Thu. Sep 9, 2021

Room 1 (Oral)

Oral sessions | Field Crop Production | O11: Direct-seeded Rice in Asia-Oceania Region

[O11] Direct-seeded Rice in Asia-Oceania Region

Chair: Yoichiro Kato (The University of Tokyo, Japan)
Chair: Virender Kumar (International Rice Research Institute, Philippines)
9:45 AM - 11:45 AM Room 1 (Oral) (Field Crop Production)

[O11-01] Direct-Seeded Rice for Economic and Environmental Sustainability of Rice in Asia: Overview

○Virender Kumar[1], Yoichiro Kato[2], Sudhanshu Singh[3] (1.Sustainable Impact Platform, International Rice Research Institute, Philippines, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Sustainable Impact Platform, International Rice Research Institute, India)

9:45 AM - 10:05 AM

[O11-02] Improvements in Abiotic Stress Tolerance Required for Drill Seeded Aerobic Rice Production

○Jaquie H Mitchell[1], Chris D Proud[1], Brian Dunn[2], Peter Snell[2], Shu Fukai[1] (1.School of Agriculture and Food Sciences, The University of Queensland, Australia, 2.Department of Primary Industries, Yanco Agricultural Institute, Australia)

10:05 AM - 10:25 AM

[O11-03] Research and Development of Direct-Seeded Rice in China

○Shaobing Peng (College of Plant Science and Technology, Huazhong Agricultural University, China)

10:25 AM - 10:40 AM

[O11-04] Direct Seeded Rice to Achieve Sustainable Production in South Asia

○Sudhanshu Singh[1], Yoichiro Kato[2], Virender Kumar[3] (1.Sustainable Impact Platform, International Rice Research Institute, India, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Sustainable Impact Platform, International Rice Research Institute, Philippines)

10:40 AM - 10:55 AM

[O11-05] Marker-Assisted Breeding for Improving Seedling Establishment under Flooded Conditions in Direct-Seeded Rice

○Kazuhiro Sasaki[1,2], Takuya Yamaguchi[3], Yoichiro Kato[2] (1.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Toyama Prefectural Agricultural, Forestry & Fisheries Research Center, Japan)

10:55 AM - 11:10 AM

[O11-06] Mechanized Dry Direct Seeding: A Technology for Improving Rice Productivity and Increasing Production Efficiency of Rainfed Lowlands in the Philippines

○Pompe Campoy Sta Cruz[1], Crisanta Sunio Bueno[2], Nino Paul Meynard Calalo Banayo[3], Ruth Agbisit[4], Roel Suralta[5], John Eric Abon[6], Aurora Corales[7], Elmer Bautista[8], Yoichiro Kato[9] (1.Crop Physiology, University of the Philippines Los Baños, Philippines, 2.Crop Physiology, University of the Philippines Los Baños, Philippines, 3.Crop Physiology, University of the Philippines Los Baños, Philippines, 4.Crop Physiology, University of the Philippines Los Baños, Philippines, 5.Crop Biotech Center, Philippine Rice Research Institute, Philippines, 6.Rice Mechanization Division, Philippine Rice Research Institute, Philippines, 7.Technology Management Division, Philippine Rice Research Institute, Philippines, 8.Rice Mechanization Division, Philippine Rice Research Institute, Philippines, 9.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan)

11:10 AM - 11:25 AM

Oral sessions | Field Crop Production | O12: Concepts, Prospects, and Potentiality of Crop Production in East Asia

[O12] Concepts, Prospects, and Potentiality of Crop Production in East Asia

Chair: Sang-In Shim (Gyeongsang National University, Korea)
Chair: Takeo Sakaigaichi (Kyushu Okinawa Agricultural Research Center, National Agriculture and Food Research Organization, Japan)
Chair: Hiroshi Ehara (Nagoya University, Japan)
2:30 PM - 4:30 PM Room 1 (Oral) (Field Crop Production)

[O12-01] Yield Performance of Recent Breeding Lines of Sweetpotato Developed for Direct Planting in Japan

○Takeo Sakaigaichi, Yumi Kai, Akira Kobayashi, Keisuke Suematsu （Division of Upland Farming Research, Kyushu Okinawa Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

2:30 PM - 2:50 PM

[O12-02] Nationwide Evaluation and Development of Direct Seeding Technology of Rice with Iron-Coated Seeds in Japanese Fields

○Minoru Yamauchi[1,3], Masaki Sugimura[2], Takashi Shiomi[2] （1.Crop Production Division, National Federation of Agricultural Cooperative Associations (Zen-Noh), Japan, 2.Agribusiness General Planning Division, Zen-Noh, Japan, 3.Presently, Consultant, Zen-Noh, Japan）

2:50 PM - 3:10 PM

[O12-03] Feed and Pasture Management Practices of Dairy Farms in Nay Pyi Taw, Myanmar

○Aye Aye Khaing, Ei Thandar Ko, Hla Than （Department of Agronomy, Yezin Agricultural University, Myanmar）

3:10 PM - 3:25 PM

[O12-04] International Differential System for Resistance in Rice Cultivars and Blast Race

○Yoshimichi Fukuta （Research Planning and Partnership Division, Japan International Research Center for Agricultural Sciences, Japan）

3:25 PM - 3:40 PM

[O12-05] Varietal Differences in Photosynthetic Characteristics, Yield and Water Use Efficiency of Rice under Drip Irrigation with Plastic Film Mulch

○Junfa Wang[1], Fawibe Olamide Oluwasegun[1], Haruki Higashi[2], Kodai Yamamoto[2], Akihiro Isoda[1] （1.Graduate School of Horticulture, Chiba University, Japan, 2.Faculty of Horticulture, Chiba University, Japan）

3:40 PM - 3:55 PM

[O12-06] Physiological and Proteome Analysis in *Brassica napus* L. of Leaves in Response to Copper Stress and Citric-Acid Application

○Yong-Hwan Ju[1], Ju Young Choi[1], Swapan Kumar Roy[1], Soo Jeong Kwon[1], Kwang Soo Kim[2], Sun Hee Woo[1] （1.Dept of Crop Science, Chungbuk National University, Korea, 2.Bio-Energy Plant Research Center, National Institute of Crop Science, Korea）

3:55 PM - 4:10 PM

[O12-07] Improvement of Wheat Quality for End-use Quality in Korean Wheat Breeding Program: *Glu-B1al* and Glu-D1y12.K

○1Seong-Woo Cho[1], Chul Soo Park[2] （1 Department of Smart Agro-Industry, Gyeongsang National University, Korea, 2 Department of Crop Science and Biotechnology, Jeonbuk National University, Korea）

4:10 PM - 4:25 PM

Oral sessions | Field Crop Production | O13: Current Issues on Tropical Crops

[O13] Current Issues on Tropical Crops

Chair: Hiroshi Ehara (Nagoya University, Japan)
Chair: Hitoshi Naito (Kurashiki University of Science and The Arts, Japan)
Chair: Rosa Rolle (Food and Agriculture Organization of the United Nations, Italy)
5:00 PM - 7:00 PM Room 1 (Oral) (Field Crop Production)

[O13-01] Expression and Insecticidal Characterization of Cry8Db Protein against *Lepidiota signata* Fabricius

P. T. T. Hien[1,2], H. T. Thuong[1], L. T. Ngoc[1], ○H. S. Nguyen[3], C. H. Ha[1], T. D. Khanh[4], P. B. Ngoc[1] （1.Institute of Biotechnology, Vietnam Academy of Science and Technology, Vietnam, 2.Hanoi Pedagogical University, Vietnam, 3.Vietnamese Academy of Agricultural Science, Hanoi, Vietnam, 4.Agricultural Genetics Institute, Vietnam National University of Agriculture, Hanoi, Vietnam）

5:00 PM - 5:20 PM

[O13-02] Growth Responses of Manno Sago Seed to Organic and NPK Fertilizers Application

○Yulius Barra Pasolon[1], Marselinus Sulu[2], Asniwati Asniwati[3], Muhidin Muhidin[4], Hitoshi Naito[5], Hiroshi Ehara[6] （1.Department of Soil Science, Faculty of Agriculture, Halu Oleo University, Indonesia, 2.International Office, Halu Oleo University, Indonesia, 3.Post Graduate Program, Halu Oleo University, Indonesia, 4.Department of Agronomy, Faculty of Agriculture, Halu Oleo University, Indonesia, 5.College of Life Science, Kurashiki University of Science and The Arts, Japan, 6.International Center for Research and Education in Agriculture, Nagoya University, Japan）

5:20 PM - 5:40 PM

[O13-03] Agronomic Practices of Oil Palm Smallholders

towards Sustainable Development Goal 12

○Margaret Chan Kit Yok[1], Suriana Baki[1], Seraphina Anak Dominic Gisong[2], Siraj Munir Bin Mohammad[1]
（1.Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA Sarawak Branch, Malaysia, 2.Kumpulan Kelestarian Aras 2, Wisma FELCRA, Malaysia）

5:40 PM - 5:55 PM

[O13-04] A Survey on Home Garden Horticultural Crops in Two Selected Areas in Myanmar

○Thanda Aung （Department of Horticulture, Yezin Agricultural University, Myanmar）

5:55 PM - 6:10 PM

[O13-05] Agro-economic Evaluation of Fertilizer Management for Wet Season Rice in Southern Cambodia

○Kea Kong[1], Yoichiro Kato[2], Sarom Men[3], Vang Seng[1], Akira Yamauchi[4], Mayumi Kikuta[5], Il-Ryong Choi[6], Hiroshi Ehara[7, 8] （1.General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 2.Institute for Sustainable Agro-ecosystem Services, The University of Tokyo, Japan, 3.Royal University of Agriculture, Cambodia, 4.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 5.Graduate School of Integrated Sciences for Life, Hiroshima University, Japan, 6.International Rice Research Institute - Korea Office, Korea, 7. Applied Social System Institute of Asia, Nagoya University, Japan, 8.International Center for Research and Education in Agriculture, Nagoya University, Japan）

6:10 PM - 6:25 PM

[O13-06] The Abundance and Diversity of Arbuscular Mycorrhizal Fungi Colonized in Roots of Sago Palm in Mineral Soil and Shallow Peat Soil

○Koki Asano[1,2], Willy Vincent Anak Kagong[3], Siraj Munir Bin Mohammad[3], Kurumi Sakazaki[4], Margaret Chan Kit Yok[3], Toshiyuki Isoi[4], Mana Kano-Nakata[5], Hiroshi Ehara[5,6] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.Faculty of Agriculture, Kasetsart University, Thailand, 3.Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA Sarawak Branch, Malaysia, 4.Faculty of Agriculture, Meijo University, Japan, 5.International Center for Research and Education in Agriculture, Nagoya University, Japan, 6.Applied Social System Institute of Asia, Nagoya University, Japan）

6:25 PM - 6:40 PM

[O13-07] The Effect of Nitrogen and Phosphorus Applications on Rice Yield Can Be Changed by Farmers' Management Practices — Transplanting Dates and Densities—

○Bruce Haja Andrianary[1], Yasuhiro Tsujimoto[2], Hobimiarantsoa Rakotonindrina[1], Michel Rabenarivo[1], Herintsitohaina Razakamanarivo[1]
（1.Laboratoire des Radioisotopes, University of Antananarivo, Madagascar, 2.Japan International Research Center for Agricultural Sciences, Japan）

6:40 PM - 6:55 PM

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

Thu. Sep 9, 2021

Room 2 (Oral)

Oral sessions | Farming System | O21: Cropping System / Crop Rotation

[O21] Cropping System / Crop Rotation

Chair: Katsuyoshi Shimizu (Kagoshima University, Japan)
Chair: Weidong Cao (Chinese Academy of Agricultural Sciences, China)

9:45 AM - 11:45 AM Room 2 (Oral) (Farming System)

[O21-01] Utilization of Green Manure in China

○Weidong Cao（Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, China）

9:45 AM - 10:05 AM

[O21-02] Climate Services for Improved Resilience of Cropping Systems

○Hideki Kanamaru（Food and Agriculture Organization of the United Nations, FAO Regional Office for Asia and the Pacific (FAORAP), Thailand）

10:05 AM - 10:25 AM

[O21-03] Effects of Ridging and Fertilizer Application on Crop Yield and Growth under Unstable Water Environments

○Yoshihiro Hirooka[1], Simon K. Awala[2], Pamwenafye I. Nanhapo[2], Koichi Shoji[3], Yoshinori Watanabe[4], Yasuhiro Izumi[5], Morio Iijima[1]（1.Graduate School of Agriculture, Kindai University, Japan, 2.Faculty of Agriculture and Natural Resources, University of Namibia, Namibia, 3.Graduate School of Agricultural Science, Kobe University, Japan, 4.Faculty of Agriculture, Fukushima University, Japan, 5.School of Environmental Science, The University of Shiga Prefecture, Japan）

10:25 AM - 10:40 AM

[O21-04] Enhancement of Drought-Tolerance of Sorghum by the Close Mixed-Planting of Pearl Millet

○Morio Iijima[1], Simon K. Awala[2], Pamwenafye I. Nanhapo[2], Yoshihiro Hirooka[1], Keotshephile Kashe[3]（1.Graduate School of Agriculture, Kindai University, Japan, 2.Faculty of Agriculture and Natural Resources, University of Namibia, Namibia, 3.Okavango Research Institute, University of Botswana, Botswana）

10:40 AM - 10:55 AM

[O21-05] Rice Introduction to Botswana through the Collaboration with Namibia and Japan; Natural and Social Environment for Rice Cropping in Okavango Delta

○Keotshephile Kashe[1], Simon K. Awala[2], Pamwenafye I. Nanhapo[2], Yoshihiro Hirooka[3], Morio Iijima[3]（1.Okavango Research Institute, University of Botswana, Botswana, 2.Faculty of Agriculture

and Natural Resources, University of Namibia, Namibia, 3.Graduate School of Agriculture, Kindai University, Japan）
10:55 AM - 11:10 AM

[O21-06] Long-term Crop Response to Discontinuation of Fertilizer Input in a Wheat-Maize Cropping System

○Syed Tahir Ata-Ul-Karim[1], Weimo Zhou[1], Naoki Moritsuka[1], Yoichiro Kato[1] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Graduate School of Integrated Arts and Sciences Agriculture, Kochi University, Japan, 4.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）
11:10 AM - 11:25 AM

Oral sessions | Farming System | O22: Crop Production System

[O22] Crop Production System

Chair: Koki Homma (Tohoku University, Japan)
Chair: Roel Suralta (Philippine Rice Research Institute, Phillipines)
2:30 PM - 4:30 PM Room 2 (Oral) (Farming System)

[O22-01] Present Status and Issues of Crop Production after the Tsunami in the Coastal Area of Sendai, Japan

○Koki Homma[1], Shuhei Yamamoto[1], Naoyuki Hashimoto[2], Masayasu Maki[3], Koshi Yoshida[4] （1.Graduate School of Agricultural Science, Tohoku University, Japan, 2.Faculty of Agriculture and Marine Science, Kochi University, Japan, 3.Faculty of Food and Agricultural Sciences, Fukushima University, Japan, 4.Graduate School of Frontier Sciences, The University of Tokyo, Japan）
2:30 PM - 2:50 PM

[O22-02] Agronomic Performance of Rainfed Lowland Rice Varieties in Different Soil Types in Cambodia

○Chanthol Uch[1,2], Yurdi Yasmi[1], Buyung A. R. Hadi[3], Kea Kong[4], Sarom Men[5], Lyda Hok[5], Chhourn Orn[6], Seang Layheng[6], Mana Kano-Nakata[7], Akira Yamauchi[8], Hiroshi Ehara[7,9] （1. International Rice Research Institute Cambodia Office, Cambodia, 2.Nagoya University Asian Satellite Campuses Institute-Cambodia, Royal University of Agriculture, Cambodia, 3.Food and Agriculture Organization of the United Nations, Italy, 4.General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 5.Royal University of Agriculture, Cambodia, 6.Cambodian Agricultural Research and Development Institute, Cambodia, 7.International Center for Research and Education in Agriculture, Nagoya University, Japan, 8.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 9.Applied Social System Institute of Asia, Nagoya University, Japan）
2:50 PM - 3:10 PM

[O22-03] Quantitative Analysis on Rice Production Changes for Sixteen Years in Pursat Province, Cambodia

○Yu Iwahashi[1], Rongling Ye[1], Satoru Kobayashi[2], Kenjiro Yagura[3], Hor Sanara[4], Kim Soben[4], Koki Homma[1] （1.Graduate School of Agriculture, Tohoku University, Japan, 2.Center for Southeast Asian Studies, Kyoto University, Japan, 3.Graduate School of Management and Information Technology, Hannan University, Japan, 4.Royal University of Agriculture, Cambodia）
3:10 PM - 3:25 PM

[O22-04] Vertical Farming: Improving Food and Nutrition Security by Integrating Agriculture into the Built Environment of Dhaka City

○Shamma Tabassum Haque[1], Md. Z. H. M. Monjur Murshed[1], Muhammad Shahidul Haque[2] （1.Department of Architecture, Rajshahi University of Engineering and Technology, Bangladesh, 2.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh）
3:25 PM - 3:40 PM

[O22-05] Spatial Variation in the Growth of Peach Trees and the Related Field Properties in a Newly Reclaimed Orchard

○Kaori Matsuoka[1], Naoki Moritsuka[2], Ryohei Nakano[3], Koji Kusumi[3], Takashi Kurosawa[3], Mika Yasuda[3], Tsuyoshi Konishi[3], Tetsuya Nakazaki[3] （1.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan, 2.Faculty of Agriculture and Marine Science, Kochi University, Japan, 3.Experimental Farm, Graduate School of Agriculture, Kyoto University, Japan）

3:40 PM - 3:55 PM

[O22-06] Assessment of Rice Cultivation in Non-system Tank Irrigated Area in Southern Region of Tamil Nadu, India

○S Selvakumar[1,3], Akihiko Kamoshita[2], S Sakthivel[1]
（1.Department of Agronomy, Tamil Nadu Agricultural University, India, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Department of Agronomy, Kumaraguru Institute of Agriculture, India）

3:55 PM - 4:10 PM

[O22-07] Trials of Mix Cropping of Indeterminate and Determinate Soybean Lines for 5 years in Tohoku, Japan

○Rongling Ye[1], Koki Homma[1], Daiki Saito[1], Kazuki Ohishi[1], Ryosuke Tajima[1], Toru Uno[1], Shin Kato[2], Akio Kikuchi[2], Takayuki Nakajima[1]（1.Graduate School of Agricultural Science, Tohoku University, Japan, 2.Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

4:10 PM - 4:25 PM

Oral sessions | Farming System | O23: Crop Modeling: Recent Progress and Applications

[O23] Crop Modeling: Recent Progress and Applications

Chair: Hiroshi Nakagawa (National Agriculture and Food Research Organization, Japan)
Chair: Xinyou Yin (Wageningen University and Research, Netherlands)
5:00 PM - 7:00 PM Room 2 (Oral) (Farming System)

[O23-01] Learning from Experiences in Physics to Improve Crop Models for Analysis of Complex Traits

○Xinyou Yin（Centre for Crop Systems Analysis, Wageningen University and Research, Netherlands）

5:00 PM - 5:20 PM

[O23-02] Potential Value of Seasonal Climate Forecast and Crop Modelling in Identifying Optimal Management Practices in Tonga

○Kwang-Hyung Kim[1], Steven Crimp[2]（1.Climate Services and Research Division, Asia Pacific Economic Cooperation Climate Center, Korea, 2.Climate Change Institute, Australian National University, Australia）

5:20 PM - 5:40 PM

[O23-03] Improving Variety Reveals Emerging Wheat Yield Gaps Associated with Humid Days in Hokkaido

○Seiji Shimoda[1], Yohei Terasawa[1], Zenta Nishio[2]
（1.Hokkaido Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Department of Agriculture, Tokyo University of Agriculture, Japan）

5:40 PM - 5:55 PM

[O23-04] Deep Learning-Based Robust Estimation for Rice Biomass Using Digital Image of Canopy

○Kota Nakajima[1], Yu Tanaka[1], Keisuke Katsura[2], Tatsuhiko Shiraiwa[1]（1.Graduate School of Agriculture, Kyoto University, Japan, 2.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan）

5:55 PM - 6:10 PM

[O23-06] Determination and Genetic Analysis of Genotype-Specific Parameters of Crop Growth Model Using Large-Scale Data of Rice Cultivation Tests in Japan

○Hiroe Yoshida[1], Satoru Sukegawa[1], Shiori Yabe[2], Akitoshi Goto[2], Hiromi Kajiya-Kanegae[3], Kaworu Ebana[4], Hiroyoshi Iwata[5], Masanori Yamasaki[6], Hiroshi Nakagawa[1]（1.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan, 2.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 3.Research Center for Agricultural Information Technology, National Agriculture and Food Research Organization, Japan, 4.Genetic Resources Center, National Agriculture and Food Research Organization, Japan, 5.Department of Agricultural and Environmental Biology, Graduate School of Agricultural and Life Science, The University of Tokyo, Japan, 6.Food Resources Education and Research Center, Graduate School of Agricultural Science, Kobe University, Japan）

6:25 PM - 6:40 PM

[O23-05] Characteristics of the Grain Weight Distribution Relating to the Ability of Resource Allocation in a Rice Panicle

○Shiori Yabe[1], Hiroe Yoshida[2], Hiromi Kajiya-Kanegae[3], Masanori Yamasaki[4], Hiroyoshi Iwata[5],

Kaworu Ebana[6], Erina Fushimi[2], Hideo Maeda[1], Takeshi Hayashi[1], Hiroshi Nakagawa[2] （1.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 2.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan, 3.Research Center for Agricultural Information Technology, National Agriculture and Food Research Organization, Japan, 4.Food Resources Education and Research Center, Graduate School of Agricultural Science, Kobe University, Japan, 5.Department of Agricultural and Environmental Biology, Graduate School of Agricultural and Life Science, The University of Tokyo, Japan, 6.Research Center of Genetic Resources, National Agriculture and Food Research Organization, Japan）
6:10 PM - 6:25 PM

Fri. Sep 10, 2021

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

Thu. Sep 9, 2021

Room 3 (Oral)

Oral sessions | S-01 - S-05 | O31: Temperature Stress

[O31] Temperature Stress

Chair: Yoshimichi Fukuta (Japan International Research Center for Agricultural Sciences, Japan)
Chair: Donghe Xu (Japan International Research Center for Agricultural Sciences, Japan)
9:45 AM - 11:45 AM Room 3 (Oral) (Abiotic Stress for Crop Production)

[O31-01] High-Temperature Impacts on Rice Quality and Adaptation Strategy of Rice Production for Climate Change in Taiwan

○Huu-Sheng Lur[1] （1.Department of Agronomy, College of Bioresources and Agriculture, National Taiwan University, Taiwan, 2.Agronomy Society of Taiwan, Taiwan）
9:45 AM - 10:05 AM

[O31-02] Genome-Wide Associated Study Identifies GCN5-Activated Glyoxal Metabolism Related Gene Conferring Heat Tolerance in Wheat

○Zhaorong Hu, Jingchen Lin, Huiru Peng, Mingming Xin, Weilong Guo, Yingyin Yao, Zhongfu Ni, Qixin Sun （College of Agronomy and Biotechnology, China Agricultural University, China）
10:05 AM - 10:25 AM

[O31-03] Development of Technologies and Crops for Stable Food Production under Adverse Environments and Changing Climate

Conditions

○Kazuo Nakashima （Food Program, Japan International Research Center for Agricultural Sciences, Japan）

10:25 AM - 10:40 AM

[O31-04] Genetic Dissection of Heat Stress Tolerance at Anthesis among Three Rice Cultivars, IR64, Koshihikari, and Takanari

○Toshiyuki Takai （Biological Resources and Post-harrvest Division, Japan International Research Center for Agricultural Sciences, Japan）

10:40 AM - 10:55 AM

[O31-05] Tomato Mutant HT7 Conferring Improved Fruit Set and Pollen Fertility under Long-Term Ambient High Temperature

○Ken Hoshikawa[1,2,3], Dung Pham[4], Hiroshi Ezura[2,3]
（1.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan, 2.Faculty of Life and Environmental Sciences, University of Tsukuba, Japan, 3.Tsukuba Plant Innovation Research Center, University of Tsukuba, Japan, 4.Graduate School of Life and Environmental Sciences, University of Tsukuba, Japan）

10:55 AM - 11:10 AM

[O31-06] Genetic Variation of Spikelet Sterility Induced by Typhoon in Introgression Lines with Genetic Background of an *Indica* Group Rice (*Oryza sativa* L.) Variety IR 64

○Asami Tomita[1,2], Md. Nashir Uddin[3], Mitsuhiro Obara[4], Hiroki Saito[1], Yoshimichi Fukuta[1]
（1.Tropical Agriculture Research Front, Japan International Research Center for Agricultural Sciences, Japan, 2.Graduate School of Environmental and Life Science, Okayama University, Japan, 3.School of Health and Life Sciences, North South University, Bangladesh, 4.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan）

11:10 AM - 11:25 AM

[O31-07] Heat Resilience in Rice by Early-Morning Flowering Trait

○Tsutomu Ishimaru （Division of Lowland Farming, Central Region Agricultural Research Center/National Agriculture and Food Research Organization, Japan）

11:25 AM - 11:40 AM

Oral sessions | Abiotic Stress for Crop Production | O32: Drought Physiology

[O32] Drought Physiology

Chair: Junichi Kashiwagi (Hokkaido University, Japan)
2:30 PM - 4:30 PM Room 3 (Oral) (Abiotic Stress for Crop Production)

[O32-01] Rice Drought Breeding Has Selected for Longer Flag Leaves and Lower Stomatal Density

○Amelia Henry[1], Santosh Kumar[2], Archana Prasad[3], Suresh Prasad Singh[4], Fahamida Akter[5], Shravan K. Singh[6], Padmini Swain[7], Ram Baran Yadaw[8], Sankar Prasad Das[9], Nimai P. Mandal[10], Arvind Kumar[1]
（1.Strategic Innovation Platform, International Rice Research Institute, Philippines, 2.Indian Council of Agricultural Research, Research Complex for Eastern Region, Patna, India, 3.Indira Gandhi Agricultural University, Raipur, India, 4.Bihar Agricultural University, Sabour, India, 5.Bangladesh Rice Research Institute, Regional Station, Rajshahi, Bangladesh, 6.Banaras Hindu University, Varanasi, India, 7.National Rice Research Institute, Cuttack, India, 8.National Rice Research Program, Hardinath, Nepal, 9.ICAR Research Complex for North Eastern Hill Region, Lembucherra, India, 10.Central Rainfed Upland Rice Research Station, Hazaribag, India）

2:30 PM - 2:50 PM

[O32-02] Physiological Traits to Breed for Drought Adaptation

○Matthew Reynolds, Margaret Krause, Francisco Pinto, Sivakumar Sukumaran （International Maize and Wheat Improvement Center, Mexico）

2:50 PM - 3:10 PM

[O32-03] Potential of Wild Relatives to Improve Wheat Drought Tolerance

○Masahiro Kishii, Matthew Paul Reynolds （Global Wheat Program, International Maize and Wheat Improvement Center, Mexico）

3:10 PM - 3:25 PM

[O32-04] Drought Resistance of NERICA, Asian Rice and African Rice with Effects of Compost and Potassium Fertilizer

○Michihiko Fujii （Faculty of Education, Shizuoka University, Japan）

3:25 PM - 3:40 PM

[O32-05] Optimizing Intermittent Irrigation Methods That Maximize Rice Productivity While Saving Irrigation Amount by Promoting Root Developmental Plasticity with Adequate Level of Nitrogen

○Emi Kameoka, Hinaki Yoshino, Hirotaka Suzuki, Yuki Omi （College of Agriculture, Food and Environment Sciences, Rakuno Gakuen University, Japan）

3:40 PM - 3:55 PM

[O32-06] Transcriptome Analysis of Soybean Responses to Water Deficit Conditions in the Field

○Yukari Nagatoshi[1], Nobuyuki Mizuno[2], Kenta Ikazaki[3], Tetsuji Oya[3], Yasuo Yasui[2], Eri Ogiso-Tanaka[4], Masao Ishimoto[4], Yasunari Fujita[1,5]（1.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan, 2.Graduate School of Agriculture, Kyoto University, Japan, 3.Crop, Livestock and Environment Division, Japan International Research Center for Agricultural Sciences, Japan, 4.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 5.Graduate School of Life Environmental Science, University of Tsukuba, Japan）

3:55 PM - 4:10 PM

[O32-07] The Ear Photosynthesis as Potential Source for Drought Yield Improvements in Wheat

○Junichi Kashiwagi[1], Suzu Nakayama[2], Yoshiko Inoue[3], Ayano Kato[3], Izumi Harada[4], Shinji Ichikawa[5], Taiken Nakashima[1], Ping An[6]（1.Research Faculty of Agriculture, Hokkaido University, Japan, 2.Pasco Shikishima Corporation, Japan, 3.Graduate School of Agriculture, Hokkaido University, Japan, 4.School of Agriculture, Hokkaido University, Japan, 5.Field Science Center for Northern Biosphere, Hokkaido University, Japan, 6.Arid Land Research Center, Tottori University, Japan）

4:10 PM - 4:25 PM

Oral sessions | Abiotic Stress for Crop Production | P33: Salinity

[O33] Salinity

Chair: Yoshihiko Hirai (Okayama University, Japan)
Chair: Sakae Agarie (Kyushu University, Japan)
Chair: Glenn Borja Gregorio (Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), Phillippines)
5:00 PM - 7:00 PM Room 3 (Oral) (Abiotic Stress for Crop Production)

[O33-01] Sustainable and Innovative Solutions to the Salinity Intrusion in the Mekong River Delta Affecting Rice Production

○Glenn Borja Gregorio[1, 2, 3]（1.College of Agriculture and Food Science, University of the Philippines Los Baños, Philippines, 2.Office of the Director, Southeast Asian Regional Center for Graduate Study and Research in, Philippines, 3.National Academy of Science and Technology, Department of Science and Technology, Philippines）

5:00 PM - 5:20 PM

[O33-02] Mechanism of Salt Removal Ability in Leaf Sheath of Rice and its Potential for Molecular Breeding

○Shiro Mitsuya[1], Sarin Neang[1], Nicola S. Skoulding[2], Joyce A. Cartagena[1], Mana Kano-Nakata[3], Akira Yamauchi[1]（1.Graduate School of Biological Sciences, Nagoya University, Japan, 2.Graduate School of Science, Nagoya University, Japan, 3.International Center for Research and Education in Agriculture, Nagoya University, Japan）

5:20 PM - 5:40 PM

[O33-03] Morphological and Microsatellite Marker Assisted Genetic Diversity Analysis of Wheat Genotypes for Salinity Tolerance

○Sayma Farabi[1], Nihar Ranjan Saha[2], Md. Hasanuzzaman[3], Md. Shahidul Haque[4], Mirza Mofazzal Islam[5]（1.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 2.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 3.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 4.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 5.Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture, Bangladesh）

5:40 PM - 5:55 PM

[O33-04] Rice Memorizes Salinity Stress by Training and Improves the Salinity Stress Response and Yield

○Satoru Sakuma[1], Akira Yamauchi[2], Shiro Mitsuya[2],

Mana Nakata[2] (1.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan)

5:55 PM - 6:10 PM

[O33-05] Cl^- More Detrimental Than Na^+ in Salt-Stressed Rice

○Yoshihiko Hirai[1], Hanh Duy Dao[1], Mao Kuroda[2], Kazushi Hirai[1] (1.Graduate School of Environmental and Life Science, Okayama University, Japan, 2.Faculty of Agriculture, Okayama University, Japan)

6:10 PM - 6:25 PM

[O33-06] Three-Dimensional Analysis on the Internal Structure of Rice Leaf Tissue and the Intracellular Structure of Mesophyll Cells

○Rachana Ouk, Takao Oi, Mitsutaka Taniguchi (Graduate School of Bioagricultural Sciences, Nagoya University, Japan)

6:25 PM - 6:40 PM

Fri. Sep 10, 2021

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

Thu. Sep 9, 2021

Room 4 (Oral)

Oral sessions | Crop Genetics and Physiology | O41: Genetic Improvement of Crop Yield

[O41] Genetic Improvement of Crop Yield

Chair: Taichiro Ookawa (Tokyo University of Agriculture and Technology, Japan)
Chair: Hiroshi Fukayama (Kobe University, Japan)
Chair: Masahiro Kishii (International Maize and Wheat Improvement Center, Mexico)
Chair: Shunsuke Adachi (Tokyo University of Agriculture and Technology, Japan)
9:45 AM - 11:45 AM Room 4 (Oral) (Crop Genetics and Physiology)

[O41-01] Physiological Traits to Breed for Yield Potential

○Matthew Reynolds, Gemma Molero, Carolina Rivera-Amado, Francisco Piñera-Chavez, Francisco Pinto, Margaret Krause, Liana Acevedo, Sivakumar Sukumaran （International Maize and Wheat Improvement Center, Mexico）
9:45 AM - 10:05 AM

[O41-02] A Challenge for the Improvement of Photosynthetic Capacity by the Introduction of C_4-Like Rubisco in Rice

○Hiroshi Fukayama[1], Keita Shiomi[1], Yuri Taketani[1], Hiroki Yoshikawa[2], Daisuke Sasayama[1], Tomoko Hatanaka[1], Tetsushi Azuma[1], Takuya Yoshizawa[2], Shun-Ichi Tanaka[2], Hiroyoshi Matsumura[2]
（1.Graduate School of Agricultural Science, Kobe University, Japan, 2.Department of Biotechnology, Ritsumeikan University, Japan）
10:05 AM - 10:25 AM

[O41-03] Predictive Modeling of Leaf Photosynthetic Rate in Field-Grown Rice Using Transcriptome Dataset

○Sotaro Honda[1], Satoshi Ohkubo[2], Makoto Kashima[3], Nan Su San[2], Anothai Nakkasame[2], Hiroki Saito[4], Taiichiro Ookawa[2], Atsushi J. Nagano[5], Shunsuke Adachi[6] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 3.College of Science and Engineering, Aoyama Gakuin University, Japan, 4.Japan International Research Center for Agricultural Sciences, Japan, 5.Faculty of Agriculture, Ryukoku University, Japan, 6.College of Agricuture, Ibaraki University, Japan）
10:25 AM - 10:40 AM

[O41-04] Natural Variation in Photosynthetic Induction Response in Rice (*Oryza sativa* L.)

○Kazuki Taniyoshi, Yu Tanaka, Tatsuhiko Shiraiwa （Graduate School of Agriculture, Kyoto University, Japan）
10:40 AM - 10:55 AM

[O41-05] Identification of QTLs for Strong Culm with Pleiotropic Effect on Panicle Morphology by GWAS Using Rice Varieties in Japan

○Tomohiro Nomura[1], Kenji Yano[2], Makoto Matsuoka[3], Ko Hirano[3], Shunsuke Adachi[4], Francisco Javier Piñera-Chavez[5], Matthew Paul Reynolds[5], Taiichiro Ookawa[1] （1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Statistical Genetics Team, RIKEN Center for Advanced Intelligence Project, Japan, 3.Bioscience and Biotechnology Center, Nagoya University, Japan, 4.College of Agriculture, Ibaraki University, Japan, 5.Global Wheat Program, International Maize and Wheat Improvement Center, Mexico）
10:55 AM - 11:10 AM

[O41-06] Highly Active *Vernonia galamensis* DGAT1 Can Effectively Increase Oil Levels in Yeast, Soybean and Arabidopsis

○Tomoko Hatanaka[1], Yoshiki Tomita[1], Choi-Wing Chau[1], Honoka Ito[2], Daisuke Sasayama[1], Hiroshi Fukayama[1], Tetsushi Azuma[1], David F. Hildebrand[3]
（1.Graduate School of Agricultural Science, Kobe University, Japan, 2.Faculty of Agriculture, Kobe University, Japan, 3.Department of Plant and Soil Sciences, University of Kentucky, United States）
11:10 AM - 11:25 AM

Oral sessions | Crop Genetics and Physiology | O42: Assimilate Partitioning for Crop Productivity and Quality

[O42] Assimilate Partitioning for Crop Productivity and Quality

Chair: Naohiro Aoki (The University of Tokyo, Japan)

Chair: Tatsuro Hirose (Takasaki University of Health and Welfare, Japan)
Chair: Yong-Ling Ruan (The University of Newcastle, Australia)
2:30 PM - 4:30 PM Room 4 (Oral) (Crop Genetics and Physiology)

[O42-01] Assimilate Partitioning in Crops: Developmental, Molecular, and Metabolic Aspects of Source-sink Interactions
○Yong-Ling Ruan (School of Environmental and Life Sciences, The University of Newcastle, Australia)
2:30 PM - 2:50 PM

[O42-02] Physiological Significance of an Alternative Step of Calvin-Benson Cycle in C_4 Photosynthesis in Mesophyll Cell Chloroplasts
○Tsuyoshi Furumoto (Ryukoku University, Japan)
2:50 PM - 3:10 PM

[O42-03] Co-Overproduction of Rubisco and Rubisco Activase Increases the Photosynthesis Rate under High Temperature in Rice
○Mao Suganami[1,2], Yuji Suzuki[3], Youshi Tazoe[1,4], Amane Makino[1] (1.Graduate School of Agricultural Science, Tohoku University, Japan, 2.Faculty of Food and Agricultural Sciences, Fukushima University, Japan, 3.Faculty of Agriculture, Iwate University, Japan, 4.Faculty of Agro-Food Science, Niigata Agro-Food University, Japan)
3:10 PM - 3:25 PM

[O42-04] What Factor Affects Genotypic Difference in Endophytic Nitrogen-fixing Ability in Rice?
○Takanori Okamoto[1], Rina Shinjo[1], Arisa Nishihara[2], Kazuma Uesaka[3], Aiko Tanaka[1], Daisuke Sugiura[1], Motohiko Kondo[1] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.Bioproduction Research Institute, National Institute of Advanced Industrial Science and Technology, Japan, 3.The Center for Gene Research, Nagoya University, Japan)
3:25 PM - 3:40 PM

[O42-05] Sink-Source Relationship in Short-duration and Hybrid Rice Varieties in Tropical Asia
○Phyo La Pyae Won[1], Noriko Kanno[2], Niño P. M. C. Banayo[3], Hongyan Liu[4], Crisanta S. Bueno[5], Pompe Sta. Cruz[6], Yoichiro Kato[7] (1.Department of Agronomy, Yezin Agricultural University, Myanmar, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.International Rice Research Institute, Philippines, 4.College of Tropical Crops, Hainan University, China, 5.International Rice Research Institute, Philippines, 6.College of Agriculture and Food Science, University of the Philippines Los Baños, Philippines, 7.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan)
3:40 PM - 3:55 PM

[O42-06] Genetic Modification of Non-structural Carbohydrate Composition in the Stem of Rice
○Naohiro Aoki[1], Tatsuro Hirose[2] (1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Faculty of Agriculture, Takasaki University of Health and Welfare, Japan)
3:55 PM - 4:10 PM

Oral sessions | Crop Genetics and Physiology | O43: High Quality Food and Ingredients

[O43] High Quality Food and Ingredients

Chair: Yoji Nitta (Fukushima University, Japan)
Chair: Akiko Fujita (Satake Corporation, Japan)
5:00 PM - 7:00 PM Room 4 (Oral) (Crop Genetics and Physiology)

[O43-01] How to Improve the Eating Quality of *Japonica* Rice in Jiangsu Province of China
○Cailin Wang, Yadong Zhang, Shu Yao, Zhen Zhu, Tao Chen, Qingyong Zhao, Lin Zhao, Lihui Zhou, Chunfang Zhao (Institute of Food Crops, Jiangsu Academy of Agricultural Sciences/Nanjing Branch of Chinese National Center for Rice Improvement/Jiangsu High Quality Rice R & D Center, China)
5:00 PM - 5:20 PM

[O43-02] The Conditional Chalky Grain Mutant *floury endosperm11-2* (*flo11-2*) of Rice (*Oryza sativa* L.) is Useful for Studies on Chalkiness
○Tomoyuki Katsube-Tanaka[1], Rehenuma Tabassum[1,3], Tokinori Dosaka[1], Hiroyuki Ichida[2], Ryouhei Morita[2], Yifan Ding[1], Tomoko Abe[2] (1.Graduate School of Agriculture, Kyoto University, Japan, 2.Nishina Center for Accelerator-Based Science, RIKEN, Japan, 3.Department of Crop Botany and Tea Production Technology, Sylhet Agricultural University, Bangladesh)

5:20 PM - 5:40 PM

[O43-03] Utilization of Image Analysis and Sensing Device Analysis for Evaluating Grain Quality of Cambodia Low Land Rice

○Srun Khema[1,2], Akiko Fujita[3], Kea Kong[1], Chhay Ngin[1], Ratana Neou[4], Koki Asano[2], Fitri Audia[2], Shuto Yamada[2], Mana Kano-Nakata[5], Akira Yamauchi[2], Toru Tashiro[5], Hiroshi Ehara[5,6]
（1.General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 3.Bioinnovation Research Office, Technical Division, Satake Corporation, Japan, 4.National Laboratory, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 5.International Center for Research and Education in Agriculture, Nagoya University, Japan, 6.Applied Social System Institute of Asia, Nagoya University, Japan）

5:40 PM - 5:55 PM

[O43-04] Recent Trend of Ultra-Fine Structure of High-Quality and -Palatable Rice in Japan

○Youji Nitta （Faculty of Food and Agricultural Sciences, Fukushima University, Japan）

5:55 PM - 6:10 PM

[O43-05] Effects of Packaging Materials and Storage Duration on Quality of Farm Saved Black Sesame (*Sesamum indicum* L.) in Central Dry Zone of Myanmar

○Nyein Htwe[1], Hnin Thida Nyo[2], Kyaw Win[3]
（1.Department of Agricultural Extension, Yezin Agricultural University, Myanmar, 2.Division of Planning, Department of Agriculture, Myanmar, 3.Rector's Office, Yezin Agricultural University, Myanmar）

6:10 PM - 6:25 PM

[O43-06] Deployment of Cooking and Eating Quality Models as a Novel Breeding Tool to Predict Texture and Premium Grain Quality Segments

Reuben James Q. Buenafe [1,2], Vasudev Kumanduri [1,3],○Nese Sreenivasulu[1] （ 1. Grain Quality and Nutrition Center, International Rice Research Institute, Philippines, 2. School of Chemical, Biological, Materials Engineering and Sciences, Mapua University, Philippines, 3. Piatrika Biosystems, United Kingdom）

6:25 PM - 6:40 PM

[O43-07] Agricultural Innovation for Improved Human Nutrition and Health

○Russell Reinke[1], Raul Boncodin[1], Mallikarjuna Swamy[1], Reynante Ordonio[2], Md Abdul Kader[3] （1. International Rice Research Institute, Philippines, 2. Philippine Rice Research Institute, Philippines, 3. Bangladesh Rice Research Institute, Bangladesh）

6:40 PM - 6:55 PM

Fri. Sep 10, 2021

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

[O11] Direct-seeded Rice in Asia-Oceania Region

Chair: Yoichiro Kato (The University of Tokyo, Japan)
Chair: Virender Kumar (International Rice Research Institute, Philippines)
Thu. Sep 9, 2021 9:45 AM - 11:45 AM Room 1 (Oral) (Field Crop Production)

[O11-01] Direct-Seeded Rice for Economic and Environmental Sustainability of Rice in Asia: Overview

○Virender Kumar[1], Yoichiro Kato[2], Sudhanshu Singh[3] (1.Sustainable Impact Platform, International Rice Research Institute, Philippines, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Sustainable Impact Platform, International Rice Research Institute, India)

9:45 AM - 10:05 AM

[O11-02] Improvements in Abiotic Stress Tolerance Required for Drill Seeded Aerobic Rice Production

○Jaquie H Mitchell[1], Chris D Proud[1], Brian Dunn[2], Peter Snell[2], Shu Fukai[1] (1.School of Agriculture and Food Sciences, The University of Queensland, Australia, 2.Department of Primary Industries, Yanco Agricultural Institute, Australia)

10:05 AM - 10:25 AM

[O11-03] Research and Development of Direct-Seeded Rice in China

○Shaobing Peng (College of Plant Science and Technology, Huazhong Agricultural University, China)

10:25 AM - 10:40 AM

[O11-04] Direct Seeded Rice to Achieve Sustainable Production in South Asia

○Sudhanshu Singh[1], Yoichiro Kato[2], Virender Kumar[3] (1.Sustainable Impact Platform, International Rice Research Institute, India, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Sustainable Impact Platform, International Rice Research Institute, Philippines)

10:40 AM - 10:55 AM

[O11-05] Marker-Assisted Breeding for Improving Seedling Establishment under Flooded Conditions in Direct-Seeded Rice

○Kazuhiro Sasaki[1,2], Takuya Yamaguchi[3], Yoichiro Kato[2] (1.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Toyama Prefectural Agricultural, Forestry & Fisheries Research Center, Japan)

10:55 AM - 11:10 AM

[O11-06] Mechanized Dry Direct Seeding: A Technology for Improving Rice Productivity and Increasing Production Efficiency of Rainfed Lowlands in the Philippines

○Pompe Campoy Sta Cruz[1], Crisanta Sunio Bueno[2], Nino Paul Meynard Calalo Banayo[3], Ruth Agbisit[4], Roel Suralta[5], John Eric Abon[6], Aurora Corales[7], Elmer Bautista[8], Yoichiro Kato[9] (1.Crop Physiology, University of the Philippines Los Baños, Philippines, 2.Crop Physiology, University of the Philippines Los Baños, Philippines, 3.Crop Physiology, University of the Philippines Los Baños, Philippines, 4.Crop Physiology, University of the Philippines Los Baños, Philippines, 5.Crop Biotech Center, Philippine Rice Research Institute, Philippines, 6.Rice

Mechanization Division, Philippine Rice Research Institute, Philippines, 7.Technology Management Division, Philippine Rice Research Institute, Philippines, 8.Rice Mechanization Division, Philippine Rice Research Institute, Philippines, 9.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）
11:10 AM - 11:25 AM

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

[O11-01] Direct-Seeded Rice for Economic and Environmental Sustainability of Rice in Asia: Overview

(Invited Speaker)

○Virender Kumar[1], Yoichiro Kato[2], Sudhanshu Singh[3] (1.Sustainable Impact Platform, International Rice Research Institute, Philippines, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Sustainable Impact Platform, International Rice Research Institute, India)

In Asia, there is increased interest to shift from puddled transplanted rice (PTR) to direct-seeded rice (DSR) to improve the economic and environmental sustainability of rice farmers as DSR saves labor and water, cultivation cost, and reduces greenhouse gas emissions. DSR is widely practiced in many Asian countries such as Malaysia, Sri Lanka, Vietnam, Thailand, Cambodia, etc. Many countries including South Asia are going through the transition from PTR to DSR. Despite multiple benefits, there are few risks associated with DSR which limit its wide-scale adoption and attainment of optimal grain yields in DSR. These risks include poor crop establishment, higher weed infestation leading to the risk of higher yield losses, limited knowledge on precision water and nutrient management, and lack of suitable cultivars bred for DSR conditions. Many current agronomic practices are very inefficient and large scope exists to improve efficiency and sustainability of DSR through precision crop and resource management practices. Moreover, many weed-related issues have emerged in courtiers where DSR is widely grown including shift in weed flora toward difficult-to-control weeds including evolution of weedy rice; and increased dependence on herbicides leading to a risk of evolution of herbicide resistance in weeds. To address these DSR issues and to develop and catalyze the wide-scale adoption of mechanized and precise sustainable DSR systems in Asia, IRRI established a new public-private multi-stakeholders R4D platform known as 'DSR Consortium (DSRC)' which will be discussed in details.

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

[O11-02] Improvements in Abiotic Stress Tolerance Required for Drill Seeded Aerobic Rice Production

(Invited Speaker)

○Jaquie H Mitchell[1], Chris D Proud[1], Brian Dunn[2], Peter Snell[2], Shu Fukai[1] (1.School of Agriculture and Food Sciences, The University of Queensland, Australia, 2.Department of Primary Industries, Yanco Agricultural Institute, Australia)

Traditionally, the temperate Australian rice production system is reliant on permanent water. Largely as a water productivity measure, there has been a shift in establishment to drill seeded technique. However, with recent droughts and increasing irrigation costs, adaptation to aerobic growing conditions has been considered. The potential for water saving with an aerobic, drill seeded system is high, however it is only an emerging system and varieties have not been developed for southern Australia. For successful aerobic production, potential donor varieties adapted to both low- and high-temperature and aerobic conditions, need to be identified.
In temperate growing areas, rice often suffers severe low-temperature damage (<19º C), and varieties need to be tolerant, particularly from panicle initiation to anthesis. Under aerobic conditions, where the crop will be exposed to greater temperature extremes and intermittent water deficit, tolerance becomes critical. With phenotypic screening for low-temperature tolerance at the booting and flowering stages,

genotypes were identified that were more tolerant than Sherpa, the current Australian cold tolerant variety. Results indicated the importance of anther dehiscence in contributing to low-temperature tolerance. Recent work focused on root morphology to explore aerobic adaptation, specifically in relation to root cone angle, rooting depth and the relationship with maintenance of crop transpiration and grain yield under aerobic conditions. The above will be discussed in the context of an aerobic, drill seeded cropping system.

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

[O11-03] Research and Development of Direct-Seeded Rice in China

(Invited Speaker)

○Shaobing Peng （College of Plant Science and Technology, Huazhong Agricultural University, China）

As labor scarcity for rice production is intensifying in China, a major shift in rice establishment is happening from seedling transplanting to direct seeding. As result, the planting area of direct-seeded rice (DSR) has increased from 1.5 to 9.2 million hectares from 2008 to 2018, which corresponded to an increase in the percentage of DSR to the national rice planting area from 8% to 30% over the same period. This expansion of DSR mainly occurred for the middle-season rice in Middle and Lower Reaches of the Yangtze River (MLYR). There is still room for the further expansion of DSR in MLYR because double-season rice in this region is usually transplanted due to limited thermal time. To shift from transplanting to direct seeding for double-season rice in MLYR, varieties with ultra-short duration (approximately 95 d in both early and late seasons) are needed. In the past eight years, we evaluated varieties with ultra-short duration and identified 6 parents for developing new varieties with ultra-short duration for direct-seeded, double-season rice in MLYR. The entire procedures of crossing and selection were conducted under DSR conditions through a shuttle breeding between Hubei and Hainan Island. New varieties with desirable traits became available in 2019 for agronomic evaluation. In 2021, we have started on-farm evaluation on these materials. The overall performance of these new varieties and the feedback from the farmers will be discussed in the presentation.

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

[O11-04] Direct Seeded Rice to Achieve Sustainable Production in South Asia

(Invited Speaker)

○Sudhanshu Singh[1], Yoichiro Kato[2], Virender Kumar[3] （1.Sustainable Impact Platform, International Rice Research Institute, India, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Sustainable Impact Platform, International Rice Research Institute, Philippines）

About 70% of rice in South Asia is grown with intensive tillage/puddling followed by manual transplanting, which is labor, water, capital, and energy-intensive method. Direct seeded rice (DSR) is an alternative establishment practice that facilitates timely establishment for sustaining the productivity of rice-based systems. The rising labor cost, increasing availability of effective herbicides, scale-appropriate machinery and short-duration high-yielding varieties favor for broader adoption of DSR in South Asia. DSR is being adopted from irrigated to rainfed lowland and upland ecologies with associated

benefits through reduced labor costs, less drudgery, water and energy savings besides significant decease in GHG emission. Availability of seed-cum-fertilizer drills fitted with inclined plate seed metering mechanism (capable of handling low seed rates along with fertilizers in one go) has caught the interest of the farmers towards dry-direct seeding. Similarly, newly developed seeding machinery like Bokto seeder, Eli seeder and drum seeder are also attracting the farmers to opt for DSR in wet ecologies. Overall economic profitability and reduced environmental footprints are now well-realized benefits and impacts of DSR. However, weed management in DSR is still the major challenge and warrants for integrated management strategies, including herbicides, competitive varieties, laser land levelling, line sowing, residue mulching, mechanical weeding, water management, etc. for achieving higher yields, economic profitability, and reduced environmental footprints.

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

[O11-05] Marker-Assisted Breeding for Improving Seedling Establishment under Flooded Conditions in Direct-Seeded Rice

(Invited Speaker)

○Kazuhiro Sasaki[1,2], Takuya Yamaguchi[3], Yoichiro Kato[2] (1.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Toyama Prefectural Agricultural, Forestry & Fisheries Research Center, Japan)

Direct-seeded rice helps meet the challenges caused by water and labor shortages, and time and cropping area conflicts. Here, we discuss our discoveries of two quantitative trait loci (QTLs) in studies aimed at improving seedling establishment under flooded conditions in direct-seeded rice. Low oxygen concentrations in flooded paddy fields cause poor seedling establishment in direct-seeded rice. *qACE3.1* is a novel QTL for coleoptile elongation under anaerobic conditions that we detected on chromosome 3 of a chromosome segment substitution line substituted with Koshihikari in the IR64 genetic background. Subsequent examination of the expression levels of genes encoding enzymes involved in starch degradation and fermentation revealed that *qACE3.1* may be involved in fermentative metabolism. In high-latitude areas in East Asia, rice seedling establishment is inhibited by low temperatures and anaerobic stress. *qESS11* is a novel QTL for seedling establishment in soil at low temperatures that we detected on chromosome 11 in a cross between Koshihikari and Awa-akamai. Although introduction of *qESS11* into a near-isogenic line improved seedling establishment in soil at low temperatures, pre-harvest sprouting was observed and grain productivity and quality were reduced. The pre-harvest sprouting was addressed by introducing QTLs for seed dormancy into the near-isogenic line. Thus, by using a gene pyramiding strategy and molecular markers, we have successfully developed breeding materials with improved seedling establishment in direct-seeded rice.

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

[O11-06] Mechanized Dry Direct Seeding: A Technology for Improving Rice Productivity and Increasing Production Efficiency of

Rainfed Lowlands in the Philippines

(Invited Speaker)
○Pompe Campoy Sta Cruz[1], Crisanta Sunio Bueno[2], Nino Paul Meynard Calalo Banayo[3], Ruth Agbisit[4], Roel Suralta[5], John Eric Abon[6], Aurora Corales[7], Elmer Bautista[8], Yoichiro Kato[9] (1.Crop Physiology, University of the Philippines Los Baños, Philippines, 2.Crop Physiology, University of the Philippines Los Baños, Philippines, 3.Crop Physiology, University of the Philippines Los Baños, Philippines, 4.Crop Physiology, University of the Philippines Los Baños, Philippines, 5.Crop Biotech Center, Philippine Rice Research Institute, Philippines, 6.Rice Mechanization Division, Philippine Rice Research Institute, Philippines, 7.Technology Management Division, Philippine Rice Research Institute, Philippines, 8.Rice Mechanization Division, Philippine Rice Research Institute, Philippines, 9.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan)

Dry direct seeding of rice (DDSR) is an adaptive practice of rainfed farmers in the Philippines to cope with insufficient rainfall that cannot support the conventional transplanting of rice. Currently, DDSR is done by manual broadcasting, furrow seeding or dibbling. Such practices entail high labor cost, and in most cases uneven crop growth and stand, which is translated to low grain yield. As of 2019, Philippine annual rice yield in rainfed lowlands is relatively lower (3.13 t ha^{-1}) than irrigated (4.43 t ha^{-1}) areas. Hence, the need for strategic R & D to improve the rice productivity and production efficiency in such fragile environment. The Department of Agriculture has prioritized investments in enhancing R & D towards improving rice productivity, which includes the rainfed environments. In line with this, a Multi-Purpose Seeder, adapted to small areas with DDSR cultural package such as, improved crop establishment, appropriate variety, and nutrient management, was evaluated and compared to farmers' practices. Evaluation and verification trials were conducted in three provinces in 2017, six provinces in 2018, and 16 provinces in 2019. Using Multi-Purpose Seeder, the amount of rice seed used for crop establishment was optimized at 60 kg ha^{-1}, a significant reduction based on current farmers' seeding rate of up to 240 kg ha^{-1}. With the use of Multi-Purpose Seeder coupled with DDSR cultural package, crop establishment cost (labor & seed) was reduced from trials conducted in 2017, 2018 and 2019. In addition to rice crop, DDSR mechanized packages for corn and mungbean are being generated to optimize crop productivity per unit land area.

[O12] Concepts, Prospects, and Potentiality of Crop Production in East Asia

*Sponsored by the Korean Society of Crop Science
Chair: Sang-In Shim (Gyeongsang National University, Korea)
Chair: Takeo Sakaigaichi (Kyushu Okinawa Agricultural Research Center, National Agriculture and Food Research Organization, Japan)
Chair: Hiroshi Ehara (Nagoya University, Japan)
Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 1 (Oral) (Field Crop Production)

[O12-01] Yield Performance of Recent Breeding Lines of Sweetpotato Developed for Direct Planting in Japan

○Takeo Sakaigaichi, Yumi Kai, Akira Kobayashi, Keisuke Suematsu （Division of Upland Farming Research, Kyushu Okinawa Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

2:30 PM - 2:50 PM

[O12-02] Nationwide Evaluation and Development of Direct Seeding Technology of Rice with Iron-Coated Seeds in Japanese Fields

○Minoru Yamauchi[1,3], Masaki Sugimura[2], Takashi Shiomi[2] （1.Crop Production Division, National Federation of Agricultural Cooperative Associations (Zen-Noh), Japan, 2.Agribusiness General Planning Division, Zen-Noh, Japan, 3.Presently, Consultant, Zen-Noh, Japan）

2:50 PM - 3:10 PM

[O12-03] Feed and Pasture Management Practices of Dairy Farms in Nay Pyi Taw, Myanmar

○Aye Aye Khaing, Ei Thandar Ko, Hla Than （Department of Agronomy, Yezin Agricultural University, Myanmar）

3:10 PM - 3:25 PM

[O12-04] International Differential System for Resistance in Rice Cultivars and Blast Race

○Yoshimichi Fukuta （Research Planning and Partnership Division, Japan International Research Center for Agricultural Sciences, Japan）

3:25 PM - 3:40 PM

[O12-05] Varietal Differences in Photosynthetic Characteristics, Yield and Water Use Efficiency of Rice under Drip Irrigation with Plastic Film Mulch

○Junfa Wang[1], Fawibe Olamide Oluwasegun[1], Haruki Higashi[2], Kodai Yamamoto[2], Akihiro Isoda[1] （1.Graduate School of Horticulture, Chiba University, Japan, 2.Faculty of Horticulture, Chiba University, Japan）

3:40 PM - 3:55 PM

[O12-06] Physiological and Proteome Analysis in *Brassica napus* L. of Leaves in Response to Copper Stress and Citric-Acid Application

○Yong-Hwan Ju[1], Ju Young Choi[1], Swapan Kumar Roy[1], Soo Jeong Kwon[1], Kwang Soo Kim[2], Sun Hee Woo[1] （1.Dept of Crop Science, Chungbuk National University, Korea, 2.Bio-Energy Plant Research Center, National Institute of Crop Science, Korea）

3:55 PM - 4:10 PM

[O12-07] Improvement of Wheat Quality for End-use Quality in Korean Wheat Breeding Program: *Glu-B1al* and Glu-D1y12.K

○[1] Seong-Woo Cho[1], Chul Soo Park[2] （1 Department of Smart Agro-Industry, Gyeongsang National University, Korea, 2 Department of Crop Science and Biotechnology, Jeonbuk National University, Korea）

4:10 PM - 4:25 PM

2:30 PM - 2:50 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 1 (Oral))

[O12-01] Yield Performance of Recent Breeding Lines of Sweetpotato Developed for Direct Planting in Japan

○Takeo Sakaigaichi, Yumi Kai, Akira Kobayashi, Keisuke Suematsu (Division of Upland Farming Research, Kyushu Okinawa Agricultural Research Center, National Agriculture and Food Research Organization, Japan)

Sweetpotato is an important carbohydrate crop in Japan. In general, sweetpotato crops are propagated using stem cuttings. According to the statistical data in 2018, working hours from preparation of stem cuttings to transplanting occupy over one third of the total. To establish a labor-saving cultivation system, we have studied "direct planting" in which small storage roots are planted instead of stem cuttings. In direct planting, we can see "mother root" and newly produced "daughter root" at harvest. Compared with daughter root, mother root has lower quality as processed food material. Therefore it is necessary to breed cultivars with small enlargement of mother root and high yield of daughter root for the extension of direct planting. In this study, yield performances of recent breeding lines, "Kyushu No.198" and "Kyushu No.199", were compared with a standard cultivar of direct planting, "Suzukogane". We carried out a field experiment in two years. Storage roots were planted in March and yield performances including mother root enlargement were investigated in August. Partitioning index which was calculated from both mother and daughter root yield indicated that both of two lines showed smaller enlargement of mother root. In addition, their yields of daughter root were significantly higher than that of "Suzukogane". These results indicate it is possible to enhance the present yielding level of daughter root through breeding. We appreciate the Project of the Bio-oriented Technology Research Advancement Institution, NARO for their financial support.

2:50 PM - 3:10 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 1 (Oral))

[O12-02] Nationwide Evaluation and Development of Direct Seeding Technology of Rice with Iron-Coated Seeds in Japanese Fields

○Minoru Yamauchi[1,3], Masaki Sugimura[2], Takashi Shiomi[2] (1.Crop Production Division, National Federation of Agricultural Cooperative Associations (Zen-Noh), Japan, 2.Agribusiness General Planning Division, Zen-Noh, Japan, 3.Presently, Consultant, Zen-Noh, Japan)

Water seeding (seeding onto a flooded soil) is advantageous over wet seeding (seeding after draining the puddled soil) in saving water and suppressing weeds. However, water seeding is rarely practiced in Asia because seeds are buoyant and float after puddling. Iron-coated seeds were invented to make water seeding feasible through increased seed density. This study aims to evaluate and improve direct seeding with Fe-coated seeds in fields to disseminate this technology nationwide. The study was conducted from 2008 to 2019 in 260 fields. Crop establishment was successful when farmers drained the fields after seeding at the coleoptile or 1st leaf emergence. However, uniform drainage of puddled fields requires time, leading to uneven seedling growth and preventing timely herbicide application. We recommended the installation of an open ditch to facilitate drainage. Drainage duration after seeding should be reduced when the temperature is below 17℃. The regression curve of grain yield versus seed rate demonstrated that grain yield is equivalent to the transplanted rice at the seed rate of 40-50 kg/ha.

The cost analysis clarified that working time during the planting season is reduced by 30% compared to that of transplanting and that the material cost was slightly decreased due to the increase in the number of herbicides used. The Fe-coated seeds performed well even in non-puddled soil. As of 2019, Fe-coated seeds were popular for direct seeding of Japan. We propose 5 guidelines oriented for sustainable direct seeding with high grain yield.

3:10 PM - 3:25 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 1 (Oral))

[O12-03] Feed and Pasture Management Practices of Dairy Farms in Nay Pyi Taw, Myanmar

○Aye Aye Khaing, Ei Thandar Ko, Hla Than （Department of Agronomy, Yezin Agricultural University, Myanmar）

Myanmar has potential for the development of livestock sector, particularly in dairy sector. Pasture enables the farmers to reduce the cost of producing milk through better forage and its quality. However, most of the dairy farms do not get the awareness on the role of pasture in dairy farming, and no information on pasture is documented in Myanmar. The milk is primarily produced in Mandalay region, Yangon region, and around the capital Naypyitaw. The study was carried out to observe feed and pasture management systems of dairy farms in Nay Pyi Taw. A total of twenty dairy farms including almost all of the middle scale dairy farms around Nay Pyi Taw area were surveyed in 2018 to observe the feed and pasture management practices in the farms. The dairy farms relied on agricultural by-products and feed concentrates. Agricultural by-products were purchased and stored in advance in the farms to overcome feed shortage during the dry period. Most of the farms used more concentrate ratio in the feed ration. Roughage-concentrate ratio should be adjusted with improved quality pasture to reduce feed cost in the farms. Although pasture was grown in a few farms, it was cultivated in small area with poor agronomic practices. Fodder scarcity is one of the major constraints, and limitations for pasture cultivation in the farms were lack of access to improved pasture varieties, poor knowledge on pasture cultivation, and water scarcity. Feed availability and quality should be improved by using improved pasture cultivars with suitable agronomic practices.

3:25 PM - 3:40 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 1 (Oral))

[O12-04] International Differential System for Resistance in Rice Cultivars and Blast Race

○Yoshimichi Fukuta （Research Planning and Partnership Division, Japan International Research Center for Agricultural Sciences, Japan）

To establish this protection system against blast disease, JIRCAS has conducted research in an international network for developing and distributing the differential system in Asian and African regions. Under the network, blast isolates and rice germplasm were collected. The pathogenicity of blast isolates using international differential varieties (DVs) and genetic variation of resistance in resistant rice cultivars were clarified. One of the network's research achievements was the clarification of the wide variations in blast races. The frequency of blast isolates virulent to DVs was clarified in each country and region and at the global level. Particularly, high frequencies of wide-spectrum blast isolate

virulence to DVs were found in Bangladesh and West Africa. Furthermore, the highest diversities of blast races were found from Yunnan province, China, to Bangladesh. The diversities of blast races were corresponded with the those of resistance in rice cultivars. The relationships between blast races and rice varieties are explained by the gene-for-gene theory. The information and application of differential system will contribute to the development of a durable protection system and for harmonizing agriculture with environment.

3:40 PM - 3:55 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 1 (Oral))

[O12-05] Varietal Differences in Photosynthetic Characteristics, Yield and Water Use Efficiency of Rice under Drip Irrigation with Plastic Film Mulch

*Nominated for Presentation Awards

○Junfa Wang[1], Fawibe Olamide Oluwasegun[1], Haruki Higashi[2], Kodai Yamamoto[2], Akihiro Isoda[1]
（1.Graduate School of Horticulture, Chiba University, Japan, 2.Faculty of Horticulture, Chiba University, Japan）

Drip irrigation system with plastic film mulch (DI) is a technology which inevitable in the wake of severe water shortage in rice-growing regions of the world. The objective of this study was to characterize the yield performance, photosynthetic characteristics and water productivity of 9 rice cultivars (3 upland cultivars, 2 F1 hybrid cultivars, 4 paddy cultivars) grown in continuous flooding (CF) and drip irrigation with plastic film mulch (DI) systems in 2 years experiment. The average grain yield of cultivars under the DI was not different compared with those under CF. However, the high number of spikelet per m^2 produced under DI compared with CF was offset by the difference in grain weight and ripening ratio caused by the irrigation system. Stomatal conductance, transpiration rate, actual and maximum quantum yield of photosystemII of the 9 cultivars were statistically non-significant under CF and DI in both years. The total water input (irrigation and rainfall) and irrigation under DI were 35%, 60% lower than of CF, respectively. Our results showed that DI had a great water-saving capacity and the average grain yield of cultivars under the DI was not significantly different compared with those under CF. Among the yield components, the high number of spikelets per m2 was responsible for the comparable yield obtained under DI in relation to CF. Moreover, upland cultivars with its moderate values seem to be the better choice for DI.

3:55 PM - 4:10 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 1 (Oral))

[O12-06] Physiological and Proteome Analysis in *Brassica napus* L. of Leaves in Response to Copper Stress and Citric-Acid Application

*Nominated for Presentation Awards

○Yong-Hwan Ju[1], Ju Young Choi[1], Swapan Kumar Roy[1], Soo Jeong Kwon[1], Kwang Soo Kim[2], Sun Hee Woo[1]
（1.Dept of Crop Science, Chungbuk National University, Korea, 2.Bio-Energy Plant Research Center, National Institute of Crop Science, Korea）

Copper (Cu) is one of the essential nutrients but excess Cu induces phytotoxicity, leading to inhibit plant growth characteristics. This study aimed to invest the proteome changes of *Brassica napus* L. under Cu stress and Citric-acid (CA) application over 7 days. The 21-days-old seedlings were exposed to different concentrations of Cu (25 and 50μ M $CuSO_4$) and CA (1.0 mM). Results showed that the fresh and dry weights of Cu + CA treated seedlings were higher than those of the Cu treated seedlings. The application of CA further enhanced the activities of antioxidant enzymes as compared with their respective Cu-only treatment. Using the gel-free proteome approach, a total of 1473 proteins were successfully identified in *B. napus* seedlings. Of these, 67 proteins were identified only in Brassica species, whereas 36 proteins identified from *B. napus* that were classified as differentially abundant proteins (DAPs). Among the 36 proteins, a total of 21 proteins were upregulated and 15 proteins were downregulated Cu stress and CA application treated. To understand molecular functions and biological processes involved in *B. napus* response to Cu stress, Gene Ontology analysis was performed whereas the most of the DAPs were annotated to protein metabolism, fatty acid biosynthetic process, TCA cycle, carbon fixation, photorespiration, fructose catabolic process and glyoxylate cycle. Taken together, this study may provide new insights into the molecular mechanisms of plant response to Cu stress, and CA application may alleviate the stress symptoms.

4:10 PM - 4:25 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 1 (Oral))

[O12-07] Improvement of Wheat Quality for End-use Quality in Korean Wheat Breeding Program: *Glu-B1al* and Glu-D1y12.K

○[1]Seong-Woo Cho[1], Chul Soo Park[2] (1 Department of Smart Agro-Industry, Gyeongsang National University, Korea, 2 Department of Crop Science and Biotechnology, Jeonbuk National University, Korea)

Wheat glutenin contributes to improve end-use quality, especially quality of bread. The objectives of this study were to identify high molecular weight molecular glutenin subunits (HMW-GSs) of Korean wheat landrace and to demonstrate genetic characteristics of *Glu-B1al* and Glu-D1y12.K as a novel y-type in HMW-GS. 310 wheat accessions and F_9 populations, derived from a Keumkang/Chinese Spring cross were used to screen genetic resources for improvement of bread-making quality. It was verified that Korean wheat landrace had *Glu-B1al* ($Bx7^{OE}$ + By8) among wheat accessions. As a result of RP-HPLC, the proportion of the Bx7 subunit in IT166460 (56.17 ± 0.22%.) was higher than that of CS (34.75 ± 1.03%) and Glenlea (46.25 ± 1.76%). Furthermore, the peak height of IT166460 (~30 mAU) was higher than that of CS (~200 mAU) and Glenlea (~580 mAU). In the F_9 population, a novel HMW-GS was found, and this novel HMW-GS showed faster electrophoretic mobility and lower molecular weight than Dy12 HMW-GS. It was designated as Glu-D1y12.K. In the future, it will be important to evaluate the quality of bread made with wheat from the wheat lines from a crossing between IT166460 and elite Korean wheat cultivars and to evaluate the effect of Glu-D1y12.K subunit on the dough rheology and bread-making quality.

[O13] Current Issues on Tropical Crops

*Sponsored by the Japanese Society for Tropical Agriculture / The Society of Sago Palm Studies
Chair: Hiroshi Ehara (Nagoya University, Japan)
Chair: Hitoshi Naito (Kurashiki University of Science and The Arts, Japan)
Chair: Rosa Rolle (Food and Agriculture Organization of the United Nations, Italy)
Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 1 (Oral) (Field Crop Production)

[O13-01] Expression and Insecticidal Characterization of Cry8Db Protein against *Lepidiota signata* Fabricius

P. T. T. Hien[1,2], H. T. Thuong[1], L. T. Ngoc[1], ○H. S. Nguyen[3], C. H. Ha[1], T. D. Khanh[4], P. B. Ngoc[1]
（1.Institute of Biotechnology, Vietnam Academy of Science and Technology, Vietnam, 2.Hanoi Pedagogical University, Vietnam, 3.Vietnamese Academy of Agricultural Science, Hanoi, Vietnam, 4.Agricultural Genetics Institute, Vietnam National University of Agriculture, Hanoi, Vietnam）
5:00 PM - 5:20 PM

[O13-02] Growth Responses of Manno Sago Seed to Organic and NPK Fertilizers Application

○Yulius Barra Pasolon[1], Marselinus Sulu[2], Asniwati Asniwati[3], Muhidin Muhidin[4], Hitoshi Naito[5], Hiroshi Ehara[6] （1.Department of Soil Science, Faculty of Agriculture, Halu Oleo University, Indonesia, 2.International Office, Halu Oleo University, Indonesia, 3.Post Graduate Program, Halu Oleo University, Indonesia, 4.Department of Agronomy, Faculty of Agriculture, Halu Oleo University, Indonesia, 5.College of Life Science, Kurashiki University of Science and The Arts, Japan, 6.International Center for Research and Education in Agriculture, Nagoya University, Japan）
5:20 PM - 5:40 PM

[O13-03] Agronomic Practices of Oil Palm Smallholders towards Sustainable Development Goal 12

○Margaret Chan Kit Yok[1], Suriana Baki[1], Seraphina Anak Dominic Gisong[2], Siraj Munir Bin Mohammad[1] （1.Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA Sarawak Branch, Malaysia, 2.Kumpulan Kelestarian Aras 2, Wisma FELCRA, Malaysia）
5:40 PM - 5:55 PM

[O13-04] A Survey on Home Garden Horticultural Crops in Two Selected Areas in Myanmar

○Thanda Aung （Department of Horticulture, Yezin Agricultural University, Myanmar）
5:55 PM - 6:10 PM

[O13-05] Agro-economic Evaluation of Fertilizer Management for Wet Season Rice in Southern Cambodia

○Kea Kong[1], Yoichiro Kato[2], Sarom Men[3], Vang Seng[1], Akira Yamauchi[4], Mayumi Kikuta[5], Il-Ryong Choi[6], Hiroshi Ehara[7, 8] （1.General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 2.Institute for Sustainable Agro-ecosystem Services, The University of Tokyo, Japan, 3.Royal University of Agriculture, Cambodia, 4.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 5.Graduate School of Integrated Sciences for Life, Hiroshima University, Japan, 6.International Rice Research Institute - Korea Office, Korea, 7. Applied Social System Institute of Asia, Nagoya

University, Japan, 8.International Center for Research and Education in Agriculture, Nagoya University, Japan）

6:10 PM - 6:25 PM

[O13-06] The Abundance and Diversity of Arbuscular Mycorrhizal Fungi Colonized in Roots of Sago Palm in Mineral Soil and Shallow Peat Soil

○Koki Asano[1,2], Willy Vincent Anak Kagong[3], Siraj Munir Bin Mohammad[3], Kurumi Sakazaki[4], Margaret Chan Kit Yok[3], Toshiyuki Isoi[4], Mana Kano-Nakata[5], Hiroshi Ehara[5,6] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.Faculty of Agriculture, Kasetsart University, Thailand, 3.Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA Sarawak Branch, Malaysia, 4.Faculty of Agriculture, Meijo University, Japan, 5.International Center for Research and Education in Agriculture, Nagoya University, Japan, 6.Applied Social System Institute of Asia, Nagoya University, Japan）

6:25 PM - 6:40 PM

[O13-07] The Effect of Nitrogen and Phosphorus Applications on Rice Yield Can Be Changed by Farmers' Management Practices — Transplanting Dates and Densities—

○Bruce Haja Andrianary[1], Yasuhiro Tsujimoto[2], Hobimiarantsoa Rakotonindrina[1], Michel Rabenarivo[1], Herintsitohaina Razakamanarivo[1] （1.Laboratoire des Radioisotopes, University of Antananarivo, Madagascar, 2.Japan International Research Center for Agricultural Sciences, Japan）

6:40 PM - 6:55 PM

5:00 PM - 5:20 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 1 (Oral))

[O13-01] Expression and Insecticidal Characterization of Cry8Db Protein against *Lepidiota signata* Fabricius

(Invited Speaker)

P. T. T. Hien[1,2], H. T. Thuong[1], L. T. Ngoc[1], ○H. S. Nguyen[3], C. H. Ha[1], T. D. Khanh[4], P. B. Ngoc[1] (1.Institute of Biotechnology, Vietnam Academy of Science and Technology, Vietnam, 2.Hanoi Pedagogical University, Vietnam, 3.Vietnamese Academy of Agricultural Science, Hanoi, Vietnam, 4.Agricultural Genetics Institute, Vietnam National University of Agriculture, Hanoi, Vietnam)

Bacillus thuringiensis (Bt) is a ubiquitous Gram-positive bacterium that can produce different insecticidal proteins during the sporulation phase growth. The objective of this study was to examine the expression, including the effects of induction temperature, time and IPTG concentrations as well as investigate insecticidal activity of Cry8Db protein against *Lepidiota signata* Fabricious. The results showed that the cry8Db gene was expressed in Rosetta-gamy Escherichia coli strain at optimal temperature 28℃, 100 μ M IPTG and for 4 h induction. SDS-PAGE and Western blot were applied to confirm the normal expression and transcription of the cry8Db gene which produced the polypeptide with a molecular mass of 73 kDa. Three stages of *Lepidiota signata* Fabricius larvae were examined in the bioassay to investigate their survival after 15 days. The protein exhibited high toxicity against *Lepidiota signata* Fabriciusin the three different larvae stages at the lowest mean lethal concentration of LC50 =183.7 ng/mL, 270.8 ng/mL and 345.5 ng/mL, respectively. This is the first report demonstrating Cry8Db protein against *Lepidiota signata* Fabricius larvae. The Cry8Db protein may become a potential environmentally friendly marker for the biological management of *Lepidiota signata* Fabricius.

5:20 PM - 5:40 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 1 (Oral))

[O13-02] Growth Responses of Manno Sago Seed to Organic and NPK Fertilizers Application

(Invited Speaker)

○Yulius Barra Pasolon[1], Marselinus Sulu[2], Asniwati Asniwati[3], Muhidin Muhidin[4], Hitoshi Naito[5], Hiroshi Ehara[6] (1.Department of Soil Science, Faculty of Agriculture, Halu Oleo University, Indonesia, 2.International Office, Halu Oleo University, Indonesia, 3.Post Graduate Program, Halu Oleo University, Indonesia, 4.Department of Agronomy, Faculty of Agriculture, Halu Oleo University, Indonesia, 5.College of Life Science, Kurashiki University of Science and The Arts, Japan, 6.International Center for Research and Education in Agriculture, Nagoya University, Japan)

Abstract

Seeds of Manno type sago (*Metroxylon sagu* Rottb.) originated from Sentani, Jaya Pura Regency, Province of Papau, were cultivated in nursery for 9 months and then transplanted at intervals of 7 m x 7 m in Halu Oleo University's Farm in July 2012 under Collaboration: Ministry of Agriculture, Forest and Fisheries of Japan, Kochi University and Halu Oleo University. Multi-organic fertilizer (MOF) at the rate of 0, 20 and 40 kg/clump was mixed with 0 or 1 kg/clump NPK fertilizer. This mixed fertilizer was applied in a circle into 15 cm depth at 100 cm from sago clump, respectively five years after planting. Application of 1 kg NPK/clump showed quickly responses on the plant high, chlorophyll content (SPAD), leaflet number and dry matter weight. The influence of MOF was observed after 6 to 12 months later on the growth and dry

matter weight of leaflet. These results concluded that Manno type sago risen from seed grew perfectly in a new agro-climate, and 82 % of clumps produced an over 50cm long trunk in 6 years.

5:40 PM - 5:55 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 1 (Oral))

[O13-03] Agronomic Practices of Oil Palm Smallholders towards Sustainable Development Goal 12

(Invited Speaker)

○Margaret Chan Kit Yok[1], Suriana Baki[1], Seraphina Anak Dominic Gisong[2], Siraj Munir Bin Mohammad[1]
（1.Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA Sarawak Branch, Malaysia, 2.Kumpulan Kelestarian Aras 2, Wisma FELCRA, Malaysia）

The increasing demand for palm oil led to rapid expansion with 60% of planted areas from forest conversion between 1990 to 2005 which has led to criticisms on sustainability on biodiversity loss, water pollution and climatic change. The independent smallholders account for 11% of the Malaysia's oil palm industry dominated by the private estates, accounting for 60% and organised small holding scheme of 29%. Mandatory requirements for the Malaysian Sustainability Oil Palm Certification add to independent smallholders' financial burdens. Thus, there is a demand for knowledge on how to increase the average palm oil yield per hectare in a sustainable way. This paper showed evidences that combination of organic approach and reduced rate of chemical fertilizers can sustain economic yield of the oil palm. At the nursery stage, the application of combination of both indigenous or commercial mycorrhiza with NPK chemical fertiliser resulted in at least 11.0%, 17.7% and 32.0% higher N, P and K contents respectively in the palm fronds over NPK chemical fertiliser alone. At immature stage of oil palm in coastal sandy soil, there were no significant differences in N and P contents in the frond after three applications of combination of empty fruit bunch compost with slow release or granulated chemical fertiliser and chemical fertilisers alone. Similarly, at mature stages of oil palm in mineral soil, there were no significant differences in the N, P and K contents in the frond after four applications of combination of empty fruit bunch compost with chemical fertilisers and chemical fertilisers alone.

5:55 PM - 6:10 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 1 (Oral))

[O13-04] A Survey on Home Garden Horticultural Crops in Two Selected Areas in Myanmar

○Thanda Aung （Department of Horticulture, Yezin Agricultural University, Myanmar）

This study aimed to assess the status of home gardens and richness of horticultural crops in selected areas and to investigate the functions of home gardening. Totally 35 ordinary households were randomly selected out of 105 households of a village for study-1 and 10 commercially produced households of another village were focused for study-2 during May to July in 2017. Collected data were area measurements of household compounds and buildings, crops information and owners' information. The results showed that compound areas were ranged from 50 to 891 m^2 for study-1 and 1300 to 3900 m^2 for study-2. The potential lands to grow more plants were 56% in study-1 and only 16% in study-2. Six kinds of crops could be classified and fruits, vegetables and ornamental plants were mostly grown in both villages. The ages of owners could be classified from 25 years to 76 years old. In study-1, 32% of

owners finished primary education level while 40% finished high school education levels in study-2. The highest family members were 3 to 4 members (35%) in study-1 and 5 to 6 (60%) for study-2. Crop growing experiences of owners were from 1 to 31 years. Among nine different income sources, farmers were nearly 50% in both studies. Most owners were expecting to do continuous planting for home gardening.

6:10 PM - 6:25 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 1 (Oral))

[O13-05] Agro-economic Evaluation of Fertilizer Management for Wet Season Rice in Southern Cambodia

○Kea Kong[1], Yoichiro Kato[2], Sarom Men[3], Vang Seng[1], Akira Yamauchi[4], Mayumi Kikuta[5], Il-Ryong Choi[6], Hiroshi Ehara[7, 8] (1.General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 2.Institute for Sustainable Agro-ecosystem Services, The University of Tokyo, Japan, 3.Royal University of Agriculture, Cambodia, 4.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 5.Graduate School of Integrated Sciences for Life, Hiroshima University, Japan, 6.International Rice Research Institute - Korea Office, Korea, 7. Applied Social System Institute of Asia, Nagoya University, Japan, 8.International Center for Research and Education in Agriculture, Nagoya University, Japan)

On-farm experiments were conducted to determine the economic efficiency of fertilizer management and the optimal rate of fertilizer application for rainfed lowland rice (*Oryza sativa* L.) cultivation on Prateah Lang (sandy) soil in Trapaing Khchav and Steung villages, O Saray commune in Tram Kak district, Takeo province in the southern Cambodia in 2013 and 2014. Five trials were conducted at different locations in 2013 and 2014. Each trial had six treatments of different nitrogen (N)-phosphorus (P_2O_5)-potassium (K_2O) rates with three replicates in 2013, and four replicates in 2014. The amounts of P_2O_5 and K_2O applied differed between the trials, although P_2O_5 and K_2O application rates were the same between the treatments in each trial. The results demonstrated that the application of 60 kg ha^{-1} of N, 30 kg ha^{-1} of P_2O_5, and 15 kg ha^{-1} of K_2O, whose cost was the second lowest (97.8 US$ ha^{-1}) among those for 25 different N-P_2O_5-K_2O rates, was the most profitable, suggesting that the N-P_2O_5-K_2O rate of 60-30-15 is the best application rate at the experimental sites. While the grain yield increased with a higher fertilizer rate, the optimum rate to maximize income was achieved at a rather low fertilizer rate, hence the fertilizer cost should be considered before determining the best fertilizer management strategy. We have been continued analyzing the economic efficiency of fertilizer management on different soil types as well.

6:25 PM - 6:40 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 1 (Oral))

[O13-06] The Abundance and Diversity of Arbuscular Mycorrhizal Fungi Colonized in Roots of Sago Palm in Mineral Soil and Shallow Peat Soil

*Nominated for Presentation Awards

○Koki Asano[1,2], Willy Vincent Anak Kagong[3], Siraj Munir Bin Mohammad[3], Kurumi Sakazaki[4], Margaret Chan Kit Yok[3], Toshiyuki Isoi[4], Mana Kano-Nakata[5], Hiroshi Ehara[5,6] (1.Graduate School of Bioagricultural

Sciences, Nagoya University, Japan, 2.Faculty of Agriculture, Kasetsart University, Thailand, 3.Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA Sarawak Branch, Malaysia, 4.Faculty of Agriculture, Meijo University, Japan, 5.International Center for Research and Education in Agriculture, Nagoya University, Japan, 6.Applied Social System Institute of Asia, Nagoya University, Japan）

Arbuscular mycorrhizal fungi (AMF) play an essential role in host plants' nutrient uptakes. In Sarawak, Malaysia, farmers generally cultivate sago palm (*Metroxylon sagu*) in peat soils without applying chemical fertilizer, expecting natural fertility of the soil. Through such experience, the growth contribution of AMF to sago palm had been suggested. In this study, we collected soils and roots in mineral soil (MS) and shallow peat soil (SPS) in Sarawak to understand the characteristics of AMF symbiosis under different soil environments. As a result, SPS showed a higher moisture content (MS, 38.1; SPS, 79.8%), lower pH (H_2O) (MS, 4.6; SPS, 4.1), soil bulk density (MS, 1.03; SPS, 0.20 g cm^{-3}), and N content (MS, 16.9; SPS, 2.7 kg m^{-3}) than MS at the same soil depth, while the P content (Bray II) (MS, 1.6; SPS, 1.9 g P_2O_5 m^{-3}) was similar. The abundance of AMF was significantly lower in SPS (39.2 ± 12.5 %) than in MS (73.2 ± 4.6 %). 122 AMF operational taxonomic units (OTUs) belonging to Acaulosporaceae, Ambisporaceae, Claroideoglomeraceae, Gigasporaceae, and Glomeraceae were detected by amplicon sequencing of the small-subunit rRNA gene. Phylogenic analysis revealed that OTUs in MS belonged to more clades than in shallow peat soil. It seems that the soil physicochemical properties influenced the abundance and diversity of AMF in SPS. It was suggested that *Glomus* and *Acaulospora* species obtained from SPS could survive in acidic and high moisture soil conditions and help the growth of sago palms in shallow peat soil.

6:40 PM - 6:55 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 1 (Oral))

[O13-07] The Effect of Nitrogen and Phosphorus Applications on Rice Yield Can Be Changed by Farmers' Management Practices — Transplanting Dates and Densities—

*Nominated for Presentation Awards

○Bruce Haja Andrianary[1], Yasuhiro Tsujimoto[2], Hobimiarantsoa Rakotonindrina[1], Michel Rabenarivo[1], Herintsitohaina Razakamanarivo[1] （1.Laboratoire des Radioisotopes, University of Antananarivo, Madagascar, 2.Japan International Research Center for Agricultural Sciences, Japan）

Efficient nutrient management is a key for sustainable increases in rice production. However, the effect of fertilizer application has been little understood on smallholder farmers' management practices despite their large variations among nearby fields such as transplanting (TP) dates and TP densities. This study was conducted to identify how these variations can change the effect of fertilizer applications on rice yield. A split-split plot design was established with three replicates in two fields in the central highlands of Madagascar. The treatments consisted of two TP densities (Sparse: 25 hills m^{-2}, Dense: 50 hills m^{-2}), four fertilizer treatments (Control, N, P, NP), and two TP dates (Early, Late). The Late was transplanted one month after Early. The result showed significant interaction of fertilizer treatment and TP date: the effect of N was only significant for Early; the NP increased yield by 95% relative to N for Late while its increased rate was 50% for Early. This interaction was due to that the P application shortened days to heading by 11-15 days and avoided cold stress for LTP while the N application had no effects on phenology development and rather increased cold-induced sterility. A significant interaction was also observed between fertilizer treatment and TP density. There were no differences at high-

yielding plots while the Dense had greater yields in low-yielding plots by compensating limited growth of individual hills. The study highlighted the importance of farmer's management practices to improve nutrient use efficiency.

[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.

[O21] Cropping System / Crop Rotation

Chair: Katsuyoshi Shimizu (Kagoshima University, Japan)
Chair: Weidong Cao (Chinese Academy of Agricultural Sciences, China)
Thu. Sep 9, 2021 9:45 AM - 11:45 AM Room 2 (Oral) (Farming System)

[O21-01] Utilization of Green Manure in China

○Weidong Cao （Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, China）

9:45 AM - 10:05 AM

[O21-02] Climate Services for Improved Resilience of Cropping Systems

○Hideki Kanamaru （Food and Agriculture Organization of the United Nations, FAO Regional Office for Asia and the Pacific (FAORAP), Thailand）

10:05 AM - 10:25 AM

[O21-03] Effects of Ridging and Fertilizer Application on Crop Yield and Growth under Unstable Water Environments

○Yoshihiro Hirooka[1], Simon K. Awala[2], Pamwenafye I. Nanhapo[2], Koichi Shoji[3], Yoshinori Watanabe[4], Yasuhiro Izumi[5], Morio Iijima[1] （1.Graduate School of Agriculture, Kindai University, Japan, 2.Faculty of Agriculture and Natural Resources, University of Namibia, Namibia, 3.Graduate School of Agricultural Science, Kobe University, Japan, 4.Faculty of Agriculture, Fukushima University, Japan, 5.School of Environmental Science, The University of Shiga Prefecture, Japan）

10:25 AM - 10:40 AM

[O21-04] Enhancement of Drought-Tolerance of Sorghum by the Close Mixed-Planting of Pearl Millet

○Morio Iijima[1], Simon K. Awala[2], Pamwenafye I. Nanhapo[2], Yoshihiro Hirooka[1], Keotshephile Kashe[3] （1.Graduate School of Agriculture, Kindai University, Japan, 2.Faculty of Agriculture and Natural Resources, University of Namibia, Namibia, 3.Okavango Research Institute, University of Botswana, Botswana）

10:40 AM - 10:55 AM

[O21-05] Rice Introduction to Botswana through the Collaboration with Namibia and Japan; Natural and Social Environment for Rice Cropping in Okavango Delta

○Keotshephile Kashe[1], Simon K. Awala[2], Pamwenafye I. Nanhapo[2], Yoshihiro Hirooka[3], Morio Iijima[3] （1.Okavango Research Institute, University of Botswana, Botswana, 2.Faculty of Agriculture and Natural Resources, University of Namibia, Namibia, 3.Graduate School of Agriculture, Kindai University, Japan）

10:55 AM - 11:10 AM

[O21-06] Long-term Crop Response to Discontinuation of Fertilizer Input in a Wheat-Maize Cropping System

○Syed Tahir Ata-Ul-Karim[1], Weimo Zhou[1], Naoki Moritsuka[1], Yoichiro Kato[1] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Graduate School of Integrated Arts and Sciences Agriculture, Kochi University, Japan, 4.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

11:10 AM - 11:25 AM

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

[O21-01] Utilization of Green Manure in China

(Invited Speaker)

○Weidong Cao （Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, China）

In south China, fallow paddy fields could be used to plant green manures. The high yield and high efficient rice - winter green manure system was established in most south provinces. In north China, the eco-protective corn/cotton - winter green manure system was proposed. In north-west China, the system of wheat - fall green manure utilized as manure and forage was developed. In this area, there is about 2 months after wheat, the short period is suitable for green manuring. In south-west China, the soil nourishing corn/tobacco - winter green manure system was used. The main green manure species used in these areas are milk vetch, February Orchid and hairy vetch, hairy vetch and common vetch, and smooth vetch and manure radish, respectively.
In paddy fields, we investigated the effects of green manure on rice yields and its potential in replacing chemical fertilizer. When reducing 40% of chemical fertilizer, rice yield is similar to that of the treatment applied 100% chemical fertilizer without green manure (11 sites, n=930). When the reducing rates are 0% and 20%, yields increased ($p<0.05$) by 6.53% and 4.15%, respectively. Our results also showed that this effect enhanced along with the planting year of green manure. The N utilization efficiencies under reduction of 0%, 20% and 40% increased by 8.4, 17.7, and 24.1 percentage points, respectively. Furthermore, in a 34 years' experiment, the result tells that yield in the treatment of milk vetch increased by 25% for early rice, and increased by 27% for late rice.

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

[O21-02] Climate Services for Improved Resilience of Cropping Systems

(Invited Speaker)

○Hideki Kanamaru （Food and Agriculture Organization of the United Nations, FAO Regional Office for Asia and the Pacific (FAORAP), Thailand）

Climate change is a significant risk for crop agriculture, particularly for vulnerable farmers in developing countries. Increasing temperature and changing precipitation pattern are affecting growing conditions of crops. Extreme weather events often make devastating impacts on crop production. FAO has been promoting Climate-Smart Agriculture which aims to achieve both climate change adaptation and mitigation while sustainably increasing productivity and income. One of the essential elements of CSA is climate services for improved resilience of cropping systems. A limited number of countries currently provide a full suite of climate services for agriculture. Addressing information needs on the short time scale, national meteorological services and ministry of agriculture collaboratively work on agrometeorological data collection, analysis, and production and dissemination of actionable advisories to farmers for their daily decision making. Based on the best science, early warning for pests and diseases is improved using daily weather monitoring, forecasts, and farm condition reports. On climate change time scale, more countries are able to assess climate risks for crops, and vulnerabilities impacting different livelihoods at community levels, using their own data for their own information needs for policy making, as an integral part of iterative process of national agriculture development planning. The

presentation will discuss the importance of climate services in order to achieve Sustainable Development Goals, particularly zero hunger and climate challenges, with illustrative examples mainly from Asian countries, and how crop scientists can contribute to transformation towards a climate resilient agriculture.

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

[O21-03] Effects of Ridging and Fertilizer Application on Crop Yield and Growth under Unstable Water Environments

○Yoshihiro Hirooka[1], Simon K. Awala[2], Pamwenafye I. Nanhapo[2], Koichi Shoji[3], Yoshinori Watanabe[4], Yasuhiro Izumi[5], Morio Iijima[1] (1.Graduate School of Agriculture, Kindai University, Japan, 2.Faculty of Agriculture and Natural Resources, University of Namibia, Namibia, 3.Graduate School of Agricultural Science, Kobe University, Japan, 4.Faculty of Agriculture, Fukushima University, Japan, 5.School of Environmental Science, The University of Shiga Prefecture, Japan)

The impact of climate change is expected to be more severe in semi-arid and arid ecosystems. Heavy rainfall and flooding events have recently become common occurrences in such regions, and it is essential to improve cultivation management practices to optimize crop productivity. The aim of the present study was to evaluate the effects of cultivation practices such as ridging and fertilizer application methods on crop yield and growth under unstable water environments. The experiments were conducted over three years (2016-2018) in experimental fields in semi-arid sub-Saharan Africa, northern Namibia. Pearl millet and cowpea were grown in the field, and the crop parameters were evaluated under different ridging and fertilizer treatments. According to the results, ridge formation by strip tillage (pulled by a small two-wheel tractor) led to proper drying of the soil, and flooding stress was prevented, which, in turn, enhanced early growth and increased yield for pearl millet and cowpea. In addition, our results showed that the crop growth from the tillering stage to the early reproductive stage is important under unstable water environments. In particular, the ridging minimized the risk for crop loss, particularly when applied in combination with manure fertilizer. Further studies analyzing crop growth are required to establish the optimal manure fertilizer quantities required and appropriate timing of chemical fertilizer application under unstable water environments.

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

[O21-04] Enhancement of Drought-Tolerance of Sorghum by the Close Mixed-Planting of Pearl Millet

○Morio Iijima[1], Simon K. Awala[2], Pamwenafye I. Nanhapo[2], Yoshihiro Hirooka[1], Keotshephile Kashe[3] (1.Graduate School of Agriculture, Kindai University, Japan, 2.Faculty of Agriculture and Natural Resources, University of Namibia, Namibia, 3.Okavango Research Institute, University of Botswana, Botswana)

The consecutive occurrences of flooding and drought in the same place could increase worldwide in near future due to climate change. Through a series of experiments conducted in both humid Japan and semi-arid Namibia, we proved the hypothesis that wetland crop species and drought resistant upland species can help each other under flood and/or drought conditions when their root systems tightly entangle each

other, termed close mixed-planting. Under flood conditions, this planting system allows the roots of wetland crops, such as rice, to supply oxygen to the roots of upland crops, such as pearl millet and sorghum. In turn, the roots of mixed cropped upland species supply water to the roots of counterpart wetland crops under drought conditions. The close mixed-planting may be one of the solutions to overcome crop failure by consecutive occurrences of flooding and drought in the same place. In north-central Namibia, some local farmers practice the close mixed-planting of pearl millet and sorghum, their staple foods. Both crops are drought tolerant, but pearl millet is much stronger than sorghum to dry conditions. In contrast, sorghum grow better in wetter conditions. By this system, pearl millet roots would, most probably, supply water to sorghum roots under drought condition, mitigating drought effects on sorghum plants. Local farmers commented that sorghum can be grown in much drier places than before by this cropping system. In this paper, we report on the close mixed-planting of sorghum and pearl millet in farm fields in Namibia and greenhouse pots in Botswana.

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

[O21-05] Rice Introduction to Botswana through the Collaboration with Namibia and Japan; Natural and Social Environment for Rice Cropping in Okavango Delta

○Keotshephile Kashe[1], Simon K. Awala[2], Pamwenafye I. Nanhapo[2], Yoshihiro Hirooka[3], Morio Iijima[3]
（1.Okavango Research Institute, University of Botswana, Botswana, 2.Faculty of Agriculture and Natural Resources, University of Namibia, Namibia, 3.Graduate School of Agriculture, Kindai University, Japan）

The Okavango Delta in north-western Botswana is formed by flood water from Angolan highlands. The delta comprises of permanent swamps and seasonal floodplains covering 6,000 ha and 1.2 M ha respectively. The seasonal floodplains support flood recession farming, an important land use and essential livelihood activity for poor and marginalized riparian communities living around the delta. Rice cropping has been introduced to seasonal wetlands formed in semi-arid area in Namibia located in upper stream of Okavango delta since 2004 by Japanese cooperation. Rice cropping can also be introduced in the lower stream of the Okavango Delta located in Botswana. Here, we started to introduce the rice cropping to Botswana through the collaboration with Namibia and Japan based on the knowledge of rice introduction to Namibia. Because water level in Botswana was changed more than in Namibia due to variation in flooding depth and flooding frequency, floating rice cultivars cultivated in Asia and/or drought tolerant upland rice cultivars may be ideal to cultivate in Botswana. For sustainable crop production system, basic research for the introduction of various rice cultivars cultivated all over the world, and for the natural environments along Okavango delta and social environments in the rural households is needed. Our final goal is to develop sustainable rice cropping system that is suitable to the annual flood water variation in the seasonal floodplains for resource-poor farmers utilizing the information of rice cultivation in Asia including Japan.

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

[O21-06] Long-term Crop Response to Discontinuation of Fertilizer

Input in a Wheat-Maize Cropping System

*Nominated for Presentation Awards

○Syed Tahir Ata-Ul-Karim[1], Weimo Zhou[1], Naoki Moritsuka[1], Yoichiro Kato[1] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Graduate School of Integrated Arts and Sciences Agriculture, Kochi University, Japan, 4.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

Modern intensive cropping systems rely on the excessive application of inorganic fertilizers. The importance of inherent soil fertility is often ignored owing to the complexity of relationships between crop productivity and soil properties in fields with continuous fertilization. Here, our goal was to improve understanding of long-term crop responses to soil nutrient availability. We suspended fertilizer application since 2007 for 11 years in maize-wheat rotation, but continuously applied standard N-P-K rates from 1993 to 2018 in control. Crop biomass and N uptake decreased to 29%-69% of the control in wheat and 28%-76% of the control in maize during 2008-2011 after the suspension of fertilization, and subsequently stabilized at 10%-41% of the control in wheat and 31%-73% of the control in maize from 2012 to 2018. Compared with wheat, maize showed reduced harvest index and grain weight and less of a decrease of leaf area index at the expense of specific leaf N, but a greater decrease of radiation-use efficiency, which highlights the contrasting adaptation strategies of the two species to the cessation of fertilization. Spatial analysis of crop growth and soil characteristics showed that grain yields of both species without fertilization were associated with both total and available soil N. Large within-field variation in yield (CV: 42% to 52%) after 3 years of suspended fertilization resulted from a slight variation in soil N availability (CV: 9%). Our findings can serve as a reference for maintaining soil nutrient and crop productivity in cropping systems with more efficient resource use.

[O22] Crop Production System

Chair: Koki Homma (Tohoku University, Japan)
Chair: Roel Suralta (Philippine Rice Research Institute, Phillipines)
Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 2 (Oral) (Farming System)

[O22-01] Present Status and Issues of Crop Production after the Tsunami in the Coastal Area of Sendai, Japan

○Koki Homma[1], Shuhei Yamamoto[1], Naoyuki Hashimoto[2], Masayasu Maki[3], Koshi Yoshida[4]
（1.Graduate School of Agricultural Science, Tohoku University, Japan, 2.Faculty of Agriculture and Marine Science, Kochi University, Japan, 3.Faculty of Food and Agricultural Sciences, Fukushima University, Japan, 4.Graduate School of Frontier Sciences, The University of Tokyo, Japan）

2:30 PM - 2:50 PM

[O22-02] Agronomic Performance of Rainfed Lowland Rice Varieties in Different Soil Types in Cambodia

○Chanthol Uch[1,2], Yurdi Yasmi[1], Buyung A. R. Hadi[3], Kea Kong[4], Sarom Men[5], Lyda Hok[5], Chhourn Orn[6], Seang Layheng[6], Mana Kano-Nakata[7], Akira Yamauchi[8], Hiroshi Ehara[7,9]（1. International Rice Research Institute Cambodia Office, Cambodia, 2.Nagoya University Asian Satellite Campuses Institute-Cambodia, Royal University of Agriculture, Cambodia, 3.Food and Agriculture Organization of the United Nations, Italy, 4.General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 5.Royal University of Agriculture, Cambodia, 6.Cambodian Agricultural Research and Development Institute, Cambodia, 7.International Center for Research and Education in Agriculture, Nagoya University, Japan, 8.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 9.Applied Social System Institute of Asia, Nagoya University, Japan）

2:50 PM - 3:10 PM

[O22-03] Quantitative Analysis on Rice Production Changes for Sixteen Years in Pursat Province, Cambodia

○Yu Iwahashi[1], Rongling Ye[1], Satoru Kobayashi[2], Kenjiro Yagura[3], Hor Sanara[4], Kim Soben[4], Koki Homma[1]（1.Graduate School of Agriculture, Tohoku University, Japan, 2.Center for Southeast Asian Studies, Kyoto University, Japan, 3.Graduate School of Management and Information Technology, Hannan University, Japan, 4.Royal University of Agriculture, Cambodia）

3:10 PM - 3:25 PM

[O22-04] Vertical Farming: Improving Food and Nutrition Security by Integrating Agriculture into the Built Environment of Dhaka City

○Shamma Tabassum Haque[1], Md. Z. H. M. Monjur Murshed[1], Muhammad Shahidul Haque[2]
（1.Department of Architecture, Rajshahi University of Engineering and Technology, Bangladesh, 2.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh）

3:25 PM - 3:40 PM

[O22-05] Spatial Variation in the Growth of Peach Trees and the Related Field Properties in a Newly Reclaimed Orchard

○Kaori Matsuoka[1], Naoki Moritsuka[2], Ryohei Nakano[3], Koji Kusumi[3], Takashi Kurosawa[3], Mika

Yasuda[3], Tsuyoshi Konishi[3], Tetsuya Nakazaki[3] （1.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan, 2.Faculty of Agriculture and Marine Science, Kochi University, Japan, 3.Experimental Farm, Graduate School of Agriculture, Kyoto University, Japan）

3:40 PM - 3:55 PM

[O22-06] Assessment of Rice Cultivation in Non-system Tank Irrigated Area in Southern Region of Tamil Nadu, India

○S Selvakumar[1,3], Akihiko Kamoshita[2], S Sakthivel[1] （1.Department of Agronomy, Tamil Nadu Agricultural University, India, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Department of Agronomy, Kumaraguru Institute of Agriculture, India）

3:55 PM - 4:10 PM

[O22-07] Trials of Mix Cropping of Indeterminate and Determinate Soybean Lines for 5 years in Tohoku, Japan

○Rongling Ye[1], Koki Homma[1], Daiki Saito[1], Kazuki Ohishi[1], Ryosuke Tajima[1], Toru Uno[1], Shin Kato[2], Akio Kikuchi[2], Takayuki Nakajima[1] （1.Graduate School of Agricultural Science, Tohoku University, Japan, 2.Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

4:10 PM - 4:25 PM

2:30 PM - 2:50 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 2 (Oral))

[O22-01] Present Status and Issues of Crop Production after the Tsunami in the Coastal Area of Sendai, Japan

(Invited Speaker)

○Koki Homma[1], Shuhei Yamamoto[1], Naoyuki Hashimoto[2], Masayasu Maki[3], Koshi Yoshida[4] (1.Graduate School of Agricultural Science, Tohoku University, Japan, 2.Faculty of Agriculture and Marine Science, Kochi University, Japan, 3.Faculty of Food and Agricultural Sciences, Fukushima University, Japan, 4.Graduate School of Frontier Sciences, The University of Tokyo, Japan)

The pacific coast of the Tohoku region was devastated by the tsunami in the Great East Japan Earthquake in 2011. The agricultural land in the coastal area of Sendai was also severely damaged, but it was reconstructed relatively smoothly. We have conducted field investigations for an agricultural producers' cooperative corporation 'Sendai arahama' since 2016 and published several reports. Here, we tentatively summarize the present status of crop production in the investigated fields and discuss the issues for the future. The crop productions were relatively low in the first investigated year but gradually increased. The main production constraint of rice was insufficient leaf growth, which was remarkable in direct sowing fields. Direct sowing on well-drained paddy field was newly started in recent years. The applicability is under evaluation. Soybean had several problems, but red crown rot was the most serious. Weeds often caused terrible damage to both rice and soybean but have been relatively well managed in recent years. The quantitative evaluation for the production constraints is recommended for the corporation to manage their fields effectively by considering cost and benefit. Since the managed fields were about 100 ha, development of effective tools is necessary.

2:50 PM - 3:10 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 2 (Oral))

[O22-02] Agronomic Performance of Rainfed Lowland Rice Varieties in Different Soil Types in Cambodia

○Chanthol Uch[1,2], Yurdi Yasmi[1], Buyung A. R. Hadi[3], Kea Kong[4], Sarom Men[5], Lyda Hok[5], Chhourn Orn[6], Seang Layheng[6], Mana Kano-Nakata[7], Akira Yamauchi[8], Hiroshi Ehara[7,9] (1. International Rice Research Institute Cambodia Office, Cambodia, 2.Nagoya University Asian Satellite Campuses Institute-Cambodia, Royal University of Agriculture, Cambodia, 3.Food and Agriculture Organization of the United Nations, Italy, 4.General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 5.Royal University of Agriculture, Cambodia, 6.Cambodian Agricultural Research and Development Institute, Cambodia, 7.International Center for Research and Education in Agriculture, Nagoya University, Japan, 8.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 9.Applied Social System Institute of Asia, Nagoya University, Japan)

A total of 10 released rice varieties and two local checks were evaluated in four provinces, Pursat, Battambang, Siem Reap and Kampong Thom, with four different soil groups of Krakor (loamy) and Tuol Samrong (clay), Prey Khmer (sandy), Prateah Lang (sandy loam). The trials were conducted in a randomized complete block design with four replications in wet season 2019 and 2020. The agronomic trait was observing for plant height, panicle length, percentage of filled grain, grain number per panicle, harvest index and grain yield. The yield of Phka Rumduol averaged about 4.4 t/ha in the four soil groups, which was the highest followed by Phka Mealdei (4.2t/ha) under rainfed condition with comparatively higher extent of tolerance to lodging, drought or blast disease. The lowest yield performance was

observed in farmers' variety, CV2 (2.8t/ha) followed by Phka Chan Sen Sar (3.0t/ha). All varieties tested in Toul Samrong soil group (clay) produced the highest yield (4.4t/ha) compared to that in other soil groups. In the contrasts, the yield in Prey Khmer soil group (sandy) was the lowest yield (2.0t/ha). The analysis of gene by environment interactions indicated that there was no interaction between genotypes and soil groups. The most popular aromatic rice variety, Phka Rumduol, demonstrated the most preferable performance across the four environments with minimum input. From these results, Phka Rumduol is considered to be the most suitable among the varieties used for rainfed lowland condition where comparatively low-input rice production systems being employed by most of Cambodian farmers.

3:10 PM - 3:25 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 2 (Oral))

[O22-03] Quantitative Analysis on Rice Production Changes for Sixteen Years in Pursat Province, Cambodia

*Nominated for Presentation Awards

○Yu Iwahashi[1], Rongling Ye[1], Satoru Kobayashi[2], Kenjiro Yagura[3], Hor Sanara[4], Kim Soben[4], Koki Homma[1]
（1.Graduate School of Agriculture, Tohoku University, Japan, 2.Center for Southeast Asian Studies, Kyoto University, Japan, 3.Graduate School of Management and Information Technology, Hannan University, Japan, 4.Royal University of Agriculture, Cambodia）

Satellite-based data have become widely used in agricultural studies in recent years. The advantages are to provide spatially and temporally wide information. However, inaccuracy and fluctuation in the data often restrict quantification of the information. In this research, we statistically analyzed satellite-based data and quantitatively estimated rice production changes for sixteen years. We analyzed leaf area index (LAI) products from moderate resolution imaging spectroradiometer (MODIS), which is an 8-day-interval data with 500-meter pixel size. Our target area, Pursat province, is in the west of Cambodia and one of main rice producing area. We selected about twenty sites from mountainside to Tonle Sap Lake and extracted LAI data for sixteen years from 2003 to 2018. The series of LAI for each site was clustered, averaged and moving-averaged in order to quantify changes of the pattern during the period. The analysis revealed some characteristic changes in the patterns at several sites. For example, LAI increased in the dry season; the peak of LAI increased in the rain season; the time of peak became earlier; and LAI suddenly decreased. These may correspond to the cultivation changes: dry season cultivation started; chemical fertilizer used; earlier maturity cultivar was planted; and land deforested. The analysis also suggested that various and drastic changes occurred in recent years. Quantification of satellite-based data with statistical analysis would support spatial distribution of rice production changes obtained by point-based interviews and field investigations.

3:25 PM - 3:40 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 2 (Oral))

[O22-04] Vertical Farming: Improving Food and Nutrition Security by Integrating Agriculture into the Built Environment of Dhaka City

*Nominated for Presentation Awards
○Shamma Tabassum Haque[1], Md. Z. H. M. Monjur Murshed[1], Muhammad Shahidul Haque[2] (1.Department of Architecture, Rajshahi University of Engineering and Technology, Bangladesh, 2.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh)

A city will always rely on rural farmers for food and nutrition. Farms inside the city provide an opportunity to take advantage of using the unused roof spaces to enhance sustainability by promoting urban farming. This paper focuses on the present conditions of vertical farming and different phases that can be implemented according to climate change and sustainable developments of Dhaka. As Dhaka is rapidly urbanizing into a mega-city, areas available for agriculture within the city are becoming infeasible for mass production. To support the skyrocketing population and the rising requirement of quality food, vertical farming can be a solution which not only can meet the growing demand for food in cities, but also enhance the ecosystem. This study was conducted from established data collection according to a survey to get a better understanding of the potential of rooftop farming. The target area for this research was Dhaka city. The selection criteria of high rise buildings were stated by limited food access, low, medium-income households, infrastructure surrounding, and also natural resources. The possible solutions and ideas have been shown in a proposed high rise through some diagrams and charts. The paper aims to inspect the existing practices and identify the possibilities and applicable methods of vertical farming in high rise buildings of Dhaka. If the utilization of vertical farming could be conceived as social practice and implemented properly with architectural techniques and applications, the food and nutrition security will be at a whole new sustainable peak.

3:40 PM - 3:55 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 2 (Oral))

[O22-05] Spatial Variation in the Growth of Peach Trees and the Related Field Properties in a Newly Reclaimed Orchard

*Nominated for Presentation Awards
○Kaori Matsuoka[1], Naoki Moritsuka[2], Ryohei Nakano[3], Koji Kusumi[3], Takashi Kurosawa[3], Mika Yasuda[3], Tsuyoshi Konishi[3], Tetsuya Nakazaki[3] (1.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan, 2.Faculty of Agriculture and Marine Science, Kochi University, Japan, 3.Experimental Farm, Graduate School of Agriculture, Kyoto University, Japan)

Spatial variability of field properties in a newly reclaimed peach orchard was assessed to identify the factor affecting spatial variations in tree growth. The orchard (50×20m) is located at Kyoto University Farm in Kizu, Japan, and was planted with 32 'Beni Shimizu' peach seedlings in 2016. In 2019, tree and field properties were evaluated by dividing the field into 32 and 128 plots, respectively. The data were analyzed geostatistically by calculating semivariogram parameters (Q value and range). Three years after the reclamation, the averages and standard deviations of tree properties were 21.9±5.2cm for tree trunk length, 108.3±21.0cm for current shoot length, and 47.6±3.0 for leaf SPAD value. All the properties decreased from southeast to northwest in the field. Among the field properties, tree properties were most strongly correlated with relative altitude (R^2: 0.65-0.69), which was followed by TDR-EC (0.30-0.61), subsoil pH (H_2O) (0.40-0.51), TDR-volumetric water content (0.22-0.56), and soil hardness (0.21-0.53). Tree growth was smaller at the lower position of field where soil EC, pH, and moisture were high, and soil hardness was low. Semivariograms of the field properties showed high Q values with ranges less than 50m: relative altitude (Q value: 1.00, range: 34.4m), TDR-EC (0.62, 22.1m), TDR-volumetric water content (0.97, 19.9m), and soil hardness (0.76, 19.1m). The field properties

related to tree growth were spatially dependent in the field, thereby allowing site-specific field management for better tree growth.

3:55 PM - 4:10 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 2 (Oral))

[O22-06] Assessment of Rice Cultivation in Non-system Tank Irrigated Area in Southern Region of Tamil Nadu, India

*Nominated for Presentation Awards

○S Selvakumar[1,3], Akihiko Kamoshita[2], S Sakthivel[1] (1.Department of Agronomy, Tamil Nadu Agricultural University, India, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Department of Agronomy, Kumaraguru Institute of Agriculture, India)

Tank water has been traditional source of irrigation in South India, but its vulnerability has been recognized due to erratic rainfall in recent years, particularly ones that do not have connections with river system (non-system tank). To semi-quantify on-farm irrigation management and rice production in non-system tank, 3 villages (Srirampur, Sirukulum, N.Nedunkulum) were selected in Virudhunagar district, Tamil Nadu, India for the survey of 146 fields from 61 farmers during 2018-19 (drought year with only 127 mm of rainfall during cropping period of September to December) and 2019-20 (normal year with 443 mm of rainfall). During the drought year (2018-19), cultivation was abandoned in 2 villages with smaller tank size due to insufficient water storage, whereas rice was cultivated in all the 60 fields in Srirampur by both irrigation from tank and bore well. During the normal year (2019-20), higher yields in Sirukulum and N.Nedunkulum was associated with higher levels of N and P fertilizers than Srirampur. Farmers irrigated their field with deeper than 7 cm and re-irrigated mostly before disappearance of ponded water. Some tail fields were for direct seeding and had deeper standing water, while head fields yielded higher due to more stable water availability. Another 2-year on-station experiment showed water-saving irrigation by monitoring at 5 cm depth below soil surface combined with unpuddled machine transplanting produced 12.4% higher mean grain yield with higher mean water use efficiency of 8.71 kg ha mm^{-1} than the conventional flooding irrigation. Prospect of technical improvement in non-system tank is to be discussed.

4:10 PM - 4:25 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 2 (Oral))

[O22-07] Trials of Mix Cropping of Indeterminate and Determinate Soybean Lines for 5 years in Tohoku, Japan

○Rongling Ye[1], Koki Homma[1], Daiki Saito[1], Kazuki Ohishi[1], Ryosuke Tajima[1], Toru Uno[1], Shin Kato[2], Akio Kikuchi[2], Takayuki Nakajima[1] (1.Graduate School of Agricultural Science, Tohoku University, Japan, 2.Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan)

Mix cropping of different cultivars of the same crop is attracting attention due to its higher productivity. Although the several mechanisms are proposed to increase productivity, this study focused on its effects on canopy structure. For the purpose, several combinations of indeterminate (IND) and determinate (DET) lines of Soybean (Glycine max (L.) Merr.) were prepared; IND/DET is majorly controlled by one gene and has quite strong effect on plant statues.
5 NIL populations (from backcrossing of Kariko739,Kariko740,Tohoku 164, Tohoku 162, Tohoku 160to

Y1312-2) and 1 RIL population (from crossing of Osuzu and Athow) were used. Each population contained 5 IND lines and 5 DET lines. Besides these populations, NIL derived from Kariko 1222 (RHL from crossing of Osuzu and Athow) was also used. Several 1 IND: 1 DET (alternative arrangement) combinations were selected from the populations and mainly tested. Mix seeding of 5 IND lines and 5 DET lines in each population was also tested. These mix croppings were compared with the mono cropping.
1 IND: 1 DET combination had positive effects on leaf area, though its effects on yield were not stable: sometime the combination showed higher yield but sometime did not. Mix seeding showed relatively better performance than 1 IND: 1 DET combinations. However, the increase of yield by mix cropping was 5% in average, suggesting that the enhancement of seed productivity is required. The IND lines tested in this study did not show superior growth and production compared to DET lines, being one of the restriction factors of low positive effects on yield. Further study on finding out suitable IND and DET lines and combinations is needed.

[O23] Crop Modeling: Recent Progress and Applications

Chair: Hiroshi Nakagawa (National Agriculture and Food Research Organization, Japan)
Chair: Xinyou Yin (Wageningen University and Research, Netherlands)
Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 2 (Oral) (Farming System)

[O23-01] Learning from Experiences in Physics to Improve Crop Models for Analysis of Complex Traits

○Xinyou Yin （Centre for Crop Systems Analysis, Wageningen University and Research, Netherlands）

5:00 PM - 5:20 PM

[O23-02] Potential Value of Seasonal Climate Forecast and Crop Modelling in Identifying Optimal Management Practices in Tonga

○Kwang-Hyung Kim[1], Steven Crimp[2] （1.Climate Services and Research Division, Asia Pacific Economic Cooperation Climate Center, Korea, 2.Climate Change Institute, Australian National University, Australia）

5:20 PM - 5:40 PM

[O23-03] Improving Variety Reveals Emerging Wheat Yield Gaps Associated with Humid Days in Hokkaido

○Seiji Shimoda[1], Yohei Terasawa[1], Zenta Nishio[2] （1.Hokkaido Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Department of Agriculture, Tokyo University of Agriculture, Japan）

5:40 PM - 5:55 PM

[O23-04] Deep Learning-Based Robust Estimation for Rice Biomass Using Digital Image of Canopy

○Kota Nakajima[1], Yu Tanaka[1], Keisuke Katsura[2], Tatsuhiko Shiraiwa[1] （1.Graduate School of Agriculture, Kyoto University, Japan, 2.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan）

5:55 PM - 6:10 PM

[O23-06] Determination and Genetic Analysis of Genotype-Specific Parameters of Crop Growth Model Using Large-Scale Data of Rice Cultivation Tests in Japan

○Hiroe Yoshida[1], Satoru Sukegawa[1], Shiori Yabe[2], Akitoshi Goto[2], Hiromi Kajiya-Kanegae[3], Kaworu Ebana[4], Hiroyoshi Iwata[5], Masanori Yamasaki[6], Hiroshi Nakagawa[1] （1.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan, 2.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 3.Research Center for Agricultural Information Technology, National Agriculture and Food Research Organization, Japan, 4.Genetic Resources Center, National Agriculture and Food Research Organization, Japan, 5.Department of Agricultural and Environmental Biology, Graduate School of Agricultural and Life Science, The University of Tokyo, Japan, 6.Food Resources Education and Research Center, Graduate School of Agricultural Science, Kobe University, Japan）

6:25 PM - 6:40 PM

[O23-05] Characteristics of the Grain Weight Distribution Relating to the Ability of Resource Allocation in a Rice Panicle

○Shiori Yabe[1], Hiroe Yoshida[2], Hiromi Kajiya-Kanegae[3], Masanori Yamasaki[4], Hiroyoshi Iwata[5], Kaworu Ebana[6], Erina Fushimi[2], Hideo Maeda[1], Takeshi Hayashi[1], Hiroshi Nakagawa[2]
（1.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 2.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan, 3.Research Center for Agricultural Information Technology, National Agriculture and Food Research Organization, Japan, 4.Food Resources Education and Research Center, Graduate School of Agricultural Science, Kobe University, Japan, 5.Department of Agricultural and Environmental Biology, Graduate School of Agricultural and Life Science, The University of Tokyo, Japan, 6.Research Center of Genetic Resources, National Agriculture and Food Research Organization, Japan）
6:10 PM - 6:25 PM

5:00 PM - 5:20 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 2 (Oral))

[O23-01] Learning from Experiences in Physics to Improve Crop Models for Analysis of Complex Traits

(Invited Speaker)

○Xinyou Yin (Centre for Crop Systems Analysis, Wageningen University and Research, Netherlands)

Algorithms in many crop models are (semi-)empirical. These models may need improving to face new challenges in crop science, such as how to handle GxE interactions. I argue that to capture these interactions, crop modellers should learn from experiences in physics. Physicists, such as Albert Einstein, used sound theories and solid mathematics in thought experiments, and came up with seemingly simple equations (such as E = mc2) to explain the behaviour of sub-atomic particles and (parts of) the universe. These equations show that there is beauty, simplicity, and regularity, at every level, from the smallest particles to the largest clusters of galaxies.

Likewise, a crop as a system is a masterpiece. Its growth involves many contrasting elements (such as carbon and nitrogen, source and sink, shoot and root, structure and reserves), and each of these contrasts plays a part in forming the regularity of the crop. I will show examples, where biological insights and mathematical analytics are combined to derive simple equations with parameters that have explicit biological meanings.

The advantages of this meta-physically based crop modelling approach are multi-fold: (i) classical crop physiology can still be explored as overarching guidelines; (ii) a clumsy, excessively numerical, modelling approach can be minimised; (iii) models integrating those known equations can be used to generate hypotheses to unravel the unknowns; and (iv) biologically meaningful parameters facilitate the application of models in assisting (genetic) analysis of G× E interactions on complex traits.

5:20 PM - 5:40 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 2 (Oral))

[O23-02] Potential Value of Seasonal Climate Forecast and Crop Modelling in Identifying Optimal Management Practices in Tonga

(Invited Speaker)

○Kwang-Hyung Kim[1], Steven Crimp[2] (1.Climate Services and Research Division, Asia Pacific Economic Cooperation Climate Center, Korea, 2.Climate Change Institute, Australian National University, Australia)

The value of improved seasonal forecasts for the agriculture sector depends on a wide range of complex and interrelated factors. These include forecast accuracy – including accuracy at relevant spatial resolution and lead times, forecast adoption rates, and farmers' attitudes to risk. In the study we focused on addressing only a small component of the first factor by testing the utility of the seasonal forecasts in informing a number of on-farm management decisions for swamp taro growers in Tonga. In terms of specific recommendations derived as part of the integration of the seasonal forecasts and a crop model calibrated using ground-truth data, it was clear that the use of targeted irrigation for specific growth stages resulted in significant improvement in mean yields across the whole year. The simulation results also suggested that planting a taro crop in the March to May period and using the seasonal forecast to help inform decisions such as planting density, fertiliser management, and irrigation

can successfully lead to improved production in most years examined. During my presentation, some other alternative approaches will be presented as well. Overall, our results indicate that using the seasonal forecasts can improve potential crop yields against seasonal climate variabilities if used to alter the management decisions above. Nevertheless, this approach does carry more risk to the individual farmer and thus should be more fully explored with further analysis of farm management decisions and sensitivity studies.

5:40 PM - 5:55 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 2 (Oral))

[O23-03] Improving Variety Reveals Emerging Wheat Yield Gaps Associated with Humid Days in Hokkaido

○Seiji Shimoda[1], Yohei Terasawa[1], Zenta Nishio[2] (1.Hokkaido Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Department of Agriculture, Tokyo University of Agriculture, Japan)

There is a lack of information on wheat yield gaps associated with changes in cultivar progression. Humid weather conditions before, during, and after flowering cause the production damage of disease and pre-harvest sprouting in Hokkaido, northern Japan. A process model, such as the World Food Studies model (WOFOST), can estimate potential yields by reflecting climate change and soil types. We used regional historical wheat sowing and heading dates during the period 1984-2019 in eastern Hokkaido (Tokachi and Okhotsk regions), where major varieties are replaced with more productive varieties almost every ten years. We implemented WOFOST using PCSE/WOFOST to enable regional and municipal estimation. There is little change in air temperature during the grain filling period from the late 1980s to the late 1990s. As a result, effective climate change adaptation measures have been implemented to avoid the hot grain filling period of early-growing species in Hokkaido. Chihoku-komugi' and 'Hokushin', exhibited higher sensitivity to air humidity before harvest and after the heading period. A new high-yield variety, 'Kitahonami', reduced the periodical mean yield gap from 2.0 Mg/ha to 1.3 Mg/ha, whereas the yield gap often expanded under low vapor pressure deficit during the specific period. Current breeding reduces humidity damage and alters the growing season sensitive to damage, while the emerging yield gap factors continue to reflect the apparent trait targets to improve. In the presentation, we will also introduce the climatic factors that further promote the outbreak of diseases. We found that changes in the yield gap of each variety reflect the benefits of breeding.

5:55 PM - 6:10 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 2 (Oral))

[O23-04] Deep Learning-Based Robust Estimation for Rice Biomass Using Digital Image of Canopy

*Nominated for Presentation Awards

○Kota Nakajima[1], Yu Tanaka[1], Keisuke Katsura[2], Tatsuhiko Shiraiwa[1] (1.Graduate School of Agriculture, Kyoto University, Japan, 2.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan)

Above ground biomass (AGB) is the most fundamental trait to evaluate the crop growth. The objective of this study is to develop a convolutional neural network (CNN)-based AGB estimation model which is

applicable for various cultivars grown under two environments. An experiment was conducted with four cultivars at Kyoto University (KU) and with three cultivars at Tokyo University of Agriculture and Technology (TUAT). Images were taken from 1.5 m above the canopy from two weeks after transplanting to one week after heading. Immediately after taking images, we harvested plants and measured its AGB. Data from KU were used for training CNN model. 25728 images and corresponding AGB were input to train the CNN model. Based on standard cultivar "Koshihikari", AGB estimation sub-model was developed to estimate the tentative biomass. Based on four cultivars, plant type evaluation sub-model was developed to adjust the tentative biomass to the final result. Observed AGB was ranged from 2.3 to 1296.2 g m^{-2}. When all cultivars were pooled, root mean square error (RMSE) of tentative biomass estimation was 101.8 and 139.9 g m^{-2} at KU and TUAT, respectively. On the other hand, RMSE of the adjusted biomass estimation was 83.6 and 121.3 g m^{-2} at two environments. The accuracy of the estimation was much improved by adjusting biomass based on the second sub-model at both environments. The proposed model in the present study succeeded to estimate the AGB of various cultivars grown under two different environments.

6:25 PM - 6:40 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 2 (Oral))

[O23-06] Determination and Genetic Analysis of Genotype-Specific Parameters of Crop Growth Model Using Large-Scale Data of Rice Cultivation Tests in Japan

○Hiroe Yoshida[1], Satoru Sukegawa[1], Shiori Yabe[2], Akitoshi Goto[2], Hiromi Kajiya-Kanegae[3], Kaworu Ebana[4], Hiroyoshi Iwata[5], Masanori Yamasaki[6], Hiroshi Nakagawa[1] (1.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan, 2.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 3.Research Center for Agricultural Information Technology, National Agriculture and Food Research Organization, Japan, 4.Genetic Resources Center, National Agriculture and Food Research Organization, Japan, 5.Department of Agricultural and Environmental Biology, Graduate School of Agricultural and Life Science, The University of Tokyo, Japan, 6.Food Resources Education and Research Center, Graduate School of Agricultural Science, Kobe University, Japan)

There is a gap between our molecular level understandings of crop responses to environments and the actual crop growth and yield in the field. Further development of the crop growth model toward integrating the genomic or other omics data will help us bridge the gap and simulate the robust genotype under the changing environments. The objectives of our study were to clarify the variation in the "genotype-specific" parameters of crop growth simulation model and to analyze the linkage between those empirically determined parameters and genomic information by GWAS. We utilized a large-scale database of rice cultivation tests which consists of rice growth data for total 38 years at 101 sites in Japan, while the number of data and the included environmental combinations of year x site were different among genotypes. We firstly determined genotype-specific parameters for phenological development of 1860 genotypes. Then, we simulated the above-ground biomass and yield of those genotypes grown at various environments by rice growth model GEMRICE and estimated the genetic and environmental effects (excluding the effects of phenology and weather conditions, respectively) by applying a linear mixed model against the gap between observed and simulated growth and yield of rice. Integrating the environmental effects into GEMRICE, finally genotype-specific parameters for biomass growth and yield formation were determined. We report the GWAS results of those parameters for 110

genotypes and discuss the methodology for integrating the genomic data into the crop growth simulation model.

6:10 PM - 6:25 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 2 (Oral))

[O23-05] Characteristics of the Grain Weight Distribution Relating to the Ability of Resource Allocation in a Rice Panicle

○Shiori Yabe[1], Hiroe Yoshida[2], Hiromi Kajiya-Kanegae[3], Masanori Yamasaki[4], Hiroyoshi Iwata[5], Kaworu Ebana[6], Erina Fushimi[2], Hideo Maeda[1], Takeshi Hayashi[1], Hiroshi Nakagawa[2] (1.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 2.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan, 3.Research Center for Agricultural Information Technology, National Agriculture and Food Research Organization, Japan, 4.Food Resources Education and Research Center, Graduate School of Agricultural Science, Kobe University, Japan, 5.Department of Agricultural and Environmental Biology, Graduate School of Agricultural and Life Science, The University of Tokyo, Japan, 6.Research Center of Genetic Resources, National Agriculture and Food Research Organization, Japan)

Rice is an important staple food. Disclosing the system controlling rice yield has been attracting our spirit of inquiry. In this study, we defined a novel criterion representing the resource allocation in a panicle based on grain weight distribution, which was represented as the mixture of two gamma distributions with five parameters. We evaluated the genotype-specific stability of the criterion using 91 rice cultivars in nine environments. Cultivars showed large variation in their stabilities. The cultivars, which decreased their average weight of high-weight grains under unfavorable environments and produced smaller amount of middle-weight grains, showed stable performance in allocation. To evaluate the possibility to control grain weight distribution genetically, the genomic prediction was conducted for the grain weight distribution parameters using the 123 cultivars. In a single environment, the proportion of high-weight grains, average weight and variance of high-weight grains were predicted with accuracies (correlation between observed and predicted values) of 0.30, 0.28, and 0.53, respectively. This result indicates the possibility of genetic control of the grain weight distribution. To overcome the challenging issue: prediction for wide environmental and genetic variations, it is required to harmonize the different levels of data, e.g., the environmental response of target traits and relating key traits and genome information. Constructing and binding of the small parts of models based on both the biological and mathematical knowledge will be helpful.

[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.

[O31] Temperature Stress

*Sponsored by Japan International Research Center for Agricultural Sciences (JIRCAS)
Chair: Yoshimichi Fukuta (Japan International Research Center for Agricultural Sciences, Japan)
Chair: Donghe Xu (Japan International Research Center for Agricultural Sciences, Japan)
Thu. Sep 9, 2021 9:45 AM - 11:45 AM Room 3 (Oral) (Abiotic Stress for Crop Production)

[O31-01] High-Temperature Impacts on Rice Quality and Adaptation Strategy of Rice Production for Climate Change in Taiwan

○Huu-Sheng Lur[1] （1.Department of Agronomy, College of Bioresources and Agriculture, National Taiwan University, Taiwan, 2.Agronomy Society of Taiwan, Taiwan）

9:45 AM - 10:05 AM

[O31-02] Genome-Wide Associated Study Identifies GCN5-Activated Glyoxal Metabolism Related Gene Conferring Heat Tolerance in Wheat

○Zhaorong Hu, Jingchen Lin, Huiru Peng, Mingming Xin, Weilong Guo, Yingyin Yao, Zhongfu Ni, Qixin Sun （College of Agronomy and Biotechnology, China Agricultural University, China）

10:05 AM - 10:25 AM

[O31-03] Development of Technologies and Crops for Stable Food Production under Adverse Environments and Changing Climate Conditions

○Kazuo Nakashima （Food Program, Japan International Research Center for Agricultural Sciences, Japan）

10:25 AM - 10:40 AM

[O31-04] Genetic Dissection of Heat Stress Tolerance at Anthesis among Three Rice Cultivars, IR64, Koshihikari, and Takanari

○Toshiyuki Takai （Biological Resources and Post-harrvest Division, Japan International Research Center for Agricultural Sciences, Japan）

10:40 AM - 10:55 AM

[O31-05] Tomato Mutant HT7 Conferring Improved Fruit Set and Pollen Fertility under Long-Term Ambient High Temperature

○Ken Hoshikawa[1,2,3], Dung Pham[4], Hiroshi Ezura[2,3] （1.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan, 2.Faculty of Life and Environmental Sciences, University of Tsukuba, Japan, 3.Tsukuba Plant Innovation Research Center, University of Tsukuba, Japan, 4.Graduate School of Life and Environmental Sciences, University of Tsukuba, Japan）

10:55 AM - 11:10 AM

[O31-06] Genetic Variation of Spikelet Sterility Induced by Typhoon in Introgression Lines with Genetic Background of an *Indica* Group Rice (*Oryza sativa* L.) Variety IR 64

○Asami Tomita[1,2], Md. Nashir Uddin[3], Mitsuhiro Obara[4], Hiroki Saito[1], Yoshimichi Fukuta[1] （1.Tropical Agriculture Research Front, Japan International Research Center for Agricultural Sciences, Japan, 2.Graduate School of Environmental and Life Science, Okayama University, Japan, 3.School of Health and Life Sciences, North South University, Bangladesh, 4.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan）

11:10 AM - 11:25 AM

[O31-07] Heat Resilience in Rice by Early-Morning Flowering Trait

○Tsutomu Ishimaru （Division of Lowland Farming, Central Region Agricultural Research Center/National Agriculture and Food Research Organization, Japan）

11:25 AM - 11:40 AM

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

[O31-01] High-Temperature Impacts on Rice Quality and Adaptation Strategy of Rice Production for Climate Change in Taiwan

(Invited Speaker)

○Huu-Sheng Lur[1] (1.Department of Agronomy, College of Bioresources and Agriculture, National Taiwan University, Taiwan, 2.Agronomy Society of Taiwan, Taiwan)

High temperature is the one of major factors affecting both the yield and quality of rice production in Taiwan. The warming rate and the frequency of heat waves in Taiwan are higher than that of global average. In the report, the integrated responses of rice quality and physiology during grain development under high temperature will be presented. High temperature induced fluctuations in peroxidation, energy balance, hormones level, carbon/nitrogen shuttle, cell acidity, cell death, starch and protein accumulation; and thus this could result in lowering the rice quality by inducing chalkiness and weight reduction of rice grains. Key adaptation measures including changes of cultivation timing, planting density, and nitrogen application are proposed by the present study. Furthermore, area suitability for rice production across the whole island of Taiwan was evaluated based on the projection of the climate change scenario in the future. Results were used for proposing an adaptation strategy of rice production/industry for coping with the ongoing climate change.

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

[O31-02] Genome-Wide Associated Study Identifies GCN5-Activated Glyoxal Metabolism Related Gene Conferring Heat Tolerance in Wheat

(Invited Speaker)

○Zhaorong Hu, Jingchen Lin, Huiru Peng, Mingming Xin, Weilong Guo, Yingyin Yao, Zhongfu Ni, Qixin Sun (College of Agronomy and Biotechnology, China Agricultural University, China)

Wheat (*Triticum aestivum* L.) is one of the major crops largely cultivated and consumed all over the world. High temperatures occur frequently, presenting major environmental challenges with respect to wheat growth and reproduction as global warming. The molecular mechanism of the heat stress response in wheat is largely unclear. Here we perform genome-wide association analysis of a wheat natural population and identify an elite haplotype of glyoxal metabolism related gene TaGLY1 that enhances heat tolerance of wheat. TaGLY1HapA differs in the protein with natural variations, which are differentially trans-activated by TaGCN5, a histone acetyltransferase. Our discovery highlights this GCN5-GLY1 signaling cascade as a strategy for heat tolerance breeding in wheat.

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

[O31-03] Development of Technologies and Crops for Stable Food Production under Adverse Environments and Changing Climate Conditions

(Invited Speaker)
○Kazuo Nakashima （Food Program, Japan International Research Center for Agricultural Sciences, Japan）

The global strains on food and nutrient supply due to increasing world population, chronic malnutrition in developing countries, projected economic growth in emerging countries, and the growing frequency of extreme weather events have become a major concern for mankind. The Goal 2 of the United Nations' 17 Sustainable Development Goals (SDGs) aims to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture. It is well known that agricultural potential in developing regions, including Africa, has not been fully realized because their adverse environments and changing climate conditions impose abiotic stresses (e.g., temperature stresses, droughts) and biotic stresses (e.g., pests, diseases) on plant growth and development. In order to establish stable and sustainable production of agricultural crops in developing countries that are vulnerable to the impact of climate change such as high and low temperature and droughts, we develop breeding materials and technologies to produce crops that are highly productive yet adaptable to such environments. In addition, we use breeding technologies including genetic modification and develop new technologies for breeding novel crop cultivars. Furthermore, we embark on a challenge to develop cultivars of orphan crops such as quinoa and amaranth with high nutritional value and resistance to adverse environments. We hope these new breeding materials and technologies could contribute in achieving food and nutrition security in developing regions.

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

[O31-04] Genetic Dissection of Heat Stress Tolerance at Anthesis among Three Rice Cultivars, IR64, Koshihikari, and Takanari

(Invited Speaker)
○Toshiyuki Takai （Biological Resources and Post-harrvest Division, Japan International Research Center for Agricultural Sciences, Japan）

Heat stress tolerance at anthesis is an important trait to achieve sustainable rice production under ongoing global warming. Many studies challenged to identify quantitative trait loci (QTLs) for heat stress tolerance at anthesis. Yet, the effects of the detected QTLs were small, and they have not been validated properly. Only qHTSF4.1 was successfully fine-mapped as a heat stress tolerant QTL. Therefore, more genetic resources and QTLs for heat stress tolerance at anthesis need to be identified. In Japan, Koshihikari is a leading cultivar with good eating quality and Takanari is a high-yielding cultivar. Although genetic mechanism of good eating quality and high yield in each cultivar was being elucidated, the information on heat stress tolerance was limited. Therefore, we compared the heat stress tolerance at anthesis in the two cultivars with that in IR64, which is a mega variety in tropics but is susceptible to heat stress at anthesis. We found that both cultivars had a certain heat stress tolerance; Takanari and Koshihikari exhibited approximately 55% and 37% spikelet fertility, respectively, under high temperature (38℃) treatment while IR64 had only 2% spikelet fertility. These results suggest that Takanari and Koshihikari are promising genetic germplasms for heat stress tolerance at anthesis. In this session, I will introduce the current progress of genetic analysis for heat stress tolerance at anthesis among the three cultivars, IR64, Koshihikari, and Takanari.

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

[O31-05] Tomato Mutant HT7 Conferring Improved Fruit Set and Pollen Fertility under Long-Term Ambient High Temperature

(Invited Speaker)

*Nominated for Presentation Awards

○Ken Hoshikawa[1,2,3], Dung Pham[4], Hiroshi Ezura[2,3] (1.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan, 2.Faculty of Life and Environmental Sciences, University of Tsukuba, Japan, 3.Tsukuba Plant Innovation Research Center, University of Tsukuba, Japan, 4.Graduate School of Life and Environmental Sciences, University of Tsukuba, Japan)

Heat stress (HS) is one such abiotic stress that causes multiple negative effects at all vegetative and reproductive stages in the plant life cycle. In the future that global warming proceeded, HS influence on food production will be an even more serious problem. Also, in tomato cultivation, HS is a major serious problem for tomato production throughout the world, and it reduces the yield and quality of tomato fruits due to significant effects on pollen development and fertility. To isolate a novel tomato breeding material for providing heat tolerance and to elucidate the molecular mechanism of the HS response in tomato cultivation, we isolated some mutants showing improved fruit setting ability under long-term ambient high temperature by testing over 4,000 lines of Micro-Tom tomato mutant collections and named them tomato heat-tolerant (HT) mutants. The HT mutants were categorized as displaying one of two types of fruit-setting: one showed parthenocarpic fruit-setting, and the other showed fruit-setting with seeds. Interestingly, among the HT mutants, HT 7 had a higher fruit number and seeded-fruit yield under long-term HS condition. In addition, the total pollen number and viability of HT 7 were much higher than those of the WT under both control and HS conditions. HT 7 succeeded at fertilization even under HS condition due to higher viable pollen production than that of the WT. HT 7 could be a valuable genetic resource for elucidating heat tolerance mechanisms as well as valuable breeding material for improving heat-tolerant fruit set in tomato.

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

[O31-06] Genetic Variation of Spikelet Sterility Induced by Typhoon in Introgression Lines with Genetic Background of an *Indica* Group Rice (*Oryza sativa* L.) Variety IR 64

(Invited Speaker)

○Asami Tomita[1,2], Md. Nashir Uddin[3], Mitsuhiro Obara[4], Hiroki Saito[1], Yoshimichi Fukuta[1] (1.Tropical Agriculture Research Front, Japan International Research Center for Agricultural Sciences, Japan, 2.Graduate School of Environmental and Life Science, Okayama University, Japan, 3.School of Health and Life Sciences, North South University, Bangladesh, 4.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan)

Wide genetic variations for degrees of spikelet sterility induced by typhoon and days to heading (DH) were found among 317 introgressions lines (INLs) derived from crosses between new plant type varieties and an *Indica* Group rice, IR 64. The sterility was induced by continuous dry wind after several days from

panicle heading of rice plant, and the variation for degrees of spikelet sterility (SS) among the 194 INLs from 83 to 86 days of DH were also observed. The SS showed positive correlations with culm length (CL), panicle length (PL), panicle weight (PW) and PW/total weight [TW: culm and leaf weight (CW)+PW)], but not with CW and panicle number (PN). Based on these variations, the 194 were classified into three groups; A1, A2 and B. SS, CL, PL, PW and CW of group A1 were the lowest values among them, and those of B were the highest. PN of B was higher than those of the others, significantly. A total of seven quantitative trait loci (QTL) for SS were detected on chromosomes (chr.) 1, 2, 4, 7 (two QTLs), 8 and 11. Among them, those of chrs. 2, 4, 7 and 11 were located in the same regions with the other QTLs for PW/TW and PN, DH, CL, PL, CW and PN, CL and PW/TW, and DH, CL and PN, respectively. These results indicated large plant architecture with large panicle, high plant height or high tiller, increased SS. The relationships among traits, and QTLs detected will be useful information for genetic improvement of tolerance to typhoon damage in rice.

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

[O31-07] Heat Resilience in Rice by Early-Morning Flowering Trait

(Invited Speaker)

○Tsutomu Ishimaru （Division of Lowland Farming, Central Region Agricultural Research Center/National Agriculture and Food Research Organization, Japan）

Global warming is projected to have a negative impact on rice production. Reduction in grain yield due to heat-induced spikelet sterility (HISS) is one of the concerns since rice is most sensitive to heat stress at flowering. Indeed, high frequency of HISS was observed in the broad area of temperate, subtropics, and tropics in hot summer/dry season.
Shifting flower opening time (FOT) to the cooler early morning has been proposed to be effective in escaping from heat stress at flowering. Variation in FOT among modern rice varieties is very limited around 9-12AM, while there is wide variation among wild rice species. To mitigate HISS at flowering, a near-isogenic line (NIL) carrying a QTL for early-morning flowering (EMF) trait was developed by using an accession of wild rice, Oryza officinalis, as genetic resource. NIL with a background of *Indica* variety, IR 64, flowered 1-2 hours earlier than modern rice varieties. Multi-environmental testing with NIL for EMF is an ongoing project. Developed NIL for EMF is a unique material not only for basic study but also for the breeding program to develop the heat-resilient rice varieties. A comprehensive strategy for heat resilience in rice by early-morning flowering trait will be presented.

[O32] Drought Physiology

Chair: Junichi Kashiwagi (Hokkaido University, Japan)

Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 3 (Oral) (Abiotic Stress for Crop Production)

[O32-01] Rice Drought Breeding Has Selected for Longer Flag Leaves and Lower Stomatal Density

○Amelia Henry[1], Santosh Kumar[2], Archana Prasad[3], Suresh Prasad Singh[4], Fahamida Akter[5], Shravan K. Singh[6], Padmini Swain[7], Ram Baran Yadaw[8], Sankar Prasad Das[9], Nimai P. Mandal[10], Arvind Kumar[1] （1.Strategic Innovation Platform, International Rice Research Institute, Philippines, 2.Indian Council of Agricultural Research, Research Complex for Eastern Region, Patna, India, 3.Indira Gandhi Agricultural University, Raipur, India, 4.Bihar Agricultural University, Sabour, India, 5.Bangladesh Rice Research Institute, Regional Station, Rajshahi, Bangladesh, 6.Banaras Hindu University, Varanasi, India, 7.National Rice Research Institute, Cuttack, India, 8.National Rice Research Program, Hardinath, Nepal, 9.ICAR Research Complex for North Eastern Hill Region, Lembucherra, India, 10.Central Rainfed Upland Rice Research Station, Hazaribag, India）

2:30 PM - 2:50 PM

[O32-02] Physiological Traits to Breed for Drought Adaptation

○Matthew Reynolds, Margaret Krause, Francisco Pinto, Sivakumar Sukumaran （International Maize and Wheat Improvement Center, Mexico）

2:50 PM - 3:10 PM

[O32-03] Potential of Wild Relatives to Improve Wheat Drought Tolerance

○Masahiro Kishii, Matthew Paul Reynolds （Global Wheat Program, International Maize and Wheat Improvement Center, Mexico）

3:10 PM - 3:25 PM

[O32-04] Drought Resistance of NERICA, Asian Rice and African Rice with Effects of Compost and Potassium Fertilizer

○Michihiko Fujii （Faculty of Education, Shizuoka University, Japan）

3:25 PM - 3:40 PM

[O32-05] Optimizing Intermittent Irrigation Methods That Maximize Rice Productivity While Saving Irrigation Amount by Promoting Root Developmental Plasticity with Adequate Level of Nitrogen

○Emi Kameoka, Hinaki Yoshino, Hirotaka Suzuki, Yuki Omi （College of Agriculture, Food and Environment Sciences, Rakuno Gakuen University, Japan）

3:40 PM - 3:55 PM

[O32-06] Transcriptome Analysis of Soybean Responses to Water Deficit Conditions in the Field

○Yukari Nagatoshi[1], Nobuyuki Mizuno[2], Kenta Ikazaki[3], Tetsuji Oya[3], Yasuo Yasui[2], Eri Ogiso-Tanaka[4], Masao Ishimoto[4], Yasunari Fujita[1,5] （1.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan, 2.Graduate School of Agriculture, Kyoto University, Japan, 3.Crop, Livestock and Environment Division, Japan International Research Center for Agricultural Sciences, Japan, 4.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 5.Graduate School of Life Environmental Science, University of Tsukuba, Japan）

3:55 PM - 4:10 PM

[O32-07] The Ear Photosynthesis as Potential Source for Drought Yield Improvements in Wheat

○Junichi Kashiwagi[1], Suzu Nakayama[2], Yoshiko Inoue[3], Ayano Kato[3], Izumi Harada[4], Shinji Ichikawa[5], Taiken Nakashima[1], Ping An[6] （1.Research Faculty of Agriculture, Hokkaido University, Japan, 2.Pasco Shikishima Corporation, Japan, 3.Graduate School of Agriculture, Hokkaido University, Japan, 4.School of Agriculture, Hokkaido University, Japan, 5.Field Science Center for Northern Biosphere, Hokkaido University, Japan, 6.Arid Land Research Center, Tottori University, Japan）

4:10 PM - 4:25 PM

2:30 PM - 2:50 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 3 (Oral))

[O32-01] Rice Drought Breeding Has Selected for Longer Flag Leaves and Lower Stomatal Density

(Invited Speaker)

○Amelia Henry[1], Santosh Kumar[2], Archana Prasad[3], Suresh Prasad Singh[4], Fahamida Akter[5], Shravan K. Singh[6], Padmini Swain[7], Ram Baran Yadaw[8], Sankar Prasad Das[9], Nimai P. Mandal[10], Arvind Kumar[1]
（1.Strategic Innovation Platform, International Rice Research Institute, Philippines, 2.Indian Council of Agricultural Research, Research Complex for Eastern Region, Patna, India, 3.Indira Gandhi Agricultural University, Raipur, India, 4.Bihar Agricultural University, Sabour, India, 5.Bangladesh Rice Research Institute, Regional Station, Rajshahi, Bangladesh, 6.Banaras Hindu University, Varanasi, India, 7.National Rice Research Institute, Cuttack, India, 8.National Rice Research Program, Hardinath, Nepal, 9.ICAR Research Complex for North Eastern Hill Region, Lembucherra, India, 10.Central Rainfed Upland Rice Research Station, Hazaribag, India）

The breeding strategy of direct selection for yield under drought has resulted in the release of a number of drought-tolerant varieties in Asia. Characterizing the physiological mechanisms behind the improved yield under drought through that strategy will provide insight to mechanistic targets for complementing the existing drought tolerant breeding pool. In this study, we measured flag leaf dimensions in breeding trials in Bangladesh, India, and Nepal. The drought breeding lines and released drought-tolerant varieties showed consistently longer flag leaves and lower stomatal density than the drought-susceptible check IR64. The drought and well-watered treatments at each site showed stronger groupings than sites within treatments for these traits. In a principal component analysis (PCA), flag leaf length grouped with rainfall during reproductive stage and soil water status, whereas flag leaf width grouped with soil physical properties (% clay, bulk density, soil water retention). In detailed characterization at IRRI, flag leaf width was most affected by season (dry or wet season) and grouped with grain yield in the PCA. However, canopy temperature under drought and harvest index across treatments showed the strongest correlations with grain yield. These results reveal the physiological traits that have been most strongly selected upon while conducting direct selection for yield under drought, and suggest additional strategies for further improvement of drought tolerance in rice based on phenological progression of drought response in respect to environmental conditions.

2:50 PM - 3:10 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 3 (Oral))

[O32-02] Physiological Traits to Breed for Drought Adaptation

(Invited Speaker)

○Matthew Reynolds, Margaret Krause, Francisco Pinto, Sivakumar Sukumaran （International Maize and Wheat Improvement Center, Mexico）

Yield under water deficit can be boosted either by increasing water uptake or by making efficient use of water (EUW); these are not mutually exclusive. If water is available in subsoil then selecting for deeper roots is an obvious strategy, assuming annual water replenishment. Direct phenotyping of roots is not feasible at breeding scale, but proxies can be used such as canopy temperature and water index which respond directly to transpiration rate as a function of vascular capacity. We demonstrate how the combination of remote sensing indices can estimate root:shoot under field conditions. Several traits contribute to EUW. Conservative use of water in photosynthesis, i.e. transpiration efficiency (TE), can

help budget water uptake, permitting crops to complete their life cycle before soil water runs out. It can be measured using carbon isotope discrimination of leaves grown without water stress. Spike photosynthesis occurs with relatively high TE due to recycling of respiratory CO_2, however, not easy to measure. Another trait related to budgeting is storage of soluble carbohydrates mainly in stems when growing conditions are favorable, that are remobilized to grains as stress intensifies. Use of physiological traits in breeding can be considered for progeny and/or parental selection. The latter involves characterizing fewer materials so more difficult-to-phenotype traits can also be considered. As an example, strategic crossing of parents with complementary source and sink traits produced considerable transgressive segregation among progeny for canopy temperature and increased stem reserves after anthesis under drought, which was found to be predictive of grain yield.

3:10 PM - 3:25 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 3 (Oral))

[O32-03] Potential of Wild Relatives to Improve Wheat Drought Tolerance

(Invited Speaker)

○Masahiro Kishii, Matthew Paul Reynolds （Global Wheat Program, International Maize and Wheat Improvement Center, Mexico）

Wheat wild relatives have very strong drought/heat tolerance and possess unique drought/heat tolerance components that normal cultivated wheat do not have. In the last 30 years, CIMMYT has developed more than 1,500 artificially developed new hexaploid bread wheat (or synthetic wheat) from the crosses between durum wheat and wild species Aegilops tauschii (D genome ancestor). Many of synthetic wheat lines have shown improved drought/heat tolerance. Recently, CIMMYT has tried to utilize additional wheat wild species, including various Aegilops species, Leymus, Thinopyrum, rye, barley and others.
These synthetic wheat and wheat-wild species hybrids have been tested in Wheat Physiology group and been utilized for wheat breeding to achieve higher drought and heat wheat cultivars.

3:25 PM - 3:40 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 3 (Oral))

[O32-04] Drought Resistance of NERICA, Asian Rice and African Rice with Effects of Compost and Potassium Fertilizer

○Michihiko Fujii （Faculty of Education, Shizuoka University, Japan）

Drought resistance of NERICA especially effects of fertilizer is not clarified enough. In this research, NERICA (two cultivars and two lines), Asian rice (one cultivar and parent of NERICA) and African rice (parent of NERICA) were cultivated in the field under drought and traits relevant to drought resistance, stomatal conductance, soil water content, SPAD value, leaf thickness, quantum yield and leaf temperature, were measured. Effects of compost and potassium fertilizer were compared among two Asian rice cultivars and two NERICA cultivars. One Asian rice and one NERICA line showed higher top dry weight and yield. In one Asian rice compost and potassium fertilizer tended to increase yield. African rice showed lower stomatal conductance and tended to show higher leaf temperature. Compost and potassium fertilizer tended to increase stomatal conductance and lower leaf temperature. Differences in

yield were significantly correlated with those in stomatal conductance (r=0.579*) and with those in leaf temperature (r=-0.535*). Differences in stomatal conductance were significantly correlated with those in leaf temperature (r=-0.719*) and with those in quantum yield in the evening (standard fertilizer: r=0.814*). Differences in leaf temperature were significantly correlated with those in quantum yield at midday (r=0.524*) which were significantly correlated with those in leaf thickness (standard fertilizer: r=0.921**), that were significantly correlated with those in SPAD value (r=0.718**). Importance of maintaining high stomatal conductance, low leaf temperature, high leaf thickness and SPAD value and effects of compost and potassium fertilizer under drought condition was suggested.

3:40 PM - 3:55 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 3 (Oral))

[O32-05] Optimizing Intermittent Irrigation Methods That Maximize Rice Productivity While Saving Irrigation Amount by Promoting Root Developmental Plasticity with Adequate Level of Nitrogen

○Emi Kameoka, Hinaki Yoshino, Hirotaka Suzuki, Yuki Omi （College of Agriculture, Food and Environment Sciences, Rakuno Gakuen University, Japan）

The intermittent irrigation method is effective for achieving both water saving and yield improvement. However delay in irrigation may cause serious drought and reduce the yield. Omi et al. (2018) and Kameoka et al. (2019) reported optimal irrigation timing for several rice varieties with different soil fertility conditions. In this study, the effects of nitrogen fertilization on the plasticity of rice root system development under intermittent irrigation conditions were examined. Nipponbare, Swarna and KDML105 were grown in pots with 4 irrigation schedules; daily, and intermittent irrigation when the soil water potential at 12.5 cm soil depth reached either -20, -40 and -70 kPa. Experiments were conducted in RCBD with 3 replications with two fertilizer treatments, a small fertilizer plot (Kameoka et al., 2019) and a standard fertilizer plot (Tran et al., 2014) under a rainout shelter in 2019. Irrigation treatment was applied from root-taking period to just before panicle initiation stage. KDML105 in standard fertilizer plot with irrigated treatment at -20 kPa showed the most plasticity of rice root development. Regardless of the amount of fertilization, plasticity was exhibited only in the nodal root elongation ability under intermittent irrigation conditions, and the degree of plasticity became more prominent with an increase of nitrogen fertilization. This study suggests that more effective intermittent irrigation can be achieved by using the optimal amount of fertilizer to exert the plasticity of root system development.

3:55 PM - 4:10 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 3 (Oral))

[O32-06] Transcriptome Analysis of Soybean Responses to Water Deficit Conditions in the Field

○Yukari Nagatoshi[1], Nobuyuki Mizuno[2], Kenta Ikazaki[3], Tetsuji Oya[3], Yasuo Yasui[2], Eri Ogiso-Tanaka[4], Masao Ishimoto[4], Yasunari Fujita[1,5] （1.Biological Resources and Post-harvest Division, Japan International Research Center for Agricultural Sciences, Japan, 2.Graduate School of Agriculture, Kyoto University, Japan, 3.Crop, Livestock and Environment Division, Japan International Research Center for

Agricultural Sciences, Japan, 4.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 5.Graduate School of Life Environmental Science, University of Tsukuba, Japan）

Drought is the most serious abiotic stress affecting crop productivity. Because of the impact on global food security, the development of drought tolerance is a major concern in plant research. Numerous studies mainly conducted under severe water stress conditions in the laboratory have revealed the central role of abscisic acid (ABA) in stress signaling and drought tolerance in plants. On the other hand, studies on the effect of soil water deficit conditions that cause reduction of plant growth in the actual field are limited. In this study, we analyzed the transcriptome profile of soybean grown in the field with different soil water contents to elucidate the underlying molecular basis of how soybean plants respond to water deficit in the actual agricultural fields. We found that the aboveground biomass and yield of soybean correlated with the soil water contents in the experimental field. The genome-wide RNA-seq analysis revealed that a large number of up-regulated genes by the water deficit conditions were enriched in the Gene Ontology terms for response to nutrient starvation. Our findings would contribute in designing new strategies to develop drought tolerant crops and could shed light on future research towards understanding plant response to water stress in relation to nutrient acquisition from the soil.

4:10 PM - 4:25 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 3 (Oral))

[O32-07] The Ear Photosynthesis as Potential Source for Drought Yield Improvements in Wheat

○Junichi Kashiwagi[1], Suzu Nakayama[2], Yoshiko Inoue[3], Ayano Kato[3], Izumi Harada[4], Shinji Ichikawa[5], Taiken Nakashima[1], Ping An[6] （1.Research Faculty of Agriculture, Hokkaido University, Japan, 2.Pasco Shikishima Corporation, Japan, 3.Graduate School of Agriculture, Hokkaido University, Japan, 4.School of Agriculture, Hokkaido University, Japan, 5.Field Science Center for Northern Biosphere, Hokkaido University, Japan, 6.Arid Land Research Center, Tottori University, Japan）

Recently, severe droughts have often occurred in major wheat cultivation regions. It is, therefore, quite important to improve the drought tolerance in wheat. Although the significant improvements with scientific knowledge have been made for it, the information on contributions of ear photosynthesis to the drought productivity is still limited. We have conducted the drought studies in wheat at Hokkaido University. Domestic and abroad wheat varieties (ICARDA and Hokkaido varieties) were evaluated the contribution of ear photosynthesis to grain yield in field trials. The wheat were cultivated under well- and restricted-irrigation conditions. At the ear emergence, the ear photosynthesis restriction was imposed by covering the entire ears with aluminum foils (shading ear treatment), and as control treatment, normal cultivation without the foil covering was set. Their canopy photosynthesis and drought performances were evaluated during the cultivation periods. The shading ears brought significant yield reductions. In addition, there was significant correlation between the canopy photosynthetic rate during the ripening period and yield. These indicated the significance of ear photosynthesis to the canopy photosynthesis which could determine the grain yield. The contributions of ear photosynthesis under drought conditions were increased significantly in two ICARDA varieties, but not in a Japanese variety. This indicated that the ear photosynthesis could more important as source organ if they were subjected to droughts, although the magnitudes would depend on the genotypes.

[O33] Salinity

Chair: Yoshihiko Hirai (Okayama University, Japan)
Chair: Sakae Agarie (Kyushu University, Japan)
Chair: Glenn Borja Gregorio (Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), Phillippines)
Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 3 (Oral) (Abiotic Stress for Crop Production)

[O33-01] Sustainable and Innovative Solutions to the Salinity Intrusion in the Mekong River Delta Affecting Rice Production

○Glenn Borja Gregorio[1, 2, 3] (1.College of Agriculture and Food Science, University of the Philippines Los Baños, Philippines, 2.Office of the Director, Southeast Asian Regional Center for Graduate Study and Research in, Philippines, 3.National Academy of Science and Technology, Department of Science and Technology, Philippines)

5:00 PM - 5:20 PM

[O33-02] Mechanism of Salt Removal Ability in Leaf Sheath of Rice and its Potential for Molecular Breeding

○Shiro Mitsuya[1], Sarin Neang[1], Nicola S. Skoulding[2], Joyce A. Cartagena[1], Mana Kano-Nakata[3], Akira Yamauchi[1] (1.Graduate School of Biological Sciences, Nagoya University, Japan, 2.Graduate School of Science, Nagoya University, Japan, 3.International Center for Research and Education in Agriculture, Nagoya University, Japan)

5:20 PM - 5:40 PM

[O33-03] Morphological and Microsatellite Marker Assisted Genetic Diversity Analysis of Wheat Genotypes for Salinity Tolerance

○Sayma Farabi[1], Nihar Ranjan Saha[2], Md. Hasanuzzaman[3], Md. Shahidul Haque[4], Mirza Mofazzal Islam[5] (1.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 2.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 3.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 4.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 5.Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture, Bangladesh)

5:40 PM - 5:55 PM

[O33-04] Rice Memorizes Salinity Stress by Training and Improves the Salinity Stress Response and Yield

○Satoru Sakuma[1], Akira Yamauchi[2], Shiro Mitsuya[2], Mana Nakata[2] (1.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan)

5:55 PM - 6:10 PM

[O33-05] Cl^- More Detrimental Than Na^+ in Salt-Stressed Rice

○Yoshihiko Hirai[1], Hanh Duy Dao[1], Mao Kuroda[2], Kazushi Hirai[1] (1.Graduate School of Environmental and Life Science, Okayama University, Japan, 2.Faculty of Agriculture, Okayama University, Japan)

6:10 PM - 6:25 PM

[O33-06] Three-Dimensional Analysis on the Internal Structure of Rice Leaf Tissue and the Intracellular Structure of Mesophyll Cells

○Rachana Ouk, Takao Oi, Mitsutaka Taniguchi （Graduate School of Bioagricultural Sciences, Nagoya University, Japan）
6:25 PM - 6:40 PM

5:00 PM - 5:20 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 3 (Oral))

[O33-01] Sustainable and Innovative Solutions to the Salinity Intrusion in the Mekong River Delta Affecting Rice Production

(Invited Speaker)

○Glenn Borja Gregorio[1, 2, 3] (1.College of Agriculture and Food Science, University of the Philippines Los Baños, Philippines, 2.Office of the Director, Southeast Asian Regional Center for Graduate Study and Research in, Philippines, 3.National Academy of Science and Technology, Department of Science and Technology, Philippines)

Salinization, as aggravated by climate hazards, has been significantly affecting rice production in the Mekong River Delta, a major rice production region in Vietnam. What can farmers do to effectively respond to salinization and ensure farm production is maximized? Suggested solutions-massive promotion of Good Agricultural Practices (GAP) including cultivating saline-tolerant rice varieties among farmers up to a level that achieved significant and wider strategic adoption. To ensure institutional flexibility to respond to climate change-induced salinity and other hazards, the following policy interventions are suggested: Sustained promotion and support for research and development towards the development and wider adoption of integrated rice farming technologies that ensure high productivity and resilience; More research on effectively identifying and designing innovative ways to improve rice production efficiency along with establishing credit and insurance systems for rice farmers; Awareness building on the adverse impacts of unsustainable practices such as extensive groundwater pumping and agro-chemical application; Investments to improve varieties that have tolerance to flooding, drought, heat, and salinity and a breeding program for new varieties, while maintaining support to traditional rice varieties; Enhanced application of modern technology and science-based recommendations along with capacity development for improved rice seed quality, innovative cropping system, pest and disease management, infrastructure and enterprise development to ensure efficiency at lowest risk for farmers; Farmers' adoption of GAP, particularly the use of climate change-ready rice varieties to effectively respond to salinization and ensure farm production is maximized.

5:20 PM - 5:40 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 3 (Oral))

[O33-02] Mechanism of Salt Removal Ability in Leaf Sheath of Rice and its Potential for Molecular Breeding

(Invited Speaker)

○Shiro Mitsuya[1], Sarin Neang[1], Nicola S. Skoulding[2], Joyce A. Cartagena[1], Mana Kano-Nakata[3], Akira Yamauchi[1] (1.Graduate School of Biological Sciences, Nagoya University, Japan, 2.Graduate School of Science, Nagoya University, Japan, 3.International Center for Research and Education in Agriculture, Nagoya University, Japan)

Rice is sensitive to high salinity and the presence of salt in the soil decreases growth and productivity. At the seedling stage, maintaining low sodium and chloride concentrations in leaf blade is a key trait in determining the growth of rice. Rice has the ability to salt remove salt in the leaf sheath and our group has focused on the physiological and molecular mechanisms. We found that, in the rice leaf sheath, excess amounts of sodium and chloride ions are unloaded from xylem vessels, preferentially transported

from vasculature to the central part, then accumulated in the fundamental parenchyma cells. Furthermore, sodium and chloride ions are removed in different parts of the leaf sheath along the longitudinal axis; basal for sodium and tip parts for chloride. A comprehensive transcription analysis using RNA seq revealed the involvement of fundamental parenchyma cells at the center of the leaf sheath, in over-accumulation of salt under salinity. There was a wide variation of sodium removal ability in the leaf sheath among the 296 rice varieties, which positively correlated with salt tolerance. GWAS revealed significantly associated SNPs for sodium removal ability in leaf sheath on chromosome 5, which will facilitate the dissection of the molecular mechanism and further molecular breeding of salt tolerant rice varieties. In contrast, there was a small variation regarding chloride removal ability in leaf sheath but it did not have a significant association with salt tolerance.

5:40 PM - 5:55 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 3 (Oral))

[O33-03] Morphological and Microsatellite Marker Assisted Genetic Diversity Analysis of Wheat Genotypes for Salinity Tolerance

*Nominated for Presentation Awards

○Sayma Farabi[1], Nihar Ranjan Saha[2], Md. Hasanuzzaman[3], Md. Shahidul Haque[4], Mirza Mofazzal Islam[5]
（1.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 2.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 3.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 4.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 5.Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture, Bangladesh）

Salt affected soils can be better utilized by developing and growing salt tolerant wheat varieties. To find out the genetic diversity, screening was conducted to evaluate the salt tolerance capacity of 46 (24 Bangladeshi and 22 exotic) wheat genotypes in Hoagland's hydroponic nutrient solution under four different salt concentrations (control, 9, 12 and 15 dS/m) on the basis of salt tolerant index (STI) and microsatellite markers. The experiment was conducted with a Completely Randomized Design (CRD) with 2 replications. The results showed that different levels of salinity significantly affected the growth attributes by reducing the length, dry and fresh weight of roots and shoots. The highest STI was shown in nine tolerant genotypes namely ESWYT P-2 Borkot, ESWYT P-5, Agroni, ESWYT P-8, BARI-23, ESWYT P-30, ESWYT P-19, ESWYT P-12. The molecular analysis of the wheat genotypes was carried out with 30 SSR markers related to salt tolerance. A total of 128 alleles were detected among the 46 wheat genotypes with an average of 4.47 alleles per locus for salt related SSR marker. The highest polymorphism information content (PIC) and Nei's (1973) gene diversity, 0.7408 and 0.7760 were produced by the marker Xtxp-12 in this experiment. Similarity indices based cluster analysis separated 46 genotypes into seven different clusters. Considering the above facts, the salt tolerant varieties and inbreed lines identified in this study could be used as parents to incorporate salt tolerance in future wheat cultivars. Further research is underway.

5:55 PM - 6:10 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 3 (Oral))

[O33-04] Rice Memorizes Salinity Stress by Training and Improves the Salinity Stress Response and Yield

*Nominated for Presentation Awards

○Satoru Sakuma[1], Akira Yamauchi[2], Shiro Mitsuya[2], Mana Nakata[2] （1.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan）

Training is a technique to apply abiotic stress in advance such as salinity to plants. It enables plants to memorize the stress and change the molecular and physiological responses, e.g. the expression of stress-responsive genes, to future stresses. Therefore, we determined whether salinity training improves the growth and yield of rice grown under long-term salt stress conditions. Also, we investigated the change in the salinity stress response at the transcriptome level.
A rice variety Nipponbare was hydroponically grown for 90 days including 4-day germination. In the germination, training plants (T) were treated with 125 mM NaCl and non-training plants (NT) were treated with distilled water. The salinity stress was applied by adding 50 mM NaCl to the hydroponic solution from 18 to 90 day. On days 18, 19, and 47, total RNA was extracted from the leaf blades and used for RNA-seq analysis.
The yield of the T was significantly increased by 1.45-fold compared with that of NT under salinity condition. However, there was no significant difference in yield under control conditions, suggesting that training improved salinity tolerance with no yield penalty under control. On day 18, just before the start of the salinity stress treatment, the expression levels of H1 genes were significantly lower in T. Although there were 1971 salinity response genes on day 19, 830 genes responded to salinity stress only in T. This suggests that H1s, linker histones which recruit DNA methyltransferase, may have retained stress memory and altered the response of other genes to subsequent salinity.

6:10 PM - 6:25 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 3 (Oral))

[O33-05] Cl^- More Detrimental Than Na^+ in Salt-Stressed Rice

○Yoshihiko Hirai[1], Hanh Duy Dao[1], Mao Kuroda[2], Kazushi Hirai[1] （1.Graduate School of Environmental and Life Science, Okayama University, Japan, 2.Faculty of Agriculture, Okayama University, Japan）

Rice is the most sensitive to salinity among cereal crops. The salinity tolerance of rice is thought to be closely related to Na^+ accumulation in shoots, then, most research on salinity tolerance in rice focuses on the toxicity of Na^+ and not Cl^-. However, the comparison of the responses to Na^+ and Cl^- is limited. To learn the effect of Na^+ and Cl^- on rice seedling, five rice varieties differing in salinity tolerance were grown in nutrient solution with NaCl and/or KCl. As the result, there was a positive correlation between the percentage of dead leaves and the Cl^- content in the plants, but not between the percentage of dead leaves and Na^+ content. To study the difference in the long-term effects of Na^+ and Cl^- on the plant growth and grain productivities, three rice varieties differing in salinity tolerance were grown in pots irrigated by water with NaCl or KCl in the same molar concentration. As the result, there was a negative significant correlation between the relative dry weight and grain yield (treated/control) and the Cl^- content in the plants. Moreover, to confirm the effects of Cl^- on the plant growth and grain productivities, three rice varieties were subjected to four iso-osmotic salt stresses, then similar results were observed. From these results, it was suggested that plant growth and grain yield under salinity conditions were reduced by Cl^- toxicity rather than Na^+ toxicity.

6:25 PM - 6:40 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 3 (Oral))

[O33-06] Three-Dimensional Analysis on the Internal Structure of Rice Leaf Tissue and the Intracellular Structure of Mesophyll Cells

*Nominated for Presentation Awards

○Rachana Ouk, Takao Oi, Mitsutaka Taniguchi （Graduate School of Bioagricultural Sciences, Nagoya University, Japan）

Anatomical characteristics of the mesophyll in leaves are essential for understanding the plant photosynthetic ability, potential productivity, and environmental stress adaptation. Mesophyll cells in rice leaf blades have an intricate shape with a large volume of chloroplasts compared to other crops, enhancing the gas exchange between stroma and intercellular airspace. The capacity of the gas diffusion inside the leaf depends on the intracellular structure and intercellular airspace. However, it is hard to characterize their structures on a three-dimensional (3D) level. This study used the 3D reconstruction method based on serial section light microscopy to compare the cell structures and intercellular airspace at three regions (adaxial, middle, abaxial) of rice leaf tissues. The 3D reconstructed models revealed that the sizes of adaxial mesophyll cells appeared to be larger than those of middle and abaxial mesophyll cells. In contrast, the mesophyll cell density in the middle region was higher than those in the adaxial and abaxial regions. The volume of chloroplasts in adaxial mesophyll cells was more significant than those in the middle and abaxial mesophyll cells. The volume of intercellular airspace in leaves showed no difference among the three regions. Based on the 3D anatomical value, we will discuss the surface areas of mesophyll cells (S_{mes}) and chloroplasts (S_c) facing intercellular airspace that are important for photosynthetic ability.

[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.

[O41] Genetic Improvement of Crop Yield

Chair: Taichiro Ookawa (Tokyo University of Agriculture and Technology, Japan)
Chair: Hiroshi Fukayama (Kobe University, Japan)
Chair: Masahiro Kishii (International Maize and Wheat Improvement Center, Mexico)
Chair: Shunsuke Adachi (Tokyo University of Agriculture and Technology, Japan)
Thu. Sep 9, 2021 9:45 AM - 11:45 AM Room 4 (Oral) (Crop Genetics and Physiology)

[O41-01] Physiological Traits to Breed for Yield Potential

○Matthew Reynolds, Gemma Molero, Carolina Rivera-Amado, Francisco Piñera-Chavez, Francisco Pinto, Margaret Krause, Liana Acevedo, Sivakumar Sukumaran （International Maize and Wheat Improvement Center, Mexico）

9:45 AM - 10:05 AM

[O41-02] A Challenge for the Improvement of Photosynthetic Capacity by the Introduction of C_4-Like Rubisco in Rice

○Hiroshi Fukayama[1], Keita Shiomi[1], Yuri Taketani[1], Hiroki Yoshikawa[2], Daisuke Sasayama[1], Tomoko Hatanaka[1], Tetsushi Azuma[1], Takuya Yoshizawa[2], Shun-Ichi Tanaka[2], Hiroyoshi Matsumura[2] （1.Graduate School of Agricultural Science, Kobe University, Japan, 2.Department of Biotechnology, Ritsumeikan University, Japan）

10:05 AM - 10:25 AM

[O41-03] Predictive Modeling of Leaf Photosynthetic Rate in Field-Grown Rice Using Transcriptome Dataset

○Sotaro Honda[1], Satoshi Ohkubo[2], Makoto Kashima[3], Nan Su San[2], Anothai Nakkasame[2], Hiroki Saito[4], Taiichiro Ookawa[2], Atsushi J. Nagano[5], Shunsuke Adachi[6] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 3.College of Science and Engineering, Aoyama Gakuin University, Japan, 4.Japan International Research Center for Agricultural Sciences, Japan, 5.Faculty of Agriculture, Ryukoku University, Japan, 6.College of Agricuture, Ibaraki University, Japan）

10:25 AM - 10:40 AM

[O41-04] Natural Variation in Photosynthetic Induction Response in Rice (*Oryza sativa* L.)

○Kazuki Taniyoshi, Yu Tanaka, Tatsuhiko Shiraiwa （Graduate School of Agriculture, Kyoto University, Japan）

10:40 AM - 10:55 AM

[O41-05] Identification of QTLs for Strong Culm with Pleiotropic Effect on Panicle Morphology by GWAS Using Rice Varieties in Japan

○Tomohiro Nomura[1], Kenji Yano[2], Makoto Matsuoka[3], Ko Hirano[3], Shunsuke Adachi[4], Francisco Javier Piñera-Chavez[5], Matthew Paul Reynolds[5], Taiichiro Ookawa[1] （1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Statistical Genetics Team, RIKEN Center for Advanced Intelligence Project, Japan, 3.Bioscience and Biotechnology Center, Nagoya University, Japan, 4.College of Agriculture, Ibaraki University, Japan, 5.Global Wheat Program, International Maize and Wheat Improvement Center, Mexico）

10:55 AM - 11:10 AM

[O41-06] Highly Active *Vernonia galamensis* DGAT1 Can Effectively Increase Oil Levels in Yeast, Soybean and Arabidopsis

○Tomoko Hatanaka[1], Yoshiki Tomita[1], Choi-Wing Chau[1], Honoka Ito[2], Daisuke Sasayama[1], Hiroshi Fukayama[1], Tetsushi Azuma[1], David F. Hildebrand[3] （1.Graduate School of Agricultural Science, Kobe University, Japan, 2.Faculty of Agriculture, Kobe University, Japan, 3.Department of Plant and Soil Sciences, University of Kentucky, United States）

11:10 AM - 11:25 AM

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

[O41-01] Physiological Traits to Breed for Yield Potential

(Invited Speaker)

○Matthew Reynolds, Gemma Molero, Carolina Rivera-Amado, Francisco Piñera-Chavez, Francisco Pinto, Margaret Krause, Liana Acevedo, Sivakumar Sukumaran （International Maize and Wheat Improvement Center, Mexico）

Boosting yield potential considers increasing net photosynthesis (source) and improving partitioning of photo-assimilates to grain (sink). Genetic variation in radiation use efficiency is observed in advanced wheat lines, and unimproved genetic resources. Research to boost photosynthesis per se considers several traits. Slow adjustment of photosynthetic efficiency during shade-sun transitions can cost 20% of potential carbon uptake. Genetically diverse wheat lines showed that natural variation in adjustment was correlated with final yield. Boosting spike photosynthesis (SP) represents an untapped opportunity to improve canopy photosynthesis since spikes intercept ~40% of incident light. Among elite lines, genetic variation in SP contribution to yield ranged from 20-50%. More optimal light and N distribution in crop-canopies can theoretically boost RUE; field research showed that lines with more evenly distributed chlorophyll in the upper three leaves express higher yield and biomass and explained >20% RUE variation. Several traits determine sink-strength. Stem middle internodes 2 and 3 grow at the same time as developing spikes, effectively competing for assimilate. Genetic variation for these internodes was associated with increased grain number without reduction in plant height in elite lines. Fruiting efficiency – grain number/dry weight of spike at flowering- was also associated with sink strength and yield. Lodging is common at high yield; significant variation for stem and anchorage strength exists in elite lines, indicating breeding targets. Pre-breeding to boost yield potential used strategic crosses to complement source and sink traits. Yield advantage of best progeny over CIMMYT checks has been up to 8% across international target environments.

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

[O41-02] A Challenge for the Improvement of Photosynthetic Capacity by the Introduction of C_4-Like Rubisco in Rice

○Hiroshi Fukayama[1], Keita Shiomi[1], Yuri Taketani[1], Hiroki Yoshikawa[2], Daisuke Sasayama[1], Tomoko Hatanaka[1], Tetsushi Azuma[1], Takuya Yoshizawa[2], Shun-Ichi Tanaka[2], Hiroyoshi Matsumura[2] （1.Graduate School of Agricultural Science, Kobe University, Japan, 2.Department of Biotechnology, Ritsumeikan University, Japan）

Ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco) is the key enzyme of photosynthetic CO_2 fixation. Rubisco in C_4 plants generally shows higher catalytic rate (k_{cat}) than that in C_3 plants. In our previous study, the chimeric incorporation of sorghum Rubisco small subunit (RbcS) significantly increased the Rubisco k_{cat} in rice. In this study, we knocked out rice RbcS multigene family by CRISPR/Cas9 and completely replaced the rice RbcS with sorghum RbcS in rice Rubisco. Obtained hybrid-Rubisco (CSS-Rubisco) showed almost C_4-plant-like catalytic properties, i.e., higher k_{cat} and K_m for CO_2. Transgenic lines expressing the hybrid-Rubisco accumulated moderately reduced levels of Rubisco and showed slight but significantly higher photosynthetic capacity at high CO_2 condition than non-transgenic rice. Grown under ambient CO_2 condition (40 Pa), the total dry weight in CSS lines was significantly lower than that in WT, whereas it was recovered to the level of WT under elevated CO_2

condition (100 and 300 Pa). The crystal structure of CSS-Rubisco in the sulfate-bound forms revealed a substantial structural difference in the β-hairpin (β C-β D) of RbcS around Leu101 in sorghum RbcS, which is likely to impact the flexibility of the 60s loop of Rubisco catalytic site. These results suggest that Leu101 in sorghum RbcS can be an important determinant of the kinetic properties of Rubisco and a promising target of improving the photosynthetic capacity in C_3 plants.

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

[O41-03] Predictive Modeling of Leaf Photosynthetic Rate in Field-Grown Rice Using Transcriptome Dataset

*Nominated for Presentation Awards

○Sotaro Honda[1], Satoshi Ohkubo[2], Makoto Kashima[3], Nan Su San[2], Anothai Nakkasame[2], Hiroki Saito[4], Taiichiro Ookawa[2], Atsushi J. Nagano[5], Shunsuke Adachi[6] (1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 3.College of Science and Engineering, Aoyama Gakuin University, Japan, 4.Japan International Research Center for Agricultural Sciences, Japan, 5.Faculty of Agriculture, Ryukoku University, Japan, 6.College of Agricuture, Ibaraki University, Japan)

Leaf photosynthetic rate is affected by several environmental factors including irradiance and temperature, as well as by genetic factors and plant age. Despite several models estimating photosynthetic rates under various environments have been released, a model considering genetic factors and plant age besides environmental factors has remained to be developed. Transcriptome containing over 23,000 gene expression data per sample appears to represent the physiological condition of a field-grown plant influenced by all these factors. Therefore, it may provide sufficient explanatory variables for a statistical model. To test this hypothesis, we obtained leaf CO_2 assimilation rates over 13,000 data points from 80 inbred rice lines derived from cvs. Koshihikari and Takanari across their growth periods. We also prepared the transcriptome profile corresponding to each photosynthesis data point from another predictive model estimating transcriptome from genotypic data, meteorological data and scaled age (Kashima et al. 2020). Taken together, we developed a novel predictive regression model with LASSO (Tibshirani 1996). This model predicted the photosynthetic dynamics of rice lines which were different from the model training lines. Our results suggest that the statistical modeling using transcriptome is a promising approach to predict photosynthetic dynamics of a certain plant under unexperienced field environment such as future climate change conditions. This approach would be also applied to the other agronomic traits which should be improved for stable food supply.

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

[O41-04] Natural Variation in Photosynthetic Induction Response in Rice (*Oryza sativa* L.)

*Nominated for Presentation Awards

○Kazuki Taniyoshi, Yu Tanaka, Tatsuhiko Shiraiwa (Graduate School of Agriculture, Kyoto University, Japan)

Leaves of crop in field conditions experience fluctuating light intensity because of cloud movement and self-shading. The CO_2 assimilation rate increases gradually when leaves are subjected to sudden increases in light intensity. This process is called as photosynthetic induction response and potentially affects the crop productivity. Here, we evaluated the genetic diversity of the photosynthetic induction response among the rice diversity research set of germplasm, with two reference genotypes; Koshihikari and Takanari. Takanari is known to be a high yielding rice variety and have superior photosynthetic induction response to Koshihikari, a popular rice variety in Japan. The photosynthetic induction response showed large diversity among 59 genotypes. Cumulative CO_2 fixation during the first 10 minutes after the transition from low to high light intensity (CCF_{10}) had at most four fold differences among genotypes, from 14.2 mmol CO_2 m^{-2} of ARC 11094 to 3.6 mmol CO_2 m^{-2} of Koshihikari. CCF_{10} was closely correlated with CO_2 assimilation rate and stomatal conductance just before the transition from low to high light intensity. These results indicate that the speed of photosynthetic induction response is predictable from the status of plants under low light intensity. In conclusion, the present study shows the large genetic diversity and a room of genetic improvement of the photosynthetic induction response in rice.

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

[O41-05] Identification of QTLs for Strong Culm with Pleiotropic Effect on Panicle Morphology by GWAS Using Rice Varieties in Japan

*Nominated for Presentation Awards

○Tomohiro Nomura[1], Kenji Yano[2], Makoto Matsuoka[3], Ko Hirano[3], Shunsuke Adachi[4], Francisco Javier Piñera-Chavez[5], Matthew Paul Reynolds[5], Taiichiro Ookawa[1] (1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Statistical Genetics Team, RIKEN Center for Advanced Intelligence Project, Japan, 3.Bioscience and Biotechnology Center, Nagoya University, Japan, 4.College of Agriculture, Ibaraki University, Japan, 5.Global Wheat Program, International Maize and Wheat Improvement Center, Mexico)

Since the "Green Revolution", *semidwarf1* (*sd1*) has been used for breeding rice (*Oryza sativa* L.) with shorter culms to prevent lodging, thereby contributing to food sufficiency especially in Asia. However, it has been pointed out that semi-dwarf varieties have low yield potential because of their low biomass production (Okuno et al., *PLoS ONE*, 2014). In addition, in recent years, typhoons have become larger due to global warming, and the rice lodging due to 'Super typhoons' has become serious problem in Japan and Southeast Asia. Therefore, in the future, it is important to enhance lodging resistance by strengthening rice culms while still achieving high yield. In this study, novel quantitative trait loci (QTLs) for traits associated with a strong culm were identified using genome-wide association study (GWAS), and pleiotropic effects of the QTLs on panicle morphology associated with yield components were evaluated. In 2018 and 2019, 168 and 334 *japonica* varieties including native varieties in Japan except Hokkaido were evaluated, respectively. High peaks associated not only the outer minor axis but also the number of secondary branches were detected on chromosome 1S, 2S, 2L and 8L in 2018, and chromosome 2L, 3S, 4L, 8L, 9L and 11S in 2019. Near the peak on chromosome 8L, *OsSPY* related to the plant architecture is located (Yano et al., *PNAS*, 2019), suggesting that *OsSPY* may affect not only panicle architecture but also culm thickness.

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

[O41-06] Highly Active *Vernonia galamensis* DGAT1 Can Effectively Increase Oil Levels in Yeast, Soybean and Arabidopsis

○Tomoko Hatanaka[1], Yoshiki Tomita[1], Choi-Wing Chau[1], Honoka Ito[2], Daisuke Sasayama[1], Hiroshi Fukayama[1], Tetsushi Azuma[1], David F. Hildebrand[3] (1.Graduate School of Agricultural Science, Kobe University, Japan, 2.Faculty of Agriculture, Kobe University, Japan, 3.Department of Plant and Soil Sciences, University of Kentucky, United States)

The worldwide production of vegetable oil is increasing due to world population growth, economic development and demand for renewable resources. Triacylglycerols (TAGs) are the major component of plant storage lipids. Acyl-CoA:diacylglycerol acyltransferase (DGAT) catalyzes the final step of Kennedy pathway and it is considered a rate-limiting enzyme responsible for the plant oil accumulation. We previously found DGAT activity of Vernonia (*Vernonia galamensis*) DGAT1 was distinctively higher than that of Arabidopsis DGAT1 and soybean DGAT1 in a yeast microsome assay. Soybean lines expressing Vernonia *DGAT1* showed a 20% increase in oil content without reductions in seed protein content or yield per unit land area.

In this study, the DGAT1 cDNAs of Arabidopsis, Vernonia, soybean and castor bean *DGAT1* were introduced into *Arabidopsis thaliana* under the control of a seed specific promoter. Oil content and fatty acid composition of T3 seeds from transgenic lines were analyzed. All Vernonia *DGAT1* expressing lines showed a significantly higher oil content (average 49% relative increase compared to the wild type) followed by soybean *DGAT1* (average 30% increase), castor *DGAT1* (average 21% increase), and most Arabidopsis *DGAT1* over-expressing lines did not show a significant increase. We also found several changes in fatty acid ratio between wild-type plants and transgenic lines. In Vernonia *DGAT1* expressing soybean lines, the ratio of 18:1 increased. In soybean *DGAT1* expressing Arabidopsis lines, the ratio of 18:3 increased and that of 18:1 decreased.

[O42] Assimilate Partitioning for Crop Productivity and Quality

Chair: Naohiro Aoki (The University of Tokyo, Japan)
Chair: Tatsuro Hirose (Takasaki University of Health and Welfare, Japan)
Chair: Yong-Ling Ruan (The University of Newcastle, Australia)
Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 4 (Oral) (Crop Genetics and Physiology)

[O42-01] Assimilate Partitioning in Crops: Developmental, Molecular, and Metabolic Aspects of Source-sink Interactions

○Yong-Ling Ruan （School of Environmental and Life Sciences, The University of Newcastle, Australia）

2:30 PM - 2:50 PM

[O42-02] Physiological Significance of an Alternative Step of Calvin-Benson Cycle in C_4 Photosynthesis in Mesophyll Cell Chloroplasts

○Tsuyoshi Furumoto （Ryukoku University, Japan）

2:50 PM - 3:10 PM

[O42-03] Co-Overproduction of Rubisco and Rubisco Activase Increases the Photosynthesis Rate under High Temperature in Rice

○Mao Suganami[1,2], Yuji Suzuki[3], Youshi Tazoe[1,4], Amane Makino[1] （1.Graduate School of Agricultural Science, Tohoku University, Japan, 2.Faculty of Food and Agricultural Sciences, Fukushima University, Japan, 3.Faculty of Agriculture, Iwate University, Japan, 4.Faculty of Agro-Food Science, Niigata Agro-Food University, Japan）

3:10 PM - 3:25 PM

[O42-04] What Factor Affects Genotypic Difference in Endophytic Nitrogen-fixing Ability in Rice?

○Takanori Okamoto[1], Rina Shinjo[1], Arisa Nishihara[2], Kazuma Uesaka[3], Aiko Tanaka[1], Daisuke Sugiura[1], Motohiko Kondo[1] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.Bioproduction Research Institute, National Institute of Advanced Industrial Science and Technology, Japan, 3.The Center for Gene Research, Nagoya University, Japan）

3:25 PM - 3:40 PM

[O42-05] Sink-Source Relationship in Short-duration and Hybrid Rice Varieties in Tropical Asia

○Phyo La Pyae Won[1], Noriko Kanno[2], Niño P. M. C. Banayo[3], Hongyan Liu[4], Crisanta S. Bueno[5], Pompe Sta. Cruz[6], Yoichiro Kato[7] （1.Department of Agronomy, Yezin Agricultural University, Myanmar, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.International Rice Research Institute, Philippines, 4.College of Tropical Crops, Hainan University, China, 5.International Rice Research Institute, Philippines, 6.College of Agriculture and Food Science, University of the Philippines Los Baños, Philippines, 7.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

3:40 PM - 3:55 PM

[O42-06] Genetic Modification of Non-structural Carbohydrate Composition in the Stem of Rice

○Naohiro Aoki[1], Tatsuro Hirose[2] （1.Graduate School of Agricultural and Life Sciences, The

University of Tokyo, Japan, 2.Faculty of Agriculture, Takasaki University of Health and Welfare, Japan）
3:55 PM - 4:10 PM

2:30 PM - 2:50 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 4 (Oral))

[O42-01] Assimilate Partitioning in Crops: Developmental, Molecular, and Metabolic Aspects of Source-sink Interactions

(Invited Speaker)
○Yong-Ling Ruan （School of Environmental and Life Sciences, The University of Newcastle, Australia）

In plants, interconnected metabolic and phytohormonal signalling networks allow adaption to changing environmental and developmental conditions and ensure the survival of species in fluctuating environments. By lifting source and sink activities to their maximum, massive yield increases can be foreseen, potentially closing the future yield gap resulting from an increasing world population and the transition to a carbon-neutral economy. To do so, a better understanding of the interplay between metabolic and developmental processes is required. In the past, these processes have been tackled independently from each other, but coordinated efforts are required to understand the fine mechanics of source– sink relations and thus optimize crop yield. Here, I introduce approaches to design high-yielding crop plants utilizing strategies derived from current metabolic concepts and our understanding of the molecular processes determining sink development.

2:50 PM - 3:10 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 4 (Oral))

[O42-02] Physiological Significance of an Alternative Step of Calvin-Benson Cycle in C_4 Photosynthesis in Mesophyll Cell Chloroplasts

(Invited Speaker)
○Tsuyoshi Furumoto （Ryukoku University, Japan）

C_4 photosynthetic plants, including several important crops, e.g., maize, sugarcane, and sorghum have developed a CO_2-concentrating metabolism based on functional differentiation of mesophyll- and bundle sheath cells. Since in addition to this CO_2-concentrating mechanism photosystem-derived oxygen generation in bundle sheath cells is also suppressed, the CO_2/O_2 partial pressure near Rubisco is high enough to inhibit the oxygenation reaction of Rubisco. In other words, in C_4 photosynthesis, the atmospheric CO_2 concentration is not the rate-limiting factor, but the light intensity is.
From the early stages of the discovery of C_4 photosynthesis, it has been known that the two enzymes of the reduction step of the Calvin-Benson cycle, 3-phosphoglycerate kinase and glyceraldehyde 3-phosphate dehydrogenase (GAPDH), also function in mesophyll cells. This is because the reducing power derived from the photosystem is produced in these cells. It was not clear what physiological phenomenon is responsible for the division of the reduction step of the Calvin-Benson cycle between the two cells in C_4 photosynthesis.
The amount of light from the sun fluctuates drastically and irregularly with clouds, and C_4 plants are thought to respond to this variation by finely regulating their metabolism. We found that GAPDH, one of the reduction steps in mesophyll cells, is activated at high light levels, and that CP12-3, which is highly expressed in C_4 photosynthetic plants, concerned in this activation. This mechanism of regulating metabolic fluxes between neighboring cells can be interpreted as a function of carbon partitioning, which has not received much attention so far.

3:10 PM - 3:25 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 4 (Oral))

[O42-03] Co-Overproduction of Rubisco and Rubisco Activase Increases the Photosynthesis Rate under High Temperature in Rice

*Nominated for Presentation Awards

○Mao Suganami[1,2], Yuji Suzuki[3], Youshi Tazoe[1,4], Amane Makino[1] (1.Graduate School of Agricultural Science, Tohoku University, Japan, 2.Faculty of Food and Agricultural Sciences, Fukushima University, Japan, 3.Faculty of Agriculture, Iwate University, Japan, 4.Faculty of Agro-Food Science, Niigata Agro-Food University, Japan)

Rubisco is a rate-limiting factor for light-saturated photosynthesis at the present atmospheric air conditions. However, overproduction of Rubisco in rice did not always lead to photosynthesis improvement. This was considered to be caused by a decline in the activation state of Rubisco. In this study, we tried to improve photosynthetic capacity by co-overproducing Rubisco and Rubisco activase (RCA). For this purpose, Rubisco-overproduced rice plants were crossed with RCA-overproduced rice plants. We successfully obtained several transgenic rice lines with 1.2- to 1.5-fold increase in Rubisco content and 1.3- to 2.2-fold increase in RCA content. Under conditions of high irradiance, 25℃ and ambient CO_2 levels, while the activation state of Rubisco in Rubisco-overproduced plants was lower than in wild-type plants, that in the co-overproduced plants was enhanced to a similar level of wild-type plants. However, the light-saturated rate of CO_2 assimilation per unit of leaf area in the co-overproduced plants did not exceed that of wild-type plants even under low CO_2 conditions. On the other hand, at high temperature (36℃), the rate of CO2 assimilation in co-overproduced plants was higher than that of wild-type plants by up to 20% under ambient and lower CO_2 conditions. These results demonstrated that under high temperature conditions, where photosynthesis is strongly limited by Rubisco capacity, co-overproduction of Rubisco and Rubisco activase was effective in improving photosynthesis in rice.

3:25 PM - 3:40 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 4 (Oral))

[O42-04] What Factor Affects Genotypic Difference in Endophytic Nitrogen-fixing Ability in Rice?

*Nominated for Presentation Awards

○Takanori Okamoto[1], Rina Shinjo[1], Arisa Nishihara[2], Kazuma Uesaka[3], Aiko Tanaka[1], Daisuke Sugiura[1], Motohiko Kondo[1] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.Bioproduction Research Institute, National Institute of Advanced Industrial Science and Technology, Japan, 3.The Center for Gene Research, Nagoya University, Japan)

Enhancement of nitrogen (N) fixing ability by endophytic bacteria in rice could lead to improving N utilization under low available N conditions. Endophytic N-fixing bacteria need a lot of energy to fix atmospheric N. However, it is unknown what carbon source and bacteria would affect N-fixing activity in rice. This study aimed to explore the effects of non-structural carbohydrates (NSC) on the N-fixing

activity and the endophytic bacterial flora in field-grown rice.
Field experiments were conducted at the Togo field of Nagoya University in 2017 & 2018. Six varieties were grown in 2017, and eight varieties and two mutant lines of Nipponbare (*agpl1* and *lse1*, each with different compositions of NSC) were grown in 2018. Acetylene reduction activity (ARA; the N-fixing activity) and NSC (glucose, sucrose and starch) concentrations in rice stems were determined at the heading stage. For the bacterial flora analysis, total DNA were extracted from the stems of three varieties and one mutant grown in 2018. Two genes were amplified by a primer set of 16S rRNA gene and nitrogenase (*nifH*) gene-specific primers (PolF/PolR) using Illumina MiSeq.
CG14 and *agpl1* mutant with higher sugar concentration showed higher ARA than Leafstar with higher starch concentration. These results suggest that stem ARA was influenced by the levels of soluble sugars. Bacterial flora analysis suggested the presence of variety and line-specific bacterial flora in both 16S rRNA and *nifH* genes. We will further discuss a new strategy for enhancing N-fixing ability in rice.

3:40 PM - 3:55 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 4 (Oral))

[O42-05] Sink-Source Relationship in Short-duration and Hybrid Rice Varieties in Tropical Asia

○Phyo La Pyae Won[1], Noriko Kanno[2], Niño P. M. C. Banayo[3], Hongyan Liu[4], Crisanta S. Bueno[5], Pompe Sta. Cruz[6], Yoichiro Kato[7] (1.Department of Agronomy, Yezin Agricultural University, Myanmar, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.International Rice Research Institute, Philippines, 4.College of Tropical Crops, Hainan University, China, 5.International Rice Research Institute, Philippines, 6.College of Agriculture and Food Science, University of the Philippines Los Baños, Philippines, 7.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan)

Poor grain filling has been often suggested as a major yield constraint in the popular short-duration rice varieties in tropical Asia. This study put emphasis on the sink-source relationship and the role of nonstructural carbohydrates (NSC) around heading on grain filling. Field experiments were conducted in four consecutive growing seasons at International Rice Research Institute (IRRI), Philippines in 2016 and 2017 to compare Rc10 (IR50404-57-2-2-3), a popular short-duration variety, and Rc132, a popular hybrid variety. The percentage of filled grains in Rc10 was lower than Rc132, although sink capacity (spikelets m^{-2} x single grain weight) of Rc10 was smaller than that of Rc132. Rc10 had lower content of stem NSC at heading whereas biomass accumulation during the grain filling stage (⊿ W) did not differ between varieties. Moreover, Rc10 translocated less NSC from stems to panicles and had lower total carbohydrate availability (NSC plus concurrent photoassimilates) than Rc132 during the early grain filling period. The results suggest that source limitation is likely a possible reason for poor grain filling of Rc10. Sufficient NSC accumulation around heading and photoassimilates supply to the developing caryopses will be required for further yield improvement in short-duration varieties in the tropics.

3:55 PM - 4:10 PM (Thu. Sep 9, 2021 2:30 PM - 4:30 PM Room 4 (Oral))

[O42-06] Genetic Modification of Non-structural Carbohydrate Composition in the Stem of Rice

○Naohiro Aoki[1], Tatsuro Hirose[2] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Faculty of Agriculture, Takasaki University of Health and Welfare, Japan）

In order to improve the self-sufficiency of food and renewable energy and make effective use of paddy fields in the future, it is important to make great strides in the multi-use of rice, such as for bioethanol and feed. We have shown that the accumulation and composition of stem non-structural carbohydrates (NSCs) can be genetically modified without affecting the function of the leaf blade or ears (endosperm). In this study, we crossed the existing high-starch feed rice cultivars "Leaf Star" or "Tachisuzuka" with a mutant line of "Nipponbare", which does not accumulate much starch in the stems due to a functional deficiency in *OsAGPL1* gene, and then grew their BC1F3 generations in paddy fields to investigate the relationship between the genotype and the stem sugar and starch contents at harvest. The results showed that stem starch content in AGPL1-deficient individuals, regardless of the parental cultivar, was almost zero, and soluble sugars were increased twice as much as in normal and heterozygous individuals, confirming the heritability of the high stem-sugar trait. In addition, the crude fat content was also increased in the stems of AGPL1-deficient individuals.

[O43] High Quality Food and Ingredients

Chair: Yoji Nitta (Fukushima University, Japan)
Chair: Akiko Fujita (Satake Corporation, Japan)
Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 4 (Oral) (Crop Genetics and Physiology)

[O43-01] How to Improve the Eating Quality of *Japonica* Rice in Jiangsu Province of China

○Cailin Wang, Yadong Zhang, Shu Yao, Zhen Zhu, Tao Chen, Qingyong Zhao, Lin Zhao, Lihui Zhou, Chunfang Zhao （Institute of Food Crops, Jiangsu Academy of Agricultural Sciences/Nanjing Branch of Chinese National Center for Rice Improvement/Jiangsu High Quality Rice R & D Center, China）

5:00 PM - 5:20 PM

[O43-02] The Conditional Chalky Grain Mutant *floury endosperm11-2* (*flo11-2*) of Rice (*Oryza sativa* L.) is Useful for Studies on Chalkiness

○Tomoyuki Katsube-Tanaka[1], Rehenuma Tabassum[1,3], Tokinori Dosaka[1], Hiroyuki Ichida[2], Ryouhei Morita[2], Yifan Ding[1], Tomoko Abe[2] （1.Graduate School of Agriculture, Kyoto University, Japan, 2.Nishina Center for Accelerator-Based Science, RIKEN, Japan, 3.Department of Crop Botany and Tea Production Technology, Sylhet Agricultural University, Bangladesh）

5:20 PM - 5:40 PM

[O43-03] Utilization of Image Analysis and Sensing Device Analysis for Evaluating Grain Quality of Cambodia Low Land Rice

○Srun Khema[1,2], Akiko Fujita[3], Kea Kong[1], Chhay Ngin[1], Ratana Neou[4], Koki Asano[2], Fitri Audia[2], Shuto Yamada[2], Mana Kano-Nakata[5], Akira Yamauchi[2], Toru Tashiro[5], Hiroshi Ehara[5,6] （1.General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 3.Bioinnovation Research Office, Technical Division, Satake Corporation, Japan, 4.National Laboratory, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 5.International Center for Research and Education in Agriculture, Nagoya University, Japan, 6.Applied Social System Institute of Asia, Nagoya University, Japan）

5:40 PM - 5:55 PM

[O43-04] Recent Trend of Ultra-Fine Structure of High-Quality and -Palatable Rice in Japan

○Youji Nitta （Faculty of Food and Agricultural Sciences, Fukushima University, Japan）

5:55 PM - 6:10 PM

[O43-05] Effects of Packaging Materials and Storage Duration on Quality of Farm Saved Black Sesame (*Sesamum indicum* L.) in Central Dry Zone of Myanmar

○Nyein Htwe[1], Hnin Thida Nyo[2], Kyaw Win[3] （1.Department of Agricultural Extension, Yezin Agricultural University, Myanmar, 2.Division of Planning, Department of Agriculture, Myanmar, 3.Rector's Office, Yezin Agricultural University, Myanmar）

6:10 PM - 6:25 PM

[O43-06] Deployment of Cooking and Eating Quality Models as a Novel Breeding Tool to Predict Texture and Premium Grain Quality Segments

Reuben James Q. Buenafe [1,2], Vasudev Kumanduri [1,3],○Nese Sreenivasulu[1] （1. Grain Quality and Nutrition Center, International Rice Research Institute, Philippines, 2. School of Chemical, Biological, Materials Engineering and Sciences, Mapua University, Philippines, 3. Piatrika Biosystems, United Kingdom）

6:25 PM - 6:40 PM

[O43-07] Agricultural Innovation for Improved Human Nutrition and Health

○Russell Reinke[1], Raul Boncodin[1], Mallikarjuna Swamy[1], Reynante Ordonio[2], Md Abdul Kader[3]（1. International Rice Research Institute, Philippines, 2. Philippine Rice Research Institute, Philippines, 3. Bangladesh Rice Research Institute, Bangladesh）

6:40 PM - 6:55 PM

5:00 PM - 5:20 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 4 (Oral))

[O43-01] How to Improve the Eating Quality of *Japonica* Rice in Jiangsu Province of China

(Invited Speaker)

○Cailin Wang, Yadong Zhang, Shu Yao, Zhen Zhu, Tao Chen, Qingyong Zhao, Lin Zhao, Lihui Zhou, Chunfang Zhao (Institute of Food Crops, Jiangsu Academy of Agricultural Sciences/Nanjing Branch of Chinese National Center for Rice Improvement/Jiangsu High Quality Rice R & D Center, China)

Rice is the most important food crop in China. Improving rice yield and quality is an important measure to guarantee the absolute supply of food and improve people's living standard in China. With the improvement of living standards, quality has become a prime target for rice breeding in Jiangsu province of China. Eating quality is the core of rice quality. However, what factors are related to eating quality? In Jiangsu Province, the temperature during heading and filling period is higher and the temperature difference between day and night is smaller, it is difficult to form good taste quality of rice. So, how to improve the eating quality? Although studies have shown that the eating quality depends mainly on the content of amylose, protein and moisture in rice, amylose content is the key. However, the eating quality depends on artificial taste, breeding is difficult. How much amylose content is good? How to choose the genotypes with good eating quality, disease resistance and high yield? All these are lack of theoretical guidance. This paper reported our twenty year's systematic studies on the breeding approaches of *japonica* rice varieties with good quality, disease resistance and high yield in Jiangsu province.

5:20 PM - 5:40 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 4 (Oral))

[O43-02] The Conditional Chalky Grain Mutant *floury endosperm11-2* (*flo11-2*) of Rice (*Oryza sativa* L.) is Useful for Studies on Chalkiness

○Tomoyuki Katsube-Tanaka[1], Rehenuma Tabassum[1,3], Tokinori Dosaka[1], Hiroyuki Ichida[2], Ryouhei Morita[2], Yifan Ding[1], Tomoko Abe[2] (1.Graduate School of Agriculture, Kyoto University, Japan, 2.Nishina Center for Accelerator-Based Science, RIKEN, Japan, 3.Department of Crop Botany and Tea Production Technology, Sylhet Agricultural University, Bangladesh)

High temperature (HT) in a grain filling associated with climate change diminishes grain quality as well as productivity of rice (*Oryza sativa* L.). Chalky grain is one of the main visible damages caused by HT, which leads to lower milling efficiency, lower palatability, and lower grade and price of rice. The underlying mechanism of the chalkiness is complicated and largely unknown, preventing sophisticated development of resistant cultivars and effective agronomical practices. In this study, we isolated and characterized the *floury endosperm11-2* (*flo11-2*) mutant, which showed higher degree of chalkiness than wild type under field conditions with mean temperature of 28℃ in a grain filling but similar degree of chalkiness to the wild type under phytotron conditions with mean temperature of 24℃. The *flo11-2* mutant has an amino acid substitution on the 259th aspartic acid with valine in the conserved ATPase domain of plastid-localized 70 kDa heat shock protein 2 (cpHSP70-2). The in vitro and in vivo analyses on the cpHSP70-2 demonstrated that lowered ATPase and chaperone activities of cpHSP70-2 are involved with the chalkiness of the *flo11-2* mutant. Using this high sensitivity of the *flo11-2* mutant to HT, we demonstrated that daily maximum temperature was more causative than daily mean or minimum

temperatures. Besides, the developmental stage around 20 days after flowering (DAF) was most sensitive to HT rather than the early stage up to 15 DAF. The *flo11-2* mutant is, therefore, a useful material for chalky grain research.

5:40 PM - 5:55 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 4 (Oral))

[O43-03] Utilization of Image Analysis and Sensing Device Analysis for Evaluating Grain Quality of Cambodia Low Land Rice

○Srun Khema[1,2], Akiko Fujita[3], Kea Kong[1], Chhay Ngin[1], Ratana Neou[4], Koki Asano[2], Fitri Audia[2], Shuto Yamada[2], Mana Kano-Nakata[5], Akira Yamauchi[2], Toru Tashiro[5], Hiroshi Ehara[5,6] (1.General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 3.Bioinnovation Research Office, Technical Division, Satake Corporation, Japan, 4.National Laboratory, Ministry of Agriculture, Forestry and Fisheries, Cambodia, 5.International Center for Research and Education in Agriculture, Nagoya University, Japan, 6.Applied Social System Institute of Asia, Nagoya University, Japan)

Cambodian milled rice export to international market has been increasing in volume remarkably. The consumer demand for rice in term of cooking and eating quality are different from country to county. To contribute to the promotion of Cambodian rice export, the evidence-based information about rice quality is very important. This study aims to compare quality of aromatic rice among eight samples in those six different *indica* lowland rice varieties from different producers/suppliers in Cambodia. Some sensing equipment analyses such as the grain scanner (image processing device), the rice taste analyzer for white rice and the taste analyzer unit for cooked rice with measures of freshness, hardness and stickiness, visual taste value, taste value using a near-infrared transmission sensor (Satake Corp., Japan) were employed with conventional chemical analyses. The whole grain percentage was over 60% and the sample grains were evaluated to be high grade according to the Cambodian standard. Although the taste values used for white rice and cooked rice are developed equipment originally for *temperate japonica*, short-grain rice varieties, and the measured values in this study are reference, the taste value showed a positive relationship with moisture content and a negative relationship with protein and amylose concentrations in white rice. The taste values by analyzer unit for cooked rice showed a positive relationship with visual taste value and stickiness, and a negative relationship with hardness.

5:55 PM - 6:10 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 4 (Oral))

[O43-04] Recent Trend of Ultra-Fine Structure of High-Quality and -Palatable Rice in Japan

(Invited Speaker)

○Youji Nitta (Faculty of Food and Agricultural Sciences, Fukushima University, Japan)

Ultra-fine structure of cooked rice were clarified using a scanning tunneling microscope with a specific preparation procedures especially focused on rice products of Fukushima Prefecture including Coastal Region. Three rice specimens which were cultivated and harvested in Fukushima Prefecture, Japan in 2018. Milled rice grains (90% milling) of cultivar 'Koshihikari' (harvested in Minamisoma city) and 'Hitomebore' (Kawauchi village) from Coastal Region ('Hamadori') locates in the Pacific Ocean side were

used. Rice grains were subjected to measure palatable-related characters by taste-evaluation machine. Cooking was conducted using 'IH pressure rice cooker', followed by freeze-drying with 'rapid freeze-vacuum lyophilization method'. Then specimens were coated surface with Pt or OsO4, and observed using electron microscope. Cultivar differences could not been observed in this experiment. In bright portions (BP) on the surface of cooked rice grain, a fine fiber-like structure and a membrane-like structure are developed with spongy-like hole inside. In surface layer of dark portion (DP), high-density-accumulation structure of gelatinized starch was observed on the surface. Though thickness of the high-density-accumulation structure ranged from thick to thin, indicates stickiness differences when eating. In addition, size of spongy-like hole was larger towards the center of the grain, seems to contribute elasticity. Conclusion is as follows: (A) Rice products of Fukushima Prefecture including Coastal Region has high-quality and palatable characters. (B) Though DP of cooked rice grain was evaluated as low-palatability so far, its inner structure has high-quality and palatable character when cooking by specific rice cookers especially in recent-developed rice cultivar/strain.

6:10 PM - 6:25 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 4 (Oral))

[O43-05] Effects of Packaging Materials and Storage Duration on Quality of Farm Saved Black Sesame (*Sesamum indicum* L.) in Central Dry Zone of Myanmar

○Nyein Htwe[1], Hnin Thida Nyo[2], Kyaw Win[3] (1.Department of Agricultural Extension, Yezin Agricultural University, Myanmar, 2.Division of Planning, Department of Agriculture, Myanmar, 3.Rector's Office, Yezin Agricultural University, Myanmar)

Sesame is one of the most important and ancient oil-seed crops. Storage and storage materials significantly effect on quality of seed during storage. Therefore, this study aimed to investigate the effects of different packaging materials and storage duration on farm saved black sesame (var. Samonnet) during storage. This study was conducted in pre-monsoon season (August 2016) and post-monsoon season (January 2017) at Central Dry Zone of Myanmar. The sesame was stored using two types of packaging materials, woven polypropylene bags and pioneer air-tight superbags (polyethylene) at six farmers' houses in each crop. Crude carbohydrate, protein, ash, oil content, free fatty acid percentage were measured. The data were recorded before storage and every two-month during the storage period of eight months. Significant effect of packaging materials on quality of black sesame was not observed in both seasons except decreasing free fatty acid percentage in pre-monsoon crop. However, during storage, ash, crude carbohydrates and free fatty acid value decreased and increasing trend of protein and oil content were found in pre-monsoon sesame. The ash, crude carbohydrates and oil content were not different from initial values, whereas, decreasing protein content and increasing free fatty acid value were recorded in post-monsoon sesame. It can be seen that protein degradation and lipid oxidation were not distinct during storage. The trend of changes of biochemical processes during storage were different between cultivated seasons of crop.

6:25 PM - 6:40 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 4 (Oral))

[O43-06] Deployment of Cooking and Eating Quality Models as a

Novel Breeding Tool to Predict Texture and Premium Grain Quality Segments

(Invited Speaker)

Reuben James Q. Buenafe [1,2], Vasudev Kumanduri [1,3], ○Nese Sreenivasulu[1] （1. Grain Quality and Nutrition Center, International Rice Research Institute, Philippines, 2. School of Chemical, Biological, Materials Engineering and Sciences, Mapua University, Philippines, 3. Piatrika Biosystems, United Kingdom）

Acceptance of new rice genotypes demanded by rice value chain depends on premium value of varieties that match consumer demands of regional preferences. High throughput prediction tools are not available to breeders to classify cooking and eating quality (CEQ) ideotypes and to capture texture of varieties. The pasting properties in combination with starch properties were used to develop two layered random forest (RF) models in order to classify the rice varieties into twelve distinct CEQ ideotypes with unique sensory profiles. Classification models developed using random forest method depicted the overall accuracy of 96 %. These CEQ models were found to be robust to predict ideotypes in both *Indica* and *Japonica* diversity panels grown under dry and wet seasons and across the years. We conducted random forest modeling using 1.8 million high density SNPs and identified top 1000 SNP features which explained CEQ model classification with the accuracy of 0.81. Furthermore these CEQ models were found to be valuable to predict textural preferences of IRRI breeding lines released during 1960–2013 and mega varieties preferred in South and South East Asia. The genome-phenome models based selection tools will be handy for screening of a variety that can be included as selection criteria in the breeding programs to cater the needs of both farmers and consumers. It was found out that Japan, Taiwan, Laos, and Thailand preferred rice that belongs to ideotype E which is generally sticky and soft rice. The identified mismatches can be addressed in future breeding programs by applying the derived models to capture the CEQ and textural preferences and disseminate the rightly chosen varieties to the target countries by matching the preference of consumers in terms of texture.

6:40 PM - 6:55 PM (Thu. Sep 9, 2021 5:00 PM - 7:00 PM Room 4 (Oral))

[O43-07] Agricultural Innovation for Improved Human Nutrition and Health

(Invited Speaker)

○Russell Reinke[1], Raul Boncodin[1], Mallikarjuna Swamy[1], Reynante Ordonio[2], Md Abdul Kader[3] （1. International Rice Research Institute, Philippines, 2. Philippine Rice Research Institute, Philippines, 3. Bangladesh Rice Research Institute, Bangladesh）

Vitamin A defi ciency is the leading cause of childhood blindness and child mortality. An estimated 33% of the world's preschool age children are vitamin A defi cient (VAD). Golden Rice is genetically modified to produce beta-carotene (provitamin A) in the rice grain to address VAD. It can complement existing VAD control efforts by supplying up to 30-50% of the EAR for vitamin A for vulnerable groups (women and children) in countries such as Bangladesh, Indonesia, and the Philippines, however Golden Rice requires regulatory approvals in these countries before deployment. We conducted molecular, phenotypic and compositional characterization of GR2E and control rice to substantiate that the food derived from golden rice is safe. GR2E introgression lines matched the performance of the recurrent parents for agronomic and yield performance and grain quality. No differences were observed in terms of pest and disease reaction per site. Lines in each genetic background had signifi cant amounts of carotenoids in the

milled grains two months after harvest and can meet our nutrition targets. Signifi cant progress has been made in achieving regulatory approvals, and multiple agencies have declared Golden Rice is as safe as ordinary rice. Recently the Philippines issued an approval for Commercial Propagation, allowing deployment of Golden Rice. Golden Rice is finally making its way to farmers' fields, and further innovations such as high iron and zinc rice are under development.

[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.