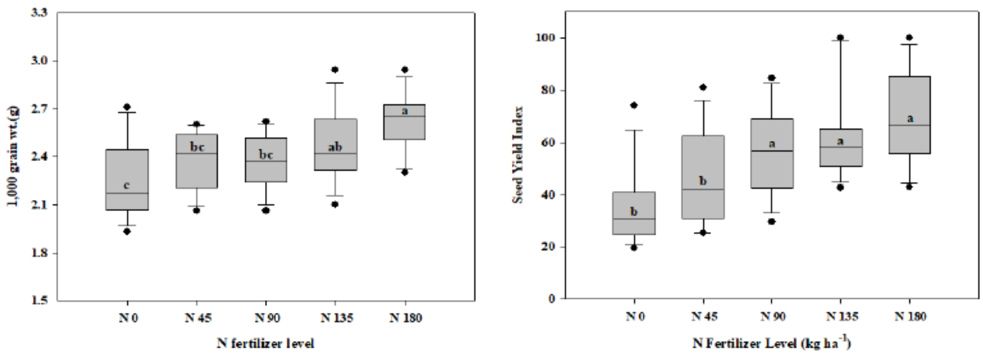

Fig. 1. 1,000 grain weight5 (Left) and Yield Index (Right) of Italian ryegrass seed as affected by nitrogen fertilizer levels in Saemangeum reclaimed tidal land.

KING COCONUT HUSK: A SOURCE OF POTASSIUM FOR COCONUT PLANTATIONS

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ABSTRACT

The most of highly weathered soils in the tropics are very low in potassium and heavily depend on the fertilizers for potassium. As organic fertilizers are lack in potassium (K), inadequate supply of K has become a problem in organic coconut cultivation. King coconut (*Cocos nucifera* var. aurantiaca) is popular as a healthy, natural beverage. Once tender nut water is extracted the husk with immature shell is considered as a waste material with poor economic value. A field experiment was conducted in a three-year old coconut plantation in the Intermediate Zone of Sri Lanka, to evaluate the nutrient supplying potential (against commonly used K fertilizers) of a product made from tender king coconut husk (TKCH) incinerated in a kiln. The treatments were, No Fertilizer (T1), Young Palm mixture consist of mineral Fertilizers-muriate of potash as K source (T2), Poultry manure + TKCH (T3), Poultry manure + Sulphate of potash (T4) and they were organized in a Randomly Complete Block Design (RCBD) with 3 replicates. The soil type of the experimental site is classified as, Aquic Quartzipsamments, uncoated sandy, non-calcareous. The response of treatments on soil and leaf nutrient status was evaluated by analysing soil and leaf samples collected six months after treatment application for one year. The K content of TKCH was 13.5% and pH was 9.4. The results showed similar trend in both samplings. The soil pH increased significantly to 6.0 in the T3 compared to all other treatments, and it has reached a favourable pH range for coconut. There was no significant difference among the treatments in soil N, leaf N and leaf K levels among the treatments, except with the control. The leaf N levels were ranged from 1.94 to 2.15% while the leaf K was ranged from 1.4 to 1.65% both nutrients were within the sufficient ranges. This indicates that the replacement of K source by TKCH has been able to supply K to a similar level of mineral fertilizers. Significantly high soil K content (0.44 meq/100 g) was observed in T3 compared to T1 (0.21 meq/100 g) and T2 (0.24 meq/100 g). The present study reveals that the incinerated tender king coconut husk has a potential to be used as a K supplement source with organic manure which are low in potassium.

Keywords: Organic Coconut; Soil Nutrients; Soil Potassium

Application of an enriched stable isotope tracer to wet-direct seeded rice cultivation: plant incorporation of seed coating-derived molybdenum

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Abstract

Enriched stable isotopes are indispensable tools for researchers studying biological systems. These isotopes have been used to study nutrient uptake and translocation in plants (Takano et al. 2002, Ueno et al. 2005, Kawasaki et al. 2004, 2005, Mori et al. 2009 a,b, 2011). However, there are few reports on the application of stable isotope tracers in field cultivation or pot experiments. Among the systems for cultivating rice (*Oryza sativa* L.), the direct seeding method is preferred over the seedling transplant method due to lower labor and time requirements. However, there has been low uptake of this technique in Japan due to poor seedling emergence and establishment. Recently, rice seedling emergence and establishment have been improved by adding a molybdenum (Mo) coating to rice seeds (Hara 2013). Although Mo is an essential element in plant growth, it is not yet clear whether the Mo derived from the coating of the seeds accumulates in the soil and plants during wet-direct seeded rice cultivation. Therefore, in the present study, we evaluated the accumulation of this element in soil and plants using an enriched stable isotope, Mo^{97} (96.6%). We produced three types of rice seeds in different cultivars (cvs. Koshihikari and Tachisuzuka for whole crop silage): seeds with no Mo coating, seeds with a low-Mo coating (approximately 0.03 mol kg^{-1} Mo) and seeds with a high-Mo coating (0.17 mol kg^{-1} Mo). These seeds were directly sown into the paddy field. We then examined the seedling establishment in this experiment and analyzed the Mo^{97} content in the soil and in each part of the plants using ICP-MS. The Mo^{97} content derived from the rice seed coating was calculated based on the natural isotope ratio of Mo^{97} and Mo^{98}. The seedling establishment rates of Koshihikari were higher than those of Tachisuzuka in the field experiment, and seedling establishment rates in both cultivars were improved with increased Mo in the rice seed coating. In the soil and rice plants, the accumulation of Mo^{97} derived from the coating was higher following the high-Mo coating treatment than in the low Mo coating treatment. The Mo^{97} content in the soil was approximately 1–3 μg kg^{-1} with the low-Mo coating treatment and 8–10 μg kg^{-1} with the high-Mo coating treatment. The Mo^{97} content of straw and grain with the low-Mo coating treatment was approximately 0.2–0.25 mg kg^{-1} and 0.05 mg kg^{-1}, respectively, and the levels with the high-Mo coating treatment were approximately 1.4 mg kg^{-1} and 0.3–0.5 mg kg^{-1}, respectively. Mo accumulation in the soil and rice plants was negligible in the low-Mo coating treatment, and barely detectable in the high-Mo coating treatment. Our results indicate that enriched stable isotope labeling can be used to demonstrate that elements present in seed coatings can accumulate in rice plant tissues. These results also suggest that Mo is unlikely to accumulate in soil or in rice plants, even after several years.

Key words**:** wet-direct seeded rice, stable isotopes, natural isotope ratio, molybdenum

Transformation of Phosphorus Species in Sediments under Aerobic and Anaerobic Environment with Various Water Salinity

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Abstract

Phosphorus (P) is an essential macromineral for plant growth, but the excessive application of P fertilizer will cause a large amount of phosphate fertilizer in agricultural land to be polluted due to scouring or runoff into rivers and oceans. Moreover, the Phosphorus storage is only sufficient for a few decades. The sampling sites used in this study were in wetland, through aerobic and anaerobic incubation experiments to understand the changes in species under different salt concentrations in water, while simulating the transformation of P in agricultural land and ocean transmission. In the incubation experiment, it was proved that Fe-P to increase the inorganic phosphorus in higher salinity. After P *K*-edge X-ray absorption spectroscopy is analyzed by LCF, the ratio of Fe-P and the extraction results can echo each other. In an anaerobic environment, the concentration of phosphorus will increase relative to the decrease in Eh. Mainly because $Fe^{3+}$is reduced to Fe^{2+} by redox reaction, releasing phosphate of iron (H) oxide. At the same time, the S *K*-edge X-ray absorption spectroscopy results show that the sulfide strength of the high oxidation valence increases due to the addition of the salt concentration to the sediment. Based on the above experimental results, it is known that in the future, the solubility of soil PP can be predicted in agricultural land and local farmers can be assisted to reduce unnecessary P fertilizer to prevent excessive P in water and produce water pollution.

Effects of Tillage Methods on main fertility characteristics of chernozem soil and maize yield

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Abstract:Reasonable tillage mode is a necessary measure to maintain the sustainable development of agriculture. In order to reveal the effects of different tillage methods on the main fertility characteristics of chernozem soil and maize yield, five tillage methods were set up in this study, including Rotary tillage (RT), Subsoiling tillage (ST), No-tillage (NT), Deep ploughing (DP) and Deep ploughing straw returning (DPS). Physical properties such as soil bulk density, water content, water-stable aggregates, chemical properties such as nitrogen, potassium, organic matter in 0-60 cm soil layer at different growth stages of maize and maize yield were analyzed. The results showed that soil bulk density increased by 4.7% and 3.8% for NT and ST treatments, and decreased by 3.4% and 2.6% for DP and DPS treatments, compared with RT treatments. The field water holding capacity of NT treatment was 2.7% lower than that of RT, ST and RT were similar, while DP and DPS treatment were 8.6% and 7.0% higher than RT, respectively ($p < 0.05$). The average moisture content of RT treatment was the lowest, and the increments of NT, ST, DP and DPS were 1.3%, 4.4%, 8.7% and 14.6%, respectively. DP and DPS treatment increased significantly. The content of soil aggregate structure (>0.25mm) was the highest for the DP treatment at the early stage of tillage, followed by DPS and NT at the later stage of tillage. And the content of soil aggregate for the DPS treatmet was the highest. The content of organic matter in NT and DPS increased by 4.2% and 1.1% respectively compared with RT. While ST and DP decreased slightly compared with RT. But the difference was not significant, indicating that reducing soil disturbance and straw returning had obvious effects on improving organic matter. The content of alkali-hydrolyzed nitrogen was the highest in RT, and decreased by 6.8% - 12.9% for other treatments. Compared with RT treatment, ST and DPS yields decreased by 7.4% and 3.3%, NT and DP increased by 2.3% and 7.8%, respectively. In conclusion, although NT has the potential to improve soil structure and organic matter, the effect of NT is not significant. DP and DPS have good fertility characteristics under the experimental conditions, and DP is a farming method with both soil fertility and yield increasing effect.

Key word：tillage pattern; black Calcium soil; fertility characteristics; maize yield

Effect of Earthworm Activity on Growth of Komatsuna and Nitrogen Dynamics by Using ^{15}N-Labeled White Clover

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Abstract
Earthworm is a major soil macro animal and well-studied that it has important roles in agricultural ecosystem such as decomposing organic matter, forming soil structure, and improving plant growth. However, there are few studies on nutrient dynamics such as nitrogen (N) through earthworm activity. In greenhouse, we cultivated Japanese mustard spinach (*Brassica rapa* var. *perviridis*, Komatsuna) in the soil applied with ^{15}N labeled white clover and earthworms to evaluate the effect of earthworm on Komatsuna growth and nutrient dynamics such as N. In 2017 spring, 1/5000a Wagner pot filled with 3.5kg sandy soil was applied with ^{15}N-labeled white clover incorporating into soil (GIE) or placing on the surface of the soil (GSE), then applied with 7 earthworms (*Metaphire californica*). As a control without earthworms, we set the treatments applying white clover incorporating into the soil (GI) or placing on the surface of the soil (GS), chemical fertilizer treatment (F), and no applied treatment (C). The N rate was 20 gN m^{-2} for the all treatments except C. The N uptake index (plant height × leaf number × SPAD value) was higher in GIE and GSE than GI and GS. At harvest, the dry yield of Komatsuna shoot was 23% higher in GIE than GI significantly, and 4% higher in GSE than GS. Root dry weight in GSE was also 35% higher than GS significantly. Shoot N uptake was 15% higher in GIE than GI, and 29% significantly higher in GSE than GS (Fig. 1). Root N uptake was also 60% significantly higher in GSE than GS. N recovery from the white clover was 5% higher in GIE than GI, and 7% higher in GSE than GS (Fig. 2). Therefore, it was considered that the earthworms stimulated the decomposition of white clover and N release, and increased the Komatsuna growth and N uptake.

Key words: Earthworm, Japanese mustard spinach (Komatsuna), N dynamics, ^{15}N tracer, white clover

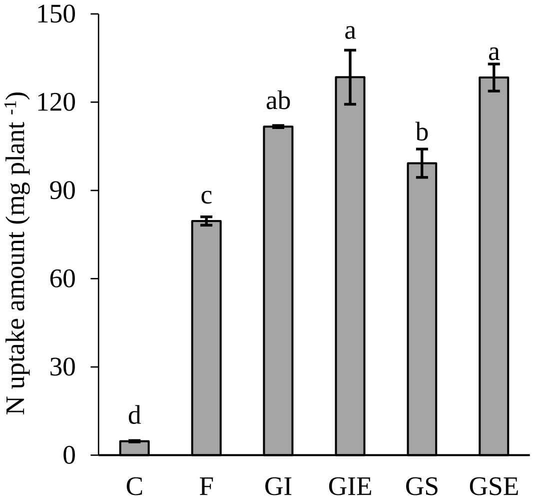

Fig. 1. Nitrogen uptake by Komatsuna grown in the soil applied with/without earthworms.
Error bars shows standard error. Different letters indicate significant difference between treatments (P < 0.05).

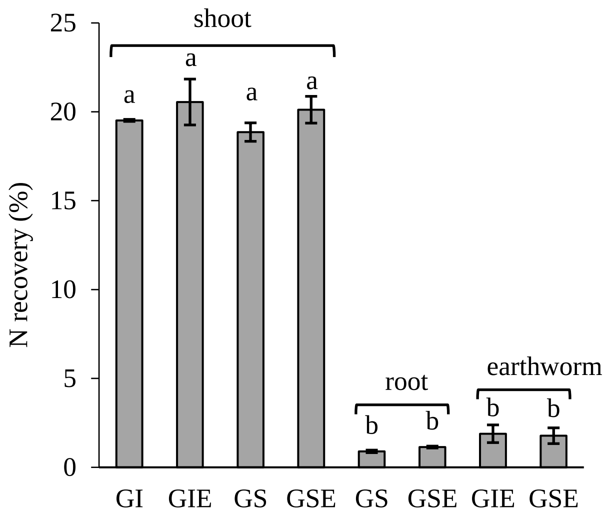

Fig. 2. Recovery rate of nitrogen from ^{15}N-labeled white clover.
N recovery = (N taken up from clover (mg pot $^{-1}$) / Applied N from clover (mg pot $^{-1}$))×100
Error bars show standard error. Different letters indicate significant difference between treatments (P < 0.05).

The research review of soil ecosystem services

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Abstract

Recently, there is a growing interest in agricultural public service function. Studies on soil ecosystem services in addition to its agricultural multi-functionality are underway. Ecosystem services and agricultural multi-functionality have a common cause called soil. To extend the concept, scope, and context of agricultural public services, it can be extended on the basis of soil functions. Therefore, the results of ecosystem services research related to soil are summarized as follows. Recently, ecosystem services are classified into four categories. Ecosystem services of FAO are divided into provisioning services, regulating services, supporting services, and cultural services. The provisioning services included crop production and water resource. Regulating services are soil related functions such as carbon sequestration, waste treatment, water purification, flood control, erosion prevention, and nutrient supply. Support services are biodiversity functions. Ecosystem services can be divided into annual value and total asset value. The nutrient content function and carbon sequestration function can be evaluated at annual value, and nutrient content and carbon stock assessment can be evaluated in total. It sugest ecosystem services addition function of soil. Among the additional functions are the energy supply function through biomass, the rare earth supply, the production of medicines, and the remove pollutant such as fine dust. Regulating services include drought resistance and soil nitrogen fixation.

Key words: Soil, Ecosystem services, review

Slag silicate fertilizer amendment decreases microbial modulation of carbon storage in submerged rice cropping systems

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Abstract
Silicon (Si) fertilization is essential to improve agronomic performance of rice. Rice is a high Si accumulating plant. Intensive rice cultivation to meet the growing food demand chronically depletes Si from soil, thus degrades soil quality and decreases the crop yield. This necessitates slag silicate fertilizer (SSF) amendment in rice cropping systems for sustainable rice cultivation. With the rapid growth of industrialization, the higher volume of byproducts (slag) generated from iron/steel production, which are rich in Si and other fertilizer components, draw attention to the need for its recycling in an increasingly efficient way, and in this contest the use of slag in agriculture, is an imperative way for sustainable development. Our understanding of the effects of the SSF amendment on soil carbon storage in rice cropping system is, however, elusive. Silicon fertilization has been proven to increase plant photosynthesis (trough enhanced mesophyll conductance) and likely increases soil labile carbon allocation through root exudates. According to the substrate regulation principle, SOC decomposition would increase as labile SOC increases, but observations of SOC decomposition under different fertilization do not always support this hypothesis. This discrepancy could be in part, due to changes in microbial communities and their functional potential related to carbon storage. This study aimed to reveal microbial modulation of carbon accrual following SSF amendment in rice cropping systems. We investigated the short-term SSF amendment (2.0 Mg ha^{-1}) impacts on microbial community structure, functional genes, CO_2 emissions, hydrolytic and oxidase enzyme activities, and soil biochemical changes in Indica and Japonica rice. Results revealed that the SSF amendment significantly increased bacterial and fungal richness and diversity, abundance of genes involved in degradation of starch, hemicelluloses, cellulose, and pectin, hydrolytic and oxidative enzyme activities, and communlative CO_2 emissions in rice paddies, irrespective of the cultivar variation.The increase in microbial communities, both hydrolytic and oxidative enzyme activities, and key functional gene for C degradation was related to higher SOC decomposition, indicating the key mechanisms driving for potential SOC decrease in submerged paddy soil subjected to SSF amendment. We conclude that the SSF amendment in submerged rice cropping system could have negative feedback impacts on soil C storage.

Keywords: Microbial community; functional gene; enzyme activity; CO_2 emission.

Early dead ripe of bread wheat (*Triticum aestivum*) by a soil inhabiting fungus, *Ophiosphaerella korrae*

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Abstract

Ripening disorder was recognized on bread wheat [*Triticum aestivum* L.] grown in trial fields of our center in May 2017. Spikes of the affected plants bleached to turn whitish brown to white, resulted in early death. When a cultivar of barley [*Hordeum vulgare* L.] was sowed with root segments of the affected plants in pots in December 2017, ripening disorder occurred. Dark brown lesions had been formed on stem bases and roots of the plants suffered from ripening disorder. A filamentous fungus was frequently isolated from the lesions under moist conditions. Its representative isolate, MAFF150117, obtained by single-hyphal isolation formed dark grayish brown colonies on potato dextrose agar in the dark at 5–30°C with maximum growth of 2.5 mm/day at 23–25°C. No sclerotia and spores were found. On the basis of a sequence analysis of the ribosomal DNA internal transcribed spacer region (ITS) and the translation elongation factor 1 gene-coding region (TEF), MAFF150117 had 99–100% sequence similarities with data in the DDBJ/EMBL/GenBank databases for the following three strains identified as *Ophiosphaerella korrae* (J. Walker & A.M. Sm. bis) Shoemaker & C.E. Babc. [Syn. *Leptosphaeria korrae* J. Walker & A.M. Sm. bis] (Shoemaker and Babcock, 1989): strain ATCC56289 [ITS: KC848509 (99%), TEF: KC848515 (99%)], strain nrcc13d [ITS: KP690985 (100%), TEF: KP691004 (99%)] and strain nrcc13y [ITS: KP690984 (100%), TEF: KP691005 (99%)] (Flores et al., 2017). The DNA sequence data of MAFF150117 were registered in the DNA databases as accessions LC440365 and LC440366 for TEF and ITS, respectively. From these results, MAFF150117 was identified as *O. korrae*. When a bread wheat cultivar was grown in pots in artificial climate chambers after being sowed with culture discs (6 mm in diameter) of MAFF150117 on synthetic nutrient agar (SNA) (1 disc per seed), ripening disorder with dark brown lesions on stem bases and roots was reproduced. Control plants simultaneously treated with aseptic SNA discs had no symptom. The isolate was consistently re-isolated from diseased plants, but not from healthy controls, demonstrating that the isolate was pathogenic to bread wheat. There is no previous report describing this disease. We named the present disease "early dead ripe of bread wheat" as a new disease. *Ophiosphaerella korrae* inhabits not only plants but also soils. We will investigate its emergent ecology in the future.

***Key words*:** Soil fungus; *Ophiosphaerella korrae*; plant disease; early dead ripe; bread wheat; *Triticum aestivum*.

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Aluminum concentration of plants growing in highly acidic solfatara fields

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Abstract

Aluminum toxicity is one of the major factors that inhibit plant growth in acidic soils. In acidic soils (pH < 5.0), high concentration of Al^{3+} strongly inhibits root growth, and affects nutrient and water uptake of plants. Solfatara fields, areas surrounding fumaroles (volcanic vents) near the hot springs or volcanoes, are characterized by severe environmental conditions such as low soil pH (< 4.0) and high Al^{3+} concentration. *Fimbristylis dichotoma* subsp. *podocarpa* and *Miscanthus sinensis* are the dominant plant species in solfatara fields in Kyushu, Western Japan (Yamamoto *et al.* 2018). In order to clarify the mechanism by which the plants tolerate to high aluminum condition, we analyzed the aluminum concentrations of *F. dichotoma* and *M. sinensis* collected from four solfatara fields in Kyushu. The aluminum content of *F. dichotoma* and *M. sinensis* determined by ICP-MS, ranged from 0.05 to 2.12 mg-Al g^{-1} DW and 0.03 to 0.87 mg-Al g^{-1} DW respectively. These values were much lower than those of Al accumulator plants reported in earlier studies (more than 1000 mg-Al kg^{-1}; Chenery 1948). The results indicate that these plants are non-Al accumulators, having any physiological strategies to exclude Al^{3+} in the rhizosphere. Our result also indicated aluminum concentration was higher in *F. dichotoma* than in *M. sinensis*, which suggests that *F. dichotoma* has higher tolerance to aluminum toxicity in plant cell.

Key words: Acidic soil; Aluminum tolerance; *Fimbristylis*; Volcanic vent; Solfatara fields.

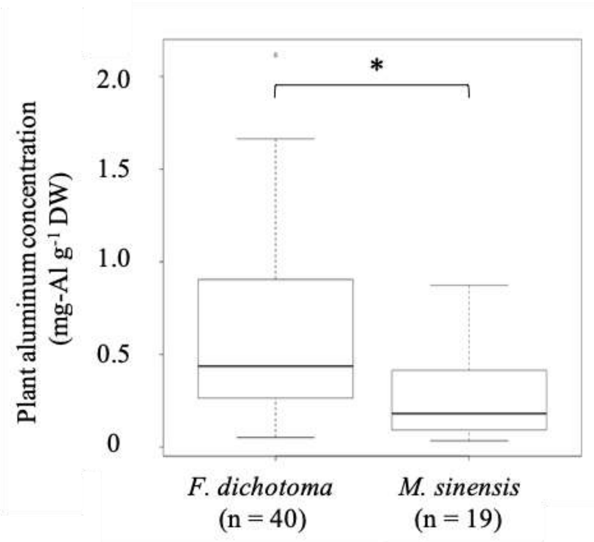

Fig. 1. Leaf aluminum concentration of the solfatara plants *F.dichotoma* and *M. sinensis*.
DW, dry weight. *$P < 0.01$ (Wilcoxon rank sum test)

Quality assessment of the soils from seven parks in Seoul

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Abstract
Accelerated urbanization due to rapid urban sprawl is common in most of the countries these days. The quality of the environment and ecosystem is deteriorated with urbanization. As a result, interest on urban environment has increased. Urban parks can build urban ecosystems and positively affect the urban environment. Soils in urban parks can help them perform their role properly through proper management. This study was carried out to assess the quality of the soils in seven parks in Seoul using physical, chemical and biological characteristics. Soils from seven parks were sampled at 87 points in mid-May 2019. Soil hardness was also measured at the time of soil sampling. The bait-lamina sticks were installed to confirm the in-situ feeding activity of the microfauna in the soil at 60 out of 87 sampling points. The installed bait-lamina sticks were collected a week later. Air dry soils were used to determine pH, organic matter content, total nitrogen content, available phosphorus content and bulk density. Soil respiration and soil enzyme activities were measured with wet soil. Bait-lamina test was completed by counting the degree of bait loss in each hole as 0%, 50%, and 100%. Organic matter content was the highest in Amsa ecology park, followed by Gildong ecological park, whereas it was low in Seoul forest and World cup park. Bulk density and surface hardness were lower in three ecological parks (Amsa, Gildong, and Achasan) than those in the rest. Unlike the urban soils in general, the pH of the soils from all seven parks were in the range of 5.93-6.72 with 6.33 in the average. Enzyme activities showed high values in Yangjae citizen’s forests and Olympic parks and low in Amsa ecological parks. For soil respiration, soils from Yangjae citizen's forest, Olympic park and Gildong ecological park were higher than the other four parks. The feeding activities of the soils were the highest in Yangjae citizen’s Forest followed by Amsa ecological park, Olympic park, World cup park, Olympic park, Seoul forest, Gildong ecological park, and Amsa ecological park. The biological activities did not increase with increasing organic matter content, which was the opposite of the expectation. It seems that the influence of human activities and management practices affected biological characteristics.

Key words: urban soil, park soil, biological activity

Environmental changes in the vicinity of wet direct-seeded rice under different soil conditions with or without organic matter - Effect of oxygen generating coating material on the 'spermosphere'

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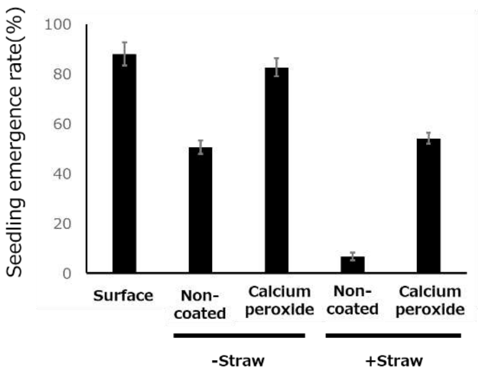
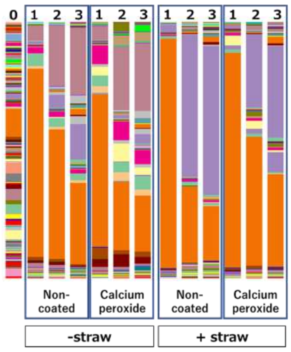
Abstract
The spermosphere is the zone surrounding seeds where interactions between the soil, microbial communities, and germinating seeds occur. The environmental changes in this zone can strongly influence seed gemination and coleoptile elongation of plants. Despite its strong effect on the future development of plants, the spermosphere remains little studied. Among the systems for cultivating rice (*Oryza sativa* L.), the direct seeding method is becoming more popular than the seedling transplant method worldwide because the former requires less labor and time. However, this cultivation technique has seen limited use in Japan owing to poor seed germination and seedling emergence. This is typically considered to be caused by several stresses produced by a drastic decrease in the soil oxidation-reduction potential around the direct-seeded rice under submerged conditions. In addition, several studies indicated that poor seed germination and seedling emergence frequently occurred under submerged condition with organic material such as straw. However, data are lacking on the environmental changes in the soil (spermosphere) around the direct-seeded rice under submerged conditions with organic matter. Elucidation of environmental changes in the spermosphere of wet direct-seeded rice might provide important information for stable seedling establishment. In this study, the effect of calcium peroxide-coating on bacterial profiles in the soil around direct-seeded rice was examined under submerged soil condition with or without rice straw application. Under submerged soil condition without straw application, seedling emergence rates of non-coated and calcium peroxide-coated seeds were approximately 47% and 87%, respectively. Under submerged soil condition with straw application, seedling emergence rates of seeds without coating and with calcium peroxide coating were approximately 10% and 43%, respectively. Although calcium peroxide improved seedling emergence regardless of straw application, compared to non-coated seeds, coexistence of straw reduced the positive effect of calcium peroxide for stable seedling emergence. After the submersion treatment, bacterial profiles were remarkably changed from anaerobic bacteria to aerobic bacteria such as *Bacillus*, *Symbiobacterium*, and *Clostridium*. Especially with straw application, the relative abundances of *Clostridium* apparently increased with time. In addition, the relative abundances of *Clostridium* were significantly higher in non-coated seeds than in calcium peroxide-coated seeds. Calcium peroxide-coating on rice seeds tended to suppress environmental changes in the spermosphere such as the relative abundances of *Clostridium* in the no straw treatment. However, the positive effect of calcium peroxide in the spermosphere coexisting with straw was limited until 1 day, suggesting that reduction in seedling emergence in calcium peroxide-coated seeds under soil conditions with straw was ascribed to the limited effect of calcium peroxide in the spermosphere.





Key words**:** spermosphere, wet-direct seeding, seedling emergence, bacterial profiles, calcium peroxide

Isolation and characterization of rhizobia associated with peanut (*Arachis hypogaea* L.)

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Abstract
Peanut (*Arachis hypogaea* L.), a kind of grain crop with economic importance can form symbiotic relationship with rhizobia and gains benefits from nitrogen fixing bacteria. Exploration of root-nodulating rhizobia will be promising and the superior isolates can be used as bioinoculant when cultivating peanut. In the present study yeast extract mannitol agar was used to obtain isolates from root nodules of peanut Tainan NO. 9 grown in fields. Bacterial identification was carried out based on 16S rDNA sequence analysis, and traits regarding plant growth promotion were also determined. Several isolates were further used as inoculants in peanut cultivation under vermiculite-containing flask experiment. Isolates affiliated with not only well-known rhizobial genera such as *Bradyrhizobium* and *Rhizobium*, but *Bacillus*, *Burkholderia*, *Klebsiella*, and *Leifsonia* were found in the root nodules of peanut. A wide range of bacterial lineages which occupied classes including Alphaproteobacteria, Betaproteobacteria, Gammaproteobacteria, Actinobacteria and Bacilli were demonstrated in root nodules. Among the tested rhizobia, five strains possessed apparent free-living nitrogen fixing capability, and *Bradyrhizobium subterraneum* VWNS1 was shown with the highest nitrogen fixing activity (5.49 nmol/tube x hr) after seven days of cultivation. Clear zone around colonies observed on tricalcium phosphate agar plate was recorded only in one strain, while three strains namely *Rhizobium tropici* E4CF1, *Rhizobium tropici* E4CF2, and *Bradyrhizobium subterraneum* VWNS1 were able to produce more than 100 μg mL^{-1} soluble phosphate after five to seven days of cultivation. Besides, IAA production (1.47 to 42.5 μg/mL) were recorded in all the tested eight strains. Seeds of peanut Tainan NO.9 purchased from three regions in Taiwan were inoculated with various rhizobial strains (*Rhizobium tropici* E4CF1, *Bradyrhizobium ottawaense* A1ES1, *Bradyrhizobium subterraneum* VWNS1 and a reference strain namely *Bradyrhizobium diazoefficiens* BCRC 13528) separately, which demonstrated that formation of root nodules were observed in all the treatments when seeds from Changhua County were used. Either *Bradyrhizobium ottawaense* A1ES1 or *Bradyrhizobium subterraneum* VWNS1 was proved to share symbiotic relationship with peanut no matter which source of seeds were used. Besides, *Bradyrhizobium subterraneum* VWNS1 was demonstrated as the most favorable strain nodulating with peanut Tainan NO. 9.

Key words**:** Peanut; root-nodulating rhizobia; plant growth promotion.

Influence of various organic fertilizer amendment on rhizospheric and endophytic bacterial community structure and tomato growth

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Abstract
Organic fertilizers show effects of providing crop nutrients and improving soil properties. They are indispensable agricultural materials in organic farming system, and they are also rich in microbial community but rarely studied. This study aimed to investigate the influence of various organic fertilizer application on tomato rhizospheric and endophytic bacterial community structure and crop growth, to understand the bacterial composition associated with tomato growth. Tomato was planted in growth chamber and greenhouse, and plant source fertilizer (PSF), animal source fertilizer (ASF) and vermicompost (VC) were applied, respectively to explore carbon metabolic potential and community structure of tomato rhizospheric and endophytic bacteria under different treatments. Under both cultivation systems, the carbon metabolic potential of bacteria in rhizosphere or root interior were the highest in PSF treatment, followed by ASF and VC treatments. Dominant bacteria classes found in all cultivation systems were Alphaproteobacteria and Ktedonobacteria, while root interiors were dominated by Alphaproteobacteria. These bacterial groups were presumed to be the indigenous flora within the cultivated medium (peat). Compared with unfertilized control, PSF treatment increased the abundance of Gammaproteobacteria in the rhizosphere. Ktedonobacteria significantly reduced after ASF application, while VC treatment tended to increase Bacteroidia. In root interior Bacteroidia increased after PSF application, Alphaproteobacteria significantly increased after ASF application, while VC treatment tended to increase Bacteroidia and Planctomycetacia. Acidimicrobiia only appeared after application of VC. Both cultivation systems showed that there was no significant difference in the biomass of tomato under different organic fertilization. However, the biomass after treated with either PSF or ASF was higher than that treated with its sterilized material in growth chamber system. In contrast, the biomass after treated with either PSF or ASF was lower than that treated with its sterilized material in greenhouse system. Greenhouse which provided an open and variable system leaded to higher bacterial diversity and different influences of organic fertilizers or their sterilized materials on tomato growth. In conclusion, the cultivated medium (peat) provided a crucial role in determining the dominant bacteria in the rhizosphere or root interior of tomato. Application of PSF, ASF or VC caused variation in the proportion of specific flora, although there was no significant difference in plant biomass. Interactions between bacterial community structure and crop growth remain to be further studied.

***Key words*:** Organic fertilizer; rhizospheric and endophytic bacteria; tomato.

Exploration of root-associated bacteria from medicinal plant *Platycodon grandiflorum*

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Abstract
The present study was undertaken to explore root-associated bacteria from *Platycodon grandiflorum*, a medicinal plant commonly grown in East Asia. Isolates were obtained from either rhizosphere or root interior with various cultural media, and phylogenetic analysis were performed based on their 16S rDNA sequences. Considered for practical application, traits regarding plant growth promotion and niche adaptation were determined in several endophytic strains which were with less biosafety concern. Besides, effects of bacterial inoculation on seedlings and mature plant growth were evaluated. A total of 17 genera which encompassed more than 30 bacterial lineages were successfully retrieved from roots, while most of them have not been reported as *P. grandiflorum*-associated bacteria, especially for the non-negligible *Proteobacteria*. Although nitrogen fixing or phosphate solubilizing and indole acetic acid producing activities were recorded in all the selected strains, these strains were beneficial or detrimental to plant growth as evidenced by their influences on length of seedlings and biomass of mature plant. Among 4 endophytic *Rhizobium* species tested in the present study, a probably novel *Rhizobium* sp. BF-E16 which was more compatible to the non-leguminous medicinal plant *P. grandiflorum* was demonstrated. It is also proposed that other than plant growth promoting traits, characteristics such as plant constituent hydrolyzing activities might be taken into considerations and their roles are needed to be clarified when exploring plant growth promoting rhizobacteria.

***Key words*:** Root-associated bacteria; *Platycodon grandiflorum*; medicinal plant; plant growth promotion; plant constituent hydrolyzing activities.

Effects of oxygen releasing compound application and its application timing on arsenic accumulation in paddy rice grown in arsenic-elevated paddy soils

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Abstract

Inorganic arsenic (As) is a highly toxic and carcinogenic metalloid which widely distributed in the environment. There is a fact that the serious health risk to human through the intake of rice grain grown in As-contaminated paddy soil, due to the high mobility and bioavailability of As in flooding conditions. In this study, we attempted to use oxygen releasing compound (ORC, calcium peroxide) to supply the oxygen in flooded soil, and further avoid iron (Fe) oxides reductive dissolution, arsenate reduction and dissolution. Therefore, the objectives of this study were to investigate the effects of ORC application and its application timing on As accumulation in rice grains. Two geogenic As-elevated soils including Gd (high organic carbon (OC) and iron (Fe) oxides contents) and Ms (relatively low OC and Fe oxides contents) were collected, and both soils have two distinct levels of As expressed as H (high) and L (low). Two ORC application timing [booting stage (B) and the two weeks after flowering stage (F)] were adopted in this study. The results showed that the concentrations of As in root and brown rice of ORC treatments were significantly lower than control treatments in Gd-H and Gd-L soils with B treatment, and the magnitude of decrease of As in brown rice of B treatments were more than F treatments. However, it found that there was no significant difference in As concentration in rice plants between ORC and control treatments in Ms soils, predicting it mainly caused by the low contents of Fe oxides in these soils, and leading to the oxidized-As could not be easily adsorbed by soil minerals. Therefore, these results suggest that the application of ORC to high contents of OC and Fe oxides soils at boosting stage of paddy rice can effectively reduce As accumulation in rice grains.

Key words: arsenic, paddy rice, oxygen releasing compound, calcium peroxide, iron oxide

Cadmium distributions and physiological traits in the rice seedlings of two major Taiwan cultivars

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Abstract
Cadmium accumulation in paddy soil posing risk to the food safety of rice has been much concerned in Asia. Physiological understandings related to genotypic variation in Cd content of rice plant will be useful in selection or breeding of low-Cd rice genotypes. The objective of the present study is to investigate the genotypic variations in Cd tolerance and distribution in rice plant, which are associated with the physiological responses to Cd stress. Two paddy rice (*Oryza sativa* L.) cultivars, including one japonica type, Tainung 71 (TNG71), and one indica type, Taichung Sen 10 (TCS10), were used in the present study. The seeds of the rice cultivars were soaked in deionized water for a 36-h germination period in the dark and then transplanted in 10% modified Hoagland solution for an about 3-week growth to be with three leaves completely emerged. Uniformly grown seedlings were treated with 50μM $CdCl_2$ in hydroponics and a check was also conducted. After 4-day treatment, the root elongation and shoot extension of rice seedlings were measured for assessing the plant growth under Cd stress. The physiological traits, malondialdehyde (MDA), hydrogen peroxide (H_2O_2), superoxide dismutase (SOD), ascorbate peroxidase (APX), and abscisic acid (ABA), of Cd-treated rice seedlings were determined and the Cd concentrations in root and shoot were measured also. In the results, for both TCS10 and TNG71 cultivars, the shoot extensions of seedling were significantly reduced by 50 μM $CdCl_2$ treatment; however, there was not significant reduction in the root elongation. And the Cd concentrations in root were much higher than those in shoot. This revealed the Cd absorbed by rice plant would be preferentially accumulated in root rather than transferred into shoot. Owing to 50μM $CdCl_2$ treatment the oxidative statuses (i.e. MDA levels and H_2O_2 concentrations) were pronounced in root more than in shoot; the antioxidant enzymes activities (i.e. SOD and APX activities) in root were probably enhanced but those in shoot reduced. The enhanced SOD activities in root would convert more superoxide radicals to H_2O_2 and result in temperately enriched MDA levels. The enhanced APX activities in root would scavenge the H_2O_2 which was continuingly converted by SOD. Thus, no significant reduction in the root elongation of rice seedlings under the Cd stress may be related to the above physiological understandings. Nevertheless, the endogenous ABA accumulation was tending towards shoot rather than root. This would be corresponding to the Cd concentrations in root much higher than those in shoot, while ABA accumulation in shoot induced a reduction of transpiration. Overall the physiological traits in response to Cd stress were more pronounced in TNG71 than in TCS10.

***Key words*:** soil pollution; paddy rice; Cd tress; abscisic acid; antioxidation.

Arsenic Accumulation and Speciation in Rice Grains Influenced by Calcium Silicate Application and Rice Cultivars grown in As-Contaminated Paddy Fields

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Abstract
The accumulation of arsenic (As) in rice grain had posed a threat to food safety and human health. Previous research indicated that increasing concentration of silicic acid in soil solutions may alleviate the negative impacts of As on rice plants. However, some studies also found that silicic acid application can lead to an increase in As uptake by rice via competitive adsorption between arsenite (iAs^{III}) and silicate on the soil surface. Therefore, further clarification on the comprehensive effects of silicic acid applied on paddy field is necessary. One japonica cultivar (TK9) and an indica cultivar (TCS10) were used in this study, which planted in two As-contaminated paddy fields located at Minsyong (Ms) and Guandu Plain (Gd), Taiwan. Based on recommended application rate of Si (750 kg SiO_2 ha^{-1}), there are four calcium silicate application rates (0, 750, 1500, and 3000 kg SiO_2 ha^{-1}) used in this study. The results show that the As concentration in shoot and brown rice of two cultivars grown in Gd and Ms fields were decreased after Si application, and the extents of decrease of As accumulation in brown rice in Gd field was higher than Ms field. In addition, it was observed that the main As species in brown rice was iAs^{III} and DMA, and the proportion of iAs^{III} was higher than DMA. The results of the growth index show the shoot biomass and grain yield of two rice cultivars grown in Ms field under Si treatments have no significant growth inhibition. However, significant decrease in biomass is observed in Gd field, which may be resulted from As phytotoxicity. Based on these results, it suggests the Si application can reduce the As accumulation in brown rice, the extents of decrease were controlled by Si application rate, soil properties, and rice cultivars. Therefore, it needs to consider these factors when the application of Si fertilizer into As-contaminated paddy fields.

Key words: Paddy rice, Arsenic species, Silicic acid, Arsenic phytotoxicity, Field experiment

Variation in Cadmium Toxicity to the Seedlings among Weedy Red Rice Accessions and Rice Cultivars

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Abstract
The infestation of weedy red rice (WRR) in Taiwan paddy fields became severe increasingly in the past few years. Because of WRR's high levels of seed shattering and dormancy, it has been a problematic weed in rice cultivation. Both WRR and cultivated rice are classified under the same genus and species (*Oryza sativa* L.). However, WRR has a high morphological diversity and versatile environmental adaptability. WRR not only exhibits negative qualities such as undesirable cooked texture but also may confer resistance to heavy metal toxicity, as well as its higher tolerances to drought and salinity stress. If WRR has a higher ability to absorb heavy metals associated with its versatile environmental adaptability, the food safety risk to rice consumption may be increased by the infestation of WRR in potentially contaminated farms. The objective of this study was to investigate the variations in Cd tolerance and distribution in plant between WRR and cultivated rice. Ten Taiwan WRR populations, three US weedy rice accessions, and seven rice cultivars were used. Seeds of the rice varieties were collected and maintained by Taiwan Agricultural Research Institute. Uniformly grown seedlings were drawn up for hydroponics with Cd treatments of 2.5, 5, 10, and 25 μM Cd for 7 days. The plant heights and the Cd concentrations in shoot and root were measured, and then the effective concentration of Cd resulting 50% growth inhibition in plant height (EC50), bio-concentration factor (BCF), translocation factor (TF) for Cd in rice plant were calculated. In the results, Taiwan WRR accessions 'W211', 'W303', and 'W60' possessed Cd tolerance superior to other used weedy rice accessions. Their EC50 values were higher than 40 μM Cd, that revealed within the range of Cd treatments there was not significant growth inhibition and would adapt to complicated survival environments. The Cd concentrations in shoot and root for all used WRR were similar to those for indica rice cultivars but higher than those for japonica rice cultivars. In addition, there was a great variation in BCF for all used WRR; one didn't find any pattern in relation to their Cd tolerances. Nevertheless, the most Cd-tolerant WRR accessions 'W211', 'W303', and 'W60' presented relatively low TF values.

Key words**:** Paddy rice; heavy metals; Cd stress; bio-accumulation; safety of rice consumption.

Arsenic accumulation in rice grains of major Taiwan rice cultivars

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Abstract
Arsenic (As) is a well-known human carcinogen and widely distributed in soil and water environments. Rice consumption is regarded as a major route of As exposure to human for the population worldwide. Last year, the permissible level for inorganic As in rice grain has been adopted by Taiwan's Ministry of Health and Welfare. However, limited information is existed on the As accumulation in rice grains of different rice cultivars in Taiwan. To understand the exposure risk of As caused by rice consumption, the objective of this study is to investigate the As accumulation in rice grains (brown rice) of major Taiwan rice cultivars. Twelve rice cultivars mainly planted in Taiwan including 3 *Indica* cultivars and 9 *Japonica* cultivars were used in this study, which planted in two natural As-rich paddy fields located in Minsyong (Ms) and Guandu Plain (Gd). The As concentrations in soils of Ms and Gd fields are 31.9 and 140.5 mg kg^{-1}, respectively. The results indicated that there was significant difference in As concentrations in brown rice among different rice cultivars in two fields, and those in brown rice of Japonica cultivars were higher than Indica cultivars. The *Japonica* cultivar TCS 17 and *Indica* cultivar TK9 had the lowest and highest As concentrations in brown rice among 12 cultivars used in this study. In addition, the concentration of As in Gd soils was about 5 times higher than those in Ms soils, but the As concentrations in brown rice of Gd soils (0.42 mg kg^{-1}) was slightly higher than Ms soils (0.25 mg kg^{-1}), it revealed that the As accumulation in rice grains might be also affected by water management and the other soil properties such as the contents of organic matter and iron oxides. This result suggests low As accumulation of rice selected from this study can be recommended to be grown in the As-rich soils.

***Key words*:** arsenic; paddy rice; rice grain; rice cultivar; paddy soil.

Effect of Bokashi Fertilizer and Slag Fertilizer on Methane Emission from Paddy Soil

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Abstract
The use of bokashi fertilizer may increase soil fertility but it probably also increases methane emission from paddy fields. While slag fertilizer contains much iron and iron may suppress methane emission. So, this research aims to clarify the effect of these fertilizers on methane emission. Two research was conducted, namely incubation experiment and field experiment. The incubation experiment showed that slag fertilizer increases methane emission. Because slag increased soil pH, and alkali decomposed organic matters and increased methane emission. The field experiment showed also increase of methane emission. This may be caused by extraordinary weather. Result of these two experiments demonstrate that it is important to use slag fertilizer appropriately and high temperature conditions may affect some properties and increase methane emission.

Key words**:** paddy; methane; slag; organic fertilizer

Compost nitrogen applied to paddy fields can be utilized as a decade-long source of the nitrogen for rice plants

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Abstract

The effective use of compost made from livestock manure and crop residues can contribute to resource recycling in agriculture and sustainable crop production. It is well known that the application of compost can increase the productivity of paddy rice as well as the fertility of the soil. Some studies examined the effect of nitrogen (N) originating from ^{15}N-labeled compost in rice cultivation for several years and showed that the N from compost was taken up by rice plants for several years after the initial application (e.g., Nishida et al. 2008). The results of those studies suggest that the N in compost applied to paddy fields can be the N source for rice plants for a longer period than those shown in the studies, i.e., a maximum of 5 years. However, to the best of our knowledge, the fate of N from compost applied to paddy fields for a period of over a decade has not been reported. Thus, the long-term effect of the N in compost on paddy rice remains unclear. We investigated the fate of N from compost applied to a paddy field using ^{15}N-labeled compost for more than a decade.

Two types of ^{15}N-labeled compost, namely, cattle manure compost (^{15}N-CMC) and rice straw compost (^{15}N-RSC) were used for a field experiment in the Tohoku Agricultural Research Center, National Agriculture and Food Research Organization (TARC, NARO) located in Daisen, Akita, Japan. ^{15}N-CMC and ^{15}N-RSC were applied to micro-plots installed in the paddy field before the crop season in 2002. Then rice plants were cultivated in the micro-plots. From 2003 until 2016, unlabeled CMC and RSC were applied and rice plants were cultivated in the micro-plots in the same way as in the first crop season. Each year, rice plant and soil samples were collected at the maturity stage and the ^{15}N content was analyzed. Thus, the fates of N from ^{15}N-CMC and ^{15}N-RSC applied to a paddy field in 2002 were observed for 15 years (crop seasons).

Nitrogen derived from both composts was taken up by rice plants over 15 years (crop seasons). The recovery efficiency of the rice plants in the first crop season was higher for RSC than for CMC. The two rates of plant uptake became similar after the third crop season and tended to gradually decrease. Although the recovery efficiencies in each crop season were low, the total recovery efficiency during 15 crop seasons was about 30% for both composts. The remaining portions of the compost N in the soil were 80%–90% after the first crop season and gradually decreased for both composts. Even after the 15th crop season, the N derived from compost remained in the soil at the rate of 30%–35%. Unrecovered portions of the compost N were 35%–40% after the 15th crop season. The unrecovered portion represents the loss of compost N. Temporal changes in accumulated recovery efficiencies were well explained by a first-order model. According to the model, cumulative recovery efficiencies for 50 crop seasons were estimated at about 35% for both composts. Similarly, the remaining portions of the compost N were estimated at about 15%–20% after the 50th crop season. Thus, using the ^{15}N-labeling technique, it was verified that N derived from compost applied to a paddy field can be the N source for rice plants for more than a decade.

***Key words*:** compost; ^{15}N; paddy field; rice

Reference

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Effects of controlled-release fertilizers on nitrogen use efficiency in rice (*Oryza sativa* L.) cultivation

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Abstract

Fertilizer is essential to increase yield of crops growing and the yield. Crops, however, take only 30~60% of the applied N-fertilizer in the soil. Fertilizer components that have not been taken by the crops may be lost by leaching, denitrification and volatilization. Leaching of nitrogen from soils can also lead to secondary pollution of the surrounding environment. For this reason, there have been many studies to increase the N use efficiency by using controlled-release fertilizers (CRFs). This study was conducted to investigate the effect of CRF on N use efficiency of rice. Field experiments were carried out by using conventional compound fertilizer (21-17-17) and CRF (30-6-6) in rice paddy at Pocheon-si. A late maturing variety, Samkwang was used for this experiment. The four fertilizer treatments used were: conventional fertilization (CF, N: 11 kg/10a); CRF-band application (CRF-B, N: 9 kg/10a); CRF-top dressing (CRF-T, N: 10.5 kg/10a); and CRF-whole-layer application (CRF-W, N: 12 kg/10a). The NH_4-N in soils were monitored at the 15th, 30th, 45th, 60th, 90th, and 120th day after transplanting. After harvest, crop growth analysis such as shoot length, number of tillers, yield and nitrogen content of polished rice were determined. The concentration of NH_4-N in CF treatment on the 15th, 30th, and 45th day after transplanting were higher than those in CRF treatments. The concentration of NH_4-N in soil for CRF-W was higher than that for CRF-B and CRF-T at the 15th, 30th, 45th and 60th days after transplanting. Result of crop growth analysis showed that shoot length, number of tillers and yield of CRF treatments were higher than those of CF. The nitrogen content of polished rice was the highest at CF (0.92%), followed by CRF-T (0.86%), CRF-W (0.81%) and CRF-B (0.78%). Nitrogen use efficiencies of CRF-T and CRF-B were significantly higher than those CF and CRF-W showing the highest nitrogen use efficiency of 102.1% in CRF-B. Results of the correlation analysis showed that the number of tillers and yield had significantly negative relations with the concentration of NH_4-N in the soil on the 15th days after transplanting. In conclusion, CRF-band application would be beneficial not only in the reduction of fertilizer usage and environmental load but also in increasing rice yield.

Key words: controlled-release fertilizer (CRF); Fertilizer; Band application, Nitrogen use efficiency

Comparison of bacterial communities among submerged rice soils collected from several regions in Japan

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Abstract

In organic rice farming, which is recently becoming more popular, various organic materials are incorporated into rice fields to maintain soil fertilities. However, how organic agricultural practices affect on soil bacterial communities has not been understood well. Recently, the authors elucidated soil bacterial community compositions and temporal changes in organic paddy fields by 16S rRNA gene amplicon sequencing analysis using a high-throughput next generation sequencer (Suzuki *et al.*, 2019). The results revealed that the bacterial community compositions in organic and neighboring conventional paddy fields were mostly similar at transplanting despite the differences in field management. Gradual changes were, then, observed in the bacterial community during the rice growth period, meaning that the bacterial community under organic management differed from those under conventional management. In this study, we collected organic and conventional rice field soils from several regions in Japan and compared their bacterial community compositions in view of fertilizer management, soil types, soil physicochemical properties and geographical distance. The aim is to clarify influential factors which determine soil bacterial communities in submerged rice fields.

Rice field soils were collected from total 46 rice fields in 7 prefectures in Japan, of which 15 fields were managed by conventional farming and 31 were by organic farming, 3-5 weeks after transplanting. The soils were classified into Andosols, Gray Lowland soils, Gley Lowland soils, Pseudogley soils and Peat soils. Using DNA extracted from the soil samples as the template, amplicon sequencing targeting the V4 region of 16S rRNA gene was performed with an Illumina MiSeq platform. QIIME2 was used for subsequent bacterial community analysis.

As a result, sequences assigned to phyla Proteobacteria, Chloroflexi, Actinobacteria, Acidobacteria and Firmicutes dominated in all soil samples. Faith's phylogenetic diversities (PDs) to indicate α-diversities of the soil microbial communities showed no significant difference between the organic and conventional soil samples. Faith's PD varied among different soil types and sampling areas. ß-Diversities of the soil microbial communities were, then, illustrated by principle coordinate analyses based on weighted UniFrac distances. The results showed plots were divided into several groups associated with soil types of the samples. Bacterial communities in Andosols, Gray Lowland soils and Peat soils were similar to one another, while those of Gley Lowland soils and Pseudogley soils were clearly different from the others. This suggests that soil types could play a key role to determine soil bacterial community structures in submerged rice soils. In addition, we confirmed that organic farming slightly shifted soil bacterial community structures compared to conventional farming. Among soil physicochemical properties, soil pH, total carbon and nitrogen contents and Fe^{2+} concentrations were likely to influence soil bacterial communities under submerged conditions.

In conclusion, this study suggests that bacterial communities of submerged rice soils could be established by the influence of soil characteristics associated with soil types.

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Key words**:** Amplicon sequencing: bacterial community; MiSeq: organic rice farming; soil type

Application Effects of Green Manure on Growth and Yield of Paddy Rice, and Soil Nutrients in Low-Input Sustainable Rice Cultivation

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Abstract
Recently, studies on sustainable agriculture have been conducted worldwide in terms of countermeasures against resource depletion and environmental pollution problems. At Ehime University Farm, paddy rice has been cultivated with only white clover as green manure (GM) for 10 years. To clarify the mechanism of this cultivation system, we examined the changes in the dynamics of nutrients, especially nitrogen (N), and yield of rice. In 2018, 4 paddy fields (G1 to G4) incorporated with GM were set. As a control, 4 conventional fields (C1 to C4) were fertilized with a slow-release chemical fertilizer (N:P:K=4.2:4.2:4.2 g m^{-2}). During the growing period, the growth of rice was periodically investigated, and the surface soil at a depth of 0 to 10 cm was collected and analyzed. The concentration of soil NH_4 was higher in GM than in control, indicating that the N supply from GM was higher than the fertilizer (Fig.1). The yields of rice in control and GM treatments were not significantly different. It suggested that GM could supply N and other nutrients equivalent to the chemical fertilizer recommended in the area. However, a wider variation in N supply was shown, and excessive N supply after heading stage was also observed. Proper techniques to manage N supply from GM are required to produce a higher amount of quality of rice in this cultivation system.

Key words: Clover; green manure; nitrogen; paddy rice; sustainable cultivation; white clover

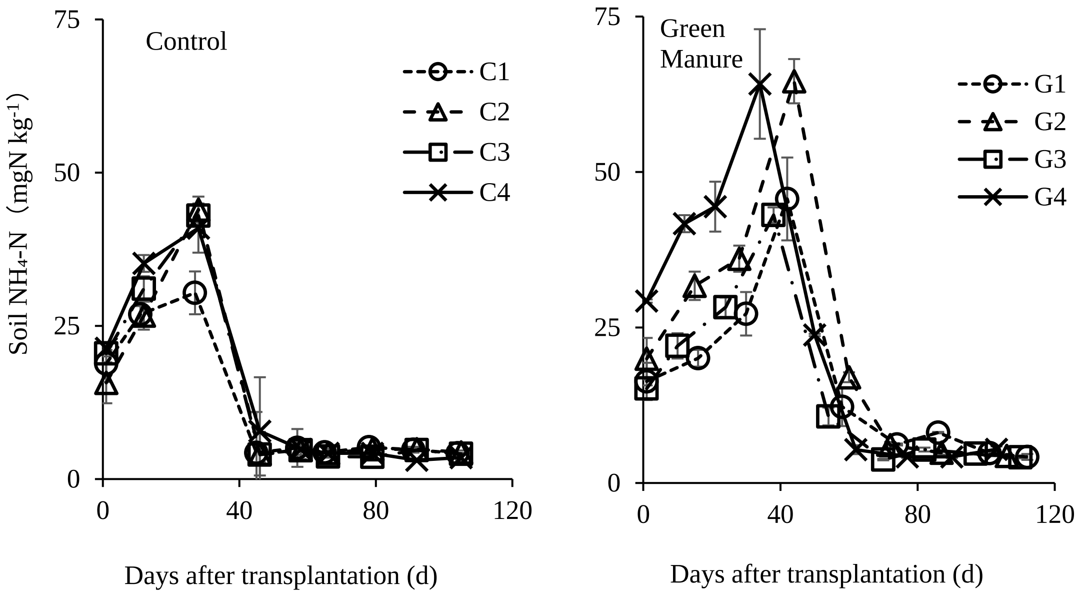

Fig. 1. Changes in soil NH_4-N (mgN kg^{-1}) in control (left) and green manure (right) treatments.

Impacts of Feedstocks and Pyrolysis Temperature of Biochar on Soil Carbon Dynamics of Oxisols and Inceptisols in Taiwan

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Abstract

Biochar is a carbon-rich material produced from heating biomass in the absence of or with limited air to above 250℃, and is distinguished itself from other carbon (C) products (e.g., charcoal, activated carbon) in that it is intended for use as a soil amendment for soil improvement and carbon sequestration, as well as other functions for environmental management. However, biochar application into soils does not always result in positive effects because of the feedstock, pyrolysis temperature, and soil type. In Taiwan, farmers often apply excess compost to ensure adequate crop yield in highly frequent tillage, highly weathered, and lower fertility soils. The potential of biochar (BC) for diminishing soil C mineralization, and improving soil nutrient availability is promising, but the study is still under-examined. To test the hypothesis, in vitro C mineralization kinetics of incubation experiment were conducted. BC (2.0%, w/w) made of nine feedstocks (400 (4), 500 (5), and 600 (6)℃), including thorny bamboo (*Bambusa stenostachya* Hackel) (A), citrus (*Citrus reticulata*) branches (B), rice husk (C), green bamboo (*Bambusa oldhamii* Munro) branches (D), Guava (*Psidium guajava* Linn.) branches (E), pummelo (*Citrus grandis* (Linn.) Osbeck) branches (F), sweet sop (*Anona squamosa* Linn.) branches (G), Mushroom bag (H), and water caltrop (*Trapa taiwanensis* Nakai) pericarps (I) were added to an Oxisols (Pc soil), and an Inceptisols (Eh soil) of Taiwan. The incubation time for A, B, and C biochar treatments was 364 days, and for D~I was 252 days. The results indicated that soil type strongly influenced the impact of BC addition on soil carbon mineralization potential. After 252-d incubation, the total soil carbon remaining (%) in Pc soil is between 96.6% (5D) and 86.7% (6B), and in Eh soil is between 68.4% (4F) and 24.0% (control). After 364-d incubation, the total soil carbon remaining (%) in Pc soil is between 95.2% (4A) and 83.7% (6B), and in Eh soil is between 60.4% (5A) and 8.4% (control). The effects of feedstocks and pyrolysis temperature showed variable results in two soils. This study is still in progressing, in future more soil characteristics will be investigated in order to examine the interaction of biochar feedstocks, pyrolysis temperature, and soil type in Taiwan.

***Key words*:** Biochar feedstock, pyrolysis temperature, soil carbon mineralization, Oxisols; Inceptisols.

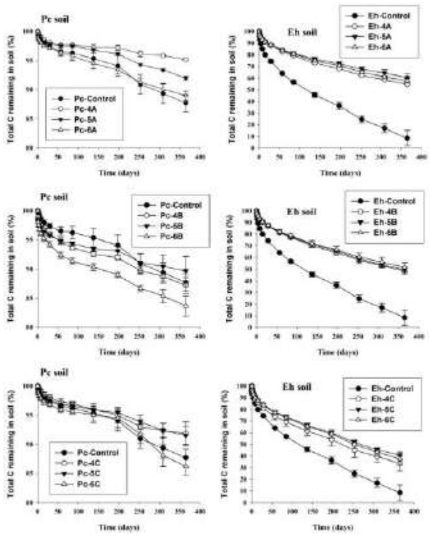

Figure 1. Temporal changes of the total C remaining (%) in Pc and Eh soil treated with A, B, and C biochar during incubation period (364 days).

Reducing greenhouse gas emissions while maintaining yield in the croplands of Huang-Huai-Hai Plain, China

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Abstract
The Huang-Huai-Hai (HHH) plain produces ~1/3 wheat and maize of China with high resource inputs, particularly synthetic nitrogen (N) fertilizers since the 1980s. Although fertilizer input has substantially increased crop yield and enhanced biomass carbon (C) input to the soil and thus stimulating soil C sequestration, GHG emissions (e.g., nitrous oxide (N_2O)) relating to the fertilizers have been also dramatically increased. Yet, a systematic regional assessment on the trade-offs between crop yield, soil C sequestration and N_2O emissions as impacted by management practices and environmental conditions is lacking. Here we calibrated a farming system model to conduct comprehensive assessment on crop yield and GHG emissions (soil CO_2 and N_2O emissions) during the period 1981-2010 across the HHH plain at the resolution of 10 km. We found that soil in HHH plain was a C sink with an annual C sequestration rate of 1.53 CO_2-eq ha^{-1} yr^{-1} (0-30 cm soil) during the period under typical agricultural practices, but this sink could only offset about 68% of global warming potential from contemporary N_2O emissions. By reducing the annual N input rate (from current more than 300 to ~250 kg N ha^{-1} yr^{-1}) and enhancing residue retention rate (from current 30% to 100%), the HHH plain could act as a net sink of GHG without sacrificing yield. Apart from management, the effects of three key environmental factors, i.e., mean annual rainfall and temperature and initial soil organic carbon stock on dynamics of crop yield, soil CO_2 and N_2O emissions were also studied.

Key words: Soil carbon sequestration; nitrous oxide emission; agricultural system; modeling; HHH Plain.

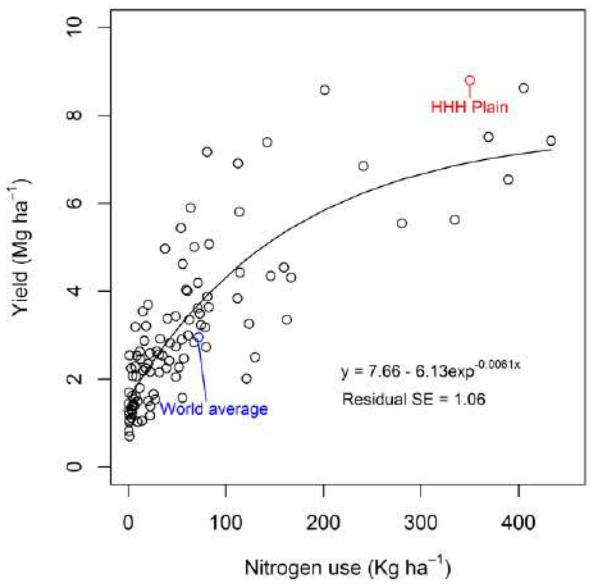

Fig. 1. The global-scale impact of nitrogen use on cereal crop yield on a country level from 2006 to 2010. The country-level data (black circles) was obtained from FAOSTAT (http://faostat3.fao.org/home/E), while data for the HHH Plain (red circle, total average yield of summer maize and winter wheat) was derived from literatures.

Soil parameters as CH_4 emission factors from Thai paddy soils–Khon Kaen and Ayutthaya

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Abstract
Methane (CH_4) is harmful as it is 25 times higher radiative forcing than CO_2. In Thailand, large portion of lands used for growing rice causes CH_4 emission. A weekly incubation experiment for two months and soil characteristic analysis before and after incubation were conducted using 30 samples randomly collected from Ayutthaya (11 samples) and Khonkaen (19 samples) in June 2018 to study an effect of soil characteristics on CH_4 emission. The average CH_4 production potential of Ayutthaya and Khonkaen is significantly at 3842 and 2114 µgC/kg/week, respectively. The results of soil parameters of Ayutthaya are all significantly higher than of Khonkaen except extractable Magnesium (Mn) and total organic carbon (TOC). In statistical analysis of soil parameters of before and after incubation, pH, organic matter (OM), exchangeable sodium (Na^+), total nitrogen (TN) significantly positively correlated CH_4 production potential but cation exchange capacity (CEC) correlated negatively. The decrease of pH and electric conductivity implies CH_4 production potential enlarged. OM is a primary electron donor using oxidants and methanogenesis takes last step producing methane. TN increased indicates that the fertilizer like ammonium or some enzymatic nitrification inhibitors may support methane production under anaerobic condition. Increasing IC implied the reduction process which mostly produce bicarbonate (HCO_3^-) except in methanogenesis. Decrease of EC shows the quick consumption of NO_3 and SO_4 when CH_4 started producing. CEC of a soil depends on pH value. Low pH causes lower CEC as H^+ displaces exchangeable cations from soil. So, the decrease of CEC is due to our soil pH is almost neutral but still a minute acidic–average of 6.53 which is likely to be optimum pH condition for methanogen.

Key words: paddy soil; methane emission; methanogenesis; incubation study; soil parameters

Projective analysis of staple food crop productivity in adaptation to future climate change in China

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Abstract

Climate change continually affects our capabilities to feed the increasing population. Rising temperatures have the potential to shorten the crop growth duration and therefore reduce crop yields. In the past decades, China has successfully improved crop cultivars to stabilize, and even lengthen, the crop growth duration to make use of increasing heat resources. However, because of the complex cropping systems in the different regions of China, the possibility and the effectiveness of regulating crop growth duration to reduce the negative impacts of future climate change remain questionable. Here, we performed a projective analysis of the staple food crop productivity in double-rice, wheat-rice, wheat-maize, single-rice, and single-maize cropping systems in China using modeling approaches. The results indicated that from the present to the 2040s, the warming climate would shorten the growth duration of the current rice, wheat, and maize cultivars by 2–24, 11–13, and 9–29 days, respectively. The most significant shortening of the crop growth duration would be in Northeast China, where single-rice and single-maize cropping dominates the croplands. The shortened crop growth duration would consequently reduce crop productivity. The most significant decreases would be 27–31, 6–20, and 7–22% for the late crop in the double-rice rotation, wheat in the winter wheat-rice rotation, and single maize, respectively. However, our projection analysis also showed that the negative effects of the warming climate could be compensated for by stabilizing the growth duration of the crops via improvement in crop cultivars. In this case, the productivity of rice, wheat, and maize in the 2040s would increase by 4–16, 31–38, and 11– 12%, respectively. Our modeling results implied that the possibility of securing future food production exists by adopting proper adaptation options in China.

***Key words*:** Model projection . Climate change . Crop productivity . Adaptation

Effect of spent coffee-grounds application on nitrification, denitrification, and N_2O emission

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Abstract

Both production and consumption of coffee are increasing worldwide in recent years. Consequently, the amount of spent coffee-grounds from bottled coffee industry is increasing rapidly. Therefore, appropriate management and effective use of spent coffee-grounds has become an important issue.

Incorporation into agricultural field soil is one of the uses of spent coffee-grounds, although its effect on nitrous oxide (N_2O) emission and microbial N_2O production processes are not well understood. We conducted an outdoor pot experiment and a soil incubation experiment to quantify the effect of spent coffee-grounds application on N_2O emission from andosol and to elucidate the relationship N_2O emission and microbial N_2O production processes after spent coffee-grounds application. The pot experiment comprised spent coffee-grounds treatments as follows: with spent coffee-grounds (WC) and without spent coffee-grounds (NC). According to the local practice of Tokyo, we cultivated spinach (*Spinacia oleracea* L.) in the each pot. The application rate of chemical fertilizers N, P_2O_5, and K_2O were 140 kg N ha^{-1}, 160 kg P_2O_5 ha^{-1}, and 100 kg K_2O ha^{-1}, respectively. We measured N_2O emissions and environmental microbial parameters of soil in the pot experiment. Moreover, soil incubation experiment design consisted of two WFPS (water-filled pore space) treatments (WFPS60% and WFPS90%) with and without spent coffee-grounds application. Each treatment of the soil incubation experiment received 0.2 mg N per g dry weight of soil. N_2O flux in the pot experiment and the soil incubation experiment were measured for 70 days and 60 days, respectively.

We found a large decrease in the N_2O emission from the WC treatment between 5 and 21 days after spent coffee-grounds application in the pot experiment than those of the NC treatment. Cumulative N_2O emission over the 70 days of the pot experiment was significantly lower in the WC treatment than in that of the NC treatment. Soil ammonium oxidation potential decreased after spent coffee-grounds application in the WC treatment. Also, soil ammonium oxidation potential in the WC treatment was lower than that in the NC treatment throughout the experimental period. We applied the acetylene inhibition technique to estimate the microbial N_2O production processes in soil. The results of acetylene inhibition technique suggested that reduction of N_2O to N_2 was larger in the WC treatment compared with that in the NC treatment. Moreover, in soil incubation experiment, the effect of spent coffee-grounds application on N_2O emission was not consistent among different WFPS. In the WFPS60%, the WC treatment tended to have higher N_2O emission compared with the NC treatment. In the WFPS90%, however, N_2O emission from the WC treatment was lower than that from the NC treatment. Our results of pot experiment and soil incubation experiment suggest that spent coffee-grounds application decreases N_2O emission from andosol by changing both nitrification and denitrification compared with that of the NC treatment, although its effectiveness could be varied with WFPS condition. Present study also showed that spent coffee-grounds application tended to decrease the crop yield. More investigation is needed to elucidate appropriate method for spent coffee-grounds application, in order to maintain crop yield while mitigating of N_2O emission from agricultural fields.

Key words**:** andosol; denitrification; nitrification; nitrous oxide; spent coffee-grounds.

The development of LCI DB of agro-materials in Korea

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Abstract

Agriculture is important sector for food security and vulnerable to climate change. To cope with climate change, all industry fields including agriculture endeavor to reduce carbon emissions. For calculating the amounts of carbon emission on agricultural products, establishment of LCI (Life Cycle Inventory) DB on agro-materials are needed.

At this study, LCI DB on major agro-materials were established to supply basic information for conducting sustainable agriculture**.** Basic carbon unit would be used to calculate the amounts of carbon emitted for production process of agricultural products. It also estimated the standard carbon emission of major agricultural products using national statistical data such as 'Yearbook of farm product income statistics' and 'Statistics of cost for farm product'.

LCA (Life Cycle Assessment) was conducted with TOTAL program or PASS in Korea. And environmental impacts of different influence categories were evaluated. The influence categories were ADP (Abiotic Depletion Potential), GWP (Global Warming Potential), ODP (Ozone Depletion Potential), AP (Acidification Potential), EP (Eutrophication Potential), and POCP (Photo-chemical Oxidant Creation Potential). The environmental impact assessment could be served for clearing up the vulnerable factors.

Key words: Life Cycle Inventory, Basic carbon unit, Agro-material, Environmental impact

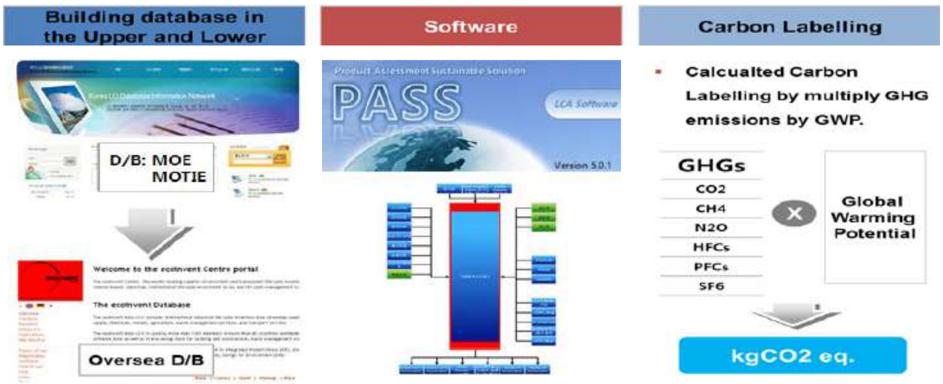

Fig. 1. System of establishment on life cycle inventory and basic carbon emission unit.

Estimation on Soil Erosion with Lysimeter in Southwest regions of Korea

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Abstract

Estimating soil erosion due to climate change may not be easy without using revised universal soil loss equation (RUSLE) in southwest regions of republic of Korea due to sporadic and localized raining events during the summer. The objective of this study is to evaluate the amount of soil erosion by a lysimeter experiment and validate the soil erosion coefficients with universal soil loss equation (USLE) model. For this study, garlic (*Allium Sativum*) was planted on a lysimeter with 13% slope and monitored every week for 5 months from November, 2018 to May, 2019. Three treatments were mulching with crop, non-mulching with crop, and non-mulching without crop. The amount of runoff water and soils from runoff by rainfall has been collected at every rainfall event. Two of 500 ml of runoff water samples were collected and analyzed for estimating eroded amount of soil by oven-dry method and chemical analysis such as soil pH and EC. Crop height, crop coverage within 1 meter by 1 meter square, and crop practice factors (P) have been collected. These database will be used for estimating soil erosion vulnerability due to weather change.

Key words**:** Runoff, RUSLE, Soil Erosion, USLE, Lysimeter, Climate Change

Estimation of Soil Carbon Sequestration at Paddy Fields Applied with Continuous Rice Straw by Using Multivariate Regression Neural Network

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Abstract
In recent years, carbon emissions such as fossil fuels have been the most significant cause of climate change. Efforts have been actively made to mitigate warming by reducing or accumulating greenhouse gas emissions. In the agricultural sector, reduction of greenhouse gas emissions and accumulation of greenhouse gases Interest in ability is increasing. Rice straw is one of the most abundant organic resources, and it can be reduced to soil to improve fertility. In the long term, it can increase the carbon content of soils to store or store greenhouse gases. So long-term accumulation tests and soil Establishment of carbon stock prediction technology is important.
In this study, 50 × 50 cm2 block was made to quantify the amount decomposed and accumulated in the soil when rice straw was reduced to paddy soil, and rice straw was applied at the level of 0, 0.5, 1, 1.5, While rice was grown for 4 weeks. The soil was collected once a month and the total carbon content in the soil was analyzed by TOC analyzer. Data sets were prepared to analyze the predicted values using machine learning. The linear regression of the tensor flow and the multivariate linear regression algorithm were used to drive the machine running.
First, in the case of univariate linear regression, even if the number of learning is increased, almost the same result as the linear regression coefficient obtained from general statistics was obtained. The variables used for the multivariate linear regression were time and input variables. The results were composed of 1201 data sets with total carbon content. In this case, W1 x X1 + W2 x X2 + b is used as the estimation formula, and learning is performed so that the cost function of W1 and W2 can be minimized. The size of the arrangement is 100, The learning rate, which is the rate that minimizes the cost function, is 0.001. A total of 1201 data sets were randomly processed into 200 test data sets, and the remaining 1001 data sets were used as learning data. The tensor flow analysis algorithm for multivariate linear regression is shown in Figure 1 below.
The initial cost function of learning was 0.34. As the learning progressed, the value of the cost function decreased as shown in Fig. 2, and finally it decreased to 0.02. The final coefficients of W1 and W2 were analyzed as 0.2995 and -0.00017, respectively. The total carbon content of the soil was estimated to be 0.2995 * hour + -0.00017 * input + 0.604 by driving the machine running using the tensor flow for multivariate linear regression with time and input variables. However, it is necessary to improve the accuracy of the estimates through the learning and verification data.

Key words**:** Heavy metals; large area experiment; phytoextraction; phytoremediation.

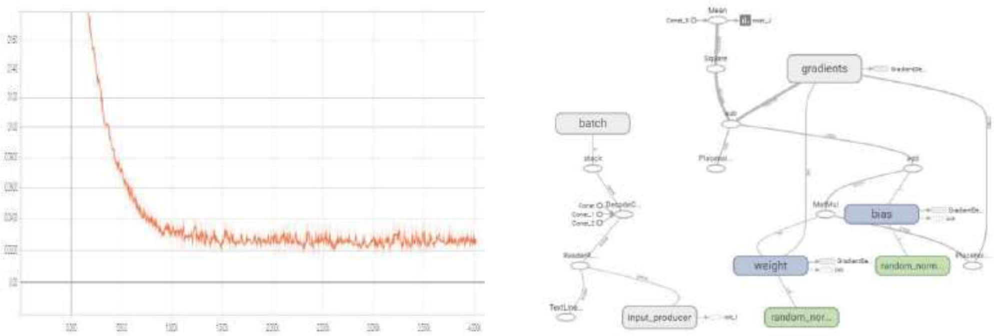

Fig. 1. The change of cost function according to training(left) and algorithm of multivariate regression neural network

Using compost, biochar and silicon as soil amendment for sustainable soil uses under saline intrusion in the Mekong River Delta-Vietnam

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Abstract
Saline intrusion, which is caused by decreased river's water level and drought, has recently been a challenge for rice production in coastal areas in the Mekong River Delta of Vietnam. This study aimed at using paddy soil sustainably under saline intrusion conditions by investigating the effects of amending compost, biochar and silicon on soil salinity leaching, changes in soil organic C, greenhouse gas emissions and rice yields. Long-term field experiments were established on alluvial and acid sulfate soils annually affected by saline intrusion in dry season. The experiment was laid out in a randomized completely block design with four replicates. Compost from sugarcane filter cake was used at a rate of 5 tons/ha; biochar from rice husk was applied at 20 tons/ha and silicon was applied at 100 kg/ha. The control was managed as farmer's practice. The experiment has been run through three consecutive crops. In parallel, a column experiment was carried out in laboratory to monitor the speed of salinity leaching enhanced by different types of biochar. The results consistently showed that amending compost and biochar significantly improved soil porosity, thus enhancing soil salinity leaching/ washing. The fluxes of CO_2 and N_2O emission were higher in the treatments amended with compost and biochar as compared with other treatments, whereas, CO_2 emission was not determined by the types of biochar. Amending compost and biochar significantly increased soil organic C, but did not significantly affect rice yields. Role of silicon on soil improvement and rice yield has not been significant yet.

Key words**:** biochar, compost, saline intrusion, soil amendment, silicon.

Effect of Gypsum amendment on Soil Environments and Italian ryegrass seed production in Saemangeum Reclaimed land of Korea

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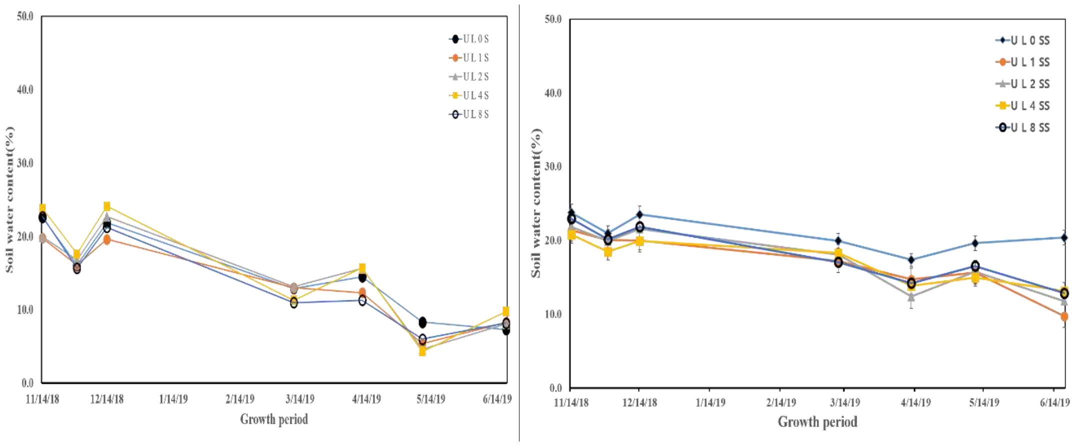
Abstract

Crop productivity in saline soil of reclaimed land is substantially limited by soil salinity and soil physico-chemical properties. The soil improvement in reclaimed land is prerequisite based on land maturity and suitability. Among soil amendments for saline soil. Gypsm,calcium sulphate, is recommended for soil improvement. Gypsum is activated under moisturized soil condition. Newly reclaimed land, Saemageum, is designed for upland crop infrastructure. Alkaline (> 7.0 of pH) and less degree of aggregate formation restricted soil development and crop growth. In this study, four levels of gypsum application were tested to determine the detrimental impact on crop growth and soil improvement under rain-fed during the growth season of winter-grown Italian ryegrass. Gypsum significantly decreased the soil pH. At harvest, in no-gypsum plot, soil pH was 6.9-7.4. In the gypsum-amended plots, soil pH maintained around 5.9~6.2 with increasing rate of gypsum. It was predicted that the higher application of gypsum could increase soil hydraulic conductivity. Compared to no-gypsum plot, soil water content in gypsum plot decreased at subsurface depth during entire growth season. Although soil EC in higher applications increased slightly. Negative impacts on crop growth were not observed. The Plant height is similar regardless of amendments. The seed production in gypsum-amended plots was better than no-gypsum plot. The lowest yield was in no gypsum plot. The highest yield was recorded in 4.0 ton ha^{-1}. Except for 1.0 ton ha^{-1}. The seed yield in three application rates was not significantly different. In conclusion, without flooding management, precipitation during winter season activated the function of gypsum in the field of newly reclaimed land. It is suggested that in order to establish the economic and safe standard for gypsum use in reclaimed land, various cropping system should be introduced into the field.

Key words**:** Gypsum, Italian ryegrass, soil improvement, Saemangeum reclaimed land

Fig. The variation of soil water content at surface(left) and subsurface(right) as affected by gypsum application rate in the Italian ryegrass field of Saemangeum reclaimed land during 2018-2019 growing season



*U: Upland

*0: No gypsum, 1, 1.0, 2:2.0, 4:4.0, 8: 8.0 ton ha^{-1}

*S: Surface, SS: Subsurface

Influence of temperature and pH on mineralization of soil organic matter in tropical peatland

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Abstract

Peatlands in Southeast Asia are largely distributed in Indonesia and Malaysia and store a large amount of carbon (C). The conversion of tropical peatlands for agriculture has been active since the 1980s, mainly for oil palm, where drainage is a pre-requisite. A 3-year field incubation study found that the rate of soil organic matter (SOM) decomposition in surface layer soils under oil palm differ depending on the original type of forest (Mixed Peat Swamp or Alan Bunga), which was due at least in part to the difference in SOM structure. Besides drainage, peatland after land clearing to a near bare condition followed by liming may affect the SOM mineralization rate. Thus, a laboratory incubation study was conducted to quantify the SOM mineralization rate in tropical peat soils at selected temperatures and pH values.

Peat soil samples at 0–25 cm depth was collected from an oil palm plantation and forest sites in its vicinity in Sarawak, Malaysia. The study sites differed in both original vegetation (Mixed Peat Swamp or Alan Bunga forest) and land use (forest or oil palm): Mixed Peat Swamp forest (MPSF) and oil palm (MPSOP), and Alan Bunga forest (ABgF) and oil palm (ABgOP). Solid state ^{13}C CP/PASS NMR spectra were obtained, and C compositions were estimated. Peat soil samples (1 g dry weight at 85% moisture content) were incubated for 91 days at 25°C and 35°C, at pH 3 and pH 7. The CO_2 production rates were estimated by determining CO_2 concentrations in the headspace using a GC-TCD (GC14B, Shimadzu, Kyoto, Japan).

The percentage (%) *O*-alkyl C values as estimated from ^{13}C CP/PASS NMR spectra were larger in the samples from MPSF, MPSOP and ABgF suggesting the presence of readily decomposed organic matter derived from polysaccharides. The AlkylC/*O*-alkyl C ratio in ABgOP was the highest, indicating that ABgOP soils were more microbially decomposed prior to experiment. ABg soils decompose at a faster rate than MPS soils when incubated under similar conditions. Q_{10} values ranged from 1.4–1.7. An increase in pH in MPS soils doubled the mineralization rates while in ABg soils the mineralization rates of SOM increased by a factor of four. The variation in the response of mineralization rates of SOM in tropical peat soils at different pHs and temperatures varies depending on the peat quality and land use type.

Keywords: ^{13}C NMR, Mixed peat swamp, Oil palm plantation, Soil organic matter, Tropical peatland

Comparison of different chamber methods to measure seasonal ammonia emission in upland field

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Abstract

Nitrogen (N) fertilizer application increases crop production, while it leads to ammonia emission increasing particulate matter ($PM_{2.5}$) in the atmosphere. The annual amount of ammonia (NH_3) emissions from agricultural field is about 3.3 MT in Korea corresponding to 6.7% of the total emission since 18% of the applied nitrogen (N) is via through NH_3 emission. However, the amount of NH_3 emission in Korean agricultural field has been calculated based on statistical information with reference emission factors from IPCC or EPA, and hence suitable and reliable measuring techniques should be required. Thus, we tested dynamic flow-through chamber methods, soil ammonia emissions without plant (SAE) and crop canopy ammonia fluxes with plant (CAF) to accurately measure NH_3 emissions. Field experiment of Red pepper cultivation with completely randomized block design was conducted to quantify NH_3 emissions in recommended fertilization (NPK) and No fertilizer application (No NPK). Amounts of N-P_2O_5-K_2O fertilizer applied to the field were 190-112-149 kg ha^{-1}, and the recommended fertilization (N-P_2O_5-K_2O) was treated at split application based on RDA recommendation. Gas samples using SAE and CAF were trapped in the 0.05N-H_2SO_4 solution during 2 hours (usually 9:00 to 11:00 AM for CAF and 12:30 to 14:30 PM for SAE) on 1 to 5 days after N fertilizer application and then at 7-day intervals. The trapped gas samples were analyzed using Nesslerization method. Results showed that 7.7±3.2% (No NPK) and 75±8.5% (NPK) of the applied N fertilizer were emitted using SAE, while CAF showed prominent reduction in NH_3 emission as 0.13±0.05% for No NPK and 3.4±1.1% for NPK, respectively. We assumed that the overestimated amount of NH_3 emission in SAE (excluded plant) was related to crop growth, the trapping time, and the temperature. Thus, our study recommended that to accurately measure NH_3 emission in the field, it should be considered best trapping time to represent daily NH_3 emission and reactive N behavior such as amount of crop N uptake, soil N stock, and N loss by leaching and runoff.

***Key words*:** particulate matter; ammonia emission; dynamic flow-through chamber method; acid trapping

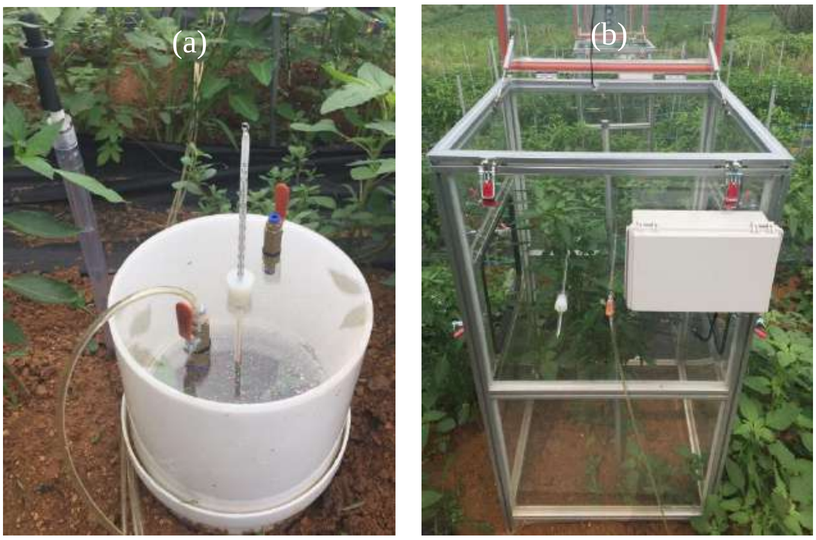

Fig. 1. Dynamic flow-through chamber methods for ammonia gas trapping (a: soil ammonia emission without plant; b: canopy ammonia flux with plant)

Influence of Soil Moisture Content on Salinity Soil in Inland Salt-Affected Soils in Northeast Thailand

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Abstract

Water content in soil is the major factor which impact on a salinity soil. This study aimed to investigate the relation between soil moisture content and changing electrical conductivity (ECe) and Sodium Absorption Ratio (SAR) in inland salt-affected area. And to study how the relation between two factors are field capacity (FC) and permanent wilting point (PWP) to ECe and SAR. The project was set up in inland salt-affected area in Khon Kaen Province, Northeast Thailand in 2017. The results indicated that the soil moisture content was lower than soil moisture content at FC, meanwhile, it was higher than PWP in dry season. While the soil moisture content in rainy season (May-November) is higher than FC and PWP. Thus, the trend of soil moisture content and ECe and SAR shows a positive relationship in dry season and a negative relationship in rainy season. But R^2 was very low. The soil moisture content had a positive relation to the ECe and SAR in dry season. While in rainy season, soil moisture content had a negative relation to both parameters are ECe and SAR. Consequently, soil moisture content at PWP and FC showed a negative relation to salinity indicators, there are ECe and SAR. Based on these data, water content in soil at FC could leach a salt to deeper soil n. Meanwhile, the performance of soil water at PWP and salt drainage did not clearly understanding. Because PWP is a small water content but the relation as same as FC. Thus we need more study about the mechanism of soil moisture content at PWP to a salinity leached to deep soil. However, the relation of soil moisture content and ECe and SAR pointed out that we could apply these data to plan the water for agricultural irrigation and cropping system, especially, in dry season. Therefore, the future investigation should be related to mechanism salt movement at different of soil water level and soil texture under the climate change.

Key words: soil moisture content, salinity soil, inland salt-affected soils, Thailand

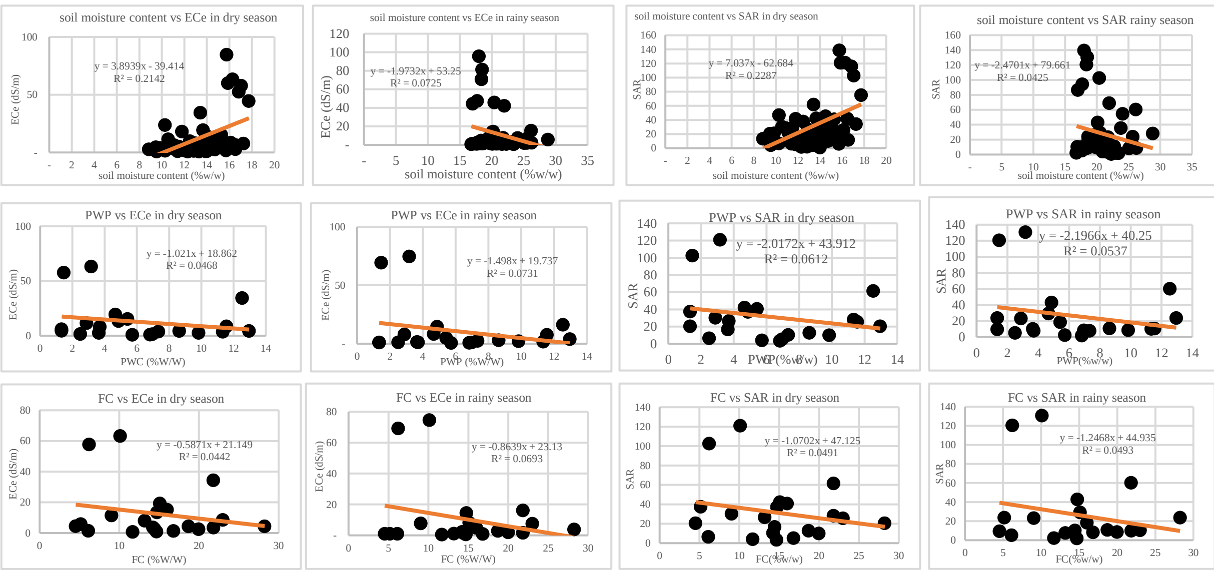

Fig. 1. Relationship between soil moisture content, permanent wilting point, field capacity and ECe and SAR.

Response of Sesame(*Sesamum indicum*) to Subsurface Drip Irrigation in Sandy-loam Soil

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Abstract
Climate changes are potentially the greatest threat to field crop production. Long-term scenario for climate change expects to increase the chance of drought damage in Korea, thus efficient water using technology is of increasing concern. The present study was evaluated the effect of subsurface drip irrigation systems on water use efficiency and sesame growth at sandy-loam soil. The experiment was conducted at National Institute of Crop Science research field in Miryang, Korea. Five irrigation treatments including the rain-fed irrigation were applied in response to application wide (70 and 140cm) and position (under ridge and furrow). Each plot had 38m in length and 12 crop rows. Soil water content at top 5cm depth averaged 0.273m^3/m^3 with subsurface irrigation, which was significantly greater than rain-fed treatment (0.092m^3/m^3), but not significant from the surface drip irrigation (0.261 m^3/m^3). However, soil water content (0.329 m^3/m^3) at subsurface 25cm layer was statistically greater compared to the surface irrigation (0.308 m^3/m^3) and rain-fed irrigation (0.284 m^3/m^3). The difference in soil water content may influence on soil water potential and soil temperature. Total irrigation amounts averaged 142mm for 70cm spacing, which was 47% less compared to 140cm spacing (267mm). Irrigation time was also reduced to 8.7 min per day with 70cm spacing from 27.0 min with 140cm dripline spacing. Sesame yield averaged 1.42 Mg/ha for two years, but it was not significant among dripline spacing. Irrigation water use efficiency (IWUE) was influenced by subsurface dripline install methods. IWUE with 70 cm spacing was 0.83 kg m^{-3}, which was 53% greater compared to 140cm dripline spacing. It is concluded that wide dripline spacing (140cm) is probably the more economical installation design for subsurface drip irrigation system compared to 70cm spacing in this soil because the initial cost for dripline may be reduced with wide spacing design, even though the IWUE is greater in the plot of 70cm dripline spacing.

***Key words*:** Sesame, subsurface drip irrigation, water management, water use efficiency

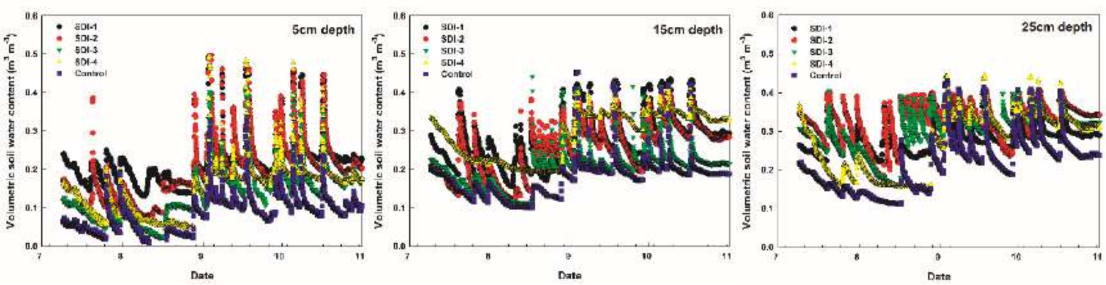

Fig. 1. The volumetric soil water content at 5, 15, 25cm depths in response to subsurface drip irrigation for sesame growth period.

Effects of Applying Husk Biochar on Uptake, Translocation, and Chemical Forms of Cadmium in Two Varieties of Pak-choi

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Abstract
Cadmium (Cd) accumulated in vegetables can enter the human body via food chains, leading to various illnesses. Stress induced by Cd also affects plant growth. Plants can decrease the toxicity by changing the chemical forms of Cd, which include inorganic (F_E), water-soluble (F_W), pectate- and protein-integrated (F_{NaCl}), undissolved phosphate (F_{HAc}), oxalate (F_{HCl}), and residual (F_R). Among them, F_E and F_W chemical forms show higher mobility compared with the others to translocate upward from roots to shoots. Biochar (BC) was found to be effective in reducing the mobility of heavy metals in soils. In this study, *Brassica chinensis* L. var. chinensis (PCC) and *Brassica chinensis* L. cv. wrinkled leaf (PCW) were grown in soil contaminated with Cd amended with or without husk BC, and harvested on the 28th, 35th, 42th, and 49th days, respectively. The experimental results showed that F_E was the major chemical form in both varieties of pak-choi, and Cd concentration in the shoot of BC-treated groups was lower compared with CK groups. BC treatment improved the growth of PCC in contaminated soil, and it decreased the bioconcentration factor and transfer factor of Cd in comparison with the CK group.

Key words: Biochar; cadmium; chemical forms; pak-choi

Funding
This program was funded in part by the Ministry of Education, Taiwan, R.O.C., under the Higher Education Sprout Project.

A Novel Application of Acoustic Televiewer and Packer-Test to Characterize Preferential Flow Paths of Groundwater within the Shallow Overburden Aquifer

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Abstract

An accurate characterization of the geometry and the corresponding hydrogeological properties in an aquifer is an important prerequisite for developing efficient strategies for groundwater pollution control. Accounting for the influence of aquifer heterogeneity on subsurface contaminant distribution is however a challenging task when pollutant transport potential is dominated by the presence of preferential flow paths, such as macropores in the soil matrix, fractures in consolidated bedrock, and regolith-bedrock interface. To observe the distribution of preferential flow paths, different nondestructive measurement methods have been proposed, such as ground-penetrating radar, ground based interferometry, microgravity analysis, and other scanning tools. Yet a very common limitation is that the whole working progress is laborious, time consuming, and often provides erroneous results.

In order to provide an efficient interpretation for the geometry of a shallow overburden aquifer, our study proposed a methodology that combines acoustic televiewer logs and straddle packer system during in-situ borehole investigation. By analyzing the reflection amplitude data with respect to the depth, a semi-3D rock formation image along the borehole sidewall can be generated. Detailed information regarding the relative strength of strata, the homogeneity of geomorphological attributes, and the distribution of weak planes along the borehole can be explicitly obtained. The presence of preferential flow paths (known to contribute to groundwater pollution) with higher advective transport rate in the formation can be identified with the use of a set of self-developed straddle packer system. Based on the investigation results collected from several study sites in Taiwan, the effectiveness of the proposed methodology will be explored and verified.

Key words**:** Acoustic Televiewer; packer test; preferential flow paths

Effect of trenchless drain installation with tractor for multipurpose utilization of poorly draining paddy fields

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Abstract

Subsurface drainage improves the productivity of poorly-drained fields by lowering a ground water table, creating a deeper aerobic zone, enabling faster soil drying and improving the root zone condition to activate functions of paddy roots. There are considerable areas of wet paddy fields in Korea that require improvement of their drainage conditions. But, the trench subsurface drainage method using heavy equipment has a problem such as great construction effort and investment cost. Therefore, the aim of this study was to develop improved subsurface drain techniques and to quantify the drainage ability of a trenchless subsurface drain as well as upland crop farming in paddy field. This trenchless drainage facility with tractor was developed to solve the problem of field configuration and installation cost. In this method, the drain pipe was dragged and placed from a small ditch using a 75 KW tractor at a target depth of 0.5 m without requiring a deep and wide excavation and throw rice-husk filter material in simultaneously. Machines for trenchless installation do not excavate a trench but act as a plough, with the soil being lifted while the piper is installed. A field experiment was performed at plain poorly-drained paddy fields located in the coarse silty, mixed, mesic family of Fluvaquentic Endoaquepts by WRB. The performance of two methods of subsurface drain installation (trenchless drain method with tractor, and trench method using heavy equipment) was evaluated using three years of field data on water table, soil water content and soybean yield. The results indicated that this trenchless subsurface drainage technologies by tractor is quite cost-effective. The cost of this certified system amounts to about 53.5% of total drainage costs, less than the costs of trencher construction methods. The water table elevations by a trenchless drain method showed a large decline in the spaced 3 m apart as compared to 5, and 7 m line. The soil moisture decreased gradually after the drastic drainage, indicating that the downward bottom flux increased because of drastic subsurface drainage. The soybean yield increased significantly by trenchless subsurface drainage, the yield of the 3 m spacing line was 30% more than that of the control. Plots drained by trenched drains yield more than plots drained by trenchless drains with tractor but difference were not statistically significant at 95 % level. In conclusion, it was clear that installation of trenchless subsurface drainage by tractors with 0.5 m depth and 3 m spacing to achieve high yield of upland crop. Therefore, the trenchless drainage using tractor improved drainage function of the field, and the factors affecting the performance of trenchless drainage were clearly revealed by this research.

Key words: Trenchless subsurface drainage; poorly drained paddy field; water table, soybean.

Table. Effects of trenchless subsurface drainage techniques by tractor in poorly drained paddy fields.

Subsurface drainage methods & spacing		Soil water content (V/V, %)	Water table (cm)	SED_{30} † (day)	SEW_{30} ‡ (cm)
Control		44.7	34.2	44	978.1
Trench	7m	30.3	90.9	1	0
Trenchless	3m	29.0	87.3	2	89.2
	5m	30.1	83.2	3	166.4
	7m	36.9	71.9	11	238.5

†SED_{30} : Sum of Excess Water over 30cm, ‡SEW_{30} : Sum of Excess Water Depth over 30cm

Feasibility of Evaluation Methods for Reference Evapotranspiration in Plastic House in Korea

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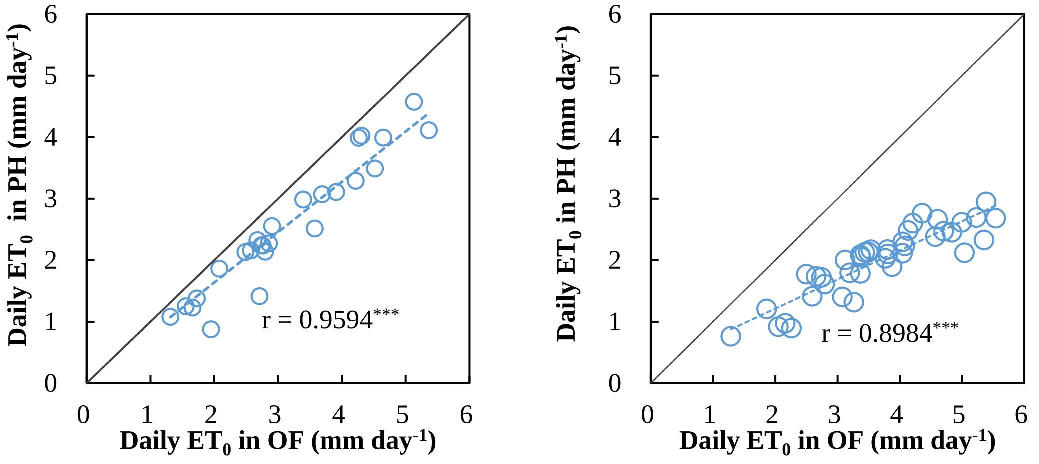
Abstract

In Korea, area of plastic house is 9% of total arable land but, income is 62% of produce in 2017. To support the system of plastic house production, irrigation knowledge is important. Irrigation demands (ID) of crops were, traditionally, determined with weather condition and crop characteristics estimated by reference evaopotranspiration (ET_o) and crop coefficients (K_c), respectively. In plastic house, the cultivation condition related to water consumption should be considered at establishing irrigation requirement. We assumed two scenarios to reflect cultivation condition on irrigation demands (ID) : i) ID = $ET_o \times K_{cp}$ and ii) ID = $ET_{op} \times K_{cp}$ when ET_{op} and K_{cp} indicate ET_o measured in plastic house (PH) and K_c for crops cultivated in PH, respectively. The former evaluates ID based on ET_o in open field (OF) and the latter does ID with ET_o in PH. The ET_o was estimated by water balance (WB) equation using lysimeter and FAO Penman-Monteith (FAO PM) equation (Allen *et al*., 1998) during Jun. 16th to Oct. 31th. The FAO PM method was found to describe well ET_o in OF during Jun. to Sept., but to overestimate in OF & PH during Oct. because of low temperature for grass growth in Korea. The values of solar radiation and ET_o calculated by FAO PM were high correlation between OF and WB during Jun. to Sept., but different trends classified by periods. The solar radiation in PH were similar during Jun. 16 - Jul. 11(1st), but lower 35% in PH than OF during Aug. 22 - Sept. 30 (2nd) period, on average. The ET_o in PH were lower 18% than OF during 1st (3.15 mm day^{-1} in OF and 2.55 mm day^{-1} in PH) and lower 46% than OF during 2nd (3.66 mm day^{-1} in OF, 2.00 mm day^{-1} in PH), on average. It resulted from reduced solar radiation intercepted by plastic film. Based on the results, we concluded that FAO PM eq. was recommendable in calculating reference evapotranspiration and calculating ID based on i) ET_o was more suitable than using ii) ET_{op}. Furthermore, establishing K_{cp} pairing ET_o would be the next step to complement evaluating irrigation demands in PH.

Key words: Reference evapotranspiration; Plastic house; Solar radiation; FAO Penman-Monteith equation; Irrigation.



a) Jun. 16 – Jul. 11 (b) Aug. 22 – Sept. 30

Fig. 1. Correlation of reference evapotranspiration (ET_0) between open field (OF) and plastic house (PH) during (a) June 16 to July 11 and (b) August 22 to September 30.

Arsenic Removal from groundwater for Agricultural Irrigation in Taiwan

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Abstract

Based on an investigation of agricultural Area in southwestern Taiwan, 19.5% of arsenic (As) content in groundwater is higher than the irrigation water criteria (0.05 mg L^{-1}) and 4.8% exceeds the limit of the second type groundwater pollution monitoring standard (0.25 mg L^{-1}). Among those agricultural lands surveyed, some soil As contents exceed soil monitoring standard, which may lead to the accumulation of As in crops. This research was conducted to explore a low-cost and convenient method to reduce As concentration in groundwater for irrigation avoiding the accumulation of As in soil and ensure food security. The results of laboratory studies reveal that the chemical coagulation method of adding Ferric Chloride ($FeCl_3$) is more efficient to remove As in groundwater than the other different methods. Based on the results of laboratory studies, some upscale field studies have been conducted with an As removal equipment. It includes 10 tons tank, air pump, dosing system and 1μm filter. The As removal rates can reach 48% and 73%, respectively on second day when 10 and 20 mg L^{-1} $FeCl_3$ was added as initial As concentration less than 0.09 and around 0.12 mg L^{-1}. And the As concentration can be drop lower than 0.05 mg L^{-1}. The pH value was reduced from 7.7 to 7.4 , EC value was increased from 844 to 856 μ S cm^{-1} and Cl^- concentration increased from 45.5 to 60.3mg L^{-1}in latter study. Except the EC higher than the criteria of irrigation water, but the other groundwater characteristics, pH and Cl^- concentration were all lower than the criteria. The results reveal that As removal processes with 10 tons of groundwater tank can conform to the irrigation water standard on the second day, and with treat capacity about 150 tons groundwater every month. It can well meet the irrigation requirement for 0.1 hectare of rice or 0.3 hectare of corn.

***Key words*:** groundwater, irrigation water, Arsenic Removal, Ferric chloride

Effect of Irrigation Water Salinity On Spring Potato growth at growth stages

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Abstract

The irrigation water is one of the important agricultural resources in the world. The reclaimed land in Korea is vulnerable to the shortage of fresh water as the water reservoir near coastal reclamation are of dynamic water salinity. In this study, to establish the critical standards for the safe use of saline water in the agricultural field of saline soil, the influence of saline water irrigation on spring potato at growth stages was assessed by pot experiment under greenhouse in 2019. Irrigation water salinity was four levels (0.1,2,4,8 dS m^{-1}). The tested growth stages were three (vegetative, tuber formation, tuber bulking). The experiment design was split plot (Main: Growth stage, Sub-main: Irrigation Water salinity, IWS). Irrigation scheduling at each growth stages (15-20 days) is based on crop water consumption. The number of pot was 96 (Twice the number of planned pot). The recovery test was done by irrigation of fresh water into saline water-treated pot. After each stage, the plant and soil are removed to analyze the relative growth and soil EC. The irrigation water salinity has variable impact on tuber growth at growth stages. Based on the comparison of relative growth at each growth stages, the growth of above-ground was influenced as the salinity increased. Compared to control (0.1 dS m^{-1}). The plant height and fresh weight was decreased 10~14% at vegetative, 5~10% at tuber formation, and 5~8% at tuber bulking. It was observed the retarding effect of water salinity was critical at vegetative stage. The inhibition impact of irrigation water salinity on tuber growth was observed in a concentration-dependent manner. Compared to control pot, from vegetative stage to tuber bulking stage, at 2.0 dS m^{-1} of IWS, tuber weight per plant(DM) reduced 3~13%. 4.0 dS m^{-1} of IWS reduced 17~ 19% of tuber weight(DM). 8.0 dS m^{-1} of IWS reduced 27~ 38% of tuber weight(DM). In consequent experiment, saline water irrigated-pot was watered by fresh water continuously to check the recovery from stress. In vegetative stage, at 2.0 and 4.0 dS m^{-1}, tuber growth reached 84 and 86%. In tuber formation stages, at 2.0 and 4.0 dS m^{-1} , the tuber weight recorded 95 and 90%. However, at 8.0 dS m^{-1} of IW, the tuber weight remained 53.9% compared to control. In tuber bulking stage, the tuber weight at three IWS levels were 81.7~91.3%. In conclusion, from three growth stages, the yield reduction rates were critical at vegetative and tuber bulking stages despite lower IWS. Considering the recovery degree of tuber growth after saline water irrigation and economical threshold of yield(85-90%), the critical level of saline water use for spring potato was recommended at less than 2.0 dS m^{-1} .

***Key words*: **Irrigation water salinity, growth stage, spring potato, reclaimed saline soil

Table. Influence of Irrigation water salinity on tuber growth and its recovery rate by fresh water irrigation after critical growth stages

Treatment		Tuber weight (g/plant)		Recovery rate (%)	
Growth stage	IWS	FW	DM	FW	DM
Control		251.1	50.9	100	100
Vegetative	2.0	225.9	44.0	90.0	86.5
	4.0	228.4	42.9	91.0	84.4
	8.0	192.4	37.1	76.6	73.0
Tuber formation	2.0	228.5	48.3	91.0	95.0
	4.0	209.0	45.9	83.2	90.2
	8.0	177.7	27.4	70.8	54.0
Tuber formation	2.0	220.3	46.4	87.7	91.3
	4.0	204.5	44.3	81.4	87.1
	8.0	184.6	41.5	73.5	81.7

*IWS: Irrigation Water Salinity (dS m^{-1})

An Investigation on the Relationships between Irrigation Water Sources and Soil Quality of Farmland of Guandu Plain, Taipei, Taiwan

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Abstract

Most farmers of Guandu Plain located in Northern Taiwan are used to practice conventional rice cultivation in rice field. For the purpose of supplying a large amount of irrigation water every year, Chi-Shin Irrigation Association manages to get mainly four types of water sources, including Guizikeng Creek, Shuimokeng Creek, Huang Creek and domestic sewage, in order to meet the demand of more than 200 ha of farmland of Guandu Plain. However, due to the development of Taipei city, the irrigation water of Guizikeng Creek is mixed with domestic sewage discharged from the households alongside the creek. Thus, the water quality of Guizikeng Creek may be affected occasionally, and its pH value can be up to 9 from time to time. In contrast, Huang Creek has been influenced by the discharge of used hot spring with extremely low pH value usually less than 4. Due to the insufficiency of irrigation water supply at the end of irrigation ditches, domestic sewage has also been used as a water source under regular monitoring basis. Unfortunately, high concentration of N of domestic sewage seems to be not avoidable. In general, potential risks of degradation of irrigation water quality may exist in different water sources, and the soil quality of farmlands after long-term irrigation may be changed consequently. In order to tackle this issue, the four types of water sources were sampled and analyzed for pH, EC, total N, P, K and As (Fig. 1). On the other hand, soil samples were collected from different farmlands directly irrigated by the four types of water sources without interference, and then be analyzed for total N, inorganic N, available P, K, Ca, Mg and extractable As, Cu, Zn, Cd, Ni, Cr, Pb. The objectives of this study were (1) to investigate the relationships between the four types of water sources and the soil quality of farmlands irrigated by the four types of water sources, and (2) to establish the soil management strategies for farmlands under different irrigation water sources to ensure the quality of crop production.

Key words: domestic sewage, hot spring, soil management, irrigation water management, rice field.

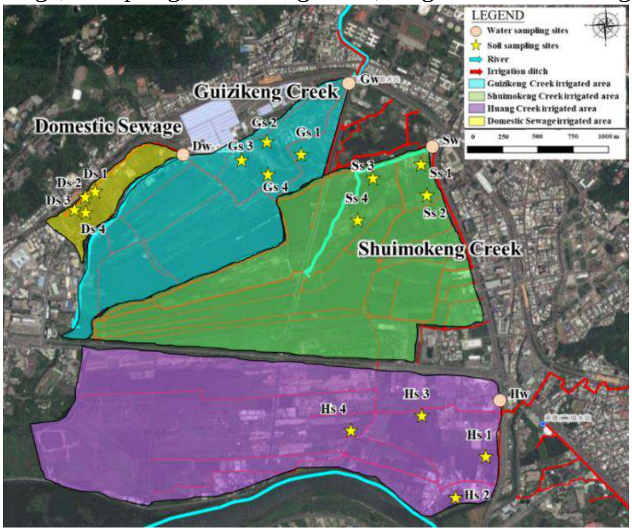

Fig. 1 Irrigation areas of the four types of water sources and sampling sites of Guandu Plain.

Feasibility of Bio-Sulfur for Removal of Cd in Aqueous Solution

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Abstract
Bio-Sulfur (Bio-S) is defined as the solid phase byproduct generated in the desulfurization process of landfill gas. Bio-S contains a small portion of the dissolved sulfide and according to the hard and soft acid-base (HSAB) theory, the S-containing ligands can strongly complex with Cd^{2+}. This study evaluated the removal of Cd from aqueous solutions by Bio-S under different batch conditions such as time, Bio-S dose, solution pH and initial Cd^{2+} concentration. The Langmuir maximum removal amount of Cd^{2+} on Bio-S was 63 mg g^{-1}, which was superior to the ordinary commercial activated carbon (Table 1). The Bio-S and Cd^{2+} complexation followed the multiple first-order kinetics with the initial fast reaction, followed by a slow step. Within 5 min greater than 47% of Cd^{2+} was removed from aqueous solution. Batch sorption experiments also showed that the dosage and initial solution pH affected the removal of the Cd^{2+} by the Bio-S. Kinetics and XPS data revealed the Bio-S react with the Cd^{2+} ion to form CdS by the chemical adsorption. The overall results demonstrated that Bio-S could be the promising efficient candidates for removing Cd^{2+} from contaminated water.
***Key words*: Bio-Sulfur; Removal; Cadmium; Cadmium sulfide**

Table 1. Isotherm parameters for the adsorption of Cd^{2+} onto Bio-S.

	Langmuir			Freundlich		
	q_{max} (mg g^{-1})	k (L mg^{-1})	r^2	1/n	K_f	r^2
Bio-S	63.29	0.03	0.999	0.15	20.52	0.902
Activated carbon	35.97	0.02	0.998	0.22	7.01	0.941

The effects of water management on the arsenic accumulation and speciation in water spinach grown in As-contaminated soils

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Abstract

Arsenic (As) is considered as one of the most dangerous carcinogens in natural environments. In general, the As availability in the aerobic soils is low, which not easily uptake and accumulated by upland crops such as vegetables. However, due to water spinach can be planted in both flooding and aerobic fields, which may cause the differences in As accumulation in plants between two water management. Therefore, the objective of the present study is to compare the distribution of As species and total As concentration in water spinach grown in As-contaminated soils with different water management (flooding and aerobic conditions). Two soils of different characteristics (Gd and Ms soils) with two As levels (L and H) were used in this study. The results showed that the arsenite (iAs^{III}) was the dominant species in the soil pore water of two tested soils under two water management, while the proportion of arsenate (iAs^{V}) in the aerobic conditions was slightly increased. It also indicated the As concentrations in the roots were higher than the shoots, and inorganic As (iAs) was the predominant species in the root and shoot of water spinach. The proportion of iAs^{V} in the plants grown in the soils under the aerobic condition was higher than the flooding conditions. In addition, it also found that there were opposite trends in As affinity to iron (Fe) oxides deposited on rhizosphere soil and root surface (Fe plaque) between Gd and Ms soils under aerobic conditions, predicting the different mechanisms resulting in the decrease of As accumulation in water spinach have existed in soils with different soil properties such as the contents of organic matter and Fe oxides. Based on the results of this study, it suggests the As concentration and species in the water spinach is highly related to the soil properties and the distribution of As species in the soil pore water, and the As accumulation in the edible parts are significantly decreased under the aerobic conditions.

Key words**:** Water spinach, water management, arsenic speciation, rhizosphere, iron oxide

Relations of interannual fluctuations of between soil respiration rates and forest dynamics in long-term observation at cool-temperate beech (*Fagus crenata*) stand, northern Japan

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Abstract
Soil respiration (the efflux of carbon dioxide (CO_2) from the forest floor) comprises a major carbon (C) releases from forested ecosystems to atmosphere as well as the respiratory C release of foliage and stem; thus, it is important to clarify and understand the relationships among the respective C dynamics elements (soil respiration on the soil surfaces, litterfall productivity, net primary production (NPP), and stand dynamics, etc.) that consist of the C dynamics in forested ecosystems. Long-term research data on C fluxes, forest dynamics, and its events in forest ecosystems are the powerful means when advancing our comprehensively understanding of forested ecosystems and their biosphere. The Tohoku Research Center of Forestry and Forest Products Research Institute (TRC, FFPRI) in Japan has started and continued to observe CO_2 flux and forest dynamics in Appi forest meteorology research site (API site), located at Appi Highlands in Iwate pref., northern Japan, since 1999 (some of observations have been started since 2003 and 2006). In this study, we will present our research results that we estimated annual amounts of soil respiration from 2004 to 2018 (Fig. 1), compared it with the long-term observation data of forest dynamics in API site, to clarify what factors could regulate the annual soil CO_2 efflux in cool-temperate deciduous broadleaved forest in Appi Highlands.

Key words**:** soil CO_2 efflux; long-term observation; forest dynamics; interannual fluctuation.

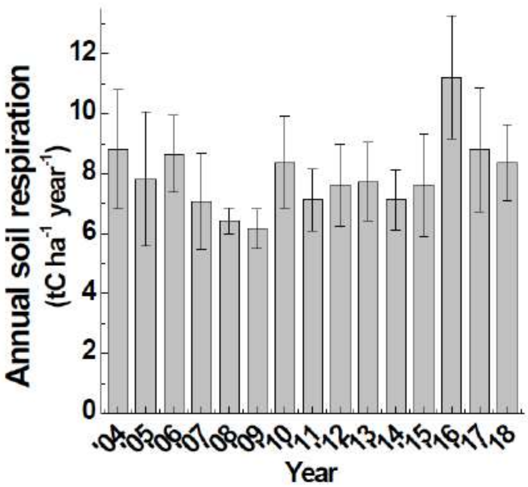

Fig. 1. Interannual fluctuations of soil respiration in cool-temperate beech (*F. crenata*) forest at Appi Highlands, northern Japan.

Effects of Pyrolyzed Temperature of Poultry Litter biochar on Immobilization of Heavy Metal Ions in Water and Soils

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Abstract
The present study employed poultry litter biochar (PLB) (broiler chicken litter, chars formed by pyrolysis at 250, 300, 400, 500, and 600℃) for heavy metal (Cd^{2+}, Cu^{2+}, Ni^{2+}, Pb^{2+},and Zn^{2+}) immobilization in water and in two soils (Oxisols (Pc) and Inceptisols (Eh)). Experiments in water were conducted to test for the ability of each PLB to immobilize a mixture of heavy metals (1.5 mM each at t0) in water. In addition, experiments in two soils were conducted to test for the effects of each PLB (10%, w/w) on the mobility of a mixture of selected heavy metals (1.5 mM each added at t0) in soil (20 g of soil L^{-1}). All experiments involving soil were conducted using synthetic rain water (SRW, pH 4.5) to simulate contaminant leaching by percolating rainfall. After equilibration with metal ions for 48 h, the results of experiments in water indicated that the sorption capacity of chars strongly depended on the metal ion type, showing the following trend for greater removal from solution: $Zn^{2+} \approx Ni^{2+} < Cd^{2+} < Cu^{2+} < Pb^{2+}$. This trend was observed for all chars. In Inceptisols and Oxisols, PLB amendment retained considerable portions of Pb^{2+}, Cu^{2+} and Cd^{2+}, and less Ni^{2+} and Zn^{2+}. PLB charred at low temperature both showed higher sorption capacity than at high temperature. ^{31}P NMR analyses suggest the abundance of organic (orthophosphate monoesters and diesters, and phosphonates) and inorganic (pyrophosphate and polyphosphates) phosphorus functional groups in biochars investigated in this study. The complete removal of Pb^{2+} likely resulted from the high affinity of Pb^{2+} for phosphate-based ligands to form Pb phosphate precipitates. We examined that the higher sorption capacity in PLB charred at low temperature (<400℃) could be attributed to the relative higher amount of substituted aliphatic C, phosphorus functional groups, and cation exchangeable capacity. The considerable sorption capacity of PLB charred at low temperature (<400℃) highlights the roles of noncarbonized biomass fractions in heavy metal immobilization. Release of functional groups from chars can have an impact on the composition of natural organic matter in the surrounding environment.
***Key words*:** Poultry litter biochar, heavy metals; immobilization; Oxisols; Inceptisols.

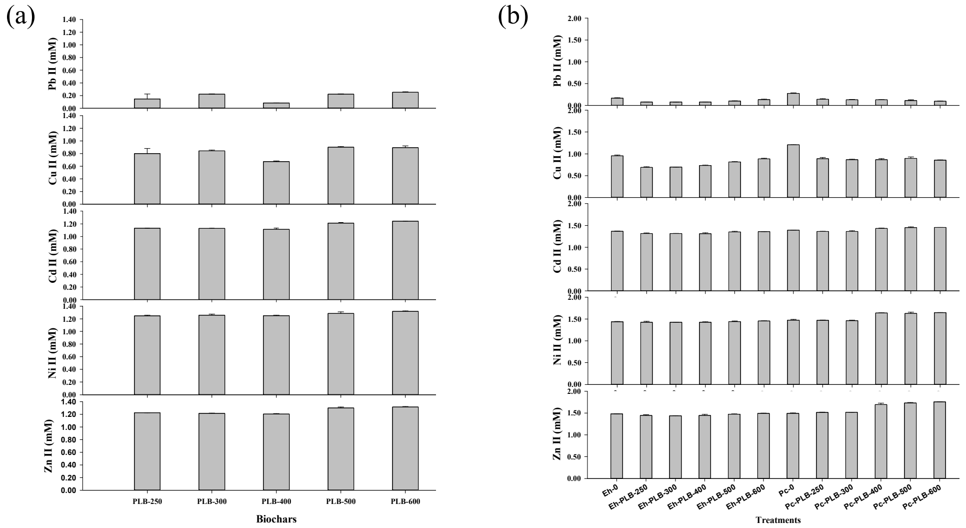

Figure 1. (a) Concentrations of Pb^{2+}, Cu^{2+}, Cd^{2+}, Ni^{2+},and Zn^{2+} remaining in solution after 24 h of equilibration of each biochar sample (5 g L^{-1} in 0.01 M NaCl) with a mixture of metals (Cd^{2+}, Cu^{2+}, Ni^{2+}, Pb^{2+},and Zn^{2+}; 1.5mMeach added together at t =0). (b) Equilibrium Pb^{2+}, Cu^{2+}, Cd^{2+}, Ni^{2+},and Zn^{2+} concentrations in Oxisols (Pc) and Inceptisols (Eh) soil (20 g soil L^{-1}) with and without 10% PLB (g biochar g^{-1} soil); 300 μmol L^{-1} each metal was added together for 48 h equilibration. All values are given as mean ± SD for duplicate experiments.

Shrub distribution on dunes in the Horqin Sandy Land of northern China

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Abstract

The Horqin region of Inner Mongolia, China, was originally a sparse forest meadow, but the vegetation has been largely destroyed by human activities during the past decades. Desertification has not only destroyed the local ecosystem and environment, but also accelerated the occurrence of yellow sand and PM2.5, influencing the atmosphere of other regions and countries. Restoration of these lands is the last resort for halting and reversing this desertification. In this study, we examined the relationships between shrubs and soil micro-environments in sand dunes of the Horqin Sandy Land, in a search pioneer plants that can be used for restoration. A transect was installed on each of the sand dunes Nogstai and Bainmod. Five plots of 5 × 5 m were set in each transect, and a vegetation survey was conducted. We also collected and analyzed soil samples from depths of 0–5 cm and 5–15 cm.

The soil moisture contents were relatively low on the slopes and tops of the dunes, and higher in the lowlands. The tops and slopes had higher coarse sand contents, and the lowlands tended to have higher contents of fine sand, silt and clay. Furthermore, the fine sand contents were higher on the northern slopes than the southern slopes, and the silt and clay contents were higher at the bottoms of steep slopes than gentler slopes. Moreover, the cation exchange capacity, total carbon, total nitrogen, exchangeable Ca^{2+}, Mg^{2+}, K^{+}, and available phosphate contents were all higher in lowland than tops and slopes of the dunes.

A total of 46 plant species in 17 families were identified in the two dune transects. There were 9 shrubs, 27 perennial grasses, and 10 annual or biennial grasses. Many of the species were in the families *Asteraceae*, *Gramineae* or *Leguminosae*. Plant coverage in the Nogstai and Bainmod transects ranged from 15–90% and 50–98%, respectively, with higher coverage in the lowlands than on the slopes and tops. Perennial grasses grew mainly in the lowlands where the water content was relatively high and where the stable addition of organic matter could be expected. On the other hand, shrubs grew more frequently on the tops and steep slopes, where soil moisture and nutrients were poor. The distribution of shrub species on the Nogstai transect is shown in the Figure.

***Key words*:** Shrubs; soil; sand dune; Horqin Sandy Land

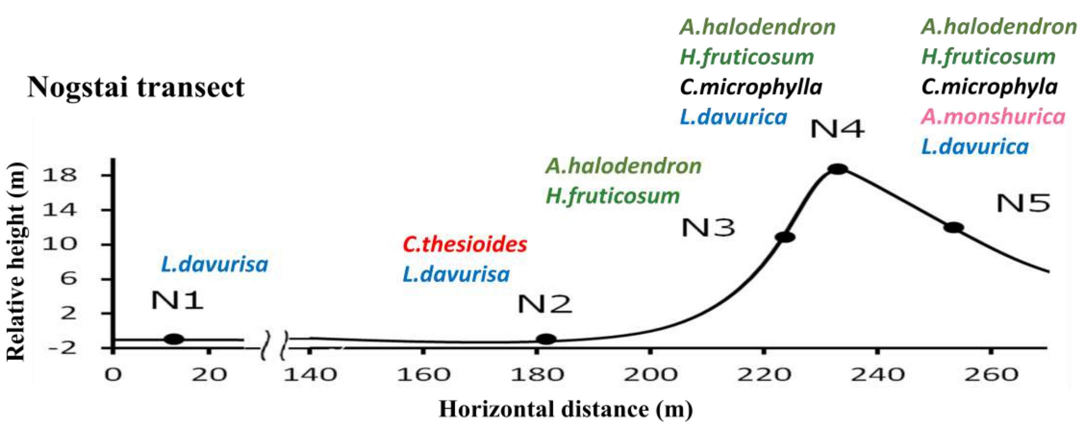

Fig. Shrub distribution in the sand dune transect

Influence of Washing Agents and Soil Particle Distribution on the Removal of Soil Fluorine

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Abstract
Fluorine (F) cannot be decomposed in nature and it is a contaminant that is harmful to human health. Soil properties have large influences on the species and behavior of F in the soil. Finer soil particle and larger soil surface may also affect the adsorption of F on the soil and thus the removal efficiency during soil washing. Therefore, sample of surface soil (0-30 cm) was collected in a F-contaminated site in central Taiwan. The objective of this study is to know the influence of types and concentrations of chemical agents, washing frequencies, and soil particle distribution on the removal efficiency of F from contaminated soil. Experimental results show that 1.0 M NaOH had greater removal efficiency compared with other agents. The total removal of F from contaminated soil also increased with the increasing of washing number; however, there was no significant difference of various particle size distribution on the removal of soil F.

Key words: Chemical washing; fluorine; soil particle

Funding
This program was funded in part by the Ministry of Education, Taiwan, R.O.C., under the Higher Education Sprout Project.

Assessment of soil erosion at Anbandegi using ^{137}Cs and $^{210}Pb_{ex}$ measurements and USLE

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Abstract

Soil erosion is a serious problem around the world, causing degradation in soil productivity as well as eutrophication nearby rivers and streams. The universal soil loss equation (USLE) has been mostly used for estimation and management of soil erosion in Korea and elsewhere. Some of the disadvantage of the USLE are requiring a lot of information to calculate the factor and being difficult to understand the spatial erosion and deposition pattern. As an alternative, erosion studies using the fallout radionuclides (FRNs) such as ^{137}Cs and $^{210}Pb_{ex}$ are using conducted in many countries, especially in European countries. Unlike the USLE, the FRNs would enable to understand the specific spatial variation of soil erosion and deposition. In addition, the estimation of soil erosion using the FRNs can be performed through measurement of radioactivity in the soil sampling only. The objectives of this study were to investigate the potential of the FRNs for soil erosion and to compare estimated soil erosion by USLE and that by FRNs at soils of highland in Anbandegi. Soil erosion was assessed by USEL and FRNs. Anbandegi was vulnerable to soil erosion due to more than 30% slope with low vegetation cover, resulting in 83.5 and 112.5 ton ha^{-1} yr^{-1} assessed by ^{137}Cs and $^{210}Pb_{ex}$, respectively. Whereas the soil erosion of the same area at Anbandegi estimated by USLE whit K factor of cheongryong series was 166.0 ton ha^{-1} yr^{-1}. Those result indicated the limitations of USLE in estimating soil loss depending upon land use and site-specific characteristics of the land. Therefore, soil erosion estimation using FRNs can be more suitable for the farm lands in highland.

Key words: Soil erosion, FRNs, ^{137}Cs, $^{210}Pb_{ex}$, USLE, Highland.

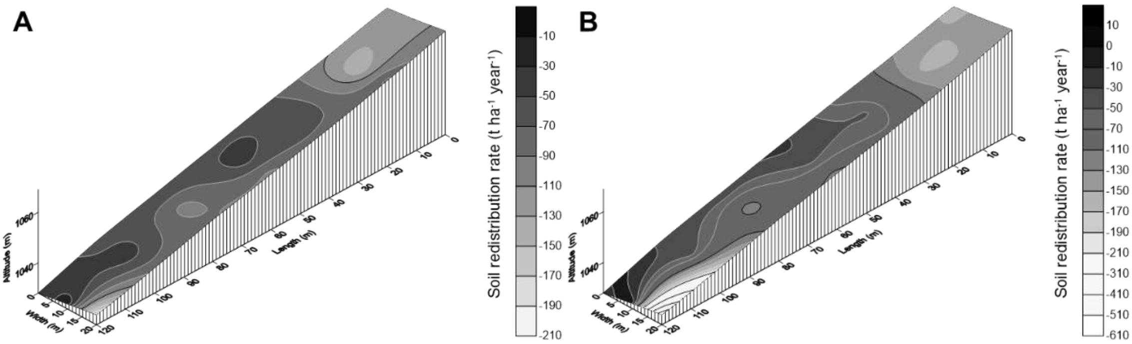

Fig. 1. Distribution of soil redistribution rates (t ha^{-1} yr^{-1}) estimated using ^{137}Cs (A) and $^{210}Pb_{ex}$ (B) measurements in a sampling site

Influence of urban agriculture practice associated with organic amendment addition on qualitative change of soil organic matter and linkage with soil quality and health

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Abstract
Legacies of anthropogenic perturbation in Cleveland (Ohio, USA) have impacted soil characteristics, contributing to degradation in the soil quality and health. Through an earlier study, we found that urban agriculture practice, most likely associated with organic amendment addition, has led to increase in total organic matter (TOM) and subsequent improvement of other soil properties. Also, various soil parameters, in particular heavy metals, represented beneficial relation with TOM in urban farm (UF) soils, but not consistent in other soil types. Thus, we questioned that rather than TOM, qualitative measure of soil organic matter (SOM) would offer a better understanding of how soil characteristics are determined by and associated with the effect of land use change. To assess the qualitative difference in SOM, labile organic C fractions such as permanganate-oxidizable carbon (POXC; i.e., active C) and potentially mineralizable carbon (PMC) that reflect C sequestration and short-term mineralization, respectively, were determined in the present study. The objective of this study was to quantify the influence of change in land use history on POXC and PMC fractions in the Cleveland soils and to determine their potential roles in restoring the degraded quality and health of urban soils by agricultural practices. Compared with grass/open field Metroparks and rural farms (RF), soils of urban vacant lots (VL) contained similar amount of TOM but had significantly lower level of POXC and higher level of PMC. By contrast, UF soils converted from post-vacant lands had the highest levels of both POXC and PMC, albeit only POXC level increased markedly. Also, compared to VL, UF soils had significantly elevated biomass of gram-negative and -positive and actinomycetes bacteria among soil organisms. Overall, POXC was more sensitive to change in land use than PMC and other soil properties, but also appeared to have better relationships with the multiple soil parameters, e.g., moisture, ammonium, soluble Ca and Mg, and heavy metals, in the OM-amended urban soils. These results suggest that increased active C via urban agricultural management associated with organic amendment input could be a major determinant in the improvements of urban soil functions such as C sequestration, nutrient availability, remediating hazardous elements, and biological structure and abundance, thereby contributing to sustainability of urban ecological services.

***Key words*:** urban farming; compost additives; POXC; PMC; soil resilience

The Growth Characteristics of Italian Ryegrass under the Saemangeum Reclaimed Land in Korea

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Abstract

Recently it has been investigated that it is utilized as a livestock complex by cultivating a forage in reclaimed land with high salinity. This study was conducted to investigate the differences in growth characteristics of Italian ryegrass (IRG) 6 cultivars at the constant salt concentration of Saemangeum reclaimed land in Korea. The salt concentration of soil was tested at two levels of 0.3% and 0.1%. Kowinearly cultivar significantly survived more than others at same soil salt concentration. The stem height of IRG was 92cm for soil salt 0.1%, and 83cm for soil salt 0.3%. In comparison between varieties, stem length of Grazer cultivar was 91.4cm, it was significantly higher than that of Florida80 cultivar 84.6cm. The length of ears was 23.6cm in Greenfarm cultivar and tended to be larger than 21.6cm in Kowinearly and 21.6cm in Florida80. The soil salinity affect the seed weight of one ear which was 0.31g at 0.1% level higher than 0.26g at 0.3% level. The thousand seed weight of Kowinearly was 2.51g, which was statistically higher than 2.15g of florida80.

Key words**:** Italian ryegrass, reclaimed land, varaietal characteristics, seed production

Effects of Iron and Sulfur on Transformation of Arsenic Species in Fluvial Sediments

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Abstract
Arsenic (As) is carcinogenic and toxic to ecosystems. The understanding for it's speciation, solubility, mobility and biotoxicity in the environment could improve the efficiency for the remediation of arsenic contamination. The common inorganic arsenic species are arsenite (AsO_3^{3-})[As^{3+}]) and arsenate (AsO_4^{3-} [As^{5+}), and As^{3+} is more toxic than As^{5+}.Studies have shown that under anaerobic conditions, the iron (hydrogen) oxidized minerals that adsorb or co-precipitate arsenic in the soil will be reduced and dissolved, which will release arsenic into the liquid phase and cause harm to the ecology. Therefore, if the influence of environmental factors on the concentration, solubility and species transformation of arsenic can be understood, it will help analyze and manage the movement and distribution of arsenic in river. Besides, numerous studies also indicated that the distribution of arsenic species is closely related to iron and sulfur in the environment. The environmental factors affect the mobility and the bindings between arsenic, iron and sulfur. Thus, this study aimed to determine the effects of sulfate and irons on the dissolution and species transformation of arsenic in fluvial sediments. Arsenic chemicals have been widely used in industrial and semiconductor manufacturing processes. Therefore, the fluvial sediments were collected from the Fazih River and the Wu River watersheds in the Taichung Industrial Park. They were amended with different sulfate-to-iron(SO_4^{2-}:Fe) molar ratios and incubated under anaerobic conditions for 30 days. Results showed that increasing addition of sulfur would cause more dissolution for arsenic and iron. The combination of sequential extraction procedure (SEP) and the X-ray absorption spectroscopy (XAS) data showed that dissolved arsenic may be released from the proportion complexed with organic matter and sorbed on poorly crystalline Fe and Al (hydr)oxides. XAS results suggested that arsenate was reduced to more toxic arsenite during the incubation period.

***Key words*:** Arsenic speciation; iron; sulfur; X-ray absorption spectroscopy; Sequential extraction procedure.

Adsorption mechanism and characteristics of Cu^{6+}, Ni^{2+}, Cu^{2+} and Zn^{2+} by biochar derived from agricultural wastes

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Poster presenter: YU-JIE CHIEN

Abstract
Water contamination by heavy metals has become more and more serious problem. Biochar possesses good pore structure, large specific surface area and a variety of surface oxygen-containing functional groups. This excellent physico-chemical characteristics of biochar is helpful for adsorption and immobilization of heavy metals. The objectives of this study were to study the effects of biochar type, pyrolysis temperature and biochar addition on adsorption characteristics of heavy metals of Chromium (VI), Nickel (II), copper (II), and zinc (II) in contaminated water. In this study, rice straw, pineapple leaves, rice husk and corn waste biochar were produced at 300, 400, 500, 600, 700 and 800 °C. The influence of feedstocks and production temperature on the adsorption characteristics and removal mechanisms of heavy metal on biochars were investigated by adsorption tests. For heavy metal removal, the effects of various type of heavy metal, initial heavy metals concentrations and adsorption time on the heavy metal adsorptive performance of biochar were studied. The experimental validation data were evaluated by adsorption kinetics and adsorption equilibrium. The results showed that biochars produced at higher temperatures had significantly higher pH values and surface areas. Scanning electron microscopy (SEM) clearly confirmed the nanoscale porous structure and interconnected pores that heavy-metal ions can easily enter. The surface of biochar contains functional groups rich in C, H, O, etc., which are able to form stable complexes with heavy-metal ions. The current results revealed that the biochars dramatically enhanced the efficiency of heavy metals adsorption. The kinetic model will be used to fit the adsorption data of biochars. In conclusion, target biochars derived from agricultural wastes provide a potential application for environmental remediation of water or soil contaminated with heavy metals.

***Key words*:** Heavy metal; biochar; adsorption characteristics; adsorption mechanisms; agricultural wastes.

Soil education for pre- and elementary-school children towards setting an international standard. – How to convey the importance of top soil to support life from the viewpoint of daily rice consumption.

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Abstract

A questionnaire with questions for rice and/or soil was distributed to elementary school pupils, junior high school students, high school students, and university students in order to investigate the actual condition of their recognition on soil. The following results were reported (Hirai and Hirai, 2015), 1) the ratio of the number of the answerers who answered “the soil had better exist a lot as much as possible in their surroundings” to the total one of the answerers is lower than its ratio of those who answered “the soil had better exist a little”, 2) there was significant positive correlation ($p < 0.05$) between “the ratio of the number of the answerers who answered “I want to know more about the soil” to the total one of the answerers and its ratio of those who answered that “they touched the soil when they cultivated paddy rice and/or upland crops”. This finding indicated that touching the soil when they produced rice and/or upland crops should be important to improve their concern with soil, 3) **most of the students recognized the soil function of plant production, but <u>few student recognized the area of paddy fields to produce the amount of average rice consumption per person per year in Japan</u>,** 4) the university students affiliating to Faculty of Education were less concerned with soil than those of Faculty of Agriculture, so that it was indicated that soil education should be performed to those affiliating to Faculty of Education in order to improve the elementary school pupils’ concern with soil.

Based on these results, we examined how to convey the importance of top soil to support human being’s life from the viewpoint of daily rice consumption and rice cultivation in Japan for elementary school children, especially 6th grader of elementary school. That is because the concern to soil for the 6th grader of the elementary school children is highly decreased, as shown the result of questionnaire survey that more than 30% of primary school children in the sixth grade replied “I would not like to know about soil.”, but only about 10% in the fifth graders did so in Tokyo (Hirai et al., 2017).

Therefore, in order to convey the importance top soil for daily rice consumption to the 6th grader, we would propose the following lecture with experiment and observation. 1) Prepare for dried rice of 70 g for edible rice ball of 150 g. The amount of the rice ball might be good enough not to feel hunger in one dish. The rice ball is around daily rice2) Count dried rice particles of five grams, and then calculate the number of grains of 70 g of the dried rice. 3) Go to a rice field and pick up one rice hill together with top soil of 15 cm depth under the rice hill, 4) Count the number of panicles of the rice plant and the number of rice hull in a panicle. 5) Multiply the number of rice hull with the panicle number, then total rice hulls can be obtained. 6) Finally, pupils can notice how many rice hills tighter with top soil of 15 cm depth are necessary to produce the number of rice grain of edible rice ball of 150 g.

***Key words*:** questionnaire survey for rice and/or soil, concern of pupils and students to soil, area to support rice consumption per person per year, the teaching contents of top soil through daily rice consumption

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The accumulation of Gallium (Ga) and Indium (In) in rice grains in Ga- and In-contaminated paddy soils

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Abstract

Emerging contaminants gallium (Ga) and indium (In) are commonly used in semiconductor manufacturing and electro-optical industries. Recent studies have shown that the concentrations of Ga and In in the environment are elevated, which might increase the risk of exposure to Ga and In through crop consumption, and further cause adverse effects to human health. Due to the rice is the staple food for over 90 % of the population in Asia area, and limited information is available on the accumulation of Ga and In in rice grains to date. Therefore, pot experiments were conducted to investigate the effects of Ga and In on the growth and the accumulation of Ga/In in rice plants grown in various soils. Rice plants were grown in three soils (Pc, TWz and Cf series soils) spiked with 30, 50, 100 mg kg^{-1} of Ga or In, respectively. The results of pore water indicated that the concentrations of Ga and In in pore water were increased with the concentration of Ga/In-spiked in all tested soils, and those concentrations were decreased with growth time. The aluminium (Al) concentration in pore water of Pc soils was higher than TWz and Cf soils, due to it had a higher amount of available Al in soils. There was no growth inhibition were found under Ga and In treatments for three tested soils. The Ga concentrations in brown rice decreased with the concentrations of Ga spiked in Pc soils, but those increased with Ga concentrations in TWz soils, which might be resulted from competitive uptake between Ga and Al in rice plants. However, there was no significant difference in Ga concentrations in brown rice among Ga treatments in pH-neutral soils (Cf soil). For all tested soils, there was no significant difference in the concentrations of In in brown rice among different In treatments. In addition, it also found that the concentrations of Ga in brown rice were about one order of magnitude higher than In. These results suggest that the accumulation of Ga in rice grain is strongly related to the Al availability in paddy soils.

Key words**:** rice grain; emerging contaminants; gallium; indium; aluminum; competitive absorption

Mo speciation in soil on the bioavailability of Mo to rice plant

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Abstract

Molybdenum (Mo) is an essential trace element to plants. Because Mo has been widely used in the production of technological products, an increasing Mo concentration in the soils of farmlands near the factories has been reported. The potential risk of Mo accumulation in staple food needs to be elucidated. Mo availability in soils was determined by factors such as soil pH, the contents of iron oxides and organic matter, and phosphate availability in soils as reported in the literature. However, Mo speciation, which also plays a key role in Mo accumulation in plants, is relatively less studied. Therefore, this study is aimed to investigate the effect of soil properties and Mo speciation in soils on the bioavailability of molybdenum to rice. A pot experiment was carried out in a phytotron with natural sunlight. One mM Mo was spiked into three soils with different pHs and textures. In certain time intervals during the growth of rice plants, soil, soil solution, and plant samples were collected. The concentrations and speciation of Mo in soils and plants were analyzed using ICP-AES or ICP-MS and X-ray absorption spectroscopy, respectively. The results showed that Mo concentration in rice plant was not directly correlated to Mo concentration in soil solution, but is significantly influenced by the content of poorly crystalline iron oxide in soils. The result of soil Mo speciation showed that Fe-bound Mo could be the most available to rice plant under submerging incubation. Fe-bound Mo and S-bound Mo were the main Mo species in rice plant. It was concluded that the content of amorphous Fe oxide in soils and the Mo speciation in soils and plants should be taken into consideration when evaluating the bioavailability of Mo to rice plant.

Key words**:** Molybdenum; bioavailability; speciation; X-ray absorption spectroscopy.

Assessment of Human Bioavailability Quotient for the Heavy Metal in Paddy Soils Below Part of the Closed Metalliferous Mine.

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Abstract

This experiment was carried out to investigate the human bioavailability quotient of the heavy metals in paddy soils below part of the closed metalliferous mine. For estimating the human bioavailability quotients for heavy metals, 30 paddy soils below part of the closed mine were collected, and analyzed for Cd. Cu, Pb, Zn, and As using simple bioavailability extraction test(SBET). The quantities of Cd, Cu, Pb, Zn and As extracted from paddy soils below part of the mine by using the SBET analysis were 28.1, 17.3, 34.1, 14.6 and 2.3% respectively. Specially, the maximum values of Cd, Pb and Zn were 73.3, 81.5 and 58.1% of human bioavailability quotient, respectively, and varied considerably among the sampling sites. The human bioavailability quotient of Cd, Cu, Pb and Zn in soils near the closed mine showed significant positive correlation among soil pH value, O.M. and Ex. Ca. contents, while it correlated negatively between soil Ex. K and Ex. Mg contents in paddy soils. Also, its of Cd, Cu, Pb and Zn in paddy soils showed significant positive correlation with 0.1M HCl extractable and total contents, while in soils, it correlated negatively with As content in soil near the closed mine. The results of the simple bioavailability extraction test (SBET) indicate that regular ingestion ofsoils by the local population could be closed a potential health threat due to long-term heavy metals exposure in these mine areas.

***Key words*:** Closed metalliferous mine, Paddy soil, Heavy metal, SBET, Bioavailability

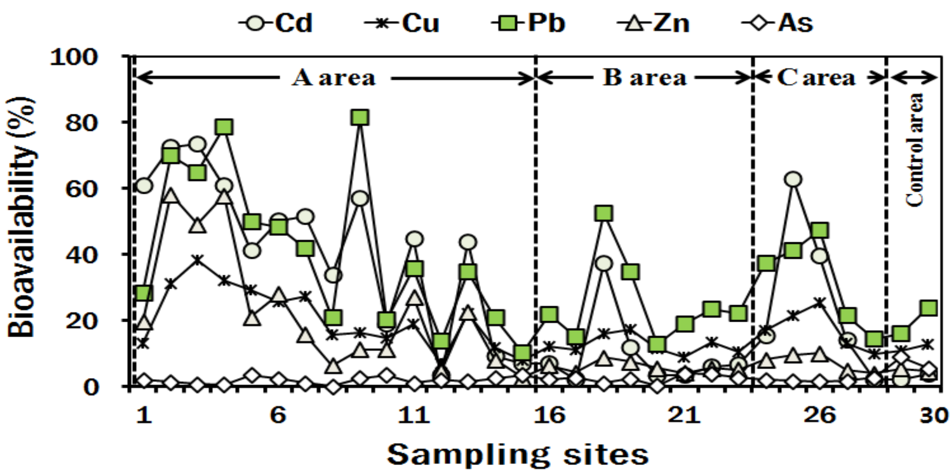

Fig. 1. Variations of human bioavailability quotient for heavy metals determined by the SBET method at sampling site in paddy soils near the closed mine.

Microplastics Pollution in Soils of Yeoju in Korea

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Abstract

Microplastics pollution has recently gained the global attention due to bioaccumulation and biomagnification. Many studies have focused only on the marine environment, whereas microplastics studies on the soil environment were not sufficient. Compared to aquatic and atmospheric environment microplastics in soil environment are long-lasting and easy to accumulate. Therefore, it is important to understand the sources and distribution of microplastics in soils. Agricultural practices, in particular, cause microplastics from plastic film house, mulching and household litters to enter the soil. Therefore, in this study we investigated the distribution of microplastics in soils of Yeoju to identify the sources of microplastics in agricultural land. The microplastics survey was conducted with 2.5 km × 2.5 km grids at Yeoju. Surface soil samples (0-5cm) were collected from each site with a hand auger. Then the land use and land category of each site were investigated. Analysis of microplastics in soils was carried out in the order of drying, density separation, organic matter digestion, filtering followed by quantification/qualification. Microplastics pollution in upland soils and roadside soils was higher than that in paddy soils and forest soils. In other words, the abundance of microplastics increased as anthropogenic activities or utilization of plastics increased. In conclusion, microplastics in soils are likely to enter rivers and oceans by rainfall, so it is urged to set up strategies to reduce microplastics pollution in soils and to restore soils contaminated with microplastics.

***Key words*: Microplastics, pollution, soil, agricultural land

Effect of Pyrolysis Temperature on Sorption of Lincomycin by Biochars

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Lincomycin antibiotic has been widely used in human and veterinary medicine. The increasing environmental concentrations of lincomycin has raised serious concerns on the proliferation of antibiotic resistance genes. Sequestration of environmental lincomycin by biochars produced from waste biomass has a great potential to be a win-win strategy for waste disposal and antibiotic resistance management. In this study, lincomycin sorption by biochars produced at different pyrolysis temperatures (300 to 600 ^{o}C) was examined in detail using batch sorption experiments at solution pH of 6.0 and 9.0. The results indicate that sorption of lincomycin by biochars is significantly affected by both biochar pyrolysis temperatures and solution pH. The lincomycin sorption of biochars was generally greater at pH 6.0 (324 ± 232 μg/g) than at pH 9.0 (190± 177 μg/g), presumably because of the greater electrostatic attraction between the positive lincomycin molecules (i.e., the pKa of lincomycin is 7.6) and negative biochar surfaces (i.e., the isoelectric point of biochars is about 2.0). In addition, the lincomycin sorption to biochars at pH 6.0 exhibited a positive relationship, while that of at pH 9.0 exhibited a U-shaped relationship with increasing pyrolysis temperature from 300 to 600 °C. The enhanced lincomycin sorption to low temperature produced biochar (i.e. 300 ^{o}C) at pH 9.0 was presumably due to the greater amount of dissolved organic carbon (DOC) released from the biochars under more alkaline condition and the DOC-blocked pores and sorption sites became available, thus increasing the lincomycin sorption. Overall, the results suggested that biochars produced at high pyrolysis temperature have the great potential as a novel sorbent for sequestering lincomycin from waters.

Key words: Biochar, Lincomycin, Antibiotics, Sorption, Pyrolysis temperature

Comparison of Japanese Soil Map based on World Reference Base for Soil Resources 2014 and 2006

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Abstract

In recent years, FAO-GSP in cooperation with IUSS, has taken an initiative to prepare and share soil information of the world, and to promote sustainable soil management. In order to respond to these activities, it is necessary to be able to uniformly disseminate Japanese soil information to the world. In 2011, we made the Comprehensive Soil Classification System of Japan, 1st approximation (CSCJ), which can classify the soils nationwide of land area regardless of land use. In 2016, we have already created the new Japanese soil map as a scale of 1:200,000 based on this CSCJ. In our previous study, we have made Japanese soil map based on WRB 2006 (Kanda et al. 2018). Then, we make a soil map with the legend of World Reference bases on soil resources 2014, and compare with Japanese soil map based on WRB 2006.

WRB 2014 soil map was created by making a correspondence table between the CSCJ and WRB 2014. Because of major changes on WRB 2014, several changes have occurred as follows; 1) The Gleyed Andosols soil group does not correspond to Andosols, and it moved to Gleysols. 2) Gley Lowland soil group transfers from Fluvisols (alluvial soil) to Gleysols. 3) Humic subgroups of Gray Lowland soils, Brown Lowland soils, Red-Yellow soils and Brown Forest soils correspond to Umbrisols (a soil with an acidic dark surface horizon). About the distribution area of each RSG in Japanese soil map on WRB 2014, Cambisols are 38%, Andosols are 32%, Fluvisols are 8%, Gleysols and Regosols are 5%, Alisols, Podzols, Anthrosols, Leptosols and Histosols are 1-3%, respectively. The major differences between soil map between WRB 2006 and WRB 2014 are as follows: 1) The distribution area of Gleysoils increased mainly due to be reclassified from Fluvisols. 2) Umbrisols distributed only 0.3% in Japan are newly added (Fig.1).

Key words: Soil classification; soil map; WRB 2006; WRB 2014.

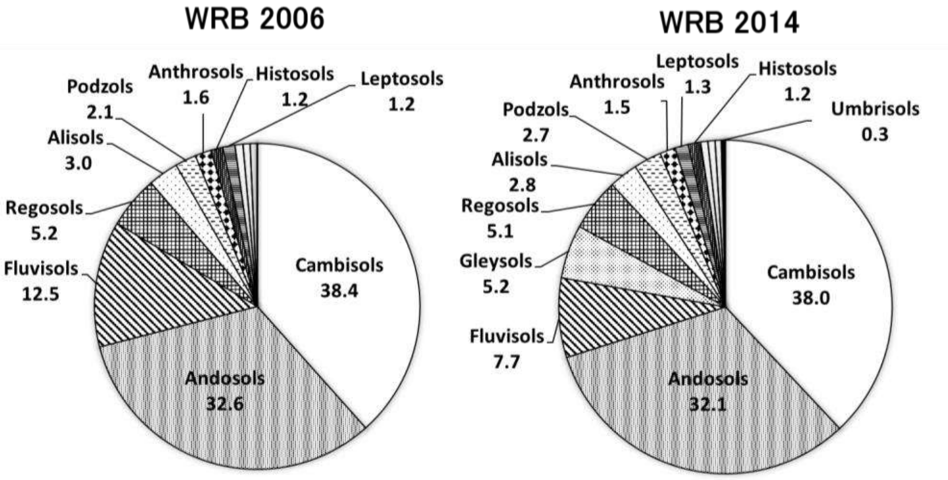

Fig. 1. Comparison of distribution area (%) of RSGs in Japanese soil map on WRB 2006 and 2014.

Reference

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The carbon storage along soil profile and its chronometric application －an example of soil chronosequence from the fluvial terraces on the Pakua tableland in central Taiwan

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Abstract

There are multiple levels of river terraces developed on the Pakua tableland in central Taiwan. The surface deposits of the terraces were weathered into reddish soils and gravels. The field morphologies and some basic analyses of the soils were well published in the literature. Unlike many of the reddish or lateritic soils in Taiwan, these soils have been recently well dated and give absolute ages at a range of 19-400 ka. As a result, they form an ideal soil chronosequence, with time constraints to explore the soil organic carbon (SOC) storage and its change through time. This study attempts to establish a SOC time series and to give an estimate of long-term accumulation in terms of SOC storage in the red soils of Taiwan. The soils and some of their data used in these studies were taken from the soil profiles in our previous studies. Two additional soil profiles were sampled for those soils or data are not available from the previous studies. The total carbon storage (TCS) for each soil profile is measured and assessed based on different depth categories of 0-30 cm, 30-50 cm, and 50-100 cm. TCS is further justified by the total thickness of the soil profile, giving the weighted carbon stocks (WCS), for comparison.

This study shows the overall carbon stocks are estimated at 2.8-3.2 $\times 10^9$ kg, with the manner of TCS and WCS, for the soils of the Pakua tableland. Moreover, the SOC tends to be highest in the surface or the most shallow soil horizons and decreases with the soil depth. The continuous pattern of carbon content in vertical distribution approached by a negative exponential function shows the amount of carbon in the soil becomes stable from a various depth ranged 50-100 cm. The carbon content at the turning point is termed carbon sequestration value (ESV), which indicates the break-down of carbon is quasi-equilibrium in the amount with the accumulation of in-situ and leaching carbons. This study shows the ESV from the exponential fitting curve of the soils are closely related to soil ages. The value of ESV linearly decreases with age. The examples in this study demonstrate the correlation for the soils without age that can be achieved by the degree in pedogenesis in an agreement with those determined by ESV in this study. It reveals the potential of using carbon storage for a chronometric application.

Keywords: Soil organic carbon, Carbon stocks, Soil chronosequence, Pakua tableland

Impacts of Categorized and Un-categorized expression of Soil Properties on its Mapping Results-Taking the Mapping Representation of Qinghai Soil Survey Data as an Example

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Abstract
Spatial representation of soil properties is always one of the most useful approaches of soil knowledge application, which is commonly achieved by investigating soil profiles that can best represent typical types of soil groups or soil series etc., and those properties will be applied to all patches of same soil type consequently, under the assumption of the same soil types should have the same soil properties. But the underlying soil type maps may have many uncertainties and even errors on it shapes and boundaries as well, just as many researchers have identified nowadays. Where new approaches of digital soil mapping raised rapidly based on assumptions of similar environments will develop similar soil properties, which mapping soil properties according to relationships between properties and environmental factors via data mining techniques, such as machine learning and fuzzy clustering etc.

This article compared the difference of two soil mapping patterns under two soil classification frames (soil genetic classification and soil taxonomic classification), by using two sets of soil survey data (one from the 2nd national soil survey in 1980s, and another from soil series survey in 2010s) accordingly. Soil is the product of long-term interaction of climate, topography, biology, parent material and other factors.The more similar the environment, the more similar the attribute of the target variable. Therefore, soil attributes or combination of attributes and soil types can reflect the environmental conditions of a specific area.

The results showed that the machine learning pattern, which is summarized as de-categorized approach, can achieve more continuous distribution of soil properties and will make the results more interpretable in most cases (soil bulk density, texture, soil organic matter, soil depth, etc). While the pattern of linking soil properties with its specific categories, which is summarized as categorized approach, can arose more patched distribution that hard to explain especially when adjacent soil belongs to very different soil types.

Given facts of the 2nd national soil survey has been convinced many inconsistencies between soil properties and their types, we suggested that categorized soil properties mapping approach should be substituted with de-categorized soil mapping approaches as much as possible in order that improve spatial variability interpretability of soil properties.

Key words: Soil properties mapping; spatial variability of soil properties; soil classification system; categorized and de-categorized expression of soil properties.

Consideration of Horizon Designation on ST and WRB Classification

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Abstract

Classification of soil is very important. Clarification of soil classification may be necessary to bind soil in different areas together. If we put the soil in the same category, we can decide how to manage and use it for various purposes.

There are two large classifications worldwide. There are more than 50 classification methods, including countries that have their own classification system in each country. One of the two is the US ST(Soil Taxonomy) and the other is the WRB(World Reference Base for Soil Resources). The ST consists of 12 orders at the top level of the classification and the WRB consists of 32 RSGs (Reference Soil Groups).

To classify the soil, cross-sectional survey is performed by visual observation. Information that cannot be observed with the naked eye is sampled for each layer and standard classification is performed through laboratory experiments. These are combined to produce a soil map. In this process, the separation of layers is very important. The horizon is divided into master horizon and subordinate characteristics.

ST and WRB are slightly different between these two levels, and the suffix symbol is additionally investigated because it is difficult to interpret only with the master horizon. For example, ST uses g when there is a gley layer. However, in the WRB, l (a part of the gley layer is oxidized) and r (gley layer are distinguished). This means that the person who carries out the classification is different when choosing the ST and WRB.

If the groundwater level is lowered, air is injected and eventually converted to an oxidation state. This degree of oxidation is important in the movement of water in terms of agricultural conditions, so it is necessary to subdivide them. It is necessary to add quantitative classification of degree of oxidation..

Key words**:** Soil Taxonomy, WRB, master horizon, suffix symbol, designation for layers

Assessment of Soil Mineralogy in Mangrove Forest at Pulau Kukup, Johor and Delta Kelantan, Malaysia

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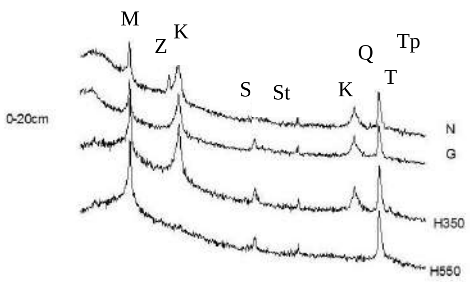
Abstract

Mangrove forests are a unique ecosystem that provides numerous services to marine environment and serves as natural barriers against shoreline damage. Mangrove rehabilitation and reclamation are important to conserve and restore mangrove forest ecosystem. Beside vegetation, knowledge on mangrove mineralogical composition of soil in these environments also important. This study was carried out to determine the soil mineralogy in selected mangrove areas at Pulau Kukup, Johor and Delta Kelantan in Tumpat district, Malaysia. Soils from 2 mangrove areas were sampled at depths of 0 to 20 cm, and 60 to 80 cm. Mineralogical analysis were performed in clay fraction by X-Ray Diffraction (XRD) and Transmission Electron Microscopy. The clay fraction for both mangrove areas contained muscovite, zincopiapite, kaolinite, spiroffite, gibbsite, quartz, terskite, and tarapacaite. Lintisite, bariandite, and amthoinite can be found only at Delta Kelantan while claraite, admontite, and struvite can be found only at Pulau Kukup, Johor. The mangrove soil at Pulau Kukup, Johor and Delta Kelantan present an assemblage consisting kaolinite as autochthonous or allochthonous minerals. From the research findings, it can be concluded that there are several differences and similarities in soil mineralogical composition for both mangrove areas.

Key words: Clay mineralogy, mangroves, Transmission Electron Microscopy, X-Ray Diffraction (XRD).



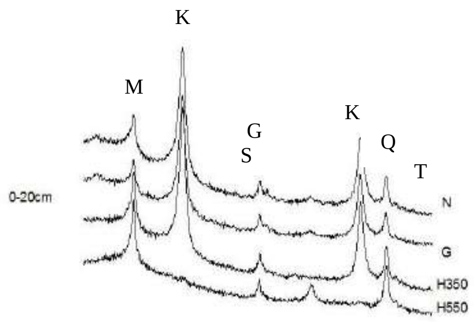


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Figure 1: X-ray diffraction patterns in the clay of the Pulau Kukup, Johor mangrove soil at depth of 0-20; M = Muscovite, Z = Zincopiapite, K = Kaolinite, S = Spirofite, St = Struvite, Q = Quartz, T = Terskite, Tp = Tarapacaite

Application Effects of Clinker-Tea-Waste-Compost on Paddy Rice Cultivation

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Abstract
In Japan, the application of silicic acid materials and iron materials is not carried out sufficiently, and the silicic acid content in the soil is decreasing. Clinker is a type of coal ash produced after the combustion of coal discharged from a thermal power plant. It is desirable to use it as a siliceous material for paddy fields because of rich in silicic acid. In this study, clinker tea waste compost (CTWC) made from clinker and tealeaf waste was applied to the paddy field, and the effect on growth, lodging resistance and yield of paddy rice were examined. This research has been conducted for three years from 2016 to 2018 in the Experimental Paddy Field at University Farm, Ehime University. In 2016 and 2017, the area applied with 7 gN m^{-2} of CTWC (N:P:K=0.59:0.12:0.06) was regarded as a standard application rate, and 1.5(CTWC1.5) and 1.9 times(CTWC1.9) of the rates were also set up. As a control treatment, chemical fertilizer (CF, 14:10:10) was applied at 8 gN m^{-2}. In 2018, instead of CTWC, chemical fertilizer (14:14:14) was applied to every treatment at 5.2 gN m^{-2} to evaluate the residual effect of CTWC applied before. Both in 2016 and 2017, the rice yield was not affected significantly even by the increase in application rate. However, the lodging index of paddy rice in 2017 had a strong correlation with the compost application rate suggesting that the application of CTWC increased the silicate content in the rice and strengthened it against lodging. The growth indexes of rice in 2018 were the highest at CTWC1.9 times of CTWC, and the stem number was the highest after 40 days after transplantation of the all treatments, and the yield was also the highest. It is considered that the residual effect of nitrogen in the CTWC applied in 2016 and 2017 worked, but further studies would be required.
***Key words*:** Clinker; compost; lodging resistance; rice; silicate; tea waste.

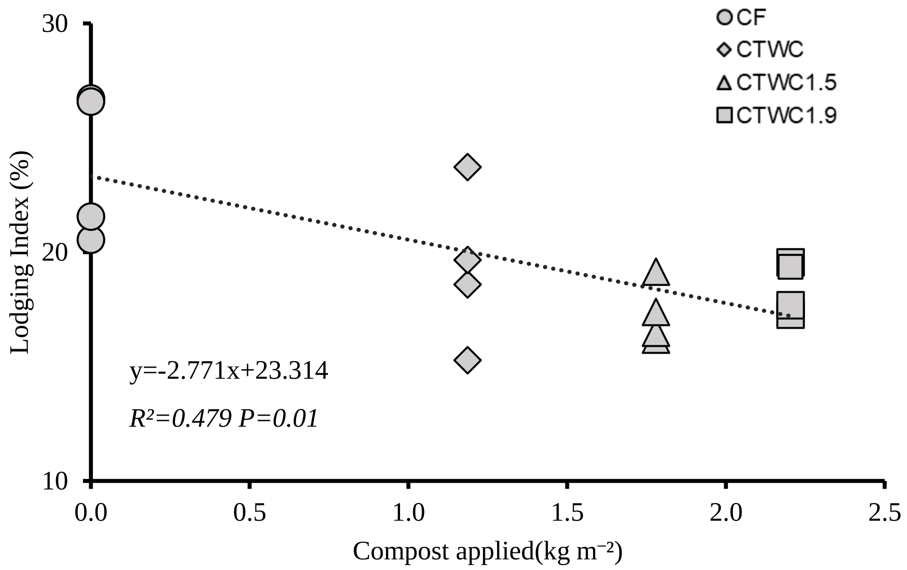

Fig. 1 Relationship between lodging index and the rates of CTWC application

EFFECTS OF ORGANIC FERTILIZER TYPES AND FOLIAR FERTILIZER DOSES ON THE QUERCETIN CONTENT OF LONGEVITY SPINACH GROWN ON ANDISOL AND VERTISOL

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Abstract

Quersetin is a compound produced by secondary metabolism of flavonoids in longevity spinach. Quercetin is used by humans because of its use as an anticancer. It is currently being cultivated to be used for herbal medicine. This study aimed to determine the effect of organic fertilizer types and foliar fertilizer doses on the quercetine content of longevity spinach. This research was conducted at the Greenhouse of Kuningan Laboratory, Department of Soil Science, Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta from December 2017 to May 2018. Quercetin test was carried out at Balittro, Cimanggu Bogor by spectrophotometric method. The treatments applied were two types of soil, namely Andisol and Vertisol, neem compost 10 tons/ha, chicken manure 10 ton/ha and Gandasil D fertilizer with doses of 1.2 and 3 g/L and a combination of the three fertilizers. Total N contentof the soil, N available, and total N in plant tissues were analyzed using the Kjeldahl method, Cottenie method, and wet destruction method with extracts of sulfuric acid and peroxide acid, respectively. The results showed that the addition of chicken manure and neem compost significantly affected soil pH, organic matter, cation exchange capacity (CEC), and total N in plant tissues. The application of Andisol and chicken manure with 1 g / L foliar fertilizer was the best treatment increasing the quercetin content of longevity spinach by 1.20%.

Keywords: Quersetin, chicken manure, neem compost, longevity spinach

Chemical Compositions of Tea Leaves of Shy−Jih−Chuen Tea Trees With Different Growing Exhibitions

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Abstract
Shy−jih−chuen, a cultivar of the tea tree, is popular in Taiwan and covers a large area of tea-growing regions at low altitudes. The aim of this study was to investigate the chemical compositions of the tea leaves sampled from the tea trees with good (G) and bad (B) growing exhibitions using aerial photographs. To compare the differences, the chemical compositions were determined by the colorimetric method via the UV/visible-spectrophotometer. The caffeine, catechins, flavone, free amino acid, total polyphenol contents were 6.3–10.6%, 47.9–81.6 mg/g, 7.8–15.1 mg/g, 1.3–4.3 mg/g, 96.7–183.9 mg/g, respectively. The medium value of catechins of B was significantly higher than that of G. Otherwise, the caffeine, flavone, free amino acid, and total polyphenol contents were not significantly different between G and B. The results show that the growth exhibition of shy-jih-chuen trees affected the catechins content in tea leaves the most. Therefore, the flavor of the tea infusion may be indirectly affected but still needs to be clarified in further study.

Key words**:** Chemical compositions; growth exhibition; large-area experiment; tea

Funding
This program was funded by the Ministry of Science and Technology of the R.O.C. (Grant number MOST 107–2313–B–005–016).

Micro Minerals Deficiency-Specific Changes in Primary Metabolites in the Shoots and Roots of Cabbage

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Abstract
Responses of metabolic network to mineral deficiency, especially micro minerals such as Fe, Cu, Mn and Zn, are partially or poorly understood due to lack of related research. Here, we conducted a detailed, broad-scale analysis of metabolic changes in the shoots and roots of cabbage plants in response to micro mineral deficiency. Cabbage plants of uniform size were transplanted into aerated 20 L hydroponic containers including 1/2-strength Hoagland nutrient solution and grown for additional 2 weeks prior to the initiation of treatment. To generate individual micro mineral-deficient conditions, Fe, Cu, Mn or Zn was eliminated from the nutrient solution. Cabbage plants displaying similar levels of growth within each treatment group were harvested to analyze primary metabolite levels at 15 d after the onset of treatment. The levels of primary metabolites analyzed in this study were greatly differed from the type of mineral deficiency and plant organs. The levels of carbohydrates generally decreased in the shoots whereas, in the roots, their levels showed different response with the types of mineral; decrease in iron and zinc deficiency and increase in copper and manganese(Fig. 1, upper left). Several intermediates of glycolysis-TCA cycle also represented that their levels greatly depended on the types of mineral and plant organs. Most of intermediates in the shoots and roots decreased due to the lack of micro minerals whereas some metabolites somewhat increased by zinc deficiency in both organs(Fig. 1, upper right). Most amino acids greatly decreased by iron deficiency in the shoots, on the other hand, zinc deficiency led to marked increase in the levels of most amino acids. In the roots, it was observed that copper and zinc deficiencies resulted in noticeable increase(Fig. 1, bottom). Some notable findings in terms of metabolite changes in response to micro minerals deficiency included that 1) iron was one of major minerals which limits the synthesis and metabolic cascade of primary metabolites and 2) the amino acid metabolism is greatly influenced by zinc deficiency. These findings might pave the way for studying the effects of the simultaneous deficiency of more than one micro mineral on this crop.

Key words: Micro minerals; deficiency; primary metabolites; cabbage.

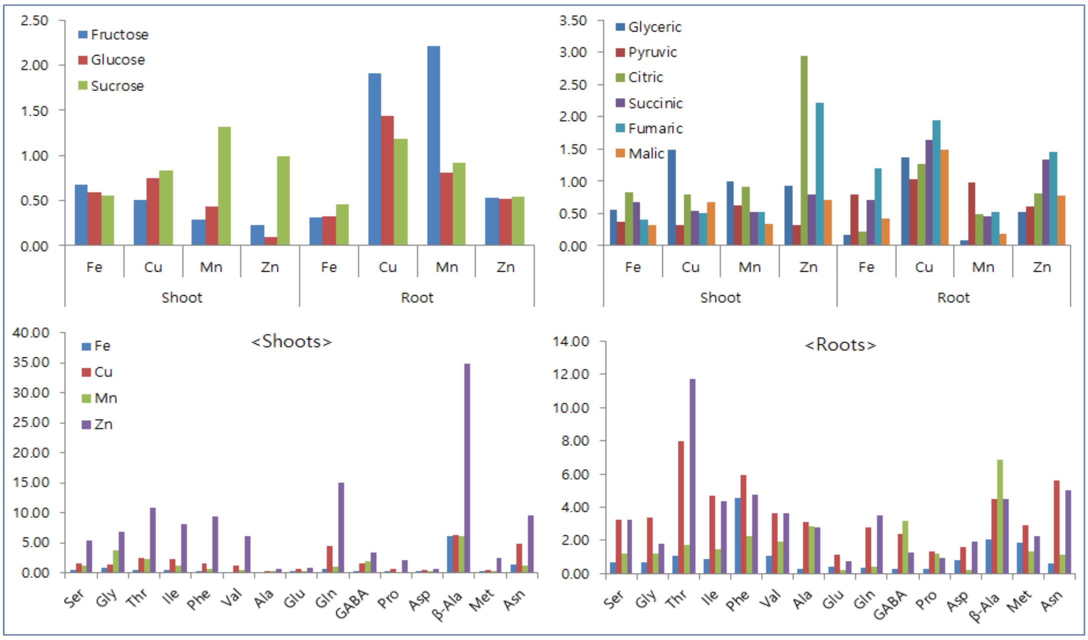

Fig. 1. Differences in the levels of metabolites in the glycolysis/TCA cycle and amino acid biosynthesis in the shoots and roots of cabbage plants.

Changes in alpine soil organic carbon decomposition during the last century

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Abstract

The Qinghai-Tibet Plateau grassland plays a significant role in the regional carbon cycle due to its large yet vulnerable permafrost soil carbon pool. Warming on the plateau have higher rates than the other areas in the same latitude, which could promote both the vegetation production, therefore the organic carbon input into the soils, and finally stimulate soil microbial respiration. However, changes in the alpine soil organic carbon (SOC) decomposition dynamics on the plateau over the last century remains largely uncertain. Here, we used a process-based biogeochemistry model, CENTURY, to study the soil organic carbon decomposition changes of alpine grassland from 1901 to 2010. We found that active carbon pool decomposition contributed the most to total respiration, followed by the slow carbon pool decomposition, while the passive carbon pool's contribution was negligible compared to the first two carbon pools. The alpine grassland SOC increased at a rate of 0.03 ton C ha^{-1} yr^{-1} during the 20st century and respiration increased at a rate of 0.12 g C m^{-2} yr^{-1}. The mean residence time (MRT) of SOC decreased by 17% due mainly to the warming.

Key words**:** soil organic carbon decomposition; climate change; alpine grassland; modeling

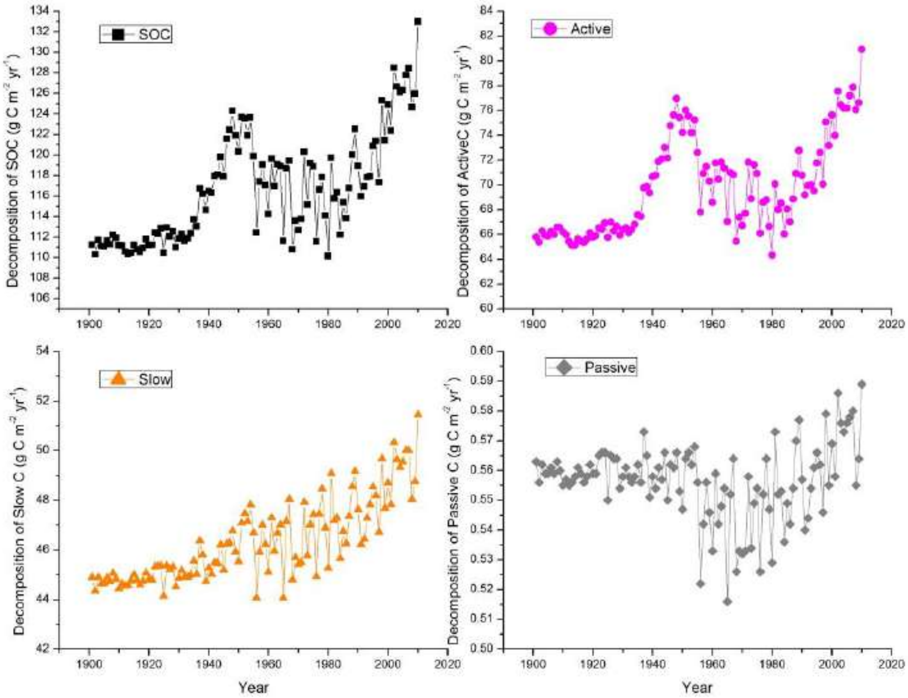

Fig. 1. The decomposition dynamics of the total SOC and three carbon pools (active, slow and passive) during the 20th century.

Effects of Calcium, Magnesium, and Potassium on Copper Toxicity in Grapevine Seedlings and the Physiological Responses

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Abstract

To prevent downy mildew (*Plasmopara viticola*), the intensive and long-term application of copper (Cu)-based fungicides in vine-growing areas has resulted in the significant accumulation of Cu on surface vineyard soils. Excessive amounts of Cu would not only disturb the balance of microbiota in soil but also be a stress on plant growth. Copper accumulation in vineyard soils to result in the Cu phytotoxic phenomena would be dependent upon the soil Cu availability, competition with common existed major cations (i.e. Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, H^{+}, etc.) in soil, plant genotypes, and viticultural practices. The present study aimed to investigate the Cu toxic phenomena in the Kyoho grapevine (*Vitis vinifera* L.) plant under Cu stress. A hydroponic experiment was conducted for testing the grapevine seedlings exposed on the dose of 15 µM Cu with different solution backgrounds of Ca, Mg and K cations. After 7-day Cu exposure, the seedlings were harvest, and the root morphology and physiological traits were observed as the plant response indexes to Cu stress. The plant Cu concentrations in root, stem, and leaf were also measured for illustration of the physiological regulation and root morphological changes. Results showed that the dose of 15 µM Cu resulted in the significant changes of root morphology, reductions of net photosynthesis rate and stomatal conductance, and increases of reactive oxygen species (ROS) and Cu concentrations in grapevine seedlings. While the solution backgrounds, Ca, Mg, and K concentrations, were increased, there were significant relief on root morphological changes, re-enhancement of net photosynthesis rate and stomatal conductance, and retardation of Cu absorption by grapevine seedlings. In addition, the activities of enzymatic antioxidants (i.e. SOD, CAT, APX, etc.) were activated significantly by increasing Ca, Mg, and K concentrations, and then the contents of ROS declined. Overall, the results suggested that there was an alleviation effect of increasing the concentrations of common existed Ca, Mg, and K cations on the Cu toxicity in grapevine seedlings.

***Key words*:** Viticulture; alleviation effect; root morphology; reactive oxygen species; antioxidant.

Alleviation of Manganese-induced Chlorosis by Iron in Sugarcane Seedlings through Reducing Mn Uptake

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Abstract

Previous studies in our lab have revealed iron (Fe)-chlorosis of sugarcane seedlings caused by excessive manganese (Mn) and the alleviation of the chlorosis by Fe application. Thus, elucidation of the mechanisms for Fe amelioration in the plant is necessary. Here, we demonstrated the effect of iron on the absorption, transport and distribution of Mn in sugarcane seedlings. The results showed that chlorotic seedlings greened after the addition of Fe, accompanying by a significant decrease in Mn content in the shoots and roots. Compared to the control without Fe addition, the treatment with 50 and 100 µM Fe decreased Mn uptake rates by 33.1% and 39.9%, respectively, and decreased Mn transfer to the shoots by 63.5% and 42.5%, respectively. By contrary, Fe treatment increased Mn distribution in the residue of the most recent expanded leaf, accompanying by a significant decrease in Mn ratio in the symplast/residue of the leaf. Furthermore, iron treatment enhanced iron plaque formation on the roots surface of sugarcane seedlings, while removal of the iron plaque resulted in more Mn absorption by the plant. These results indicate that the alleviation of Mn-induced chlorosis by iron in sugarcane is achieved by reducing Mn uptake and Mn transfer from roots to shoots, and more Mn distribution into the cell residue fraction.

Key words**:** Manganese; Iron; Chlorosis; alleviation

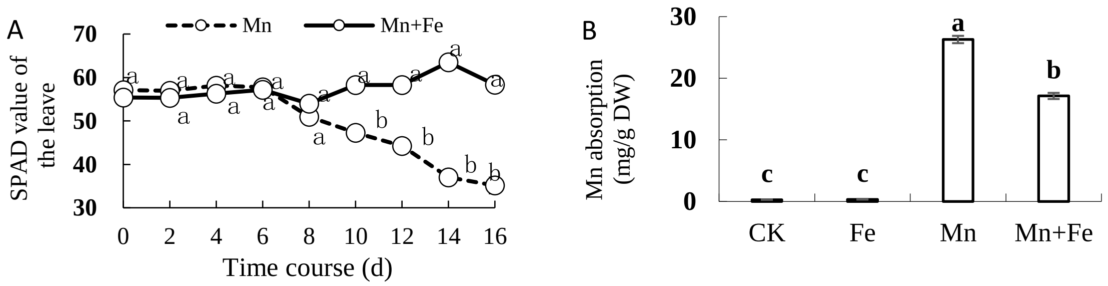

Fig 1. Leaf chlorophyll content indicated as SPAD values (A) and plant Mn absorption (B) after sugarcane seedlings were expose to 0.5 mM $MnCl_2$ solution for 2, 4, 6, 8, 10, 12, 14, 16 d (A) or an nutrient solution with 5 µM Fe (CK), 0.1mM Fe (Fe), 0.5mM Mn (Mn), or 0.1mM Fe and 0.5mM Mn (Mn+Fe) (B).

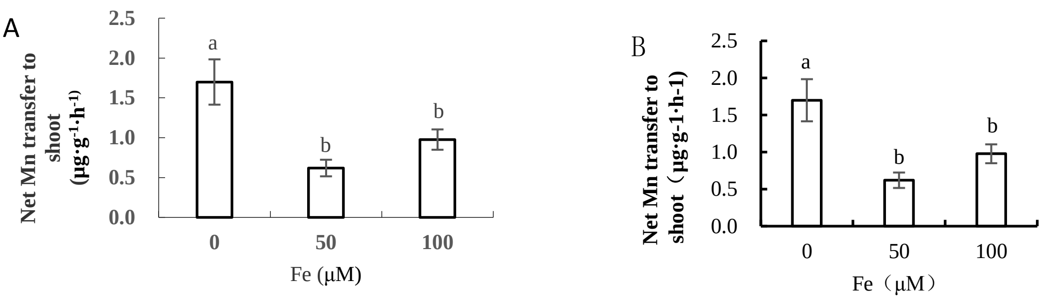

Fig. 2. Net root Mn uptake (A) and Mn transfer to shoot (B) in sugarcane seedlings exposed to solution with 50 µM Mn and varying concentrations of Fe (0, 50, and 100 µM) for 9 h at 30℃ or 4℃ temperatures. Net root Mn uptake and Mn transfer to shoot were calculated by subtracting values at 4℃ from those at 30℃.

Phosphate release from humic acid-ferrihydrite co-precipitates in the presence of citric acid

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Abstract

Previous studies mainly focused on the enhancements of the phosphate (P) availability in soils by organic acids; however, the effects of citric acid on the structures of humic acid-ferrihydrite (HA-FH) co-precipitates and P sorption on HA-FH received less scientific attentions. Because HA-FH co-precipitates distributed widely in soil system and they may become a scavenge of P and citric acids, understanding the interactions of P/citric acids with HA-FH can broaden our knowledge regarding the effects of the geochemical reactions on P managements and C sequestrations. Our collective results showed that the maximum sorption capacities of citric acid on HA-FH co-precipitates decreased with an increasing molar ratio of C in HA-FH co-precipitates. The results of Fe K-edge X-ray absorption spectroscopy (XAS) showed that the local structures of Fe in FH-HA co-precipitates became loose after the addition of citric acid, resulting in decreasing anion sorption capacities. In addition, the P sorption capacities of HA-FH co-precipitates were strongly affected by the order of citric acid or P additions. As P was first added into the systems, the adsorbed P could be released by the citric acid. Thus, the maximum sorption capacity of P on FH-HA decreased 80% as compared with the system without citric acid. On the other hand, adsorbed citric acid may form a diffusion barrier of P, and thus, an approximately 50% declination of the maximum sorption capacity of P on FH-HA co-precipitates was observed when citric acid was added prior to P. Accordingly, the citric acid could improve the availability of P in soils, and the elevation of P availability was more favorable when the citric acid was interacted first with FH-HA co-precipitates.

***Key words*:** Phosphate; citric acid; humic acid-ferrihydrite co-precipitates

The Interaction between Biochars and Soil Colloids in Soils.

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Land application of biochar has been considered as a beneficial soil amendment method. However, most studies investigated the effects of biochar application on soil properties or crop yield, but less on the biochar itself. Thus, the current understanding of soil-biochar interactions in biochar-amended soils is limited. This study investigated the interactions between soil colloidal particles and biochar during the incubation experiment. Acidic soil were amended with rice-straw biochars produced at two different temperatures (i.e. BC350 and BC600). Incubation experiments were conducted to investigate the retention of soil particles such as Fe/Al (hydr)oxides by the biochars. After the incubation experiments, wet sieving procedure was conducted to separate the weakly retained soil particles, and leave the strongly retained ones on the biochars. The retention of Fe on BC350 and BC600 were increasing by about 109% and 231%, respectively, compared to the original counterparts. The contents of quartz on both biochars were also increased as revealed by XRD. Our findings indicated that biochar may retain soil particles, which may further affect the behaviors of biochar in soils, such as the adsorption of phosphorus or heavy metals. These findings provide insights into the interactions of biochar with soil particles and the effects of biochar on the properties of the biochar-amended soils.

Key words**:** biochar; soil colloid; adsorption.

The Establishment and Development of *Haloxylon ammodendron* Promotes Salt Accumulation in Surface Soil of Arid Sandy Land

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Abstract

Haloxylon ammodendron, a representative C_4 succulent xerophyte and salt-secreting plant, is widely used in vegetation reestablishment programs to stabilize shifting sand, and is one of the dominant shrubs in the shelter belt used to control desertification in the desert-oasis ecotone in northwestern China. In this study, we collected soil samples in an age sequence of 0-, 2-, 5-, 13-, 16-, 31-, and 39-year-old *H. Ammodendron* plantations to assess the effects of the shrub on soil fertility and salinity. The results showed that SOC and total N concentrations increased significantly with increasing plantation age and increased 5.95-(in the interspaces) to 9.05-fold (under the canopy) and 6.15- to 8.46-fold at the 0-5 cm depth at the 39-year-old plantation compared with non-vegetated sandy land. Simultaneously, *H. ammodendron* establishment and development resulted in a significant salt accumulation in the surface layer. On average, total soil salt content at the 0-5 cm and 5-20cm depth increased 16.8-fold and 4.4-fold, respectively, compared with non-vegetated sandy land. The increase of total salt derived mostly from the accumulation of SO_4^{2-}, Ca^{2+} and Na^+ with *H. ammodendron* development. The accumulation in salinity was more significant than the increase in fertility, suggesting that improved soil fertility did not limit the impact of salinization. The adverse effect of salt accumulation may result in *H. ammodendron* plantation degradation and impact community stability in the long run.

Key words: *Haloxylon ammodendron*; soil salt and its component; soil organic carbon; plantation chronosequence; sandy land in desert-oasis ecotone

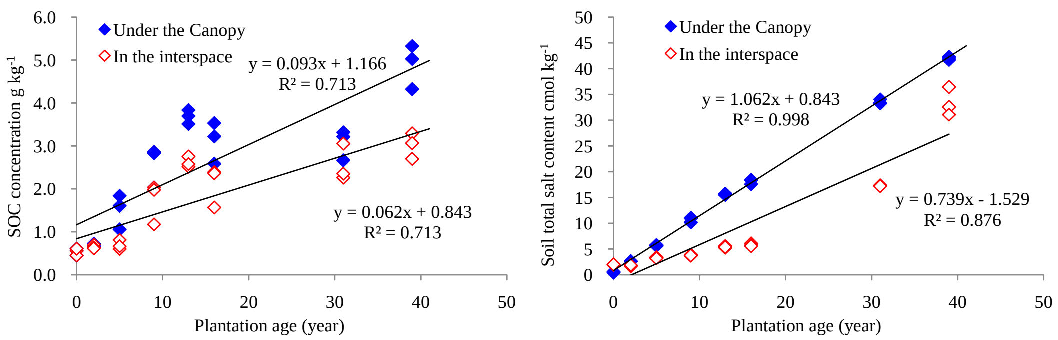

Fig. 1. The relationships of SOC concentration and total salt content at the 0-5 cm depth with plantation age

Effect of Organic Material Treatment on Growth Characteristics of *Zizyphus jujuba* Mill.

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Abstract
In Korea, the jujube (*Zizyphus jujuba* Mill.) has been mainly consumed as a dried jujube, but recently due to its high sugar content and texture, the consumption of jujube is increasing in the form of fresh fruit. This study was carried out to investigate the effect of using organic materials for the organic farming in jujube. We tried to compare the soil chemistry, leaf nutrient contents and growth characteristics after treating several organic materials in a test package planted at a planting distance of 4 × 2m in a rain-shelter culture. Organic materials such as rice bran, bark, expeller cake, compost and their mixture were used treated. Amount of organic materials treated was adjusted to the recommended nitrogen every year from 2017 to 2019. And we treated chemical fertilizer as a control. As a result of analysis of soil chemical properties until March 2019, soil pH, organic matter, available phosphoric acid, and exchangeable cations increased within a proper range after the organic material treatment, although there were monthly variation due to the effects of soil temperature and moisture. There was no significant difference in chemical fertilizer treatment. We found that the nitrate nitrogen content in the soil was about 100ppm, 2 to 5 times higher than other treatment methods, in treatments of chemical fertilizer and compost, which have the high nitrogen availability. Leaf analysis results in August 2018 showed differences depending on the mineral content of organic materials treated. As a result of the investigation on growth characteristics in September, 2018, the leaf widths of the old and new branches were 4.9 cm, which was the largest in the four organic material mixture.

Key words**:** Jujube, Organic materials, Soil chemical property, Growth characteristic

Determination of a release characteristic of controlled-release coated fertilizer for rhizosphere application using logistic curve

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Abstract
The main agenda for the use of controlled release fertilizer (CRF) is to increase nutrient use efficiency (NUE) in agriculture and more accurately improve nutrient management techniques to better match the nutrients supplied to the soil according to plant nutrient requirements. Hence, we developed a controlled-release coated fertilizer for rhizosphere application (CCFR) of urea, mono-ammonium phosphate (MAP) and potassium sulfate (PS) to improve NUE in upland field crops. And we manufactured the CCFRs encapsulated with low density polyethylene (LDPE), ethylene vinyl acetate (EVA), starch, and humic acid (HA). To identify their release characteristics in water, initial concentrations of CCFRs (urea-N, P_2O_5, and K_2O) were treated as 1,000 mg L^{-1}, and target periods of each nutrient which ≥80% of the nutrients are released in water at 25°C were 30, 60, and 90 days for urea-N, 90 days for P_2O_5, and 60 and 90 days for K_2O, respectively. Water samples were collected for determination of cumulative amount of nutrients on the 1st, 5th and 10th days after treatment and then at 10-day intervals. Results showed that the release amount of the accumulated nutrients with the time conformed to the logistic curve showing high significance in all CCFRs. From the logistic equation applied to the CCFRs for Urea-N, P_2O_5, and K_2O, regression result of a negatively linear relationship between rate constant (k) and the time attaining at 80% of maximum nutrient release ($T_{0.8L}$) was highly significant (Fig. 1). The result assumed that if we find factors affecting the value of k or $T_{0.8L}$, it could adjust the release characteristics of the CCFRs.

***Key words*:** controlled-release coated fertilizer; nutrient release; rate constant; logistic curve.

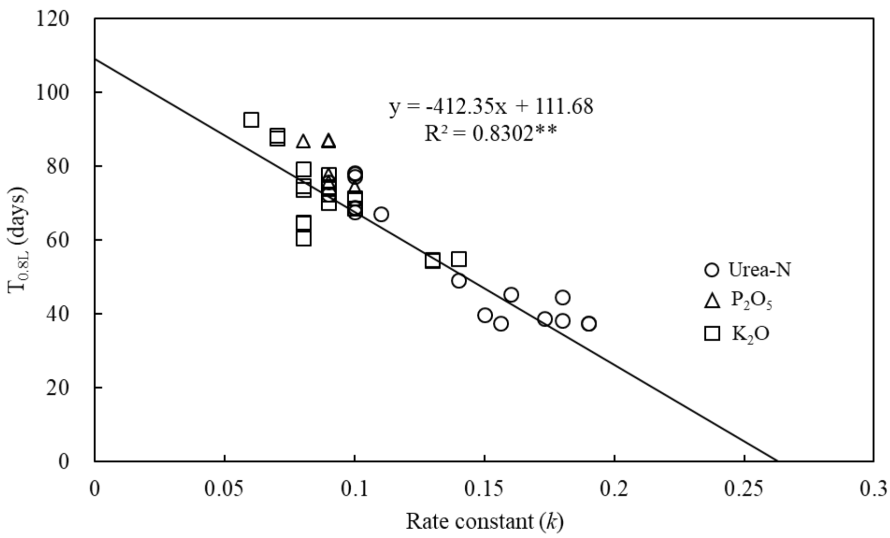

Fig. 1. Regression result of a negatively linear relationship between rate constant (k) and the time attaining at 80% of maximum release ($T_{0.8L}$).

Effect of leaf nutrients on internal browning of pineapple under cold storage

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Abstract

Internal browning (IB) of pineapple (*Ananas comosus* (L.) Merr.) under cold storage often accompany with the degradation of fruit quality thus restrict the shipping capacity for export from Taiwan. In order to evaluate the effect of pre-harvest leaf nutrition on internal browning of pineapple, this study was conducted to (1) analyze the leaf and fruit collected from field sites surveyed both at pre-harvest and post-harvest; (2) validate the effect of leaf nutrition on fruit quality by fertilization treatments conducted in Pingtung County in 2019. The D-leaf (the longest mature leaf) samples were collected at two weeks before estimated harvest date and the fruit were correspondingly harvested from the same field. Twenty farmlands were surveyed in 2018 and 2019. The leaf samples were separated into two parts of white basal and central section to analyze nutrients concentration individually. The fruits were observed with vertical cutting immediately on harvest date, and 3 weeks and 4 weeks after cold storage under 7.5°C. The percentage of internal browning were estimate by Image-J software and meanwhile the metabolites in the fruit sample were also analyzed. The analytical results of linear regression indicated IB was correlated negatively with leaf potassium content, but positively with leaf Mg content. The positive relationship between leaf K concentration and citric acid concentration in the fruit were also found significantly. It suggested the mechanism of leaf K on IB might be related to the fruit citric acid. There is no significant relationship between leaf calcium concentration and IB in this study. However, some literature reported low incidence of internal browning was observed in calcium application treatment. This inconsistency might be due to narrow leaf calcium concentration range in our study. In 2019, field trials were adjusted by foliar spray of potassium, calcium and magnesium individually at the fruit growing stage to further evaluate and validate the effect of these nutrients on fruit storage.

The Effects of Green Manure on Availability and Solubilization of Soil Phosphorus

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Abstract

Intensive inputs of high P including organic materials, such as livestock compost or organic fertilizer, to soil cause soil phosphorus accumulation. The accumulated phosphorus in soil needs to be solubilized by some mechanisms. Hairy vetch can fix the nitrogen from atmosphere, and this additional nitrogen might impact microbial activity that solubilizes soil phosphorus. This study was conducted to investigate whether green manure increases availability and solubilization of phosphorus in soil. Two green manures, barley (B) and hairy vetch (H) were sown as pure crop (140~160kg/ha of B ; 40~90kg/ha of H) and mixtures with varying seeding ratio 1:2, 2:1 (B1H2, B2H1) from November 2016 to June 2019. We investigated water soluble phosphate (W-P) as soil available phosphorus and estimated the amount of solubilized phosphorus on harvest of green manure. Dry matter yields of green manure were variable, however mixtures (B2H1, B1H2) shown high dry matter yields for all 3 years. P uptake by green manure increased with dry matter yield of green manure increase (R^2=0.5697). After harvest of green manure, the contents of W-P remaining in soil were increased in mixtures (2017 and 2019, not 2018) and hairy vetch (2017~2019) compared with control. The amount of solubilized P was increased with increase of hairy vetch seeding ratio (H > B1H2 > B2H1). In conclusion, green manure especially hairy vetch and mixtures increase P availability and solubilization in soil. Considering their variable biomass yields, mixture is suggested to be more useful than hairy vetch.

***Key words*:** Green manure; hairy vetch; barley; phosphorus availability; phosphorus solubilization.

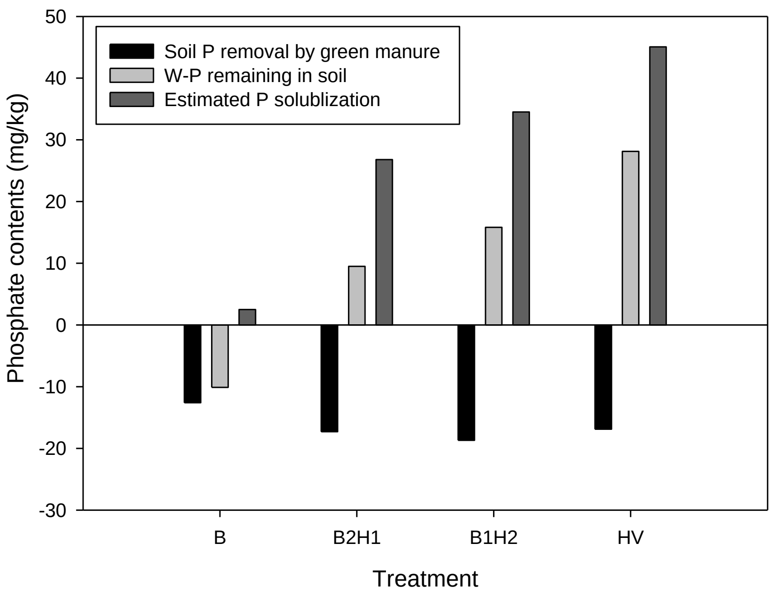

Fig. 1. The estimated amount of solubilized P after cultivation of hairy vetch and barley; all data is the mean value for 3 years.

Change of Soil Phosphorus Distribution by Sorghum Cultivation in Converted Paddy Soil

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Abstract

The need of upland crop cultivation in paddy field increased due to overproduction of rice and growing importance of activating upland farming in korea. The crop yield decreased according to increase cultivation period of upland crop in paddy field. The cause was widely known as soil organic matter content and nutrient supply decrease. The objective of this study was to research for soil phosphate availability through investigating change of soil phosphorus distribution according to cultivation period of sorghum in paddy field. The organic phosphate exponentially decreased from 2160 mg kg^{-1} to 400 mg kg^{-1} during 3years. The inorganic phosphate increased from 844 mg kg^{-1} to 1005 mg kg^{-1} according to change of reductant soluble phosphate at 1st year and decreased to 775 mg kg^{-1} at 2nd year and maintained until 3rd year. Available phosphate decreased from 130 mg kg^{-1} to 110 mg kg^{-1} during 3years. We assumed that organic phosphate mainly affected phosphate availability in converted paddy field

***Key words*:** paddy soil; upland crop cultivation; soil phosphorus distribution; phosphate availability

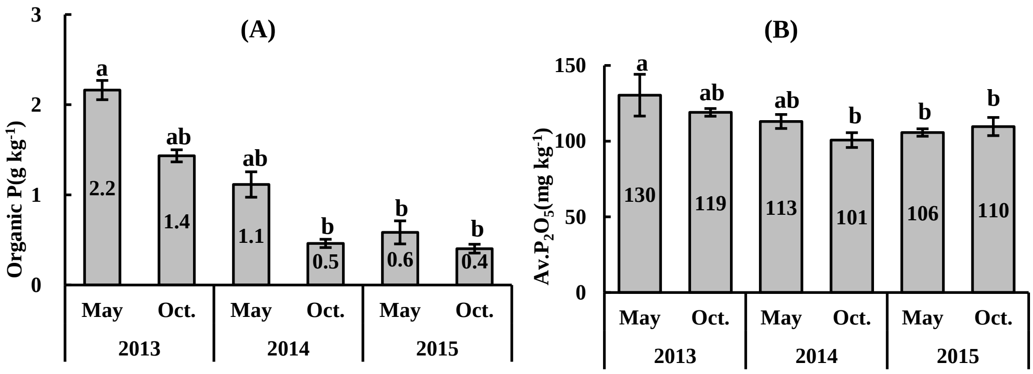

Fig. 1. The change of soil organic phosphorus(A) and Av.P_2O_5(B) by sorghum cultivation in converted paddy soil

Effects of Nitrogen Fertilizer Amount on Rice Yield and Quality of Rice Flour Varieties

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Abstract

Recently, new varieties of rice for various uses are being developed in Korea. Especially Rice flour varieties suitable for dry-milling were developed to reactivate the rice processing industry, so high yielding culture methods are needed to reduce the production cost of these varieties. Therefore, the growth characters, yield and qualities of new varieties(Seolgaeng, Hangaru, Singil) and promising line(Jeonju 615) were evaluated for 2 years in paddy field. The japonica type rice(Seolgaeng, Hangaru, Jeonju 615) were treated in four degrees, from 90kg ha^{-1} to 150kg ha^{-1}, and tongil type rice, Singil, were treated from 150kg ha^{-1} to 300kg ha^{-1}. When 150kg ha^{-1} of nitrogen fertilizer was treated, the heading date of all Japonica varieties was delayed about 1 day compared with 90kg ha^{-1}. The tongil type variety, Silgil, was also delayed about 1 day. the yield in 150kg ha^{-1} treated block was higher around 60% than 90kg ha^{-1} in Seolgaeng and Hangaru. This extreme increase in yield is thought to be due to the degradation of nitrogen utilization efficiency of the rice due to the high temperature, so the annual repeat experiment is underway. On the other hand, Jeonju 615 was not different between 90kg ha^{-1} and 180kg ha^{-1}. The yield of Singil treated 300kg ha^{-1} was increased around 10% in comparison with 150kg ha^{-1}. The protein content of grains tended to increase with increasing nitrogen fertilizer, while Seolgaeng and Hangaru were not increased. The amylose content was similar and there was no statistical significance.

Key words**:** rice flour variety; nitrogen fertilizer; rice yield; protein content

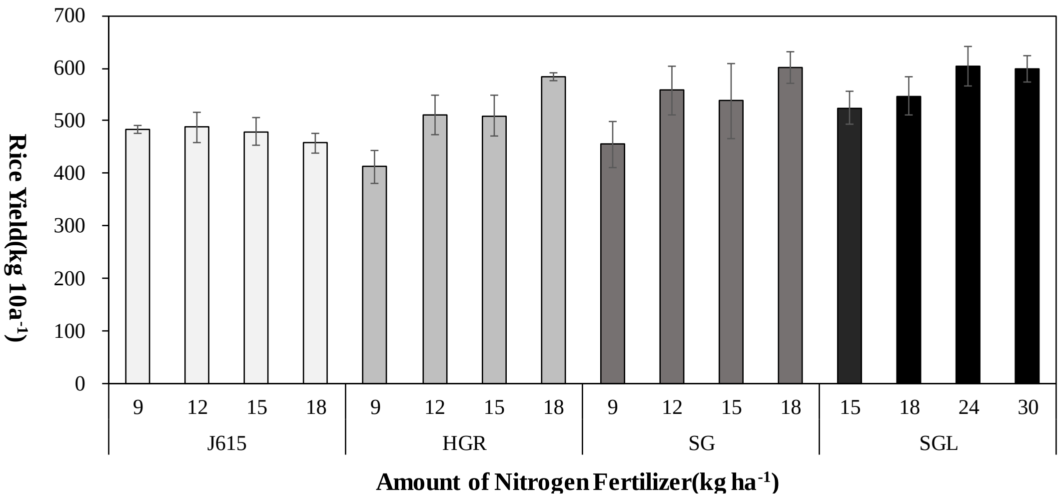

Fig. 1. The Yield of Rice Flour Varieties and Promising Line According to Different Amount of Nitrogen Fertilizer (J615=Jeonju 615; HGR=Hangaru; SG=Seolgaeng; SGL=Singil)

Changes of the Yield and Avenanthramide Content by the Quantity of Nitrogen Fertilizer in Naked Oats

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Abstract

Different quantities of nitrogen fertilizer were applied to naked oats variety 'Daeyang' to study the development of cultivation techniques which maximize functional component of oats. Oats were sowed in the fall in 2018 and in the spring in 2019. In the fall sowing, the levels of nitrogen fertilizer were 50, 100(standard), 150 and 200%. In the spring sowing, they were 70, 100(standard), 130 and 160%. As standard fertilization, nitrogen, phosphate and potassium were applied as 91, 74, 39 kg ha^{-1}, respectively. In the fall sowing, the yields of oats tended to increase a little as the quantity of nitrogen fertilizer increased except 50%, but they were not statistically significant. In the spring sowing, the yields tended to decrease a little as the quantity of nitrogen fertilizer increased, but they were not also significant. In the fall sowing, the avenanthramide(AVN) content of oats increased as the quantity of nitrogen fertilizer increased except 50%, and the maximum content of total AVN was about 56 μg g^{-1} at 200% nitrogen (AVN-C about 22 μg g^{-1}). In the spring sowing, the avenanthramide(AVN) content of oats increased as the quantity of nitrogen fertilizer increased except 160%, and the maximum content of total AVN was about 72 μg g^{-1} at 130% nitrogen (AVN-C about 25 μg g^{-1}). Farm income and food self-sufficiency rate will increase if the cultivation techniques of oats develop.

***Key words*:** Avenanthramide; nitrogen fertilizer; oats.

Effect of CRF (Controlled-release fertilizer) on early growth of rice (*Oryza sativa* L.)

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Abstract

The nitrogen use efficiency of nitrogen fertilizer during cultivation is 10~40%. This is because nitrogen in the soil is lost by volatilization, denitrification and leaching. For this reason, Rural Development Administration of Korea recommends split application for nitrogen fertilizer. However, adopting split application for nitrogen fertilizer is not easy in Korea due to costly labor and aging in rural society. One of the solutions for this problem can be use of CRFs (controlled-release fertilizers) for high nitrogen use efficiency. This experiment was carried out in a rice field located at Ansan, Gyeonggi-province to investigate the early growth of rice (*Oryza sativa* L.) depending on the dissolution characteristics of two CRFs, CRF-f (30-6-6) and CRF-c (18-7-9), for 60 days after transplanting. Four fertilization treatments were SF (Standard fertilization, N: 11 kg/10a), CRF-f (N: 9 kg/10a), CRF-c (N: 9 kg/10a) and control (no fertilization). Two late maturing varieties of rice used for this experiment were Samkwang and Chuchung. Soil and plant samples were collected on the 3th, 7th, 15th, 30th, 45th, and 60th day from transplanting and were analyzed for ammoniacal nitrogen of soil, plant height, number of tillers and dry weight. Ammoniacal nitrogen content in soil of SF treatment was higher than those of other treatments by the 30th day. However, the ammoniacal nitrogen content in soil of SF treatment decreased rapidly after the 30th day. CRF-f treatment showed high ammoniacal nitrogen of soil content on the 15th day, CRF-c treatment showed high ammoniacal nitrogen content in soil on the 30th and 45th days from transplanting. Plant height showed that all treatments except for the control treatment in both varieties tended to increase over time without significant difference. However, the number of tillers and dry weight of CRF-f and CRF-c showed significantly higher than SF after the 30th day. In particular, the result of plant height, number of tillers and dry weight of CRF-f for Chuchung showed the highest values of 69.0 cm, 34.9, 29.5 g, respectively. Compared to SF treatment, CRF treatments showed the ability of continuous supply of nitrogen to soil until the 60th day from transplanting. CRF treatments also showed better plant growth than SF treatment resulting from high nitrogen use efficiency.

***Key words*: Rice, Controlled-release fertilizer, initial release**

Effects of coinoculation with *Rhizobium* and plant growth promoting rhizobacteria on the nitrogen fixation and nutrient uptake of *Trifolium repens* in low phosphorus soil

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Poster presenter: Kimberly Alo Tampus

Abstract
Low soil phosphorus (P) availability is a notable limitation for legume nodulation, nitrogen fixation and yield, and it is therefore important to improve legume growth under P-deficient conditions. This study aimed to determine the effects of coinoculation with *Rhizobium* and plant growth promoting rhizobacteria (PGPR) on the nitrogen fixation and nutrient uptake of white clover (*Trifolium repens*) in a P-deficient soil. White clover plants were inoculated with one of the two *Rhizobium* strains CHB1120 and CHB1121 alone or coinoculated with either of the *Rhizobium* strains and one of the two PGPR strains, *Bacillus aryabhattai* strain Sb and *Azotobacter vinelandii* strain G31. White clover inoculated with either CHB1120 or CHB1121 alone and coinoculated with one of the two *Rhizobium* strains and the PGPR significantly enhanced nodule numbers compared with the noninoculated control. The coinoculation of either CHB1120 or CHB1121 and Sb showed a significantly greater level of nitrogenase than the single inoculation of CHB1120 or CHB1121. In addition, the single inoculation of CHB1120 or CHB1121 and their coinoculation with PGPR significantly increased nitrogen contents in both shoots and roots under P-deficient conditions. The coinoculation of CHB1121 and G31 showed the greatest N content in shoots. Moreover, the single inoculation of the two *Rhizobium* strains and their coinoculation with G31 and Sb significantly increased the K, Ca, and Mg contents in shoots compared with the noninoculated control. In summary, the PGPR used in this study can enhance the symbiotic potential of rhizobia under low P conditions.

Key words: biofertilizer; nutrient uptake; soil fertility; legume; nitrogen fixation; nitrogen-fixing bacteria; plant growth promoting rhizobacteria; nitrogen.

Reduced basal N fertilizer rate improves maize seedling growth, water and N use efficiencies under drought stress by optimizing root morphology and distribution

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ABSTRACT

Frequent spring droughts and nitrogen (N) fertilizer overuse limit rain-fed maize production in Northeast China. However, the interactions between water-stress and N rates on maize seedling growth and root development remain elusive. In this study, a pot experiment was conducted with maize grown under three N rates (N omission, low and high N rates, i.e., N0, LN and HN) and severe water-stress (SS), moderate water-stress (MS) and well-watered (WW) conditions for 2-week from 4-leaf stage. Dry biomass (DM), leaf rolling performance, water use efficiency (WUE), N fertilizer use efficiency (NUE), root morphology and distribution were evaluated. It was showed that soil water levels and N rates had significant individual and interactive effects on most measured parameters. The dual stress of drought and N deficiency severely limited maize growth and N uptake. Nitrogen fertilization improved maize growth, N uptake and WUE under water-stress. However, compared with HN treatment, LN treatment had less water consumption, higher leaf relative water content and less leaf rolling symptom both under the MS and SS conditions. The reason is that LN enhanced root growth and elongation with more fine roots, especially in deep soil. Notably, maize plants in MS-LN treatment had an optimal root distribution characterized by higher root length density (0.30 cm cm^{-3}), larger and deeper penetration scale throughout the soil layers, and thus showed fewer drought responses and obtained the highest WUE (4.1 g L^{-1}) and NUE (17.2%) among all the water-stress treatments. In contrast, HN limited root growth and extension in deep soil and in turn increased water and N depletion, resulting in more serve leaf rolling and lower WUE and NUE. Therefore, reducing basal N rate is recommended to optimize root growth, morphology and distribution at the seedling stage in rain-fed maize production, to enhance drought resistance and improve WUE and NUE.

Keywords: Water-N interaction; Root architecture; Drought resistance; Dry biomass; Leaf rolling; N uptake

S05-P02

Studies on proteomic roles of the *Cucumis melo* L. symbiotic associations with arbuscular mycorrhizal fungi under different sodium chloride concentrations

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Abstract
Arbuscular mycorrhizal fungi (AMF) are a kind of soil microorganisms that can infect the roots and cause symbiotic association with higher plants. Some researches showed that inoculation of AMF can increase the absorption of nutrients, the capacity of anti-stress (e.g. drought,salt and disease) by melon (Cucumis melo L.). This study was conducted to evaluate the roles of proteins on salt-tolerance mechanism after melon inoculated by AMF. The melons were cultivated in the hydroponic solution containing 0%, 0.25% or 0.5% NaCl for AMF and non-AMF seedlings. Plant growth was negatively affected in the 0.5% NaCl concertration in non-AMF seedlings. Root apice of AMF seedling after treating with different NaCl concentrations that were chosen for the estimation of proteins. The results showed that 12 proteins were significantly different after treating with different sodium chlorite (NaCl) concentrations, with 4 upregulated and 8 downregulated proteins. The root of melon inoculated AMF under NaCl stress could be characterized by cellular activities involved in carbohydrate metabolism, energy metabolism, organic acid production, alleviating salt damage, which may be critical for promotion of nutrients absorption, anti-stress and so on. This study may provide an important reference to future genomic research for the inoculation of AMF on different plants and the improvement of inoculated technology.

Key words: arbuscular mycorrhizal fungi (AMF), melon, salt, proteins.

Table 1. LC/MS/MS identification of the differentially expressed proteins in melon roots

Spot No.		Accession No.	Protein Description	MOWSE score	Experimental Mr / pI	Theoretical Mr / pI	Protein expression ir
6	1	gi|224057715 gi|255547734*	predicted protein [Populus trichocarpa] PLE, putative [Ricinus communis]	46	31.01/7.36	66.66/5.91 66.32/6.38	0%
10	1	gi|53791748	hypothetical protein [Oryza sativa Japonica Group]	56	44.97/4.39	42.64/9.72	0.5%
14	1 3	gi|218198433 gi|6911142	hypothetical protein OsI_23479 [Oryza sativa Indica Group] putative glycine-rich RNA binding protein 1 [Catharanthus roseus]	205 52	48.47/5.81	52.23/4.64 14.27/8.71	0%
18	1	gi|159472671	heat shock protein 70C [Chlamydomonas reinhardtii]	138	67.05/4.71	65.44/5.60	0%
25	1	gi|384250526	malate dehydrogenase [Coccomyxa subellipsoidea C-169]	90	32.45/6.45	34.06/5.54	0%
27	1	gi|195627118	rhomboid family protein [Zea mays]	48	110.86/3.58	43.58/6.05	0%
33	1	gi|23496435	endochitinase MCHT-2 [Cucumis melo]	83	31.35/9.13	34.80/8.57	0%
75	1 4	gi|302794672 gi|384253773	hypothetical protein SELMODRAFT_153081 [Selaginella moellendorffii] ARM repeat-containing protein [Coccomyxa subellipsoidea C-169]	69 49	42.09/4.28	43.45/6.19 100.35/5.17	0%
129	1 3	gi|205830697 gi|13486803	RecName: Full=Unknown protein 18 Epstein-Barr virus EBNA-1-like protein [Oryza sativa Japonica Group]	76 58	36.62/8.89	1.39/5.80 40.27/11.08	0.5%
163	1 2	gi|205830697 gi|54606795	RecName: Full=Unknown protein 18 orf774 [Beta vulgaris subsp. vulgaris]	65 52	44.72/4.20	1.39/5.80 90.37/7.61	0.5%
175	1	gi|303285200	predicted protein [Micromonas pusilla	96	39.15/3.99	31.71/7.64	0.5%

Endophytic fungal diversity in barley and their effect on the growth stimulation

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Endophyte is a microbe that doesn't show the symptom even though it can infect to the host plant. They sometimes give some function such as plant growth promoting effect and environmental stress tolerance to a host plant. If it will be possible to use endophytes having useful ability in agriculture, they can be strong tool for sustainable agriculture. On the other hand, the demand of barley products is increasing in Japan because of health trend. However, the barley is mainly imported from other countries because the production area of barley is insufficient and hasn't expanded in Japan. The aim of this study is to find the endophyte having the plant growth promoting (PGP) ability on barley growth. Keeping in this aim, the diversity of endophytes in the barley was investigated and screened the PGP endophyte on barley.

The barley roots were taken from 4 different locations like Yamanashi, Ibaraki, Gunma and Toyama prefecture in Japan. In order to isolate the endophytes from root, the samples were washed using tap water and then sterilized their surface according to 70%EtOH, 1% NaClO and sterilized distilled water. The surface sterilized roots were cut into small pieces and then put on the potato dextrose agar. Totally 77 strains of endophytes from barley roots were grown and identified 20 genera by morphology and PCR-RFLP analysis besed on the ITS region. Moreover, barley growing experiment for screening of PGP endophyte showed that *Leptosphaeria* sp. strain T-2 increased the growth compared with control in the shoot, root and spiked biomass (Fig. 1). *Leptosphaeria* sp. strain T-2 could observe the hyphal elongation by microscopy in the root after finish the growing experiment. Moreeover, this strain does not show pathogenicity on barley so that it may be available as biofertilizer.

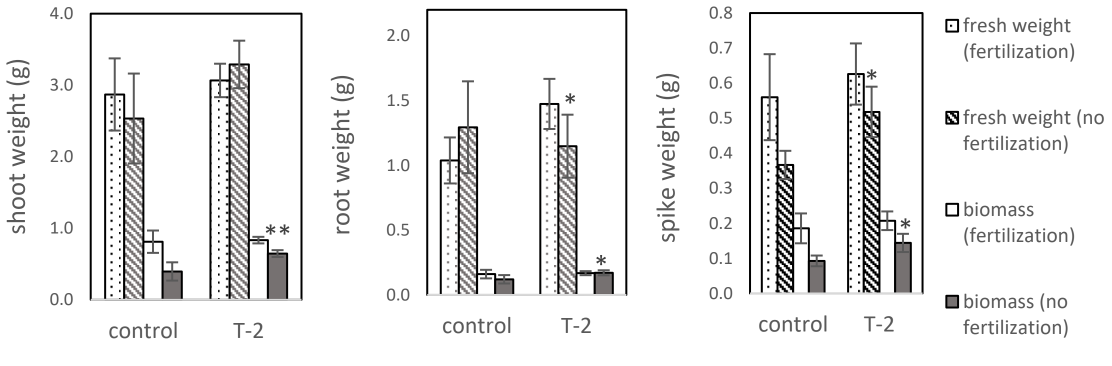

Fig.1 Effects of endophyte inoculation on the biomass production of barley. (*: $P<0.05$, **: $P<0.01$)

Key words: endophyte; plant growth promoting (PGP) ability; *Leptosphaeria* sp.; barley; biofertilizer

Protists enhanced Short-term Effects of Biochar Treatment on the Growth of Rice Plants

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Abstract

Biochar is considered as one of the sustainable approaches for improving soil fertility and enhancing agricultural productivity. In addition, it has been found to affect microbial communities in the soil. Current information on biochar-microorganism interaction comes mainly from bacterial and fungal studies with only a little contribution from heterotrophic protists-biochar interaction. Heterotrophic protists - a major microeukaryotic group in the rice rhizosphere densely colonize rice roots and their grazing activities on bacteria ensure nutrient turnover thus promoting plant growth. This study aims to investigate the effect of protists on (i) short-term impacts of biochar on rice plant growth and (ii) rhizo-bacterial community structure and bacterial genes involved in nitrogen processes in a biochar-treated paddy field soil. A controlled laboratory experiment was performed with sterile rice seedlings (*Oryza sativa* L. Nipponbare) planted in a sterilized paddy field soil treated with 2 or 4 % (weight basis) of either rice husk biochar (RH) or poultry litter biochar (PL). Each microcosm was inoculated with indigenous protist-free bacterial community with and without mixed protist community. Metagenomic sequencing of 16S rRNA gene was used to reveal the impact of protists and biochars on the indigenous bacterial community structure and abundance of genes putatively involved in nitrogen cycling. The addition of biochar and heterotrophic protists significantly and differentially affected the bacterial community structure. Protists specifically decreased the relative abundance of Bacteriodales, while Alphaproteobacteria, Cyanobacteria, Bacilli and Actinobacteria benefited the protist grazing. RH addition increased the relative abundance of Gemmatimonadetes, Saprospirales, and Rhodocyclades, while PL increased the relative abundance of Alphaproteobacteria and Flavobacteria. The bacterial gene abundances involved in nitrogen cycling were affected by both protists and biochar such that protists significantly increased the gene abundances involved in N-mineralization. In addition, increase of biological N-fixation and nitrification by biochar addition was suggested. The beneficial effect of biochar on plant growth and N uptake was significantly increased by the presence of protists. Generally, the results obtained from this study highlighted the importance of protists grazing activities on biological N-cycling processes in a biochar-treated soil and as well, suggested that the presence of protists influenced the effects of biochar on the bacterial community structure.

***Key words*: Biochar; heterotrophic poultry litter; protist; rice husk.

Head blight of durum wheat (*Triticum turgidum* subsp. *durum*) by a soil inhabiting fungus, *Fusarium asiaticum*

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Abstract
Fusarium causing head blight of durum wheat [*Triticum turgidum* subsp. *durum* (Desf.) Husn.] in Japan has been actually undemonstrated as the causal agent based on Koch's postulates, as well as unconfirmed for the species (Abe et al., 1966; Kai et al., 1998; Yanaka et al., 2018). This study revealed that *Fusarium asiaticum* O'Donnell, T. Aoki, Kistler & Geiser was one of the pathogens. It was frequently isolated from spikes of durum wheat with the typical symptom of head blight in trial fields of our center in April to June 2016–2018. Its representative isolate, MAFF150131, formed pale pink to dark red colonies on potato dextrose agar in the dark at 5–35°C, with maximum mycelial growth of 5.4 mm/day at 28°C. Conidia produced on synthetic nutrient agar at 25°C under fluorescent light were hyaline, falcate with single foot cells, 3–5 septate and 26–36 × 2–4 µm. No teleomorph was confirmed. The DNA sequence of the histone H3 gene-coding region of MAFF150131 coincided with previous data for a strain, NRRL13818, classified as *F. asiaticum* with 100% similarity (DDBJ accessions are LC489416 and AY452821 for MAFF150131 and NRRL13818, respectively). When conidial suspension of MAFF150131 was sprayed onto plants of a durum wheat cultivar at the flowering stage, the natural symptom was reproduced. Control plants simultaneously treated with sterilized distilled water had no symptom. The isolate was consistently re-isolated from diseased spikes, but not from healthy controls, demonstrating that the isolate was pathogenic to durum wheat. There is no previous report describing the disease of the crop by *F. asiaticum*. We propose to include *F. asiaticum* as a pathogen of head blight of durum wheat. *Fusarium asiaticum* inhabits not only plants but also soils. We will investigate its emergent ecology in the future.

Key words**:** Soil fungus; *Fusarium asiaticum*; plant disease; head blight; durum wheat; *Triticum turgidum* subsp. *durum*.

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Soil Bacterial Community Structure of Tropical Peat Swamp Forests across a Peat Dome in Sarawak, Malaysia

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Abstract
Tropical peat swamp forest is a global store of carbon in a water-saturated, anoxic and acidic environment. In Sarawak, a distinct transition in the structure of the forest vegetation can be observed from the edge to the center of a tropical peat dome. It is characterized by an uneven-canopied high forest from the edge of the swamp to zones of lower tree height, decreased tree girth, thicker leaves and lower tree species richness towards the center of the swamp. This study was conducted to profile the soil bacterial communities in three forest types of tropical peat swamp namely, Mixed Peat Swamp (MPS), Alan Batu (ABt), and Alan Bunga (ABg) forests across a peat dome using next-generation sequencing (NGS). The result showed that the major bacterial groups of Acidobacteria, Proteobacteria, Actinobacteria, Firmicutes, Planctomycetes, Verrucomicrobia, Nitrospirae, Cyanobacteria and Spirochaetes are dominant in all three forest types. It also suggested that the soil bacterial community were significantly influenced by forest types and soil depth due to the different physicochemical properties. The physical and chemical properties included in this study were water table (WT), soil pH, total carbon (C), total nitrogen (N), C/N ratio, loss-on-ignition (LOI) and pyrophosphate solubility index (PSI). Among these parameters, PSI showed the highest correlation, followed by pH, LOI and WT. The bacterial community composition in MPS is distinctly different from ABt and ABg and is driven by higher humification level and lower pH. As for ABt and ABg forests, the bacterial community is driven by higher pH and higher organic matter content. Further investigation is required to fully understand the role of soil bacterial community in supporting the forest through the formation of peat, carbon sequestration and nutrient cycling.

Keywords: *Tropical peat swamp forest; peat soil; soil organic matter; soil bacterial community*

Effect of Individual and Mixture Application of Pesticides on Soil Microbial Communities

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Abstract

In the process of agricultural production, insecticides and fungicides are often applied at the same time to save labor and control a variety of pests and diseases in the field. Soil microbial communities are often directly affected as non-target organisms under different pesticide applications in the soil. The research was conducted to assess the impacts of insecticide imidacloprid (IM) and fungicide dimethomorph (DT) on the change of microbial ecology. The functional diversity was assessed using data collected from Biolog EcoPlates to calculate the Average Well Color Development (AWCD), Richness (R) and Shannon–Weaver index (H). From the results, the application of imidacloprid individually on day 7 and day 56 was characterized by lower AWCD compared to the rest of the pesticide-treated soils. This may suggest a higher ecological hazard of the insecticide to soil environments in the short term compared to other treatments. In future study, the change of microbial composition in the soil caused by different pesticides applications used in the field would be further researched through next generation sequencing to understand the impact of pesticides application individually and as a mixture on soil microorganisms at a molecular level.

Key words**:** Average well color development , Dimethomorph, Imidacloprid, and soil microbial communities.

Isolation and characterization of bacteria associated with tomato (*Solanum lycopersicum* L.) leaves

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Abstract
In response to the increasing population around the world, food production largely relies on the application of chemical fertilizers and chemical pesticides. However, the high amount of agrochemical input has led to many environmental problems such as soil degradation and ecological imbalance. Development of microbial agents used to increase nutrient availability or control plant pathogen provides alternatives to sustain plant growth and health. Plant rhizosphere and phyllosphere have been demonstrated to harbor highly diverse microorganisms with various functions. However, our knowledge of the microbiology of phyllospheric bacteria has historically lagged behind our knowledge of the microbiology of rhizobacteria. This motivates us to isolate and characterize bacteria associated with leaves of tomato, the most significantly horticultural crop worldwide. In the present study a total of 44 and 68 isolates were obtained from phyllosphere of tomato using nutrient agar and methanol medium agar, respectively. 16S rDNA sequences assigned them to 14 genera namely *Acinetobacter*, *Bacillus*, *Brachybacterium*, *Exiguobacterium*, *Lysinibacillus*, *Methylobacterium*, *Microbacterium*, *Paenibacillus*, *Pantoea*, *Paracoccus*, *Pseudomonas*, *Rhizobium*, *Sphingomonas* and *Xanthomonas*. Among them, genera *Xanthomonas* and *Pseudomonas* were the dominant bacterial groups obtained from phyllosphere no matter which medium was used for isolation. Twenty-three isolates were selected and used for further studies. The antagonistic test demonstrated that 5 isolates were able to inhibit the growth of tomato pathogen *Xanthomonas campestri* pv. *vesicatoriar*. Inoculation of *Bacillus* sp. NYPO 7 was successfully used to control plant disease, as can be seen from the decrease of disease index from 4.3 to 2.4. Higher biomass of tomato seedlings were also recorded in *Bacillus* sp. NYPO 7 or *Pantoea* sp. MYEO 12 inoculating treatment after 6 weeks of cultivation. Considered for plant growth promoting traits, the highest free-living nitrogen fixing activities ranging from 0.136-0.456 ηmol/ (tube x hr) were obtained. Five isolates showed promising tricalcium phosphate solubilizing activities, and the soluble P ranged from 225 to 1430 $\mu g\ mL^{-1}$ after 4 days of cultivation. All 23 isolates possessed IAA producing abilities. Six isolates were used separately as inoculants in pot experiment to evaluate their performance on tomato growth. The results demonstrated that dry weight of stems and leaves was slightly higher in half dose of chemical fertilization along with *Lysinibacillus* sp. NYPO 3 inoculating treatment than that in half dose of chemical fertilization treatment only. Distinct community level physiological profiles were obtained after bacterial inoculation, demonstrating that soils under different treatments harbored microorganisms with different carbon catabolic potentials.

***Key words*:** Tomato; phyllospheric bacteria; antagonistic test; plant growth promoting traits.

Applications of engineered biochar for alleviating the obstacles of continuous cropping

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Abstract

The continuous cropping obstacles are a result of negative feedback effects (NFE) between plants and soils. Many factors could lead to the occurrences of NFE, which is induced commonly by the accumulations of autotoxins/allelochemicals and the buildups of pathogen populations. According to the previous studies, the autotoxins or allelochemicals (such as phenolic acids) excreted by plant roots or derived from the plant residues are the major cause of NFE. Therefore, in the current study, three materials, including rice husks (R), tea wastes (T), wood meals (W), were selected to prepare the bio-adsorbents for scavenging the phenolic compounds. Our goals are to mitigate the problems of continuous cropping obstacles and promote both yield and quality of specific crops. In the first year of the study, three agricultural wastes of R, T, and W were used as raw materials which were then carbonized to prepare biochar at different temperatures and treated by a variety of chemicals to obtain the optimal biochar samples for subsequent studies. About 195 biochar samples were prepared and the adsorption ability of each biochar for the target phenolic compounds was tested. Results showed that the WP400 samples (W was rinsed in P solution prior to carbonization at 400ºC) exhibited the highest adsorptive capacity of phenolic compounds. Phosphoric acid could serve as an acid catalyst to promote bond cleavage and the formation of crosslinks via processes such as cyclization, and condensation for keeping volatile C materials. Besides, it could combine with organic species to form phosphate and polyphosphate bridges that connect and crosslink biopolymer fragments and increased accessible pore structures. These P-induced reactions that promoted specific surface areas and porosities of biochar structures may lead to high adsorptive ability of WP400. Moreover, we found that WP400 exhibited more strong affinity for phenolic acids derived from cinnamic acid than that from benzoic acid. Biochar could also inhibit the effects of continuous cropping obstacles of gingers and tomato caused by specific pathogens of *Pythium myriotylum*, *Fusarium oxyporum*, and *Ralstonia solanacearum*. For instance, our preliminary studies found that WP400 could inhibit the growth of *Pythium myriotylum* (ca. 35%), and as high as 100% inhibition were observed for the *Ralstonia solanacearum* while treating with the biochar from the tangerine and red pine wood carbonized at 300ºC.

***Key words*:** Continuous cropping; allelochemicals; phenolic acids; biochar.

Effects of irradiation and pH effect on Cr(III) photo-oxidation in the presence of Fe(III)

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Poster presenter: Chi-Wun Lu

Abstract
Chromium is a commonly found pollutant in the soils/sediments and water bodies because it can be discharged intentionally or unintentionally from various industrial activities. Chromium exists in two major forms of Cr(III) and Cr(VI). The physicochemical properties and toxicities of Cr(VI) and Cr(III) are quite different. Cr(III) is a cation, exhibiting a lower mobility and toxicity than that of Cr(VI), and thus, the possible oxidation of Cr(III) to harmful Cr(VI) in a natural system had received much scientific concerns in the past decades. Photolysis of $FeOH^{2+}$ is a well-known pathway occurred naturally which are capable of generating hydroxyl radicals (·OH) for Cr(III) oxidation in an acidic solution. However, the role of subsequent Cr(III) photo-oxidation as influenced by pH remains unexplored. Therefore, the objectives of this study are to evaluate systematically the effects of pH on the photo-oxidation of Cr(III) in the presence of Fe(III). Result showed that Cr(III) could be oxidized in the presence of Fe(III) at pH 2-4 under UV irradiation. At pH 3, Cr(III) photo-oxidation exhibited the highest efficiency because the proportion of $FeOH^{2+}$, a major Fe species of generating OH radicals upon its photolysis, was greatest according to the calculations.

***Key words*:** photocatalytic, Fe(III),pH effect, Cr(III) photo-oxidation, Cr(VI)

Ecological Risk Assessment of Paddy Rice Exposed to Arsenic in a Contaminated Site in Taiwan

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Abstract

In this study, a risk assessment approach proposed by US Environmental Protection Agency was used to assess the ecological risk of paddy rice exposed to arsenic (As) in a contaminated site in Taiwan. For problem formulation, an As concentration that results in 10% reduction of rice production (EC10) was adopted as ecological endpoint. Based on the result of investigation in the site, a log normal distribution LN(35.3298 mg/kg, 2.0022) was used to represent As concentration distribution in the soil for exposure analysis. For ecological response analysis, a dose-response relationship between rice production and soil As concentration was established from published literatures. Then a probabilistic risk characterization analysis was conducted by Monte Carlo simulation technique to obtain the distribution of risk quotient (RQ) of paddy rice exposed to As. Result of the analysis showed that the median and 95%-tile value of RQ was 3.77 and 11.95, respectively, indicating a potential ecological risk of soil As to rice production in the contaminated sites. Furthermore, based on the simulation result, a soil As concentration of 10 mg/kg was recommended as a regulatory standards for better managing rice production risk associated with As exposure.

Key words**:** Arsenic; ecological endpoint; probabilistic risk assessment; risk quotient.

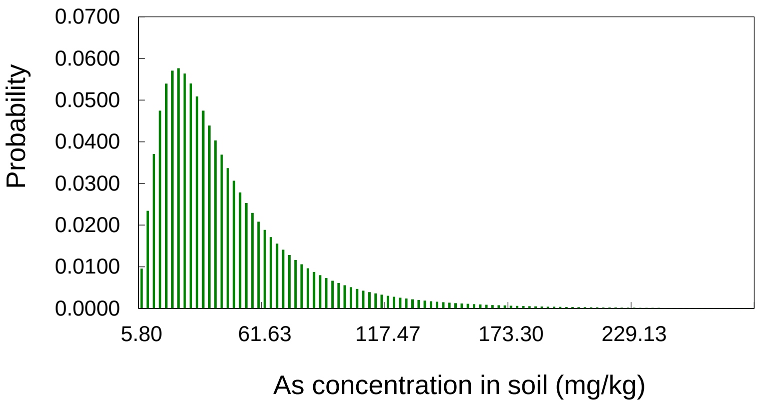

Fig. 1. The distribution of soil As concentration in the contaminated site.

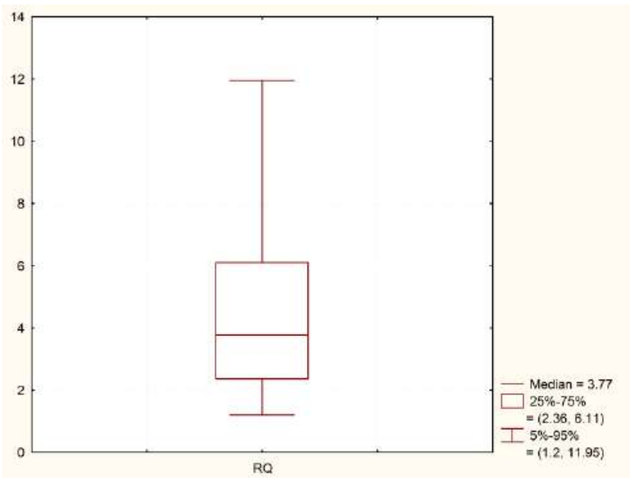

Fig. 2. The box-whisker plot of risk quotient (RQ) of paddy rice associated with As exposure.

Genotypic Differences in Cadmium Concentration of Soybean

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Abstract

The cadmium-contaminated paddy fields which located in Mae Sod District, Tak Province, Thailand were initially reported by the International Water Management Institute (IWMI) in 2002. In that area, rice cultivation (*Oryza sativa* L.) is the majority in the rainy season, whilst after rice harvesting, the minority crop-soybean (*Glycine max*) is established. In 2012, the authors had proposed the promising low-grain cadmium of Thai's rice cultivar (RD15) and the farmers were encouraged to grow this new cultivar. Recently, soy-based meat substituted had increasingly been accepted due partially to either the higher cost of meats or the intention to avoid cholesterol and saturated fats which obtained from meats. Therefore, the objective of this study was to determine the genotypic variation in cadmium concentration of soybean seed for the purpose of selecting the low-seed cadmium cultivars. Pot experiment was carried out with completely randomized design of 13 soybean cultivars as treatment with 3 replicates. The soil which collected from Cd-polluted paddy field in Mae Sot district had the average pH of 6.08 and the Cd concentration which extracted by the *0.005 M* DTPA pH 7.3 procedure was 0.421 mg kg^{-1} air-dried soil. The results showed that, among 13 cultivars, the Cd concentrations ranged from 0.001 – 1.059 mg kg^{-1} (Fig. 1), with an average of 0.331 ± 0.041 mg kg^{-1}. Significant genotypic differences in seed Cd levels were noticeable. The seed Cd concentrations was lowest for the KKU35 (0.107 ± 0.081 mg kg^{-1}), and the highest for Sukhothai 3 (0.625 ± 0.320 mg kg^{-1}). Three of 13 cultivars [KKU35, Chaingmai 60 (0.178 ± 0.097 mg kg^{-1}) and SJ5 (0.189 ± 0.080 mg kg^{-1})] contained lower seed cadmium than the maximum permissible Cd concentration of soybean seed (0.20 mg kg^{-1}) adopted by the Codex Alimentarius Commission of FAO/WHO. Within the three low-seed cadmium, Chaingmai 60 cultivar is popular in this area. The finding suggests that selecting low-seed Cd soybean cultivars for cadmium-contaminated area, human Cd intake can be reduced.

***Key words*:** Cadmium; soybean; contaminated soil, Mae Sot, Thailand

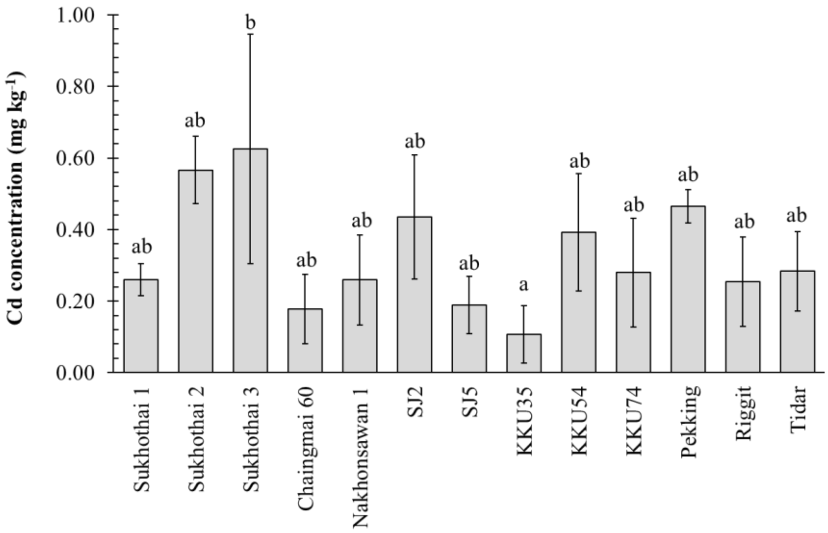

Fig. 1 Seed Cd concentrations of soybean grown in a Cd-polluted paddy soil. The vertical bars indicate the standard error of 3 replications. Any given bar followed by the same letter is not significantly different according to the DMRT test ($p < 0.05$).

Evaluation of Cadmium Toxicity and Distribution in Rice Plant Associated with Physiological Regulation

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Abstract
This study conducted a hydroponic experiment to investigate rice genotypic variations in cadmium (Cd) absorption and toxicity related to plant physiological traits. The reductions of shoot growth were more significant than those of root growth for the rice cultivars with Cd treatment. However, absorbed Cd was preferentially accumulated in the root than in the shoot. This suggested that less Cd transfer from the root to the shoot would be related to the Cd tolerance and shoot growth improvement. The oxidative statuses of rice plant under Cd stress depended on the configurations of H_2O_2 in the root and shoot and the oxidative damages of Cd stress were determined by the malondialdehyde (MDA) contents in plant. The results showed more enhanced MDA by Cd treatment in the root than in the shoot. This consisted with that the superoxide dismutase (SOD) and ascorbate peroxidase (APX) activities were more pronounced in the shoot than in the root by Cd treatment (Table 1). The regulation tendencies of SOD and APX were also related to the Cd preferential accumulation in the root. Thus, the root would play a role in protecting the shoot from oxidative damages of Cd stress for rice plants.

***Key words*: ** Paddy rice; pollution-safe cultivars; metal toxicity; oxidative stress; antioxidants.

Table 1. Correlation coefficients between the plant growth factors, relative root elongation (RRE) and relative shoot extension (RSE), the plant Cd concentrations in root and shoot and their translocation factor (*TF*) values versus the tendency index (*TI*) values of physiological traits, superoxide dismutase (SOD), ascorbate peroxidase (APX), H2O2, and malondialdehyde (MDA).

TI values of physiological traits	Plant growth		Plant Cd		
	RRE	RSE	Root	Shoot	*TF*
SOD	-0.39 (p>0.30) †	-0.35 (p>0.30)	**0.65 (p=0.08)**	-0.04 (p>0.30)	**-0.64 (p=0.08)**
APX	-0.36 (p>0.30)	0.24 (p>0.30)	-0.25 (p>0.30)	**-0.73 (p=0.04)**	**-0.62 (p=0.10)**
H_2O_2	**0.77 (p=0.02)**	-0.20 (p>0.30)	-0.44 (p=0.28)	0.01 (p>0.30)	0.46 (p=0.25)
MDA	0.32 (p>0.30)	-0.21 (p>0.30)	-0.09 (p>0.30)	0.01 (p>0.30)	0.06 (p>0.30)

† *p* values in parentheses are the significant levels.

Effect of Paddy-Upland Rotation on the Abundance of Methane-oxidizing and Ammonia-oxidizing Microbial Communities in Paddy Field Soil

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Abstract

Paddy-upland rotation systems have been used as a major land management of paddy fields in Japan. In the paddy-upland rotational fields, upland crops are cultivated under drained conditions in summer for one year to several years, followed by paddy rice cropping for one year to several years. The soil conditions are kept oxic during the upland periods in these fields. Microbial communities in paddy field soil are greatly affected by these managements. As an example of anaerobes, the abundance of methanogenic archaeal community in the paddy-upland rotational fields decreased to about one tenth of that in the consecutive paddy fields (Liu *et al.*, 2015). In the present study, we have focused on aerobes, methane-oxidizing bacteria (MOB) and ammonia-oxidizing bacteria (AOB) and archaea (AOA), to reveal the effect of paddy-upland rotation on the abundance of the microbial communities. These microbial members share some similar features besides aerobes; MOB utilize methane monooxygenase in the first step of methane oxidation, while the enzymes of ammonia monooxygenase in AOB and AOA exhibit functional and structural similarities to the methane monooxygenase in MOB.

Soil samples were collected from the rotational plots and consecutive paddy (control) plots at the experimental fields in the Tohoku Agricultural Research Center, NARO, Japan, where paddy rice under flooded conditions was rotated with soybean under upland conditions at different rotation histories. Abundance of MOB, AOB and AOA communities was estimated by the quantitative PCR analyses of *pmoA* and *amoA* genes for DNAs extracted from the soil samples.

The gene abundance of *pmoA* of MOB was an order of magnitude greater in the consecutive paddy plots (10^6 copies g^{-1} dry soil) than in the rotational plots (10^5 copies g^{-1} dry soil). In contrast, the gene abundance of *amoA* of AOB was an order of magnitude greater in the rotational plots (10^8 copies g^{-1} dry soil) than in the consecutive paddy plots (10^7 copies g^{-1} dry soil). The gene abundance of *amoA* of AOA was on the order of 10^9 copies g^{-1} dry soil both in the rotational and consecutive paddy plots and showed very small differences between the plots. These results indicated that the factors affecting the behavior of the community abundance caused by the paddy-upland rotation could be different among MOB, AOB and AOA in the paddy field soil.

Key words**:** Ammonia-oxidizing archaea, ammonia-oxidizing bacteria, methane-oxidizing bacteria, paddy field soil, paddy-upland rotation.

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Effects of rice husk biochar on heavy metals solubility under dynamic redox-conditions in a contaminated soil

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Abstract

Soil contamination with potentially toxic elements (PTEs) in Taiwan is still a noteworthy environmental issue, such as chromium, nickel, copper, and zinc. These PTEs may be absorbed by plants or infiltrated into groundwater through weathering, leaching or redox conditions, and affecting the safety of food crops, microbial community abundance and human health risks, in particular PTEs contaminated paddy soil. Biochar (BC) as a carbon-rich material, is a cost-effective soil amendment that has been recommended for remediation of PTEs contaminated soils. However, the efficiency of BC to immobilize PTEs in contaminated paddy soils under dynamic redox conditions has not been clearly up to date. Thus, in this study, we have (i) quantified the impact of pre-defined redox conditions on the release dynamic of dissolved Cr, Ni, Cu, and Zn in the studied soil as affected by biochar addition, and (ii) determined the impact of redox potential (Eh), pH, dissolved organic carbon (DOC), metals, anions and specific UV absorbance (SUVA $_{254nm}$) on dynamics of heavy metals. In this study, the soil was collected from the alluvial plain of Changhua county in western Taiwan, and the soil was analyzed for basic soil characteristics and total metal content corresponding to the sequential extraction. An automated biogeochemical microcosm system was added with 300 g soil and ultrapure water in 1:8 ratio. The range of the pre-defined redox conditions was 250 mV to -200 mV, and oxidized to 250 mV. The total incubation period was approximately 35 to 48 days. The pre-set Eh windows were achieved at least 24 h before sampling and automatically maintained with the flushing of N_2 and O_2. Incubated soil samples were collected at different oxidation-reduction potentials, after centrifugation, filtering in a nitrogen glove box, and measuring heavy metal, dissolve organic carbon, anion concentration and specific ultraviolet absorbance (SUVA $_{254\ nm}$) in the filtrate. According to the experimental results, the range of the pre-defined redox conditions was +250 mV to - 200 mV, and oxidized to +250 mV. The temporal course of Eh and pH in the MCs revealed converse relationship in S and S+BC was detected, which was presumed to the reduction and dissolution of Mn hydroxides and microbial activity. The concentration of DOC in S and S+BC under reducing conditions increased might be due to release of the bounded organic matter onto the reductively dissolved-Fe/Mn and the release of DOC from soluble organic metabolites produced by reducing bacteria under reductive conditions. Moreover, the concentration of DOC has consistent trends with metals because more DOC may complex with metals and form mobile metal carbon compounds complexes. The increase in SUVA $_{254nm}$ with incubation time related to the community of microbial population. Anions had a significant positive relationship with DOC. Biochars have the potential to immobilize heavy metals in contaminated soils; however, in this study, the solubility of metals in S+BC were much higher than in S. It might be due to DOC, more DOC could provide more sites for metals to complex. To sum up, Biochar application and the systematic increase of Eh promote the release of Cr, Cu, Ni, and Zn into the solution, which might be due to increase of DOC. Using this 5% rice husk biochar in this treated soil increases the soluble concentrations of metals under dynamic redox conditions, and creates potential environmental risks.

Keywords: Potentially toxic element, paddy soil, microcosm apparatus, redox potential, biochar.

Changes in rice growth and heading response to root cutting during transplanting

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Abstract

When the rice is transplanted using transplanting machine, the roots of the seedlings are cut. This causes transplanting shock, which inhibits rice growth and nutrient absorption from soil. Eventually, the decrease in initial growth and nutrient uptake after transplanting will affect the yield of rice. In this experiment, we analyzed the changes of rice growth and heading response according to the root conditions after transplanting. For our experiment, we used Odae(Oryza sativa, temperate japonica, early maturing ecotypes). 10, 20-day-old seedlings were transplanted on the same day (May 28) in 2018 using 1/5000a Wagner pots. As a fertilizer, we used a composite slow-release fertilizer based on 9 kg/10a nitrogen, 4.5 kg/10a phosphate, and 5.7 kg/10a potassium at the area ratio corresponding to three plants instead of the pot area. There were no differences in the rice heading date depending on whether or not root cutting conditions of transplanting seedling. In case of direct seedling treatment, 10 and 20 days seedling compared to transplanting seedling was shortened by about 2.7 days and 3.3 days, respectively.

There was no significant difference in the development of leaves number according to root cutting, but it was confirmed that the number of tillering decreased slightly according to root cutting. On the other hand, the growth of shoot and root was inhibited by root cutting treatment because nutrient uptake was limited by root cutting. In conclusion, the restoration of the inhibited growth by transplanting will depend on the leaf age of seedling and the degree of transplanting shock response of each seedling. And further research is needed on the physiological mechanisms of this transplanting shock.

Key words**:** Nutrient, Rice, Root, Flowering, Transplanting shock

Potential Health Implications of Bioaccumulation of Chromium and Nickel in Lowland Rice of Paddy Soils derived from Ophiolitic Rocks in Zambales, Philippines

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Abstract
Safe and sufficient food is aimed for sustainable development. Therefore, research on safety of crops grown in natural geological hazard areas such as ophiolitic rocks is necessary. This study bridges human health and the natural occurrence of heavy metals in soils as it tackles the potential health risk associated with the bioaccumulation chromium (Cr) and nickel (Ni) in rice (*Oryza sativa*) grown along the Zambales Ophiolite Complex (ZOC). Paired soil and rice plants were collected in three different paddy areas along the ZOC (i.e. Masinloc, Candelaria, and Sta. Cruz). The total Cr and Ni concentrations in rice and soil, soil physicochemical properties, bioaccumulation and translocation factors, and the USEPA hazard quotients were determined. Results revealed that Cr and Ni in rice plant are accumulated mostly in the roots. Although the paddy soils had elevated total Cr and Ni concentrations, hyperaccumulation did not occur as bioaccumulation factors (0.0035-0.0072 for Cr; 0.0006-0.0053 for Ni) and the soil-to-root translocation factors for Cr and for Ni were < 1. Significant correlation ($p<0.05$) of soil properties with soil to root translocation showed that particle size distribution, pH, and organic matter may affect the bioavailability of Cr and Ni for plant uptake. Rice may also have sequestration mechanisms to avoid high accumulation of Cr and Ni, especially in the shoot and grains. Low risk for both male and female Filipino adults was determined as hazard quotient values for Cr and for Ni were also < 1. While it is safe to consume rice grown in the area in terms of Cr and Ni dietary intake, more studies are needed to explore other heavy metals, bioavailable Cr and Ni concentration, and other natural geologic hazard sites in the Philippines.

Key words**:** bioaccumulation, heavy metals, paddy soils, health risk

Effects of Poultry litter Biochar Application on the Uptakes of Phosphorus by rice

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Abstract
Biochar is a useful resource to improve the physicochemical properties of soil, increase fertilizer-use efficiency, and increase crop production, is widely used as a soil conditioner. The phosphorus in biochar is not only a P source for plant growth, but also an important factor caused the eutrophication of water. Poultry farming generates a large amount of litters, causing a problem of waste management. Pyrolysis of poultry litter is a potential strategy to reduce the amount of poultry litter as well as the associated odor and health hazard. This practice produces poultry litter biochar (PLB), which may be used as a soil amendment, but the factors regulating the releases of phosphorus from PLB have not be well understood. Biochars with specific properties, which are dependent on both temperature and feedstock in the pyrolysis of conversion of biomass into biochar, should be produced in accord with soil amendment requirements. So far the effect of biochar amendment on soil P availability was not well understood. In this study, the effects of PLB on the growth of rice were investigated. Poultry litter and PLBs obtained at different pyrolysis temperature (350 and 600℃) were applied as either P fertilizer or soil amendment (0.5 and 1.0%). The results showed that the growth of rice were significantly increased by the biochar treatment and the positive effect of the low-temperature PLB was better that the high-temperature counterpart. Biochar treatment had no significantly increases the P concentrations in plants. At higher P additions, the biochar application rate of 1% promoted the releases of more than did those of 0 and 0.5 %. P availibity in soil increase with increasing biochar dosage compared to control. Compared with C600 amendment, C350 amendment enhanced more P extracted from soil. Biochar applied in acid soil that increase available phosphorus which was biochar romised to increase soil pH, to enhance fertilizer-use efficiency, and to improve nutrient-retention capacity. Thus, PLBs can be used as a source of P for growing rice while biochar produced at low temperature are better to improve paddy rice growth and productivity.

Key words**:** biochar, poultry litter biochar, phosphorus

Comparing Effects of Environmentally Friendly Farming on Rice (*Oryza sativa* L.) Quality and Yield between Cultivars of Taoyuan 3 and Tainan 11 on Guandu Plain, Taipei, Taiwan

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Abstract

Due to the moist weather and the soil texture of clay loam, more than 200 ha of farmland of Guandu Plain located in the northern Taiwan has been rice field under conventional farming for many years. The common rice cultivar grown on Guandu Plain is Tainan 11, which is known for its characteristic of high yield. In addition, due to Guandu Plain in Taipei is very close to urban area, it is important to develop not only a safe environment for crop production but also a suitable place for residents' recreation. In early March of 2019, around 0.6 ha of farmland in the southern part of Guandu Plain was assigned to grow two rice cultivars, including Taoyuan 3 (TY3) and Tainan 11 (TN11), based on environmentally friendly farming. It was the very first time that TY3 was introduced and grown on Guandu Plain. Aims of this study were (1) investigating if there was any difference in quality and yield of TN11 under environmentally friendly farming instead of conventional farming, and (2) comparing the performances of quality and yield between TY3 and TN11 under environmentally friendly farming. The preliminary results showed that the use of oiltea seed meal could efficiently prevent apple snails (*Pomacea canaliculate*). With appropriate application of organic compost, decreased amount of N supply could positively assist the rice in resisting rice leaf beetles (*Oulema oryzae*). The aromatic characteristic of TY3 significantly presented in this study. As so far, the serious problem could be manual weeding due to it is extremely difficult to get agricultural labour power in many countries nowadays. In general, TY3 made a good adaptation to Guandu Plain. According to the characteristic of TY3 as aromatic rice, it should be worthy to promote on Guandu Plain under environmentally friendly farming and with the potential to increase local farmers' competitive capability.

***Key words*:** aromatic rice, compost, rice field, pest resistance, soil management, weeding

Seedling establishment and rice yield in non-puddling direct seeded rice cultivation under different field conditions with or without tillage

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Abstract

Rice (*Oryza sativa* L.) is a staple food in Asia this has mainly been cultivated by transplanting. Transplanting cultivation methods involve raising seedlings in nurseries, transporting them to the field and subsequently transplanting them; this requires a large amount of labor and is time consuming. Methods that reduce both labor and time demands, such as the direct-seeding system of rice cultivation are therefore becoming more popular than traditional transplanting methods. The wet-direct seeding method generally requires several steps (plowing, soaking and puddling) in wet land tillage before direct seeding. Puddling is an important process with regard to transplanting and wet direct seeding, because it reduces the percolation rate, which conserves water, and increases the efficiency of nutrient uptake and herbicide use. However, some Japanese farmers would like to omit the puddling process in order to save time, particularly in busy farming seasons. A rice seeder combined with a tractor-mounted paddy harrow and equipped with compaction roller back to paddy harrow has been developed (Takahashi et al. 2017, Okada et al. 2018). In the present study, we determined the impact of this rice seeder on seedling establishment and rice yield when using the wet-direct seeding method. We then conducted field experiments at three sites (A–C) for three years (2017–2019) using several treated seeds such as non-coated pre-germinated rice seeds (PG), primed rice seeds (P), iron-coated rice seeds (Fe) and Mo-coated rice seeds (Mo). The field conditions over the 3-year period are shown in Table 1. In 2017, seedling establishment rates at site A-1 were 51 (PG), 54 (P), 43 (Fe) and 59% (Mo). On the other hand, seedling establishment rates at site A-2 were 43 (PG), 50 (P) 29 (Fe) and 47% (Mo). Rice yields at site A-1 were 493 (PG), 509 (P), 523 (Fe) and 444 (Mo) kg/10a, while rice yields at site A-2 were 565 (PG), 592 (P), 580 (Fe) and 654 (Mo) kg/10a. These results indicated that non-puddling direct seeded rice cultivation can be used regardless of tillage (plow-lever) before seeding. In 2018 (site A-3), seedling establishment rates were 18 (PG), 13 (P), 45 (Fe) and 14% (Mo) under non-plow-lever soil conditions with rice plant residues. Sowing speed was slower in 2018 than in 2017 because use of the paddy harrow in non-tillage soil with rice plant residues was problematic. With the exception of iron-coated seeds, the main causative factor for poor seed establishment was attacks from birds such as sparrows. Consequently, rice yields were 377 (PG), 313 (P), 290 (Mo) and 427 (Fe) kg/10a. In 2019, seedling establishment rates at site A were 50 (Fe) and 58% (PG). The rate at site B was 73% (Fe), while those at site C were 51 (PG), 56 (Fe) and 78 (Mo)%. Based on these results, we conclude that non-puddling direct seeding rice cultivation can be effectively adopted under tillage field conditions. We discuss herein future perspectives and important elements of this technique that are particularly relevant when it is adapted for use in rice cultivation.

Table1: Location, cultivar, field conditions and seed types at the three sites over the 3-year period

Year	2017		2018	2019		
Location	Hiroshima (siteA-1)	Hiroshima (siteA-2)	Hiroshima (siteA-3)	Hiroshima (siteA-3)	Hiroshima (siteB)	Shimane (site C)
Cultivar	Koimomiji		Koimomiji	Koimomiji	Shikiyutaka	Kinumusume
Tilage	Plow-leveler	Notillage	Nontillage	Plow-vertical harrow	Plow-vertical harrow	Plow-vertical harrow
Crop cultivation before adoption of this technique	Soybean	Soybean	Rice	Rice	Rice	Soybean
Field condition before direct seeding	No weed residue	Weed residue	Rice plant residues	No residue	No residue	No residue
Seed types	Pre-germinated, primed, Mo-coated, iron-coated	Pre-germinated, primed, Mo-coated, iron-coated	Pre-germinated, primed, Mo-coated, iron-coated	Iron-coated, pre-germinated	Iron-coated	Iron-coated, Mo-coated, pre-germinated

***Key words*:** wet-direct seeding, non-puddling, different material coated seeds, seedling establishment

Biochar significantly reduced nitrogen oxide emission from upland soils by reducing autotrophic nitrification

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Abstract

Biochar amendment has been found to effectively improve soil fertility and reduce nitrogen (N) losses in arable soil, however how biochar affects nitrous oxide (N_2O) emission and N transformation processes remains unclear. A field experiment was conducted in an area of calcareous fluvo-aquic soil in the North China Plain, and included 5 treatments with three replicates: no N fertilizer (CK); chemical fertilizer (NPK) application at 200 kg N ha^{-1} (F); and NPK fertilizer plus maize straw biochar application at rates of 3 (FB3), 6 (FB6) and 12 (FB12) t ha^{-1}. A ^{15}N tracing incubation study, in combination with the ^{15}N tracing model, was also carried out to evaluate the effect of biochar on the N_2O production processes using NPK soil and biochar-amended soil at 12 t ha^{-1} after 3 years of application.

During the maize growth season, N_2O emission was 0.57 kg N_2O-N ha^{-1} under CK treatment, and increased to 3.30 kg N_2O-N ha^{-1} under NPK treatment. In contrast, N_2O emissions were significantly reduced by 31.4–39.9% ($P < 0.05$) under FB treatments compared with NPK, and N_2O emission factor of the applied N was significantly reduced from 1.36% under NPK to 0.71−0.85% under FB ($P < 0.05$). During the wheat growth season, biochar had no effect on N_2O emissions. Biochar application did not affect maize yield; however, a slight reduction in wheat yield was found under FB12.

During the incubation, cumulative N_2O emission in NPK soil increased from 24.13 (40% WFPS, water-filled pore space) to 26.40 μg N_2O-N kg^{-1} (80% WFPS), whereas it was significantly ($P < 0.05$) reduced to 18.27–23.94 μg N_2O-N kg^{-1} in FB12 soil, with a reduction of 9.3–17.7%.

Gross mineralization rates in NPK soil were 3.59–5.63 μg N g^{-1} d^{-1} (40–80% WFPS) and reduced to 0.60 μg N g^{-1} d^{-1} in FB12 soil (60% WFPS). The gross mineralization rate of recalcitrant organic N in NPK soil increased from 3.54 to 5.60 μg N g^{-1} d^{-1} as soil moisture increased from 40% to 80% WFPS, while the mineralization rate of labile organic N was maintained at 0.03−0.05 μg N g^{-1} d^{-1}. In contrast, the gross mineralization rate of labile organic N in FB12 soil increased to 0.60 μg N g^{-1} d^{-1} whereas that of recalcitrant organic N was reduced to nearly zero. Biochar application increased the NH_4^+ immobilization rate by 4.4 times, thereby reducing the rate of autotrophic nitrification. Both the NH_4^+ mineralization-immobilization turnover and the ratio of nitrification to NH_4^+ immobilization were reduced in FB12 soil, consequently lowering the potential for NO_3^- leaching in soil. Overall, our results suggest that adding biochar contributes to mitigating N_2O emissions, primarily by decreasing the autotrophic nitrification rate through a reduced NH_4^+ supply by increasing mineral N immobilization and lowering organic N mineralization.

Key words: Biochar; N_2O emission; N transformation process; N_2O production pathway; ^{15}N trace model

Quantifying carbon input for targeted soil organic carbon sequestration in China's croplands

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Abstract

Increasing the soil organic carbon (SOC) pool in croplands can not only promote crop production but also mitigate climate change. The objective of this work was to quantify the needed C input rates for both maintaining China's cropland SOC and improving it to global average level. By using a biogeophysical model (Agro-C), we performed simulations with a high spatial resolution (10×10 km) across China's croplands to quantify the C input rate under given scenarios. The model simulations showed that an average C input of 2.1 Mg C ha^{-1} year^{-1} is required to stop soil C loss and that SOC density could approach the global mean of 55 Mg C ha^{-1} by 2050 when 5.1 Mg C ha^{-1} year^{-1} is incorporated into the soils. The quantified C inputs showed a large spatial disparity, depending on the existing SOC level, mean annual temperature and precipitation. The existing SOC level in Heilongjiang Province, where the cropland area accounts for 9.2 % of the national total, is much higher but the current C input is much lower than it is elsewhere. Increasing the organic C input should be given priority in this province.

***Key words*:** Agro-C model; Croplands; Soil organic carbon; Carbon sequestration; China.

The establishment of soil characteristics and parameters of Taiwan representative flatland soil series

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Abstract
Various environmental features in Taiwan have led to diversified types of soil. Effective soil management and sustainability of soil resources can be obtained through systematic investigations of the major soil types. Therefore, there have been several rural soil surveys and investigation projects, which were mostly focused on soil features and fertility investigations with the purpose of improving agricultural productivity. Based on demands for soil quality evaluations, pollution management, and risk assessment in the future, the Environmental Protection Administration (EPA) has conducted soil pedon investigations for a representative soil series of flatland soils in Taiwan since 2013. The total area of the representative soil series has covered approximately 42% of the flatlands in Taiwan as of 2018, for which the sampling and analysis of 84 representative soil profiles and 417 soil horizon samples have already been completed. The investigations were all conducted according to the USDA Soil Survey Manual, which is divided into different diagnostic horizons by one meter excavation based on the soil genesis of the soil profile. In addition to the 30 recorded in-situ soil morphological descriptions of soil features, 53 soil parameters were obtained for laboratory analyses of soil characteristics, including the median and range values of soil physical, chemical, and biological characteristics. All soil characteristics and parameters have been uploaded on the National Soil Quality Database for other data users as a reference soil database for soil quality management, soil pollution prevention, health risk assessment, and academic research.

***Key words*:** soil survey, representative soil series, soil management and utilization, soil database, health risk assessment.

Preliminary DNDC Model to Estimate Carbon Emissions from Different Irrigation Methods

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Abstract
In this study, the DeNitrification-DeComposition model (DNDC model) was used to estimate the methane (CH_4) and nitrous oxide (N_2O) emissions of different irrigation methods (alternative wetting-drying and continuously flood) during the cultivating period (from transplanting to harvesting), and the two greenhouse gases were converted into carbon dioxide emissions. The simulation results showed that the daily nitrous oxide emissions using the AWD irrigation method and the CF irrigation method were 0.0113 ± 0.0026 (kg C $ha^{-1}d^{-1}$) and 0.0130 ± 0.0027 (kg C $ha^{-1}d^{-1}$) respectively, no significant difference (p = 0.645) was found in between. The simulation results were different from the general simulation results, which need to be further verified with other factors taken into consideration. The nitrous oxide emission fluxes of the two irrigation methods were simulated to peak after fertilization and between crop seasons. In terms of methane emissions, the simulation results showed that the daily emissions of the AWD irrigation method and the CF irrigation method were 0.73±0.1 (kg C $ha^{-1}d^{-1}$) and 22.92±0.19 (kg C $ha^{-1}d^{-1}$) respectively, with significant difference (p = 0.000) detected. However, both treatments had emitted methane during the growing period regardless of the irrigation methods. The results showed that methane and nitrous oxide emissions were directly effected by water management and fertilizer application. With proper irrigation management and reasonable fertilization according to the different water and nutrient requirements of crops in each growing phases, we could reduce the methane and nitrous oxide emitted from farmland.

Key words: DNDC model; AWD; nitrous oxide; methane.

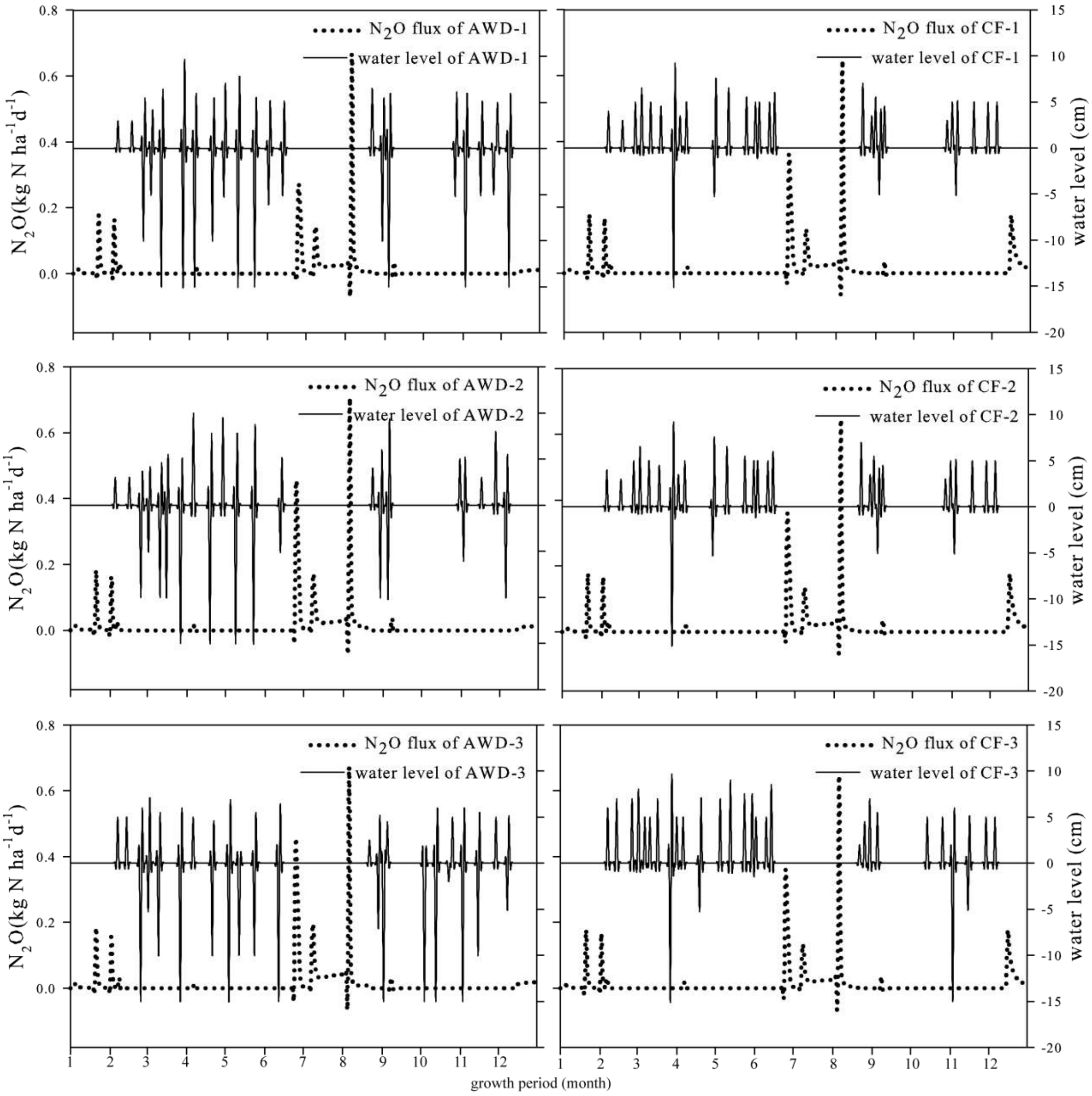

Fig. 1. The daily flux of nitrous oxide (N_2O). The irrigation treatment of AWD and CF had larger N_2O fluxes between the first crop season and the second crop season. N_2O fluxes were also detected after N fertilizer application.

Development of CO_2 emission factor caused by use of lime according to 2006 guideline in Korea

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Abstract

In order to provide an accurate value of the CO_2 emission coefficient from applied lime in the upland ecosystem, the CO_2 emission factors were characterized under different levels of ^{13}C-lime applied pepper field soil in the current study. The seasonal CO_2 fluxes increased significantly with increasing limestone and dolomite application levels, reaching maximum values of around 1,000 kg ha^{-1} for red pepper. Calculated by linear regressions between lime application levels and seasonal $^{13}CO_2$ fluxes originating from ^{13}C-lime, the direct CO_2 emission rates from lime were projected to be 0.0086 (limestone) and 0.0157 (dolomite) kg C per kg for red pepper. To develop a comprehensive greenhouse gas inventory management system for agriculture, fishery, and forestry sector which enables to collect diverse activity data and achieve systematic management with flexibility regarding changes of calculation standards and models.

***Key words*:** CO_2 emission; limestone; dolomite; upland .

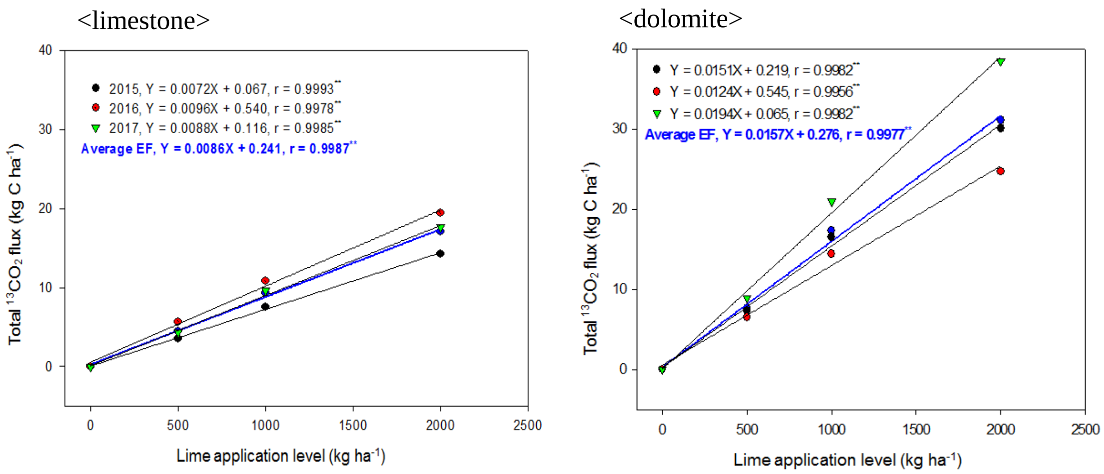

Fig. 1. Correlation between lime application levels $^{13}CO_2$ emission in pepper field.

Progress of soil greenhouse gas measurement method by gas chromatography in the two decades

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Abstract

Greenhouse gas emission from agricultural ecosystems are one of major environmental issue, recently. Our research aim is improving greenhouse gas flux measurement method precisely, inexpensively and automatically in agricultural ecosystems. Measurement method for CO2, CH4 and N2O simultaneous analysis (3GHG-GC) was firstly launched in 2005 (Fig. 1) followed by automatic gas sampling system (AGSS) in 2006, automatic injector for GC (RoVi) in 2013 and nitrogen generation system from compressed air for precise GC analysis in 2011, respectively. 3GHG-GC was recently further improved that the carrier gas of this method was changed from helium to nitrogen or argon to meet global requirement to save helium consumption.

…

***Key words*:** greenhouse gas; carbon dioxide; methane; nitrous oxide.

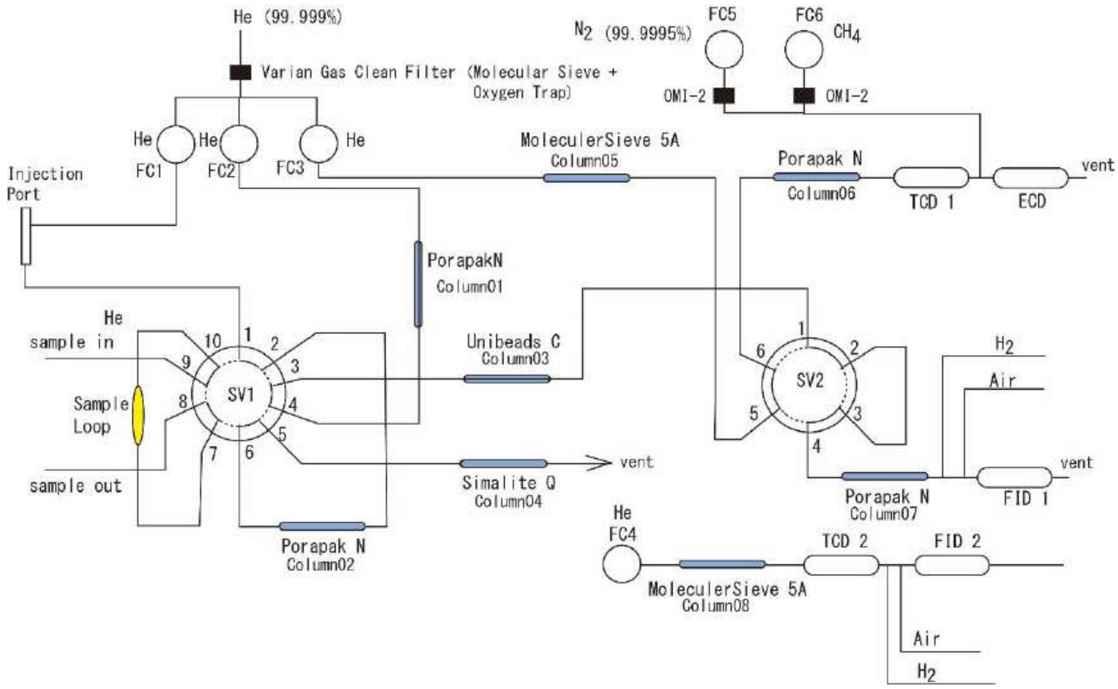

Fig. 1. Block diagram of combined analytical system of soil greenhouse gases by gas chromatography.

Influence of different N sources and water management on crop yield response to IR50 rice and greenhouse gas emission

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Abstract

Both chemical and organic N fertilizers may lead to high environmental impacts if their application is not properly managed. The oxygen availability in soil due to water management can affect the greenhouse gas emission in rice. To understand the interacted effects of different N sources and water regimes on the crop yield response and greenhouse gas emission in rice, we conducted the pot experiment with split-plot design with 3 replicates by using IR50 (Indica rice). Different N treatments include control (0N), urea, cow dung (CD), chicken manure (CM) and bokashi (B) at the rate of 0.24 kg N per 3 kg soil. Water management treatments were continuous flooding (CF) and alternate wetting and drying (AWD).

The combined effects of N fertilizers and water regimes resulted in high tillering by CM and Urea under AWD. AWD significantly increased tiller numbers ($P<0.0019$), but the grain yield was not statistically different ($P<0.0520$) between two water regimes. Urea, CM and Bokashi significantly increased the grain yield as compared to control and CD. In this study, AWD saved 5% of water use without affecting the grain yield. The effect of fertilizers on methane (CH_4) emission was significantly different depending on plant growth stages. It indicated that the interaction between fertilizers and CH_4 emission are complex with different processes including plant growth, the decomposition rate of fertilizers applied and cultivars. The global warming potential (CH_4) was successfully reduced ($P<0.0407$) by AWD as compared to CF.

Keywords: N fertilizers, water management, yield and greenhouse gas.

Table. 1 Yield and yield components, total water use and the global warming potential (GWP) as affected by different N sources and two water regimes in IR 50 rice.

Treatment	Grain Yield (g pot^{-1})	Spikelet Number	Panicle Number	Tiller Number	Straw Dry Matter (g pot^{-1})	1000 Grain Wt. (g pot^{-1})	WUE (g L^{-1})	CH_4 (kg CO_2-eq. ha^{-1})
Fertilizers								
Control	10.4b	81.1bc	10.2c	11.3c	11.7b	12.7b	0.84cd	10.7a
Urea	19.6a	82.0bc	15.7a	21.5a	18.3a	15.5a	1.3a	47.5a
CD	11.7b	71.0c	13.0b	15.7b	13.1b	12.7b	0.72d	28.8a
CM	17.8a	86.7ab	15.8a	24.0a	19.4a	13.3ab	0.94bc	14.0a
Bokashi	17.9a	97.0a	11.8bc	16.7b	18.0a	15.6a	1.0b	60.1a
Water Regimes								
CF	14.9a	83.3a	12.5a	15.5b	16.8a	14.1a	0.87b	63.5a
AWD	16.0a	83.8a	14.1a	20.1a	15.3a	13.8a	0.98b	0.95b
Statistical variance								
Fertilizer (F)	**<0.0001**	**0.0004**	**<0.0001**	**<0.0001**	**<0.0001**	**0.0037**	**<0.0001**	0.2668
Water Regimes(WR)	0.0520	0.8280	0.1789	**0.0019**	0.2046	0.7071	**0.0230**	**0.0407**
F*WR	0.0782	0.4903	**0.0068**	**0.0006**	**0.0012**	0.1679	0.3472	0.1248

Values followed by different letters and bold are significant, Tukey HSD test. WUE means water use efficiency.

The Characteristics of Soil Organic Matter of Andosols of Forest Sites in Japan using Particle Size Fractionation and STXM NEXAFS

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Abstract
Soil Organic Matter (SOM) and its relations to the global carbon cycle plays a pivotal role in mitigating climate change and global warming by decreasing carbon emissions. To understand carbon stabilization in the soil, it is essential to study SOM in the molecular level to identifying the differences of characteristics of SOM according to its particle size fractions and carbon functional groups as soil ages. The accumulation of SOM in Andosol soils makes it an ideal soil type for studying SOM (Baldock *et al*, 2000; Miyazawa *et al*, 2013).
For this study, study sites with similar parent material of volcanic ash and land use as forests but differ in soil age were used to obtain physio-chemical properties of soil like; soil pH (H_2O, KCl and NaF), Electric conductivity, Cation Exchange Capacity and Exchangeable cations (Mg^{2+}, Ca^{2+}, K^+ and Na^+). Particle size fractionation method was according to Asano and Wagai (2014). Organic Carbon (OC) and Total nitrogen (TN) content was determined by an Elemental Analyzer. Carbon distribution and functional groups were determined by Scanning Transmission X-ray Microscopy (STXM) with Near Edge X-ray Absorption Fine Structure (NEXAFS) at UVSOR BL4U.
From results, the cationic properties of young sites' show high cation content at the surface owing to organic matter while the old site was owing to clay. Particle size fractionation show that the young site was predominantly fine sand (20µm-200µm) and course sand (200µm-2000µm) while the old site was dominated by clay (<2µm) and silt (2µm-20µm). OC content was highest at the <2µm fraction for both sites but TN content was highest in the old site. Result of STXM observation show OC distribution of the <2µm fraction of young site was minimal carbon, on the other hand, high carbon intensity for the old site. Carbon functional groups obtained by NEXAFS indicated that the young soil sites were predominantly carboxylic C (288eV) with some Aromatic C (285eV) and minimal Aliphatic C (287eV) whereas the old soil site was mainly Aromatic C (285eV) and Aliphatic C (287eV).

***Key words*: Carbon functional groups; Particle Size Fractionation; Soil Organic Matter; STXM NEXAFS; Volcanic Ash Soil.

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Effect of soil salinity on autumn potato productivity in reclaimed land of Korea

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Abstract
Crop productivity in saline soil of reclaimed land is substantially affected by soil salinity. Tolerant crop choice and adaptation strategies (soil amendment and water management) are very important factors in saline agriculture. In this study, green house experiment was performed to determine how fall potato cultivars are tolerable and which cultivar is recommendable. in saline soils. Based on three soil EC conditions (S1:0.7 dS m^{-1}, S2:3.2 dS m^{-1}, S3:4.5 dS m^{-1}), seven cultivars (suseon, sebong, eunseon, hongseon, daeji, gangseon, namseon) of fall potato was assessed in Saemaegem reclaimed land of Korea. In the initial stage, the germination rate in two higher EC soils of S2 and S3 were lower than lower soil EC of S1. The germination rates in three soil EC were 79, 64, 41% respectively. At harvest, the tuber number per plant in S1 and S2 were 3.7 and 3.6. In the soil of S3, the number was decreased 2.9 significantly. Tuber weight per plant(TWP) in three soil EC levels were substantially decreased by increasing EC. In the soil of S1, TWP ranged from 95.6 to 146.8 g. In the soil of S2, TWP ranged 85.5 to 123.8g. In the soil of S3, TWP ranged from 79.9 to 93.6g. Among seven cultivars, three cultivars (daeji, suseon, eunseon) showed better growth. Increasing soil EC decreased considerably yield index. In two higher EC (S2 and S3), yield index were 78 and 70 compared to that in S1. Based on germination and TWP, the relative yield index is one of the indicatives for saline farming. In this test, it was observed that Daeji, Suseon, Hongseon were better in S1. However, in S2, Daeji were better than Suseon and Hongseon. It is suggested that Daeji was more tolerable cultivar which is adaptive to saline soil.

Key words: soil EC, autumn potato, cultivar, crop yield index

Table 1. Comparison of tuber weight per plant and relative yield index of seven fall potato cultivars as affected by three soil EC levels

Cultivar	Soil salinity			Mean
	S1	S2	S3	
	g/plant			
Kangseon	124.1	100.7	96.4	107.1
Namseon	125.2	85.1	80.0	96.8
Daeji	**146.8**	**123.8**	**88.2**	**119.6**
Sebong	95.6	85.5	92.7	91.3
Suseon	**146.1**	95.7	79.9	107.3
Eunseon	117.6	105.1	96.9	106.5
Hongseon	**146.6**	**109.4**	**93.6**	**116.5**
Mean	128.9	100.8	89.7	-
Yield Index	100	78	70	-

Effect of Water logging duration on sorghum×sudangrass hybrid growth in Saemangeum reclaimed land of Korea

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Abstract
There are several limiting factors for crop productivity in agricultural paddy field of the coastal reclaimed land in Korea. Due its reclamation process, soil physico-chemical properties such as soil EC, lower soil fertility and lower hydraulic conductivity lead to lower crop productivity in the reclaimed land. Based on land maturity and suitability, instead of cash crops, forage crops are firstly introduced in the reclaimed land. It is known that except for paddy rice crop, the agricultural crops in the reclaimed land of Korea are vulnerable to water and salinity stress (water-logging and drought). In this study, known for one of the highly cultivating forage, was assessed to determine how much damaged in three water-logging conditions(2,4,6days) and which cultivar is more productive at two critical growth stages (vegetative and heading stages). The sorghum×sudangrass hybrid was affected significantly by water-logging stress factors. The vulnerability to water-logging is bigger at vegetative stages than heading stages. The duration of waterlogging for two and four days are similar regardless of growth stages. However, water-logging for six days led to considerably 36% of yield reduction compared to two and four days. In this study, The nine cultivars were compared depending on water logging intensity and timing. Among nine cultivars, six cultivars are heading types, the other three cultivars are non-heading types. Non-heading three cultivars are more productive and tolerable than heading types.

Keywords : waterlogging stress, paddy field, sorghum×sudangrass hybrid, reclaimed land

Table. The effect of waterlogging stress on crop growth and yield in reclaimed land for 2018

Treatment		Plant height (cm)	No. of leaves (개)	Stem diameter (mm)	Yield ton/ha(FW)
Growth stage (A)	Vegetative	231.6b	8.9a	8.7a	34.9b
	Heading	238.5a	8.9a	7.9a	41.2a
Waterloggin Duration(days) (B)	2	244.6a#	9.1a	8.3a	43.8a
	4	239.0b	9.1a	7.9b	41.3b
	6	221.4c	8.6b	7.9b	29.1c
Cultivar (C)	Cadan99b	259.8a	9.6bc	7.9bc	32.8e
	Dream	236.5d	9.4d	6.7d	25.9f*
	Sweetsiux WMR	251.9b	9.3c	7.6c	32.7e
	Revolution	230.4e	9.7ab	8.1ab	40.8d
	SX-17	238.9c	10.1a	8.5a	40.9d
	***JUMBO**	**228.1f**	**8.7d**	**8.4a**	**44.0b**
	Evergreen	**217.5g**	**7.8e**	**8.4a**	**41.7c**
	Turbe	**217.3g**	**7.8e**	**8.3ab**	**46.0a**

***Bolded three cultivars are non-heading type**
 # The same letter in the column are not significant (DMRT p<0.05)

Estimation of Carbon Sequestration Potential Density of Topsoil Nearby Critical Regions (Riparian Zone) of Soil Erosion

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Abstract

As climate change is accelerating in recent years, efforts are being made globally to cut greenhouse gas emissions. In this regard, COP21(Conference of the Parties 21) launched the agenda for '4 per mille soils for food security and climate' which emphasizes soil carbon sequestration, as a result, research on soil carbon sequestration has been actively conducted worldwide. Therefore, in this study investigated the physico-chemical characteristics of the topsoil near the riparian zone (4 major rivers), the high risk area of soil erosion, and calculated the status of carbon sequestration (C_{fine}) and carbon sequestration potential density (C_{spd}) of the topsoil according to land use in Korea. First, in order to calculate the C_{fine} and C_{spd} of the riparian zone topsoil, a total of 4,414 points were collected by dividing the riparian zone in to four divisions, according to the land use, it was classified into upland (UL), grassland (GL), orchard (OC), forest (FR) and bare land (BL). The physico-chemical characteristics of the topsoil were analyzed by bulk density, coarse element, fraction of particle size and soil organic carbon. And the C_{fine} and the C_{spd} were calculated using the empirical equation through the literature. As a result of C_{fine} calculation in the topsoil, the average value of C_{fine} was high in FR and OC where soil organic carbon contents was high in most divisions. Especially, the highest C_{fine} value of FR was 110.72 g kg^{-1} in Yeongsan-Seomjin river, 44.26 g kg^{-1} in Geum river, 132.96 g kg^{-1} in Nakdong river and 35.15 g kg^{-1} in Han river. As a result of calculating the C_{spd} indicating that carbon sequestration is possible, negative values (-) in the FR of the Nakdong river division and the OC of the Geum river division indicate that the carbon is supersaturated. The C_{spd} value was the highest in BL of all divisions, the values were in 1.35 kg m^{-2} in Yeongsan-seomjin river, 0.43 kg m^{-2} in Geum river, 0.82 kg m^{-2} in Nakdong river and 2.17 kg m^{-2} in Han river, respectively. In the future, the bare land is expected to be highly utilizable for carbon sequestration and storage in soil, and sustainable soil erosion management will be needed.

***Key words*:** Carbon sequestration; riparian zone; soil erosion; topsoil.

Comparison of N_2O emission factor and N use efficiency among different kind of organic fertilizers at Andosol grassland in northern Japan

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Abstract
[Objectives] Although use of animal wastes as organic fertilizer is important for sustainable agriculture, there are few studies comparing the effect of different kind of organic fertilizers on soil N_2O emission and plant N uptake in field scale. Purpose of this study is to evaluate the effects of three kind of organic fertilizers made by animal wastes under the adequate fertilization in grassland.
[Methods] Five treatment plots, no NPK fertilization (NF), chemical fertilizer (CF), cattle manure (CM), cattle slurry (CS) and digested slurry (DS), were established in a grassland in southern Hokkaido, Japan. Fertilization was conducted according to regional recommendation, however, the unbalance of N, P and K contents in the organic fertilizers was modified by using the chemical fertilizers. N_2O fluxes were measured by closed chamber method every week from May 2017 to October 2018 (638 days) and cumulative N_2O emission was obtained. Plant N uptake was calculated as the product of plant dry weight and N content. N_2O emission factor (EF N_2O) was calculated by dividing the cumulative N_2O emission derived from CF or organic fertilizer by amount of applied N of CF or organic fertilizer, respectively, and N use efficiency (NUE) was calculated by dividing the plant N uptake from CF or organic fertilizer by amount of applied N of CF or organic fertilizer, respectively.
[Result] Cumulative N_2O emission was larger in 2017 than in 2018, and tended to be CS>CF=DS>CM>NF (Fig. 1). EFN_2O varied between the years. EFN_2O in 2017 and 2018 of CF was 4.0 and 1.0%, respectively, and EFN_2O of organic fertilizers in 2017 and 2018 was -4.7 and -1.6% for CM, 7.1 and -0.8% for CS and 1.0 and -1.1% for DS, respectively (Fig. 1). Similar to N_2O, plant N uptake was larger in 2017 than in 2018, and tended to be CS>CF=CM>DS>NF (Fig. 2). NUE in 2017 and 2018 of CF was 83 and 32%, respectively, and NUE of organic fertilizers in 2017 and 2018 was -65 and 31% for CM, 179 and 52% for CS, and -26 and 41% for DS, respectively (Fig. 2). Negative values of EFN_2O and NUE shown in some of the organic fertilizers suggests that the application of the organic fertilizer contributes to nitrogen immobilization in soil. This was supported by the negative correlation between the EFN_2O or NUE and the CN ratio of organic fertilizers.
[Conclusion] The result shown here indicates cattle slurry promote plant N uptake but also N_2O emission. This is because lower C/N ratio of cattle slurry compared with other organic fertilizers. Controlling CN ratio of organic fertilizer is important to balancing crop production and environment protection.

Key words: organic fertilizer, nitrous oxide, emission factor, nitrogen use efficiency, grassland

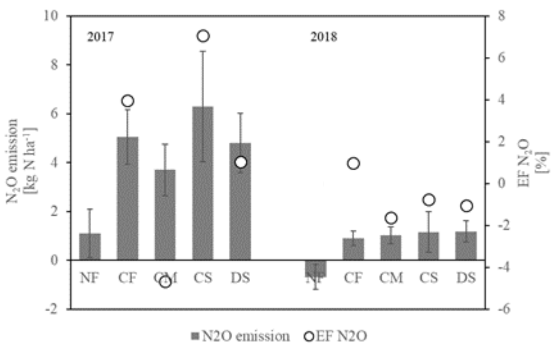

Fig. 1. N_2O emission and EF N_2O

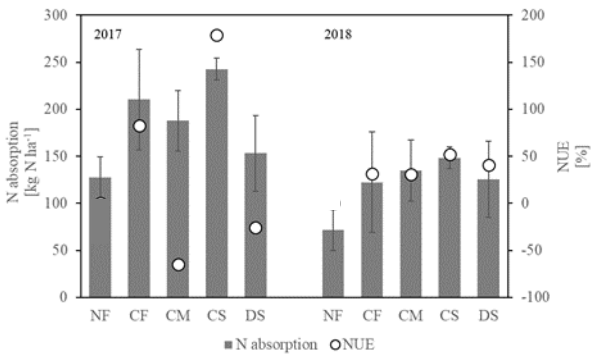

Fig. 2. Plant N absorption and NUE

Effects of Moisturizing on Improving the Determination of Soil Organic Matter Content through VNIR Reflectance Measurements

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Abstract

Soil organic matter (SOM) has play an important role of soil physical, chemical, and biological properties. Using Visible–Near Infrared (VNIR, 350–2500 nm) reflectance spectroscopy to determine SOM content is nowadays a technique that has the advantages of fast, cost effective, non-destructive, minimal sample preparation, and producing no hazardous chemical wastes than traditional soil sampling and laboratory analysis. However, the method has not been successfully applied on fields directly due to interferences by varied soil moisture content, physical conditions and the requirements of calibration datasets with similar soil properties. In this study, rewetting soil samples to at least 25% gravimetric water content was employed to reduce the effects of varied soil moisture content on measured reflectance spectra. Partial least square regression (PLSR) models that may have universal applicability were developed using a dataset that includes samples having major soil characteristic reflectance curves as given by Stoner and Baumgardner (1981). When validated against two other independent datasets, accuracy assessments were MBD = 0.07%, RMSD = 0.94%, RPIQ = 2.96 and MBD = 0.28%, RMSD = 1.14%, RPIQ = 1.70, respectively.

Key words: Proximal sensing, Soil organic matter, Sample rewetting.

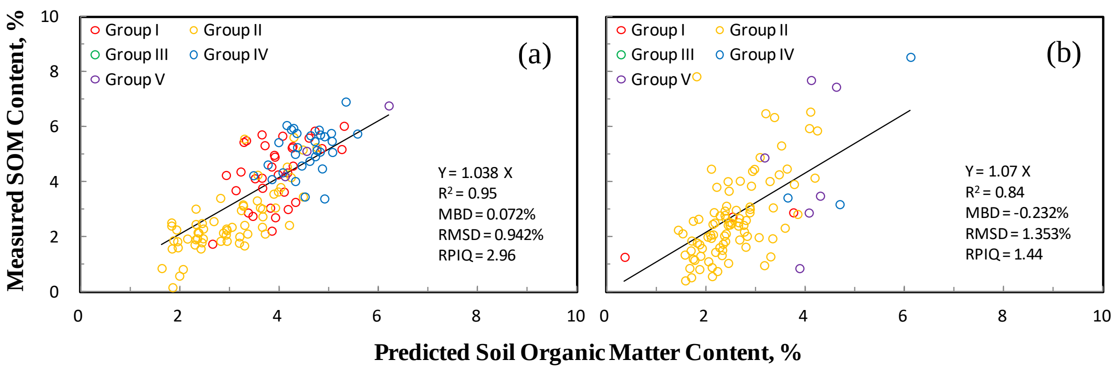

Figure 1. Validation test of SOM predicted by PLSR techniques using independent datasets collected from (a) YL Farm and (b) Tea Plantations. Group I to V are soils with spectral reflectance curves identified as minimally-altered, iron-affected, iron-dominated, organic-affected, and organic-dominated, respectively, by Stoner and Baumgardner (1981).

Establishment and Discussion of Soil Heavy Metal Background Concentration in Taiwan

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Abstract

Based on the demands of the soil quality evaluation, pollution management, and the revision of soil pollution control standard in the future, Environmental Protection Administration (EPA) has conducted several soil investigations with theoretical foundations of geology and pedology systemically. Through the soil parent material sampling (rock and sediment) and representative soil pedons sampling, the background concentration investigation of representative soil was completed gradually in specific areas (areas with high natural background concentration of chromium-nickel) and the wide area (drinking water quality protection area and flat area) around whole Taiwan island. This paper describes the process of investigation, data processing methods, and the result by using statistical methods to estimate the threshold value of natural background concentration of the soil in Taiwan. Based on the description, this paper suggests applying “The Reference Value of Upper Limit for Natural Background Concentration" as a reference for the evaluation of soil quality management. After the background concentration evaluation, this paper suggests the upper limit reference value for the drinking water quality protection area (mountain area) should be as follows As: 30 mg/kg, Hg: 0.5 mg/kg, Cd: 0.3 mg/kg, Cr: 100 mg/kg, Cu: 80 mg/kg, Ni: 130 mg/kg, Pb: 60 mg/kg, Zn: 200 mg/kg; and the upper limit reference value of soil background concentration for the flatland should be as follows As: 30 mg/kg, Hg: 0.5 mg/kg, Cd: 0.3 mg/kg, Cr: 60 mg/kg, Cu: 50 mg/kg, Ni: 50 mg/kg, Pb: 40 mg/kg, Zn: 150 mg/kg.

***Key words*:** background concentration, baseline, threshold value, soil investigation, soil quality.

S08-P04

Simulation of Solute Transport in a Sandy Soil Irrigated with Treated Wastewater

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Abstract
The shortage of water resources required for agriculture is an important issue. Therefore, use of treated wastewater (TWW) for irrigation is receiving increasing attention worldwide. The important obstacle to extend the use of the TWW for irrigation is the water quality: higher concentration of salts (sodium and chloride), organic matters and nutrients compared to natural water. Therefore, the irrigation with TWW may cause accumulation of salt such as sodium and chloride. However, long-term experiments are needed to evaluate effects of TWW irrigation on soil salt accumulation for field environments. Therefore, we conducted column experiments and multicomponent solute transport simulations as a preliminary study for investigating the effects of TWW irrigation on soil salt accumulation.
The TWW was collected from a rural sewage-treatment plant in Japan, where is installed with secondary treatment and chlorination processes. Sodium concentration, chloride concentration and Sodium Adsorption Ratio (SAR) of TWW was 2.3 $mmol_c\ L^{-1}$, 1.8 $mmol_c\ L^{-1}$ and 2.36 $(mmol_c\ L^{-1})^{0.5}$, respectively. A column (Diameter 6 cm; Hight 30 cm) was filled up with a sandy clay loam soil (Clay 16%; Silt 8%; Sand 76%). The TWW was applied to the soil column at infiltration rate of 160 mm d^{-1} for 30 days. Leached solutions were collected from the bottom of the soil column at an arbitrary time. In addition, soil solutions were collected from some depth of the soil column at an arbitrary time. Cation and anion concentrations in the leached solutions and soil solutions were measured by ion chromatography. Multicomponent solute transport simulation was conducted using Hydrus-1D software. Cation exchange reactions were considered by Gapon equations in the simulation model.
From the results of the column experiment, sodium concentration and SAR in leached solution was reached to the same concentrations with that of applied solution in 5 days (800 mm) (Fig. 1). From the results of the Hydrus simulation, we could properly simulate sodium concentration and SAR in leached solutions (Fig. 1). We are going to simulate the effects of TWW irrigation on soil salt accumulation for field environments using solute transport parameters obtained from column experiments.
***Key words*:** Treated wastewater irrigation; Column experiments; Hydrus-1D; Cation exchange.

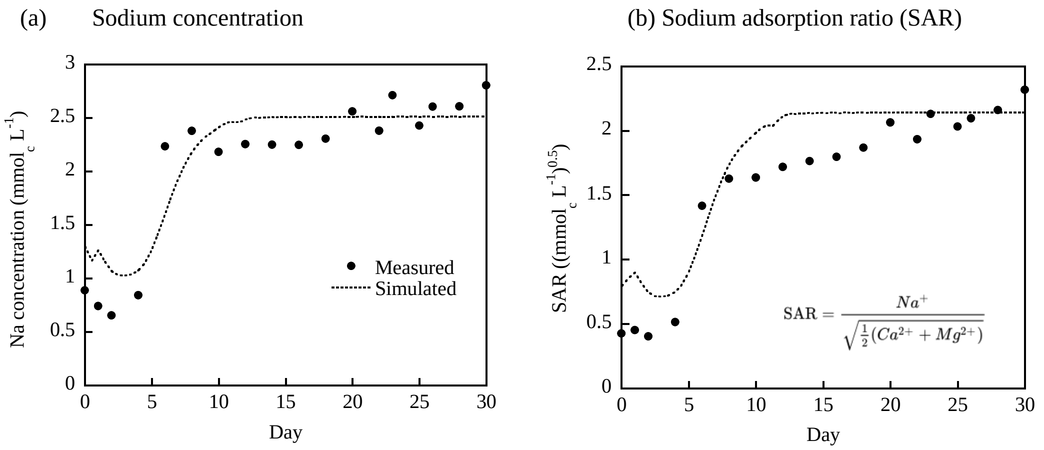

Fig. 1. Comparisons of (a) measured and simulated sodium concentration and (b) measured and simulated sodium adsorption ratio (SAR) in leached solutions from a soil column

Amendment of Husk Biochar on Chemical Forms and Health Risks of Cadmium in Two Varieties of Lettuce

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Abstract
The tolerance and detoxification ability of plants to heavy metals is related to the chemical forms present. In this study, two different varieties of lettuce were planted in potted contaminated soils mixed with and without husk biochar (BC), and harvested at different periods of time. The objective of this study is to understand the BC's effect on the chemical forms of cadmium (Cd) in the edible tissues of lettuce grown in these treatments. Experimental results showed that the variety of lettuce did affect the accumulated Cd concentration. Compared with the control treatment, BC treatment increased the pH value of the soil, which may reduce the bioavailability of Cd in the contaminated soil and thus reduced the accumulation of Cd in the lettuces. The accumulated Cd concentrations of all lettuce varieties under different treatments were lower than the human body safety concentration standards set by the World Health Organization.

Key words: Biochar; cadmium; chemical forms; lettuce

Funding
This program was funded in part by the Ministry of Education, Taiwan, R.O.C., under the Higher Education Sprout Project.

Smart Agriculture - Evaluation of Smart Irrigation System for Rice Paddy Cultivation in Taiwan

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Abstract

In Taiwan, rice production chain is well-developed and supported by different agri-machineries during whole growing season. However, there is no automation system in water management, which is still very labor-intensive compared with other actives. Although Taiwan's precipitation is large, some production areas may experience drought risk due to uneven distribution of precipitation time and small reservoir water storage. In order to increase the flexibility of soil water and human resource, the study goal will establish the smart paddy watch of telepresence platform to introduce the AI sensor and internet of things (IoT) techniques, which improve the efficiency of paddy irrigation and field labor. We have set up the two irrigation models for conventional and AWD (alternate wetting and drying) type to measure the system potential during the cropping season of 2018-2019 in Taichung. Various sensors and small weather stations are integrated to monitor the paddy environmental factors such as water level, conductivity, temperature, relative humidity, photometer and electronic flow meters. According the feedback of the paddy irrigation of remote control system, rice farmers can track the paddy water level in real time and control irrigation through mobile phones. The results showed that using the AWD irrigation mode, each season can save about 30% of water compared to the conventional mode, and up to more than 40-50% irrigation in the rainy season based on the similar yield potential. In this system can not only link the signal between intelligent sensors to control irrigation, but also collect the temporal and spatial variations of yield trait and cultivation events in the database. To follow the way, the farmers can use this control system of soil irrigation and individual dataset to optimize the actives timing in the next season. The smart cultivation system will be helpful to save in time, labor and paddy water.

Key words: Rice, Intelligent agriculture, Water management, Alternate wetting and drying planting

Effects of applying rice husk biochar on the chemical forms of cadmium in the water spinach

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Abstract
In this study, rice husk biochar was added to cadmium- (Cd-) contaminated soil, and two varieties of water spinach (*Ipomoea aquatica* Forsk. cv. White bone and *Ipomoea aquatica* Forsk. cv. Chinese) were planted, respectively. The crops were harvested on day 28th, 35th, 42rd and 49th to investigate the changes of Cd concentrations in the edible parts of water spinach. In addition, using the chemical forms of Cd in water spinach, the intake of Cd by human body through the consumption of water spinach could be calculated and then compare with the maximum allowable limit, 60 μg/day/person prescribed by the WHO. The results showed that the addition of rice husk biochar to the soil promoted the growth of two varieties of water spinach, and significantly reduced the Cd concentration in the edible parts. In the control group without applying rice husk biochar, the Cd concentration in the edible parts increased as the increase of growing periods.

Key words: Biochar; cadmium; chemical forms; water spinach

Funding
This program was funded in part by the Ministry of Education, Taiwan, R.O.C., under the Higher Education Sprout Project.

Geographical Distribution for Water Quality of Agricultural Ground Water in Korea

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Abstract
As the recent agricultural environment problem has mixed with the natural environment of weather, it is difficult to cope with simple information processing such as diagrams and quantification.
In order to contribute to the systematic development of eco-friendly agricultural policies, a basis for viewing the actual conditions and changes of the farming environment in a time-space manner by standardizing various environmental information and preparing an information list is needed.
Therefore, this study was intended to establish a comprehensive information analysis system for various and complex agricultural environment problems by preparing the results of the survey of variation in the water quality of agricultural ground water in 2008 and 2018 with a time-space distribution map linked to GIS in Korea. The nationwide distribution of water quality of agricultural ground water was identified using on 200 ground water items for farming purposes by land use (rice paddy, upland, plastic house) and by timing (April, July).
In 2008, the average pH of agricultural groundwater was 6.8, NO_3-N 5.45 mg/L, and Cl^- 23.3 mg/L, and the average concentration of NO_3-N by land use type was investigated in the order of upland > plastic house > rice paddies, but it was found to be below the 20 mg/L as threshold limit for agricultural water quality in Korea.
In 2018, the average pH of underground water for agriculture was 6.9, NO_3-N 6.42 mg/L, and Cl^- 25.8 mg/L, and the average concentration of NO_3-N for each type of land use was investigated in order of plastic house > upland > rice paddies, but it was found to be below the 20 mg/L as threshold limit of water quality for agriculture in Korea.
Comparing the average annual groundwater quality between 2008 and 2018, other ingredients except K were slightly higher or similar in 2018 than in 2008. This is believed to have affected farming due to the influence of cultivated crops, excluding weather conditions (such as rainfall) and rice paddies.
In terms of the excess water quality threshold limits for agricultural groundwater, Cl^- concentration was suitable for agricultural water quality threshold limits in 2008 and 2018, whereas pH exceeded water quality threshold limits by 4.7% and 1.2% respectively, and NO_3-N by 2.8% and 4.3% respectively.

***Key words*:** Water Quality; Agricultural Ground Water; Geographical Distribution; Threshold Limit.

Assessment of Open-Field Smart Farming Practice for Ameliorating the Impact of the Soil Salinity on Upland Crops in the Reclaimed Land based on Subsurface Drainage

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Abstract

Soil salinity is one of the major constraints to crop production in saline lands all over the world. In Korea, crop establishment in reclaimed land is highly dependent on the degree of soil salinity management. Soil salinization is too much complex and dynamic to evaluate based on destructive and labor-consuming measurements. This is affected by not only weather parameters such as rainfall and evaporation, but also soil properties and ground-water fluctuations. In this study, NICS(National Institute of Crop Science, RDA,Korea) has assessed the platform set to collect site-specific weather data and monitor saline soil environments for advancement of measures to ameliorate the adverse impact of soil salinity on crop growth based on application of Information, Communication and Telecommunication(ICT) in the various test fields equipped subsurface drainage. During cropping season in 2018, in the two research fields(drainage and soil improvement test), soil salinization and moisture variations in root-zone and underground have been monitored by sensing devices, GS3, which is specific in saline soil, has measured the soil EC(Electrical Conductivity), water content and temperature in the root-zone and CTD diver that is strongly specific under saline ground water measured ground-water variation and EC. Simultaneously, the collected information has been transmitting from in-situ to end-users ubiquitously by wireless LTE. The platform is the first one to monitor how the inter-correlation of weather and soil salinity affects crop environment in saline arable land. Although some defectives in sensing and transmitting heavy data in the beginning are found. The pilot-scale ICT sensing platform in open-field farm will be promising and useful in multiple sectors agricultural water management(Irrigation and Drainage) and crop growth safety. It is suggested that for further practical application. the long-term dataset need to be analyzed and supplementary agricultural management practices, which are appropriate in reclaimed land, should be merged into.

***Key words*:** Subsurface drainage, Open-field smart farm, ICT, soil salinity

Table. Growth characteristics and yield of waxy corn as affected by several treatments for 2018 growth season

#Treat	*PL	NL	SD	HTE	EL	ED	EW	SR	Yield
	cm	No/plant	mm	cm	cm	mm	g/plant	%	kg/10a (F.W)
Control	83c	9b	12c	23c	7c	20c	11c	20	75.6c
CCSD	126b	9b	20a	46b	13b	32b	65b	60	260.7b
TLSSD	147a	8b	21a	56a	15a	40a	107a	95	715.0a

#TLSSD : Trenchless Subsurface Drainage, CSSD : Conventional Subsurface Drainage
*(PH) Plant Height, (NL) Number of leaves,(SD) Stem Diameter, (HtE) Height To Ear
(EL) Ear Length (ED) Ear Diameter (EW) Ear Weight (SR) Survival Rate (F.W) Fresh Weight

Potential Substitutes for Quicklime (CaO) as Disinfectant for Carcass Burial Sites

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Abstract
Burial of the killed livestock carcasses is one of the major disposal options according to the domestic animal infectious disease control law of the Ministry of Agriculture, Forestry and Fisheries (MIFAFF) in Korea to prevent the spread of infectious diseases in the case of outbreak of livestock infectious diseases such as FMD (foot and mouth disease) and AI (avian influenza). During outbreak of FMD occurred in Korea in 2010, most of livestock carcasses were buried. However, the potential leakage of leachate from buried livestock carcasses had increased the likelihood of contamination of nearby soil and water body. After 2014, FRP (fiber reinforced plastics) storage tanks have been used to store livestock carcasses. Quicklime (CaO) has mainly been used as a disinfectant in the process of burying livestock carcasses due to sterilizing effect by controlling pH and raised temperature, low cost and facilitation of supply. However, quicklime generates heat from more than 100°C when it contacts with moisture. As a result, the covering materials of burial site are damaged by the heat generated by the quicklime and moisture resulting in the leachate leakage. Therefore, in this study, we tried to find a safe alternative to quicklime as disinfectant for burial sites of livestock carcasses. The hydrated lime, ($Ca(OH)_2$) turned out to be a candidate material for replacing quicklime because it has the ability to adjust pH and has no exothermic reaction. To investigate the ability of the hydrated lime to disinfect the soil a column experiment was designed. Soil and quicklime or hydrated lime were packed in 3 cm (inner diameter) columns; deionized water adjusted to pH 4, 7 and 10 were supplied to the columns at a rate of 20 mL/h; the leachates were collected and were analyzed for pH. Results showed that the pH reached 12 or higher in all treatments and was maintained for more than 50 days. The sterilization effect of the hydrated lime by pH adjustment was confirmed. Since no damage of covering materials from heat release reaction was observed and no safety concerns were existed, thus, we propose the hydrated lime as an alternative to quicklime as disinfectant for burial of mass livestock carcasses.

***Key words*:** Livestock, leachate, burial site, disinfectant, quicklime, hydrated lime

The effect of groundwater level variation on soybean production in a large-scale field in Hokkaido, Japan

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Abstract
Subsurface irrigation-drainage systems are recently installed in large-scale fields in Hokkaido, Japan. This system makes it possible to drain excess water after rain and supply water under drought conditions, through the buried pipes. It is important to control the groundwater level uniformly for crop production, especially in large-scale fields. The objectives of this study were to clarify the spatial variability in groundwater level in a mineral soil-dressed peatland field, and to evaluate the effect of the variation in groundwater level on soybean production.

This study was carried out at Imakane located in southern Hokkaido. In the field (250 m × 65 m), drainage pipes were buried 1.0 m below the surface at 10 m intervals. Soybean [*Glycine max* (L.) Merr.] was planted in 2018. The mineral-soil thickness of the soil-dressed peatland field ranged from 35 cm to 75 cm. The groundwater levels were measured at 21 points in the field. At each point, a perforated pipe with a water level logger was installed between the drainage pipes. The soil physical properties and the soybean yield were also measured.

The accumulated rainfall from June to September in 2018 was 731 mm, and was greater than the average in the past decade (569 mm). The average groundwater level from June to September varied from −0.68 m to −0.21 m among the points, and correlated with the dry bulk density and the solid phase rate of Ap2 horizon. The change in the groundwater level due to a rainfall event was estimated by subtracting minimum value from the maximum value during the event. The amount of change in the groundwater level increased with increasing rainfall amount. The ratio of the amount of change in the groundwater level to the rainfall amount was calculated as the slope of the liner regression line at each point. The ratio varied from 0.9 mm mm^{-1} to 6.0 mm mm^{-1} among the points. The ratio showed a negative correlation with the average groundwater level (r = −0.50, p < 0.05), but there was no significant relationship between the ratio and the saturated hydraulic conductivity. The ratio might show the permeability in the field, and the bypass flow could occur easily at the points where the groundwater level was low. The yield of soybean ranged from 27 kg 10a^{-1} to 139 kg 10a^{-1}. The yield was negatively correlated with the solid phase rate of Ap2 horizon (r = −0.47, p < 0.05), and was positively correlated with the ratio of the change in the groundwater level to the rainfall amount (r = 0.41, p = 0.06). These results could show that the high groundwater level will not only increase the solid phase rate of Ap2 horizon, but also decrease the yield. Furthermore, the high permeability could be important to soybean production in higher rainfall year.

Key words**:** spatial variation; groundwater level; soybean yield.

Optimum Range on Soil Physical Indicators under Plastic Film House in Korea

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Abstract

Soil is the most available growing system for crops. The roots of crops are able to absorb water and nutrients from the soil medium. The soil physical properties are important for the root growth and penetration. The purpose of this study was to select indicators that could prevent the growth of crops in the plantation area and to establish the appropriate soil physicality criterion according to the plant crops. Analysis of soil chemical properties such as pH, EC, organic matter content, effective phosphoric acid, soil physical properties such as effective rhizosphere, soil, and bulk density in the main crops by crops from 2015 to 2017 for planted crops such as lettuce, strawberry, cucumber. For plastic film house, similarly, soil depth, groundwater table, bulk density, and air content were chosen as soil physical indicators. The optimum ranges were set as follows; deeper than 50 cm for soil depth and groundwater table, less than bulk density 1.5 Mg m^{-3} and more than 10% air content for all soils.

***Key words**: air porosity, bulk density, effective soil depth, plastic film house*

Table 1. The optimum range of soil physical indicators for crops cultivated greenhouse.

Greenhouse Crops	Available soil depth	Bulk density	Air phase
	(cm)	(Mg m^{-3})	(%)
Cucumber, Lettuce, Oriental melon, Strawberry, Tomato, Watermelon	above 50	below 1.5	above 10

Distribution of Soil Carbon Storage in Plantation Forest of Central Taiwan: A Case Study in Experimental Forest, National Taiwan University

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Abstract and key words

The objective of this study was to survey soil and analyze distribution of carbon storage in plantation forest of central Taiwan for supplying reference data of central Taiwan forest soil carbon storage assessment. The results indicated that soil pH range was between 4.48 and 6.71. Comparing with different carbon storage of soil pedons, soil carbon storage was ranged between 68 and 246 ton C ha^{-1} at 0-30 cm。 The ratio of 0.59-0.99 of the soil carbon storage to a depth of 100 cm was stored at 0~30 cm, indicating that soil carbon storage at depth of 0-30 cm can explain 59% total soil carbon storage. Comparing with soil carbon storage and environmental factor in plantation forest of central Taiwan, soil carbon storage was related with elevation and the distribution was affected by micro-topography. The soil carbon storage was also affect by mudslide processes. Although the soil surface was recovered high soil carbon storage amount in the mudslide area, the soil carbon storage of deep layers was not estimated due to high gravel percentage. As soil carbon storage quick test, sampling 0-30 cm soil layer, it will decrease man power and cost of analysis and fast estimate soil carbon storage.

Key words: Carbon storage, Nutrient, Soil carbon.

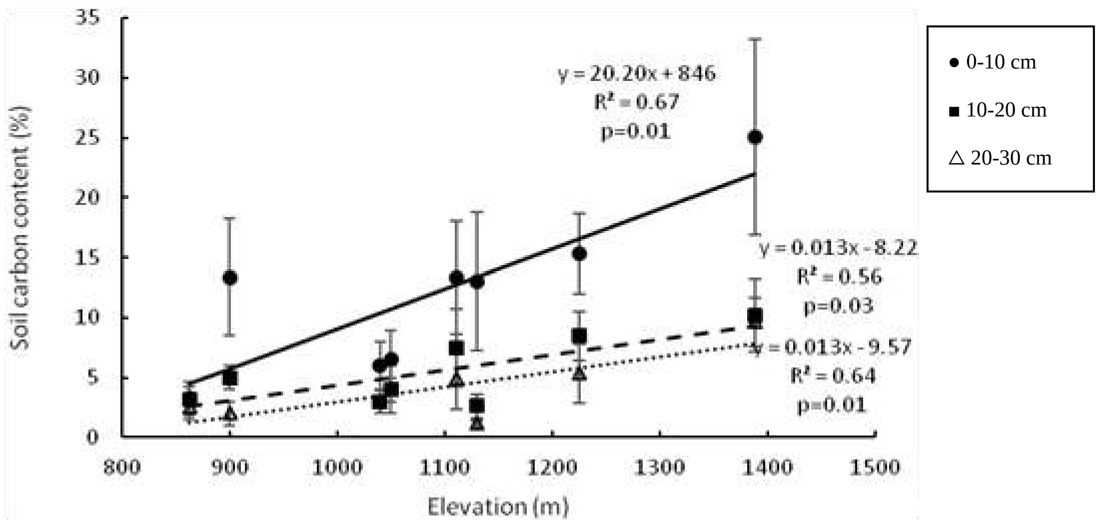

Fig. 1. Relationship of carbon content of different soil depth and elevation in Experimental Forest, National Taiwan University

Effect of Land-use Change on Litterfall Production and Nutrient Accumulation in the Montane Area of Central Taiwan

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Abstract

Land-use changes can affect litterfall production and nutrient accumulation through vegetation conversion. During March 2016 to February 2018, the litterfall production and nutrient accumulation under the natural broad-leaved forest and the adjacent Japanese cedar (*Cryptomeria japonica*) and Moso bamboo (*Phyllostachys pubescens*) forests in Fenghuang montane area in Xitou and Neimoupu tracts of the Experimental Forest, National Taiwan University, Nantou County, central Taiwan were investigated. The results showed that leaves are the dominant litterfall in all forests during two years, but 22 % of total litterfall production was contributed by the leaves of a few broad-leaved trees growing in the Japanese cedar forest. Broad-leaved forest showed seasonality in leaf litterfall, which was consistent with the results of the previous study (Yang, 2007). The massive amount of total litterfall in three forests in September 2016 was due to three moderate-intensity typhoons (Fig. 1). Therefore, the typhoon was considered a primary factor affecting the total litterfall production. Furthermore, the heavy rainfall in the unusual long rainy season from April to July 2017 caused a significantly greater amount of total litterfall in all forests. The broad-leaved forest showed the greatest amount of litterfall production comparing to Japanese cedar and bamboo forests, whereas Japanese cedar has the lowest litterfall production among three forests (broad-leaved (7.7 ton yr^{-1} ha^{-1}) > bamboo (7.26 ton yr^{-1} ha^{-1}) > Japanese cedar (5.4 ton yr^{-1} ha^{-1})). The results showed that land-use change can decrease litterfall production and could decrease nutrient accumulation in forest soils. Since the contents of C, N, P, K, Ca, and Mg of litterfall for estimating the nutrient contribution to forest soils are still under analysis, more results will be presented in the future.

***Key words*:** litterfall; natural broadleaved forest; Japanese Cedar; Moso bamboo

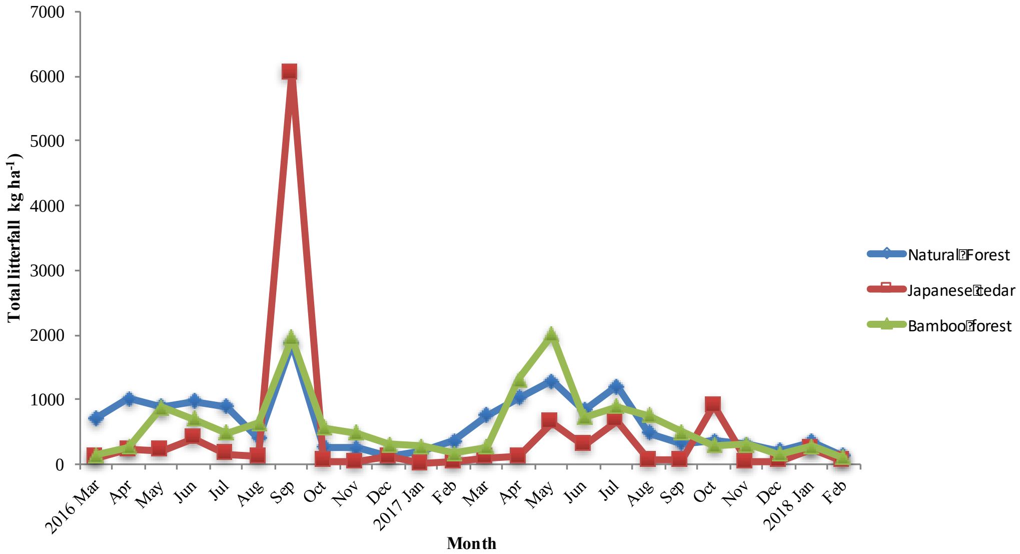

Fig. 1. Monthly litterfall production in the natural broad-leaved, Japanese cedar and Moso bamboo forests in Xitou, the Experimental Forest, National Taiwan University.

Reference

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Proteins in Xylem Exudates from Rapeseed Plants (*Brassica napus* L.) Play a Crucial Role in Cadmium Phytoremediation

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Abstract
Phytoremediation is an economical and viable method for reducing cadmium (Cd) in polluted soils. Cd is transported from the roots to the stem. Binding of Cd by organic acids and amino acids and its subsequent transportation through plants via xylem vessels has been verified. However, the roles that proteins play in Cd transport are still unclear. Rapeseed plants were selected for this study. After treating with Cd (0, 10 and 30 µmol L–1 (µM)), the proteins of the plant were analysed using two-dimensional electrophoresis. Twelve significantly differentially regulated spots were identified using mass spectrometry when the Cd concentration was increased; six of these spots were upregulated and six were downregulated. By identifying the functions of these proteins, transport of Cd to the xylem of rapeseed plants could be classified according to the cellular physiologies involved in carbohydrate metabolism, energy production, and redox damage reduction. This study provides a crucial basis for further proteomic and genetic studies on environmental Cd phytoremediation.

***Key words*:** Soil pollution; Phytoremediation; Two-dimensional electrophoresis.

Table 1. LC/MS/MS identification of the differentially expressed proteins

No.	Accession no.	Protein description	MOWSE score	Experimental Mr / p*I*	Theoretical M_r / p*I*	Highly expressed in
	gi|17939849	Mitochondrial F1 ATP synthase beta subunit [*Arabidopsis thaliana*]	243	52.05 / 5.66	63.56 / 6.52	
	gi|3893822	ATPase beta subunit [*Nicotiana sylvestris*]	184		59.60 / 5.73	
9	gi|2116558	F1 ATPase [*Pisum sativum*]	110		60.28 / 6.63	Ex.
	gi|149384751	ATP synthase beta chain [*Heterogonium pinnatum*]	73		24.25 / 5.52	
	gi|13236786	ATP synthase beta subunit [*Burretiokentia hapala*]	72		53.75 / 5.21	
43	gi|15228194	SBPase (Sedoheptulose-bisphosphatase); phosphoric ester hydrolase / sedoheptulose-bisphosphatase [*A. thaliana*]	83	38.95 / 4.91	42.79 / 6.17	Control
48	gi|15224582	GSTF10 (HALIANA GLUTATHIONE S-TRANSFERASE PHI 10); Copper ion binding / glutathione binding / glutathione transferase [*A. thaliana*]	104	24.73 / 5.36	24.22 / 5.49	Ex.
56	gi|7488556	Hypothetical protein - wild cabbage (fragment)	85	30.28 / 5.33	29.01 / 4.94	
	gi|27362906	Putative lactoylglutathione lyase-like protein [*Capsella rubella*]	82		5.90 / 5.04	Control
	gi|159463262	Predicted protein [*Chlamydomonas reinhardtii*]	48		118.17 / 9.04	
77	gi|31790095	Glutathione S-transferase 2 [*Brassica juncea*]	128	24.07 / 6.03	24.28 / 5.66	Ex.
	gi|1402898	gst6 [*A. thaliana*]	89		23.75 / 6.08	
90	gi|5730139	Ferredoxin-NADP+ reductase [*A. thaliana*]	91	33.25 / 5.70	40.48 / 8.66	Control
	gi|61969078	Putative ferredoxin-NADP reductase [*Solanum peruvianum*]	43		35.44 / 7.71	
94	gi|205830697	RecName: Full=Unknown protein 18	63	52.45 / 6.59	1.39 / 5.80	Control
	gi|6911142	Putative glycine-rich RNA binding protein 1 [*Catharanthus roseus*]	52		14.27 / 8.71	

Fate and Transport of Polybromodiphenyl Ethers (PBDEs) in Soil: Identification and Monitoring Near a PBDE-utilizing Factory in Taoyuan, Taiwan

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Abstract
The fate and transport of polybromodiphenyl ethers (PBDEs), one emerging contaminant and one group of flame retardants, in soil have been studied more than 3 years in some farms near its utilizing factory in Taoyuan, Taiwan. The biotic and abiotic processes of PBDE in the subsurface were also evaluated. One heavily contaminated site near Taoyuan industrial area, Taiwan, utilizing decabromodiphenyl ether (DBDE) was identified. The composition of contaminate in the soils was close to that in the commercial product, which suggest the source of contamination possibly from the factory since its air venting hole is direct to the farm. The very low PBDE dissipation in the environment was observed. The results revealed that 2-15 cm depth accounted for the most PBDEs accumulation, also indicating transport into deeper soil possibly through rainfall. The soil PBDEs can be uptaken via crops (shown in our recent papers) then possibly consumed by human beings. Therefore, it is urgent to establish the feasible PBDE treatments procedure as well as continuous monitoring in this contaminated site.

***Key words*: **Polybromodiphenyl ethers; decabromodiphenyl ether; soil; transport.

Remediation of Pb, Zn and Cd in Contaminated Mining Soils Using Alkaline Materials Derived from Sub-agricultural Products (Biochar) and Non-Hazardous Industrial Byproducts (Apatite and Fly Ash)

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Abstract

Heavy metal contamination of crop lands surrounding mines is a major environmental issue in North Vietnam. In situ immobilization of heavy metals in contaminated soils using alkaline materials from agricultutal sub-products and non-hazardous industrial byproducts was investigated. The amendments included biochar, fly ash, and apatite were added to the contaminated soils taken from lead and zinc mine to observe immobilization of heavy metals, such as Pb, Zn and Cd. The five type forms of heavy metals were analyzed using a sequential extraction method. The amounts of exchangeable heavy metal ions were used to evaluate immobilization of tested heavy metals. The increase in soil pH caused by adding amendments created more negative charge on the soil surface that promoted Pb, Zn and Cd adsorption. Heavy metals were mainly bound in the organic, Fe/Mn and carbonate fractions of the biochar and the mixture of biochar and apatite by either ion exchange, adsorption, dissolution/precipitation and through substitution of cations in large organic molecules. Biochar mixed together with apatite and fly ash can reduce greater amount of the exchangeable Pb, Zn and Cd.

After 90-days incubation with these amendments, soils were used to grow maize to observe the growth of plants. The selected substance can be regarded as the low-cost amendments to effectively reduce uptake of heavy metals by plants. .

Keywords: Adsorption, Biochar, Fly ash, Apatite, Heavy Metal, Mining soil and Maize.

Metal Bioavailability in Soils with Implications to Metallophytes Diversity in a Cu-Au Processing Site in Kias, Benguet, Philippines

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Abstract
Unregulated mining activities could generate large amounts of heavy metal(loid)s in tailings being by-products of copper-gold processing and could pose environmental concerns. The objective of this study is to assess the correlation of the metal bioavailability and other soil abiotic parameters to the metallophyte diversity in Kias, Benguet. The investigation on the potential of metallophytes to take up metal(loid)s as contaminants has been progressing. A 25-year old Cu-Au processing site in Kias, Benguet was used to study the effect of different soil abiotic parameters and bioavailable form of heavy metals such as Cu, Pb and Zn in the metallophytes diversity. Twelve (12) sampling points were chosen for the study. Based from the fieldworks conducted in the site, seven (7) plant species were identified and categorized into their respective metallophyte classification. All soil samples are classified as sandy loam, dominated by sand (57.49 - 75.56%), silt (15.73 - 39.56%), and clay (2.95 - 8.71%). This denotes low water retention capacity, resulting to an acidic environment. The pH level among the sampling sites ranged from 5.87 - 6.87 (slightly acidic). The % Organic Matter, ranging from 2.39 to 9.87% in all samples are considered high (>5%). However, lower OM influences the metal mobility in plants since complexation with ligands such as citric acid, malic acid, fumaric acid and oxalic acid for Zn, and histidine and humic acids for Pb, are inhibited. The % moisture ranged from 1.83 to 3.99%, which may be considered low. In addition, nutrient levels ranged from 0.06 to 0.15% for Total Nitrogen and 6.80 to 30.7 mg/kg for Available Phosphorus, respectively. Moreover, soil physico-chemical properties such as texture, pH, organic matter, and moisture determine the fraction of heavy metal(loid)s that can be accumulated by the plants and can be immobilized in the soil. Metal(loid)s such as Cu and Zn are classified as readily available in soil; whereas, Pb is categorized as one of the least bioavailable metals.

Key words: Heavy metals, metallophytes, diversity, bioavailability

Characterization of Lead Pollution Near Mine and Smelter in Korea using Lead Stable Isotopes.

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Abstract
Farm lands have a high risk of heavy metal contamination from pollution in industrial areas. Transfer of heavy metals from soil to plants and their subsequent consumption is the major exposure route for human. This study was conducted to evaluate lead pollution of farm land near mine and smelter using lead stable isotopes as environmental tracers. Environmental samples such as soil and plants were analyzed; input and output materials were also collected from soil near the smelter and mine. The $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$ ratios of plants were closer to the ratios of soil from sites WD(wondong mine). But the isotope ratios of plants in site JH(Janghang smelter)were different from that of the soil. This means that the pollution pathway other than soil contaminated the plant. The concentration of plant heavy metals is known to have little correlation with the total value of the soil. Because there was no isotopic data of surrounding dust, it was interpreted using the isotope ratio of the atmospheric environment in Korea. The ratios of $^{207}Pb/^{206}Pb$ in the atmospheric environment in Korea were 0.861±0.016 and the composition of lead isotopes in atmospheric samples was reported to fallow the composition of lead isotope by smelter. Lead contamination of the plants in site SM near the smelter was estimated to come from the atmosphere, not the soil. When the ratio of $^{207}Pb/^{206}Pb$ is higher than 0.850, plants are affected by the smelter. The ratio of less than 0.850 is judged to show the mixing characteristics by mine and smelter.

Key words: Heavy metals; isotopic composition, translocation, source tracking

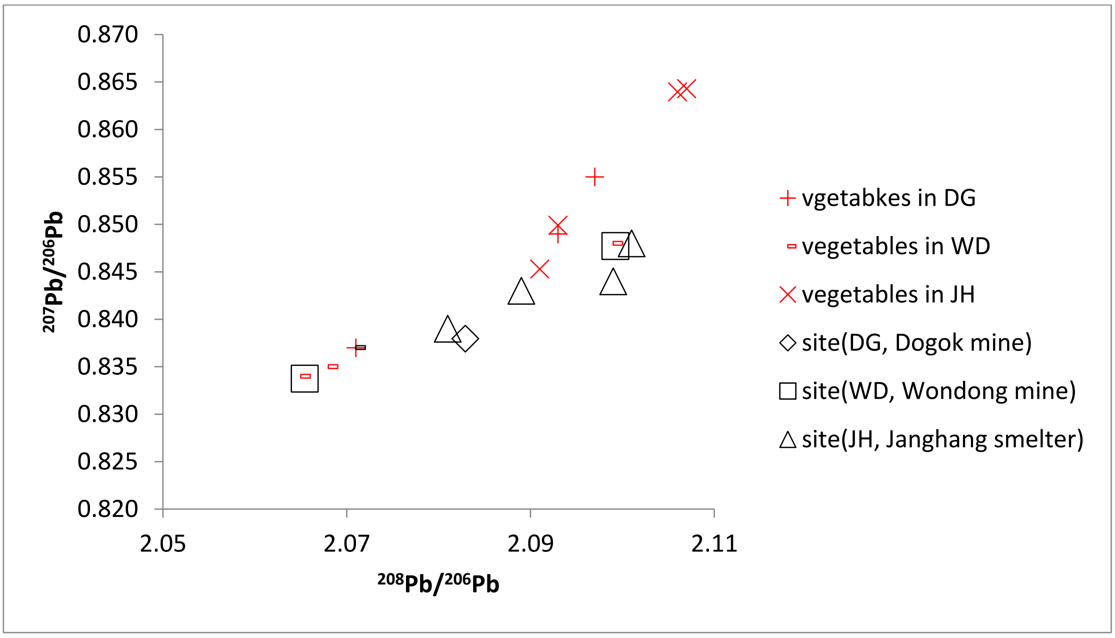

Fig. 1. Comparison of lead isotope ratios between soils and plants.

Developing Correlation of Soil Cadmium and Uptake of Cadmium in Rice with Unmanned Aerial Vehicle-derived Multispectral Images

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Abstract

The problem of heavy metal pollution in farmland soil is more critical with every passing, which poses a threat to food security and human health. However, traditional methods of detecting heavy metal pollution was only selective abstraction and destructive. The aim of this study is to develop a standard protocol for field Unmanned Aerial Vehicle (UAVs) times series multispectral images to assist in the prediction of above ground and brown rice cumulative cadmium (Cd) concentration management evaluation system. Rice potential danger of Cd pollution field located in Taoyuan Bade. The experiment period during first crop season in 2018, planting Taikeng 9 (TK 9), Taikeng 14 (TK 14) and Taitung 30 (TT 30). UAVs carried Parrot Sequoia Multispectral camera (Red, Green, Red Edge, NIR) for collecting aerial images in time series. Fifty-three vegetative indices (VIs) derived from four original wavebands reflectance and integration of VIs were tested in this study for analysis correlation between Cd concentration in vegetative phase, reproductive phase and maturation phase. Result shows that the best VIs for different phenotypes regression varies over time and varieties. Cd content in brown rice of rice variety TY9 were highly correlated with GNDVI at 89 days after transplanting (DAT) (R^2 = 0.870) , TY14 were highly correlated with ARI at 75 DAT (R^2 = 0.985) and TT30 were highly correlated with MCARI/MTVI2 at 40 DAT (R^2 = 0.985). VIs derived from three calculated methods about normal single band, UAV multiple spectral and simulating multiple spectral from hyperspectral were tested in this study for regression analysis. In summary, this system can provide estimate the current grain concentration by VIs. If it exceeds the rice limit of 0.4 ppm, agronomic management measures are taken to achieve the purpose of early warning. The accumulation of heavy metal Cd concentration in rice can immediately assist in monitoring content and crop growth of rice, and contribute to the development of precision agriculture.

Key words: Oryza sativa L., reflectance, remote sensing, heavy metals, cadmium pollution, vegetative indices, UAV, multispectral images, hyperspectral

Sequestration of Mercury and Methylmercury in Contaminated Estuary-Sediment by a Thin Layer Cap

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Abstract
To date, the thin layer cap is the modern strategy on contaminated sediment remediation. This study is aimed to investigate (1) the Hg removal efficiency of various type sorbents influenced by various environmental factors and (2) the effect of thin layer cap on Hg-contaminated sediment remediation via microcosm experiments. In the aqueous batch experiments, the Hg removal efficiencies of activated carbon (AC), sulfurized activated carbon (SAC), and iron sulfide (FeS) were all remarkable. With the presence of salinity, the Hg removal efficiency of AC and SAC showed an increase as the salinity levels increased, however, the Hg removal ability of FeS was only slightly affected in all salinity levels tested. The performance of sorbents for Hg removal in different salinity levels from highest to lowest was: FeS, SAC, and AC. The ability of sorbents to remove Hg was also affected to varying degrees by the presence of dissolved organic matter (DOM). In general, DOM tended to reduce Hg removal efficiency of sorbents. The complexation of DOM and Hg was not conducive to sorbents' sorption because DOM contained thiol groups that may react with Hg to form stable complexes. In the microcosms system, the Hg removal of sorbents were shown to be less significant due to the closed circulation flow. Nevertheless, in the freshwater system, the MeHg removal ability of sorbents was greater than that in the estuary system. Nevertheless, the production of MeHg in the estuary system (0.10−0.14 ng/L) was far lesser than that in the freshwater system (2.26−11.35 ng/L) when compared with no capped microcosms in both freshwater system and estuary system. The MeHg inhibitory effects of SAC and FeS were slightly lower than that by AC. Overall, FeS showed the best Hg removal efficiency, resistance to salinity, and slightly affected by DOM in aqueous adsorption experiments. In contrast, in the microcosms, AC was shown to be the best MeHg adsorption material.

***Key words*: Mercury; Methylmercury; thin layer capping; sediment; microcosm.**

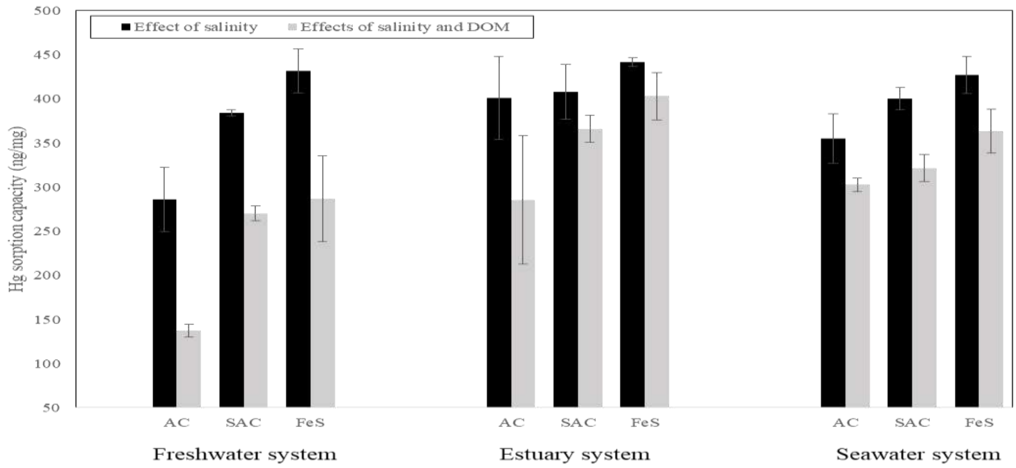

Fig. 1. The comparison of various salinity levels and DOM on Hg sorption capacity in the aqueous batch experiment.

Toxic metal(loid)s threshold values in soil established via phytoavailability based empirical model

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Abstract

The phytoavailability of heavy metal(loid)s in soil could be important indicators to speculate environmental risk to plants and food safety. So, the most realistic threshold value of the metal(loid)s phytoavailability in soil are needed to be established. In this study, toxic metal(loid)s including As, Cd, and Pb guideline values based on phytoavailable pool of corresponding metal(loid)s in soil were developed through an empirical regression model. Rice was cultivated in 100 different soils which had a wide range of metal(loid)s concentration and selected soil properties including soil pH, organic matter, and cation exchange capacity. At harvest, chemically extractable (1 M NH_4NO_3, 0.05 M EDTA, Mehlich3) metal(loid)s concentrations in soils and their contents accumulated in rice grain were determined. The obtained data were used for regression analysis. Then, according to the empirical model derived in this study, soil metal(loid)s phytoavailability threshold values were established by substituting rice standard limit of metal(loid)s in the empirical model. Also, previous experimental data and the data from field survey were employed for compensating the soil phytoavailable threshold values for rice derived from pot study. Overall, the calculated Cd phytoavailable guideline values for rice, for instance, were 0.04 mg kg^{-1} with 1 M NH_4NO_3, 0.98 mg kg^{-1} with 0.05 M EDTA, and 0.97 mg kg^{-1} with Mehlich3. These values imply that safe crops can be produced if the phytoavailable pool of metal(loid)s is maintained under these values in soil.

Key words**:** Arsenic; Cadmium; Guideline valus; Heavy metals; Lead; Phytoavailability;

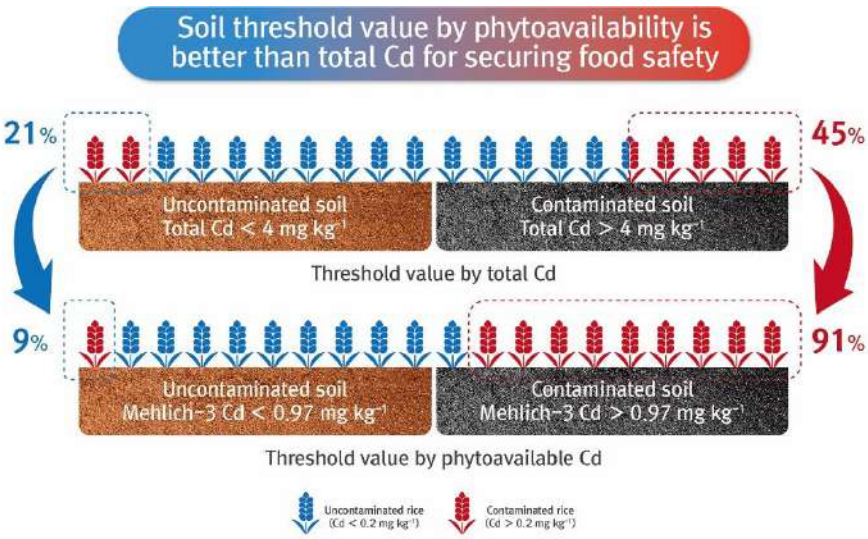

Fig. 1. The initial and final concentration of Cr in the shoot of 12 plants which were large area-planting in the metals-contaminated site for 33 d.

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14th International Conference of the East and Southeast Asia Federation of Soil Science Societies

Organized by

East and Southeast Asia Federation of Soil Science Societies (ESAFS)

The Chinese Society of Soil and Fertilizer Sciences (CSSFS), Taiwan

National Taiwan University (NTU), Taipei, Taiwan

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