Fri. Sep 10, 2021

Room 1 (Oral)

Oral sessions | Field Crop Production | O14: Legume Production in Asia

[O14] Legume Production in Asia

Chair: Kuniyuki Saito (Okayama University, Japan)
Chair: Tianfu Han (Chinese Academy of Agricultural Sciences, China)
9:45 AM - 11:45 AM Room 1 (Oral) (Field Crop Production)

[O14-01] Current Status of Soybean Production, Consumption, Trade and Research in Asia

○Tianfu Han[1], Shiyan Tian[1], Guangming Yang[1], Wei Si[2] (1.Institute of Crop Sciences, Chinese Academy of Agricultural Sciences, China, 2.College of Economics and Management, China Agricultural University, China)

9:45 AM - 10:05 AM

[O14-02] Soybean Adaptation under Saturated Soil Culture with Application of Paddy Straw Biomass Ameliorant, Biological and Chemical Fertilizers on Tidal Swamp in Indonesia

○Munif Ghulamahdi (Department of Agronomy and Horticulture , Faculty of Agriculture, IPB University, Indonesia)

10:05 AM - 10:25 AM

[O14-03] Study on High Yielding Canadian Soybean Cultivars in Central Hokkaido and Its High Yielding Factors
— Comparison with Hokkaido Cultivars in Yield Components, Growth Analysis and Branching Plasticity —

○Taiki Yoshihira[1], Ayano Furuse[2], Yuho Tsuji[3] (1.Department of Sustainable Agriculture, College of Agriculture, Food and Enviroment Sciences, Rakuno Gakuen University, Japan, 2.Department of Sustainable Agriculture, College of Agriculture, Food and Enviroment Sciences, Rakuno Gakuen University, Japan, 3.Department of Sustainable Agriculture, College of Agriculture, Food and Enviroment Sciences, Rakuno Gakuen University, Japan)

10:25 AM - 10:40 AM

[O14-04] Response to High Temperature Environments in Production, Quality and Physiological Activity of Two Soybean varieties

○Taiyu Lin, Yuki Okamoto, Tatsuhiko Shiraiwa (Graduate School of Agriculture, Kyoto University, Japan)

10:40 AM - 10:55 AM

[O14-05] The Changes of Soil Properties and Crop Responses to Organic Amendments of Dryland Cambisol Soil by Different Cropping System

○Sabaruddin Zakaria[1], Helmi Helmi[2], Sukzal Teuku[1], Sufardi Sufardi[2], Zaitun Zaitun[1], Abdul Ghafur[1], Elly Kesumawati[1], Khairul Basri[2], Darusman Darusman[2], T. Fadrial Karmil[3] (1.Department of Agrotechnology, Agriculture Faculty, Syiah Kuala University, Indonesia, 2.Department of Soil Science, Agriculture Faculty, Syiah Kuala University, Indonesia, 3.Veterinary Faculty, Syiah Kuala University, Indonesia)

10:55 AM - 11:10 AM

[O14-06] Field Evaluation of Country Bean (*Lablab purpureus* L. Sweet) Germplasms Collected from Different Locations of Bangladesh to Pod Borer Resistance

○Rahima Khatun, Muhammad Shahidul Haque (Department of Biotechnology, Bangladesh Agricultural University, Bangladesh)

11:10 AM - 11:25 AM

Room 2 (Oral)

Oral sessions | KL-02 | O24: Smart Farming (Remote Sensing, ITC)

[O24] Smart Farming (Remote Sensing, ITC)

Chair: Yoshio Inoue (The University of Tokyo, Japan)
Chair: Sutkhet Nakasathien (Kasetsart University, Thailand)
Chair: Hiroshi Ehara (Nagoya University, Japan)
9:45 AM - 11:45 AM Room 2 (Oral) (Farming System)

[O24-02] Satellite- and Drone-Based Remote Sensing of Crops and Soils for Smart Farming - Algorithms and Applications

○Yoshio Inoue (Graduate School of Engineering, The University of Tokyo, Japan)

10:05 AM - 10:25 AM

[O24-03] Multi-Scale Integrated Crop Growth Monitoring and Diagnosis for Smart Farming

○Tao Cheng, Xia Yao, Yongchao Tian, Xiaojun Liu, Qiang Cao, Jun Ni, Xiaohu Zhang, Yan Zhu, Weixing Cao (National Engineering & Technology Center for Information Agriculture (NETCIA), Nanjing Agricultural University, China)

10:25 AM - 10:40 AM

[O24-04] Kubota's Initiatives on Smart Agriculture &

Future Developments

○Satoshi IIDA （Senior Technical Advisor, KUBOTA Corporation, Japan）

10:40 AM - 10:55 AM

[O24-05] Yield Increase and Fertilizer Decrease by Precision Fertilization in Transplanted and Direct-Seeded Rice in the Northern Part of Japan

○Hiroyuki Shiratsuchi, Hiromi Imasu, Keiko Ito, Masami Furuhata （Division of Lowland Farming Research, Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

10:55 AM - 11:10 AM

[O24-06] Development of Robust Spatial Statistical Approach for On-Farm Experimentation

○Takashi S. T. Tanaka[1,2] （1.Faculty of Applied Biological Sciences, Gifu University, Japan, 2.Artificial Intelligence Advanced Research Center, Gifu University, Japan）

11:10 AM - 11:25 AM

Room 3 (Oral)

Oral sessions | Abiotic Stress for Crop Production | O34: O_2 Deficiency, Submergence

[O34] O_2 Deficiency, Submergence

Chair: Mikio Nakazono (Nagoya University, Japan)
Chair: Feng Yu (Hubei University, China)
9:45 AM - 11:45 AM Room 3 (Oral) (Abiotic Stress for Crop Production)

[O34-01] A Group VII Ethylene Response Factor Gene, *Zmereb180*, Coordinates Waterlogging Tolerance in Maize Seedlings

○Feng Yu[1], Kun Liang[2], Tian Fang[2], Hailiang Zhao[2], Pingfang Yang[1], Fazhan Qiu[2] （1.College of Life Science, Hubei University, China, 2.College of Plant Science and Technology, Huazhong Agricultural University, China）

9:45 AM - 10:05 AM

[O34-02] Adaptive Root Traits for Internal Aeration of Crops under Waterlogged Soil Conditions

○Mikio Nakazono[1, 2], Takaki Yamauchi[3], Hirokazu Takahashi[1], Yoshiro Mano[4] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.UWA School of Agriculture and Environment, Faculty of Science, University of Western Australia, Australia, 3.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 4.Forage Crop Research Division, Institute of Livestock and Grassland Science, National Agriculture and Food Research Organization, Japan）

10:05 AM - 10:25 AM

[O34-03] Response of Rice Varieties with Difference Submergence Tolerance to Two Period of Submerged Stress

○Rujito Agus Suwignyo[1], Jun-Ichi Sakagami[2], Mery Hasmeda[1], Dharma Siahaan[1], Hiroshi Ehara[3] （1.Department of Agronomy, Faculty of Agriculture, Sriwijaya University, Indonesia, 2.Tropical Crop Science Laboratory, Faculty of Agriculture, Kagoshima University, Japan, 3.International Center for Research and Education in Agriculture, Nagoya University, Japan）

10:25 AM - 10:40 AM

[O34-04] Adaptive Responses to Flood in Wild Rice Species with Various Genomes Other Than AA

○Daisuke Sasayama, Mayuko Niikawa, Tomoko Hatanaka, Hiroshi Fukayama, Tetsushi Azuma （Graduate School of Agricultural Science, Kobe University, Japan）

10:40 AM - 10:55 AM

[O34-05] *SNORKELs* and Deepwater Response in the African Cultivated Rice *Oryza glaberrima*

○Quanshu Luo, Misaki Nakazawa, Daisuke Sasayama, Tomoko Hatanaka, Hiroshi Fukayama, Tetsushi Azuma （Graduate School of Agricultural Science, Kobe University, Japan）

10:55 AM - 11:10 AM

[O34-06] Morpho-Physiological Responses of Common Buckwheat (*Fagopyrum esculentum* Moench) and Rice (*Oryza sativa* L.) to Waterlogging Stress

○Ju-Young Choi[1], Seong-Woo Cho[3], Swapan Kumar Roy[1], Jae-Buhm Chun[4], Soo-Jeong Kwon[1], Jwa-Kyung Sung[1], Jun-Ichi Sakagami[2], Sun-Hee Woo[1] （1.Department of Crop Science, Chungbuk National University, Korea, 2.Department of Biological production, Kagoshima Uniuversity, Korea, 3.Department of Agronomy and Medicinal Plant Resources, Gyeongnam National University of Science and Technology, Korea, 4.Crop Foundation

Division, Rural Development Administration, Korea)
11:10 AM - 11:25 AM

Room 4 (Oral)

Oral sessions | Crop Genetics and Physiology | O44: Root Genetics and Breeding

[O44] Root Genetics and Breeding

Chair: Yoshiaki Inukai (Nagoya University, Japan)
Chair: Yinglong Chen (The University of Western Australia, Australia)
9:45 AM - 11:45 AM Room 4 (Oral) (Crop Genetics and Physiology)

[O44-01] Towards Designed Genetic Improvement of Root System Architecture for Developing of Climate-Resilient Rice

○Yusaku Uga (Institute of Crop Science, National Agriculture and Food Research Organization, Japan)
9:45 AM - 10:05 AM

[O44-02] Phenotyping and Modelling Root Trait Variability in Crop Species

○Yinglong Chen[1, 2], Kadambot Siddique[1] (1.The UWA Institute of Agriculture and School of Agriculture and Environment, The University of Western Australia, Australia, 2.Institute of Soil and Water Conservation, Northwest A&F University, China)
10:05 AM - 10:25 AM

[O44-03] Genome-Wide Association (GWA) Mapping of Selected Philippine Rice Germplasm for Root Plasticity Alleles

Patrick Louie Lipio[1], ○Jonathan Manito Niones[2], Antoinette Cruz[3], Desiree Hautea[1], Roel Rodriguez Suralta[3], Nonawin Lucob-Agustin[2], Maria Corazon Cabral[2] (1.Institute of Plant Breeding, University of the Philippines-Los Baños, Philippines, 2.Genetic Resources Division, Philippine Rice Research Institute, Philippines, 3.Crop Biotechnology Center, Philippine Rice Research Institute, Philippines)
10:25 AM - 10:40 AM

[O44-04] Non-Destructive Method for Sampling, Preserving, and Analyzing Soil-Grown Root Systems

○Takuya Koyama[1,2], Shun Murakami[2], Masaaki Hashimoto[1], Katsuhiko Yoshidome[3], Yusuke Arakawa[3], Toshihiko Karasawa[4] (1.School of Agriculture, Utsunomiya University, Japan, 2.Graduate School of Regional Development and Creativity, Utsunomiya University, Japan, 3.Kyushu Okinawa Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 4.Central Region Agricultural Research Center, National Agriculture and Food Research Organization, Japan)
10:40 AM - 10:55 AM

[O44-05] Physiological Traits and Genomic Regions Associated with Rice (*Oryza sativa* L.) Root Cone Angle Grown in an Aerobic Production System

○Ricky Vinarao[1], Christopher Proud[1], Xiaolu Zhang[1], Peter Snell[2], Shu Fukai[1], Jaquie Mitchell[1] (1.School of Agriculture and Food Sciences, The University of Queensland, Australia, 2.Department of Primary Industries, Yanco Agricultural Institute, Australia)
10:55 AM - 11:10 AM

[O44-06] Functional Significance of Roots for Adaptation and Productivity of Crop Plants Grown under Various Environmental Stresses

○Akira Yamauchi[1], Mana Kano-Nakata[2], Shiro Mitsuya[1], Yoshiaki Inukai[2], Roel Rodriguez Suralta[3], Jonathan Manito Niones[3] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.International Center for Research and Education in Agriculture, Nagoya University, Japan, 3.Philippine Rice Research Institute, Philippines)
11:10 AM - 11:25 AM

Room 1 (Oral)

Closing /Award Ceremony

11:45 AM - 12:45 PM Room 1 (Oral) (Field Crop Production)

[O14] Legume Production in Asia

Chair: Kuniyuki Saito (Okayama University, Japan)
Chair: Tianfu Han (Chinese Academy of Agricultural Sciences, China)
Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 1 (Oral) (Field Crop Production)

[O14-01] Current Status of Soybean Production, Consumption, Trade and Research in Asia

○Tianfu Han[1], Shiyan Tian[1], Guangming Yang[1], Wei Si[2] (1.Institute of Crop Sciences, Chinese Academy of Agricultural Sciences, China, 2.College of Economics and Management, China Agricultural University, China)

9:45 AM - 10:05 AM

[O14-02] Soybean Adaptation under Saturated Soil Culture with Application of Paddy Straw Biomass Ameliorant, Biological and Chemical Fertilizers on Tidal Swamp in Indonesia

○Munif Ghulamahdi (Department of Agronomy and Horticulture , Faculty of Agriculture, IPB University, Indonesia)

10:05 AM - 10:25 AM

[O14-03] Study on High Yielding Canadian Soybean Cultivars in Central Hokkaido and Its High Yielding Factors — Comparison with Hokkaido Cultivars in Yield Components, Growth Analysis and Branching Plasticity —

○Taiki Yoshihira[1], Ayano Furuse[2], Yuho Tsuji[3] (1.Department of Sustainable Agriculture, College of Agriculture, Food and Enviroment Sciences, Rakuno Gakuen University, Japan, 2.Department of Sustainable Agriculture, College of Agriculture, Food and Enviroment Sciences, Rakuno Gakuen University, Japan, 3.Department of Sustainable Agriculture, College of Agriculture, Food and Enviroment Sciences, Rakuno Gakuen University, Japan)

10:25 AM - 10:40 AM

[O14-04] Response to High Temperature Environments in Production, Quality and Physiological Activity of Two Soybean varieties

○Taiyu Lin, Yuki Okamoto, Tatsuhiko Shiraiwa (Graduate School of Agriculture, Kyoto University, Japan)

10:40 AM - 10:55 AM

[O14-05] The Changes of Soil Properties and Crop Responses to Organic Amendments of Dryland Cambisol Soil by Different Cropping System

○Sabaruddin Zakaria[1], Helmi Helmi[2], Sukzal Teuku[1], Sufardi Sufardi[2], Zaitun Zaitun[1], Abdul Ghafur[1], Elly Kesumawati[1], Khairul Basri[2], Darusman Darusman[2], T. Fadrial Karmil[3] (1.Department of Agrotechnology, Agriculture Faculty, Syiah Kuala University, Indonesia, 2.Department of Soil Science, Agriculture Faculty, Syiah Kuala University, Indonesia, 3.Veterinary Faculty, Syiah Kuala University, Indonesia)

10:55 AM - 11:10 AM

[O14-06] Field Evaluation of Country Bean (*Lablab purpureus* L. Sweet) Germplasms Collected from Different Locations of Bangladesh to Pod Borer Resistance

○Rahima Khatun, Muhammad Shahidul Haque (Department of Biotechnology, Bangladesh

Agricultural University, Bangladesh）
11:10 AM - 11:25 AM

9:45 AM - 10:05 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 1 (Oral))

[O14-01] Current Status of Soybean Production, Consumption, Trade and Research in Asia

(Invited Speaker)

○Tianfu Han[1], Shiyan Tian[1], Guangming Yang[1], Wei Si[2] (1.Institute of Crop Sciences, Chinese Academy of Agricultural Sciences, China, 2.College of Economics and Management, China Agricultural University, China)

Soybean has served as a major crop and food source in Asia for over 5000 years. During the period from 2016-2019, the annual average of soybean planting area in Asia was 20.08 Mha, this accounts for 16.26% of the world total (123.49 Mha). Soybean production was 28.57 Mt, accounting for 8.27% of the global total (345.78 Mt), with China, India, Indonesia, Kazakhstan, and Japan as the top five soybean producing countries. The annual average of soybean imports in Asia was 111.91 Mt or 79.15% of the global total (141.38 Mt), and China is the biggest soybean buyer (importing 65.24% of the global total) all over the world, during the same period.
Recent years witnessed a rapid development of Asian countries in soybean scientific research. From 1 January 2016 till 15 April 2020, Science Citation Index Expanded under Web of Science (SCI Expanded) collected 4076 soybean related articles published by authors from Asian countries, more than half (52.26%) of the global total (7800). China, South Korea, Japan, India and Iran were the top five Asian countries leading by article number. From 2016 till April 15, 2020, authors from China published 2503 soybean related articles or 32.10% of the total soybean related articles in the world.

10:05 AM - 10:25 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 1 (Oral))

[O14-02] Soybean Adaptation under Saturated Soil Culture with Application of Paddy Straw Biomass Ameliorant, Biological and Chemical Fertilizers on Tidal Swamp in Indonesia

(Invited Speaker)

○Munif Ghulamahdi (Department of Agronomy and Horticulture , Faculty of Agriculture, IPB University, Indonesia)

Saturated soil culture (SSC) is a cultivation that gives continuous irrigation and maintains water depth constantly and makes soil layer under root in saturated condition. This technology is appropriate to prevent pyrite oxidation on tidal swamp. This research were conducted in South Sumatera and Jambi Province from 2009-2018. This objective of this research are to study the adaptation mechanism and the efficiency of production input of soybean with biological and chemical fertilizer. This research used field and green house experimentation. This research consisted of : 1) adaptation mechanism, 2) soybean response in the different water depth , 3) effect of paddy straw biomass ameliorant, 4) effect of macro and micro nutrient , 5) efficiency of P fertilizer of Fungy Micorrhiza Arbuscular, 6) application of *Rhizobium* sp. and N foliar fertilizer. This research result were : 1) adaptation mechanism on SSC was begun with the increasing of root ethylene, root aerenchyme formation, root development, nitrogenase activity, and nutrient uptake, 2) Tanggamus with water depth 20 cm under soil surface gave the highest productivity , 3) paddy straw increased humic acid, decreased Al and increased soil pH 4). application of P + K + Ca + Dung + Zn gave the highest productivity, 5) application of Micorrhiza increased efficiency of

P, 6) application of inoculant *Rhizobium* sp. and N foliar fertilizer gave the highest productivity. Soybean productivity on Type C overflow with SSC technology on Tanggamus was obtained 4.6 t ha^{-1}.

10:25 AM - 10:40 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 1 (Oral))

[O14-03] Study on High Yielding Canadian Soybean Cultivars in Central Hokkaido and Its High Yielding Factors — Comparison with Hokkaido Cultivars in Yield Components, Growth Analysis and Branching Plasticity —

○Taiki Yoshihira[1], Ayano Furuse[2], Yuho Tsuji[3] （1.Department of Sustainable Agriculture, College of Agriculture, Food and Enviroment Sciences, Rakuno Gakuen University, Japan, 2.Department of Sustainable Agriculture, College of Agriculture, Food and Enviroment Sciences, Rakuno Gakuen University, Japan, 3.Department of Sustainable Agriculture, College of Agriculture, Food and Enviroment Sciences, Rakuno Gakuen University, Japan）

A comparison of 17 Canadian cultivars bred before 1997 in the two years of 2016 and 2017 with Toyomusume (TM) showed that OAC Dorado, Alliance and Brock were higher yields than TM in the same maturing period. The high-yielding factors of these high-yielding cultivars were examined from the yield component and growth analysis in 2018 and 2019.
The high yield of Canadian high-yielding cultivars did not come from the harvest index, but from the height of total dry matter yield.
Crop growth rate was higher in OAC Dorado and Brock than in TM throughout the ripening period due to the high net assimilation rate.
The slope of the regression line of dry matter production with respect to the integrated received light amount was lower in all cultivars in 2018, which is the low-yield year, than in 2019, but the Canadian high-yield cultivars were higher than the Hokkaido cultivars in both years.
There was a significant positive correlation between total branch length in the pinching treatment and seed yield, and high yield cultivars had higher branching plasticity.
The high yield of the Canadian cultivars was derived from the total dry yield, which was caused by the difference in pod weight increase rate during the ripening period. This increase in pod weight was due to the high net assimilation rate. It was confirmed from the difference in solar radiation use efficiency (RUE). It was presumed that these cultivars had high branching plasticity and high stability against changes in planting density.

10:40 AM - 10:55 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 1 (Oral))

[O14-04] Response to High Temperature Environments in Production, Quality and Physiological Activity of Two Soybean varieties

*Nominated for Presentation Awards

○Taiyu Lin, Yuki Okamoto, Tatsuhiko Shiraiwa （Graduate School of Agriculture, Kyoto University, Japan）

High temperature (HT) or high night temperature (HNT) in warm region negatively impacts soybean production. For adaptation, we need to understand crop physiological responses and explore adaptive germplasms. We examined the responses to HT and HNT of 2 soybean varieties, a Japanese var. Fukuyutaka and a US var. DS25-1. The latter was the best stable performer at Indonesia among genotypes from temperate regions.
The two varieties were grown in a temperature gradient chamber (TGC) and a phytotron. The TGC created a temperature gradient from near-ambient to that plus up to 3℃ all day long (HT) or only night (HNT) from the R1 to R7 stages. In the phytotron, only Fukuyutaka was treated with NT of 22 and 28℃, extreme HNT. Plant growth, seed appearance quality and physiological traits were assessed.
DS25-1 showed stable growth performance under both HT and HNT, while Fukuyutaka tended to reduce total biomass and yield in both the TGC and phytotron studies. The negative response of Fukuyutaka to HT and HNT was associated with tendencies of earlier senescence, Nfix and higher maintenance respiration. The stable performance of DS25-1 was attributed to the stable biomass production and the number of flowers under HT and HNT. DS25-1 also showed more stable seed appearance than Fukuyutaka. HNT as 28℃ in the phytotron caused declines of Pn and earlier senescence, which were not evident in the TGC study with moderate HT and HNT. Decline of Pn also evident when HNT was given only R1-R5, suggesting that physiological activity is sensitive to HNT particularly in early reproductive period.

10:55 AM - 11:10 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 1 (Oral))

[O14-05] The Changes of Soil Properties and Crop Responses to Organic Amendments of Dryland Cambisol Soil by Different Cropping System

○Sabaruddin Zakaria[1], Helmi Helmi[2], Sukzal Teuku[1], Sufardi Sufardi[2], Zaitun Zaitun[1], Abdul Ghafur[1], Elly Kesumawati[1], Khairul Basri[2], Darusman Darusman[2], T. Fadrial Karmil[3] (1.Department of Agrotechnology, Agriculture Faculty, Syiah Kuala University, Indonesia, 2.Department of Soil Science, Agriculture Faculty, Syiah Kuala University, Indonesia, 3.Veterinary Faculty, Syiah Kuala University, Indonesia)

Dryland farmers in Aceh has low income because their soil is poor. For example the average yield of sweet corn in the region is around 8-10 ton cob ha^{-1}. The opportunity exists to close the dryland yield gaps and consequently to increase farm income. A field evaluation of soil, maize and soybean responses to fertiliser and soil amendments was conducted in 2017 in the Pidie district, Aceh Province, Indonesia. The treatments applied were 10 t/ha each of rice husk biochar and cow manure with and without 400 kg/ha NPK fertilizer. Crops grown with 400 kg/ha NPK only was used as the control. Crops were grown as sweet-corn and soybean monoculture and mixed crop planting. Key soil parameters measured before and after one growing season include soil pH, soil organic C, N-total, soil available P and Exc. K. Except for soil available P at 45 days after planting, none of the soil properties responded to the application of either rice husk biochar or cow manure. Yield of sweet-corn under the control treatment was 23.2 ton cob ha^{-1} which demonstrated a large improvement the average region's yield. However, sweetcorn yield was not different between soil amendment and cropping system treatments at around 22-23 ton cob ha^{-1}. They yield of soybean range from 1.4-1.7 ton by the application of either rice husk biochar or cow manure, increased about 40-70% compare to control treatment. As expected, yield of monoculture soybean (1.9 ton ha^{-1}) was doubled that in the mixed system (0.99 ton ha^{-1}).

11:10 AM - 11:25 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 1 (Oral))

[O14-06] Field Evaluation of Country Bean (*Lablab purpureus* L. Sweet) Germplasms Collected from Different Locations of Bangladesh to Pod Borer Resistance

*Nominated for Presentation Awards

○Rahima Khatun, Muhammad Shahidul Haque （Department of Biotechnology, Bangladesh Agricultural University, Bangladesh）

The infestation of pod borer to Country bean, *Lablab purpureus* L. Sweet is a major pest causing huge loss. Screening of different country bean germplasms will provide us resistant varieties with high yielding capacity. Here, fifty *L. purpureus* germplasms were subjected to field evaluation for morphological and yield related characteristics and analyzed by ANOVA to identify the differences and means were separated by DMRT using IBM SPSS software. In addition, the correlations studies of different variables with pod damage were also analyzed. A great deal of diversity among the collected germplasm on morphological and yield and pod borer related characteristics was observed. It is found that on an average 687.25 gram of green pods were yielded per plant with the range of 55.02 in BARI-5 Sheem to 1781.09 gram in BD-10806 was observed. The pod damage percent varied significantly. Average pod damage percent was 13.44 with the range of 4.75 in BD-1079 to 24.82 percent in BD-11089 which were statistically different. This suggested that BD-10799 is a resistant accession while BD-11089 is highly susceptible to pod borer attack. Less than 10% pod damage was recorded to thirteen germplasm namely, BD-10799, BD-10801, BD-10802, BD-10805, BD-10818, BD-11091, BD-11095, BD-11098, BD-11099, Goal Goda, Mostafa, Kaloputi, and Chanchal germplasm. While the total pod yield was considered, it was found that nine of them produced higher pod yield (at least 500g/plant) namely, BD-10801, BD-10802, BD-10805, BD-10818, BD-11098, BD-11099, Goal Goda, Mostafa, Kaloputi, germplasm. These identified germplasm should be considered for future variety development programs.

[O24] Smart Farming (Remote Sensing, ITC)

*Sponsored by Asian Association of Agricultural Colleges and Universities (AAACU)
Chair: Yoshio Inoue (The University of Tokyo, Japan)
Chair: Sutkhet Nakasathien (Kasetsart University, Thailand)
Chair: Hiroshi Ehara (Nagoya University, Japan)
Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 2 (Oral) (Farming System)

[O24-02] Satellite- and Drone-Based Remote Sensing of Crops and Soils for Smart Farming - Algorithms and Applications

○Yoshio Inoue （Graduate School of Engineering, The University of Tokyo, Japan）
10:05 AM - 10:25 AM

[O24-03] Multi-Scale Integrated Crop Growth Monitoring and Diagnosis for Smart Farming

○Tao Cheng, Xia Yao, Yongchao Tian, Xiaojun Liu, Qiang Cao, Jun Ni, Xiaohu Zhang, Yan Zhu, Weixing Cao （National Engineering & Technology Center for Information Agriculture (NETCIA), Nanjing Agricultural University, China）
10:25 AM - 10:40 AM

[O24-04] Kubota's Initiatives on Smart Agriculture & Future Developments

○Satoshi IIDA （Senior Technical Advisor, KUBOTA Corporation, Japan）
10:40 AM - 10:55 AM

[O24-05] Yield Increase and Fertilizer Decrease by Precision Fertilization in Transplanted and Direct-Seeded Rice in the Northern Part of Japan

○Hiroyuki Shiratsuchi, Hiromi Imasu, Keiko Ito, Masami Furuhata （Division of Lowland Farming Research, Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan）
10:55 AM - 11:10 AM

[O24-06] Development of Robust Spatial Statistical Approach for On-Farm Experimentation

○Takashi S. T. Tanaka[1,2] （1.Faculty of Applied Biological Sciences, Gifu University, Japan, 2.Artificial Intelligence Advanced Research Center, Gifu University, Japan）
11:10 AM - 11:25 AM

10:05 AM - 10:25 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 2 (Oral))

[O24-02] Satellite- and Drone-Based Remote Sensing of Crops and Soils for Smart Farming - Algorithms and Applications

(Invited Speaker)

○Yoshio Inoue （Graduate School of Engineering, The University of Tokyo, Japan）

Smart farming (SF) is an intelligent agricultural management approach based on the advances in sensing, robotic, and information technologies. This paper discusses the background needs for SF and the role of remote sensing and geoinformation. Recent advances in remote sensing technologies for diagnostic information of crops and soils are reviewed based on our leading case studies. We have developed the operational workflow to create diagnostic information on crops and soils from high-resolution satellite imagery. The constellation of micro-satellites allows the timely or frequent observations at high spatial resolution (～5 m). Results showed that the application of high-resolution satellite sensors would enhance the strategic decision making in SF in regional scales. On the other hand, we have developed an original drone-based remote sensing system equipped with visible, multispectral, and thermal sensors. The state-of-the-art algorithms derived from hyperspectral datasets were successfully applied to derive the diagnostic information on crops and soils (crop growth, water stress, soil fertility, weed, disease, lodging and 3D topography). The linkage between the remotely-sensed information and drone-based application of seeds, pesticides, fertilizers would greatly enhance the efficiency of labor and material applications. Drone-based remote sensing would allow low-cost, super-resolution, and flexible observations of crops and soils in individual farm scales.

10:25 AM - 10:40 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 2 (Oral))

[O24-03] Multi-Scale Integrated Crop Growth Monitoring and Diagnosis for Smart Farming

(Invited Speaker)

○Tao Cheng, Xia Yao, Yongchao Tian, Xiaojun Liu, Qiang Cao, Jun Ni, Xiaohu Zhang, Yan Zhu, Weixing Cao （National Engineering & Technology Center for Information Agriculture (NETCIA), Nanjing Agricultural University, China）

Smart agriculture (SA) is a major trend in global agricultural development and major economies have released SA roadmaps or development strategies for the next decade. In particular, smart farming has emerged from the integration of crop cultivation and information technologies and has received widespread attention in the new era of Agriculture 4.0. This talk presents our recent advances in the monitoring and diagnosis of winter wheat and rice growth with canopy, drone and satellite data within the context of smart farming. At canopy level, we developed novel approaches with ground-based imaging or non-imaging data and have made significant progress in reducing background effects for improved leaf nitrogen concentration or chlorophyll content. Given the advent of drones, we have established various methods to combine multi-source information (e.g., spectral, textural, structural) from unmanned aerial vehicle (UAV) imagery for accurate estimation of crop biomass and nitrogen uptake. With satellite imagery, we have developed practical field boundary delineation and crop mapping methods for efficient field-based precision management across farms or even larger areas. These crop monitoring technologies have been integrated with growth diagnosis algorithms to make nitrogen topdressing recommendations for green agriculture. The smart farming technologies have been applied

across major rice and winter wheat production regions in China, which have helped farmers to improve resource use efficiency and increase grain yield. The applied research and co-operative extension activities have led to significant effects in promoting the awareness of smart farming in local crop production and advancing the digital transformation of agricultural development.

10:40 AM - 10:55 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 2 (Oral))

[O24-04] Kubota's Initiatives on Smart Agriculture & Future Developments

(Invited Speaker)

○Satoshi IIDA （Senior Technical Advisor, KUBOTA Corporation, Japan）

As an approach to advance the next generation agriculture, Kubota has been engaged on the development of smart agriculture technology by using ICT and IoT. In this session, Dr. Iida will discuss 1) precision farming through data utilization, 2) ultra-labor-saving through partial and full automation, and 3) status of technology development for reducing workload and saving labor as solutions for the challenges faced by farmers who support the agriculture.

10:55 AM - 11:10 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 2 (Oral))

[O24-05] Yield Increase and Fertilizer Decrease by Precision Fertilization in Transplanted and Direct-Seeded Rice in the Northern Part of Japan

○Hiroyuki Shiratsuchi, Hiromi Imasu, Keiko Ito, Masami Furuhata （Division of Lowland Farming Research, Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

NDVI maps taken by a drone and yield maps created by a yield measurement system are available for rice production in Japan. We also developed a lodging measuring technology. The objective is to increase the yield without lodging by precision fertilization in the northern part of Japan. Precision basal-dressing and top-dressing on-farm trials were conducted in transplanted and direct-seeded rice in 2017 - 2019. The precision basal-dressing rate of each paddy field was calculated based on lodging degree and yield in the previous year. The top-dressing maps were obtained based on NDVI maps and top-dressing rate functions adjusted based on lodging degree and yield in the previous year. Fertilizer was broadcasted according to top-dressing maps with an unmanned industrial helicopter. In the transplanted rice, the precision basal dressing increased fertilization rate by 7 kgN/ha and yield by 270 kg/ha, without change of lodging degree. The precision top dressing decreased fertilization rate by 18 kgN/ha and increased yield by 160 kg/ha with slight increase of lodging. In the direct-seeded rice, the precision basal dressing decreased fertilizer by 14 kgN/ha and increased lodging slightly and yield by 160 kg/ha. The precision top dressing decreased fertilizer by 4 kgN/ha and lodging slightly, and increased yield by 310 kg/ha. The estimated benefits ranged from 11,890 to 50,380 yen/ha. In conclusion, the precision fertilization increased yield and decreased fertilizer, and consequently increased the benefits.

11:10 AM - 11:25 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 2 (Oral))

[O24-06] Development of Robust Spatial Statistical Approach for On-Farm Experimentation

○Takashi S. T. Tanaka[1,2] (1.Faculty of Applied Biological Sciences, Gifu University, Japan, 2.Artificial Intelligence Advanced Research Center, Gifu University, Japan)

On-farm experimentation is a means of farmer-centric research and extension that examines the effect of crop management and variety selection on crop productivity in famers' own fields. A recent development in precision agricultural technologies such as yield monitor for combine harvester and variable-rate application technology enables farmers and crop advisors to implement on-farm experimentations easily. However, spatial autocorrelation in a response variable (e.g. crop yield) is frequently observed in on-farm experimentations, which violates the conventional statistical assumption and leads to unreliable inferences. Thus, we developed a REML-based spatial linear mixed model representing the anisotropic spatial variations to account for the underlying spatial structure and to reduce the bias of estimates efficiently. The state-of-art anisotropic model was compared with ordinary least squares (OLS) regression and isotropic spatial model through a simulation study of winter wheat yield in Japan. We further considered the feasibility and precision of different experimental designs. The result demonstrated that the anisotropic model successfully reduced the Type I error rates regardless of experimental designs. Our result further indicated that OLS regression model underestimated the variance of estimates, and the hypothetical treatment effect was outside of the confidence interval. Overall, the anisotropic spatial model was considered to outperform the isotropic spatial model as it could accommodate the actual spatial structure more precisely.

[O34] O_2 Deficiency, Submergence

Chair: Mikio Nakazono (Nagoya University, Japan)
Chair: Feng Yu (Hubei University, China)
Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 3 (Oral) (Abiotic Stress for Crop Production)

[O34-01] A Group VII Ethylene Response Factor Gene, *Zmereb180*, Coordinates Waterlogging Tolerance in Maize Seedlings

○Feng Yu[1], Kun Liang[2], Tian Fang[2], Hailiang Zhao[2], Pingfang Yang[1], Fazhan Qiu[2] (1.College of Life Science, Hubei University, China, 2.College of Plant Science and Technology, Huazhong Agricultural University, China)

9:45 AM - 10:05 AM

[O34-02] Adaptive Root Traits for Internal Aeration of Crops under Waterlogged Soil Conditions

○Mikio Nakazono[1,2], Takaki Yamauchi[3], Hirokazu Takahashi[1], Yoshiro Mano[4] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.UWA School of Agriculture and Environment, Faculty of Science, University of Western Australia, Australia, 3.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 4.Forage Crop Research Division, Institute of Livestock and Grassland Science, National Agriculture and Food Research Organization, Japan)

10:05 AM - 10:25 AM

[O34-03] Response of Rice Varieties with Difference Submergence Tolerance to Two Period of Submerged Stress

○Rujito Agus Suwignyo[1], Jun-Ichi Sakagami[2], Mery Hasmeda[1], Dharma Siahaan[1], Hiroshi Ehara[3] (1.Department of Agronomy, Faculty of Agriculture, Sriwijaya University, Indonesia, 2.Tropical Crop Science Laboratory, Faculty of Agriculture, Kagoshima University, Japan, 3.International Center for Research and Education in Agriculture, Nagoya University, Japan)

10:25 AM - 10:40 AM

[O34-04] Adaptive Responses to Flood in Wild Rice Species with Various Genomes Other Than AA

○Daisuke Sasayama, Mayuko Niikawa, Tomoko Hatanaka, Hiroshi Fukayama, Tetsushi Azuma (Graduate School of Agricultural Science, Kobe University, Japan)

10:40 AM - 10:55 AM

[O34-05] *SNORKELs* and Deepwater Response in the African Cultivated Rice *Oryza glaberrima*

○Quanshu Luo, Misaki Nakazawa, Daisuke Sasayama, Tomoko Hatanaka, Hiroshi Fukayama, Tetsushi Azuma (Graduate School of Agricultural Science, Kobe University, Japan)

10:55 AM - 11:10 AM

[O34-06] Morpho-Physiological Responses of Common Buckwheat (*Fagopyrum esculentum* Moench) and Rice (*Oryza sativa* L.) to Waterlogging Stress

○Ju-Young Choi[1], Seong-Woo Cho[3], Swapan Kumar Roy[1], Jae-Buhm Chun[4], Soo-Jeong Kwon[1], Jwa-Kyung Sung[1], Jun-Ichi Sakagami[2], Sun-Hee Woo[1] (1.Department of Crop Science, Chungbuk National University, Korea, 2.Department of Biological production, Kagoshima Uniuversity, Korea, 3.Department of Agronomy and Medicinal Plant Resources, Gyeongnam

National University of Science and Technology, Korea, 4.Crop Foundation Division, Rural Development Administration, Korea）
11:10 AM - 11:25 AM

9:45 AM - 10:05 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 3 (Oral))

[O34-01] A Group VII Ethylene Response Factor Gene, *Zmereb180*, Coordinates Waterlogging Tolerance in Maize Seedlings

(Invited Speaker)

○Feng Yu[1], Kun Liang[2], Tian Fang[2], Hailiang Zhao[2], Pingfang Yang[1], Fazhan Qiu[2] (1.College of Life Science, Hubei University, China, 2.College of Plant Science and Technology, Huazhong Agricultural University, China)

Group VII ethylene response factors (ERFVIIs) play important roles in ethylene signaling and plant responses to fl ooding. However, natural ERFVII variations in maize (ZmERFVIIs) that are directly associated with waterlogging tolerance have not been reported. Here, a candidate gene association analysis of the ZmERFVII gene family showed that a waterlogging-responsive gene, ZmEREB180, was tightly associated with waterlogging tolerance. ZmEREB180 expression specifi cally responded to waterlogging and was up-regulated by ethylene; in addition, its gene product localized to the nucleus. Variations in the 5′-untranslated region (5′-UTR) and mRNA abundance of this gene under waterlogging conditions were signifi cantly associated with survival rate (SR). Ectopic expression of ZmEREB180 in Arabidopsis increased the SR after submergence stress, and overexpression of ZmEREB180 in maize also enhanced the SR after long-term waterlogging stress, apparently through enhanced formation of adventitious roots (ARs) and regulation of antioxidant levels. Transcriptomic assays of the transgenic maize line under normal and waterlogged conditions further provided evidence that ZmEREB180 regulated AR develop-ment and reactive oxygen species homeostasis. Our study provides direct evidence that a ZmERFVII gene is involved in waterlogging tolerance. The detailed regulatory networks involved by ZmEREB180 have been investigating. These fi ndings could be applied directly to breed waterlogging-tolerant maize cultivars and improve our understanding of waterlogging stress.

10:05 AM - 10:25 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 3 (Oral))

[O34-02] Adaptive Root Traits for Internal Aeration of Crops under Waterlogged Soil Conditions

(Invited Speaker)

○Mikio Nakazono[1, 2], Takaki Yamauchi[3], Hirokazu Takahashi[1], Yoshiro Mano[4] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.UWA School of Agriculture and Environment, Faculty of Science, University of Western Australia, Australia, 3.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 4.Forage Crop Research Division, Institute of Livestock and Grassland Science, National Agriculture and Food Research Organization, Japan)

Flooded (waterlogged) soil conditions negatively affect growth and survival of most plants in agricultural and natural ecosystems; the exceptions being rice and other wetland species that are well adapted to these conditions. To acclimate to soil waterlogging, roots of some plants form aerenchyma. Aerenchyma enables internal aeration between shoots and roots, and its formation is therefore important for the adaptation of plants to excess water environments. Lysigenous aerenchyma forms in roots as a result of the death and subsequent lysis of cortical cells. In roots of some waterlogging-tolerant plants such as rice and *Zea nicaraguensis* (a wild relative of maize), lysigenous aerenchyma is constitutively formed even under aerobic conditions, and its formation is induced under oxygen-deficient conditions. The former and latter are respectively designated as "constitutive" and "inducible"

aerenchyma formations. Recently, we identified some key factors regulating constitutive or inducible aerenchyma formation in rice roots. In addition to the aerenchyma, in rice, *Z. nicaraguensis* and some other wetland species, a barrier to radial oxygen loss (ROL) that greatly reduces oxygen leakage from basal parts enhances the oxygen diffusion to the apex. We are now conducting genetic and physiological analyses to identify a gene controlling ROL barrier formation in *Z. nicaraguensis*. In this session, we present the recent advances we have made in understanding the mechanisms of formation of the aerenchyma and the induction of a barrier to ROL in roots.

10:25 AM - 10:40 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 3 (Oral))

[O34-03] Response of Rice Varieties with Difference Submergence Tolerance to Two Period of Submerged Stress

(Invited Speaker)

○Rujito Agus Suwignyo[1], Jun-Ichi Sakagami[2], Mery Hasmeda[1], Dharma Siahaan[1], Hiroshi Ehara[3]
（1.Department of Agronomy, Faculty of Agriculture, Sriwijaya University, Indonesia, 2.Tropical Crop Science Laboratory, Faculty of Agriculture, Kagoshima University, Japan, 3.International Center for Research and Education in Agriculture, Nagoya University, Japan）

Indonesia has very large area of swamp land to support agricultural production and food security. However, these swamp areas are not yet supported by proper agricultural facilities so that the rice farmers are facing some problems of submerged stress during germination and vegetative phases. This study evaluated the growth response of rice genotypes different to submergence tolerance to two stages of submerged stress using three tolerant rice genotypes FR13A, Inpari30 and Inpara5 and two sensitive ones Ciherang and Pegagan. Submerged stress treatment was carried out twice, five days submerged stress in the germination phase and 10 days submerged stress treatment at 27 DAS. Submerged stress treatment in the germination phase led to a lower increase in plant height in submergence tolerance varieties, however in the recovery phase a week after treatment, intolerant varieties showed higher growth rate. The effect of submerged stress at the germination phase continues until 27 DAS, and it is greater on intolerant varieties. In the second submerged stress treatment, except for Inpara5, tolerance varieties showed better growth compared to intolerant varieties. FR13A had the highest tolerant ability after double submerged stress as it had the highest shoot and root growth rate during recovery period. There is no significant difference among Pegagan, Ciherang, Inpara 5 and Inpari 30, but Inpara 5 and Inpari 30 were better than Pegagan and Ciherang varieties, as seen from the level of stress resistance to submerged stress.

10:40 AM - 10:55 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 3 (Oral))

[O34-04] Adaptive Responses to Flood in Wild Rice Species with Various Genomes Other Than AA

○Daisuke Sasayama, Mayuko Niikawa, Tomoko Hatanaka, Hiroshi Fukayama, Tetsushi Azuma （Graduate School of Agricultural Science, Kobe University, Japan）

In the Asian cultivated rice *Oryza sativa*, there are two adaptive responses to flood: submergence tolerance and floating ability. Submergence tolerance, conferred by *SUB1A*, is response to complete

submergence at the seedling stage, whereas floating ability, conferred by *SNORKEL* (*SK*) genes, is response to gradual submergence at the mature stage. We investigated the presence of these genes and growth response to submergence in *Oryza* wild rice species belonging to different genome groups from *O. sativa* (AA genome), such as BB (diploid *O. punctata*), BBCC (*O. minuta* and tetraploid *O. punctata*), CC (*O. eichingeri* and *O. officinalis*), CCDD (*O. alta*, *O. grandiglumis* and *O. latifolia*), EE (*O. australiensis*), and FF genome species (*O. brachyantha*). Upon complete submergence of 14-d-old seedlings for 2 weeks, accessions of BBCC, CC, CCDD, and EE genome species displayed a high survival rate. On the other hand, gradual submergence of 50-d-old plants promoted internodal elongation in accessions of BB and CCDD genome species and consequently the plants were not drowned at least for 10 days. The results suggest that genes involved in submergence tolerance and floating ability are present in CC and EE genomes, and BB and DD genomes, respectively. However, in these genomes, *SUB1A* and *SK*s genes could not be detected.

10:55 AM - 11:10 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 3 (Oral))

[O34-05] *SNORKELs* and Deepwater Response in the African Cultivated Rice *Oryza glaberrima*

*Nominated for Presentation Awards

○Quanshu Luo, Misaki Nakazawa, Daisuke Sasayama, Tomoko Hatanaka, Hiroshi Fukayama, Tetsushi Azuma （Graduate School of Agricultural Science, Kobe University, Japan）

SNORKEL1 (SK1) and *SNORKEL2 (SK2)* were discovered as ERF-type transcription factors that confer floating ability in the Asian cultivated rice *Oryza sativa*. Here we describe the identification of *SK* genes and growth response to partial submergence in the African cultivated rice *Oryza glaberrima*. Screening for *SK* gene presence by PCR amplification of genomic DNA using gene-specific primers revealed that putative *SK1* and *SK2* genes were amplified in 49 of 50 *O. glaberrima* accessions. By sequencing of the PCR products, 3 *SK1* genes, *OgSK1-A* to *OgSK1-C*, and 4 *SK2* genes, *OgSK2-A* to *OgSK2-D*, were identified. The *OgSK1* genes have 84.4 to 95.5% nucleotide identity to *OsSK1* whereas the *OgSK2* genes have 65.2 to 98.0% nucleotide identity to *OsSK2*. Seventeen of these *O. glaberrima* accessions were tested for elongation response to gradual submergence at 50 days of age. In *O. glaberrima* accessions possessing *SK2-A, SK2-B* or *SK2-C* gene, as well as in *O. sativa* deepwater rice, submergence induced expression of each gene in internodes and promoted internodal elongation. On the other hand, *O. glaberrima* accessions carrying *SK2-D* gene or carrying no *SK* genes did not show submergence-induced internodal elongation. These data suggest that the diversity of *SK* genes exist in African cultivated rice, some of which can be expressed and function in the deepwater response.

11:10 AM - 11:25 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 3 (Oral))

[O34-06] Morpho-Physiological Responses of Common Buckwheat (*Fagopyrum esculentum* Moench) and Rice (*Oryza sativa* L.) to Waterlogging Stress

*Nominated for Presentation Awards

○Ju-Young Choi[1], Seong-Woo Cho[3], Swapan Kumar Roy[1], Jae-Buhm Chun[4], Soo-Jeong Kwon[1], Jwa-Kyung Sung[1], Jun-Ichi Sakagami[2], Sun-Hee Woo[1] (1.Department of Crop Science, Chungbuk National University, Korea, 2.Department of Biological production, Kagoshima Uniuversity, Korea, 3.Department of Agronomy and Medicinal Plant Resources, Gyeongnam National University of Science and Technology, Korea, 4.Crop Foundation Division, Rural Development Administration, Korea)

Waterlogging, a major environmental stress, is a severe constraint on crop growth and productivity in many regions in the world. This study aimed to investigate the morpho-physiological changes of buckwheat and rice under waterlogging stress. The common buckwheat (*Fagopyrum esculentum* cv. Harunoibuki) and rice (*Oryza sativa* L.) used in this study were collected from the Laboratory of Tropical Science at Kagoshima University in Japan. The seedlings were exposed to waterlogging stress with 0~1 cm of water depth for 3-days at early growth stage. The plant height, SPAD, chlorophyll fluorescence, root traits (length, surface area and volume), aerenchyma, Radial oxygen loss barrier and dry weight were measured. Waterlogging also caused dramatic changes in the plant height, chlorophyll content and root morphology. SPAD value and chlorophyll fluorescence of buckwheat was significantly (p<0.01) affected under waterlogging stress. In case of buckwheat chlorophyll fluorescence showed the significant changes with 0.54 Fv/Fm in early growth stage under waterlogging stress. Also, the root morphology was affected significantly (p<0.01) under waterlogging stress. Waterlogging affected root length, surface area and volume in buckwheat. Root (length, surface area, volume) caused serious damage by waterlogging stress. No aerenchyma and ROL barrier were found in Buckwheat, however, flooding stress enhanced adventitious roots substantially. The findings concluded that buckwheat was more sensitive regarding physiological characteristics under waterlogging stress.

[O44] Root Genetics and Breeding

*Sponsored by the Japanese Society of Breeding

Chair: Yoshiaki Inukai (Nagoya University, Japan)

Chair: Yinglong Chen (The University of Western Australia, Australia)

Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 4 (Oral) (Crop Genetics and Physiology)

[O44-01] Towards Designed Genetic Improvement of Root System Architecture for Developing of Climate-Resilient Rice

○Yusaku Uga （Institute of Crop Science, National Agriculture and Food Research Organization, Japan）

9:45 AM - 10:05 AM

[O44-02] Phenotyping and Modelling Root Trait Variability in Crop Species

○Yinglong Chen[1, 2], Kadambot Siddique[1] （1.The UWA Institute of Agriculture and School of Agriculture and Environment, The University of Western Australia, Australia, 2.Institute of Soil and Water Conservation, Northwest A&F University, China）

10:05 AM - 10:25 AM

[O44-03] Genome-Wide Association (GWA) Mapping of Selected Philippine Rice Germplasm for Root Plasticity Alleles

Patrick Louie Lipio[1], ○Jonathan Manito Niones[2], Antoinette Cruz[3], Desiree Hautea[1], Roel Rodriguez Suralta[3], Nonawin Lucob-Agustin[2], Maria Corazon Cabral[2] （1.Institute of Plant Breeding, University of the Philippines-Los Baños, Philippines, 2.Genetic Resources Division, Philippine Rice Research Institute, Philippines, 3.Crop Biotechnology Center, Philippine Rice Research Institute, Philippines）

10:25 AM - 10:40 AM

[O44-04] Non-Destructive Method for Sampling, Preserving, and Analyzing Soil-Grown Root Systems

○Takuya Koyama[1,2], Shun Murakami[2], Masaaki Hashimoto[1], Katsuhiko Yoshidome[3], Yusuke Arakawa[3], Toshihiko Karasawa[4] （1.School of Agriculture, Utsunomiya University, Japan, 2.Graduate School of Regional Development and Creativity, Utsunomiya University, Japan, 3.Kyushu Okinawa Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 4.Central Region Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

10:40 AM - 10:55 AM

[O44-05] Physiological Traits and Genomic Regions Associated with Rice (*Oryza sativa* L.) Root Cone Angle Grown in an Aerobic Production System

○Ricky Vinarao[1], Christopher Proud[1], Xiaolu Zhang[1], Peter Snell[2], Shu Fukai[1], Jaquie Mitchell[1] （1.School of Agriculture and Food Sciences, The University of Queensland, Australia, 2.Department of Primary Industries, Yanco Agricultural Institute, Australia）

10:55 AM - 11:10 AM

[O44-06] Functional Significance of Roots for Adaptation and Productivity of Crop Plants Grown under Various Environmental Stresses

○Akira Yamauchi[1], Mana Kano-Nakata[2], Shiro Mitsuya[1], Yoshiaki Inukai[2], Roel Rodriguez Suralta[3], Jonathan Manito Niones[3] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.International Center for Research and Education in Agriculture, Nagoya

University, Japan, 3.Philippine Rice Research Institute, Philippines）
11:10 AM - 11:25 AM

9:45 AM - 10:05 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 4 (Oral))

[O44-01] Towards Designed Genetic Improvement of Root System Architecture for Developing of Climate-Resilient Rice

(Invited Speaker)

○Yusaku Uga （Institute of Crop Science, National Agriculture and Food Research Organization, Japan）

Adequate root system architecture (RSA) is imperative for the successful production of crops in excess or deficient conditions of water and nutrients because the root is the essential organ for uptake of water and nutrients in crop plants. Therefore, genetic improvement of the RSA should be considered as an option to enhance production in crops under abiotic stress. We previously demonstrated that altering *DRO1*, a quantitative trait locus (QTL) for root growth angle, improves drought avoidance in rice. We recently isolated another QTL for root growth angle, *qSOR1*. We created four different RSA types in rice through QTL pyramiding of functional and non-functional alleles in the *DRO1* and *qSOR1* genes, indicating that a breeding line with the desired RSA could be developed without phenotypic selection in the field. So, the application of root-related QTLs would facilitate the development of a rice cultivar showing wide adaptability of abiotic stress. However, identification of the root traits critical for crop production under abiotic stress remains a challenge, primarily because the underground location of the roots inhibits visual analysis. To visualize the root system, we launched a non-destructive 3D root phenotyping platform using X-ray CT imaging. Using this platform, development of a design for an ideal RSA that is robust to abiotic stress is ongoing.

10:05 AM - 10:25 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 4 (Oral))

[O44-02] Phenotyping and Modelling Root Trait Variability in Crop Species

(Invited Speaker)

○Yinglong Chen[1, 2], Kadambot Siddique[1] （1.The UWA Institute of Agriculture and School of Agriculture and Environment, The University of Western Australia, Australia, 2.Institute of Soil and Water Conservation, Northwest A&F University, China）

Understanding root system architecture (RSA) in crop species is critical for identifying root traits for breeding cultivars with improved resource uptake and better adaptation to adverse environments. Crop root systems are often poorly adapted to soils with the major limiting factors being poor soil water holding capacity and nutrient deficiencies in many farmland. RSA significantly influences crop foraging and capturing soil water and nutrients and thus determines crop productivity. Wide-scale use of root-related genetic information in crop breeding programs relies on accurate phenotyping of relatively large populations. Recently we developed a semi-hydroponic phenotyping system for high-throughput phenotyping of root trait variability in substantial collections of several important crops, including narrow-leafed lupin, barley, chickpea, wheat, maize and soybean. The utility of this phenotyping system in gathering the data for parameterising the simulation models of root architecture enables model simulations. The development of root phenotyping, imaging and modelling technologies in studying RSA under edaphic stress provide assistance in selecting future crop genotypes with efficient root system for enhanced abiotic stress tolerance and improved crop adaptation.

10:25 AM - 10:40 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 4 (Oral))

[O44-03] Genome-Wide Association (GWA) Mapping of Selected Philippine Rice Germplasm for Root Plasticity Alleles

(Invited Speaker)

Patrick Louie Lipio[1], ○Jonathan Manito Niones[2], Antoinette Cruz[3], Desiree Hautea[1], Roel Rodriguez Suralta[3], Nonawin Lucob-Agustin[2], Maria Corazon Cabral[2] （1.Institute of Plant Breeding, University of the Philippines-Los Baños, Philippines, 2.Genetic Resources Division, Philippine Rice Research Institute, Philippines, 3.Crop Biotechnology Center, Philippine Rice Research Institute, Philippines）

The identified novel root plasticity alleles can potentially be utilized in future rice breeding program for developing climate change resilient varieties. The genome wide association analysis was conducted on a selected panel of traditional varieties, previously characterized for root morphology under soil moisture stress. The result showed 17 correlated SNPs located in Chromosomes 2, 5, 7, 9 and 12, related to the root growth under soil moisture stress conditions. Rootbox phenotyping validated the accessions with promising root plasticity traits on Chromosome 2 region, which involved in the promotion of L-type lateral root development under fluctuating soil moisture stress. The accession Baksalan Kawalwal showed a 99% increase in L-type lateral root length under fluctuating soil moistures, relative to their continuously waterlogged counterparts. Moreover, there was a significant interaction between genotype and water treatment on L-type lateral roots. A member of PYR_PYL_RCAR_like protein family, for possible protein domains located near the QTL was identified. This protein involved in lateral root growth and drought tolerance in Arabidopsis thaliana, and whose orthologues in rice are also involved in drought and cold tolerance.

10:40 AM - 10:55 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 4 (Oral))

[O44-04] Non-Destructive Method for Sampling, Preserving, and Analyzing Soil-Grown Root Systems

○Takuya Koyama[1,2], Shun Murakami[2], Masaaki Hashimoto[1], Katsuhiko Yoshidome[3], Yusuke Arakawa[3], Toshihiko Karasawa[4] （1.School of Agriculture, Utsunomiya University, Japan, 2.Graduate School of Regional Development and Creativity, Utsunomiya University, Japan, 3.Kyushu Okinawa Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 4.Central Region Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

The root box-pin board method has been used for sampling and preserving the whole root system with minimum impairment and disturbance to its structure. This method requires a root box with one removable front wall, a pin board, and a folio of transparent sheet with many holes. The whole root system was detached from the pin board by the sheet with many holes and preserved between the sheet, but preparation of the sheet was tedious and time-consuming. In the process of root sampling, quick and accurate alignment of the pin board and the root box was difficult. Furthermore, imaging root system between the sheet required root staining. Thereby, we devised the root sampling equipment and improved the image acquisition and analysis processes. A work table with guide bars facilitated the fast and accurate alignment of the pieces of equipment. An urethane foam sheet, a grid frame, and a grid pressing plate made unnecessary the preparation of the transparent sheet with many holes. A scanner for A3 size with transparency unit and the image analyzing software 'WinRhizo' offered the precise evaluation of root surface area without root staining. These improvements allow easy sampling,

preservation, and analysis of the whole root system, which contribute to develop resource-efficient crops and/or cultivation systems.

10:55 AM - 11:10 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 4 (Oral))

[O44-05] Physiological Traits and Genomic Regions Associated with Rice (*Oryza sativa* L.) Root Cone Angle Grown in an Aerobic Production System

*Nominated for Presentation Awards

○Ricky Vinarao[1], Christopher Proud[1], Xiaolu Zhang[1], Peter Snell[2], Shu Fukai[1], Jaquie Mitchell[1] (1.School of Agriculture and Food Sciences, The University of Queensland, Australia, 2.Department of Primary Industries, Yanco Agricultural Institute, Australia)

Aerobic rice production system (AP) uses less water than traditional flooded culture, and could be a solution to the imminent water availability crisis brought about by changing climate. Genotypes with narrow root cone angle (RCA) could produce deep root system, and are considered to be adapted to AP. This study aims to physiologically characterise recombinant inbred lines derived from IRAT109 for RCA and related traits and to determine genomic loci associated with these traits through genome wide association (GWA) mapping. The second season field trial which evaluated 18 selected top and tail lines identified in a glasshouse experiment, revealed significant genotypic variation in RCA, early vigour (EV), light interception, canopy temperature depression, leaf death, pulling score (PS), days-to-heading (DTH), biomass, plant height, panicle weight (PW), harvest index, and grain yield. Genotypes with narrower RCA achieved higher EV and PS, indicating their advantage in early growth and root system development. GWA identified a consistent genomic region associated with RCA located in chromosome 4. Genotypes with the target allele had narrower RCA, higher EV, PS, DTH and PW compared with genotypes with non-target allele. Post QTL analysis and allele mining identified a NAC TF candidate gene. Evaluation of narrow RCA in intermittent water stress conditions and development of molecular markers are underway. This study provides physiological and genomic understanding of RCA and with genomics-based breeding, will hasten the development of AP-adapted, sustainably produced rice.

11:10 AM - 11:25 AM (Fri. Sep 10, 2021 9:45 AM - 11:45 AM Room 4 (Oral))

[O44-06] Functional Significance of Roots for Adaptation and Productivity of Crop Plants Grown under Various Environmental Stresses

○Akira Yamauchi[1], Mana Kano-Nakata[2], Shiro Mitsuya[1], Yoshiaki Inukai[2], Roel Rodriguez Suralta[3], Jonathan Manito Niones[3] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.International Center for Research and Education in Agriculture, Nagoya University, Japan, 3.Philippine Rice Research Institute, Philippines)

Roots play significant functional roles in adaptation and productivity of crop plants especially when grown under various abiotic stresses. We have accumulated experimental evidences showing that a root system of an individual plant is an integration of component roots with dissimilar morphology, anatomy,

physiological functions, and in developmental responses to various soil conditions. The ability of plant to change its morphology, as environmental conditions change is defined as phenotypic plasticity. A series of experiments are now in progress to determine the functional roles of root plasticity by using various accessions/populations. Root plasticity has been phenotyped by using a range of methods, including rootbox-pinboard method, slant tube method, line source sprinkler system, and under field conditions using both monolith and core sampling. These results have consistently showed that the root plasticity specifically in branching, deep rooting, the associated aerenchyma formation, and rooting angle which are exhibited in response to varied soil conditions, substantially contribute to the maintained/promoted growth and productivity through enhanced physiological functions. Genotyping is also in progress by using some of the population to locate genes responsible for the root plasticity traits. Further study is in progress to more precisely identify the quantitative trait loci responsible for the root plasticity and to examine the physiological function of such plasticity for plant adaptation and productivity.

Closing /Award Ceremony

Closing /Award Ceremony

Chair: Hiroshi Ehara (Nagoya University, Japan)
Fri. Sep 10, 2021 11:45 AM - 12:45 PM Room 1 (Oral) (Field Crop Production)

Closing Address 1 11:45 AM - 11:50 AM
President of Crop Science Society of Japan
Junko Yamagishi

Closing Address 2 11:50 AM - 11:55 AM
Chairperson of the Steering Committee of ACSAC10
Akira Yamauchi (Professor at Nagoya University, Japan)

ACSAC11 Representative 11:55 AM - 12:00 PM

Award Ceremony 12:00 PM - 12:45 PM