Wed. Sep 8, 2021

Plenary Room

Opening Ceremony
11:00 AM - 11:30 AM Plenary Room

Keynote Lectures | Keynote Lectures | KL-01

New Agricultural Research Paradigms to Build Resilient Food Systems
Lecturer: Jacqueline d'Arros Hughes (Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India)
Chair: Hiroshi Ehara (Nagoya University, Japan)
11:30 AM - 12:00 PM Plenary Room

[KL-01] New Agricultural Research Paradigms to Build Resilient Food Systems
Jacqueline d'Arros Hughes （Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India）
11:30 AM - 12:00 PM

Keynote Lectures | Keynote Lectures | KL-02

Ten Reasons Why Asian Crop Science Must be Reinforced
Lecturer: Osamu Koyama (President, Japan International Research Center for Agricultural Sciences, Japan)
Chair: Hiroshi Ehara (Nagoya University, Japan)
12:00 PM - 12:30 PM Plenary Room

[KL-02] Ten Reasons Why Asian Crop Science Must be Reinforced
Osamu Koyama （President, Japan International Research Center for Agricultural Sciences, Japan）
12:00 PM - 12:30 PM

Workshop (Presented by Sponsoring Company)
Latest Photosynthesis Measurement Systems (Meiwafosis Co., Ltd.)
12:30 PM - 1:00 PM Plenary Room

[WS-01] Latest Photosynthesis Measurement Systems
Meiwafosis Co., Ltd.
12:30 PM - 1:00 PM

Symposium | Symposium | S-01 - S-05

Climate Change and Advancing Rice Production in Asia
Chair: Jun-Ichi Sakagami (Kagoshima University, Japan)
1:55 PM - 4:30 PM Plenary Room

[S-01] Reduced Stomata Density and Size: The key to improve WUE in Climate-ready Rice
Mutiara K. Pitaloka[1], Robert S. Caine[2], Christopher Hepworth[3], Emily L. Harrison[2], Jen Sloan[2], Cattleya Chutteang[1], Chutima Phuntong[1], Rungsan Nongngok[1], Theerayut Toojinda[5], Siriphat Ruengpayak[4], Siwaret Arikit[1,4], Julie E. Gray[2], ○Apichart Vanavichit[1,4,5]
（1.Department of Agronomy, Faculty of Agriculture, Kasetsart University,Thailand, 2.Department of Molecular Biology and Biotechnology, University of Sheffield, UK, 3.Department of Animal and Plant Sciences, University of Sheffield, UK, 4.Rice Science Center, Kasetsart University, Thailand, 5.National Center of Genetic Engineering and Biotechnology (BIOTEC), National Science and Technology Development Agency (NSTDA), Thailand）
2:00 PM - 2:20 PM

[S-02] Maximizing Rice Production and Quality under Climate Change
○Junhwan Kim, Wangyu Sang, Pyeong Shin, Jaekyeong Baek, Dongwon Kwon, Yunho Lee, ChungIl Cho, Myungchul Seo （National Institute of Crop Science, RDA, Korea）
2:20 PM - 2:40 PM

[S-03] Global Climate Changes and Their Impacts on Crop Production
Toshihiro Hasegawa （Division of Climate Change Adaptation Research, Institute for Agri-Environmental Sciences, National Agricultural and Food Research Organization, Japan）
2:40 PM - 3:00 PM

[S-04] Challenges and Adaptation for Rice Production under Climate Change in Taiwan
Huu-Sheng Lur[1], ○Ming-Hwi Yao[2] （1.Department of Agronomy, National Taiwan University, Taiwan, 2.Taiwan Agricultural Research Institute, Council of Agriculture, Taiwan）
3:10 PM - 3:30 PM

[S-05] Farming Systems under Environmental Changes in the Mekong Delta of Vietnam
Nguyen Duy Can （College of Rural Development, Can Tho University, Vietnam）
3:30 PM - 3:50 PM

Young Scientist Forum
Supported by Working group for Fostering Young Scientists and Gender-Equal Participation, Crop Science Society of Japan (CSSJ)

5:00 PM - 7:00 PM Plenary Room

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

○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

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

[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

Thu. Sep 9, 2021

Room 1 (Poster)

[P1] Field Crop Production

12:15 PM - 2:00 PM Room 1 (Poster) (Field Crop Production)

[P1-01] Seed Size Evaluation of Rice Genotypes for Direct Seeding Development Cultivar
○Ahmad Rifqi Fauzi[1], Ahmad Junaedi[2], Iskandar Lubis[2], Munif Ghulamahdi[3], Hajrial Aswidinnoor[4]（1.Graduate School of Agronomy and Horticulture Study Program, Bogor Agricultural University, Indonesia, 2.Division of Plant Production, Agronomy and Horticulture Department, Faculty of Agriculture, Bogor Agricultural University, Indonesia, 3.Division of Plant Ecophysiology, Agronomy and Horticulture Department, Faculty of Agriculture, Bogor Agricultural University, Indonesia, 4.Division of Plant Genetic and Plant Breeding, Agronomy and Horticulture Department, Faculty of Agriculture, Bogor Agricultural University, Indonesia）
12:15 PM - 1:00 PM

[P1-02] Effects of Seed Drying and Storage Conditions on the Germination Characteristics and Emergence Rates in Early-Winter Direct Seeding of Paddy Rice
○Kensaku Suzuki, Seiji Oikawa, Naoko Aikawa, Hiroyuki Shimono（Department of Plant Biosciences, Faculty of Agriculture, Iwate University, Japan）
1:15 PM - 2:00 PM

[P1-03] Root-Elongated Seeds Can Extend the First Leaf Quickly in Direct-Seeded Rice
○Hiromi Imasu, Hiroyuki Shiratsuchi, Keiko Ito, Masami Furuhata（Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan）
12:15 PM - 1:00 PM

[P1-04] Effect of Seed Maturity on Seedling Establishment in Early-Winter Direct-Sowing Cultivation In Rice
○Seiji Oikawa, Kensaku Suzuki, Naoko Aikawa, Maya Matsunami, Hiroyuki Shimono（Department of Plant Biosciences, Faculty of Agriculture, Iwate University, Japan）
1:15 PM - 2:00 PM

[P1-05] Effect of Deep Seed Placement on the Crop Establishment and Yield of Dry Direct-Seeded Rice
○Noriko Kanno[1], Kyoko Ito[2], Taiken Nakashima[2],

Ricardo Garcia[3], Roel R. Suralta[4], Aurora M. Corales[4], Crisanta S. Bueno[5], Niño P. M. C. Banayo[5], Pompe C. Sta. Cruz[5], Virender Kumar[6], Yoichiro Kato[1]
（1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Graduate School of Agriculture, Hokkaido University, Japan, 3.Pangasinan State University Sta Maria, Philippines, 4.Philippine Rice Research Institute, Philippines, 5.University of the Philippines Los Baños, Philippines, 6.International Rice Research Institute, Philippines）
12:15 PM - 1:00 PM

[P1-06] Identification of Quantitative Trait Loci Controlling Nitrogen Use Efficiency-Related Traits in Rice at the Seedling Stage under Salt Condition by Genome-Wide Association Study
○NhungThi Hong Phan[1,2], Cuong Van Pham[2], Pierre Bertin[1]（1.Earth and Life Institue, Université Catholique de Louvain, Belgium, 2.Agronomy Faculty, Vietnam National University of Agriculture, Vietnam）
1:15 PM - 2:00 PM

[P1-07] Analysis of the N Uptake Pattern to Improve Increasing Yields of Dry Direct-Seeding Rice in a Cool Climate
○Mari Namikawa[1,2], Toshihiro Hasegawa[1], Takayuki Yabiku[1], Toshinori Matsunami[1]（1.Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Crop Science Laboratory, United Graduate School of Agricultural Sciences, Iwate University, Japan）
12:15 PM - 1:00 PM

[P1-08] Changes in Rice Farming from 2009 to 2019 in Three Rice Ecosystems with Contrasting Water Availability in Cambodia
-Labor Saving and Mechanization-
○Rinako Takashima[1,2], Akihiko Kamoshita[2], Sareth Chea[3], Sophornthida Lim[3]（1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Asian Natural Environmental Science Center, The University of Tokyo, Japan, 3.Socioeconomic office, Cambodian Agricultural Research and Development Institute (CARDI), Cambodia）
1:15 PM - 2:00 PM

[P1-09] Effect of Climate on the Yield of 'Ilpum' Rice Cultivar in Gyeongbuk Province, South Korea over the Past 25 Years
○Jong-Hee Shin[1], Chae-Min Han[1], Jung-Bae Kwon[1], Sang-Kuk Kim[2], Yong-Seub Shin[1]（1.Crop Research, Gyeongsangbuk-do Provincial Agricultural Research and Extension Services, Korea, 2., Bioresources Research Institute, Korea）
12:15 PM - 1:00 PM

[P1-10] Differences in Growth and Physiological Characteristics of Winter Wheat Growth under Various Nitrogen Topdressing Conditions
Jae-Gyeong Jeong[1], Jaeeun Choi[1], Young-Hun Lee[1], Gi-Eun Song[1,2], Jonghan Ko[3], Kyung-Do Lee[4], ○Sang-In Shim[1]（1.Department of Agronomy, Gyeongsang National University, Korea, 2.Division of Applied Life Science (BK21 Plus), Gyeongsang National University, Korea, 3.Department of Applied Plant Science, Chonnam National University, Korea, 4.Climate Change and Agro-Ecology Division, RDA, Korea）
1:15 PM - 2:00 PM

[P1-11] Importance of Water Resource Conservation in Agriculture of the Aso Region - Lessons from the Kumamoto Earthquake
○Jun Abe[1], Naoki Kato[2], Atsushi Kashimura[1], Hitoshi Kinouchi[1], Chinobu Okamoto[1]（1.School of Agriculture, Tokai University, Japan, 2.Kyushu Okinawa Agricultural Research Center, National Agriculture and Food Research Organization, Japan）
12:15 PM - 1:00 PM

[P1-12] Cultivar Difference of Iron Toxicity Tolerance in Rice (*Oryza sativa* L.) during Germination and Seedling Stages
○Haruka Aratani[1], Indrastuti A. Rumanti[2], Yoichiro Kato[1]（1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2., Indonesian Center for Rice Research, Indonesia）
1:15 PM - 2:00 PM

[P1-13] Variation in Grain Characteristics of Upland Rice Cultivated in Southeast Sulawesi, Indonesia
○Mayumi Kikuta[1], Yulius Barra Pasolon[2], Fransiscus Suramas Rembon[2], Akira Miyazaki[3], Yoshinori Yamamoto[3]（1.Graduate School of Integrated Sciences of Life, Hiroshima University, Japan, 2.Faculty of Agriculture, Halu Oleo University, Indonesia, 3.Faculty of Agriculture and Marine Science, Kochi University, Japan）

12:15 PM - 1:00 PM

[P1-14] Combined UAV and Phenotyping Data to Optimize the Growing Status and Management System on Rice Variety, TN11 and NCYU-TN2 in Taiwan

○Yu-Chien Tseng[1], Chun-Yi Wu[1], Wen Lii Huang[1], Wei-Jun Huang[2], Rong-Kuen Chen[3] (1.Agronomy Department, National Chiayi University, Taiwan, 2.Biomechatronic Engineering Department, National Chiayi University, Taiwan, 3.Chiayi Branch Station, Tainan District Agricultural Research and Extension Station, Taiwan)

1:15 PM - 2:00 PM

[P1-15] On-Farm Assessment on Growth and Yield Response of Maize to Different Planting Methods and Tillage Conditions in Rice-Based Cropping System in the Philippines

Kyoko Ito[1], Noriko Kanno[2], Ricardo Garcia[3], Roel R. Suralta[4], Aurora M. Corales[4], John O. Abon[4], Elmer G. Bautista[4], Crisanta S. Bueno[5], Niño P. M. C. Banayo[5], Pompe C. Sta. Cruz[5], Yoichiro Kato[2], ○Taiken Nakashima[1] (1.Graduate School of Agriculture, Hokkaido University, Japan, 2.The University of Tokyo, Japan, 3.Pangasinan State University Sta Maria, Philippines, 4.Philippine Rice Research Institute, Philippines, 5.University of the Philippines Los Baños, Philippines)

12:15 PM - 1:00 PM

[P1-16] Assessment of Dual-Purpose Sweet Potato Cultivation in Japan: Effects of Shoot Harvest Regimes and Cultivar Differences

○Kazuki Taguchi (Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan)

1:15 PM - 2:00 PM

[P1-17] Improved Fertilizer Use Efficiency of Rice by Deep-Place Fertilization Method

○Mumtahina Nabila[1], Keigo Yoshinaga[2], Shin Okamura[3], Tomoya Kumachi[2], Hiroyuki Shimono[2,4], Maya Matsunami[2] (1.United Graduate School of Agricultural Sciences, Iwate University, Japan, 2.Faculty of Agriculture, Iwate University, Japan, 3.Graduate School of Integrated Arts and Sciences, Iwate University, Japan, 4.Agri-Innovation Center, Iwate University, Japan)

12:15 PM - 1:00 PM

[P1-18] Ex-Ante Analysis of Rice Agroecosystems Areas, Yield and Production in Asia

○Jayson Osopelia Villamor (Department of Crop Science, Central Luzon State University, Philippines)

1:15 PM - 2:00 PM

[P1-19] NB-LRR-Encoding Genes Conferring Susceptibility to Organophosphate Pesticides and Leaf Greenness in Sorghum

○Zihuan Jing[1], Fiona Wacera W[1], Tsuneaki Takami[1], Hideki Takanashi[2], Fumi Fukada[1], Yoji Kawano[1], Hiromi Kajiya-Kanegae[3], Hiroyoshi Iwata[2], Nobuhiro Tsutsumi[2], Wataru Sakamoto[1] (1.Institute of Plant Science and Resources, Okayama University, Japan, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Research Center for Agricultural Information Technology, National Agriculture and Food Research Organization, Japan)

12:15 PM - 1:00 PM

[P1-20] Effect of *Phytophthora sojae* Inoculation on Soybean — Mortality as Affected by Environmental Factors and Growth of Survived Plant

○Terufumi Tada, Momo Kato, Chihiro Tanaka, Tatsuhiko Shiraiwa (Graduate School of Agriculture, Kyoto University, Japan)

1:15 PM - 2:00 PM

[P1-21] Effect of Narrow-Row Planting with Inter-Row Strip Tillage by Chisel Plough on Yield and Labor Saving to Soybean Cultivation at Field Converted from Paddy in Shonai-Plane of Japan

○Hiroyuki Takeda[1], Hidefumi Saito[1], Naoto Ikeyama[2], Hiroshi Saito[3] (1.Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Faculty of Agriculture, Yamagata University, Japan, 3.Rice Breeding and Crop Science Experiment Station, Yamagata Integrated Agricultural Research Center, Japan)

12:15 PM - 1:00 PM

[P1-22] The Evaluation of Disease Resistance, Agronomic Traits and Yield Among Four Market Types in Peanut (*Arachis hypogaea* L.) Germplasm Collection

○Hsin-I Kuo[1], Hung-Yu Dai[2], Yong-Pei Wu[3], Yu-Chien Tseng[1] (1.Agronomy Department, National Chaiyi University, Taiwan, 2.Agronomy Department, Chiayi Agricultural Experiment Station, Taiwan Agricultural

Research Institute, Taiwan, 3.Crop Division, Taiwan Agricultural Research Institute, Taiwan）
1:15 PM - 2:00 PM

[P1-23] Investigation of the Albinism Derived from Sub-Species Hybridization in Peanuts
○Chuan-You Li[1], Hung-Yu Dai[2], Yu-Chien Tseng[1]
（1.Agronomy Department, National Chiayi University, Taiwan, 2.Crop Division, Taiwan Agricultural Research Institute, Taiwan）
12:15 PM - 1:00 PM

[P1-24] Co-Inoculation of *Bacillus pumilus* TUAT1 and *Bradyrhizobium diazoefficiens* USDA110 on Soybean
○Rifa Fadhilah Munifah Hasibuan, Hinako Sugiura, Minori Miyatake, Naoko Ohkama-Ohtsu, Keisuke Katsura （Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan）
1:15 PM - 2:00 PM

[P1-25] Fodder and Grain Production by Double-Cropping System of Rye
○Masahiro Akimoto[1], Honami Okamoto[2], Taiki Yoshihira[3] （1.Agro-Environmental Science, Obihiro University of Agriculture and Veterinary Medicine, Japan, 2.Plant Science Unit, Obihiro University of Agriculture and Veterinary Medicine, Japan, 3.Collage of Agriculture, Food and Environmental Sciences, Rakuno Gakuen University, Japan）
12:15 PM - 1:00 PM

[P1-26] Anaerobic and High Light Stress-Induced Leaf Abscission in Chili Pepper (*Capsicum* spp.)
○Keita Goto[1], Shotaro Tamaru[1], Peter Balyejusa Ssenyonga[2], Emmanuel Kiprono Bore[2], Shin Yabuta[3], Jun-Ichi Sakagami[3] （1.The United Graduate School of Agricultural Sciences, Kagoshima University, Japan, 2.Graduate School of Agriculture, Forestry and Fisheries, Kagoshima University, Japan, 3.Faculty of Agriculture, Kagoshima University, Japan）
1:15 PM - 2:00 PM

[P1-27] Leaf Senescence Evaluation of Selected Interspecific Progenies between *O. sativa* and *O. glaberrima*; NERICA Varieties for Stay-Green Characteristics during Grain-Filling Period
○Peter Balyejusa Ssenyonga[1], Shin Yabuta[2], Shotaro Tamaru[3], Jun-Ichi Sakagami[1,2,3] （1.Graduate School of Agriculture, Forestry and Fisheries, Kagoshima University, Japan, 2.Faculty of Agriculture, Kagoshima University, Japan, 3.The United graduate School of Agricultural Sciences, Kagoshima University, Japan）
12:15 PM - 1:00 PM

Room 2 (Poster)

Poster Session | Farming System | P2: Poster Session

[P2] Farming System
12:15 PM - 2:00 PM Room 2 (Poster) (Farming System)

[P2-01] Soil Fertility Decline by Repeated Cropping of Rice for Whole Crop Silage – A Case of Mifune Town in Kumamoto Prefecture, Japan
○Naoki Moritsuka[1], Kaori Matsuoka[2], Kosuke Baba[1]
（1.Faculty of Agriculture and Marine Science, Kochi University, Japan, 2.Institute of Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan）
12:15 PM - 1:00 PM

[P2-02] A Case Study of Learning to Work on a Farm in a Special Need Education School for Children with Intellectual Disabilities – Focusing on the Cultivation of Rice Plant
○Izumi Oh-E （Retired, Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan）
1:15 PM - 2:00 PM

[P2-03] Growth and Yield of Rice, and Soil Enzyme Activites in Super Low External-Input Paddy Rice Field
○Taichi Tsujimoto[1], Kazuhiro Hosoya[1], Hideto Ueno[1], Yo Toma[1], Yoichi Yamashita[2], Masataka Adachi[2], Takayuki Kono[2] （1.Graduate School of Agriculture, Ehime University, Japan, 2.Faculty of Agriculture, Ehime University, Japan）
12:15 PM - 1:00 PM

[P2-04] Nitrogen and Water Demands for Maximum Growth of *Solanum tuberosum* under Doubled CO_2: Interaction with Phosphorus Based on the Demands
○Yan Yi, Daisuke Sugiura, Katsuya Yano （Graduate School of Bioagricultural Sciences, Nagoya University, Japan）
1:15 PM - 2:00 PM

[P2-05] An Evaluation on *Glycine tabacina* for Being a

Cover Crop

○Kuan-Huang Lin, Yuan-Ching Tsai （Department of Agronomy, National Chiayi University, Taiwan）

12:15 PM - 1:00 PM

[P2-06] Different Tillage Systems rather than Winter Cropping Affect the Corn Growth and Yield, and the Community Composition of Arbuscular Mycorrhizal Fungi

○Yuya Tatewaki[1], Ryo Matsuno[2], Koya Nakamura[1], Kengo Wada[1], Masao Higo[2], Katsunori Isobe[2]
（1.Graduate School of Bioresource Sciences, Nihon University, Japan, 2.College of Bioresource Sciences, Nihon University, Japan）

1:15 PM - 2:00 PM

[P2-07] Decomposition of Hairy Vetch Mulch under Snow and Its Effect on Nitrogen Dynamics in Soil

○Toshiyuki Hirata[1], Taishi Uchibayashi[2], Atsushi Matsumura[3] （1.Field Science Center for Northern Biosphere, Hokkaido University, Japan, 2.Graduate School of Environmental Science, Hokkaido University, Japan, 3.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan）

12:15 PM - 1:00 PM

[P2-08] Effect of Peanut Residues on Nitrogen and Phosphorus Uptake of the Succeeding Wheat Grown in the Paddy-Converted Upland Field

○Haruki Masuda[1], Yuko Michiyama[1], Daisuke Yoshimura[1], Takuji Seo[1], Toru Kira[1], Atsushi Matsumura[2], Hiroyuki Daimon[1] （1.Faculty of Agriculture, Ryukoku University., Japan, 2.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan）

1:15 PM - 2:00 PM

[P2-09] Effect of Shoot Cutting and Mulching of Hairy Vetch during Flowering Stage on the Yield and N Content of Wheat in the Mixed Cropping System

○Kan Tamaki[1], Daisuke Yoshimura[1], Takuji Seo[1], Toru Kira[1], Atsushi Matsumura[2], Arata Tarui[2], Hiroyuki Daimon[1] （1.Faculty of Agriculture, Ryukoku University, Japan, 2.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan）

12:15 PM - 1:00 PM

[P2-10] DNA Barcoding of Weed Species in Hokkaido and Application to *ex-situ* Evaluate of Their Abundance

○Maria Stefanie Dwiyanti[1], Toshiyuki Hirata[2], Hironori Nagano[1], Junya Yamagishi[3], Masahiro Akimoto[4] （1.Research Faculty of Agriculture, Hokkaido University, Japan, 2.Field Science Center for Northern Biosphere, Hokkaido University, Japan, 3.Research Center for Zoonosis Control, Hokkaido University, Japan, 4.Department of Agro-environmental Science, Obihiro University for Agriculture and Veterinary Medicine, Japan）

1:15 PM - 2:00 PM

[P2-11] Climate Impact on Yield and Cultivation Area of Rainfed Rice in Central Benin, West Africa

○Joji Miyazawa, Akira Miyazaki （Faculty of Agriculture and Marine Science, Kochi University, Japan）

12:15 PM - 1:00 PM

[P2-12] Cropping System Which Consists of Potato in Winter Season, Green Manure and Sugarcane under Kunigami Merge Soil in Northern Part of Okinawa Island

○Hideyuki Mochida （Innovation creation section, Bio-Oriented Technology Research Advancement Institution, Japan）

1:15 PM - 2:00 PM

[P2-13] Evaluation of Crop Performance under Different Nitrogen Regimes in Rice-Ratoon Rice Systems in Central Japan

○Weiyi Xie, Yoichiro Kato （Graduate School of Agricultural Sciences, The University of Tokyo, Japan）

12:15 PM - 1:00 PM

[P2-14] Grain Yield and Biodiversity in Lowland Rice Ecosystems: Comparison between Conventional and Organic Management Practices

○Haruki Okuda, Yoichiro Kato （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

1:15 PM - 2:00 PM

[P2-15] Using a High Density Seedling Mat Reduces Transplanted Rice (*Oryza sativa* L.) Production Costs: A Case Study in Vietnam

○Kazunori Sawamoto[1], Ngo Quang Hieu[2], Truong Chi Thanh[3] （1.Development Division, Yanmar

Agribusiness Co., Ltd., Japan, 2. Can Tho University, Vietnam, 3.Yanmar Agricultural Research Institute, Vietnam）
12:15 PM - 1:00 PM

[P2-16] Evaluation of the Differences in Yield Response to Organic Fertilizer between Two Soybean High-Yielding Lines 'Toiku 273' and 'Tokei1335' by Hierarchical Bayesian Model

○Yuichi Nagasaki[1], Hiroyuki Tsuji[1], Satoshi Kobayashi[2], Hideki Kurosaki[3] （1.Hokkaido Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Agricultural Research Department Tokachi Agricultural Experiment Station, Hokkaido Research Organization, Japan, 3.Agricultural Research Department Central Agricultural Experimental Station, Hokkaido Research Organization, Japan）
1:15 PM - 2:00 PM

[P2-17] Effect of Varieties and Organic Manures on Rice Yield and Methane Emission under Water Management

○Ei Phyu Win[1], Kyaw Kyaw Win[2], Kyaw Ngwe[3], Than Da Min[4], Hla Than[5] （1.Department of Agronomy, Yezin Agricultural University, Myanmar, 2.Department of Agronomy, Yezin Agricultural University, Myanmar, 3.Department of Soil and Water Science, Yezin Agricultural University, Myanmar, 4.Department of Agronomy, Yezin Agricultural University, Myanmar, 5.Department of Agronomy, Yezin Agricultural University, Myanmar）
12:15 PM - 1:00 PM

[P2-18] Soil Temperature, Growth and Yield of Rhizome by Different Mulching Treatments of Chinese Artichoke (*Stachys sieboldii* Miq.)

○Yeongmi Jang, Bumsik Choi, Sharavdorj Khulan, Jin-Woong Cho （College of Agricultural and Life Sciences, Chungnam National University, Korea）
1:15 PM - 2:00 PM

[P2-19] Effect of Different Types of Mulching on Soil Temperature, Growth and Rhizome Yield of Lycopi Herba (*Lycopus lucidus* Turcz.)

○Yeongmi Jang, Bumsik Choi, Sharavdorj Khulan, Jin-Woong Cho （College of Agricultural and Life Sciences, Chungnam National University, Korea）
12:15 PM - 1:00 PM

[P2-20] Effect of Flood and Drip Irrigation and Difference of Organic Material Input on Morphological and Physiological Traits in Rice Root

○Jiabin Bian[1], Kanchana Chomsang[2], Masahiro Morokuma[3], Masanori Toyota[3] （1.College of Agronomy & Resources and Environment, Tianjin Agricultural University, China, 2.United Graduate School of Agricultural Science, Ehime University, Japan, 3.Faculty of Agriculture, Kagawa University, Japan）
1:15 PM - 2:00 PM

[P2-21] *In Vitro* Screening and Morphological Trait Assisted Selection for Salinty Tolerance in Wheat Genotypes at Seedling Stage

○Mohammad Hasanuzzaman[1], Nihar Ranjan Saha[1], Sayma Farabi[1], Muhammad Monirul Islam[2], Muhammad Shahidul Haque[1] （1.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 2.Biotechnolohy Division, Bangladesh Institute of Nuclear Agriculture, Bangladesh）
12:15 PM - 1:00 PM

[P2-22] Verification of Effects of "Three-dimensional farming system" on Soybean Cultivation in a Converted Paddy Field in a Temperate Zone

○Irumi Shimizu[1], Yuto Seno[2], Tesshu Tamai[2] （1.Graduate School of Agriculture, Ryukoku University, Japan, 2.Faculty of Agriculture, Ryukoku University, Japan）
1:15 PM - 2:00 PM

[P2-23] Production of Nitrogen Fixed Nutrient Solution for Hydroponic Culture by Flow Plasma System

○Tesshu Tamai[1], Ryoji Iyo[1], Yuya Yokoyama[1], Yoshiteru Mizukoshi[2], Yoshimi Nishimura[3], Chiaki Terashima[4] （1.Faculty of Agriculture, Ryukoku University, Japan, 2.Future Technology Research Laboratory, ULVAC, Inc., Japan, 3.Kurita Manufacturing Co., Ltd, Japan, 4.Photocatalysis International Research Center, Tokyo University of Science, Japan）
12:15 PM - 1:00 PM

[P2-24] Alternative Usage of Poultry Litter Ash for Phosphorus and Potassium Fertilizer in Forage Rice Cultivation

○Yuka Sasaki[1], Keishiro Sato[1,2], Takayuki Tokuhashi[1,3], Ken-ichi Kakuda[1] （1.Faculty of Agriculture, Yamagata University, Japan, 2., Agro-

Kanesho Co., Ltd., Japan, 3.Niigata Central Union of Agricultural Cooperatives, Japan）
1:15 PM - 2:00 PM

[P2-25] Effects of Shading by Solar Panels on Growth and Yield of C_3 and C_4 Crops
○Masahiro Morokuma, Masanori Toyota （Faculty of Agriculture, Kagawa University, Japan）
12:15 PM - 1:00 PM

[P2-26] Effects of Proximity to Missing and Poorly Growing Plants on Cabbage Head Size
○Hiroyuki Tsuji （Division of Farming System Research, Hokkaido Agricultural Research Center, National Agriculture and Food Research Organization, Japan）
1:15 PM - 2:00 PM

[P2-27] Three-Dimensional Analysis of Soybean Grain Shapes Using a Flatbed Scanner
○Dan Eiju[1,2], Masataka Wakayama[1], Fumiko Namiwa[3], Masaru Tomita[1,2] （1.Institute for Advance Biosciences Keio University, Japan, 2.Faculty of Environment and Information Studies, Keio University, Japan, 3.Horticulture Science, Yamagata Integrated Agricultural Research Center, Japan）
12:15 PM - 1:00 PM

[P2-28] Satellite-Based Assessment of Soybean Plant Density by Using UAV Imagery and Machine Learning Algorithm
○Luthfan Nur Habibi[1], Tsutomu Matsui[2], Takashi Tanaka[2,3] （1.Graduate School of Natural Science and Technology, Gifu University, Japan, 2.Faculty of Applied Biological Sciences, Gifu University, Japan, 3.Artificial Intelligence Advanced Research Center, Gifu University, Japan）
1:15 PM - 2:00 PM

[P2-29] Effect of Environmental Differences on Empirical Regression Models for Estimating Leaf Area Index Using Vegetation Indices in Rice
○Tomoaki Yamaguchi[1], Daniel Menge[2], Emily Gichuhi[2], Peprah Clement Oppong[1], Megumi Yamashita[1], Daigo Makihara[3], Keisuke Katsura[1] （1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2., Kenya Agricultural and Livestock Research Organization, Kenya, 3.International Center for Research and Education in Agriculture, Nagoya University, Japan）
12:15 PM - 1:00 PM

[P2-30] Detection of Lodging Area in a Paddy Field from a Digital Surface Model (DSM)
○Tadashi Tsukaguchi[1], Fumio Uno[2], Yoichi Fujihara[1] （1.Faculty of bioresources and environmental sciences, Ishikawa Prefectural University, Japan, 2.Ishikawa Agriculture and Forestry Research Center, Japan）
1:15 PM - 2:00 PM

[P2-31] Nitrogen Dynamics in Paddy Fields under Different Rice Bran Levels
○Mchuno Alfred Peter, Tasuku Eigen, Ami Shimomura, Beno Anton Kiwale, Kunio Watanabe, Nobuhito Sekiya （Graduate School of Bioresources, Mie University, Japan）
12:15 PM - 1:00 PM

[P2-32] Do New Rice Cultivars Respond to Chemical Fertilizers Better than Old Cultivars?
○Beno Anton Kiwale, Asaka Murai, Mchuno Alfred Peter, Nobuhito Sekiya （Graduate School of Bioresources, Mie University, Japan）
1:15 PM - 2:00 PM

[P2-33] A Case Study on Labor Productivity of Paddy Rice Seed Production in Japan
○Mizuho Fujii, Akihiko Kamoshita （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）
12:15 PM - 1:00 PM

[P2-34] Selection of Sorghum Growth Indicators for the Development of Smart Farm of Field Food Crops
○Kang-Su Kwak, Si-Young Rho （Division of Smart Farm Development, Department of Agricultural Engineering, National Institute of Agricultural Sciences, Rural Development Administration, Korea）
1:15 PM - 2:00 PM

Room 3 (Poster)

Poster Session | Abiotic Stress for Crop Production | P3: Poster Session

[P3] Abiotic Stress for Crop Production

12:15 PM - 2:00 PM Room 3 (Poster) (Abiotic Stress for Crop Production)

[P3-01] Influence of Low Temperature at Booting Stage on Growth and Yield in Fall and Spring Sown Wheat

Jaeeun Choi[1], Jae-Gyeong Jung[1], Young-Hun Lee[1], Ki-Eun Song[1,2], Jonghan Ko[3], Kyung-Do Lee[4], ○Sang-In Shim[1] （1.Department of Agronomy, Gyeongsang National University, Korea, 2.Division of Applied Life Science (BK21 Plus), Gyeongsang National University, Korea, 3.Department of Applied Plant Science, Chonnam National University, Korea, 4.Climate Change and Agro-Ecology Division, Rural Development Administration, Korea）
12:15 PM - 1:00 PM

[P3-02] Selection of Transcripts Relating to Chlorophyll Content of Rice Seedlings at Low Temperature Using RNA-Sequencing Data

○Akari Fukuda[1], Tatsuro Hirose[2], Yoichi Hashida[2], Naohiro Aoki[3], Atsuhi J. Nagano[4] （1.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 2.Faculty of Agriculture, Takasaki University of Health and Welfare, Japan, 3.Graduate School of Agricultural and Life Science, The University of Tokyo, Japan, 4.Faculty of Agriculture, Ryukoku University, Japan）
1:15 PM - 2:00 PM

[P3-03] Membrane Lipid Unsaturation Confers Cold Germination Ability to Seeds of Upland Cotton (*Gossypium hirsutum*)

Lakhvir Kaur Dhaliwal[1], Junghyun Shim[1], Masoud Zabet[2], Benildo G. de los Reyes[1], ○Rosalyn B. Angeles-Shim[1] （1.Department of Plant and Soil Science, College of Agricultural Sciences and Natural Resources, Texas Tech University, United States, 2.Center for Biotechnology and Genomics, Texas Tech University, United States）
12:15 PM - 1:00 PM

[P3-04] Characteristics of Photoassimilates Distribution in the Resistant Variety to the High-Temperature Damage to Rice Grain Ripening

○Saki Yoshino[1], Chiharu Sone[2,3], Kyoko Toyofuku[2,3], Fumiaki Takakai[2,3], Takato Mizumoto[2], Yoko Ishikawa[2,3], Atsushi Ogawa[2,3] （1.Graduate School of Bioresource Sciences, Akita Prefectural University, Japan, 2.Faculty of Bioresource Sciences, Akita Prefectural University, Japan, 3.Japan Science and Technology Agency, Core Research for Evolutionary Science and Technology Project, Japan）
1:15 PM - 2:00 PM

[P3-05] Comparison of Drought Resistance of NERICA, Asian Rice and African Rice and Effects of Phosphorus Fertilizer

○Michihiko Fujii （Faculty of Education, Shizuoka University, Japan）
12:15 PM - 1:00 PM

[P3-06] The Effects of Arbuscular Mycorrhizal Symbiosis on the Growth, Yield and Drought Resistance of Foxtail Millets (*Setaria italica*)

○Wei-Yi Lin, Ou-Chi Chang, Yi-An Chen, Ting-Chen Chang （Department of Agronomy, National Taiwan University, Taiwan）
1:15 PM - 2:00 PM

[P3-07] The Effect of Ultra-Fine Bubble on Soybean Growth under Osmotic Stress Condition

○Kaito Yamashita[1], Yoshihiro Hirooka[1], Yoshikatsu Ueda[2], Koji Yamane[1], Chikashi Kamimura[3], Morio Iijima[1] （1.Graduate School of Agriculture, Kindai University, Japan, 2.Research Institute for Sustainable Humanosphere, Kyoto University, Japan, 3.Eatech Co. Ltd, Japan）
12:15 PM - 1:00 PM

[P3-08] Simple Model for Root Distribution across Soil Depth in Rice (*Oryza sativa* L.) under Fluctuating Soil Moisture Conditions

Hien Thi Thanh Nguyen, Tohru Kobata, ○Kuniyuki Saitoh （Graduate School of Environmental and Life Science, Okayama University, Japan）
1:15 PM - 2:00 PM

[P3-09] Diurnal Changes in Chloroplast Positioning and Photosynthesis in Finger Millet

○Eri Maai[1], Kazusa Nishimura[2], Rihito Takisawa[3], Tetsuya Nakazaki[2] （1.Faculty of International Agriculture and Food Studies, Tokyo University of Agriculture, Japan, 2.Graduate School of Agriculture, Kyoto University, Japan, 3.Faculty of Agriculture, Ryukoku University, Japan）
12:15 PM - 1:00 PM

[P3-10] Effect of Seed Hydro-Priming on Initial, Middle, and Late Growth Stage of Rice under the Different Soil Moisture Conditions

○Yoshihiro Nakao[1], Minoru Yoshino[2], Kisho Miyamoto[2], Aki Houshiyama[1], Eri Ishikawa[1], Jun-Ichi Sakagami[1] （1.Faculty of Agriculture, Kagoshima University, Japan, 2.Japan International Cooperation Agency, Japan）

1:15 PM - 2:00 PM

[P3-11] Differences in Aquaporin Expression and Their Response to Osmotic Stress among Component Roots in a Rice Root System

○Yumika Watanabe[1, 2], Shiro Mitsuya[1], Akira Yamauchi[1] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.School of Biological Sciences, The University of Western Australia, Australia)

12:15 PM - 1:00 PM

[P3-12] Does Plasticity of Anatomical Traits Influence Water Stress Tolerance in Rice?

○Manikanta Ch L N[1], Beena R[2], Rejeth R[3] (1.Department of Plant Physiology, Kerala Agricultural University, India, 2.Department of Plant Physiology, Kerala Agricultural University, India, 3.Department of Plant Physiology, Kerala Agricultural University, India)

1:15 PM - 2:00 PM

[P3-13] Crops Response to Water Stress Combination with Temperature Like— Rainfed Condition in Cereal

○Phanthasin Khanthavong[1,3], Shin Yabuta[2], Jun-Ichi Sakagami[1,2] (1.The United Graduate School of Agricultural Sciences, Kagoshima University, Japan, 2.Faculty of Agriculture, Kagoshima University, Japan, 3.Maize and Cash Crops Research Center, National Agriculture and Forestry Research Institute, Laos)

12:15 PM - 1:00 PM

[P3-14] Root and Leaf Plasticity in Response to Soil Moisture Fluctuation in Rice

○Yasutaka Noda[1,2], Mana Kano-Nakata[2], Shiro Mitsuya[1], Akira Yamauchi[1] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.International Center for Research and Education in Agriculture (ICREA), Nagoya University, Japan)

1:15 PM - 2:00 PM

[P3-15] Combination of GGE and BLUP Models in the Selection of Rice Varieties Adapted to the Rainfed Lowlands

○Via Ann Marcelo[1], Maria Corazon Cabral[2], Jonathan Niones[3], Roel Suralta[4], Mana Kano-Nakata[2], Akira Yamauchi[2] (1.Plant Breeding and Biotechnology Division, Philippine Rice Research Institute, Philippines, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 3.Genetic Resources Division, Philippine Rice Research Institute, Philippines, 4.Crop Biotechnology Center, Philippine Rice Research Institute, Philippines)

12:15 PM - 1:00 PM

[P3-16] Absorption and Physiological Treatment Mechanism of Cesium under High NaCl Conditions in Quinoa (*Chenopodium quinoa* Willd.)

○Kengo Wada[1], Katsunori Isobe[2], Masao Higo[2], Yoshihiro Kawamura[1], Yuya Tatewaki[1], Koya Nakamura[1] (1.Graduate School of Bioresource Science, Nihon University, Japan, 2.College of Bioresource Science, Nihon University, Japan)

1:15 PM - 2:00 PM

[P3-17] Differences in the Strategies of Salinity Tolerance between Two Different Genotypic Groups of Quinoa (*Chenopodium quinoa* Willd.)

○Mire Hong[1], Yasunari Fujita[2], Yasuo Yasui[3], Keisuke Katsura[1] (1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Biological Resourse and Post-harvest Division, Japan International Research Center for Agriculture Sciences, Japan, 3.Graduate School of Agriculture, Kyoto University, Japan)

12:15 PM - 1:00 PM

[P3-18] Mapping of Salinity Tolerance in Rice Through Genome-Wide Association Study (GWAS) at Seedling and Reproductive Stages

○Marjorie Punzalan de Ocampo[1,2], Bui Phuoc Tam[1,3], JamesA. Egdane[1], Shiro Mitsuya[2], Akira Yamauchi[2], Amelia Henry[1], Abdelbagi M. Ismail[1] (1.Strategic Innovation-Systems Physiology, International Rice Research Institute, Philippines, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 3.CuuLong Delta Rice Research Institute, Vietnam)

1:15 PM - 2:00 PM

[P3-19] NaCl-Stimulated ATP Synthesis in a Halophyte (*Mesembryanthemum crystallinum* L.)

○Ryoma Sato[1], Kazuki Yoshida[1], Ayako Konishi[2], Dan Q. Tran[3], Kazuyuki Saito[4], John C. Cushman[5], Sakae Agarie[4] (1.Graduate school of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Faculty of Agriculture, Kagawa University, Japan, 3.The United Graduate School of Agricultural Sciences, Ehime University, Japan, 4.Faculty of

Agriculture, Kyushu University, Japan, 5.Department of Biochemistry and Molecular Biology, University of Nevada, United States）
12:15 PM - 1:00 PM

[P3-20] Expression Analysis of Genes Involved in Removal of Na^+ and Cl^- by Leaf Sheath in Rice
○Sarin Neang[1,3], Nicola Stephanie Skoulding[1], Joyce A. Cartagena[1], Mana Kano-Nakata[2], Akira Yamauchi[1], Shiro Mitsuya[1] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.International Center for Research and Education in Agriculture, Nagoya University, Japan, 3.Department of Agro-Industry, Ministry of Agriculture, Forestry and Fisheries, Cambodia）
1:15 PM - 2:00 PM

[P3-22] Evaluation of Salinity Tolerance in Rice Lines Carrying Overlapping Chromosome Segments of *Oryza longistaminata* in a Genetic Background of Kernel Basmati
○Rena Tomita[1], Emily Waringa Gichuhi[2], Daniel Makori Menge[2], Mayumi Kikuta[3], Daigo Makihara[4] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.Industrial Crops Research Institute, Kenya Agricultural and Livestock Research Organization, Kenya, 3.Graduate School of Integrated Sciences for Life, Hiroshima University, Japan, 4.International Center for Research and Education in Agriculture, Nagoya University, Japan）
1:15 PM - 2:00 PM

[P3-23] Identification of Rice Varieties Showing Superior Salt Removal Ability in Leaf Sheath and Its Contrasting Varieties
○Itsuki Goto, Akira Yamauchi, Shiro Mitsuya （Graduate School of Bioagricultural Sciences, Nagoya University, Japan）
12:15 PM - 1:00 PM

[P3-24] Transcriptional Regulation of the Stress-Inducible Photosynthesis in the Common Ice Plant, *Mesembryanthemum crystallinum* L.
○Sakae Agarie[1], Kento Kuroda[2], Kasumi Nishikawa[2], Nanako Isshiki[2], Yoko Ide[3], Kazuyuki Saito[1], John C. Cushman[4] （1.Faculty of Agriculture, Kyushu University, Japan, 2.Faculty of Agriculture, Kagawa University, Japan, 3.Faculty of Agriculture, Saga University, Japan, 4.Department of Biochemistry and Molecular Biology, University of Nevada, Reno, United States）
1:15 PM - 2:00 PM

[P3-25] Morphological Characterization of Calcium Oxalate Crystals and Effect of Growth-Medium Calcium Levels on Morphology of the Crystals in Tubers and Roots of Chinese Yam
○Michio Kawasaki[1,2], Ryotaro Shibata[2], Shinichiro Ito[2] （1.Faculty of Agriculture, Setsunan University, Japan, 2.Faculty of Agriculture and Life Science, Hirosaki University〔previous affiliation〕, Japan）
12:15 PM - 1:00 PM

[P3-26] Root Type-Specific Transcriptome Diversity in Salinity Tolerant and Sensitive Rice Varieties
○Joyce Cartagena[1], Yao Yao[1], Shiro Mitsuya[1], Takashi Tsuge[2] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.Department of Biological Chemistry, Chubu University, Japan）
1:15 PM - 2:00 PM

[P3-27] Breeding for Submergence-Tolerant Rice by Marker Assisted Backcross
○Yu-Chien Tseng[1], Yu-Chia Hsu[1], Yu-Chin Chang[2], Yong-Pei Wu[2] （1.Agronomy Department, National Chiayi University, Taiwan, 2.Agronomy Department, Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan）
12:15 PM - 1:00 PM

[P3-28] Seed-Flooding Tolerance in Soybean is Related to Germination Ability under Water
○Shinjiro Ootsuka, Ryutaro Morita, Junko Yamagishi, Naohiro Aoki （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）
1:15 PM - 2:00 PM

[P3-30] Utilization of *SEMIDWARF1* for Vigorous Growth, Weed Competitiveness and Deep-Water Resistance in Rice Varieties for Organic Farming
○Marina Iwasa, Keisuke Katsura, Takashi Motobayashi, Taiichiro Ookawa （Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan）
1:15 PM - 2:00 PM

[P3-31] Naked Waxy Barley Yield and Grain β-glucan Affected by Soil Heterogeneity in Different Arable Lands
○Atsushi Matsumura[1], Takuya Morishita[2], Syuusuke Nakai[2], Hiroyuki Masumoto[1], Masanori Yanase[1]

（1.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan, 2.College of Life, Environment and Advanced Sciences, Osaka Prefecture University, Japan）
12:15 PM - 1:00 PM

[P3-32] Transitional Oxygen Point (TOP), a Physiological Indicator to Evaluate Waterlogging Tolerance in Crops

○Yutaro Oba[1], Akihiro Nose[1], Makoto Tokuda[2], Shao Hui Zheng[1]（1.Tropical Crop Science, Agriculture, Saga University, Japan, 2.Systems Ecology, Agriculture, Saga University, Japan）
1:15 PM - 2:00 PM

[P3-33] Comparative Transcriptome Analysis in Sorghum (*Sorghum bicolor* L.) Leaves during Vegetative Stage under Waterlogging Stress

○Ku Hyun Kwon[1], Sang-Heon Choi[1], Ju-Young Choi[1], Soo-Jeong Kwon[1], Hyen-Chung Chun[2], Dong-Gyu Lee[1], Seong-Hyun Yu[1], Tae-Woong Yun[1], Sun Hee Woo[1]（1.Department of Crop Science, Chungbuk National University, Korea, 2.National Institute of Crop Science, Rural Development Administration, Korea）
12:15 PM - 1:00 PM

[P3-34] Death of Roots Retards the Growth Recovery of Common Buckwheat under Waterlogged Conditions

○Shun Murakami[1], Masaaki Hashimoto[2], Hiromitsu Aoki[2], Yasuhiro Hirata[2], Yoshiharu Wada[1,2], Takuya Koyama[1,2]（1.Graduate School of Regional Development and Creativity, Utsunomiya University, Japan, 2.School of Agriculture, Utsunomiya University, Japan）
1:15 PM - 2:00 PM

[P3-35] Effects of Root Aerenchyma Formation and Photosynthetic Activity of Leaves under Submergence on Post-Submergence Recovery in *Oryza sativa* and *O. glaberrima*

○Chiharu Sone, Yuta Echizenya, Daichi Tozawa, Kyoko Toyofuku, Atushi Ogawa（Faculty of Bioresource Sciences, Akita Prefectural University, Japan）
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[P3-36] Hypoxic Tolerance of Four Millets is Attributable to Constitutive Aerenchyma Formation and Root Hair Development of Adventitious Root

○Asana Matsuura[1], Yasuyuki Kato[1], An Ping[2]（1.School of Agriculture, Tokai University, Japan, 2.Arid Land Research Center, Tottori University, Japan）
1:15 PM - 2:00 PM

[P3-37] Contrasting Rice Cultivars Responses to Increasing CO_2 Levels and Temperature

○Nene Furukawa[1], Murat Aycan[2], Nahar Lutfun[1], Toshihiro Nagamori[1], Eckart Priesack[3], Bertrand Gakière[4], José Luis Araus[5], Iker Aranjuelo[6], Marouane Baslam[2], Toshiaki Mitsui[1,2]（1.Dept. of Life and Food Sciences, Graduate School of Science and Technology, Niigata University, Japan, 2.Laboratory of Biochemistry, Faculty of Agriculture, Niigata University, Japan, 3.Institute of Biochemical Plant Pathology, Helmholtz Center-Munich, Germany, 4.Institute of Plant Sciences Paris-Saclay (IPS2), CNRS University Paris-Saclay, France, 5.Integrative Crop Ecophysiology Group, University of Barcelona, Spain, 6.Agrobiotechnology Institute, Spanish National Research Council, Spain）
12:15 PM - 1:00 PM

[P3-38] Introgression of Dormant Gene *Sdr4-k* Improves Grain Quality of Sake Rice

○Shinya Kanazawa[1], Maiko Iwano[1], Marouane Baslam[2], Shigeru Hanamata[2], Murat Aycan[2], Isao Hanashiro[3], Kazuhiko Sugimoto[4], Toshiaki Mitsui[1,2]（1.Graduate School of Science and Technology, Niigata University, Japan, 2.Faculty of Agriculture, Niigata University, Japan, 3.Faculty of Agriculture, Kagoshima University, Japan, 4.Institute of Crop Science, National Agriculture and Food Research Organization, Japan）
1:15 PM - 2:00 PM

[P3-39] Effects of Jasmonic Acids on Rice Flower Opening Time and Fertility under High Temperature Conditions

○Kazuhiro Kobayasi[1], Ramin Taheri[2], Masato Tsurumi[3], Yuki Mizokane[3], Fumihiko Adachi[1], Kazuhiro Ujiie[1], Akio Tanaka[4], Taku Tanogashira[4], Hitoshi Ogiwara[5]（1.Institute of Agricultural and Life Sciences, Shimane University, Japan, 2.Graduate School of Natural Science and Technology, Shimane University, Japan, 3.Faculty of Life and Environmental Sciences, Shimane University, Japan, 4. Kagoshima Prefectural Institute for Agricultural Development, Japan, 5.National Agriculture and Food

Research Organization, Japan）
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[P3-40] The Effect of N-application on cpHSP70-2 Accumulation to Improve Rice (*Oryza sativa* L.) Grain Chalkiness
○Olusegun Idowu, Tomoyuki Katsube-Tanaka （Graduate School of Agriculture, Kyoto University, Japan）
1:15 PM - 2:00 PM

[P3-41] Genetic Analysis of Drought Response Index in a *Temperate Japonica* Rice Mapping Population
○Poornima Ramalingam[1,2], Ha-An Thi Nguyen[1], Kamoshita Akihiko[1] （1.Department of Plant Biotechnology, Tamil Nadu Agricultural University, India, 2.Asian Research Center for Bio-Resources and Environmental Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Asian Research Center for Bio-Resources and Environmental Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）
12:15 PM - 1:00 PM

[P3-42] Contribution of the Chromosome 11 of a Salinity-Tolerant Rice Variety Nona Bokra to High Dry Matter Production under Salinity and Its QTL Mapping
○Yumika Yamamoto[1], Masaki Uchida[1], Mana Kano-Nakata[2], Akira Yamauchi[1], Shiro Mitsuya[1] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.International Center for Research and Education in Agriculture, Nagoya University, Japan）
1:15 PM - 2:00 PM

[P3-43] Genotypic Variation in Root Morpho-Anatomical Traits of Rice Cultivars with High and Low Adaptability under Multi-Stress Environment
○Maria Corazon Julaton Cabral[1,2], Via Ann Candelaria Marcelo[3], Roel Rodriguez Suralta[3], Jonathan Manito Niones[3], Antoinette Soriano Cruz[3], Hiroshi Ehara[1,2], Yoshiaki Inukai[1,2], Akira Yamauchi[1], Mana Kano-Nakata[1,2] （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）
12:15 PM - 1:00 PM

[P3-44] Heavy Flooding Effects on Productivity of Paddy Rice Cultivar 'Nanatsuboshi'
○Hideki Okamoto[1], Junji Fujikura[2], Katsuhiro Furukawa[2] （1.Tenpoku Sub-centre, Dairy Research Centre, Hokkaido Research Organization, Japan, 2.Kamikawa Agricultural Experiment Station, Hokkaido Research Organization, Japan）
1:15 PM - 2:00 PM

[P3-45] Root Anatomical Traits Related to Root Oxygen Consumption and Transportation between Upland Rice and Lowland Rice Varieties
○Shotaro Tamaru[1], Keita Goto[1], Phanthasin Khanthavong[1], Shin Yabuta[2], Jun-Ichi Sakagami[1,2] （1.The United Graduate School of Agricultural Sciences, Kagoshima University, Japan, 2.Faculty of Agriculture, Kagoshima University, Japan）
12:15 PM - 1:00 PM

[P3-46] Roles of Root Plasticity to Growth and Yield of Quinoa under Different Soil Water Regimes
○Dinh Thi Ngoc Nguyen[1], Cuong Van Pham[1], Thiem Thi Tran[1], Akira Yamauchi[2] （1.Faculty of Agronomy, Vietnam National University of Agriculture, Vietnam, 2.Faculty of Agronomy, Vietnam National University of Agriculture, Vietnam, 3.Faculty of Agronomy, Vietnam National University of Agriculture, Vietnam, 4.Graduate School of Bioagricultural Sciences, Nagoya University, Japan）
1:15 PM - 2:00 PM

[P3-47] Integrated Transcriptome and Proteome Analysis Reveals Complex Regulatory Mechanism of Maize (*Zea mays* L.) in Response to Zinc Deficiency Stress
Jinyao Zhang[1,3], Shuhui Song[1], Yinghong Pan[2], Fangsen Xu[3], ○Hong Wang[1] （1.Institute of Agriculture Resources and Regional Planning, Chinese Academy of Agricultural Sciences, China, 2.The National Key Facility for Crop Gene Resources and Genetic Improvement, Institute of Crop Science, Chinese Academy of Agricultural Sciences, China, 3.College of Resources and Environment, Huazhong Agriculture University, China）
12:15 PM - 1:00 PM

Room 4 (Poster)

[P4] Crop Genetics and Physiology

12:15 PM - 2:00 PM Room 4 (Poster) (Crop Genetics and Physiology)

[P4-01] Genetic Variation of Rice Germplasm Including *Oryza sativa* and *O. glaberrima* in Guinea

○Yoshimichi Fukuta[1], Seiji Ynagaihara[2], Nhai Nguyen[3], Oanh Nguyen[3], Narry Mamadou[4], Diawara Souleymane[4], Bah Oumar[4] (1.TARF, Japan International Research Center for Agricultural Sciences, Japan, 2.GRPH, Japan International Research Center for Agricultural Sciences, Japan, 3.AGI, Vietnam, 4.IRAG, Guinea)

12:15 PM - 1:00 PM

[P4-02] Genetic Diversities of Traits Associated with Culm Strength Using a *Temperate Japonica* Rice Varieties

○Koki Chigira[1], Natsuko Kojima[1], Masanori Yamasaki[2], Shunsuke Adachi[3], Taiichiro Ookawa[1] (1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Food Resources Education and Research Center, Graduate School of Agricultural Science, Kobe University, Japan, 3.College of Agriculture, Ibaraki University, Japan)

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[P4-03] Histone Acetyltransferase GCN5 Regulates the Expression of *OsRBCS3* and *OsRBCS5*, Rubisco Small Subunit Genes, in Response to Nitrogen Supply in Rice (*Oryza sativa* L.)

○Shicheng Feng[1], Fumiya Miyamoto[2], Sakae Agarie[3], Kazuyuki Saitou[4] (1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, China, 2.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 3.Faculty of Agriculture (Graduate School), Kyushu University, Japan, 4.Faculty of Agriculture (Graduate School), Kyushu University, Japan)

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[P4-04] Visualizing Aleurone Layers in Mature Rice Grains by a Modified Half-Cut Method

○Thi Mai Phuong Nguyen[1], Tomomi Abiko[2], Ohn Mar Khin[3], Toshihiro Mochizuki[2] (1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Faculty of Agriculture, Kyushu University, Japan, 3.Department of Agricultural Research, Ministry of Agriculture, Livestock and Irrigation, Myanmar)

1:15 PM - 2:00 PM

[P4-05] Regulation of the Expression of *OsRBCS3*, a Rubisco Small Subunit Gene, by Histone Deacetylase *HDA713* under Nitrogen Deficiency in Rice

○Fumiya Miyamoto[1], Shicheng Feng[2], Sakae Agarie[3], Kazuyuki Saitou[4] (1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 3.Faculty of Agriculture(Graduate School), Kyushu University, Japan, 4.Faculty of Agriculture(Graduate school), Kyushu University, Japan)

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[P4-06] Estimation of Canopy Transpiration Rate in Rice after Heading Stage by Extracting Leaf Temperature in Thermal Images

○Rintaro Kondo, Yu Tanaka, Tatsuhiko Shiraiwa (Graduare School of Agriculture, Kyoto University, Japan)

1:15 PM - 2:00 PM

[P4-07] Engineering CAM Traits into C3 crops

○Aoi Saito[1], Mie Wakabayashi[2], Shiori Terai[2], Shiori Yamabe[2], Satoko Kobayashi[2], Kazuyuki Saito[3], John C. Cushman[4], Sakae Agarie[3] (1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Faculty of Agriculture, Kagawa University, Japan, 3.Faculty of Agriculture, Kyushu University, Japan, 4.Department of Biochemistry and Molecular Biology, University of Nevada, United States)

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[P4-08] Assessment of Geographical Distribution and Genetic Diversity of Five Sorghum Taxa Collected in Taiwan

○Wei-hsun Hsieh[1], Yi-tzu Kuo[1], Han-hsuan Chin[1], Hsien-chun Liao[2], Chih-hui Chen[2], Yann-rong Lin[1] (1.Agronomy, National Taiwan University, Taiwan, 2.Experimental Stations Research, Endemic Species Research Institute, Taiwan)

1:15 PM - 2:00 PM

[P4-09] Resistant Loci to Physiological Disorder Cupping in Chinese Cabbage (*Brassica rapa* var.*Pekinensis*)

○Haruto Takamori[1], Osamu Kawaide[3], Tokuko

Sakaguchi[1], Minami Nakazawa[1], Natsuki Ito[1], Ayuka Furukubo[2], Minami Amaike[2], Takashi Ito[5], Fumio Azuhata[3], Mashiro Okada[2], Seiji Chino[5], Hideo Matsumura[4], Satoshi Niikura[3], Nobuaki Hayashida[2] (1., Shinshu University, Japan, 2.Division of Applied Biology, Faculty of Textile, Shinshu University, Japan, 3.TOHOKU SEED CO., LTD., Japan, 4.Gene Research Center, Shinshu University, Japan, 5.Engineering Department, Faculty of Textile, Shinshu University, Japan)
12:15 PM - 1:00 PM

[P4-10] Genetic Diversity of Foxtail Millet (*Setaria italica*) Landraces of Taiwan

Yen-chiun Chen[1], Yong-pei Wu[2], Yee-ching Chong[1], ○Yann-rong Lin[1] (1.Department of Agronomy, National Taiwan University, Taiwan, 2.Department of Agronomy, Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan)
1:15 PM - 2:00 PM

[P4-11] Branched-Chain Amino Acid Aminotransferases (BCATs) Play Important Roles for the Induction of Autophagy in Leaf Senescence of Soybean

○Tung Tuan Do[1,3], Takaaki Ishibashi[2], Takashi Yuasa[2] (1.Interdisciplinary Graduate School of Agriculture and Engineering, University of Miyazaki, Japan, 2.Faculty of Agriculture, University of Miyazaki, Japan, 3.Faculty of Agronomy, Thai Nguyen University of Agriculture and Forestry, Vietnam)
12:15 PM - 1:00 PM

[P4-12] DGAT1s from Different Plant Species Show Different Triacylglycerol Biosynthesis Activities

○Tomoko Hatanaka[1], Wakana Miyashita[1], Kouki Shibutani[2], Daisuke Matsuoka[1], 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)
1:15 PM - 2:00 PM

[P4-13] Genome Wide Association Study for Leaf Photosynthetic Properties in 166 *Temperate Japonica* Rice Cultivars

○Yoshiaki Seki[1], Kentaro Hayami[1], Tomohiro Nomura[1], Yu Tanaka[2], Taiichiro Ookawa[1], Makoto Matsuoka[3], Shunsuke Adachi[1] (1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Graduate School of Agriculture, Kyoto University, Japan, 3.Bioscience and Biotechnology Center, Nagoya University, Japan)
12:15 PM - 1:00 PM

[P4-14] Assessment of Genetic Diversity and Relatedness in Citrus Fruits Using RAPD Markers

○Nihar Ranjan Saha, Jarina Binte Jalil, Muhammad Shahidul Haque (Department of Biotechnology, Bangladesh Agricultural University, Bangladesh)
1:15 PM - 2:00 PM

[P4-15] Pyramiding of Disease Resistance Genes into Popular Rice Varieties of Bangladesh

○Tapas Kumer Hore, Corinne Mira Marfori-Nazarea, Mary Ann Inabangan-Asilo, Ratna Wulandari, BP Mallikarjuna Swamy (RGDV Platfrom, International Rice Research Institute, Philippines)
12:15 PM - 1:00 PM

[P4-16] Genetic Analysis of Agronomic and Biofortification Traits in Multiple Rice Populations

○Tapas Kumer Hore, Mary Ann Inabangan Asilo, Gaurav Joshi, Amery Amparodo, BP Mallikarjuna Swamy (RGDV Platfrom, International Rice Research Institute, Philippines)
1:15 PM - 2:00 PM

[P4-17] Meta-QTLs and Candidate Genes Associated with Grain Zinc Content in Rice

○Gaurav Joshi[1,2], B. P. Mallikarjuna Swamy[1], Indra Deo Pandey[2], Yan Paing Soe[3], Jose E. Hernandez[4], Chau Thanh Nha[5], Alvin Palanog[6], Mark Ian Calayugan[4], Mary Ann Inabangan Asilo[1], Amery Amparado[1], Tapas Kumer Hore[1] (1.Rice Breeding Innovations, International Rice Research Institute, Philippines, 2.Genetics and Plant Breeding, Govind Ballabh Pant University of Technology and Agriculture, India, 3.Seed Division, Department of Agriculture, Myanmar, 4.Institute of Crop Science, University of the Philippines Los Baños, Philippines, 5.Genetics and Plant Breeding Department, Cửu Long Delta Rice Research Institute, Vietnam, 6.Research and Development, Philippine Rice Research Institute, Philippines)
12:15 PM - 1:00 PM

[P4-18] Global Analysis of a Rice Panel to Identify QTLs and Genotypes Useful for Rice Breeding

○Gaurav Joshi[1,2], B. P. Mallikarjuna Swamy[1], Mona Liza Jubay[1], Indra Deo Pandey[2], Maria Camila Rebolledo[10, 11], Dmytro Chebotarov[1], Kenneth McNally[1], Rakesh Kumar Singh[9], Hei Leung[1], Sunil Kumar Verma[4], Satish B. Verulkar[4], Shuhha Banerjee[4], Hsu Myat Noe Hnin[3], Rollin de Ocampo[1], Federico Molina[5], Bertrand Muller[11], Justine Bonifacio[1], Eliel Petro Paez[10], Adin Blokounon[7], Kazuki Saito[7], Khady Nani Dramé[8], Stephen Klassen[1], Narne Chamundeswari[6], P. V. Satyanarayana[6] （1.Rice Breeding Innovations, International Rice Research Institute, Philippines, 2.Department of Genetics and Plant Breeding, Govind Ballabh Pant University of Technology and Agriculture, Pantnagar, India, 3.Institute of Crop Science, University of the Philippines Los Baños, Philippines, 4.Department of Plant Molecular Biology and Biotechnology, Indira Gandhi Agricultural University, Raipur (Chhattisgarh), India, 5.Rice Breeding, National Institute of Agricultural Research of Uruguay, Uruguay, 6.Plant Breeding, Regional Agricultural Research Station, Maruteru, India, 7.Sustainable Productivity Enhancement Program, Africa Rice Center, Côte d'Ivoire, 8.Capacity Development, Africa Rice Center, Côte d'Ivoire, 9.Crop Diversification and Genetics, International Center for Biosaline Agriculture, United Arab Emirates, 10.Rice Program, International Center for Tropical Agriculture (CIAT), Colombia, 11.Centre de Coopération Internationale en Recherche Agronomique Pour le Développement (CIRAD), France）

1:15 PM - 2:00 PM

[P4-19] A Metabolite Profiling to Explore the Physiological Function of *Short Panicle 1* during Panicle Formation of Rice

Yifan Lin[1], Ryutaro Morita[1], Masaki Okamura[2], Junko Yamagishi[1], ○Naohiro Aoki[1] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Central Region Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

12:15 PM - 1:00 PM

[P4-20] Assessment of *Indica* Rice Cultivars for the Use of Whole Crop Silage

Yoshikage Goto, Junko Yamagishi, ○Naohiro Aoki （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

1:15 PM - 2:00 PM

[P4-21] Morphological Characteristics Related to the Accumulation of Non-Structural Carbohydrates in Stems of Rice at Heading Stage

○Yu Wakabayashi, Ryutaro Morita, Junko Yamagishi, Naohiro Aoki （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

12:15 PM - 1:00 PM

[P4-22] Comparative Analysis of Sugar Metabolism in Rice Leaves under Field and Controlled Environments

○Yoichi Hashida[1], Ayumi Tezuka[2], Mari Kamitani[3], Makoto Kashima[4], Yuko Kurita[3], Atsushi J. Nagano[3,5] （1.Faculty of Agriculture, Takasaki University of Health and Welfare, Japan, 2.Research Institute for Food and Agriculture, Ryukoku University, Japan, 3.Faculty of Agriculture, Ryukoku University, Japan, 4.College of Science and Engineering, Aoyama Gakuin University, Japan, 5.Institute for Advanced Biosciences, Keio University, Japan）

1:15 PM - 2:00 PM

[P4-23] A Metabolite Profiling to Seek the Molecular Determinant of Spikelet Number in Rice

○Ryutaro Morita[1], Masaki Okamura[2], Shiori Yabe[3], Hiroe Yoshida[4], Satoru Sukegawa[4], Hiroshi Nakagawa[4], Naohiro Aoki[1] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Central Region Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 3.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 4.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan）

12:15 PM - 1:00 PM

[P4-24] Contribution of Several Source Organs to Dry Matter Accumulation into Panicles after Heading of Hulless Barley Sown at Different Terms

○Takuya Araki[1], Yasuhiro Kondo[2], Takato Yano[2], Ryo Kodani[2], Yukina Sakamoto[2] （1.Graduate School of Agriculture, Ehime University, Japan, 2.Faculty of Agriculture, Ehime University, Japan）

1:15 PM - 2:00 PM

[P4-25] Analysis on the Roles of Vacuolar Invertase Isoform, *OsINV3* in Root Development of Rice

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

12:15 PM - 1:00 PM

[P4-26] The Purification of Recombinant TGW6, which Limits Grain Size in Rice

○Tatsuki Akabane[1], Nobuhiro Suzuki[2], Wataru Tsuchiya[2], Etsuko Katoh[2], Naoki Hirotsu[1] (1.Graduate School of Life Sciences, Toyo University, Japan, 2.Structural Biology Team, Advanced Analysis Center, National Agriculture and Food Research Organization, Japan)

1:15 PM - 2:00 PM

[P4-27] Analysis of Genotype and Environment Interaction, and the Response of Grain Yield of Lowland Rice (*Oryza sativa* L.) to Nitrogen Application Under Different Environment in the Philippines

○Kim Nyka Caraan Perdiguerra[1,2], Pompe Campoy Sta. Cruz[1], Shiro Mitsuya[2], Akira Yamauchi[2] (1.Institute of Crop Science, College of Agriculture and Food Science, University of the Philippines Los Baños, Philippines, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan)

12:15 PM - 1:00 PM

[P4-28] Morphological Characteristics of Mealy and Translucent Endosperm Cells of Hulless Barley (*Hordeum vulgare* var. *nudum*) During the Ripening Stage

○Yuto Hatakeyama[1, 2], Ryo Kotani[3], Yukina Sakamoto[3], Kosuke Haraguchi[3], Nana Matsui[3], Takuya Araki[1] (1.Faculty of Agriculture, Ehime University, Japan, 2.Japan Society for the Promotion of Science Research Fellow, Japan, 3.Graduate School of Agriculture, Ehime University, Japan)

1:15 PM - 2:00 PM

[P4-29] Effect of Silicon Application on Grains of *Sorghum bicolor* under Drought Conditions

○Ryoichi Araki[1], Yuka Takano[1], Hidetoshi Miyazaki[2], Hiroyuki Ii[3], Ping An[4], Teru Tanaka[5] (1.Faculty of Education, Wakayama University, Japan, 2.Research unit, The Global Environmental Forum, Japan, 3.Faculty of Systems Engineering, Wakayama University, Japan, 4.Arid Land Research Center, Tottori University, Japan, 5.Faculty of Agriculture, Setsunan University, Japan)

12:15 PM - 1:00 PM

[P4-30] Relationship between Non-Destructive Measurement Parameters and Yield in Sweet Potatoes

○Masayuki Kadowaki[1], Tomohiro Araki[2], Risa Umehara[2], Sokichi Shiro[1], Shingo Matsumoto[1] (1.Institute of Agricultural and Life Sciences Academic Assembly, Shimane University, Japan, 2.Faculty of Life and Environmental Science, Shimane University, Japan)

1:15 PM - 2:00 PM

[P4-31] Heat Stress Impact on Heading and Ripening in Major Korean Rice Variety

○Woonha Hwang, Chungkeun Lee, Jaehyeok Jung, Hyeonseock Lee, Seoyeong Yang, Yeonhwa Lim, Myeonggu Choi (Crop Production and Physiology Division, National Institute of Crop Science, Korea)

12:15 PM - 1:00 PM

[P4-32] Genetic Variations of Rhizome Yield, Essential Oil Content and Constituents in *Curcuma* Species and Strains

○Akira Miyazaki[1], Yukari Shiino[1], Hiroshi Hayakawa[2], Yoshito Ohtani[1], Yoshinori Yamamoto[1] (1.Faculty of Agriculture and Marine Science, Kochi University, Japan, 2.Museum of Natural and Environmental History, Shizuoka, Japan)

1:15 PM - 2:00 PM

[P4-33] Relationship between Pre-Harvest Sprouting Variation and Physicochemical Properties in Varieties of Rice Flour

○Chae Min Han, Jong Hee Shin, Jung Bae Kwon, Jong Gun Won (Division of Crops Research, Gyeongsangbuk-do Provincial Agricultural Research & Extension Services, Korea)

12:15 PM - 1:00 PM

[P4-34] Physicochemical Properties of Rice Varieties Adapted to a Mountainous Region in Mid-South Korea

○Chae Min Han, Jong Hee Shin, Jung Bae Kwon, Jong Gun Won (Division of Crop Research, Yeongsangbuk-do Provincial Agricultural Research & Extension

Services, Korea）
1:15 PM - 2:00 PM

[P4-35] Marker-Assisted Selection to Develop the High Nutrition Rice, Giant-Golden-Purple Rice, PFR32, and Giant-Golden-Red Rice, RFR13
○Yu-Chia Hsu[1], Yu-Chien Tseng[1], Yu-Chi Cheng[2], Bing-Nan Lin[1], Yong-Pei Wu[2]（1.Department of Agronomy, National Chiayi University, Taiwan, 2.Department of Agronomy, Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan）
12:15 PM - 1:00 PM

[P4-36] Genetic and Morphological Mechanisms for Soil-Surface Roots Originated from a New Plant Type Cultivar in Rice (*Oryza sativa* L.)
○Asami Tomita[1,2], Hiroki Saito[2], Yoshimichi Fukuta[2]（1.Graduate School of Environmental and Life Science, Okayama University, Japan, 2.Tropical Agriculture Research Front, Japan International Research Center for Agricultural Sciences, Japan）
1:15 PM - 2:00 PM

[P4-37] Development and Genetic Analysis of Compensatory Growth of Lateral Roots in Rice
○Tsubasa Kawai[1, 3], Misuzu Nosaka-Takahashi[2], Yutaka Sato[2], Yinglong Chen[3], Kadambot H. M. Siddique[3], Hirokazu Takahashi[1], Mikio Nakazono[1], Akira Yamauchi[1], Yoshiaki Inukai[4]（1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.National Institute of Genetics, Japan, 3.The UWA Institute of Agriculture, The University of Western Australia, Australia, 4.International Center for Research and Education in Agriculture, Nagoya University, Japan）
12:15 PM - 1:00 PM

[P4-38] Daytime or Nighttime: When Plant Roots Uptake Nitrogen?
○Md Mehedi Hasan[1], Maya Matsunami[2], Hiroyuki Shimono[2]（1.United Graduate School of Agricultural Sciences, Iwate University, Japan, 2.Faculty of Agriculture, Iwate University, Japan）
1:15 PM - 2:00 PM

[P4-39] Maintaining Higher Leaf Photosynthesis After Heading Stage Contributes to Higher Biomass Accumulation in Rice
○Sotaro Honda[1], Satoshi Ohkubo[2], Nan Su San[2], Anothai Nakkasame[2], Kazuki Tomisawa[2], Keisuke Katsura[2], Taiichiro Ookawa[2], Atsushi J. Nagano[3], Shunsuke Adachi[2,4]（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.Faculty of Agriculture, Ryukoku University, Japan, 4.College of Agriculture, Ibaraki University, Japan）
12:15 PM - 1:00 PM

[P4-40] Genetic Analysis of Root Vascular Traits in a Population from Two *Temperate Japonica* Rice Ecotypes
○Ha-An Thi Nguyen[1], Akihiko Kamoshita[1], Poornima Ramalingam[1,2], Phoura Y[1]（1.Asian Research Center for Bioresources and Environmental Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Department of Plant Biotechnology, Tamil Nadu Agricultural University, India）
1:15 PM - 2:00 PM

[P4-41] CO_2-Responsive CCT Protein Interacts with 14-3-3 Proteins and Regulates the Expression of Starch Synthesis-Related Genes
○Fumihiro Miyagawa, Naoki Shibatani, Aiko Koudou, Daisuke Sasayama, Tomoko Hatanaka, Tetsushi Azuma, Hiroshi Fukayama（Graduate School of Agricultural Science, Kobe University, Japan）
12:15 PM - 1:00 PM

[P4-42] CRISPR/Cas9 — Based Genome Editing of *GCN5*, a Histone Acetyltransferase Gene, in Rice (*Oryza sativa* L.)
○Shu Takakura[1], Fumiya Miyamoto[1], Shicheng Feng[1], Sakae Agarie[2], Kazuyuki Saitou[2]（1.Graduate School of Bioresource and Bioenviroment Sciences, Kyushu University, Japan, 2.Faculty of Agriculture (Graduate School), Kyushu University, Japan）
1:15 PM - 2:00 PM

Fri. Sep 10, 2021

Room 1 (Oral)

Closing /Award Ceremony
11:45 AM - 12:45 PM Room 1 (Oral) (Field Crop Production)

Opening Ceremony

Opening Ceremony

Chair: Hiroshi Ehara (Nagoya University, Japan)
Wed. Sep 8, 2021 11:00 AM - 11:30 AM Plenary Room

Opening Address 11:00 AM - 11:10 AM
President of Asian Crop Science Association
Sun-Hee Woo (Chungbuk National University, Korea)

Greeting Message 11:10 AM - 11:20 AM
Chairperson of the Organizing Committee of ACSAC10
Makie Kokubun (Professor Emeritus at Tohoku University, Japan)

Information from ACSAC10 Secretariat 11:20 AM -11:30 AM

Keynote Lectures | Keynote Lectures | KL-01

New Agricultural Research Paradigms to Build Resilient Food Systems

Lecturer: Jacqueline d'Arros Hughes (Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India)
Chair: Hiroshi Ehara (Nagoya University, Japan)
Wed. Sep 8, 2021 11:30 AM - 12:00 PM Plenary Room

[KL-01] New Agricultural Research Paradigms to Build Resilient Food Systems

Jacqueline d'Arros Hughes （Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India）
11:30 AM - 12:00 PM

11:30 AM - 12:00 PM (Wed. Sep 8, 2021 11:30 AM - 12:00 PM Plenary Room)

[KL-01] New Agricultural Research Paradigms to Build Resilient Food Systems

Jacqueline d'Arros Hughes （Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India）

Current food systems based on over-reliance on a limited number of crops and marginalisation of smallholder farmers who produce a significant portion of the world's total food grain production are neither sustainable, nor resilient. The present pandemic has exposed the vulnerabilities and inequities of our current food systems and its impact on the most marginalized communities. It has exacerbated malnutrition and slowed progress towards achieving SDG 2 (Zero Hunger) as well as many of the other SDGs around gender, health and nutrition and beyond. Sustainable changes are required to increase agricultural production, improve global supply chains and value webs, decrease food losses and waste, and to ensure that heathy and nutritious food is available and affordable for all.

A transformation of our food systems requires bridging yield gaps, fixing long and inefficient supply chains where profits accrue to intermediaries who add little value, reducing food losses and waste, curbing greenhouse gas emissions, shifting and diversifying diets to eliminate undernutrition, over-nourishment as well as the hidden hunger of micronutrient malnutrition.

Diets, and the food systems that deliver them, are at the intersection of the challenges associated with malnutrition, human health, natural resource degradation, and climate change. There is already high-quality research on various aspects of climate change, health and food and nutrition security. To transform food systems, inter-disciplinary research in support of policy makers facing difficult decisions at the intersection of human and planetary health is urgently required.

Policy makers are confronted with rapidly evolving, rapidly changing and sometimes even U-turns of scientifi c views across multiple disciplines. Current research fails to meet the most pressing needs of policy makers (especially in relation to managing policy trade-offs and costs). More research needs to be driven by the specific needs of national governments and their policy makers. Inter-disciplinary / multi-disciplinary / transdisciplinary research linkages across disciplines – climate, natural resources, food, health, and nutrition is required to fully address the diversity and complexity of global and local food systems. This calls for a new approach to find the solutions we and our planet desperately need. The public sector, the private sector and all participants and stakeholders at all levels in our agriculture and food systems need to work together to make this happen.

The complexity of our food systems calls for the best minds of the public and private sectors, with research institutions, civil society think tanks and advocacy groups, to pool their skills and resources to transform our dryland food systems for the benefit of all.

Keynote Lectures | Keynote Lectures | KL-02

Ten Reasons Why Asian Crop Science Must be Reinforced

Lecturer: Osamu Koyama (President, Japan International Research Center for Agricultural Sciences, Japan)

Chair: Hiroshi Ehara (Nagoya University, Japan)

Wed. Sep 8, 2021 12:00 PM - 12:30 PM Plenary Room

[KL-02] Ten Reasons Why Asian Crop Science Must be Reinforced

Osamu Koyama （President, Japan International Research Center for Agricultural Sciences, Japan）

12:00 PM - 12:30 PM

12:00 PM - 12:30 PM (Wed. Sep 8, 2021 12:00 PM - 12:30 PM Plenary Room)

[KL-02] Ten Reasons Why Asian Crop Science Must be Reinforced

Osamu Koyama （President, Japan International Research Center for Agricultural Sciences, Japan）

The issues of sustainability have recently become common among a wide range of population as the Sustainable Development Goals of the United Nations (SDGs) have gained global recognition. The issues are increasing its urgency and intensity. Climate change, for example, is now being called as "climate crisis" because of frequent extreme climate events, which in turn strongly affect agriculture and food security. Among the SDGs, sustainable agriculture is undoubtedly one of the most critical issues for the existence of human beings. Thus, the United Nations will hold a Food Systems Summit in September 2021 in order to foster innovative ideas and prompt collective actions worldwide.

Asia is well known for being the origin of human civilization and for its long history of crop cultivation. For example, sustainable rice paddy cultivation has been continuing for thousands of years, and wheat is said to be one of the first crops cultivated by human beings in the Middle East. However, Asia, which accounts for about 60% of the world's population, has always been suffering from famines and starvation. Although Asia has partly succeeded in providing enough food by introducing modern technologies, the region as a whole has gradually become dependent on imported food. And the region's high population density and intensive farming systems have turned agriculture-related environmental issues into a most pressing concern in recent years. In addition, Asia, with its diversified natural conditions — from dry to humid, from continental to archipelagic, and from cold to hot temperature — is a showcase of cropping systems, and consequently, a showcase of food-related problems such as poor soil fertility and limited water resources, weeds, pests, and so on. We Asians must find solutions against these various problems by ourselves as nobody else has enough capacity and experiences to provide the proper answers. Without these answers for Asia, the rest of the world would not be able to attain the goal of sustainable agriculture.

Crop science, as an academic field that deals with the relationships between plants species and human beings, can provide objective and technical solutions — namely, proper land use, proper chemical input use, proper water use, proper energy and labor use, and the proper combinations of the above — to most of the aforementioned problems. Furthermore, as a knowledge base of holistic wisdom accumulated in the long history of humankind, crop science can provide effective answers to complicated questions regarding human-nature relationship, namely, how to adapt to extreme climate, how to conserve biodiversity and ecosystem, how to optimize food and dietary culture, and eventually, how to maintain human society. Thus, there are plenty of reasons why Asian crop science should be energized more. It is natural to say, in the year of the Food Systems Summit, that Asian crop scientists should lead and guide the world towards creating sustainable and harmonious food systems.

Workshop

Workshop (Presented by Sponsoring Company)

Latest Photosynthesis Measurement Systems

(Meiwafosis Co., Ltd.)

Wed. Sep 8, 2021 12:30 PM - 1:00 PM Plenary Room

[WS-01] Latest Photosynthesis Measurement Systems

Meiwafosis Co., Ltd.

12:30 PM - 1:00 PM

12:30 PM - 1:00 PM (Wed. Sep 8, 2021 12:30 PM - 1:00 PM Plenary Room)

[WS-01] Latest Photosynthesis Measurement Systems

Meiwafosis Co., Ltd.

1. Features of LI-6800 Portable Photosynthesis System (LI-COR)
2. Features of LI-600 Porometer/ Fluorometer (LI-COR)
3. Demonstration of LI-600 (LI-COR)

Meiwafosis provides a wide range of instruments to monitor and analyze plant growth and the global environment.

[Products]

LI-COR, Inc.
- Photosynthesis (LI-68800, LI-600)
- N2O/CH4/CO2/H2O Gas Monitoring (Trace Gas, LI-830 and LI-850, LI-7500DS, LI-7200RS, LI-7700)
- Light Measurements (LI-190R, LI-200R, LI-210R, LI-250A, LI-1500G, etc.)
- Leaf Area, Plant Canopy (LI-3000C, LI-3100C, LAI-2200C, etc.)

Dynamax Inc.
- Transpiration Sap Flow (Dynagage Sap Flow Sensors, etc.)

Stevens Water Monitoring Systems Inc.
- Soil Monitoring (Hydra Probe, etc.)

Others
- Nano Particle Analyses / Fine Bubble, Humic substance, viruses, etc.
(VIDEO DROP, Exoid, NanoFCM, etc.)

Meiwafosis Own Products
- EM observation, Element Analyses / EDS, AES, XPS, EBSD, etc.
(Osmium Coater, Carbon Coater, Soft Plasma Etching Device)

Symposium | Symposium | S-01 - S-05

Climate Change and Advancing Rice Production in Asia

Chair: Jun-Ichi Sakagami (Kagoshima University, Japan)

Wed. Sep 8, 2021 1:55 PM - 4:30 PM Plenary Room

[S-01] Reduced Stomata Density and Size: The key to improve WUE in Climate-ready Rice

Mutiara K. Pitaloka[1], Robert S. Caine[2], Christopher Hepworth[3], Emily L. Harrison[2], Jen Sloan[2], Cattleya Chutteang[1], Chutima Phuntong[1], Rungsan Nongngok[1], Theerayut Toojinda[5], Siriphat Ruengpayak[4], Siwaret Arikit[1,4], Julie E. Gray[2], ○Apichart Vanavichit[1,4,5] （1.Department of Agronomy, Faculty of Agriculture, Kasetsart University,Thailand, 2.Department of Molecular Biology and Biotechnology, University of Sheffield, UK, 3.Department of Animal and Plant Sciences, University of Sheffield, UK, 4.Rice Science Center, Kasetsart University, Thailand, 5.National Center of Genetic Engineering and Biotechnology (BIOTEC), National Science and Technology Development Agency (NSTDA), Thailand）

2:00 PM - 2:20 PM

[S-02] Maximizing Rice Production and Quality under Climate Change

○Junhwan Kim, Wangyu Sang, Pyeong Shin, Jaekyeong Baek, Dongwon Kwon, Yunho Lee, ChungIl Cho, Myungchul Seo （National Institute of Crop Science, RDA, Korea）

2:20 PM - 2:40 PM

[S-03] Global Climate Changes and Their Impacts on Crop Production

Toshihiro Hasegawa （Division of Climate Change Adaptation Research, Institute for Agri-Environmental Sciences, National Agricultural and Food Research Organization, Japan）

2:40 PM - 3:00 PM

[S-04] Challenges and Adaptation for Rice Production under Climate Change in Taiwan

Huu-Sheng Lur[1], ○Ming-Hwi Yao[2] （1.Department of Agronomy, National Taiwan University, Taiwan, 2.Taiwan Agricultural Research Institute, Council of Agriculture, Taiwan）

3:10 PM - 3:30 PM

[S-05] Farming Systems under Environmental Changes in the Mekong Delta of Vietnam

Nguyen Duy Can （College of Rural Development, Can Tho University, Vietnam）

3:30 PM - 3:50 PM

2:00 PM - 2:20 PM (Wed. Sep 8, 2021 1:55 PM - 4:30 PM Plenary Room)

[S-01] Reduced Stomata Density and Size: The key to improve WUE in Climate-ready Rice

(Thailand)
Mutiara K. Pitaloka[1], Robert S. Caine[2], Christopher Hepworth[3], Emily L. Harrison[2], Jen Sloan[2], Cattleya Chutteang[1], Chutima Phuntong[1], Rungsan Nongngok[1], Theerayut Toojinda[5], Siriphat Ruengpayak[4], Siwaret Arikit[1,4], Julie E. Gray[2], ○Apichart Vanavichit[1,4,5] (1.Department of Agronomy, Faculty of Agriculture, Kasetsart University,Thailand, 2.Department of Molecular Biology and Biotechnology, University of Sheffield, UK, 3.Department of Animal and Plant Sciences, University of Sheffield, UK, 4.Rice Science Center, Kasetsart University, Thailand, 5.National Center of Genetic Engineering and Biotechnology (BIOTEC), National Science and Technology Development Agency (NSTDA), Thailand)

Rice is among the lowest water-use efficient crops. To produce a kg of polished rice, 2.5 tons of water on average is needed. Rice plants utilize most of the uptake water for evapotranspirational cooling via stomata. In order to develop water-used efficient rice, reducing stomatal density and size may help optimizing transpiration and photosynthetic assimilation. Climate-ready, Nutrient-dense rice is an integrative approach to develop new rice varieties of the future agriculture. By pyramiding genes/QTLs controlling broad-spectrum resistance to biotic and abiotic stresses into high nutritional rice background, we have generated series of rice ideotypes to mitigate the effects of climate change and to cope with double malnutrition in 2050.

By forward screening on a large-scale M_5 fast neutron mutagenized population, four stomatal model lines were identified expressing distinct stomata density (High vs Low Density = HD vs LD), and size (Big vs Small Sizes = BS vs SS). Gas exchange analysis revealed that the stomatal model lines were not different in photosynthetic assimilation (*A*) and chlorophyll fluorescence. In response to increasing [CO_2], no difference in *A* from 100-600 ppm [CO_2] for all stomatal model lines but beyond the peak, SS was more responsive to increasing [CO_2] than any stomatal model lines. Nonetheless, HD had higher stomatal conductance (*gs*) and *gsmax* than any stomatal model lines. All stomatal model lines were also similar in rhythmic stomatal responses to ten minutes dark/light transition cycles, except SS was more rapid than BS in the initial stomata closure.

The stomatal model mutants did not show any significant difference in response on a short term water stress. Long-term water stresses had less impact on leaf drying, F_v/F_m, grain yield, and harvest index in LD and SS. In the field, all stomatal model lines and JHN wt had similar WUE in well-water treatment. Nonetheless, LD showed the highest WUE and biomass/plant than any stomatal model lines in the long-term water-stress treatment.

In addition, three cycles of forward screening for recovery from drought stresses on 971 M_5 lines revealed three drought-selected mutants showing good recovery. Surprisingly, when compared to the stomatal model lines, all drought-selected mutants had lower stomatal density similar to LD. Comparison under well-water and water-stress revealed the three drought-selected mutants and LD gained better water-used efficiency and more drought tolerance than BS, HD, and SS. This is a conclusive evidence linking LD, WUE, and drought tolerance.

It is not clear the impact of altered stomatal traits on transpirational cooling under heat and drought stresses. Our recent experiments on heat stress indicated that high stomata density (HD) were beneficial in high air temperature tolerance at reproductive stage while SS and LD accumulated higher canopy temperature than HD, BS, and JHN-wt. in a mild heat at 30℃. Nonetheless, SS and LD were cooler under water deficit.

Specific DNA markers associated with altered stomata traits were used for marker-assisted backcrossing to optimize high yielding, multiple resistance, grain quality, and water-use efficiency.

2:20 PM - 2:40 PM (Wed. Sep 8, 2021 1:55 PM - 4:30 PM Plenary Room)

[S-02] Maximizing Rice Production and Quality under Climate Change

(Korea)

○Junhwan Kim, Wangyu Sang, Pyeong Shin, Jaekyeong Baek, Dongwon Kwon, Yunho Lee, ChungIl Cho, Myungchul Seo （National Institute of Crop Science, RDA, Korea）

The crop growth model, Oryza2000, was simulated to study the temporal and spatial change of the rice productivity of South Korea based on the RCP 8.5 climate change scenario. In general, the decline rate of early ecotype yield was the fastest, followed by the medium-late and the medium. Finally, it was predicted that more than 25% reduction in yield would occur in most areas by the end of the 21st century. The rice quality was evaluated indirectly through the 1000grain weight obtained from the crop growth simulation. The simulation result showed that the 1000grain weight change was similar to the change pattern of rice yield. For adaptation measures, we had tried to shift seeding date. Shifting seeding date was a strategy to avoid low grain filling rate at high temperatures. As a result, shifting of seeding date could delay the decreasing rate of yield as scenario. However, shifting of seeding date could not be a perfect countermeasure to keep current yield level because of uncertainty of solar radiation in future climate condition. Therefore, based on the simulated results, it is necessary to conduct an actual field test every 10 or 15 years

2:40 PM - 3:00 PM (Wed. Sep 8, 2021 1:55 PM - 4:30 PM Plenary Room)

[S-03] Global Climate Changes and Their Impacts on Crop Production

(Japan)

Toshihiro Hasegawa （Division of Climate Change Adaptation Research, Institute for Agri-Environmental Sciences, National Agricultural and Food Research Organization, Japan）

Atmospheric concentrations of major greenhouse gases (GHG) such as carbon dioxide (CO_2), methane, and nitrous oxide have increased by about 50%, 160 %, and 23 %, respectively, since the preindustrial era (https://public.wmo.int/en), mainly as a result of anthropogenic activities. These changes have already raised air temperatures globally for the past 100 years and increased extreme climate events in various regions across the globe. There is a growing body of evidence that the long-term change in air temperatures and associated changes in precipitation amount and patterns have already been affecting crop production, but with varying degrees across different regions. As climate change progresses, the impacts will be greater, but they depend on various factors such as GHG emission scenarios, times, locations, and warming degrees. Since the last assessment report by the Intergovernmental Panel on Climate Change in 2014, a large body of literature has become available for the projected impacts using crop simulation models run under different representative GHG concentration pathways at different spatial scales. Recently, a global dataset has been developed by compiling more than 8000 simulation results from 203 independent studies, providing a valuable source of comprehensive analysis on the projected impacts on major crops. Here I first summarize the impacts of plausible climate change in the current century on the major crop yields, demonstrating that the sign and magnitudes of the effects are heavily dependent on the current temperature levels, with special references to Asian regions. The impacts of climate change also appear in various processes of food systems, including food prices, labor

capacity, transport, storage, and food safety, which ultimately undermine food and nutrition security. On the other hand, food systems are a major source of GHG, accounting for about 1/3 of the anthropogenic emission. In the later part of the presentation, I introduce some examples of complex interactions between food systems and atmospheric conditions that need better understandings to enhance synergies and reduce trade-offs between adaptation and mitigation measures.

3:10 PM - 3:30 PM (Wed. Sep 8, 2021 1:55 PM - 4:30 PM Plenary Room)

[S-04] Challenges and Adaptation for Rice Production under Climate Change in Taiwan

(Taiwan)
Huu-Sheng Lur[1], ○Ming-Hwi Yao[2] (1.Department of Agronomy, National Taiwan University, Taiwan, 2.Taiwan Agricultural Research Institute, Council of Agriculture, Taiwan)

Located in East Asia, the climate of Taiwan is governed by the East Asian Monsoon resulting in the strong seasonality of precipitation pattern and the topographic features further amplify the vulnerability to different natural disasters as compared to other countries. It is crucial to develop the resilient agriculture by improving Taiwan's future agricultural production systems with respect to the future trends of climate change. Paddy rice is the major crop produced in Taiwan, and the small fluctuations of rice yield could lead to serious impact on food security. Evaluation of the major crop production under the different effects of climate change would be essential for bettering the future strategies for enhancing food security. Crop production simulation frequently employs the future climate data predicted by global climate models. The effects of climate change on rice production were evaluated based on the future climate data of four different climate scenarios provided by the United Nation's Intergovernmental Panel on Climate Change. Results indicated that total rice production would decrease by approximately 5%–15%, and this could be the consequence of the reduction of the number of growing days and the undergrowth of grains associated with the poor photoassimilation of vegetative organs due to global warming. Analysis of the future Representative Concentration Pathway (RCP) 8.5 scenario showed that rice yields will decrease in near-term, mid-term, and long-term horizons of the century by 5.1%, 12.5%, and 22%, respectively, especially in northern and eastern of Taiwan. These results are consistent with evaluation results concerning other Asian countries. Climate change refers to not only the changes in average temperatures but also the intensity and frequency of extreme weather events, and the unpredictability of natural disasters has increased the uncertainties for understanding the future changes of crop production. The limitation of existing atmospheric models for predicting disaster occurrence, especially heavy rainfall or strong wind events. The current crop model could simulate various specific disasters but not including typhoons and heat waves which are one of the most important disasters in Asia causing yield reduction during the harvesting season or the flowering stages of crops. The present study analyzed the meteorological changes that have caused the reduction of rice production in Taiwan over the past 60 years. These data were used with the predicted frequency of different climatic scenarios in the future to estimate the effects of future disaster factors on rice yield. Moreover, the approach to establishing a resilient system for rice production that would withstand the various effects of climate change has been considered. In particular, the water used for rice cultivation accounts for approximately 50% of the total water resources in Taiwan. As the traditional policy, farmers are offered with subsidies and undergo fallowing during drought periods. This paper introduces an advanced system to change current farming practice into the dry-field direct seeding as an adaptative farming method to water shortages in farming regions. The present findings provide new

insights on farming systems for climate change adaptation.

3:30 PM - 3:50 PM (Wed. Sep 8, 2021 1:55 PM - 4:30 PM Plenary Room)

[S-05] Farming Systems under Environmental Changes in the Mekong Delta of Vietnam

（ Vietnam）
Nguyen Duy Can （College of Rural Development, Can Tho University, Vietnam）

The Mekong Delta is the most important agricultural area of Vietnam and has often been described as the "Rice Bowl of Vietnam". This Delta provides to more than half of food production and over 95% of rice for export from Vietnam. From long time ago, rice monoculture is a predominant system of agricultural production of the Delta. The reason for this is the environmental conditions such as land and water resources are favorable for rice growing. In addition, other than rice, there are a great potential for fruit trees, fish, shrimp rearing, and to develop diversification of rice-based farming or integrated farming systems in the Delta. Although specialization is the global trend in agriculture, integrated farming systems have emerged in the Mekong Delta of Vietnam during the last two decades. An important motive was the desire to improve the livelihoods, the diet of the nuclear families and to adapt to environmental change. Integrated farming systems are often considered equal to extensive or low-input farming systems and to sustainable agriculture, but usually receives low incomes. The transformation of the farming systems from an extensive, low-input system into an intensive, industry farming system associated with changes in government policy, production technologies and environmental changes. Recently agriculture in Southeast Asia, especially in the Mekong Delta of Vietnam is vulnerable to climate change. Therefore, adaptation measures are required to sustain agricultural productivity, to reduce vulnerability, and to enhance the resilience of the agricultural system to climate change. There are many adaptation practices in the production systems to reduce the effects of climate change. Some farming systems and government policy toward agriculture contributes to adaptation to environmental changes.
This paper focusses on two issues. The first issue presents a systematic review of the historical development of the predominant production systems under environmental changes in the Mekong Delta with major characteristics, performance, perspectives and with reference to other Southeast Asian countries. In the second one, as climate change has already begun, adaptation or the modification of farming practices and production to be discussed – and also the major options in the agricultural sector for adaptation to climate change.

Young Scientist Forum

Young Scientist Forum

Supported by Working group for Fostering Young Scientists and Gender-Equal Participation, Crop Science Society of Japan (CSSJ)
Wed. Sep 8, 2021 5:00 PM - 7:00 PM Plenary Room

Let’s join the free discussion that everyone can talk together via Zoom!
The Forum prepared 3 topics as bellow;

1) Think about Communication among the Young scientists &Students in Asia

2) Think about Women roles in Agricultural Sciences in Asia

3) Think about Future of ACSAC for Young Scientists

We will use breakout rooms of Zoom. The participants will be divided into several groups of four or five, and do free discussion for 10 to 15 min for each topic. Let’s share your experiences, opinions, and ideas. After discussion, each group will report the summary what they discussed briefly (1 to 3 min per each group, total 10 to 15 min). The members of groups will be swapped at each topic. Through the discussions, we will reach new suggestions to our community and also establish new personal relationships.

The Forum prepared online whiteboards “Jamboard” to facilitate discussion. We can see Jamboard while talking on Zoom. The participants don’t need to install any software or app except Zoom (but please confirm update version is the newest).

[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.

[P1] Field Crop Production

Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster) (Field Crop Production)

[P1-01] Seed Size Evaluation of Rice Genotypes for Direct Seeding Development Cultivar

○Ahmad Rifqi Fauzi[1], Ahmad Junaedi[2], Iskandar Lubis[2], Munif Ghulamahdi[3], Hajrial Aswidinnoor[4] (1.Graduate School of Agronomy and Horticulture Study Program, Bogor Agricultural University, Indonesia, 2.Division of Plant Production, Agronomy and Horticulture Department, Faculty of Agriculture, Bogor Agricultural University, Indonesia, 3.Division of Plant Ecophysiology, Agronomy and Horticulture Department, Faculty of Agriculture, Bogor Agricultural University, Indonesia, 4.Division of Plant Genetic and Plant Breeding, Agronomy and Horticulture Department, Faculty of Agriculture, Bogor Agricultural University, Indonesia)

12:15 PM - 1:00 PM

[P1-02] Effects of Seed Drying and Storage Conditions on the Germination Characteristics and Emergence Rates in Early-Winter Direct Seeding of Paddy Rice

○Kensaku Suzuki, Seiji Oikawa, Naoko Aikawa, Hiroyuki Shimono (Department of Plant Biosciences, Faculty of Agriculture, Iwate University, Japan)

1:15 PM - 2:00 PM

[P1-03] Root-Elongated Seeds Can Extend the First Leaf Quickly in Direct-Seeded Rice

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

12:15 PM - 1:00 PM

[P1-04] Effect of Seed Maturity on Seedling Establishment in Early-Winter Direct-Sowing Cultivation In Rice

○Seiji Oikawa, Kensaku Suzuki, Naoko Aikawa, Maya Matsunami, Hiroyuki Shimono (Department of Plant Biosciences, Faculty of Agriculture, Iwate University, Japan)

1:15 PM - 2:00 PM

[P1-05] Effect of Deep Seed Placement on the Crop Establishment and Yield of Dry Direct-Seeded Rice

○Noriko Kanno[1], Kyoko Ito[2], Taiken Nakashima[2], Ricardo Garcia[3], Roel R. Suralta[4], Aurora M. Corales[4], Crisanta S. Bueno[5], Niño P. M. C. Banayo[5], Pompe C. Sta. Cruz[5], Virender Kumar[6], Yoichiro Kato[1] (1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Graduate School of Agriculture, Hokkaido University, Japan, 3.Pangasinan State University Sta Maria, Philippines, 4.Philippine Rice Research Institute, Philippines, 5.University of the Philippines Los Baños, Philippines, 6.International Rice Research Institute, Philippines)

12:15 PM - 1:00 PM

[P1-06] Identification of Quantitative Trait Loci Controlling Nitrogen Use Efficiency-Related Traits in Rice at the Seedling Stage under Salt Condition by Genome-Wide Association Study

○NhungThi Hong Phan[1,2], Cuong Van Pham[2], Pierre Bertin[1] (1.Earth and Life Institue,

Université Catholique de Louvain, Belgium, 2.Agronomy Faculty, Vietnam National University of Agriculture, Vietnam）

1:15 PM - 2:00 PM

[P1-07] Analysis of the N Uptake Pattern to Improve Increasing Yields of Dry Direct-Seeding Rice in a Cool Climate

○Mari Namikawa[1,2], Toshihiro Hasegawa[1], Takayuki Yabiku[1], Toshinori Matsunami[1] （1.Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Crop Science Laboratory, United Graduate School of Agricultural Sciences, Iwate University, Japan）

12:15 PM - 1:00 PM

[P1-08] Changes in Rice Farming from 2009 to 2019 in Three Rice Ecosystems with Contrasting Water Availability in Cambodia -Labor Saving and Mechanization-

○Rinako Takashima[1,2], Akihiko Kamoshita[2], Sareth Chea[3], Sophornthida Lim[3] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Asian Natural Environmental Science Center, The University of Tokyo, Japan, 3.Socioeconomic office, Cambodian Agricultural Research and Development Institute (CARDI), Cambodia）

1:15 PM - 2:00 PM

[P1-09] Effect of Climate on the Yield of 'Ilpum' Rice Cultivar in Gyeongbuk Province, South Korea over the Past 25 Years

○Jong-Hee Shin[1], Chae-Min Han[1], Jung-Bae Kwon[1], Sang-Kuk Kim[2], Yong-Seub Shin[1] （1.Crop Research, Gyeongsangbuk-do Provincial Agricultural Research and Extension Services, Korea, 2., Bioresources Research Institute, Korea）

12:15 PM - 1:00 PM

[P1-10] Differences in Growth and Physiological Characteristics of Winter Wheat Growth under Various Nitrogen Topdressing Conditions

Jae-Gyeong Jeong[1], Jaeeun Choi[1], Young-Hun Lee[1], Gi-Eun Song[1,2], Jonghan Ko[3], Kyung-Do Lee[4], ○Sang-In Shim[1] （1.Department of Agronomy, Gyeongsang National University, Korea, 2.Division of Applied Life Science (BK21 Plus), Gyeongsang National University, Korea, 3.Department of Applied Plant Science, Chonnam National University, Korea, 4.Climate Change and Agro-Ecology Division, RDA, Korea）

1:15 PM - 2:00 PM

[P1-11] Importance of Water Resource Conservation in Agriculture of the Aso Region - Lessons from the Kumamoto Earthquake

○Jun Abe[1], Naoki Kato[2], Atsushi Kashimura[1], Hitoshi Kinouchi[1], Chinobu Okamoto[1] （1.School of Agriculture, Tokai University, Japan, 2.Kyushu Okinawa Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

12:15 PM - 1:00 PM

[P1-12] Cultivar Difference of Iron Toxicity Tolerance in Rice (*Oryza sativa* L.) during Germination and Seedling Stages

○Haruka Aratani[1], Indrastuti A. Rumanti[2], Yoichiro Kato[1] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2., Indonesian Center for Rice Research, Indonesia）

1:15 PM - 2:00 PM

[P1-13] Variation in Grain Characteristics of Upland Rice Cultivated in Southeast Sulawesi, Indonesia

○Mayumi Kikuta[1], Yulius Barra Pasolon[2], Fransiscus Suramas Rembon[2], Akira Miyazaki[3], Yoshinori Yamamoto[3] （1.Graduate School of Integrated Sciences of Life, Hiroshima University, Japan, 2.Faculty of Agriculture, Halu Oleo University, Indonesia, 3.Faculty of Agriculture and Marine Science, Kochi University, Japan）

12:15 PM - 1:00 PM

[P1-14] Combined UAV and Phenotyping Data to Optimize the Growing Status and Management System on Rice Variety, TN11 and NCYU-TN2 in Taiwan

○Yu-Chien Tseng[1], Chun-Yi Wu[1], Wen Lii Huang[1], Wei-Jun Huang[2], Rong-Kuen Chen[3] （1.Agronomy Department, National Chiayi University, Taiwan, 2.Biomechatronic Engineering Department, National Chiayi University, Taiwan, 3.Chiayi Branch Station, Tainan District Agricultural Research and Extension Station, Taiwan）

1:15 PM - 2:00 PM

[P1-15] On-Farm Assessment on Growth and Yield Response of Maize to Different Planting Methods and Tillage Conditions in Rice-Based Cropping System in the Philippines

Kyoko Ito[1], Noriko Kanno[2], Ricardo Garcia[3], Roel R. Suralta[4], Aurora M. Corales[4], John O. Abon[4], Elmer G. Bautista[4], Crisanta S. Bueno[5], Niño P. M. C. Banayo[5], Pompe C. Sta. Cruz[5], Yoichiro Kato[2], ○Taiken Nakashima[1] （1.Graduate School of Agriculture, Hokkaido University, Japan, 2.The University of Tokyo, Japan, 3.Pangasinan State University Sta Maria, Philippines, 4.Philippine Rice Research Institute, Philippines, 5.University of the Philippines Los Baños, Philippines）

12:15 PM - 1:00 PM

[P1-16] Assessment of Dual-Purpose Sweet Potato Cultivation in Japan: Effects of Shoot Harvest Regimes and Cultivar Differences

○Kazuki Taguchi （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

1:15 PM - 2:00 PM

[P1-17] Improved Fertilizer Use Efficiency of Rice by Deep-Place Fertilization Method

○Mumtahina Nabila[1], Keigo Yoshinaga[2], Shin Okamura[3], Tomoya Kumachi[2], Hiroyuki Shimono[2,4], Maya Matsunami[2] （1.United Graduate School of Agricultural Sciences, Iwate University, Japan, 2.Faculty of Agriculture, Iwate University, Japan, 3.Graduate School of Integrated Arts and Sciences, Iwate University, Japan, 4.Agri-Innovation Center, Iwate University, Japan）

12:15 PM - 1:00 PM

[P1-18] Ex-Ante Analysis of Rice Agroecosystems Areas, Yield and Production in Asia

○Jayson Osopelia Villamor （Department of Crop Science, Central Luzon State University, Philippines）

1:15 PM - 2:00 PM

[P1-19] NB-LRR-Encoding Genes Conferring Susceptibility to Organophosphate Pesticides and Leaf Greenness in Sorghum

○Zihuan Jing[1], Fiona Wacera W[1], Tsuneaki Takami[1], Hideki Takanashi[2], Fumi Fukada[1], Yoji

Kawano[1], Hiromi Kajiya-Kanegae[3], Hiroyoshi Iwata[2], Nobuhiro Tsutsumi[2], Wataru Sakamoto[1]
（1.Institute of Plant Science and Resources, Okayama University, Japan, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Research Center for Agricultural Information Technology, National Agriculture and Food Research Organization, Japan）
12:15 PM - 1:00 PM

[P1-20] Effect of *Phytophthora sojae* Inoculation on Soybean — Mortality as Affected by Environmental Factors and Growth of Survived Plant

○Terufumi Tada, Momo Kato, Chihiro Tanaka, Tatsuhiko Shiraiwa （Graduate School of Agriculture, Kyoto University, Japan）
1:15 PM - 2:00 PM

[P1-21] Effect of Narrow-Row Planting with Inter-Row Strip Tillage by Chisel Plough on Yield and Labor Saving to Soybean Cultivation at Field Converted from Paddy in Shonai-Plane of Japan

○Hiroyuki Takeda[1], Hidefumi Saito[1], Naoto Ikeyama[2], Hiroshi Saito[3] （1.Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Faculty of Agriculture, Yamagata University, Japan, 3.Rice Breeding and Crop Science Experiment Station, Yamagata Integrated Agricultural Research Center, Japan）
12:15 PM - 1:00 PM

[P1-22] The Evaluation of Disease Resistance, Agronomic Traits and Yield Among Four Market Types in Peanut (*Arachis hypogaea* L.) Germplasm Collection

○Hsin-I Kuo[1], Hung-Yu Dai[2], Yong-Pei Wu[3], Yu-Chien Tseng[1] （1.Agronomy Department, National Chaiyi University, Taiwan, 2.Agronomy Department, Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan, 3.Crop Division, Taiwan Agricultural Research Institute, Taiwan）
1:15 PM - 2:00 PM

[P1-23] Investigation of the Albinism Derived from Sub-Species Hybridization in Peanuts

○Chuan-You Li[1], Hung-Yu Dai[2], Yu-Chien Tseng[1] （1.Agronomy Department, National Chiayi University, Taiwan, 2.Crop Division, Taiwan Agricultural Research Institute, Taiwan）
12:15 PM - 1:00 PM

[P1-24] Co-Inoculation of *Bacillus pumilus* TUAT1 and *Bradyrhizobium diazoefficiens* USDA110 on Soybean

○Rifa Fadhilah Munifah Hasibuan, Hinako Sugiura, Minori Miyatake, Naoko Ohkama-Ohtsu, Keisuke Katsura （Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan）
1:15 PM - 2:00 PM

[P1-25] Fodder and Grain Production by Double-Cropping System of Rye

○Masahiro Akimoto[1], Honami Okamoto[2], Taiki Yoshihira[3] （1.Agro-Environmental Science, Obihiro University of Agriculture and Veterinary Medicine, Japan, 2.Plant Science Unit, Obihiro University of Agriculture and Veterinary Medicine, Japan, 3.Collage of Agriculture, Food and Environmental Sciences, Rakuno Gakuen University, Japan）
12:15 PM - 1:00 PM

[P1-26] Anaerobic and High Light Stress-Induced Leaf Abscission in Chili Pepper (*Capsicum* spp.)

○Keita Goto[1], Shotaro Tamaru[1], Peter Balyejusa Ssenyonga[2], Emmanuel Kiprono Bore[2], Shin Yabuta[3], Jun-Ichi Sakagami[3] （1.The United Graduate School of Agricultural Sciences, Kagoshima University, Japan, 2.Graduate School of Agriculture, Forestry and Fisheries, Kagoshima University, Japan, 3.Faculty of Agriculture, Kagoshima University, Japan）

1:15 PM - 2:00 PM

[P1-27] Leaf Senescence Evaluation of Selected Interspecific Progenies between *O. sativa* and *O. glaberrima*; NERICA Varieties for Stay-Green Characteristics during Grain-Filling Period

○Peter Balyejusa Ssenyonga[1], Shin Yabuta[2], Shotaro Tamaru[3], Jun-Ichi Sakagami[1,2,3] （1.Graduate School of Agriculture, Forestry and Fisheries, Kagoshima University, Japan, 2.Faculty of Agriculture, Kagoshima University, Japan, 3.The United graduate School of Agricultural Sciences, Kagoshima University, Japan）

12:15 PM - 1:00 PM

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-01] Seed Size Evaluation of Rice Genotypes for Direct Seeding Development Cultivar

*Nominated for Presentation Awards

○Ahmad Rifqi Fauzi[1], Ahmad Junaedi[2], Iskandar Lubis[2], Munif Ghulamahdi[3], Hajrial Aswidinnoor[4]
(1.Graduate School of Agronomy and Horticulture Study Program, Bogor Agricultural University, Indonesia, 2.Division of Plant Production, Agronomy and Horticulture Department, Faculty of Agriculture, Bogor Agricultural University, Indonesia, 3.Division of Plant Ecophysiology, Agronomy and Horticulture Department, Faculty of Agriculture, Bogor Agricultural University, Indonesia, 4.Division of Plant Genetic and Plant Breeding, Agronomy and Horticulture Department, Faculty of Agriculture, Bogor Agricultural University, Indonesia)

Direct seeding of rice (DSR) system would be potentially giving more efficient rice production which less labor and saving water. An appropriate DSR cultivar will improve DSR systems through early vigor trait that may relate to seed size. This research has objective to evaluate the relationship among seed observed variables, i,e.: seed (whole grain), endosperm and embryo size (area, length, width, perimeter, and length-to-width ratio (LWR)) and its early vigor test. The rice germplasm consists of 55 rice genotypes (50 genotypes originating from the IPB University breeding program and 5 national varieties). Description of rice germplasm indicated that the size of seeds, endosperms, and embryos among tested genotypes are significantly different, and the seed and endosperm size (length, perimeter, and LWR) are positively correlated with 1000-grain weight and length of endosperm and seed have given direct effect by path analysis (R^2 = 42.6%). The rice genotypes are continuously observed for early vigor characters by seed germination test and will be evaluated its relationship with seed size traits. Further evaluation on the growth and development performance in the greenhouse and field experiment of selected potentially rice germplasm will be performed to confirm the early vigor character with agronomical goal of this DSR cultivated system.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-02] Effects of Seed Drying and Storage Conditions on the Germination Characteristics and Emergence Rates in Early-Winter Direct Seeding of Paddy Rice

○Kensaku Suzuki, Seiji Oikawa, Naoko Aikawa, Hiroyuki Shimono (Department of Plant Biosciences, Faculty of Agriculture, Iwate University, Japan)

Large-scale cultivation is necessary for cost reduction and labor saving in paddy rice farming. However, the concentration of demand for machinery and labor during the limited seeding period in spring restricts the scale expansion, especially in snowy areas. Early-winter direct seeding is a promising way to overcome this limitation (Shimono et al. 2012, *Jpn J. Crop Sci.*, **81**, 93-98; Oikawa et al. 2019, *Jpn J. Crop Sci.*, **88**, 259-267), although its practical use requires an improvement in the very low emergence rate in spring. Our recent preliminary studies suggested that seed drying and/or storage conditions may affect the rate: lower drying temperatures appeared to increase the emergence rates of some cultivars. In this study, we tested the combination of three different temperatures (30℃, 40℃ and 50℃) for drying and four different temperatures (-30℃, 4℃, 15℃ and 25℃) for storage, to compare the

germination and emergence rates of a *japonica* rice cultivar "Hitomebore", to help improve the emergence rate in early-winter dry-direct seeding cultivation. The germination rate of stored seeds did not change over the storage period up to spring. However, regardless of the drying temperatures, the longer the storage period or the higher storage temperature tested (except -30℃, where the germination speed did not change), the higher the germination speed. The relationship between the germination speed of stored seeds and emergence rate in the field is discussed.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-03] Root-Elongated Seeds Can Extend the First Leaf Quickly in Direct-Seeded Rice

*Nominated for Presentation Awards

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

In direct seeding of rice, rapid elongation of the coleoptile and the first leaf (incomplete leaf) is crucial for seedling establishment. It is reported that root-elongated seeds can grow faster and achieve higher establishment rate than conventionally used pre-germinated seeds because of the fast elongation of the coleoptile. Roots elongate when soaked seeds were put under the warm aerobic condition. To investigate whether this treatment has good effects on the first leaf as well as on the coleoptile, we conducted two experiments. Root-elongated seeds, root-cut seeds and pre-germinated seeds were sown in the pots filled with puddled soil and 1.5cm depth of water at 15° C. The time required for the emergence of the first leaf after the coleoptile had emerged was shorter in the former two seed treatments than in the latter. The same seeds were sown in the submerged agarose medium at 18° C. Until the leaf age of 1.5, leaves of root-elongated seeds and root-cut seeds elongated faster than those of pre-germinated seeds. After then, the speed of the leaf elongation was the same between the all seed treatments. The results show that seed germination under aerobic condition promotes the elongation of the first leaf, and that this is not due to the function of the root. These findings and previous reports suggest that the moderate humidity and oxygen supply during the seed pre-germination promotes the development of the plumule in the embryo, enables the rapid elongation of the coleoptile and the first leaf beneath the flooded soil surface, and improves the seedling establishment.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-04] Effect of Seed Maturity on Seedling Establishment in Early-Winter Direct-Sowing Cultivation In Rice

○Seiji Oikawa, Kensaku Suzuki, Naoko Aikawa, Maya Matsunami, Hiroyuki Shimono （Department of Plant Biosciences, Faculty of Agriculture, Iwate University, Japan）

Early-winter Direct-sowing cultivation in rice is being put to practical use to extend the cropping season in cold regions. We examined the effect of seed maturity on seedling establishment in three rice cultivars ("Akitakomachi", "Hitomebore" and "Koshihikari") using seeds harvested at three different timing (20, 30, 40 days after heading, DAH). Seeds harvested 20DAH had a lower seedling establishment than seeds harvested 40DAH for all cultivars. The dormancy of seeds harvested at 40DAH tended to be

higher than 20DAH in two out of three cultivars. In fact, we found seeds broken their dormancy (50℃, 7days) reduced the seedling establishment. The results showed that the well ripened seeds through the deeper dormancy might be suitable to Early-winter Direct-sowing cultivation in rice than un-ripened seeds.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-05] Effect of Deep Seed Placement on the Crop Establishment and Yield of Dry Direct-Seeded Rice

*Nominated for Presentation Awards

○Noriko Kanno[1], Kyoko Ito[2], Taiken Nakashima[2], Ricardo Garcia[3], Roel R. Suralta[4], Aurora M. Corales[4], Crisanta S. Bueno[5], Niño P. M. C. Banayo[5], Pompe C. Sta. Cruz[5], Virender Kumar[6], Yoichiro Kato[1]
（1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Graduate School of Agriculture, Hokkaido University, Japan, 3.Pangasinan State University Sta Maria, Philippines, 4.Philippine Rice Research Institute, Philippines, 5.University of the Philippines Los Baños, Philippines, 6.International Rice Research Institute, Philippines）

Dry direct seeding is widely employed for rice cultivation where water and labor shortage is an issue in transplanting practices. However, drought during the seedling emergence often causes poor crop establishment. This problem might be solved by deep sowing technique since it utilizes the residual moisture below the soil surface. The objective of this study was to examine the effects of different sowing depths on growths and yields of dry direct-seeded rice. Two trials were conducted in rainfed lowlands; an on-station trial in Tokyo, Japan (35°44'N, 139°32'E) and an on-farm trial in Pangasinan, the Philippines (16°00'N, 120°46'E). Four cultivars (Dular, Dontokoi, Rc10 and Rc348) were grown by seeding at two depths (1 cm and 7 cm) during the summer of 2018 in Japan, and two cultivars (Rc222 and Rc420) at two depths (1 cm and 6 cm) on three sowing dates during the wet season of 2019 in the Philippines. In both trials, deep-sown plots had significantly lower emergence rate than shallow-sown plots (25% vs. 73%). When deep-sown, cultivars with longer mesocotyl and 1st internode emerged better than others. When deep-sown rice had less than 30% of emergence, the yield was 25% to 55% of shallow-sown rice mainly due to reduced panicle number. The compensation effects of increased tillers per hill and grains per panicle were smaller than the negative effect of low plant density caused by deep sowing. The results suggested that securing crop establishment (more than 17 hills m^{-2}) by choosing appropriate cultivar is important in deep sowing technique for dry direct-seeded rice.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-06] Identification of Quantitative Trait Loci Controlling Nitrogen Use Efficiency-Related Traits in Rice at the Seedling Stage under Salt Condition by Genome-Wide Association Study

*Nominated for Presentation Awards

○NhungThi Hong Phan[1,2], Cuong Van Pham[2], Pierre Bertin[1] （1.Earth and Life Institue, Université Catholique de Louvain, Belgium, 2.Agronomy Faculty, Vietnam National University of Agriculture,

Vietnam)

Background: Rice cultivation is facing two severe environmental concerns, salt intrusion and overuse of nitrogen fertilizers. Hence, breeding new varieties aiming to improve nitrogen use efficiency (NUE), especially under salt conditions, is indispensable. However, genetic information related to NUE traits under salt conditions is limited.
Methods: A total of 2,391 rice accessions from the 3K Rice Genome Project were selected to evaluate dry weight under two N concentrations (0.36 mM N - LN and 2.86 mM N - SN) crossed with two NaCl concentrations (0 mM NaCl - 0Na and 60 mM NaCl - 60Na) at the seedling stage. We carried out an association study for shoot dry weight (SDW), root dry weight (RDW), whole plant dry weight (PDW), the ratio of SDW and RDW (SRR), and relative PDWLN0Na-SN0Na, PDWSN60Na-SN0Na, PDWLN60Na-LN0Na, and PDWLN60Na-SN60Na. The GWAS was conducted with 235,210 SNPs and phenotypic data of 2,391 accessions.
Results: A total of 157 QTLs associated with eight tested traits under the four applied treatments were identified by GWAS. Among them, 39, 27, 30, and 31 QTLs were detected under 0SN, 0LN, 60SN, and 60LN treatment, respectively, whereas 12, 5, 4, and 9 QTLs related to the relative PDWLN0Na-SN0Na, PDWSN60Na-SN0Na, PDWLN60Na-LN0Na, and PDWLN60Na-SN60Na were identified. Few QTLs were detected in both treatments of low N and normal N levels or of non-saline and saline conditions. Many QTLs co-located with previously detected QTLs related traits. These results indicated that the false positive probability of the QTLs identified in this study could be very low.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-07] Analysis of the N Uptake Pattern to Improve Increasing Yields of Dry Direct-Seeding Rice in a Cool Climate

*Nominated for Presentation Awards

○Mari Namikawa[1,2], Toshihiro Hasegawa[1], Takayuki Yabiku[1], Toshinori Matsunami[1] (1.Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Crop Science Laboratory, United Graduate School of Agricultural Sciences, Iwate University, Japan)

Dry direct-seeded rice (DSR) is a promising alternative to reduce labor costs compared to transplanted rice, but its low nitrogen (N) fertilizer use efficiency is one of the constraints to the efficient management of DSR in a cool climate. To explore reasons for low NUE in northern Japan, we examined the N uptake patterns of DSR under three different fertilizer regimes under three environments: two years in Morioka and one in Hanamaki, Iwate Prefecture, Japan. We used two cultivars ('Akitakomachi' and 'Yumiazusa') in Morioka and one ('Moeminori') in Hanamaki. In all N treatments at both sites, N uptake patterns exhibited the initial exponential growth (phase 1) followed by a linear growth (phase 2) as a function of the accumulated effective thermal index (AETI). These patterns are well characterized by four parameters: N uptake at the 5th leaf age (*NLA5*), Relative Nitrogen Uptake Rate (*RNR*) in phase 1, breakpoint AETI at which the pattern shifts from the exponential to linear phase (*Nbreak+a AETI*), and the constant rate of N uptake in phase 2 (*a*). Nitrogen treatments had significant effects on *NLA5*, *RNR* and *a*. Multiple regression analysis revealed that the three parameters had significantly positive effects on grain yield, but *NLA5* and *RNR* had greater effects than *a*. We, therefore, conclude that the N uptake pattern during the exponential growth phase imposes the major limitation to yield. *NLA5* differed between environments suggesting initial growth/soil conditions also play a role in controlling early growth and thus grain yields.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-08] Changes in Rice Farming from 2009 to 2019 in Three Rice Ecosystems with Contrasting Water Availability in Cambodia -Labor Saving and Mechanization-

*Nominated for Presentation Awards

○Rinako Takashima[1,2], Akihiko Kamoshita[2], Sareth Chea[3], Sophornthida Lim[3] (1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Asian Natural Environmental Science Center, The University of Tokyo, Japan, 3.Socioeconomic office, Cambodian Agricultural Research and Development Institute (CARDI), Cambodia)

Rice farming in Cambodia has changed along with its rapid economic development but the differences across its diverse rice ecosystems have not been systematically studied. In order to assess regional differences in the changes in rice farming from 2009 to 2019 from (i) technology for water management, (ii) rice market opportunity and (iii) agriculture labor availability, a questionnaire survey was conducted in August 2019 in total of 151 households (HH) in 4 regions under 3 different rice ecosystems; 48 HH from Banan in Battambang Province (irrigated rice ecosystem; IR), 37 HH from Sangke in Battambang Province (deep-water rice ecosystem; DW), 34 HH from Kampong Chhnang Province and 32 HH from Takeo Province (rainfed lowland rice ecosystem; RL). Sangke changed from single deepwater rice production during wet season to short duration irrigated double rice production (i.e., dry season rice and early wet season rice) after the big flood damages in 2011. Rice income increased from 2009 to 2019 greater in IR and DW than RL; RL relied higher proportion of income on off-farm jobs. In order to cope with declining agricultural labor availability, mechanization and/or direct seeding played important roles in all the 3 rice ecosystems. Half of the farmers use both combine harvesters and tractors (only in IR and DW) whereas hand tractors and combine harvesters were used in RL. The amount of labor per hectare (person*day/ha) was one-twentieth of the HH with combine harvesters and tractors for direct seeding, compared to the households with only hand tractors for transplanting.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-09] Effect of Climate on the Yield of 'Ilpum' Rice Cultivar in Gyeongbuk Province, South Korea over the Past 25 Years

○Jong-Hee Shin[1], Chae-Min Han[1], Jung-Bae Kwon[1], Sang-Kuk Kim[2], Yong-Seub Shin[1] (1.Crop Research, Gyeongsangbuk-do Provincial Agricultural Research and Extension Services, Korea, 2., Bioresources Research Institute, Korea)

The aim of this study was to analyze the relationship between rice yield of 'Ilpum', the main rice cultivar in Gyeongbuk province, and climate elements in Daegu (southern plain area) and Andong (inland mountainous area) regions in Gyeongbuk, south Korea. Over the past 25 years, rice yield of 'Ilpum' cultivar has increased in both regions. The rice yield in the recent 5 years increased by about 13% and 20%, respectively, compared to that produced in the late 1990s in Daegu and the early 2000s in the Andong region. The number of panicles per hill and grain ripening rate significantly affected rice yield in

'Ilpum' cultivars in Daegu region. The relationship between heading date and rice yield had a negative significant correlation in Andong region. The air temperature is rising and sunshine duration is getting longer from the late 1990s to present in both regions. To understand the effect of climate factors on rice yield, the milled rice yield of 'Ilpum' cultivar produced over the past 25 years (1995-2019) at both locations, Daegu and Andong, were evaluated. The rice yields increased owing to long sunshine duration during the grain filling stage in both regions. In Andong, rising maximum temperature during the vegetative stage increased rice yield. Rising air temperature during reproductive stage also increase rice yield. Especially, long sunshine hours through whole rice growing period increased rice yield of this cultivar in Andong region.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-10] Differences in Growth and Physiological Characteristics of Winter Wheat Growth under Various Nitrogen Topdressing Conditions

Jae-Gyeong Jeong[1], Jaeeun Choi[1], Young-Hun Lee[1], Gi-Eun Song[1,2], Jonghan Ko[3], Kyung-Do Lee[4], ○Sang-In Shim[1] (1.Department of Agronomy, Gyeongsang National University, Korea, 2.Division of Applied Life Science (BK21 Plus), Gyeongsang National University, Korea, 3.Department of Applied Plant Science, Chonnam National University, Korea, 4.Climate Change and Agro-Ecology Division, RDA, Korea)

The experiments with various levels of nitrogen topdressing was conducted to investigate the effects of various nitrogen topdressing conditions on the growth of winter wheat in Jinju, Korea from autumn 2018 to spring 2019. When nitrogen topdressing was applied at 0% of the standard fertilization rate, leaf SPAD value and NDVI were the lowest at 25.5 and 0.5210, respectively, and the plant height, leaf area index and yield-related characteristics were also the lowest. Crude protein content of grain was highest as 13.9% at recommended fertilizer application rate and lowest as 11.08% without nitrogen topdressing. Hyperspectral analysis, a non-destructive method, was performed using a portable hyperspectral camera to know changes in physiological characteristics of crops. As a result of analyzing the hyperspectral reflectance characteristics of winter wheat leaves according to various nitrogen topdressing rates, the difference in the hyperspectral reflectance at booting stage was most remarkable, and the reflectance in the green color region was high at 20% of the recommended N topdressing rate and low at the 80% of recommended N topdressing rate. The results show that the crude protein content in grain is the lowest as 7.81% at 20% nitrogen topdressing rate, which is consistent with the highest as 13.78% at 80% nitrogen topdressing rate.

This study is a part of Cooperative Research Program for Agriculture & Technology Development (Project No. PJ013841032020) from Rural Development Administration, Korea.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-11] Importance of Water Resource Conservation in Agriculture of the Aso Region - Lessons from the Kumamoto Earthquake

○Jun Abe[1], Naoki Kato[2], Atsushi Kashimura[1], Hitoshi Kinouchi[1], Chinobu Okamoto[1] （1.School of Agriculture, Tokai University, Japan, 2.Kyushu Okinawa Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

In April of 2016, Kumamoto Earthquake caused huge disaster to agriculture in the Aso region, which is a large mountainous area in central Kyushu Island of Japan. We interviewed the affected farmers about the actual situation of the damage, focusing on the problem of water supply. In Aso City, which is located in the north of the Aso Caldera and has many large paddy fields, cracks, land irregularities, and liquefaction damaged the paddy fields. In addition, a long-distance underground waterway from the river was damaged and the water supply to the irrigation canal was cut off. In some areas it took three years to recover. Under such circumstances, the irrigation canals that use "natural water" (mountain stream) were less damaged and could be used again immediately. Despite such advantage of "natural water" for paddy irrigation, the supply of natural water has become unstable due to changes in the usage pattern of Mt. Aso and perhaps due to the decrease in snowfall caused by global warming. Natural alternative water sources also played an important role in the field of livestock. Dairy cow farmers helped cows by bringing water daily from nearby springs for months to a year and a half. Although traditional beef cattle grazing is declining, conservation of Aso grasslands should be important for a stable water supply.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-12] Cultivar Difference of Iron Toxicity Tolerance in Rice (*Oryza sativa* L.) during Germination and Seedling Stages

*Nominated for Presentation Awards

○Haruka Aratani[1], Indrastuti A. Rumanti[2], Yoichiro Kato[1] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2., Indonesian Center for Rice Research, Indonesia）

Iron (Fe) toxicity is a major constraint for rice production on acid sulfate soils in tropical deltas, where development of Fe toxicity-tolerant cultivars is prerequisite. In this study, genotype screening systems for Fe toxicity tolerance during germination and seedling stages were examined. For the screening during the germination stage, hydroponic and soil cultures and the use of agar medium were evaluated. Hydroponic and soil cultures proved suitable for large scale screening due to their simplicity and rapidity, while uniform seeding and water depth was critical in soil culture. In the screening during the seedling stage with hydroponic culture, varying Fe levels (0-400 mg L^{-1}) were compared, and we found that significant shoot biomass reduction occurs with more than 300 mg L^{-1} Fe. Our results also showed that the effect of pH was small in the range of pH 4-5, compared to that of Fe level in the range of 0-800 mg L^{-1}. Among seven cultivars (Cilamaya Muncul, DV85, INPARA2, INPARA5, IR64, Mahsuri and Taichung 65) grown at 500 mg L^{-1} Fe, Taichung 65 showed least shoot biomass reduction and the lowest shoot Fe concentration. This result suggested that Taichung 65 has root-based tolerant mechanism, possibly by preventing Fe from permeating the root or inhibiting the Fe transport from the root to the shoot. In conclusion, genotype screening systems for Fe toxicity during germination and seedling stages were established and Taichung 65 showed tolerance in the seedling stage, possibly by operating its root-based tolerant mechanism.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-13] Variation in Grain Characteristics of Upland Rice Cultivated in Southeast Sulawesi, Indonesia

*Nominated for Presentation Awards

○Mayumi Kikuta[1], Yulius Barra Pasolon[2], Fransiscus Suramas Rembon[2], Akira Miyazaki[3], Yoshinori Yamamoto[3] (1.Graduate School of Integrated Sciences of Life, Hiroshima University, Japan, 2.Faculty of Agriculture, Halu Oleo University, Indonesia, 3.Faculty of Agriculture and Marine Science, Kochi University, Japan)

Farms in Southeast Sulawesi Province, Indonesia, historically grow upland rice crops that utilize the slash-and-burn farming system. However, little is known about grain quality and the differences between upland rice varieties in this region. Ten traditional upland rice varieties were collected from the fields, and one upland variety was collected at a market in Kendari located within the province. Grain appearance was investigated. Amylose and protein content in brown rice were determined. These traditional varieties were highly varied in terms of grain appearance and grain quality-related factors. Grain color was white in six varieties, brown in four varieties, and blackish in one variety. The 1000-grain weight ranged from 20.7 to 33.5 g between the 11 rice varieties. The protein content in the 11 varieties ranged from 7.8% to 10.7%, with average of 8.7 %. Two rice varieties were characterized as glutinous with 0% amylose content. Amylose content in the eight varieties ranged from 14.8% to 19.7%, and they were characterized as non-glutinous. Additionally, we found one non-glutinous variety with extremely low amylose content (5.6%), which is a unique characteristic. These results indicate that this region contains valuable upland rice varieties, and this information is useful for future genetic resource studies.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-14] Combined UAV and Phenotyping Data to Optimize the Growing Status and Management System on Rice Variety, TN11 and NCYU-TN2 in Taiwan

○Yu-Chien Tseng[1], Chun-Yi Wu[1], Wen Lii Huang[1], Wei-Jun Huang[2], Rong-Kuen Chen[3] (1.Agronomy Department, National Chiayi University, Taiwan, 2.Biomechatronic Engineering Department, National Chiayi University, Taiwan, 3.Chiayi Branch Station, Tainan District Agricultural Research and Extension Station, Taiwan)

Rice (*Oryza sativa* L.) is one of the most important crop in the world. Climate changes increase the risk of rice production and decrease the yield. Also, the population aging problem in agriculture makes it difficult to have enough labor resources. The goal of the study is to combine UAV (unmanned aerial vehicle) data with phenotyping data in the field. By analyzing both data, to build a decision system and help researchers/farmers manage the production system in time and at early stage. On this study, rice cultivar TN11 and NCYU-TN2 were utilized. TN11 is the most popular cultivar in Taiwan and has the largest planted acreage. NCYU-TN2 is the drought tolerance cultivar derived from a population of *japonica* rice and Taiwanese rice landrace. The experiment included four nitrogen treatment (70, 140, 210, 280 ton/ha). UAV with multi spectrum camera was implemented four times during the season (initial stage, tiller develop stage, grain-fill stage and prior to harvest). The phenotype investigation was

conducted in the field at the same time. The UAV results were analyzed using Pix4D software and three values were mainly used, including NDVI (Normalized Difference Vegetation Index), NBI (Nitrogen Balance Index) and NDRE (Normalized Difference Red Edge Index). The results showed the nitrogen amount had positive correlation with plant height and NCYU-TN2 was taller than TN11, however, TN11 had more tiller numbers than NCYU-TN2. The tiller develop stage had the largest SPAD value on both cultivars. The regression analysis was conducted between yield/NDVI, yield/NBI, and yield/NDRE on different stages and both cultivars. NDVI and NDRE have better fitness than NBI on both cultivars. NCYU-TN2 showed R^2 =0.70 (r=0.84) between NDRE and yield on grain-fill stage.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-15] On-Farm Assessment on Growth and Yield Response of Maize to Different Planting Methods and Tillage Conditions in Rice-Based Cropping System in the Philippines

Kyoko Ito[1], Noriko Kanno[2], Ricardo Garcia[3], Roel R. Suralta[4], Aurora M. Corales[4], John O. Abon[4], Elmer G. Bautista[4], Crisanta S. Bueno[5], Niño P. M. C. Banayo[5], Pompe C. Sta. Cruz[5], Yoichiro Kato[2], ○Taiken Nakashima[1] (1.Graduate School of Agriculture, Hokkaido University, Japan, 2.The University of Tokyo, Japan, 3.Pangasinan State University Sta Maria, Philippines, 4.Philippine Rice Research Institute, Philippines, 5.University of the Philippines Los Baños, Philippines)

Maize (Zea mays L.) is the second most produced cereal crop in the Philippines. In many areas, it is grown in rice-based multiple cropping system. With the declining labor availability in rural areas, a labor-saving maize production is needed. Hence a hand tractor-mounted multiple-purpose (MP) seeder has been developed as a low-cost mechanized planting option for rice, maize and mung beans. In this study, we performed an on-farm experiment in Northwestern Luzon, the Philippines in 2019-2020 dry season to evaluate growth and yield response of maize to varying combinations of planting methods and tillage intensities. Three planting methods used were mechanized planting with MP Seeder (MP), manually operated local farmers' practice (FP), and high precision manual planting (PP) in combination with two tillage conditions; single and triple passes of rotavation for minimum (MT) and heavy tillage (HT), respectively. In MP, the time and labor costs for planting were drastically reduced compared to FP and PP. In contrast, higher plant density and lower variation in within-row distance were observed in both FP and PP. The yield was not significantly different among planting methods indicating a compensation growth in MP. No significant differences between MT and HT were detected in any parameters above. These results suggest that the use of MP seeder with minimal tillage can reduce labor and seed costs while maintaining yield level similar to the current farmers' practices, although there is still some room for improvement in MP seeder in terms of its seeding precision.

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[P1-16] Assessment of Dual-Purpose Sweet Potato Cultivation in Japan: Effects of Shoot Harvest Regimes and Cultivar Differences

*Nominated for Presentation Awards
○Kazuki Taguchi （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

Sweet potato (*Ipomoea batatas* L.) is often cultivated for dual purposes by resource-poor farmers, and both tuberous root and shoot are harvested. Leaves are important as nutrient sources as they are rich in minerals and protein. The objectives of this study were to evaluate the effect of timing and intensity of mid-season harvest of shoot on tuberous root yield and total shoot yield, and cultivar differences in the response to mid-season harvest of shoot.
Two field trials were conducted at the upland farm of the University of Tokyo, Japan in the summer of 2020. In Trial 1, seven treatments (50%45DAP, 50%75DAP, 50%45DAP&75DAP, 100%45DAP, 100%75DAP, 20%45DAP&60DAP&75DAP, control) were compared, where 50%45DAP means 50% of shoot were harvested at 45 days after transplanting (DAP). In Trial 2, three cultivars (Beniazuma, Koganesengan and Suiou) were grown with mid-season harvest of shoot.
In Trial 1, total shoot yield was highest in 100%75DAP and least in 100%45DAP. Tuberous root yield was highest in control, while not significantly different from 50%45DAP. In Trial 2, total shoot yield was highest in Suiou, while Koganesengan for tuberous root yield. The total amount of iron in edible part (leaf + tuberous root) significantly increased by mid-season harvest of shoot.
The results showed that total shoot yield, tuberous root yield and crops' nutrient contents in dual-purpose sweet potato cultivation depend on the timing and intensity of shoot harvest. Suitable cultivars should possess both vigorous shoot recovery from mid-season harvest and genetic potential of high tuberous root yield.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-17] Improved Fertilizer Use Efficiency of Rice by Deep-Place Fertilization Method

*Nominated for Presentation Awards
○Mumtahina Nabila[1], Keigo Yoshinaga[2], Shin Okamura[3], Tomoya Kumachi[2], Hiroyuki Shimono[2,4], Maya Matsunami[2] （1.United Graduate School of Agricultural Sciences, Iwate University, Japan, 2.Faculty of Agriculture, Iwate University, Japan, 3.Graduate School of Integrated Arts and Sciences, Iwate University, Japan, 4.Agri-Innovation Center, Iwate University, Japan）

Deep-Place Fertilization (DPF) method is known to increase rice productivity than the conventional broadcast fertilization method in paddy field with improving nutrient use efficiency. However, no information is available for root traits suitable for DPF method. The present study evaluated the effects of DPF on root growth and nitrogen(N) use efficiency by field and root box experiments using rice cultivar Akitakomachi. Ammonium sulphate, slow-release N fertilizer used as N source. Nutrient mixed in soil used as control whereas nutrient ball placed in 7cm (DP1), 7cm and 15cm (DP2) depth of soil was the treatment condition. In DP2 treatment, fertilizer used in half amount in each position. At heading stage, greater root length, root surface area found at both DPF conditions compared to control especially at deep soil layer (below 10cm from soil surface). Increased surface area of deeper roots allowed plants to uptake more N during the ripening period. At maturity, N accumulation in above-ground parts found higher in DPF treatments and this resulted in higher yield production. The allocation of root to deeper position was supported by root box experiment. Increased root accumulation was found just below the fertilizer position in DPF conditions which indicates that DPF method induced root growth toward fertilizer. Taken together, deep fertilization induces the root growth to the lower layer of soil which

improves N use efficiency and yield production.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-18] Ex-Ante Analysis of Rice Agroecosystems Areas, Yield and Production in Asia

*Nominated for Presentation Awards

○Jayson Osopelia Villamor （Department of Crop Science, Central Luzon State University, Philippines）

Asian continent is home to more than half of the world's population which is at approximately 4.6 B as of 2018. It covers one-tenth of the global land areas. Rice is the major crop and staple food of most Asian people. Rice agroecosystems is the dominant landscape that is sustaining the food source of its inhabitants. With the use of FAOSTAT rice datasets and utilisation of data science vital information on areas devoted to rice crop, its yield and production were derived in this study. The whole of Asian continent was sub-divided per region namely: Central, Eastern, Southern, South-eastern and Western. Results showed that wider land areas were planted to rice as well as higher yields were recorded in Eastern, Southern and South-eastern regions. In consideration of the average per capita consumption for rice among Asians at 96 kg/person/year, the continent is experiencing a downward trend that could lead to rice production insufficiency. Possible adverse impacts of changing climatic conditions, ageing farmers and the overall declining rice yield despite the advances in rice production technologies. These issues can be mitigated by giving preferential attention by head of states, government regulatory or laws and policy implementing bodies as well as by all concerned stakeholders. Identified strategies proven by science and even by indigenous knowledge should be used and implemented accordingly to sustain life and wellness of the Asian populations.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-19] NB-LRR-Encoding Genes Conferring Susceptibility to Organophosphate Pesticides and Leaf Greenness in Sorghum

*Nominated for Presentation Awards

○Zihuan Jing[1], Fiona Wacera W[1], Tsuneaki Takami[1], Hideki Takanashi[2], Fumi Fukada[1], Yoji Kawano[1], Hiromi Kajiya-Kanegae[3], Hiroyoshi Iwata[2], Nobuhiro Tsutsumi[2], Wataru Sakamoto[1] （1.Institute of Plant Science and Resources, Okayama University, Japan, 2.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Research Center for Agricultural Information Technology, National Agriculture and Food Research Organization, Japan）

In crops, leaf greenness or injury can be monitored for optimal growth and photosynthesis capacity, but developmental and environmental factors can influence leaf greenness negatively. Leaves may experience cell death following the application of organophosphate pesticides leading to growth defects, similar to pathogen infection. To understand organophosphate pesticide sensitivity (OPS) and leaf greenness in sorghum, we conducted QTL analysis in a recombinant inbred line derived from the Japanese cultivar NOG, which exhibits OPS. Assessment of leaf greenness in natural conditions allowed us to detect several QTLs, although the appearance of these QTLs was not fully reproducible over multiple years. However, mapping OPS in this population identified a prominent QTL on chromosome 5, which

corresponded to *Organophosphate-Sensitive Reaction (OSR)* reported previously in other mapping populations. The *OSR* locus included a cluster of three genes potentially encoding nucleotide-binding leucine-rich repeat (NB-LRR, NLR) proteins, among which *NLR-C* was considered to be responsible for OPS in a dominant fashion. *NLR-C* was functional in NOG, whereas the other resistant parent, BTx623, had a null mutation caused by the deletion of promoter sequences. Our finding of *OSR* as a dominant trait is important not only in understanding the diversified role of NB-LRR proteins in cereals but also in securing sorghum breeding free from OPS.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-20] Effect of *Phytophthora sojae* Inoculation on Soybean — Mortality as Affected by Environmental Factors and Growth of Survived Plant

*Nominated for Presentation Awards

○Terufumi Tada, Momo Kato, Chihiro Tanaka, Tatsuhiko Shiraiwa （Graduate School of Agriculture, Kyoto University, Japan）

Loss of soybean production due to Phytophthora stem and root rot (PSR) is serious, but the information on cultivation methods to reduce the PSR damages is limited. The objectives of this study were (1) to investigate major factors on the mortality rate due to PSR, and (2) to evaluate the effect of the pathogen existence and flooding on the traits of survived plants. (1) The seedlings of soybean cultivar 'Enrei' were inoculated with two *Phytophthora sojae* isolates (Ps060626-4-1 and Ps060710-3-1) in three different ways, like compulsory inoculation to injured hypocotyl under high relative humidity (CIH), or that under low humidity (CIL), or exposing uninjured plant to inoculum suspension under low humidity (EIL). The ratio of dead plants was highest in CIH (0.81) followed by CIL (0.65), and EIL (0.38). This result suggested that the mortality of soybean could be promoted by injury and high relative humidity. (2) The seedlings of soybean cultivar 'Enrei' were inoculated with the two pathogen isolates under non-flooded and flooded conditions and its effects on the growth of the plants were quantitatively evaluated. In all nine experiments except one, the inoculation caused maximum root length (MRL) to be significantly shorter. The interaction between inoculation and flooding influenced MRL and shoot dry weight. The results indicated that soybean seedlings grew more poorly when the plants survived from *P. sojae* attack compared to plants without the pathogen inoculation.

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[P1-21] Effect of Narrow-Row Planting with Inter-Row Strip Tillage by Chisel Plough on Yield and Labor Saving to Soybean Cultivation at Field Converted from Paddy in Shonai-Plane of Japan

○Hiroyuki Takeda[1], Hidefumi Saito[1], Naoto Ikeyama[2], Hiroshi Saito[3] （1.Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Faculty of Agriculture, Yamagata University, Japan, 3.Rice Breeding and Crop Science Experiment Station, Yamagata Integrated

Agricultural Research Center, Japan）

It has become difficult to manage soybean cultivation because of insufficient labor against to increasing cropping area although soybean cultivation converted from paddy has been increased in Shonai-plain at the side of Japan Sea of Tohoku region in Japan. To reduce labor on conventional cultivation (CC) and to increase yield we introduced a sowing machine developed in NARO which could not only be planted in narrow row without preliminary tillage and ridge making but also be kept soil moisture suitable by the inter-row strip tillage with chisel plough. For the experiment, soybean cv. Satonohohoemi was cultivated on farm-owned field located at Shonai-plane in 2016 - 2018. There was no significant difference in average soybean yield among three years between narrow-row cultivation (NRC) and CC. The maximum yield was got at the case of cultivation including at field just converted after paddy, which in NRC were 273 g/m2 by hand harvesting or 227 kg/10 a by combine harvester. Total working time in NRC was 7.4 hours per 10 a which was equivalent to about 20 percent decrease against CC. Total cost per 10 a on NRC was 64.3 thousand-yen witch equivalent to 4 percent decrease to CC in spite of the induction of new sowing machine. Among 3-year experimentation, NRC with inter-row strip tillage by chisel plough of soybean has no superiority on the yield than in CC, however it was contributed to the reduction of total working time in CC.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-22] The Evaluation of Disease Resistance, Agronomic Traits and Yield Among Four Market Types in Peanut (*Arachis hypogaea* L.) Germplasm Collection

○Hsin-I Kuo[1], Hung-Yu Dai[2], Yong-Pei Wu[3], Yu-Chien Tseng[1] （1.Agronomy Department, National Chaiyi University, Taiwan, 2.Agronomy Department, Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan, 3.Crop Division, Taiwan Agricultural Research Institute, Taiwan）

Peanut (*Arachis hypogaea* L.) is allotetraploid (AABB, 2n=4x=40) legume with high oil and protein content. It is classified into four market types (Virginia, Runner, Valencia and Spanish). Virginia and Runner belong to the subspecies (ssp), *hypogaea*; Spanish and Valencia belong to ssp. *fastigiata*. In this study, we randomly selected 150 peanut accessions from National Plant Genetic Resources Center in Taiwan, including 74 Spanish types, 21 Valencia types, 24 Virginia types and 31 Runner types. They were planted in the field with standard management protocol in spring and fall, 2019. There are four disease (rust, leaf spot, witches' broom and stem rot) evaluated at the late stage of the growth. Several agronomic traits (pod length, pod width, 50-pods weight, shelling percentage and 100-seeds weight) and yield were also measured after harvest. The results of Pearson correlation analysis showed yield was significantly negatively related to rust resistance and significantly positively related to 50-pods weight and 100-seeds weight. Combined ANOVA of market types with correlation analysis, our findings suggest that Virginia and Runner, these two market types are more resistant to rust and stem rot disease, however, Valencia and Spanish are more resistant to leaf spot and have higher shelling percentage, 50-pods weight and yield. In future breeding program, it is a goal to combine rust and stem rot resistant lines (Virginia and Runner) with high yield lines (Valencia and Spanish) using molecular markers and backcross selection.

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[P1-23] Investigation of the Albinism Derived from Sub-Species Hybridization in Peanuts

○Chuan-You Li[1], Hung-Yu Dai[2], Yu-Chien Tseng[1] (1.Agronomy Department, National Chiayi University, Taiwan, 2.Crop Division, Taiwan Agricultural Research Institute, Taiwan)

Peanut (*Arachis hypogaea* L.) is a crop grown in the tropical and subtropical areas. It is classified as a grain legume. There are four market types in peanuts, including Runner, Virginia, Spanish and Valencia. Both Runner and Virginia belong to the subspecies (ssp), *hypogaea*; Spanish and Valencia belong to ssp. *fastigiata*. The albinism can be observed during sub-species hybridization. It is very common to utilize sub-species hybridization to deliver the desired traits from one subspecies to another in peanut breeding programs. In this study, we used 10 albino lines (F_4 generation), which came from a cross between PI599592 (Runner) and PI599345 (Spanish). They were planted using complete randomized design (CRD) with three replicates. Also, two parental lines, PI599592 and PI599345 plus two commercial cultivars, TN14 and TNS9 were included in this experiment. According to the results, we find the albino lines have significant lower plant height and fewer leafs compared to TN14, TNS9, PI599592 and PI599345. Since albino peanuts have slower growth rate, the flowering times are also delayed. The SPAD and spectrophotometer show chlorophyll contents in albino lines are lower than the normal peanuts. The results of albino lines are just a beginning. Future work will be focused on observing the parents' chromosome structure in pollens and the albino chloroplast structure by using microscope. The results will help researchers understand more about the albinos from subspecies hybridization, and how to avoid albinism in peanut breeding.

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[P1-24] Co-Inoculation of *Bacillus pumilus* TUAT1 and *Bradyrhizobium diazoefficiens* USDA110 on Soybean

*Nominated for Presentation Awards

○Rifa Fadhilah Munifah Hasibuan, Hinako Sugiura, Minori Miyatake, Naoko Ohkama-Ohtsu, Keisuke Katsura (Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan)

Application of bio-fertilizer is vital to find inoculation methodology that do not inhibit symbiosis between rhizobium and plants. However, co-inoculation of rhizobium with different microorganism on legumes generally inhibit interdependency with rhizobia. The present study was conducted to find the ideal inoculation method of the bio-fertilizer "Yumebio" containing *Bacillus pumilus* TUAT1 which have plant growth promoting activity without inhibiting rhizobial infection to soybean. Soybean plants were inoculated with *Bradyrhizobium diazoefficiens* USDA110 on the timing of sowing seeds, then 3 treatments were prepared. Simultaneous inoculation of "Yumebio" with rhizobia (SI), Inoculation of "Yumebio" 1 week after rhizobia inoculation (I), and no inoculation of "Yumebio" (NI). Biomass dry weight (shoot and root) and nitrogenase activity based on acetylene reduction assay (ARA) measured at four weeks after sowing. Both ARA per plant and nodule weight were increased significantly with "I" treatment compared to those with "NI". However, there were no significant differences between "SI" and "NI" for shoot biomass and ARA per plant. Nodule numbers were decreased by "SI" compared to "NI". This study suggests that simultaneous inoculation of "Yumebio" and rhizobia inhibits nodule development, and inoculation of "Yumebio" 1 week after inoculation of rhizobia is ideal timing to promote soybean growth

without inhibiting rhizobium infection to soybean.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-25] Fodder and Grain Production by Double-Cropping System of Rye

○Masahiro Akimoto[1], Honami Okamoto[2], Taiki Yoshihira[3] (1.Agro-Environmental Science, Obihiro University of Agriculture and Veterinary Medicine, Japan, 2.Plant Science Unit, Obihiro University of Agriculture and Veterinary Medicine, Japan, 3.Collage of Agriculture, Food and Environmental Sciences, Rakuno Gakuen University, Japan)

To establish double-cropping system of rye in which productions of course feed in the first crop and grain in the second crop are performed, proper harvesting time for the first crop was studied. Rye variety 4R-507 was grown at Obihiro, Japan in 2018-2019 and 2019-2020. Plant bodies were harvested as the first crop at three different growth stages, boot stage (BT-plants), initial heading stage (IH-plants), and heading stage (HE-plants), then, the grains on the aftermath were harvested as the second crop. Dry-matter yield and nutritional value of the first crops and grain yield of the second crops were compared among three plants. In both experimental periods, dry-matter yield of the first crop was higher in order of HE-plants, IH-plants, and BT-plants. The nutritional values such as content rates of unstructured organic matters and digestible fibers tended to be higher in the first crop harvested at earlier growth stage, and the highest total digestible nutrients was observed in BT-plants. Vigorous regrowth was achieved after the harvest of the first crop in the plants mowed in earlier growth stage, and BT-plants developed large aftermath with many new tillers than other plants. BT-plants showed the highest grain yield about half of the value of conventionally grown plants (single-cropping rye). The aftermath regrew from the stubbles mowed after panicle heading could produce meager grains. In conclusion, proper harvesting time for the first crop should be boot stage for practicing double-cropping system of rye.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-26] Anaerobic and High Light Stress-Induced Leaf Abscission in Chili Pepper (*Capsicum* spp.)

*Nominated for Presentation Awards

○Keita Goto[1], Shotaro Tamaru[1], Peter Balyejusa Ssenyonga[2], Emmanuel Kiprono Bore[2], Shin Yabuta[3], Jun-Ichi Sakagami[3] (1.The United Graduate School of Agricultural Sciences, Kagoshima University, Japan, 2.Graduate School of Agriculture, Forestry and Fisheries, Kagoshima University, Japan, 3.Faculty of Agriculture, Kagoshima University, Japan)

Photosynthetically active organs in plant leaf must achieve a delicate balance between the leaf water status or the light energy harvested by chlorophyll, and their photosynthetic capacity to convert light into chemical energy as ATP and $NADPH_2$ (Reinbothe et al., 1996; Huq et al., 2004). As one of the responses to abiotic stress, chili pepper (*Capsicum* spp.) induced the expression of genes that respond to ethylene and ROS, and induced H_2O_2 production at the abscission zone, which preceded leaf abscission (Munné-Bosch and Alegre, 2004; Sakamoto et al., 2008). Present study aimed to provide the significance

of leaf abscission as a survival and adaptive strategy to environment by analyzing leaf physiological and biochemical parameters in chili pepper grown under different soil water status (well-drain and flood) and light conditions (non-shade and 60% shade). Leaf nitrogen status (SPAD) and maximum quantum yield (F_v/F_m) were investigated at respective 5 leaf positions divided as position 1 (P1), P2, P3, P4 and P5 from top to the lowest parts of the plant. Results demonstrated leaf abscission occurred in anaerobic and high light stressed plants. These plants abscised leaves at P4 or P5 (larger old leaf), but not at all in P1 to P3 (smaller young leaf). Additionally, they maintained higher SPAD and F_v/F_m at P1. Thereby, it can be suggested that abiotic stress-induced leaf abscission in chili pepper contributes to nutrient remobilization during stress and to avoid large loss through transpiration.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 1 (Poster))

[P1-27] Leaf Senescence Evaluation of Selected Interspecific Progenies between *O. sativa* and *O. glaberrima*; NERICA Varieties for Stay-Green Characteristics during Grain-Filling Period

*Nominated for Presentation Awards

○Peter Balyejusa Ssenyonga[1], Shin Yabuta[2], Shotaro Tamaru[3], Jun-Ichi Sakagami[1,2,3] (1.Graduate School of Agriculture, Forestry and Fisheries, Kagoshima University, Japan, 2.Faculty of Agriculture, Kagoshima University, Japan, 3.The United graduate School of Agricultural Sciences, Kagoshima University, Japan)

The stay-green ability in rice plants is an important factor for plant survival in especially stressful environments. The characteristic has shown potential function for additional dry matter production in some cereal varieties. Leaf greenness directly impact leaf activity in terms of photosynthesis performance main source of energy for plant organs growth. In this experiment, we evaluated the leaf chlorophyll content (SPAD) in flag leaf sections under incubation conditions to ascertain varietal senescence performance differences during the grain-filling period for stay-green characterization. In the glasshouse six NERICAs (1, 4, 10, 19, 41 and 60) varieties were grown and were evaluated from heading, 20 days and 40 days after flowering (DAH). The flag leaf, a center section of 5 cm length was incubated in dark at 35^0C and daily SPAD reading was recorded. There was a drastic decline in the SPAD value of the flag leaf of NERICA 19 and 41, followed by NERICA 60 in the glasshouse. The period SPAD value reduced by 50% (T_{50}); NERICA 1 and 10 at 20 DAH was superior with 6.7 and 5.1 days longer, respectively. NERICA 1 and 4 at 40 DAH scored higher with 4.9 and 3.1 days, respectively compared to other varieties. NERICA 1 and 4 showed a strong negative correlation between flag leaf SPAD value of plant and section incubation at both 20 and 40 DAH. The preliminary findings suggest NERICA 1 to be a candidate variety for stay-green characterization due to prolonged leaf senescence with further physiological growth and environmental assessments.

[P2] Farming System

Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster) (Farming System)

[P2-01] Soil Fertility Decline by Repeated Cropping of Rice for Whole Crop Silage – A Case of Mifune Town in Kumamoto Prefecture, Japan

○Naoki Moritsuka[1], Kaori Matsuoka[2], Kosuke Baba[1] (1.Faculty of Agriculture and Marine Science, Kochi University, Japan, 2.Institute of Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan)

12:15 PM - 1:00 PM

[P2-02] A Case Study of Learning to Work on a Farm in a Special Need Education School for Children with Intellectual Disabilities – Focusing on the Cultivation of Rice Plant

○Izumi Oh-E (Retired, Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan)

1:15 PM - 2:00 PM

[P2-03] Growth and Yield of Rice, and Soil Enzyme Activites in Super Low External-Input Paddy Rice Field

○Taichi Tsujimoto[1], Kazuhiro Hosoya[1], Hideto Ueno[1], Yo Toma[1], Yoichi Yamashita[2], Masataka Adachi[2], Takayuki Kono[2] (1.Graduate School of Agriculture, Ehime University, Japan, 2.Faculty of Agriculture, Ehime University, Japan)

12:15 PM - 1:00 PM

[P2-04] Nitrogen and Water Demands for Maximum Growth of *Solanum tuberosum* under Doubled CO_2: Interaction with Phosphorus Based on the Demands

○Yan Yi, Daisuke Sugiura, Katsuya Yano (Graduate School of Bioagricultural Sciences, Nagoya University, Japan)

1:15 PM - 2:00 PM

[P2-05] An Evaluation on *Glycine tabacina* for Being a Cover Crop

○Kuan-Huang Lin, Yuan-Ching Tsai (Department of Agronomy, National Chiayi University, Taiwan)

12:15 PM - 1:00 PM

[P2-06] Different Tillage Systems rather than Winter Cropping Affect the Corn Growth and Yield, and the Community Composition of Arbuscular Mycorrhizal Fungi

○Yuya Tatewaki[1], Ryo Matsuno[2], Koya Nakamura[1], Kengo Wada[1], Masao Higo[2], Katsunori Isobe[2] (1.Graduate School of Bioresource Sciences, Nihon University, Japan, 2.College of Bioresource Sciences, Nihon University, Japan)

1:15 PM - 2:00 PM

[P2-07] Decomposition of Hairy Vetch Mulch under Snow and Its Effect on Nitrogen Dynamics in Soil

○Toshiyuki Hirata[1], Taishi Uchibayashi[2], Atsushi Matsumura[3] (1.Field Science Center for Northern Biosphere, Hokkaido University, Japan, 2.Graduate School of Environmental Science, Hokkaido University, Japan, 3.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan)

12:15 PM - 1:00 PM

[P2-08] Effect of Peanut Residues on Nitrogen and Phosphorus Uptake of the Succeeding Wheat Grown in the Paddy-Converted Upland Field

○Haruki Masuda[1], Yuko Michiyama[1], Daisuke Yoshimura[1], Takuji Seo[1], Toru Kira[1], Atsushi Matsumura[2], Hiroyuki Daimon[1] （1.Faculty of Agriculture, Ryukoku University., Japan, 2.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan）

1:15 PM - 2:00 PM

[P2-09] Effect of Shoot Cutting and Mulching of Hairy Vetch during Flowering Stage on the Yield and N Content of Wheat in the Mixed Cropping System

○Kan Tamaki[1], Daisuke Yoshimura[1], Takuji Seo[1], Toru Kira[1], Atsushi Matsumura[2], Arata Tarui[2], Hiroyuki Daimon[1] （1.Faculty of Agriculture, Ryukoku University, Japan, 2.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan）

12:15 PM - 1:00 PM

[P2-10] DNA Barcoding of Weed Species in Hokkaido and Application to *ex-situ* Evaluate of Their Abundance

○Maria Stefanie Dwiyanti[1], Toshiyuki Hirata[2], Hironori Nagano[1], Junya Yamagishi[3], Masahiro Akimoto[4] （1.Research Faculty of Agriculture, Hokkaido University, Japan, 2.Field Science Center for Northern Biosphere, Hokkaido University, Japan, 3.Research Center for Zoonosis Control, Hokkaido University, Japan, 4.Department of Agro-environmental Science, Obihiro University for Agriculture and Veterinary Medicine, Japan）

1:15 PM - 2:00 PM

[P2-11] Climate Impact on Yield and Cultivation Area of Rainfed Rice in Central Benin, West Africa

○Joji Miyazawa, Akira Miyazaki （Faculty of Agriculture and Marine Science, Kochi University, Japan）

12:15 PM - 1:00 PM

[P2-12] Cropping System Which Consists of Potato in Winter Season, Green Manure and Sugarcane under Kunigami Merge Soil in Northern Part of Okinawa Island

○Hideyuki Mochida （Innovation creation section, Bio-Oriented Technology Research Advancement Institution, Japan）

1:15 PM - 2:00 PM

[P2-13] Evaluation of Crop Performance under Different Nitrogen Regimes in Rice-Ratoon Rice Systems in Central Japan

○Weiyi Xie, Yoichiro Kato （Graduate School of Agricultural Sciences, The University of Tokyo, Japan）

12:15 PM - 1:00 PM

[P2-14] Grain Yield and Biodiversity in Lowland Rice Ecosystems: Comparison between Conventional and Organic Management Practices

○Haruki Okuda, Yoichiro Kato （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

1:15 PM - 2:00 PM

[P2-15] Using a High Density Seedling Mat Reduces Transplanted Rice (*Oryza sativa* L.) Production Costs: A Case Study in Vietnam

○Kazunori Sawamoto[1], Ngo Quang Hieu[2], Truong Chi Thanh[3] （1.Development Division, Yanmar Agribusiness Co., Ltd., Japan, 2. Can Tho University, Vietnam, 3.Yanmar Agricultural Research Institute, Vietnam）

12:15 PM - 1:00 PM

[P2-16] Evaluation of the Differences in Yield Response to Organic Fertilizer between Two Soybean High-Yielding Lines 'Toiku 273' and 'Tokei1335' by Hierarchical Bayesian Model

○Yuichi Nagasaki[1], Hiroyuki Tsuji[1], Satoshi Kobayashi[2], Hideki Kurosaki[3] （1.Hokkaido Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Agricultural Research Department Tokachi Agricultural Experiment Station, Hokkaido Research Organization, Japan, 3.Agricultural Research Department Central Agricultural Experimental Station, Hokkaido Research Organization, Japan）

1:15 PM - 2:00 PM

[P2-17] Effect of Varieties and Organic Manures on Rice Yield and Methane Emission under Water Management

○Ei Phyu Win[1], Kyaw Kyaw Win[2], Kyaw Ngwe[3], Than Da Min[4], Hla Than[5] （1.Department of Agronomy, Yezin Agricultural University, Myanmar, 2.Department of Agronomy, Yezin Agricultural University, Myanmar, 3.Department of Soil and Water Science, Yezin Agricultural University, Myanmar, 4.Department of Agronomy, Yezin Agricultural University, Myanmar, 5.Department of Agronomy, Yezin Agricultural University, Myanmar）

12:15 PM - 1:00 PM

[P2-18] Soil Temperature, Growth and Yield of Rhizome by Different Mulching Treatments of Chinese Artichoke (*Stachys sieboldii* Miq.)

○Yeongmi Jang, Bumsik Choi, Sharavdorj Khulan, Jin-Woong Cho （College of Agricultural and Life Sciences, Chungnam National University, Korea）

1:15 PM - 2:00 PM

[P2-19] Effect of Different Types of Mulching on Soil Temperature, Growth and Rhizome Yield of Lycopi Herba (*Lycopus lucidus* Turcz.)

○Yeongmi Jang, Bumsik Choi, Sharavdorj Khulan, Jin-Woong Cho （College of Agricultural and Life Sciences, Chungnam National University, Korea）

12:15 PM - 1:00 PM

[P2-20] Effect of Flood and Drip Irrigation and Difference of Organic Material Input on Morphological and Physiological Traits in Rice Root

○Jiabin Bian[1], Kanchana Chomsang[2], Masahiro Morokuma[3], Masanori Toyota[3] （1.College of Agronomy & Resources and Environment, Tianjin Agricultural University, China, 2.United Graduate School of Agricultural Science, Ehime University, Japan, 3.Faculty of Agriculture, Kagawa University, Japan）

1:15 PM - 2:00 PM

[P2-21] *In Vitro* Screening and Morphological Trait Assisted Selection for Salinty Tolerance in Wheat Genotypes at Seedling Stage

○Mohammad Hasanuzzaman[1], Nihar Ranjan Saha[1], Sayma Farabi[1], Muhammad Monirul Islam[2], Muhammad Shahidul Haque[1] （1.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 2.Biotechnolohy Division, Bangladesh Institute of Nuclear Agriculture, Bangladesh）

12:15 PM - 1:00 PM

[P2-22] Verification of Effects of "Three-dimensional farming system" on Soybean Cultivation in a Converted Paddy Field in a Temperate Zone

○Irumi Shimizu[1], Yuto Seno[2], Tesshu Tamai[2] （1.Graduate School of Agriculture, Ryukoku University, Japan, 2.Faculty of Agriculture, Ryukoku University, Japan）

1:15 PM - 2:00 PM

[P2-23] Production of Nitrogen Fixed Nutrient Solution for Hydroponic Culture by Flow Plasma System

○Tesshu Tamai[1], Ryoji Iyo[1], Yuya Yokoyama[1], Yoshiteru Mizukoshi[2], Yoshimi Nishimura[3], Chiaki Terashima[4] （1.Faculty of Agriculture, Ryukoku University, Japan, 2.Future Technology Research Laboratory, ULVAC, Inc., Japan, 3.Kurita Manufacturing Co., Ltd, Japan, 4.Photocatalysis International Research Center, Tokyo University of Science, Japan）

12:15 PM - 1:00 PM

[P2-24] Alternative Usage of Poultry Litter Ash for Phosphorus and Potassium Fertilizer in Forage Rice Cultivation

○Yuka Sasaki[1], Keishiro Sato[1,2], Takayuki Tokuhashi[1,3], Ken-ichi Kakuda[1] （1.Faculty of Agriculture, Yamagata University, Japan, 2., Agro-Kanesho Co., Ltd., Japan, 3.Niigata Central Union of Agricultural Cooperatives, Japan）

1:15 PM - 2:00 PM

[P2-25] Effects of Shading by Solar Panels on Growth and Yield of C_3 and C_4 Crops

○Masahiro Morokuma, Masanori Toyota （Faculty of Agriculture, Kagawa University, Japan）

12:15 PM - 1:00 PM

[P2-26] Effects of Proximity to Missing and Poorly Growing Plants on Cabbage Head Size

○Hiroyuki Tsuji （Division of Farming System Research, Hokkaido Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

1:15 PM - 2:00 PM

[P2-27] Three-Dimensional Analysis of Soybean Grain Shapes Using a Flatbed Scanner

○Dan Eiju[1,2], Masataka Wakayama[1], Fumiko Namiwa[3], Masaru Tomita[1,2] （1.Institute for Advance Biosciences Keio University, Japan, 2.Faculty of Environment and Information Studies, Keio University, Japan, 3.Horticulture Science, Yamagata Integrated Agricultural Research Center, Japan）

12:15 PM - 1:00 PM

[P2-28] Satellite-Based Assessment of Soybean Plant Density by Using UAV Imagery and Machine Learning Algorithm

○Luthfan Nur Habibi[1], Tsutomu Matsui[2], Takashi Tanaka[2,3] （1.Graduate School of Natural Science and Technology, Gifu University, Japan, 2.Faculty of Applied Biological Sciences, Gifu University, Japan, 3.Artificial Intelligence Advanced Research Center, Gifu University, Japan）

1:15 PM - 2:00 PM

[P2-29] Effect of Environmental Differences on Empirical Regression Models for Estimating Leaf Area Index Using Vegetation Indices in Rice

○Tomoaki Yamaguchi[1], Daniel Menge[2], Emily Gichuhi[2], Peprah Clement Oppong[1], Megumi Yamashita[1], Daigo Makihara[3], Keisuke Katsura[1] （1.Graduate School of Agriculture, Tokyo

University of Agriculture and Technology, Japan, 2., Kenya Agricultural and Livestock Research Organization, Kenya, 3.International Center for Research and Education in Agriculture, Nagoya University, Japan）

12:15 PM - 1:00 PM

[P2-30] Detection of Lodging Area in a Paddy Field from a Digital Surface Model (DSM)

○Tadashi Tsukaguchi[1], Fumio Uno[2], Yoichi Fujihara[1] （1.Faculty of bioresources and environmental sciences, Ishikawa Prefectural University, Japan, 2.Ishikawa Agriculture and Forestry Research Center, Japan）

1:15 PM - 2:00 PM

[P2-31] Nitrogen Dynamics in Paddy Fields under Different Rice Bran Levels

○Mchuno Alfred Peter, Tasuku Eigen, Ami Shimomura, Beno Anton Kiwale, Kunio Watanabe, Nobuhito Sekiya （Graduate School of Bioresources, Mie University, Japan）

12:15 PM - 1:00 PM

[P2-32] Do New Rice Cultivars Respond to Chemical Fertilizers Better than Old Cultivars?

○Beno Anton Kiwale, Asaka Murai, Mchuno Alfred Peter, Nobuhito Sekiya （Graduate School of Bioresources, Mie University, Japan）

1:15 PM - 2:00 PM

[P2-33] A Case Study on Labor Productivity of Paddy Rice Seed Production in Japan

○Mizuho Fujii, Akihiko Kamoshita （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

12:15 PM - 1:00 PM

[P2-34] Selection of Sorghum Growth Indicators for the Development of Smart Farm of Field Food Crops

○Kang-Su Kwak, Si-Young Rho （Division of Smart Farm Development, Department of Agricultural Engineering, National Institute of Agricultural Sciences, Rural Development Administration, Korea）

1:15 PM - 2:00 PM

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-01] Soil Fertility Decline by Repeated Cropping of Rice for Whole Crop Silage – A Case of Mifune Town in Kumamoto Prefecture, Japan

○Naoki Moritsuka[1], Kaori Matsuoka[2], Kosuke Baba[1] (1.Faculty of Agriculture and Marine Science, Kochi University, Japan, 2.Institute of Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan)

Production of rice for whole crop silage (WCS rice) is popular in southern Kyushu, especially in Kumamoto. At Mifune town in Kumamoto, WCS rice has been grown with a lower fertilizer input than edible rice, although both panicle and straw of WCS rice are removed from the field. This study aimed to evaluate the effects of repeated cropping of WCS rice on soil properties and rice productivity. From 2014, a monitoring survey has been carried out at 8 adjacent fields (39 sites) managed by the same farmer. WCS rice (Minamiyutaka) has been grown in 4 fields from around 2008 and edible rice (Hinohikari) has been grown in the other 4 fields. The balances of N, P, K and Si during the rice cropping in 2016 were estimated to be positive in edible rice fields and negative in WCS rice fields. Compared to the soil properties in the edible rice fields, the topsoil in WCS rice fields showed lower concentrations for exchangeable K (28-54%), hot HNO_3-extractable K (61-69%), available Si (69-73%), mineralizable N (76-84%), and available P (77-80%). The dry matter weight of rice seedlings grown in small pots filled with the surface soils collected from 39 monitoring sites in 2018 was positively correlated with the concentration of available N ($r = 0.85$), exchangeable K ($r = 0.74$), and available Si ($r = 0.72$) in the soil. A nutrient omission pot experiment using a surface soil collected from one of the WCS rice fields further revealed that the dry matter weight of rice at milk ripe stage was decreased by about 40% by either N or K omission.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-02] A Case Study of Learning to Work on a Farm in a Special Need Education School for Children with Intellectual Disabilities – Focusing on the Cultivation of Rice Plant

○Izumi Oh-E (Retired, Tohoku Agricultural Research Center, National Agriculture and Food Research Organization, Japan)

The purpose of this study was to explore the development of agricultural work learning using rice, a key crop in Japan, at a special need education school for children with intellectual disabilities. Rice, soybean, adzuki bean, and sesame were cultivated in a special need education high school for children with intellectual disabilities. The crops cultivated in the work study were given cooking training at the end of the year. The students enjoyed the cooking training and were able to work actively on the activities. In the cooking training, sesame and roasted soybean flour rice cake were made through work processes such as making rice cake, boiling adzuki bean, roasting and crushing sesame and soybean, and the student's evaluation was high. Some students were able to understand the flow of production, processing and distribution (consumption), saying that they can understand by themselves making different forms of crops at the time of harvest and after processing. When companies in different industries enter the agricultural field, there is an increasing movement to stabilize employment and business, taking into

account the connection between agriculture and welfare. Therefore, it was thought that the study of farm work at the special needs school contributed more to the child's career after graduation.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-03] Growth and Yield of Rice, and Soil Enzyme Activites in Super Low External-Input Paddy Rice Field

*Nominated for Presentation Awards

○Taichi Tsujimoto[1], Kazuhiro Hosoya[1], Hideto Ueno[1], Yo Toma[1], Yoichi Yamashita[2], Masataka Adachi[2], Takayuki Kono[2] (1.Graduate School of Agriculture, Ehime University, Japan, 2.Faculty of Agriculture, Ehime University, Japan)

Sustainable crop production has been required worldwide against resource depletion and environmental pollution. We have been cultivated paddy rice only with white clover as green manure for more than 10 years. In this study, we investigated the dynamics of nutrients and enzyme activities in the soil as well as the growth and of rice to clarify the mechanism of this cultivation system.In 2018, three rice varieties, Koshihikari (*Oryza sativa*L. cv. Kosihikari), Akitakomachi, and Matsuyamamii were cultivated. The green manure (GM) plot was applied with only white clover incorporation, and that in the control (C) was applied with a slow-release chemical fertilizer at 4.2:4.2:4.2 g m^{-2} ($N:P_2O_5:K_2O$).There was no significant difference in the yield the both polts had around 400g m^{-2}, comparable to the local farmer's yield. Taste quality index were 70 or more in all plots. Soil available N decreased until mid-drying and then increased. On the whole GM kept 30 mg N $kg^{-1}$and was higher than C. The β-glucosidase and protease activity had more than 2 times higher in GM than C by 3-4 weeks after transplantation, and phosphatase activity had more than 2 times higher in GM than C in the whole season. Leaf color in C was stable around 30, however, unstable and fluctuated in GM. From the above, it was assumed that GM application increased the activity of microorganisms, and enhances the metabolism of N and P in the soil, made it possible to supply N and P equivalent to C, and resulting the same yield of the conventional.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-04] Nitrogen and Water Demands for Maximum Growth of *Solanum tuberosum* under Doubled CO_2: Interaction with Phosphorus Based on the Demands

*Nominated for Presentation Awards

○Yan Yi, Daisuke Sugiura, Katsuya Yano (Graduate School of Bioagricultural Sciences, Nagoya University, Japan)

Crop growth promotion utilizing elevated carbon dioxide concentrations (e[CO_2]) may be limited by soil nutrient availability. Although numerous studies have suggested the importance of nitrogen (N) for the promotion of growth under e[CO_2], N requirement for maximum growth is rarely examined. We have found that increase in potato (*Solanum tuberosum* L.) biomass depends on phosphorus (P) under e[CO_2]. To address whether the N requirement for maximum growth under e[CO_2] is dependent on P or not, we quantified potato growth and water consumption in response to five N supply rates at low P (LP) and

high P (HP). A pot experiment was conducted in controlled-environment chambers with ambient [CO_2] (a[CO_2]) and e[CO_2]. Foliar critical N concentration per area (critical [N]area), the minimum N requirement for 90% maximum plant growth, was similar (1.43 g N m^{-2}) regardless of [CO_2] under LP. Under HP, however, the critical [N]area increased under e[CO_2] (1.65 g N m^{-2}) compared with a[CO_2] (1.52 g N m^{-2}). Water use did not change with e[CO_2] under HP, whereas it decreased with e[CO_2] under LP despite the increase in biomass owing to higher water-use efficiency (WUE). Although WUE with e[CO_2] or HP was independent of N supply, biomass increment with e[CO_2] or HP depended on N supply. We concluded that N and water required by potato plants under e[CO_2] would be dependent on P supply. Although under HP, e[CO_2] increased N but not water required to obtain maximum growth, N demand was unchanged and water demand decreased by e[CO_2] under LP, probably owing to growth limited by P availability.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-05] An Evaluation on *Glycine tabacina* for Being a Cover Crop

*Nominated for Presentation Awards

○Kuan-Huang Lin, Yuan-Ching Tsai （Department of Agronomy, National Chiayi University, Taiwan）

Glycine tabacina is a perennial wild specie of genus *Glycine*. It can be found in seashore, cemetery and lawn of school in Penghu, Kinmen and Taiwan. As the government encouraged the ecofriendly farming, cover crops are used to improve soil health and reduce using of herbicide in management schemes that make it possible. *Glycine tabacina* which is perennial, creeper and has stronger recover ability was noticed. The salt, drought and heat tolerance are also expected. In addition, *G. tabacina* has the symbiosis rhizobium for nitrogen fixation which is unique for Fabaceae and can present a physical barrier to reduce weed emergence. So it may worth to promote *G. tabacina* as a cover crop for seashore and barren orchard in Taiwan.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-06] Different Tillage Systems rather than Winter Cropping Affect the Corn Growth and Yield, and the Community Composition of Arbuscular Mycorrhizal Fungi

*Nominated for Presentation Awards

○Yuya Tatewaki[1], Ryo Matsuno[2], Koya Nakamura[1], Kengo Wada[1], Masao Higo[2], Katsunori Isobe[2]
（1.Graduate School of Bioresource Sciences, Nihon University, Japan, 2.College of Bioresource Sciences, Nihon University, Japan）

Several studies have reported that different types of tillage and winter cropping can impact the community structure of arbuscular mycorrhizal fungi (AMF). However, it is unclear that the combined effects of tillage and winter cropping change the AMF communities. Therefore, this study investigated how combined different tillage and winter cropping systems affect the community composition of AMF in the roots of subsequent corn (*Zea mays* L.). In this study, the effects of six treatments consisting of three single winter cover cropping (hairy vetch, daikon radish, and fallow) with rotary tillage or no tillage on the soil biochemical properties, AMF colonization, and growth performance of subsequent corn

were evaluated. Our results showed that the dry matter weight and P uptake of corn at the 6 weeks after sowing was higher in the rotary tillage than the no tillage. The AMF colonization in the corn was also higher in the rotary tillage than the no tillage. Moreover, the tillage systems significantly changed the AMF community compositions in the roots. In the rotary tillage, the relative abundance of genus *Scutellospora* was higher than the no tillage. In contrast, the relative abundance of Glomeromycetes was higher in the no tillage than the rotary tillage. These results showed that the AMF compositions were shaped by tillage systems rather than winter cropping. Additionally, the differences in the AMF communities may be one of the factors for affecting the P uptake and yield of corn. Acknowledgement: This work was supported by JSPS KAKENHI Grant Number JP19K06005.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-07] Decomposition of Hairy Vetch Mulch under Snow and Its Effect on Nitrogen Dynamics in Soil

○Toshiyuki Hirata[1], Taishi Uchibayashi[2], Atsushi Matsumura[3] (1.Field Science Center for Northern Biosphere, Hokkaido University, Japan, 2.Graduate School of Environmental Science, Hokkaido University, Japan, 3.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan)

Hairy vetch, a leguminous cover crop, is known to have a high nitrogen content and a strong weed suppression ability by covering and allelochemicals, Hairy vetch is generally used after cultivation of the main crop. However, in a cool area with a long snowfall period, such as Hokkaido, there is a problem that the growth period of hairy vetch was limited by snow cover. In this study, we examined the decomposition of hairy vetch under snow and the effect on soil nitrogen dynamics by them. A field examination and mineralization test were conducted. In the field test, hairy vetch was sown in August. Soil samples were collected and measured nitrogen contents every month from November to April. In the culture test, the amount of nitrogen from hairy vetch was measured under the temperature conditions of 2℃ and 25℃. In the field test, total inorganic nitrogen in the hairy vetch plot was increased from February, and in March rapidly before snowmelt. Further, the portion of ammonia nitrogen in the hairy vetch plot was higher than other cover crop plots. In the culture condition, the maximum value of total inorganic nitrogen was exhibited the 7th day after culturing at 25℃, and 56th day after culturing at 2℃. The amount of ammonium nitrogen was decreased after 7 DAC at 25℃, while the concentration of nitrate-nitrogen was low during culturing period at 2℃. It is considered that the high level of ammonia nitrogen derived from hairy vetch works effectively as a nitrogen resource in spring and a weed-suppressing substance just before snow melting.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-08] Effect of Peanut Residues on Nitrogen and Phosphorus Uptake of the Succeeding Wheat Grown in the Paddy-Converted Upland Field

*Nominated for Presentation Awards

○Haruki Masuda[1], Yuko Michiyama[1], Daisuke Yoshimura[1], Takuji Seo[1], Toru Kira[1], Atsushi Matsumura[2], Hiroyuki Daimon[1] (1.Faculty of Agriculture, Ryukoku University., Japan, 2.Graduate School of Life and

Environmental Sciences, Osaka Prefecture University, Japan）

In upland field converted from the paddy, a depletion of soil fertility due to the continuous degradation of organic matters occurred under aerobic condition should be complemented to maintain the crop productivity. We reported that incorporation of green manure legumes, such as Crotalaria and Sesbania, might be effective in maintaining soil fertility. However, the growers fundamentally desire to introduce cash crops in the crop rotation. In this study, crop residues of peanut, which contains considerable amounts of N and P in the shoots at harvesting time, were quantitatively evaluated in the nutrients supply to the succeeding wheat. Two peanut cultivars, "Ohmasari" and "Chibahandachi", were tested in the field experiment conducted in 2018 - 2019 at the Ryukoku University Farm in Ohtsu, Japan. The shoots as peanut residue were cut into less than 10 cm and then incorporated using a cultivator up to a depth of 20 cm of the plots in autumn 2018. Seeds of wheat cv. "Minaminokaori" were sown on 28 November 2018 and harvested on 12 July 2019. The amount of N and P incorporated as crop residues was 5.3 kg N/10 a and 0.5 kg P/10 a in "Ohmasari" and 2.4 kg N/10 a and 0.3 kg P/10 a in "Chibahandachi", and the ratio of C/N and C/P of the residues was 21 and 24 and 242 and 194, respectively in each cultivar. Contribution of peanut residue to N and P absorption of the succeeding wheat differed between two cultivars. Analysis of nutrient recycling through soil microbial communities after incorporation of the residues is now in progress.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-09] Effect of Shoot Cutting and Mulching of Hairy Vetch during Flowering Stage on the Yield and N Content of Wheat in the Mixed Cropping System

○Kan Tamaki[1], Daisuke Yoshimura[1], Takuji Seo[1], Toru Kira[1], Atsushi Matsumura[2], Arata Tarui[2], Hiroyuki Daimon[1] （1.Faculty of Agriculture, Ryukoku University, Japan, 2.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan）

Mixed cropping with leguminous crop is effective approach to reduce N input for gramineous crop production. In the growth of bread wheat, which significantly requires N fertilizer input in top dressing, the N transferred from winter legumes to wheat in mixed cropping should be evaluated to reduce the N fertilizer rate. In this study, we estimated the amounts of N uptake of wheat grown with hairy vetch, that might release N from the root nodules collapsed by cutting the aboveground parts during flowering stage. A field experiment was conducted in 2019 - 2020 at the Experimental Farm of Ryukoku University in Ohtsu, Shiga, Japan, with two treatments; 1) single cropping of wheat cv. "Minaminokaori", consisted of five rows, 2) mixed cropping of wheat and hairy vetch "Kantaro", in which four rows of wheat and three rows of hairy vetch were made. Effect of cutting shoots of hairy vetch on flowering stage on N uptake of wheat was evaluated from the following points; 1) removing the shoots from the plot, 2) mulching them on the bottom of wheat stands. No fertilizer N was applied, and P and K fertilizers were applied at 10 kg/10 a, respectively. In early spring, the SPAD value of the upper leaves and N content of wheat in mixed cropping were higher than those in single cropping, indicating that the mixed cropping with hairy vetch enhanced the N uptake of the associated wheat. A quantitative evaluation of N transference from hairy vetch to wheat is now in progress.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-10] DNA Barcoding of Weed Species in Hokkaido and Application to *ex-situ* Evaluate of Their Abundance

○Maria Stefanie Dwiyanti[1], Toshiyuki Hirata[2], Hironori Nagano[1], Junya Yamagishi[3], Masahiro Akimoto[4]
（1.Research Faculty of Agriculture, Hokkaido University, Japan, 2.Field Science Center for Northern Biosphere, Hokkaido University, Japan, 3.Research Center for Zoonosis Control, Hokkaido University, Japan, 4.Department of Agro-environmental Science, Obihiro University for Agriculture and Veterinary Medicine, Japan）

In order to manage weeds efficiently, it is necessary to understand their occurrence and distribution patterns. Field investigation of weed population was usually based on morphological traits and spectral data such as Normalized Difference Vegetation Index (NDVI). However, the field observation for weed species identification was difficult in emerging populations in spring and often not suitable for analysis over a vast region. In this study, we constructed a DNA database for Hokkaido weed species and attempted to establish a new method for evaluating weed communities using next-generation sequencer (NGS). The *trnL* (UAA) intron region, which is a hypervariable region of the chloroplast genome, was determined for 40 weed species collected from Hokkaido University Biological Production Research Farm and 48 species from Obihiro Livestock University Farm. For the NGS-based evaluation, we used barnyardgrass (Japanese name 'Inubie' , *Echinochloa crus-galli*) and 'Ezonogishi-gishi' (*Rumex obtusifolius*). Total DNA was extracted from 0.3, 0.5, 1, 1.5 and 3 g of leaf by the CTAB method, and the *trnL* region was amplified by PCR. PCR amplicons were sequenced using Miseq. To compare DNA extraction efficiency and PCR amplification efficiency, an equal amount of rice DNA was added to each sample during or after weed DNA extraction. Rice DNA read count was used as reference to count read data of each weed species. Based on the results, we plan to further investigate biomass estimation methods using NGS.

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[P2-11] Climate Impact on Yield and Cultivation Area of Rainfed Rice in Central Benin, West Africa

*Nominated for Presentation Awards

○Joji Miyazawa, Akira Miyazaki （Faculty of Agriculture and Marine Science, Kochi University, Japan）

Demands for rice have been increasing in West Africa, however, the majority of rice is cultivated in the rainfed ecology, resulting in low yields. The changes of rice yield and production area in rainfed culture were surveyed in the town of Glazoue in central Benin, where rice is commonly cultivated in both upland and lowland conditions. According to the survey conducted during 2014-2016 with 12 farmers, rice is grown between June-November, after preceding crops such as cowpea and maize which are grown between April-July. Rice yields decreased in accordance to low rainfall, with 1.8 t ha $^{-1}$ under 866 mm in 2014, 1.1 t ha $^{-1}$ under 552 mm in 2013 and 0.3 t ha $^{-1}$ under 430 mm in 2015. Rice cultivation area of the farmers decreased 90% from 1.15 ha $^{-1}$ in 2013 to 0.12 ha $^{-1}$ in 2016. Farmers with less than 2 t ha $^{-1}$ in 2014 (LYF) greatly decreased their rice fields in 2015 and halted rice cultivation in 2016, whereas, farmers with more than 2 t ha $^{-1}$ in 2014 (HYF) did not greatly decrease their rice fields in 2015 and continued rice in 2016. LYF tended to grow rice on slopes where water retention was low, resulting in delayed sowing of 13 days and significantly lower yields. These results suggested that the minimum yield of 2 t ha $^{-1}$ under adequate seasonal rainfall was regarded as the criteria for stable and continued rice

production, regardless of suboptimal conditions in other years. Therefore, it is necessary for farmers to carefully select fields that support this level of production.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-12] Cropping System Which Consists of Potato in Winter Season, Green Manure and Sugarcane under Kunigami Merge Soil in Northern Part of Okinawa Island

○Hideyuki Mochida （Innovation creation section, Bio-Oriented Technology Research Advancement Institution, Japan）

Upland farming which consists of sugar cane is established settled in traditionally in the Okinawa Island. It is main crop in the upland farming because it results in relatively high profitability. However, because its early growth is slow, and topsoil is exposed for a long term, a large quantity of erosion out of the field by heavy rain, and the sugar cane invites terrible erosion followed by the decline of soil production capacity. Green manure is effective to reduce decline of soil fertility because it prevents soil erosion to cover topsoil by a green manure and increase of organic matter by its plowing-in. Green manure plowing-in gives good effect on physical and chemical characteristics of the soil. In that case soil gas phase rate is improved remarkably. Guinea grass with much biomass has most efficient. Plowing-in of Crotalaria juncea among Crotalaria species was effective in improvement of available nitrogen compared with Guinea grass, which was closely related with the increase of yield and of the starch value of potato. In addition, the crop rotation with the sugarcane increases available nitrogen and potato yield. On the other hand, it was revealed that the crop rotation had a repressive effect the same as resistant variety. Bacterial wilt for potato decreases by taking crop rotation with sugarcane and a long-term rotation. Besides, bacterial wilt might occur frequently by the crop rotation including Guinea grass. Therefore, the choice of the green manure as the preceding crop was important.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-13] Evaluation of Crop Performance under Different Nitrogen Regimes in Rice-Ratoon Rice Systems in Central Japan

*Nominated for Presentation Awards

○Weiyi Xie, Yoichiro Kato （Graduate School of Agricultural Sciences, The University of Tokyo, Japan）

Ratoon rice cultivation is the practice of obtaining a second harvest from tillers regenerating from rice stubbles. The objectives of this study were to compare the annual rice productivity of the rice-ratoon rice and single rice cropping systems and identify appropriate nitrogen management in the rice-ratoon rice system in central Japan. Field experiments were conducted at the Institute of Sustainable Agro-ecosystem Services, The University of Tokyo (35°43'N, 139°32'E) in 2019 and 2020. First, The annual productivity of rice-ratoon rice systems (cvs. Akihikari in 2019 and Akitakomachi in 2020) were compared with conventional single-rice cropping systems using high-yielding hybrid and inbred *japonica* cultivars (cvs. Hybrid Togo3 and Yamadawara). The annual productivity of the rice-ratoon rice system (7.6-7.9 t ha^{-1} yr^{-1}) was less than that of single rice cropping systems (8.5 to 10.2 t ha^{-1} yr^{-1}), indicating

the importance of nutrient management and the choice of appropriate short-duration cultivars to achieve high yield of ratoon rice. Second, the effect of the timing of N (nitrogen) topdressing on the crop growth in the rice-ratoon rice system was evaluated. Applying N at 5 days after heading of main rice promotes tiller bud regeneration and accelerates canopy re-establishment after the harvest of main rice, which is mediated not by the change in the availability of nonstructural carbohydrates but by the improved plant N nutrition at harvest of main rice. However, applying N around main rice heading stage also increased the grain N concentration, potentially lowering the palatability of *japonica* rice.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-14] Grain Yield and Biodiversity in Lowland Rice Ecosystems: Comparison between Conventional and Organic Management Practices

*Nominated for Presentation Awards

○Haruki Okuda, Yoichiro Kato （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

There is a growing interest in sustainable agro-ecosystem management aiming at biodiversity conservation. Previous works on flora and fauna in rice ecosystems have focused on two aspects: biotic constraint to yield and biodiversity loss. Meanwhile, attempts to harmonize crop productivity and biodiversity are still limited. The objective of this study was to clarify the effects of weeding and fertilizer application regimes on rice growth and biodiversity in lowland fields with conventional and organic management practices. Field trials were conducted at the Institute for Sustainable Agro-ecosystem Services, the University of Tokyo, Tokyo, Japan in the summer of 2020. Four treatments were compared in lowland fields with conventional and organic management practices: control, additional N topdressing, intensive mechanical weeding, and mild mechanical weeding. In organic management, weed biomass at heading was greatest in control. But there was no difference in N concentration in rice plants among the treatments, suggesting that there was little competition between rice and weeds for N. Threatened species were detected only in organic management, suggesting that the use of agrochemicals promotes biodiversity loss in lowland rice ecosystems. There was no difference in the rice yield and brown rice quality among treatments and management practices. Our results suggested that it is possible to avoid yield loss without herbicide application where weed biomass is less than 150 g m^{-2} at heading and the target yield is less than 7 t ha^{-1}.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-15] Using a High Density Seedling Mat Reduces Transplanted Rice (*Oryza sativa* L.) Production Costs: A Case Study in Vietnam

○Kazunori Sawamoto[1], Ngo Quang Hieu[2], Truong Chi Thanh[3] （1.Development Division, Yanmar Agribusiness Co., Ltd., Japan, 2. Can Tho University, Vietnam, 3.Yanmar Agricultural Research Institute, Vietnam）

Planting seedlings using high density rice seedling mats requires fewer trays, reducing the costs of producing seedlings by decreasing the necessary materials and labor. To identify if this method impacted growth and yield, experiments were carried out from November 2016 to March 2017 on a farm in Long An province, Vietnam using the rice (*Oryza sativa* L.) variety IR4525. Twice the conventional amount of dry seed, 250 g, were sown per tray at a high density and left to germinate for 16 days. From each high density seedling mat, 4–6 seedlings were picked per hill and planted by a rice transplanting machine. The machine used was a seven-row planter with 25 cm rows, and it was optimized to select a small area of the seedling mat. Two planting density sizes at the paddy field, 25 × 16 cm and 25 × 22 cm, were tested. As a result, each seedling's leaf age were 3.2 - 3.5, and the height of seedlings was 12–18 cm at the time of planting. The number of high density seedling mats used for transplanting were 134 and 106 per ha, respectively, which is about half of the number of seedling mats used in conventional transplanting. Grain yields were 8,052 and 7,707 kg per ha for the 25 × 16 cm and 25 × 22 cm planting density trays, respectively, which did not differ from conventional method yields. Given these results, the average yield of the high density transplanting method is similar to conventional method yield. Furthermore, this new methodology does not change conventional nursery management or require new nursery materials.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-16] Evaluation of the Differences in Yield Response to Organic Fertilizer between Two Soybean High-Yielding Lines 'Toiku 273' and 'Tokei1335' by Hierarchical Bayesian Model

○Yuichi Nagasaki[1], Hiroyuki Tsuji[1], Satoshi Kobayashi[2], Hideki Kurosaki[3] (1.Hokkaido Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 2.Agricultural Research Department Tokachi Agricultural Experiment Station, Hokkaido Research Organization, Japan, 3.Agricultural Research Department Central Agricultural Experimental Station, Hokkaido Research Organization, Japan)

The purpose of this study is to evaluate the differences in yield response between the two high-yielding lines, 'Toiku 273' and 'Tokei 1335', observed in our previous study. Organic fertilizer under narrow row condition increased the yield of Toiku 273 but did not that of Tokei 1335 (Nagasaki et al. 2020, 249th CSSJ meeting). Here we compared the response to yield components with the same hierarchical Bayesian model as in the previous study, which is very flexible to estimate the effect of each type of treatment on each line.
Field experiments were conducted at Hokkaido Agricultural Research Center with four treatments: standard rows (66 cm), narrow rows (33 cm), densely planted narrow rows, and organic fertilizer under the narrow rows. Both fixed and random effects of 100-seed weight and fertile pod number were estimated. To estimate the posterior distribution of the parameters, the Markov chain Monte Carlo method was implemented using "Stan."
In the narrow row condition, the fertile pod number of Toiku 273 was larger than that of Tokei 1335; conversely, the 100-seed weight was smaller. The application of organic fertilizer increased the 100-seed weight of both lines. However, its effect on fertile pod number was unclear for both lines. These results suggest that organic fertilizer under narrow row condition was mainly effective during seed filling. This indicates that the highest yield in this experiment (Toiku 273 with organic fertilizer under the narrow row) is attributed to the larger sink size and enhanced source amount by organic fertilizer.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-17] Effect of Varieties and Organic Manures on Rice Yield and Methane Emission under Water Management

○Ei Phyu Win[1], Kyaw Kyaw Win[2], Kyaw Ngwe[3], Than Da Min[4], Hla Than[5] (1.Department of Agronomy, Yezin Agricultural University, Myanmar, 2.Department of Agronomy, Yezin Agricultural University, Myanmar, 3.Department of Soil and Water Science, Yezin Agricultural University, Myanmar, 4.Department of Agronomy, Yezin Agricultural University, Myanmar, 5.Department of Agronomy, Yezin Agricultural University, Myanmar)

To assess the effect of different organic manure and varieties on methane emission, the pot experiment was conducted at Yezin Agricultural University in wet season, 2016. Organic manures (control-no manure, compost and cowdung), and the two rice varieties (Manawthukha-135 days and IR 50-115 days), were tested. The results showed that in both rice varieties, high grain yield was observed in control compared with manure amendments and the minimum grain yield was observed in cowndung treatment. The rate and cumulative amount of CH_4 emissions in Manawthukha was higher than that in IR 50 in accord with yield because of longer growth duration. Although no significant, numerically lowest methane emission was observed in cowdung manure treatment (68.6 g CH_4 m^{-2}) for Manawthukha and in cowdung and control treatment (44.6 and 43.4 g CH_4 m^{-2}) for IR 50 variety. Based on these results, the field experiment was conducted at Madaya township during the dry and wet seasons, 2017 to find out the water management and different rate of cowdung manure on methane emission and yield of IR 50 rice variety. The higher methane emission was recorded in CF as compared with AWD. In both seasons, the higher grain yields (1.8% in dry and 7.6% in wet) was recorded in AWD than in CF. The higher methane emission was recorded from OM3 and the lower emission from OM0 in both water management practices. In AWD, the methane emission was restricted in the aerated soil condition although higher amount of cowdung manure was added.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-18] Soil Temperature, Growth and Yield of Rhizome by Different Mulching Treatments of Chinese Artichoke (*Stachys sieboldii* Miq.)

○Yeongmi Jang, Bumsik Choi, Sharavdorj Khulan, Jin-Woong Cho (College of Agricultural and Life Sciences, Chungnam National University, Korea)

The Chinese artichoke (*Stachys sieboldii* Miq.) is a perennial herbaceous plant of the Lamiaceae family and geophyte plant in the ground. In this study, we attempted to find the effect of mulching material in Chinese artichoke.
The study was located at the experimental site of College of Agriculture and Life Science, CNU in Korea (latitude:36°36″, Longitude: 127°35″). We selected four treatments (Non-mulched, Black-PE, Green-PE, and Clear-PE) to find most suitable mulching material. Plant space was performed by the randomized block design at 60cm× 30cm. The seeding date was April 9, 2019 and the rhizome were harvested in early

December,2019.
The highest plant height occured at Black-PE 56cm and Non-mulched was 44.7 cm, which was significantly lower than the mulching treatments. In LAI, highest value was observed with Black-PE and lowest value was in Non-mulched. The SPAD index showed between 25 and 40 on average. For Photosynthesis, the highest was Clear-PE and the lowest was Black-PE. The highest dry weight was 822.1g of the Black-PE but Non-mulching was the lowest with 336.0g. Dry weight of rhizome, the Clear-PE was highest with 176.6g, followed by Non-mulched 148.7g, Green-PE with 134.3g, and Black-PE at 108.1g. The number of the rhizome was highest with Non-mulched (813), followed by (782) in the Clear-PE. Through this, it was confirmed that Non-mulched product had a high yield, but the product quality was poor. It is considered that Clear-PE was high quantity and weight of the rhizome is showing that, Clear-PE is most suitable for this plant.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-19] Effect of Different Types of Mulching on Soil Temperature, Growth and Rhizome Yield of Lycopi Herba (*Lycopus lucidus* Turcz.)

○Yeongmi Jang, Bumsik Choi, Sharavdorj Khulan, Jin-Woong Cho （College of Agricultural and Life Sciences, Chungnam National University, Korea）

The Lycopi Herba (*Lycopus lucidus* turcz.) is a perennial herbaceous plant of the Lamiaceae family, and geophyte plant in the ground. Objective of study is : to investigate the effects of mulching material during the growth and development of harvest in Lycopi Herba.
The study was conducted at the experimental site of Chungnam National University (latitude:36°36″, Longitude: 127°35″). For experiment, we applied four types of treatment to find the appropriate mulching material which were: Non-mulched, Black-PE, Green-PE, and Clear-PE. Plant spacing was performed by the randomized block design with three replications at plant density of 60cm× 30cm. The seedling date was April 10th, 2019 and the rhizome were harvested at the end of November,2019.
In plant height, Clear-PE was the highest at 107.2 cm, followed by Green-PE 102.6 cm, Non-mulched 99.1 cm and Black-PE 96.6 cm, respectively, and for the LAI, highest was Clear-PE with 13.2, and the lowest was Non-mulched at 8.3. The SPAD index, found between 30 and 45 on average. The Black-PE the SPAD index was highest until the August comparing than the other treatments. The photosynthesis was highest under Black-PE and followed by Clear-PE, Non-mulched and Green-PE. The dry weight was highest with 2774.2g of Clear-PE, and the dry weight of rhizome, the Black-PE was highest with 680.0 g. The highest number of the rhizome was occurred in Black-PE. As the final results showing that highest number and weight of rhizome was observed in Black-PE treatment which is showing the most suitable mulching material.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-20] Effect of Flood and Drip Irrigation and Difference of Organic Material Input on Morphological and Physiological Traits in Rice Root

○Jiabin Bian[1], Kanchana Chomsang[2], Masahiro Morokuma[3], Masanori Toyota[3] （1.College of Agronomy & Resources and Environment, Tianjin Agricultural University, China, 2.United Graduate School of Agricultural Science, Ehime University, Japan, 3.Faculty of Agriculture, Kagawa University, Japan）

We investigate the effects of irrigation method (drip or flood) and different management of organic material on root morphological characteristics and its distribution and physiological functions of the rice cultivar Hinohikari. Experiments were conducted in the paddy field in the University farm (input organic materials every year) for both drip and flood irrigation and the paddy and upland field (no input organic material) in the campus of the Faculty (Campus) under flood and drip irrigation, respectively. The planting density was 13.8 and 16.7 hills m^{-2} for Farm and Campus, respectively. Plant root was sampled with a core sampler (ø 5cm × 30cm) and root length and surface area were determined using image analysis. Yield in flood was significantly higher than in drip irrespective of the site. The increase of dry weight, bleeding rate and specific root length during the ripening stage were significantly higher in flood than in drip. The root depth index at the heading stage was significantly deeper in drip than in flood. All root morphological characteristics were larger in Farm than in Campus, though the difference between site was not significant excepting that length and surface area of root at heading were significantly higher in Farm than those in Campus. These results indicated that the root diameter is thicker, and root distribution is deeper in drip than in flood. It also suggested that the farm soil which was applied organic materials every year is more conducive to root growth.

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[P2-21] *In Vitro* Screening and Morphological Trait Assisted Selection for Salinty Tolerance in Wheat Genotypes at Seedling Stage

○Mohammad Hasanuzzaman[1], Nihar Ranjan Saha[1], Sayma Farabi[1], Muhammad Monirul Islam[2], Muhammad Shahidul Haque[1] （1.Department of Biotechnology, Bangladesh Agricultural University, Bangladesh, 2.Biotechnolohy Division, Bangladesh Institute of Nuclear Agriculture, Bangladesh）

Salinity is the primary threat to wheat production in the world. Genetic diversity is a pre-requisite to creating new varieties for salt tolerance. Therefore, this experiment was operated to evaluate the level of genetic diversity among 44 (22 Bangladeshi and 22 exotic) wheat genotypes for salinity tolerance at seedling stage in Hydroponic culture. All the genotypes were examined at 12 dS/m and 15 dS/m NaCl stress. ESWYT accession P-37 is the most salts tolerant at 12dS/m NaCl stress, whereas BAW accession 1262 and BAW accession 1284 are the most salts tolerant at 15dS/m NaCl stress. High heritability and positive phenotypic-genotypic correlations suggested that all the 6 morphological trait are associated with salt tolerance and could be used as selection criteria. In another experiments, we studied the in vitro response of three highly regenerative wheat genotypes viz., BARI Gom-27, BARI Gom-31 and BARI Gom-32 for salt tolerance selection. Callus was initiated in MS medium with 3 mg/l 2,4-D and different concentration of NaCl (0, 9, 12 and 15 dS/m) were added with the medium to create salt stress. Among the three genotypes studied BARI Gom-27 was significantly superior for callus induction with 41.2 per cent. When the callus for genotypes were transferred to regeneration media in the same level of NaCl stress highest level of regeneration was showed in BARI Gom-27 (51.6 per cent). The genotypes identified as salt-tolerant in this study may be used as parents to incorporate salt tolerance in the future wheat breeding program.

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[P2-22] Verification of Effects of "Three-dimensional farming system" on Soybean Cultivation in a Converted Paddy Field in a Temperate Zone

*Nominated for Presentation Awards

○Irumi Shimizu[1], Yuto Seno[2], Tesshu Tamai[2] (1.Graduate School of Agriculture, Ryukoku University, Japan, 2.Faculty of Agriculture, Ryukoku University, Japan)

Kozui Otani (1876-1948) introduces a strange farming technique named "three-dimensional farming system" in his book "Tropical Agriculture". "Three-dimensional farming system" means a farming method that digs a deep trench (180cm or more) between ridges and promotes growth of crops. We verified if this method was effective for soybean (*Glycine max* L. cv. Kotoyutaka) cultivation in a converted paddy field in a temperate zone. In order to reproduce the farming system, trenches with a depth of about 100 cm were dug at both ends of the ridge, and soybean was transplanted in the ridge. The growth and yield of soybean were investigated during the flowering and full-ripe stages. As a result, in the flowering stage, the shoot dry weight was about twice, the root dry weight was about 1.6 times, and the number of nodules was about twice those of the control by the farming system. In the full-ripe stage, even though significant increases of the main stem length, the stem diameter, and the shoot dry weight were observed by the farming system, the number of pods set, coarse grain weight, and 100 grain weight increased only slightly. It was suggested that nutrient translocation from the foliage to the grain was not performed successfully. Moreover, by the farming system, the soil temperature became strongly affected by the atmospheric temperature, and the drainage property of the soil was improved. However, no clear difference could be confirmed for EC. It also became clear that the microflora of cultivated soil greatly changed especially in the deep part.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-23] Production of Nitrogen Fixed Nutrient Solution for Hydroponic Culture by Flow Plasma System

○Tesshu Tamai[1], Ryoji Iyo[1], Yuya Yokoyama[1], Yoshiteru Mizukoshi[2], Yoshimi Nishimura[3], Chiaki Terashima[4] (1.Faculty of Agriculture, Ryukoku University, Japan, 2.Future Technology Research Laboratory, ULVAC, Inc., Japan, 3.Kurita Manufacturing Co., Ltd, Japan, 4.Photocatalysis International Research Center, Tokyo University of Science, Japan)

The flow plasma system we have developed can fix atmospheric nitrogen as nitric acid in water. If this plasma-treated water can be used as a nutrient solution, the amount of nitrogen required for crop cultivation can be supplied anytime and anywhere when needed, realizing agriculture with a low environmental load. In order to verify this possibility, leaf lettuce (*Lactuca sativa* var. *crispa*) was hydroponically cultivated using this plasma-treated water, and its growth and components were investigated. As a result, a large amount of nitrogen was taken into the plant grown in nutrient solution containing the plasma-treated water, and the size and weight of the plant increased significantly. These indicates that the plasma-treated water can be a nitrogen fertilizer. However, it was clarified that Mo in the electrodes eluted into the plasma-treated water and was accumulated in high concentration in the plant. In addition, Mo in the nutrient solution inhibited the absorption of S and Fe into the plant, while

was not affected that of other minerals. Since the large amount of Mo and the inability to ingest S and Fe are harmful to the human body, it is necessary to modify the composition of the nutrient solution and improve the electrodes. On the other hand, it was shown that the plasma-treated water had a bactericidal effect on *Escherichia coli* and algae. Controlling this system might bring the nutrient solution with sterilizing capacity while supplying nitrogen.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-24] Alternative Usage of Poultry Litter Ash for Phosphorus and Potassium Fertilizer in Forage Rice Cultivation

○Yuka Sasaki[1], Keishiro Sato[1,2], Takayuki Tokuhashi[1,3], Ken-ichi Kakuda[1] (1.Faculty of Agriculture, Yamagata University, Japan, 2., Agro-Kanesho Co., Ltd., Japan, 3.Niigata Central Union of Agricultural Cooperatives, Japan)

Forage rice cultivation is needed to enhance productivity while reducing production cost. The highest blending ratio of forage rice in feed is used for broiler. Broiler litter is useful if it is burned in a boiler connecting with floor heating system of chicken house, and its residue is poultry litter ash (PLA). PLA is inexpensive and unutilized resource and in high phosphorus (P) and potassium (K). The objective of this study was to investigate the efficacy of PLA for alternative usage of P and K fertilizer in forage rice cultivation. A field experiment was conducted in 2017 and 2018 in a paddy field of Field Science Center, Faculty of Agriculture, Yamagata University, Japan. The field had two area: P fertilizer had not been applied (No-P) and K fertilizer had not been applied (No-K) since 1999. Treatments were the application of PLA burned at about 500℃, PLA burned at about 800℃, and NPK fertilizer in both area and NK fertilizer in No-P area and NP fertilizer in No-K area. Both PLA contained P in more than 90% of citric acid-soluble form while less than 1% of water-soluble form; K in more than 90% of citric acid-soluble form and about 30% of water-soluble form. Yield and P uptake did not differ significantly among treatments in No-P. Thus, we could not conclude the efficacy of PLA for alternative usage of P fertilizer. Yield and K uptake were significantly lower in NP treatment than the others and did not differ significantly among NPK and two PLA treatments in No-K. Thus, both PLA can replace K fertilizer. K fertilizer efficiency of PLA to NPK treatment was about 80%.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-25] Effects of Shading by Solar Panels on Growth and Yield of C_3 and C_4 Crops

○Masahiro Morokuma, Masanori Toyota (Faculty of Agriculture, Kagawa University, Japan)

It is spreading to locate the solar panels at crop cultivation field. At that field, we can get the sell power income by solar panels with the agricultural income. However, we do not have enough information about the effects of shading by solar panels on the growth and yield of crops. In the present study, we have demonstrated that the effects of shading by solar panels on the growth and yield of C_3 and C_4 crops. We compared the growth and yield of crops grown under solar panels (solar plot) with those of crops grown at control field (control plot). The experiments were conducted in 2018 and 2019 at the farmer's field in Kagawa Prefecture, Japan. The average percentage of shading by solar panels during

growth periods was about 30%. Experimental materials were maize (C_4) and soybean, sweet potato, radish (C_3). The fresh weight of corn grain in solar plot was not significantly different than that in control plot. The main stem length of soybean in solar plot was significantly longer than that in control plot. The grain yield of soybean in solar plot was significantly higher than that in control plot. There were no significant difference between each plot in the yield of sweet potato and radish. In conclusion, the yield of C_3 and C_4 crops grown under the shading by solar panels during growth periods were not significantly influenced .

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-26] Effects of Proximity to Missing and Poorly Growing Plants on Cabbage Head Size

○Hiroyuki Tsuji (Division of Farming System Research, Hokkaido Agricultural Research Center, National Agriculture and Food Research Organization, Japan)

The objective of this study was to characterize the weight variation of cabbage heads in the field by estimating cabbage size variation and the number of cabbages that were larger than the standard size from the rates of missing and poorly growing plants in the same field. Cabbage seedlings were transplanted on May 24, 2019, in Experiment 1 and on July 8, 2019, in Experiment 2. Three weeks after planting, the positions of missing plants and poorly growing plants were recorded. The results of Experiment 1 categorized plants into six groups as follows: plants that grew poorly at 3 weeks after planting and had a head weight at harvest (1) less than the threshold, i.e., average −2SD (P1), or (2) more than the threshold (P2); and plants with normal growth at 3 weeks after planting and were next to (3) missing plants (Nm), (4) poorly growing plants (Np), (5) normal plants with a head weight at harvest less than the threshold weight (NN1), and (6) normal plants with a head weight more than the threshold weight (NN2). The average values and coefficients of variation were determined. In Experiment 2, cabbage head weight and plant numbers were investigated. The plant number of each group and distribution of head weight in Experiment 2 were estimated from the number of missing and poorly growing plants in Experiment 2, and the parameters corresponded to the results of Experiment 1. Accordingly, we could successfully determine the exact number of cabbage heads bigger than the standard size.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-27] Three-Dimensional Analysis of Soybean Grain Shapes Using a Flatbed Scanner

*Nominated for Presentation Awards

○Dan Eiju[1,2], Masataka Wakayama[1], Fumiko Namiwa[3], Masaru Tomita[1,2] (1.Institute for Advance Biosciences Keio University, Japan, 2.Faculty of Environment and Information Studies, Keio University, Japan, 3.Horticulture Science, Yamagata Integrated Agricultural Research Center, Japan)

Soybeans are classified by grain shape, color, and the hilum color. Although rice shape can analyze using grain analyzer, methods of analyzing soybean properties were insufficient. Here, we aimed to develop new methods for analyzing the soybean shape and color. Using the methods, we have characterized

soybean morphologies among various species.

One hundred of soybean seeds were set into grid-like partitioned board (soybean grid board). XY bean shape information was obtained using flatbed scanner. As Z-axis information (thickness) was difficult to obtain, we set the soybean grid board and scanner vertically on the desk and scanned. The images were processed by ImageJ software. For extracting soybean outline from images, the appropriate color spaces were selected.

For soybean outline extraction, the Lab color space was suitable than other color space.
L-values which indicate brightness discriminate between i) brown, red and black, ii) green iii) yellow varieties. a-values (green and redness component) were suitable for brown, red and black. Using L and a-values, soybean color characteristics could be discriminated.

Positive and strong correlations were found between grain weight and volume (R = 0.84), major axis (R = 0.76), and minor axis (R = 0.74), respectively. While, the correlation between grain weight and grain thickness (R = 0.49), aspect ratio (major axis / minor axis) (R = 0.30) and the flatness (long axis/grain thickness) (R = -0.12) were very low. Using those characteristics, the soybean species characteristics were discriminable among variety of

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1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-28] Satellite-Based Assessment of Soybean Plant Density by Using UAV Imagery and Machine Learning Algorithm

*Nominated for Presentation Awards

○Luthfan Nur Habibi[1], Tsutomu Matsui[2], Takashi Tanaka[2,3] (1.Graduate School of Natural Science and Technology, Gifu University, Japan, 2.Faculty of Applied Biological Sciences, Gifu University, Japan, 3.Artificial Intelligence Advanced Research Center, Gifu University, Japan)

Stable seedling establishment of soybean is an essential component for high crop yield; thus, the prediction of plant density would be a valuable information to develop more effective agronomic practices. A current development of remote sensing and machine learning algorithm may enable us to examine plant density effectively. The objective of this study was to develop a model for predicting the number of established soybean plants using machine learning algorithm (YOLOv3) and UAV-based imageries. The YOLOv3 model trained with a dataset of 450 images and confidence threshold of 0.65 scored the highest predicting capability with R^2 value of 0.912 and RMSE of 0.84 plants m^{-2}. Furthermore, we examined the possibility of predicting plant density using satellite imageries through a linear mixed effect model analysis. Normalized difference vegetation index data derived from PlanetScope imageries was treated as a fixed effect, and sowing date was treated as a random effect. Different sowing dates were assumed to affect the following development of soybean canopy; thus, it might influence the plant density. Consequently, the model with variable slopes and intercepts according to the sowing dates showed the highest accuracy with RMSE of 1.64 plant m^{-2} and smallest value of Akaike information criterion. This result indicated that the model that did not incorporate the effect of sowing dates might lead to unreliable results. To improve the model capability, we should include other factors such as soil and weather condition data in further studies.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-29] Effect of Environmental Differences on Empirical Regression Models for Estimating Leaf Area Index Using Vegetation Indices in Rice

*Nominated for Presentation Awards

○Tomoaki Yamaguchi[1], Daniel Menge[2], Emily Gichuhi[2], Peprah Clement Oppong[1], Megumi Yamashita[1], Daigo Makihara[3], Keisuke Katsura[1] （1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2., Kenya Agricultural and Livestock Research Organization, Kenya, 3.International Center for Research and Education in Agriculture, Nagoya University, Japan）

Leaf area index (LAI) is an important parameter for monitoring rice growth, and various empirical models to predict LAI using vegetation indices (VIs) have been proposed. Most of the models, however, were developed based on data collected from a single location, which makes it difficult to apply these models to other environmental conditions. The objective of this study was to compare two empirical models for predicting LAI using VIs that were developed using data from Japan and Kenya with Basmati 370 as a common rice variety, and to reveal the physiological factors causing differences between the models. Spectral reflectance of rice canopies was measured using a hyper-spectral sensor just before destructive measurement of LAI at 2-week intervals from transplanting to heading. Simple ratio (SR) was one of the best VIs to predict LAI in a linear regression model. However, there was a significant difference in the slope coefficients of the regression curves of the developed models for the two locations. As the SR increased, the change in LAI was more pronounced in Japan than in Kenya, which means the rice plants in Kenya could develop leaf area efficiently with less mutual shading. In Kenya, plant length increased at a slower rate than in Japan probably because of lower temperature, hence plants were able to distribute smaller and more erect leaves. In order to develop a universal model to predict rice growth using VIs, further understanding of the interaction effects between genotypic and environmental factors on rice morphology is necessary.

1:15 PM - 2:00 PM （Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster)）

[P2-30] Detection of Lodging Area in a Paddy Field from a Digital Surface Model (DSM)

○Tadashi Tsukaguchi[1], Fumio Uno[2], Yoichi Fujihara[1] （1.Faculty of bioresources and environmental sciences, Ishikawa Prefectural University, Japan, 2.Ishikawa Agriculture and Forestry Research Center, Japan）

Images acquired by a camera mounted on a UAV (unmanned aerial vehicle) can be processed to reconstruct 3D structure as a DSM. Through the use of this technique, areas where lodging has occurred can be detected by gauging the degree of lodging as the difference in relative elevation between heading and maturity, or delta plant height. The association between the degree of lodging and a vegetation indices (VIs) at various growth stages is useful for the setting of the target VI value at a certain growth stage for local topdressing. The objective of this study was to estimate the degree of lodging by using a DSM and to associate it with the values of VIs before heading. We recorded paddy fields where a rice cultivar Koshihikari was grown with various rates of nitrogen application to 2 crops a year in 2019 and 2020. Images were periodically taken by a multispectral camera mounted on a UAV and by an RGB camera mounted on another UAV. We processed the multispectral images to VI maps and the RGB images to a

DSM. We created 1-m cells on the VI maps and DSM of the fields and calculated the mean values of VIs and the difference in the mean relative elevation, or delta plant height, between heading and maturity in each cell. We found highly significant associations between VIs and delta plant height. In addition to lodging, such associations could be used for determining local topdressing rates or for detecting unevenness of the soil surface or fertility in the field. This work was partly supported by Contracting Research on Policy for Agriculture, Forestry and Fisheries.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-31] Nitrogen Dynamics in Paddy Fields under Different Rice Bran Levels

*Nominated for Presentation Awards

○Mchuno Alfred Peter, Tasuku Eigen, Ami Shimomura, Beno Anton Kiwale, Kunio Watanabe, Nobuhito Sekiya （Graduate School of Bioresources, Mie University, Japan）

The application of organic material (OM) is essential for sustainable rice production, and understanding decomposability is important for the effective use of OM. We hypothesize that easily-decomposable OM such as rice bran (RB) sharply increases inorganic nitrogen (IN) as plant growth begins, and the mineralization ceases in advance of plant maturity. To test this hypothesis, the mineralization, leaching, and plant uptake of nitrogen were investigated from winter to summer in rice fields where early-maturing cultivar Natsuhikari was applied with 0, 40, 80, and 160kgNha^{-1} of RB. NH_4- and NO_3-nitrogens were quantified in soils at 0-2, 2-10, 10-20, and 20-25cm depths for estimation of mineralization, and soil water pressure was measured at 15 and 30cm depths for assessment of leaching. Aboveground biomass was collected at five growth stages for estimation of nitrogen uptake. Mineralization started long before irrigation at low temperatures and prolonged until plant maturity. Soil nitrogen was the primary source for plants throughout the growth period; it contributed 69.4% of total nitrogen uptake. RB contribution was estimated at 3.9%, 31.5%, and 37.3% in 40, 80, and 160kgNha^{-1}, respectively. A sharp decline of mineralized nitrogen was observed, implying the occurrence of immobilization despite the low C/N ratio (19) of RB. The concentration of IN was three times higher at harvest than at the start of the experiment. These results indicate that a gradual increase in temperature linearly increases nitrogen mineralization, and larger amounts of RB application allow continuous mineralization of nitrogen throughout the growth period with potential involvement of immobilization.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-32] Do New Rice Cultivars Respond to Chemical Fertilizers Better than Old Cultivars?

*Nominated for Presentation Awards

○Beno Anton Kiwale, Asaka Murai, Mchuno Alfred Peter, Nobuhito Sekiya （Graduate School of Bioresources, Mie University, Japan）

Nitrogen is the most important nutrient for rice growth, and rice's responsiveness to nitrogen application is cultivar-specific. We hypothesize that improved cultivars (Bekoaoba and Momiroman) increase biomass more than old cultivars (Yuminariho and Yamadanishiki) when chemically fertilized; the

old cultivars increase biomass more than new cultivars when organically fertilized. The four cultivars with two controls (Koshihikari and Nipponbare) were subjected to five nitrogen levels (80 and 160KgN/ha in the form of organic and chemical and non-fertilized as control) applied once before transplanting. Biomass was collected at four active tillering, panicle initiation heading and maturity stages. At maturity, contrary to our expectation, old cultivars increased biomass in chemically fertilized plots than unfertilized control, while new cultivars' responses to chemical fertilizer were insignificant except for Bekoaoba in the 80kgN/ha. When chemically fertilized, Yuminariho and Yamadanishiki increased biomass during reproductive and ripening, respectively. Also, chemically fertilized Bekoaoba at 80kgN/ha lately increased biomass due to nitrogen immobilization during active tillering stage (biomass was higher in unfertilized than in chemically fertilized plots). Irrespective of genetic background, organic fertilizer had insignificant or even adverse effects on biomass at maturity than unfertilized control, implying occurrence of nitrogen immobilization throughout growth period. The results infer that cultivar's responsiveness to nitrogen application is influenced by soil organic matter or immobilization capacity of soils.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-33] A Case Study on Labor Productivity of Paddy Rice Seed Production in Japan

*Nominated for Presentation Awards

○Mizuho Fujii, Akihiko Kamoshita （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

In Japan, paddy rice seeds are mainly produced by seed producing farmers who are designated by prefectures. At present, shortage of successors of seed producing farmers is getting serious due to the heavy labor load and difficulty in acquiring technical skills for seed production. While seed producing farmers have the advantage of higher selling price of seed rice than food rice, more labor is required to meet the quality standard as seeds such as genetic purity, sanitary, high germinability, no contamination with other varieties nor weeds. If the labor load can be reduced and labor productivity can be shown to increase, more new seed farmers can join. The purpose of this study is to clarify the factors behind the differences in labor productivity among farmers. We compared seed production technology among farmers in 3 prefectures; (1) S seed association in Toyama prefecture, which has the largest sales of seeds outside the prefecture in Japan, (2) C seed association in Hokkaido, which has the largest management scale, and (3) T seed association in Gunma prefecture, which purchases seeds outside the prefecture. The working hours for removal of off-type plants and cleaning of machines were long in all the 3 groups. Labor productivity was highest in C seed association in Hokkaido, where the working hours per area for works such as removal of off-type plants, cleaning of machines, and pest control were shortest. Gross profits were highest in S seed association in Toyama because of the higher producer prices of the seeds.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 2 (Poster))

[P2-34] Selection of Sorghum Growth Indicators for the Development of Smart Farm of Field Food Crops

○Kang-Su Kwak, Si-Young Rho （Division of Smart Farm Development, Department of Agricultural Engineering, National Institute of Agricultural Sciences, Rural Development Administration, Korea）

Digital agriculture is a useful solution to improve the productivity and quality of agricultural products, also to solve the aging problem in rural areas. Meanwhile, image analysis is a very important tool for the development of smart farm technology. Moreover, research on growth indicators to understand the growth situation of crops should be preceded for the development of image-based smart farm technology. We chose sorghum as a test crop for the image analysis because it makes us easy to acquire growth images due to its simple plant shape. Sorghum(var. Noeulchal) was sown in a tray sowing box and seedling was raised for 9days, then it was transplanted into the main field. And, we created fertilizer(control, heavy, no) and soil moisture(control, excess, drought) treatment plots to select key growth indicators with large growth changes among treatments, and investigated total 11 growth indicators(culm length, plant height, stem diameter, leaf age, internode length 1~2, 2~3, 3~4, ear length, ear width, upper leaf color, lower leaf color) every week after transplanting. As a result of the experiment, we selected meaningful key growth indicators through ANOVA variance analysis and DMRT as follows; (Fertilizer section) Culm length, plant length, stem diameter and upper leaf color at no fertilizer plot during the vegetation stage; Plant length during the reproductive stage. (Irrigation section) Upper leaf color at excess moisture plot during the vegetation stage; Stem diameter, upper leaf color and lower leaf color at excess moisture plot; Upper leaf color and lower leaf color at drought plot during the reproductive stage. We are currently pursuing an image analysis experiment using the YOLO algorithm.

[P3] Abiotic Stress for Crop Production

Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster) (Abiotic Stress for Crop Production)

[P3-01] Influence of Low Temperature at Booting Stage on Growth and Yield in Fall and Spring Sown Wheat

Jaeeun Choi[1], Jae-Gyeong Jung[1], Young-Hun Lee[1], Ki-Eun Song[1,2], Jonghan Ko[3], Kyung-Do Lee[4], ○Sang-In Shim[1] (1.Department of Agronomy, Gyeongsang National University, Korea, 2.Division of Applied Life Science (BK21 Plus), Gyeongsang National University, Korea, 3.Department of Applied Plant Science, Chonnam National University, Korea, 4.Climate Change and Agro-Ecology Division, Rural Development Administration, Korea)

12:15 PM - 1:00 PM

[P3-02] Selection of Transcripts Relating to Chlorophyll Content of Rice Seedlings at Low Temperature Using RNA-Sequencing Data

○Akari Fukuda[1], Tatsuro Hirose[2], Yoichi Hashida[2], Naohiro Aoki[3], Atsuhi J. Nagano[4] (1.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 2.Faculty of Agriculture, Takasaki University of Health and Welfare, Japan, 3.Graduate School of Agricultural and Life Science, The University of Tokyo, Japan, 4.Faculty of Agriculture, Ryukoku University, Japan)

1:15 PM - 2:00 PM

[P3-03] Membrane Lipid Unsaturation Confers Cold Germination Ability to Seeds of Upland Cotton (*Gossypium hirsutum*)

Lakhvir Kaur Dhaliwal[1], Junghyun Shim[1], Masoud Zabet[2], Benildo G. de los Reyes[1], ○Rosalyn B. Angeles-Shim[1] (1.Department of Plant and Soil Science, College of Agricultural Sciences and Natural Resources, Texas Tech University, United States, 2.Center for Biotechnology and Genomics, Texas Tech University, United States)

12:15 PM - 1:00 PM

[P3-04] Characteristics of Photoassimilates Distribution in the Resistant Variety to the High-Temperature Damage to Rice Grain Ripening

○Saki Yoshino[1], Chiharu Sone[2,3], Kyoko Toyofuku[2,3], Fumiaki Takakai[2,3], Takato Mizumoto[2], Yoko Ishikawa[2,3], Atsushi Ogawa[2,3] (1.Graduate School of Bioresource Sciences, Akita Prefectural University, Japan, 2.Faculty of Bioresource Sciences, Akita Prefectural University, Japan, 3.Japan Science and Technology Agency, Core Research for Evolutionary Science and Technology Project, Japan)

1:15 PM - 2:00 PM

[P3-05] Comparison of Drought Resistance of NERICA, Asian Rice and African Rice and Effects of Phosphorus Fertilizer

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

12:15 PM - 1:00 PM

[P3-06] The Effects of Arbuscular Mycorrhizal Symbiosis on the Growth, Yield and Drought Resistance of Foxtail Millets (*Setaria italica*)

○Wei-Yi Lin, Ou-Chi Chang, Yi-An Chen, Ting-Chen Chang (Department of Agronomy, National Taiwan University, Taiwan)

1:15 PM - 2:00 PM

[P3-07] The Effect of Ultra-Fine Bubble on Soybean Growth under Osmotic Stress Condition

○Kaito Yamashita[1], Yoshihiro Hirooka[1], Yoshikatsu Ueda[2], Koji Yamane[1], Chikashi Kamimura[3], Morio Iijima[1] （1.Graduate School of Agriculture, Kindai University, Japan, 2.Research Institute for Sustainable Humanosphere, Kyoto University, Japan, 3.Eatech Co. Ltd, Japan）

12:15 PM - 1:00 PM

[P3-08] Simple Model for Root Distribution across Soil Depth in Rice (*Oryza sativa* L.) under Fluctuating Soil Moisture Conditions

Hien Thi Thanh Nguyen, Tohru Kobata, ○Kuniyuki Saitoh （Graduate School of Environmental and Life Science, Okayama University, Japan）

1:15 PM - 2:00 PM

[P3-09] Diurnal Changes in Chloroplast Positioning and Photosynthesis in Finger Millet

○Eri Maai[1], Kazusa Nishimura[2], Rihito Takisawa[3], Tetsuya Nakazaki[2] （1.Faculty of International Agriculture and Food Studies, Tokyo University of Agriculture, Japan, 2.Graduate School of Agriculture, Kyoto University, Japan, 3.Faculty of Agriculture, Ryukoku University, Japan）

12:15 PM - 1:00 PM

[P3-10] Effect of Seed Hydro-Priming on Initial, Middle, and Late Growth Stage of Rice under the Different Soil Moisture Conditions

○Yoshihiro Nakao[1], Minoru Yoshino[2], Kisho Miyamoto[2], Aki Houshiyama[1], Eri Ishikawa[1], Jun-Ichi Sakagami[1] （1.Faculty of Agriculture, Kagoshima University, Japan, 2.Japan International Cooperation Agency, Japan）

1:15 PM - 2:00 PM

[P3-11] Differences in Aquaporin Expression and Their Response to Osmotic Stress among Component Roots in a Rice Root System

○Yumika Watanabe[1, 2], Shiro Mitsuya[1], Akira Yamauchi[1] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.School of Biological Sciences, The University of Western Australia, Australia）

12:15 PM - 1:00 PM

[P3-12] Does Plasticity of Anatomical Traits Influence Water Stress Tolerance in Rice?

○Manikanta Ch L N[1], Beena R[2], Rejeth R[3] （1.Department of Plant Physiology, Kerala Agricultural University, India, 2.Department of Plant Physiology, Kerala Agricultural University, India, 3.Department of Plant Physiology, Kerala Agricultural University, India）

1:15 PM - 2:00 PM

[P3-13] Crops Response to Water Stress Combination with Temperature Like—Rainfed Condition in Cereal

○Phanthasin Khanthavong[1,3], Shin Yabuta[2], Jun-Ichi Sakagami[1,2] （1.The United Graduate School of Agricultural Sciences, Kagoshima University, Japan, 2.Faculty of Agriculture, Kagoshima University, Japan, 3.Maize and Cash Crops Research Center, National Agriculture and Forestry Research Institute, Laos）

12:15 PM - 1:00 PM

[P3-14] Root and Leaf Plasticity in Response to Soil Moisture Fluctuation in Rice

○Yasutaka Noda[1,2], Mana Kano-Nakata[2], Shiro Mitsuya[1], Akira Yamauchi[1] （1.Graduate School

of Bioagricultural Sciences, Nagoya University, Japan, 2.International Center for Research and Education in Agriculture (ICREA), Nagoya University, Japan）

1:15 PM - 2:00 PM

[P3-15] Combination of GGE and BLUP Models in the Selection of Rice Varieties Adapted to the Rainfed Lowlands

○Via Ann Marcelo[1], Maria Corazon Cabral[2], Jonathan Niones[3], Roel Suralta[4], Mana Kano-Nakata[2], Akira Yamauchi[2] （1.Plant Breeding and Biotechnology Division, Philippine Rice Research Institute, Philippines, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 3.Genetic Resources Division, Philippine Rice Research Institute, Philippines, 4.Crop Biotechnology Center, Philippine Rice Research Institute, Philippines）

12:15 PM - 1:00 PM

[P3-16] Absorption and Physiological Treatment Mechanism of Cesium under High NaCl Conditions in Quinoa (*Chenopodium quinoa* Willd.)

○Kengo Wada[1], Katsunori Isobe[2], Masao Higo[2], Yoshihiro Kawamura[1], Yuya Tatewaki[1], Koya Nakamura[1] （1.Graduate School of Bioresource Science, Nihon University, Japan, 2.College of Bioresource Science, Nihon University, Japan）

1:15 PM - 2:00 PM

[P3-17] Differences in the Strategies of Salinity Tolerance between Two Different Genotypic Groups of Quinoa (*Chenopodium quinoa* Willd.)

○Mire Hong[1], Yasunari Fujita[2], Yasuo Yasui[3], Keisuke Katsura[1] （1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Biological Resourse and Post-harvest Division, Japan International Research Center for Agriculture Sciences, Japan, 3.Graduate School of Agriculture, Kyoto University, Japan）

12:15 PM - 1:00 PM

[P3-18] Mapping of Salinity Tolerance in Rice Through Genome-Wide Association Study (GWAS) at Seedling and Reproductive Stages

○Marjorie Punzalan de Ocampo[1,2], Bui Phuoc Tam[1,3], JamesA. Egdane[1], Shiro Mitsuya[2], Akira Yamauchi[2], Amelia Henry[1], Abdelbagi M. Ismail[1] （1.Strategic Innovation-Systems Physiology, International Rice Research Institute, Philippines, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 3.CuuLong Delta Rice Research Institute, Vietnam）

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[P3-19] NaCl-Stimulated ATP Synthesis in a Halophyte (*Mesembryanthemum crystallinum* L.)

○Ryoma Sato[1], Kazuki Yoshida[1], Ayako Konishi[2], Dan Q. Tran[3], Kazuyuki Saito[4], John C. Cushman[5], Sakae Agarie[4] （1.Graduate school of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Faculty of Agriculture, Kagawa University, Japan, 3.The United Graduate School of Agricultural Sciences, Ehime University, Japan, 4.Faculty of Agriculture, Kyushu University, Japan, 5.Department of Biochemistry and Molecular Biology, University of Nevada, United States）

12:15 PM - 1:00 PM

[P3-20] Expression Analysis of Genes Involved in Removal of Na^+ and Cl^- by Leaf Sheath in Rice

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

Japan, 3.Department of Agro-Industry, Ministry of Agriculture, Forestry and Fisheries, Cambodia）

1:15 PM - 2:00 PM

[P3-22] Evaluation of Salinity Tolerance in Rice Lines Carrying Overlapping Chromosome Segments of *Oryza longistaminata* in a Genetic Background of Kernel Basmati

○Rena Tomita[1], Emily Waringa Gichuhi[2], Daniel Makori Menge[2], Mayumi Kikuta[3], Daigo Makihara[4] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.Industrial Crops Research Institute, Kenya Agricultural and Livestock Research Organization, Kenya, 3.Graduate School of Integrated Sciences for Life, Hiroshima University, Japan, 4.International Center for Research and Education in Agriculture, Nagoya University, Japan）

1:15 PM - 2:00 PM

[P3-23] Identification of Rice Varieties Showing Superior Salt Removal Ability in Leaf Sheath and Its Contrasting Varieties

○Itsuki Goto, Akira Yamauchi, Shiro Mitsuya （Graduate School of Bioagricultural Sciences, Nagoya University, Japan）

12:15 PM - 1:00 PM

[P3-24] Transcriptional Regulation of the Stress-Inducible Photosynthesis in the Common Ice Plant, *Mesembryanthemum crystallinum* L.

○Sakae Agarie[1], Kento Kuroda[2], Kasumi Nishikawa[2], Nanako Isshiki[2], Yoko Ide[3], Kazuyuki Saito[1], John C. Cushman[4] （1.Faculty of Agriculture, Kyushu University, Japan, 2.Faculty of Agriculture, Kagawa University, Japan, 3.Faculty of Agriculture, Saga University, Japan, 4.Department of Biochemistry and Molecular Biology, University of Nevada, Reno, United States）

1:15 PM - 2:00 PM

[P3-25] Morphological Characterization of Calcium Oxalate Crystals and Effect of Growth-Medium Calcium Levels on Morphology of the Crystals in Tubers and Roots of Chinese Yam

○Michio Kawasaki[1,2], Ryotaro Shibata[2], Shinichiro Ito[2] （1.Faculty of Agriculture, Setsunan University, Japan, 2.Faculty of Agriculture and Life Science, Hirosaki University〔previous affiliation〕, Japan）

12:15 PM - 1:00 PM

[P3-26] Root Type-Specific Transcriptome Diversity in Salinity Tolerant and Sensitive Rice Varieties

○Joyce Cartagena[1], Yao Yao[1], Shiro Mitsuya[1], Takashi Tsuge[2] （1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.Department of Biological Chemistry, Chubu University, Japan）

1:15 PM - 2:00 PM

[P3-27] Breeding for Submergence-Tolerant Rice by Marker Assisted Backcross

○Yu-Chien Tseng[1], Yu-Chia Hsu[1], Yu-Chin Chang[2], Yong-Pei Wu[2] （1.Agronomy Department, National Chiayi University, Taiwan, 2.Agronomy Department, Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan）

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[P3-28] Seed-Flooding Tolerance in Soybean is Related to Germination Ability under Water

○Shinjiro Ootsuka, Ryutaro Morita, Junko Yamagishi, Naohiro Aoki （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

1:15 PM - 2:00 PM

[P3-30] Utilization of *SEMIDWARF1* for Vigorous Growth, Weed Competitiveness and Deep-Water Resistance in Rice Varieties for Organic Farming

○Marina Iwasa, Keisuke Katsura, Takashi Motobayashi, Taiichiro Ookawa （Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan）

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[P3-31] Naked Waxy Barley Yield and Grain β-glucan Affected by Soil Heterogeneity in Different Arable Lands

○Atsushi Matsumura[1], Takuya Morishita[2], Syuusuke Nakai[2], Hiroyuki Masumoto[1], Masanori Yanase[1] （1.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan, 2.College of Life, Environment and Advanced Sciences, Osaka Prefecture University, Japan）

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[P3-32] Transitional Oxygen Point (TOP), a Physiological Indicator to Evaluate Waterlogging Tolerance in Crops

○Yutaro Oba[1], Akihiro Nose[1], Makoto Tokuda[2], Shao Hui Zheng[1] （1.Tropical Crop Science, Agriculture, Saga University, Japan, 2.Systems Ecology, Agriculture, Saga University, Japan）

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[P3-33] Comparative Transcriptome Analysis in Sorghum (*Sorghum bicolor* L.) Leaves during Vegetative Stage under Waterlogging Stress

○Ku Hyun Kwon[1], Sang-Heon Choi[1], Ju-Young Choi[1], Soo-Jeong Kwon[1], Hyen-Chung Chun[2], Dong-Gyu Lee[1], Seong-Hyun Yu[1], Tae-Woong Yun[1], Sun Hee Woo[1] （1.Department of Crop Science, Chungbuk National University, Korea, 2.National Institute of Crop Science, Rural Development Administration, Korea）

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[P3-34] Death of Roots Retards the Growth Recovery of Common Buckwheat under Waterlogged Conditions

○Shun Murakami[1], Masaaki Hashimoto[2], Hiromitsu Aoki[2], Yasuhiro Hirata[2], Yoshiharu Wada[1,2], Takuya Koyama[1,2] （1.Graduate School of Regional Development and Creativity, Utsunomiya University, Japan, 2.School of Agriculture, Utsunomiya University, Japan）

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[P3-35] Effects of Root Aerenchyma Formation and Photosynthetic Activity of Leaves under Submergence on Post-Submergence Recovery in *Oryza sativa* and *O. glaberrima*

○Chiharu Sone, Yuta Echizenya, Daichi Tozawa, Kyoko Toyofuku, Atushi Ogawa （Faculty of Bioresource Sciences, Akita Prefectural University, Japan）

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[P3-36] Hypoxic Tolerance of Four Millets is Attributable to Constitutive Aerenchyma Formation and Root Hair Development of Adventitious Root

○Asana Matsuura[1], Yasuyuki Kato[1], An Ping[2] （1.School of Agriculture, Tokai University,

Japan, 2.Arid Land Research Center, Tottori University, Japan）

1:15 PM - 2:00 PM

[P3-37] Contrasting Rice Cultivars Responses to Increasing CO_2 Levels and Temperature

○Nene Furukawa[1], Murat Aycan[2], Nahar Lutfun[1], Toshihiro Nagamori[1], Eckart Priesack[3], Bertrand Gakière[4], José Luis Araus[5], Iker Aranjuelo[6], Marouane Baslam[2], Toshiaki Mitsui[1,2]（1.Dept. of Life and Food Sciences, Graduate School of Science and Technology, Niigata University, Japan, 2.Laboratory of Biochemistry, Faculty of Agriculture, Niigata University, Japan, 3.Institute of Biochemical Plant Pathology, Helmholtz Center-Munich, Germany, 4.Institute of Plant Sciences Paris-Saclay (IPS2), CNRS University Paris-Saclay, France, 5.Integrative Crop Ecophysiology Group, University of Barcelona, Spain, 6.Agrobiotechnology Institute, Spanish National Research Council, Spain）

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[P3-38] Introgression of Dormant Gene *Sdr4-k* Improves Grain Quality of Sake Rice

○Shinya Kanazawa[1], Maiko Iwano[1], Marouane Baslam[2], Shigeru Hanamata[2], Murat Aycan[2], Isao Hanashiro[3], Kazuhiko Sugimoto[4], Toshiaki Mitsui[1,2]（1.Graduate School of Science and Technology, Niigata University, Japan, 2.Faculty of Agriculture, Niigata University, Japan, 3.Faculty of Agriculture, Kagoshima University, Japan, 4.Institute of Crop Science, National Agriculture and Food Research Organization, Japan）

1:15 PM - 2:00 PM

[P3-39] Effects of Jasmonic Acids on Rice Flower Opening Time and Fertility under High Temperature Conditions

○Kazuhiro Kobayasi[1], Ramin Taheri[2], Masato Tsurumi[3], Yuki Mizokane[3], Fumihiko Adachi[1], Kazuhiro Ujiie[1], Akio Tanaka[4], Taku Tanogashira[4], Hitoshi Ogiwara[5]（1.Institute of Agricultural and Life Sciences, Shimane University, Japan, 2.Graduate School of Natural Science and Technology, Shimane University, Japan, 3.Faculty of Life and Environmental Sciences, Shimane University, Japan, 4. Kagoshima Prefectural Institute for Agricultural Development, Japan, 5.National Agriculture and Food Research Organization, Japan）

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[P3-40] The Effect of N-application on cpHSP70-2 Accumulation to Improve Rice (*Oryza sativa* L.) Grain Chalkiness

○Olusegun Idowu, Tomoyuki Katsube-Tanaka（Graduate School of Agriculture, Kyoto University, Japan）

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[P3-41] Genetic Analysis of Drought Response Index in a *Temperate Japonica* Rice Mapping Population

○Poornima Ramalingam[1,2], Ha-An Thi Nguyen[1], Kamoshita Akihiko[1]（1.Department of Plant Biotechnology, Tamil Nadu Agricultural University, India, 2.Asian Research Center for Bio-Resources and Environmental Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Asian Research Center for Bio-Resources and Environmental Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

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[P3-42] Contribution of the Chromosome 11 of a Salinity-Tolerant Rice Variety Nona Bokra to High Dry Matter Production under Salinity and Its QTL

Mapping

○Yumika Yamamoto[1], Masaki Uchida[1], Mana Kano-Nakata[2], Akira Yamauchi[1], Shiro Mitsuya[1]
（1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.International Center for Research and Education in Agriculture, Nagoya University, Japan）

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[P3-43] Genotypic Variation in Root Morpho-Anatomical Traits of Rice Cultivars with High and Low Adaptability under Multi-Stress Environment

○Maria Corazon Julaton Cabral[1,2], Via Ann Candelaria Marcelo[3], Roel Rodriguez Suralta[3], Jonathan Manito Niones[3], Antoinette Soriano Cruz[3], Hiroshi Ehara[1,2], Yoshiaki Inukai[1,2], Akira Yamauchi[1], Mana Kano-Nakata[1,2]（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）

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[P3-44] Heavy Flooding Effects on Productivity of Paddy Rice Cultivar 'Nanatsuboshi'

○Hideki Okamoto[1], Junji Fujikura[2], Katsuhiro Furukawa[2]（1.Tenpoku Sub-centre, Dairy Research Centre, Hokkaido Research Organization, Japan, 2.Kamikawa Agricultural Experiment Station, Hokkaido Research Organization, Japan）

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[P3-45] Root Anatomical Traits Related to Root Oxygen Consumption and Transportation between Upland Rice and Lowland Rice Varieties

○Shotaro Tamaru[1], Keita Goto[1], Phanthasin Khanthavong[1], Shin Yabuta[2], Jun-Ichi Sakagami[1,2]
（1.The United Graduate School of Agricultural Sciences, Kagoshima University, Japan, 2.Faculty of Agriculture, Kagoshima University, Japan）

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[P3-46] Roles of Root Plasticity to Growth and Yield of Quinoa under Different Soil Water Regimes

○Dinh Thi Ngoc Nguyen[1], Cuong Van Pham[1], Thiem Thi Tran[1], Akira Yamauchi[2]（1.Faculty of Agronomy, Vietnam National University of Agriculture, Vietnam, 2.Faculty of Agronomy, Vietnam National University of Agriculture, Vietnam, 3.Faculty of Agronomy, Vietnam National University of Agriculture, Vietnam, 4.Graduate School of Bioagricultural Sciences, Nagoya University, Japan）

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[P3-47] Integrated Transcriptome and Proteome Analysis Reveals Complex Regulatory Mechanism of Maize (*Zea mays* L.) in Response to Zinc Deficiency Stress

Jinyao Zhang[1,3], Shuhui Song[1], Yinghong Pan[2], Fangsen Xu[3], ○Hong Wang[1]（1.Institute of Agriculture Resources and Regional Planning, Chinese Academy of Agricultural Sciences, China, 2.The National Key Facility for Crop Gene Resources and Genetic Improvement, Institute of Crop Science, Chinese Academy of Agricultural Sciences, China, 3.College of Resources and Environment, Huazhong Agriculture University, China）

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[P3-01] Influence of Low Temperature at Booting Stage on Growth and Yield in Fall and Spring Sown Wheat

Jaeeun Choi[1], Jae-Gyeong Jung[1], Young-Hun Lee[1], Ki-Eun Song[1,2], Jonghan Ko[3], Kyung-Do Lee[4], ○Sang-In Shim[1] (1.Department of Agronomy, Gyeongsang National University, Korea, 2.Division of Applied Life Science (BK21 Plus), Gyeongsang National University, Korea, 3.Department of Applied Plant Science, Chonnam National University, Korea, 4.Climate Change and Agro-Ecology Division, Rural Development Administration, Korea)

Due to global climate change, winter temperatures are getting warmer and, in addition, low-temperature damage often occurs in late March and early April in overwintering crops. In this study, we compared changes in fall and spring sown wheat (cv. Jokyeong) cultivated in Jinju, Korea in 2017-2018 season (no low temperature damage) and 2018-2019 season (low temperature outbreak at booting stage). In the growth and yield-components analysis, the total biomass of fall sown wheat was 13,694 kg· ha^{-1} in 2018 and 20,461 kg· ha^{-1} in 2019. Grain yield was 5,370 kg· ha^{-1} in 2018 and 4,918 kg· ha^{-1} in 2019. In case of spring sown, it was found that the total biomass and grain yield was higher in 2018-2019 season by 6,513 kg· ha^{-1} and 3,411 kg· ha^{-1}, respectively, than in 2017-2018 season. Protein content showed different results, crude protein content of grains was higher in the fall sown wheat in the 2018-2019 season, however, the content was higher in spring sown wheat in 2017-2018 season. In the case of abnormal low temperature damage occurs at booting stage, spring sowing was better in terms of the grain yield, but protein content was better in fall sowing.

This study is a part of Cooperative Research Program for Agriculture & Technology Development (Project No. PJ0138412021) from Rural Development Administration, Republic of Korea.

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[P3-02] Selection of Transcripts Relating to Chlorophyll Content of Rice Seedlings at Low Temperature Using RNA-Sequencing Data

○Akari Fukuda[1], Tatsuro Hirose[2], Yoichi Hashida[2], Naohiro Aoki[3], Atsuhi J. Nagano[4] (1.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 2.Faculty of Agriculture, Takasaki University of Health and Welfare, Japan, 3.Graduate School of Agricultural and Life Science, The University of Tokyo, Japan, 4.Faculty of Agriculture, Ryukoku University, Japan)

The seedlings of an *indica* rice cultivar, Kasalath, showed chlorosis symptoms at 18℃; although the leaves of a *japonica* cultivar, Arroz da Terra, remained green at 18℃. In this study, transcripts relating to the chlorophyll content of rice seedlings at 18℃ were investigated using RNA sequencing (RNA-seq) data. Differential expression analysis revealed that the expression levels of photosynthetic genes were repressed in Kasalath seedlings at 18℃ compared to the seedlings grown at 25℃. However, stress-responsive genes were expressed at higher levels at 18℃ than at 25℃ in the Kasalath seedlings. Furthermore, the transcripts whose expression levels were related to chlorophyll content were statistically selected using the RNA-seq data of 21 F_2 plants derived from a cross between Arroz da Terra and Kasalath. For the regression models, frequently selected genes included photosynthetic and

stress responsive genes. The expression levels of the photosynthetic genes in the high-frequently selected genes had significant positive correlations with chlorophyll content in 95 F_2 plants at 18℃. Contrastingly, the expression levels of stress-responsive genes had significantly negative correlations with chlorophyll content, suggesting that low temperature-sensitive lines expressed more stress-responsive genes than tolerant lines at 18℃.

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[P3-03] Membrane Lipid Unsaturation Confers Cold Germination Ability to Seeds of Upland Cotton (*Gossypium hirsutum*)

Lakhvir Kaur Dhaliwal[1], Junghyun Shim[1], Masoud Zabet[2], Benildo G. de los Reyes[1], ○Rosalyn B. Angeles-Shim[1] (1.Department of Plant and Soil Science, College of Agricultural Sciences and Natural Resources, Texas Tech University, United States, 2.Center for Biotechnology and Genomics, Texas Tech University, United States)

The rapid influx of water during imbibition of a mature, dry seed triggers cell membrane re-organization from the hexagonal to the lamellar phase. During this transition, the cell membrane becomes highly permeable, resulting in cytoplasmic leakage and ultimately to poor seed germination. Membrane unsaturation has been reported to reduce cell membrane permeability by increasing its flexibility during reorganization in water-imbibing seeds. We screened cotton mutants with varying fatty acid (FA) profiles for their ability to germinate at 12℃ and 15℃. FA mutants with lower palmitic acid and higher linoleic acid content (LP/HL) showed a higher and more uniform germination at both low temperatures compared to the wild type. Hydropriming at 30℃ prior to cold treatment resulted in the faster and more uniform germination of the wild type, although the observed improvements were not at par with the cold germination ability of non-imbibed LP/HL mutants. Electrolyte leakage was higher in the wild type than in the LP/HL mutants after imbibition at 12℃ and 15℃ for up to 4 hours. Phospholipidomic studies showed higher incorporation of unsaturated linoleic acid in membrane lipids of the LP/HL mutants compared to the wild type. Results of the study indicate that the higher proportions of unsaturated fatty acids in the seeds of the LP/HL mutants enhanced the fluidity of cell membrane during reorganization, allowing the rapid restoration of cellular functions at low temperatures and facilitating the faster and higher germination of seeds.

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[P3-04] Characteristics of Photoassimilates Distribution in the Resistant Variety to the High-Temperature Damage to Rice Grain Ripening

*Nominated for Presentation Awards

○Saki Yoshino[1], Chiharu Sone[2,3], Kyoko Toyofuku[2,3], Fumiaki Takakai[2,3], Takato Mizumoto[2], Yoko Ishikawa[2,3], Atsushi Ogawa[2,3] (1.Graduate School of Bioresource Sciences, Akita Prefectural University, Japan, 2.Faculty of Bioresource Sciences, Akita Prefectural University, Japan, 3.Japan Science and Technology Agency, Core Research for Evolutionary Science and Technology Project, Japan)

Due to the rise in temperature caused by global warming in recent years, deterioration of the appearance quality of rice called "high-temperature damage to rice grain ripening" has frequently occurred in Japan. The purpose of this study was to clarify the characteristics of carbon distribution of resistant variety to the high-temperature damage to rice grain ripening under high temperature conditions from the heading stage to the ripening stage. As varieties, "Fusaotome", a resistant variety to the high-temperature damage to rice grain ripening, and "Akitakomachi", a sensitive variety, were tested. The heading time of these two varieties was the same. High temperature treatment and normal temperature treatment were set after the heading period. Compared to Akitakomachi, high-temperature treatment produced less immature grains in Fusaotome, and the deterioration of appearance quality due to high temperature was suppressed. The photosynthetic rate of Fusaotome was maintained higher than that of Akitakomachi regardless of the growth stage. The dry weight of the roots was heavier in Fusaotome than in Akitakomachi. Carbon dioxide labeled with stable isotope ^{13}C was exposed during the heading period, and the effect of high temperature on assimilation was investigated. During the heading period, the distribution ratio of assimilated products to the ears was higher in Fusaotome than in Akitakomachi. Based on these results, it was considered that Fusaotome, a variety resistant to high-temperature ripening disorders, maintains photosynthesis and water absorption from the roots even under high-temperature conditions during the heading period, and increases the rate of translocation to the ears to prevent deterioration in appearance quality.

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[P3-05] Comparison of Drought Resistance of NERICA, Asian Rice and African Rice and Effects of Phosphorus Fertilizer

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

Recently NERICA was developed by a crossing of African rice and Asian rice and is considered to be drought resistant, but drought resistance of NERICA is not clarified enough. In this research, NERICA (four cultivars and two lines), Asian rice (three cultivars 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 values and leaf thickness, were measured and compared with dry matter production and yield. Effects of phosphorus fertilizer were also compared among two NERICAs. One NERICA cultivar, one NERICA line and two Asian rice cultivars showed higher top dry weight and one Asian rice cultivar, one NERICA line and one NERICA cultivar showed higher yield. In one NERICA phosphorus fertilizer tended to increase top dry weight and yield. Asian rice cultivars tended to show higher stomatal conductance than NERICA. Cultivar and line differences in yield (ear weight) were significantly correlated with those in stomatal conductance (average: r=0.679**, first measurement: r=0.796**) and in Asian rice and NERICA with those in leaf thickness (r=0.662**). Cultivar and line differences in stomatal conductance were significantly correlated with those in leaf thickness (r=0.633*) and cultivar and line differences in leaf thickness were significantly correlated with SPAD value (r=0.643**) on similar date. Importance of maintaining high stomatal conductance and high leaf thickness, and effects of phosphorus fertilizer under drought condition was suggested.

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[P3-06] The Effects of Arbuscular Mycorrhizal Symbiosis on the Growth, Yield and Drought Resistance of Foxtail Millets (*Setaria italica*)

○Wei-Yi Lin, Ou-Chi Chang, Yi-An Chen, Ting-Chen Chang （Department of Agronomy, National Taiwan University, Taiwan）

Arbuscular mycorrhizal fungi (AMF) are the beneficial endosymbionts which can enhance nutrient uptake and stress resistance of host plants. These fungi are able to associate with more than 80% of land plant species, including foxtail millets. Foxtail millets (*Setaria italica*) is wildly grown in the world, however, it is still not clear about the potential of applying AMF on millet production and the stress tolerance. We selected two millet landraces collected in Taiwan (line 110) and India (line 209), respectively, and examined the effects of AMF on their growth responses, phosphate concentration and drought tolerance. Phosphate concentration was significantly increased in both lines with AMF treatment, compared to mock-treatment, although the growth was not promoted. It is noteworthy that the thousand grain weight was significantly increased in AMF-treated line 110. Under drought treatment, AMS enhanced the drought tolerance of line 110, while for lines 209, both mock- and AMF-treated plants were strongly tolerant to drought. Furthermore, the low level of malondialdehyde content in both mock- and AMF-treated line 209 and the decreased level in AMF-treated line 110, compared to mock-treated plants, supported the drought-tolerance phenotype that we observed. Taken together, our finding showed that AMF has great potential for improving foxtail millets production. We also observed the effects of host plant genotype on the benefits of AMS. Further study is required to reveal the effects of genotype on AMS and the mechanism of drought tolerance in millets.

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[P3-07] The Effect of Ultra-Fine Bubble on Soybean Growth under Osmotic Stress Condition

*Nominated for Presentation Awards

○Kaito Yamashita[1], Yoshihiro Hirooka[1], Yoshikatsu Ueda[2], Koji Yamane[1], Chikashi Kamimura[3], Morio Iijima[1]
（1.Graduate School of Agriculture, Kindai University, Japan, 2.Research Institute for Sustainable Humanosphere, Kyoto University, Japan, 3.Eatech Co. Ltd, Japan）

Ultrafine bubbles (UFB) exhibit a number of unique physical characteristics; however, reports on plant growth enhancement by UFB application are controversial. In the series of our former studies, we proved that the nutrient condition of plant growth medium is the key factor to govern the effects of UFB on young soybean seedlings. When no nutrients were supplied, positive effects of UFB water were evident, but low nutrition reduced UFB water-mediated growth enhancement and high nutrition totally obliterated any growth enhancement by UFB water. The purpose of this presentation is to clarify whether the UFB application mitigates the effects of drought stress on soybean plants. A simple experimental system based on hydroponic culture was used to evaluate the effect of UFB on the early growth of soybean seedlings under higher osmotic stress environment. In conclusion, UFB water-induced growth enhancement was eff ective and signifi cant under the nutrient defi cit and osmotic stress. Additional research is necessary to analyze drought stress and UFB application using soil cultured plants.

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[P3-08] Simple Model for Root Distribution across Soil Depth in Rice (*Oryza sativa* L.) under Fluctuating Soil Moisture Conditions

Hien Thi Thanh Nguyen, Tohru Kobata, ○Kuniyuki Saitoh (Graduate School of Environmental and Life Science, Okayama University, Japan)

A simple method for describing rice root distribution under fluctuating soil moisture conditions was developed. Four rice cultivars with different levels of drought tolerance were grown in pots with a diameter/height of 0.30/0.85 m, and watering was terminated at the booting stage. The distribution of root length density (RLD) at maturity was described by a quadratic function of soil depth (D_S) in each cultivar under moist and desiccated soil conditions. The equation resulted in three parameters indicating the root distribution traits of each cultivar: the RLD at half the observed D_S($RLD_{0.5}$) and the reduction rate, expressed as RLD per D_S (slope) and the maximum rate at D_S=0 (intercept) in the differentiated equation. Cultivars with high $RLD_{0.5}$ absorbed large amounts of water from deep D_S. Higher intercept and $RLD_{0.5}$ values accompanied higher slope values, and the same trends were observed for diverse rice cultivars and growth stages. This simple model is convenient for use in evaluating root distribution traits in rice.

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[P3-09] Diurnal Changes in Chloroplast Positioning and Photosynthesis in Finger Millet

*Nominated for Presentation Awards

○Eri Maai[1], Kazusa Nishimura[2], Rihito Takisawa[3], Tetsuya Nakazaki[2] (1.Faculty of International Agriculture and Food Studies, Tokyo University of Agriculture, Japan, 2.Graduate School of Agriculture, Kyoto University, Japan, 3.Faculty of Agriculture, Ryukoku University, Japan)

Finger millet is an important cereal crop cultivated in the arid and semi-arid regions and often experiences high-intensity light during the day. Mesophyll (M) chloroplasts in finger millet are known to aggregate to the bundle sheath side when leaves are constantly irradiated with extremely high-intensity light. This aggregative movement of M chloroplasts is also observed in the natural environment, but whether a natural light regime is effective in inducing the response remains unclear. Abscisic acid is reported to trigger not only the aggregative movement but also stomatal closure, but photosynthetic responses accompanying the aggregative movement also remain unknown. We investigated changes in chloroplast positioning and photosynthetic traits under diurnal patterns of light, mimicking the natural light environment. M chloroplasts showed the aggregative movement with increasing light intensity whether it frequently fluctuated or not, and kept their aggregative positions in the early afternoon. With decreasing light intensity, M chloroplasts returned to the random position in the evening. These results suggest that M chloroplasts often rearrange their intracellular positions during the daytime and the chloroplast aggregative movement can be induced by a natural regime of light. The chloroplast aggregative movement was observed with increasing stomatal conductance, suggesting that stomatal closure seems not crucial to trigger the chloroplast response.

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[P3-10] Effect of Seed Hydro-Priming on Initial, Middle, and Late Growth Stage of Rice under the Different Soil Moisture Conditions

*Nominated for Presentation Awards

○Yoshihiro Nakao[1], Minoru Yoshino[2], Kisho Miyamoto[2], Aki Houshiyama[1], Eri Ishikawa[1], Jun-Ichi Sakagami[1] (1.Faculty of Agriculture, Kagoshima University, Japan, 2.Japan International Cooperation Agency, Japan)

Low soil moisture causes poor plant emergence and establishment which leads decreasing the upland rice yield. Hydro-priming technique is known as the treatment which promotes enzyme activity, starch degradation, and accumulation of dry resistance substances and improves plant emergence and growth. In resent research, it has been found that the priming effect is not fully appeared under some soil moisture conditions. Therefore, we investigated details of hydro-priming effect on rice growth and yield under different soil moisture conditions. In first experiment, plant emergence and early growth parameter (plant height, root length and dry weight) under the wide range of soil moisture conditions were examined by using small planting pot. In second experiment, primed and untreated seed were cultivated in different soil moisture conditions and priming effect on the middle and late growth stage was examined. This study showed that root growth was increased significantly in primed seed compered to untreated seeds under the dry condition at the initial growth stage. This trait may enhance subsequent plant growth of primed seed under the dry soil moisture condition. During middle and late growth stage, leaf age of primed seed proceeded in advance in primed seed than in untreated seed under dry soil moisture condition. Therefore, it was suggested that priming treatment make growth period short under the dry condition which leads to reduce plant injury caused by less rainfall in late growth stage.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-11] Differences in Aquaporin Expression and Their Response to Osmotic Stress among Component Roots in a Rice Root System

*Nominated for Presentation Awards

○Yumika Watanabe[1, 2], Shiro Mitsuya[1], Akira Yamauchi[1] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.School of Biological Sciences, The University of Western Australia, Australia)

A rice root system consists of component roots including seminal root, nodal root, and L-type and S-type lateral root. These roots have different morphological and anatomical structures, and show different responses to the environmental stresses such as drought. Our previous studies showed a possibility that S-type lateral root may have the highest contribution to water uptake among the component roots in a whole root system based on the relationship between hydraulic conductivity of the whole root system and surface area of each component root (Watanabe et al., 2020). Additionally, aquaporin genes have

been reported to regulate water transport across the cell membrane in the radial direction of a root. However, the differences in aquaporin contribution among those component roots are still unknown. This study, therefore, aimed to compare aquaporin expression levels among component roots. Plants were hydroponically grown with and without osmotic stress. Among the 33 aquaporin gene family, we measured the expression level of PIP2;4 and PIP2;5 which were reported to be involved in water transport in rice root using Real-time PCR. The results showed the expression levels of PIP2;4 and PIP2;5 in lateral roots were higher than nodal roots. In addition, osmotic stress treatment significantly increased the expression level in S-type and L-type lateral roots with branching for PIP2;4. These results indicate that the aquaporin function may differ among component roots, and also with ages.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-12] Does Plasticity of Anatomical Traits Influence Water Stress Tolerance in Rice?

*Nominated for Presentation Awards

○Manikanta Ch L N[1], Beena R[2], Rejeth R[3] (1.Department of Plant Physiology, Kerala Agricultural University, India, 2.Department of Plant Physiology, Kerala Agricultural University, India, 3.Department of Plant Physiology, Kerala Agricultural University, India)

Plant roots play a vital role in acquisition of water and nutrients, their substantial plasticity to prevailing water limited environments has a greater emphasis for sustainable crop production, but these traits were often neglected due to the difficulty in handling large sample for studies. Root anatomical traits governing the radial and axial movement of water are expected to perform better in up taking and conducting water to reduce the yield gap under water stress environments. To understand the importance of root traits in mitigating water stress, an experiment was conducted in two phases. In first phase 35 rice genotypes were evaluated for various morpho-physiological and yield related traits tolerant to drought, from which a representative set of three drought tolerant and three drought susceptible genotypes were identified for phase two. In second phase the selected six (6) genotypes, three drought tolerant - Nagina - 22, Karuthamodan (Ptb 29), Chuvannamodan (Ptb 30) and three drought susceptible – Annapoorna (Ptb 35), Jyothi (Ptb 39) and Swetha (Ptb 57) were further evaluated by maintaining at 100% and 50% FC of available soil moistture. Anatomical and morphological investigations made on the roots of genotypes at their respective booting stage, showed that root length, root diameter, stele diameter, metaxylem number, metaxylem width and ratio of stele diameter to root diameter ratio were significantly varying at genotypic and treatment level ($P < 0.05$). Present study reveals that, genotypes with better plastic nature and conservative for maintenance cost performed satisfactorily under water limited conditions revealing their tolerance.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-13] Crops Response to Water Stress Combination with Temperature Like— Rainfed Condition in Cereal

*Nominated for Presentation Awards

○Phanthasin Khanthavong[1,3], Shin Yabuta[2], Jun-Ichi Sakagami[1,2] (1.The United Graduate School of Agricultural Sciences, Kagoshima University, Japan, 2.Faculty of Agriculture, Kagoshima University,

Japan, 3.Maize and Cash Crops Research Center, National Agriculture and Forestry Research Institute, Laos）

The effect of soil moisture content (MSC) on root and shoot growth was depended on crops. Under combination factors like– water and temperature stresses may change root and shoot phenotyping. This study aimed to evaluate the effect of various SMC combinations with low or high temperatures on morphological and physiological traits in maize, millet, rice, and sorghum. The experiments were conducted in the greenhouse by using a slope field. The same experimental design but the difference of daily temperature was conducted in September (range from 25–34℃)(Exp. A) and October/November (range from 15–24℃) (Exp. B), 2021. The treatments consisted of nine different SMC range from waterlogging to dry MSC. Shoot dry weight (SDW) of maize and sorghum was deceased by higher SMC in all experiments, but not for millet in Exp. B. However, rice was less change on SDW in all experiments. SDW of all crops had a significant correlation with leaf area and plant length for all experiments. Decreasing SDW of maize under low SMC combination with high temperature was observed in Exp. A. Millet and sorghum had lower SDW and for all SMC in Exp. B compared to Exp. A due to lower stomatal conductance. Our results suggested that the effect of SMC depends on crops and temperature. Waterlogging reduced SWD due to reduction of stomatal conductance, leaf area, and plant length in maize and sorghum with independent temperatures, but millet was dependent on temperatures. Under low SMC, maize was sensitive to high temperature. Millet and sorghum were sensitive to low temperature. Rice was less effect on SWC and independent temperature.

Keywords: Stomatal conductance, soil moisture content, morphology, shoot dry weight, slope field.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-14] Root and Leaf Plasticity in Response to Soil Moisture Fluctuation in Rice

*Nominated for Presentation Awards

○Yasutaka Noda[1,2], Mana Kano-Nakata[2], Shiro Mitsuya[1], Akira Yamauchi[1] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.International Center for Research and Education in Agriculture (ICREA), Nagoya University, Japan）

Drought and soil moisture fluctuation (SMF) stress negatively affect plant growth and development in rainfed rice ecosystem. In our previous study, CSSL47 (chromosome segment substitution line derived from Nipponbare and Kasalath crosses) and KDML105 showed high root plasticity in response to SMF (Suralta et al. 2010; Owusu-Nketia et al. 2018). Also, leaf morphoanatomical plasticity in response to environmental stresses has been reported. This study aimed to evaluate the leaf morphoanatomical response in relation to root plasticity expression under SMF conditions and those contribution to dry matter production using Nipponbare, CSSL47 and KDML105. We hypothesized that root plasticity exhibited more in mild drought-SMF than severe drought-SMF. Rice plants were grown under waterlogged conditions (Control), 20% of soil moisture content as mild drought to waterlogged (SMF20) and 10% of soil moisture content as severe drought to waterlogged (SMF10) in root box (L × W × H = 25 cm × 2 cm × 40 cm) under glasshouse conditions. CSSL47 and KDML105 showed greater shoot dry matter production than Nipponbare under SMF, which was attributed to the greater root system and stomatal number per plant resulting the maintenance of water uptake. However, there was no difference in stomatal density among the three varieties. Also, more plasticity was exhibited in SMF20 than in SMF10. These results

implied that CSSL47 and KDML105 can increase leaf area and the number of stomata per plant and contributed to the increase in dry matter production under SMF with mild drought to waterlogged.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-15] Combination of GGE and BLUP Models in the Selection of Rice Varieties Adapted to the Rainfed Lowlands

○Via Ann Marcelo[1], Maria Corazon Cabral[2], Jonathan Niones[3], Roel Suralta[4], Mana Kano-Nakata[2], Akira Yamauchi[2] (1.Plant Breeding and Biotechnology Division, Philippine Rice Research Institute, Philippines, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 3.Genetic Resources Division, Philippine Rice Research Institute, Philippines, 4.Crop Biotechnology Center, Philippine Rice Research Institute, Philippines)

Developing lines tolerant to water stress that are highly productive, widely adapted, and stable across environments is crucial to sustain yield increases in the rainfed lowlands (RL). Fourteen varieties were tested in Multi-Environment Trials in 19 experiments across three years. Genotype plus Genotype-vs-Environment interaction (GGE) and Best Linear Unbiased Prediction (BLUP) models were used for genotype mega-environment evaluation while correlation identified traits which are related to grain yield. Genotype confidence index revealed that half of the environments were identified as unfavorable RL, wherein, DRS14 is the best performing genotype across all environments (3.48 t/ha), unfavorable RL (2.78 t/ha), and favorable RL (4.11 t/ha). Moreover, the GGE model identified DRS14 as the best ranking genotype that is location-specific to 18 out of 19 environments. However, based on the mean vs stability biplot and the BLUP model, DRS14 is highly unstable. Bivariate analysis showed that grain yield is positively correlated to shoot dry weight, while low negative relationships were observed for total root length (10-20 cm) and total lateral root length (10-20 cm). Ultimately considering productivity, wide adaptation, and stability across environments in both models, DRS768, DRS63, YTH183, and YTH303 meet parameters in productivity, wide-adaptation, and stability across RL environments.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-16] Absorption and Physiological Treatment Mechanism of Cesium under High NaCl Conditions in Quinoa (*Chenopodium quinoa* Willd.)

*Nominated for Presentation Awards

○Kengo Wada[1], Katsunori Isobe[2], Masao Higo[2], Yoshihiro Kawamura[1], Yuya Tatewaki[1], Koya Nakamura[1] (1.Graduate School of Bioresource Science, Nihon University, Japan, 2.College of Bioresource Science, Nihon University, Japan)

Quinoa (*Chenopodium quinoa*) is known a high salt-tolerant plant, and high cesium (Cs) absorption plant, too. One of reason about high salt-tolerant in quinoa was the existence of bladder cells on the leaf surface, and the excess salts were accumulated in bladder cells. Since cesium is a harmful element for plant growth, the absorbed cesium should be excreted from plant, accumulated in the vacuole or be detoxified. Thus, the change of Cs-absorbing ability of quinoa by NaCl application, and the physiological

treatment mechanism of absorbed Cs in the plant were clarified in this study.
The growth (particularly, shoot fresh weight, and leaf area) of quinoa were promoted by the application of NaCl in the soil. In addition, the Cs absorption was promoted by the application of NaCl, and the almost of absorbed Cs were accumulated in the leaves. However, the number of bladder cells on the leaf surface did not increased by application of NaCl. In addition, the number of bladder cells decreased with decreasing leaf position. The Cs concentration of leaf was similar to that of removed bladder cells leaf, and there was no significant difference on Cs concentration between the bladder cells and the leaves. These results suggested that the most of Cs absorbed by quinoa plants were accumulated in leaves and were not specifically tranced from the leaves to bladder cells. In the future, it is necessary to clarify how Cs accumulated in leaves is rendered harmless in cells.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-17] Differences in the Strategies of Salinity Tolerance between Two Different Genotypic Groups of Quinoa (*Chenopodium quinoa* Willd.)

*Nominated for Presentation Awards

○Mire Hong[1], Yasunari Fujita[2], Yasuo Yasui[3], Keisuke Katsura[1] (1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Biological Resourse and Post-harvest Division, Japan International Research Center for Agriculture Sciences, Japan, 3.Graduate School of Agriculture, Kyoto University, Japan)

Salinity causes yield loss and it is a common problem in the world. Millions of hectares of land have been damaged by salinity and more will be degraded by salinity. Quinoa (*Chenopodium quinoa* Willd.), a halophyte crop, is receiving increased attention due to its high tolerance to salinity. Quinoa is divided into 3 genotypic groups (Christensen et al., 2007); Southern highland (SH) type, Northern highland type, and Lowland (L) type. SH type is thought to have a high tolerance to salinity since it can survive in Bolivian saline area. However, little is known about the physiological mechanisms and differences in salinity tolerance among the genotypic groups of quinoa. In this study, three lines of SH type quinoa and three lines of L type quinoa were used, and their salinity tolerance was evaluated in pot experiments. We found that regardless of the genotype, quinoa had a high salinity tolerance compared to other crops such as rice and barley. Quinoa could maintain a low Na^+/K^+ ratio in the shoot under high salinity stress condition. The strategy of salinity tolerance differed greatly between the genotypic groups. SH type quinoa avoided the accumulation of Na^+ into the shoot and maintained high biomass. However, L type quinoa maintained high biomass even though they accumulated Na^+ in the shoot. In conclusion, quinoa had a high salinity tolerance regardless of genotypic groups and they showed different strategies between the two genotypic groups to survive under salinity stress conditions.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-18] Mapping of Salinity Tolerance in Rice Through Genome-Wide Association Study (GWAS) at Seedling and Reproductive Stages

*Nominated for Presentation Awards
○Marjorie Punzalan de Ocampo[1,2], Bui Phuoc Tam[1,3], JamesA. Egdane[1], Shiro Mitsuya[2], Akira Yamauchi[2], Amelia Henry[1], Abdelbagi M. Ismail[1] （1.Strategic Innovation-Systems Physiology, International Rice Research Institute, Philippines, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 3.CuuLong Delta Rice Research Institute, Vietnam）

Rice genotypes may have different stress tolerance levels depending on the growth stage of the crop. Studies are needed to investigate whether traits contributing seedling stage tolerance can also contribute to reproductive stage tolerance. In this study, 299 lines from the previously genotyped rice diversity panel 1 (RDP1) were used to assess morphological and physiological traits, and map loci controlling salinity tolerance in rice for both seedling and reproductive stages through genome-wide association studies (GWAS). The salinity stress treatment was 12 dS m^{-1} in the seedling stage and 10 dS m^{-1} in the reproductive stage. The filtered, 4.8 M SNP dataset from 3KRG Release 1.0 and phenotypic data were analyzed using a linear mixed-model by the R package of GAPIT. The threshold was 1.11 x 10^{-8} at level of 1% after Bonferroni multiple test correction. GWAS identified highly significant peaks for salinity tolerance at seedling stage on chromosome 5 (SES score); and chromosome 10 (root length, shoot Na^+:K^+ ratio and vigor) and no significant peaks at the reproductive stage. One variety, Dhala Shaitta, showed salinity tolerance at both seedling and reproductive stages. SES score was strongly correlated with shoot Na^+:K^+ ratio at seedling stage, and grain yield was highly correlated with leaf chlorophyll a+b content at reproductive stage. Further genetic and physiological studies are needed to divulge the underlying mechanisms and genes involved in seedling and reproductive stage salinity tolerance.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-19] NaCl-Stimulated ATP Synthesis in a Halophyte (*Mesembryanthemum crystallinum* L.)

*Nominated for Presentation Awards
○Ryoma Sato[1], Kazuki Yoshida[1], Ayako Konishi[2], Dan Q. Tran[3], Kazuyuki Saito[4], John C. Cushman[5], Sakae Agarie[4] （1.Graduate school of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Faculty of Agriculture, Kagawa University, Japan, 3.The United Graduate School of Agricultural Sciences, Ehime University, Japan, 4.Faculty of Agriculture, Kyushu University, Japan, 5.Department of Biochemistry and Molecular Biology, University of Nevada, United States）

NaCl is one of the factors causing damages in plants that severely impedes their growth and reduces crop productivity. Halophyte, a group of salt-tolerant plants, evolved sophisticated mechanisms to survive under the severe salinity conditions, and they also show halophilism, which is a growth response that increases in the presence of NaCl at a concentration in which almost all crops die. The salt-tolerant and halophilic reactions require a large amount of ATP. In the previous study, we found that the ATP synthesis increased with increasing NaCl concentration in the mitochondria isolated from a halophyte, the common ice plant (*Mesembryanthemum crystallinum* L.). In the present study, RNA-Seq analysis was performed to determine the genes related to NaCl-stimulated ATP synthesis in the NaCl-treated cultured cells of the ice plant. We found that mRNA encoding the subunit B of ATP synthase is expressed at a higher level with NaCl. We also identified a specific amino acid sequence of the ice plant that shows high homology with vacuolar ATPase (V-ATPase, a member of ATP synthase superfamily) using BLASTP and the amino acid sequences of Na^+-driven ATP synthases isolated from archaea. Besides, we found that ATP synthesis of the mitochondria treated with uncoupling agent to dissipate H^+ gradient between the

mitochondrial matrix and intermembrane space was maintained with NaCl. In the presentation, we will discuss the possibility of Na^+-driven ATP synthesis and the mechanism of increased H^+-driven ATP synthesis in the halophyte.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-20] Expression Analysis of Genes Involved in Removal of Na^+ and Cl^- by Leaf Sheath in Rice

○Sarin Neang[1,3], Nicola Stephanie Skoulding[1], Joyce A. Cartagena[1], Mana Kano-Nakata[2], Akira Yamauchi[1], Shiro Mitsuya[1] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.International Center for Research and Education in Agriculture, Nagoya University, Japan, 3.Department of Agro-Industry, Ministry of Agriculture, Forestry and Fisheries, Cambodia)

A significant mechanism of salt-tolerance in rice is the ability to remove Na^+ and Cl^- in the leaf sheath, which limits the entry of these toxic ions into the leaf blade. The leaf sheath removes Na^+ and Cl^- in the basal and tip parts, respectively, by unloading them from xylem vessels and sequestering them into the fundamental parenchyma cells (Neang et al. 2019). This study aimed to identify Na^+ and Cl^- transporter genes, their distribution patterns of Na^+ and Cl^- along the longitudinal axis of leaves and in the internal tissues of leaf sheaths, and the genes that increase their expression levels under salinity. Our results indicated that *OsHKT1;1*, *OsHKT1;5*, *OsNHX1*, *2*, *3* and *5* might be involved in the Na^+ accumulation in basal parts of leaf sheaths under salinity. Additionally, *OsHKT1;5* may be involved in Na^+ unloading from xylem vessels. The Na^+ accumulation in fundamental parenchyma cells is probably mediated by *OsNHX3* in the central parts and *OsNHX5* in the peripheral parts under salinity. Furthermore, our results indicated that Cl^- removal in leaf sheaths is possibly regulated by *OsNPF2;4*, *OsCLC1*, *OsCLC2*, *OsSLAH1* and *OsSLAH2*. Cl^- accumulation in fundamental parenchyma cells might be associated with *OsNPF2;4* and *OsCLC2* under salinity.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-22] Evaluation of Salinity Tolerance in Rice Lines Carrying Overlapping Chromosome Segments of *Oryza longistaminata* in a Genetic Background of Kernel Basmati

*Nominated for Presentation Awards

○Rena Tomita[1], Emily Waringa Gichuhi[2], Daniel Makori Menge[2], Mayumi Kikuta[3], Daigo Makihara[4] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.Industrial Crops Research Institute, Kenya Agricultural and Livestock Research Organization, Kenya, 3.Graduate School of Integrated Sciences for Life, Hiroshima University, Japan, 4.International Center for Research and Education in Agriculture, Nagoya University, Japan)

In the Hola irrigation scheme, which is developed in semi-arid area of Kenya, Basmati rice varieties with locally preferred aromas are grown. However, rice cultivation in this area is suppressed by salinity stress. *Oryza longistaminata*, a wild rice species native to Kenya, is an important donor for improvement of rice tolerance to environmental stresses, including salinity. To determine the chromosome regions of

O. longistaminata involved in salinity tolerance, we evaluated *Longistaminata* Chromosome Segment Introgression Lines (LCSILs) carrying chromosome segments from *O. longistaminata* in the genetic background of Kernel Basmati. We conducted a pot experiment using nine lines, which were selected in a previous study. Two types of soils were used in the experiment, a weakly acidic sandy clay collected from a rice growing area in the Central Highlands of Kenya (soil A), and weakly alkaline sandy loams collected from the Hola irrigation scheme (soil B). LCSIL 19 and 48 were classified as a group with strong salt tolerance in both soils treated with NaCl (approximately 150 mM). In addition, the Na^+ and Na^+/ K^+ of leaf blades for LCSIL 19, 20, and 48, which maintained higher yield under salted soil B, were lower than those of the parent line, Kernel Basmati. In LCSIL 19, 20, and 48, chromosome segments of *O. longistaminata* could be located on chromosomes 4, 5, and 11, respectively, and genes contained therein may have been involved in the regulation of leaf Na^+ and Na^+/ K^+.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-23] Identification of Rice Varieties Showing Superior Salt Removal Ability in Leaf Sheath and Its Contrasting Varieties

*Nominated for Presentation Awards

○Itsuki Goto, Akira Yamauchi, Shiro Mitsuya （Graduate School of Bioagricultural Sciences, Nagoya University, Japan）

In rice plants, salt sensitivity is associated with the accumulation of Na^+ and Cl^- in the shoots, especially in the photosynthetic tissues. Therefore, salt removal ability at the leaf sheath is an important mechanism of salt tolerance. For further research of molecular mechanism and molecular breeding, we aimed to screen rice varieties showing high Na^+ and/or Cl^- removal ability and its contrasting varieties. Salt removal ability at the leaf sheath can be evaluated by the sheath : blade ratios of Na^+ or Cl^- concentrations. In our study, 20 rice varieties were grown hydroponically under control and saline conditions, and the sheath : blade ratios of Na^+ or Cl^- concentrations were measured. We screened a superior rice variety IR-44595 that showed higher Na^+ removal ability in leaf sheath, and the contrasting variety 318. Regarding Cl^-, OKSHITMAYIN showed a superior removal ability in leaf sheath compared with WC 4419. Moreover, we determined the Na^+ accumulation pattern in leaf sheath of IR-44595 and 318. The highest Na^+ concentration was found in the basal part of leaf sheath of both varieties. Cl^- accumulation pattern in the leaf sheath of OKSHITMAYIN and WC 4419 is now under investigation. Also, candidate genes encoding Na^+ or Cl^- transporters that contribute to Na^+ or Cl^- removal ability in leaf sheath of above varieties will be discussed in the conference.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-24] Transcriptional Regulation of the Stress-Inducible Photosynthesis in the Common Ice Plant, *Mesembryanthemum crystallinum* L.

○Sakae Agarie[1], Kento Kuroda[2], Kasumi Nishikawa[2], Nanako Isshiki[2], Yoko Ide[3], Kazuyuki Saito[1], John C. Cushman[4] （1.Faculty of Agriculture, Kyushu University, Japan, 2.Faculty of Agriculture, Kagawa University, Japan, 3.Faculty of Agriculture, Saga University, Japan, 4.Department of Biochemistry and

Molecular Biology, University of Nevada, Reno, United States）

Crassulacean acid metabolism (CAM) is a photosynthetic pathway that evolved from C_3 mode under the condition of limited water supply. The expressions of the genes related to the key metabolic process of CAM are regulated under circadian control. CAM species fixed CO_2 at night by phosphoenolpyruvate carboxylase (PEPC) and stored produced malic acid in the vacuole. PEPC is activated by phosphorylation mediated by PEPC kinase (PPCK). A facultative CAM plant, *Mesembryanthemum crystallinum*, shifts photosynthetic mode from C_3 to CAM under salinity and drought stresses. To elucidate the factors of transcriptional regulation in the transition of CO_2 fixation, we isolated the 5'-flanking regions of CAM-related genes for two isoforms of PEPC, PEPCK and NADP-ME, which were encoded by *Mcppc1*, *Mcppc2*, *McPpck*, and *Mod1*, respectively. The transient assay of the promoter regions of *McPpck* indicated that the region within 540 bp upstream from the start codon included cis-element controlling the expression of the gene. We analyzed the expression of 20 genes encoding transcriptional factors, which were homologs of drought-induced genes of *Talinum triangulare*. The expression of MYB96 increased at night, and MYB-core and AC-element that are binding sites of MYB 96 were found in the region, indicating that the transcriptional factor is associated with the induction of CAM in *Mesembryanthemum crystallinum*.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-25] Morphological Characterization of Calcium Oxalate Crystals and Effect of Growth-Medium Calcium Levels on Morphology of the Crystals in Tubers and Roots of Chinese Yam

○Michio Kawasaki[1,2], Ryotaro Shibata[2], Shinichiro Ito[2] （1.Faculty of Agriculture, Setsunan University, Japan, 2.Faculty of Agriculture and Life Science, Hirosaki University〔previous affiliation〕, Japan）

Calcium oxalate crystals are widely found in various plant species. The crystals have been proposed to have various functions including regulation of calcium levels in plant bodies. In Chinese yam, the tuber grows from the base of normal stem and many roots grow from the tuber. In this study, morphological characterization of calcium oxalate crystals and involvement of the crystals in calcium homeostasis in the roots and tubers of Chinese yam grown under different calcium levels of growth-medium were investigated. Under scanning electron microscopy and optical microscopy, crystals scattered in the cortex and stele of tubers. In this study, crystals were found in the cortex of root tips. Almost all of crystals were observed as bundle of needle-shaped crystals (raphide type). These crystals were identified as calcium oxalate crystals by energy dispersive X-ray spectroscopy (EDS). The number of crystal bundles, lengths of major and minor axes of crystal bundle, and area of crystal bundle in the tuber sections were higher in 20 mM and 40 mM calcium nitrate treatments than in 0 mM calcium nitrate treatments. In the sections of root tips, area of crystal bundle was higher in 20 mM calcium nitrate treatments than in 0 mM calcium nitrate treatments. Calcium mapping images by EDS showed a positive correlation between the area localized calcium per crystal cell and calcium level of treatments. Thus, it is suggested that the crystals possibly participate in the regulation of calcium levels in not only tubers but also in the tips of roots grown from the tubers.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-26] Root Type-Specific Transcriptome Diversity in Salinity Tolerant and Sensitive Rice Varieties

○Joyce Cartagena[1], Yao Yao[1], Shiro Mitsuya[1], Takashi Tsuge[2] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.Department of Biological Chemistry, Chubu University, Japan)

Salinity tolerance in rice is a very important trait especially in areas affected by soil salinity such as coastal regions in rice-producing countries. The roots are the key organs that detect and respond to salinity stress; thus, it is important to have an understanding of how root growth is regulated. Previous studies showed that the different types of rice roots respond differently to abiotic stress and the difference can be related to the difference in function. However, the molecular mechanism of this differential response is still uncovered. In this study, the gene expression profiles of nodal roots, S-type lateral roots, and L-type lateral roots from two contrasting rice genotypes were compared. Significant differences in transcriptome profiles among root types might indicate difference in function, especially during response to salinity stress. The details of the gene expression profiles and gene categories identified will be presented and discussed.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-27] Breeding for Submergence-Tolerant Rice by Marker Assisted Backcross

○Yu-Chien Tseng[1], Yu-Chia Hsu[1], Yu-Chin Chang[2], Yong-Pei Wu[2] (1.Agronomy Department, National Chiayi University, Taiwan, 2.Agronomy Department, Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan)

Rice (*Oryza sativa* L.) is an important food crop in the world. Due the climate change, to develop a rice variety which can tolerate the abiotic stress becomes a critical research topic. On this study, submergence-tolerant *indica* variety, IR96321-315-240 was used as donor parent. DT3 is the recurrent parent, which is drought tolerant and show good yield, eating quality and agronomic traits as elite Taiwanese variety, Taiken 9 (TK9). Marker-assisted selection (MAS) was applied in backcross breeding method. For foreground selection, there were two submergence-tolerant markers, Sub1A and SubAB1, utilized on BC_2F_1, BC_3F_1 and BC_3F_2 generations to select submergence-tolerant gene, *Sub1A*. Also, the flooding experiment in the field was applied in BC_3F_2 generation and the surviving plants then used for foreground and background selection.The results showed the similarity between surviving plants and recurrent parent was 92.87%. There are 100 plants evaluated for agronomic traits, yield and eating quality from BC_3F_3 generations. Eleven plants were selected and three of them had higher yield than DT3; three of them had better eating quality than DT3. By MAS, the submergence-tolerant trait has been successfully delivered to a drought tolerant, high yield and quality rice variety.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-28] Seed-Flooding Tolerance in Soybean is Related to Germination Ability under Water

*Nominated for Presentation Awards
○Shinjiro Ootsuka, Ryutaro Morita, Junko Yamagishi, Naohiro Aoki （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

In Japan, soybean (*Glycine max* [L.] Merr.) is mostly cultivated in the paddy conversion fields. However, such converted fields tend to be flooded, which is one of the major causes to reduce the soybean yield. In particular, flooding stress after sowing dramatically decreases the seed emergence rate. Thus, seed-flooding tolerance of soybean is an important agricultural trait. In this study, to clarify the physiological factors of seed-flooding tolerance, we investigated the relationship between seed emergence rate in the field, water absorption rate, and germination ability under water, using some soybean varieties with different seed-flooding tolerance. As a result, the seed emergence rates were not correlated with the water absorption rate of seed, while highly correlated with the germination ability under water. To examine the relationship between seed emergence rate and germination ability of soybean under water in more detail, the accumulation pattern of seed storage substances such as total soluble protein and lipid, soluble sugars and starch during germination were analyzed using the hypocotyl and cotyledon of seed-flooding tolerant and susceptible varieties grown under water. Although the accumulation patterns in cotyledon were not changed, while glucose and fructose contents of hypocotyl of seed-flooding tolerant variety were higher than that of susceptible variety. These results suggest that seed germination ability under water is an important factor for seed-flooding tolerance of soybean, and it could be associated with sugar metabolism in hypocotyl.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-30] Utilization of *SEMIDWARF1* for Vigorous Growth, Weed Competitiveness and Deep-Water Resistance in Rice Varieties for Organic Farming

*Nominated for Presentation Awards
○Marina Iwasa, Keisuke Katsura, Takashi Motobayashi, Taiichiro Ookawa （Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan）

The interest in environmental conservation agriculture with reduced chemical fertilizers and pesticides applications has increased under the SDGs. The Green Revolution rice varieties with *sd1* adapted to the application of heavy chemical fertilizers and pesticides were developed and widespread. They obtained the resistance to lodging by using mutation in *SD1* that induces the inhibition of GA synthesis. Weed management and the amount of initial growth pose huge challenges in organic farming, because of no synthetized fertilizers and pesticides application. Some cultivation methods have been considered to resolve such problems; eg. organic fertilizer application and conducting the deep-water management. The development of new varieties adapted to organic farming are required for the post-Green Revolution. However, it is still unknown what characteristics should be introduced or what's the useful gene for organic farming, and such research approach has not been undertaken. In this study, we analyzed three key characteristics for organic farming of rice: vigorous growth in initial stage, deep-water resistance and weed competitiveness. Although the effectiveness of *SD1* for weeds competition was not enough, varieties carrying *SD1* grew better than those carrying *sd1* with the deep-water management and green manure application as an organic fertilizer due to their rapid shoot elongation. Therefore, it could be one of the key genes under the organic fertilizer application and the deep-water

management to control weeds during the initial growth stage.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-31] Naked Waxy Barley Yield and Grain β-glucan Affected by Soil Heterogeneity in Different Arable Lands

○Atsushi Matsumura[1], Takuya Morishita[2], Syuusuke Nakai[2], Hiroyuki Masumoto[1], Masanori Yanase[1]
（1.Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan, 2.College of Life, Environment and Advanced Sciences, Osaka Prefecture University, Japan）

Due to the high dietary fiber content (β-glucan) of barely, its use in human nutrition is becoming more important in the world. Naked waxy barley contains relatively more β-glucan. Because adequate consumption of a high-fiber food is globally recommended for keeping healthy, waxy barley is one of the promising crops. In general, soils are heterogeneously distributed in cropping field. Barley, which is considered susceptible to waterlogging, often rotated with rice and exposed to waterlogging under heavy rain. Soil physico-chemical properties such as soil penetration resistance, soil water content, pH, available nutrients, which are the factors that affect the growth of waxy barley, supposed to be changed by soil heterogeneity. At present, the relationship between soil physico-chemical heterogeneity and yield of naked waxy barley are poorly understood. Here, we examined these relationships using multiple regression analysis. Two different managed fields, one with upland field converted from paddy and the other with conventional upland field, were used in this experiment. In each filed, spatial variability was observed in soil properties, and upland field from paddy showed higher variation in soil properties. For grain yield in upland field from paddy, pH, EC and water content had significant influence. The β-glucan content was negatively correlated with water content. In case of conventional upland field, grain yield and spike number were influenced by EC and soil water content. For β-glucan content, EC and mineral N had significant positive influence.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-32] Transitional Oxygen Point (TOP), a Physiological Indicator to Evaluate Waterlogging Tolerance in Crops

*Nominated for Presentation Awards

○Yutaro Oba[1], Akihiro Nose[1], Makoto Tokuda[2], Shao Hui Zheng[1] （1.Tropical Crop Science, Agriculture, Saga University, Japan, 2.Systems Ecology, Agriculture, Saga University, Japan）

Soil waterlogging causes poor growth and yield loss of various crops. Under waterlogging soil, plant root respiration is inhibited with hypoxia. The hypoxia is led with excess water inhibiting ventilation and with organic aerobic respirations. Although evaluation of waterlogging tolerance is important to improve crop yields, few efficient physiological indicators have been proposed for interspecific and varietal comparisons of the waterlogging tolerance. In this study, we attempted to establish a useful physiological indicator of the intensity of waterlogging tolerance in some poaceaeous crops. We measured the respiration rate and retainability in seminal and crown roots of rice, maize, wheat and teosinte. Based on a predicted O2 dependence relationship model and our data, we newly established a method calculating Transitional Oxygen Point (TOP). The TOP is defined as the inflection point between

the semi-linear and curvilinear phases in the model. The TOPs in seminal and crown roots were relatively low in rice, which possesses high waterlogging tolerance. In contrast, the TOPs were relatively high in crops with low waterlogging tolerance such as maize and wheat. We propose that the TOP is a useful indicator of waterlogging tolerance of crops, and the respiration rate/retainability at the TOP becomes a novel index for the evaluation of waterlogging tolerant intensity in crops.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-33] Comparative Transcriptome Analysis in Sorghum (*Sorghum bicolor* L.) Leaves during Vegetative Stage under Waterlogging Stress

○Ku Hyun Kwon[1], Sang-Heon Choi[1], Ju-Young Choi[1], Soo-Jeong Kwon[1], Hyen-Chung Chun[2], Dong-Gyu Lee[1], Seong-Hyun Yu[1], Tae-Woong Yun[1], Sun Hee Woo[1] (1.Department of Crop Science, Chungbuk National University, Korea, 2.National Institute of Crop Science, Rural Development Administration, Korea)

Waterlogging stress induces dramatical alterations to sorghum growth and development. However, little information on the waterlogging tolerance and associated mechanisms of sorghum is known. Presently, several morpho-physiological indexes and transcriptome profiling under waterlogging stress were investigated during the 3- and 5-leaf stages in sorghum. Growth characteristics of sorghum showed significant differences in the plant height, stem length, and SPAD values under waterlogging stress compared to untreated seedlings. The functional annotation revealed that the top GO enriched DEGs, based on biological process, were involved in transcription and secondary metabolite biosynthetic processes at 3-leaf stages while the flavonoid biosynthetic process, flavonoid glucuronidation, secondary metabolite was counted as the top GO enriched DEGs in 5-leaf. In KEGG pathway enrichment based on RNA-Seq data, the top GO enriched DEGs are involved in phenylpropanoid biosynthesis, plant hormone signal transduction, and glutathione metabolism in 3-leaf stage. However, in 5-leaf stage, the top GO enriched DEGs are involved in plant hormone signal transduction, photosynthesis, glutathione metabolism. Under waterlogging stress, the plant hormone signal transduction pathways tended to be down-regulated towards all hormone signaling pathways except SA at 3-leaf stage. The over-expression of GST enzyme-related pathways in both the 3-leaf and 5-leaf stage may provide a deeper understanding of the mechanism underlying the response to waterlogging and guidance for the breeding of sorghum.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-34] Death of Roots Retards the Growth Recovery of Common Buckwheat under Waterlogged Conditions

*Nominated for Presentation Awards

○Shun Murakami[1], Masaaki Hashimoto[2], Hiromitsu Aoki[2], Yasuhiro Hirata[2], Yoshiharu Wada[1,2], Takuya Koyama[1,2] (1.Graduate School of Regional Development and Creativity, Utsunomiya University, Japan, 2.School of Agriculture, Utsunomiya University, Japan)

In converted paddy fields, waterlogging severely decreases the growth and yield of common buckwheat (*Fagopyrum esculentum* L.). In this study, we examined the hypothesis that under waterlogged conditions

low soil redox potential (Eh) causes the death of root tips, which retards the shoot growth recovery of common buckwheat. We grew common buckwheat cv. kitawasesoba in root boxes. When seedlings had the 3rd leaf, the root boxes went through either 3 or 6-day waterlogging treatments (W3 or W6), whereas the other root boxes remained as drained controls (C). Death of roots was evaluated by changes of root surface area and a number of root tips turned red by triphenyltetrazolium chloride (TTC) staining. Only Eh of W6 decreased to 300 mV, in which almost all dissolved oxygen would disappear. After waterlogging treatments, both Eh of W3 and W6 recovered to the same value as C. The shoot dry weight(SDW) of W3 recovered remarkably after waterlogging treatment, but that of W6 did not recovered after waterlogging treatment. The root surface area of W3 and W6 showed similar changing trends to SDW. The number of red root tips of W3 was significantly smaller than that of C only at 3 days after the waterlogging treatment initiation (DATI), while that of W6 was significantly fewer than that of C from 3 to 13 DATI. From these results, we concluded that when Eh decreased to about 300 mV, the death of root tips severely inhibited the shoot growth recovery of common buckwheat.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-35] Effects of Root Aerenchyma Formation and Photosynthetic Activity of Leaves under Submergence on Post-Submergence Recovery in *Oryza sativa* and *O. glaberrima*

○Chiharu Sone, Yuta Echizenya, Daichi Tozawa, Kyoko Toyofuku, Atushi Ogawa (Faculty of Bioresource Sciences, Akita Prefectural University, Japan)

Rice plants cope with flash floods using either an "escape strategy" involving rapid shoot elongation or a "quiescence strategy" involving survival underwater with minimal activity. In previous studies, leaf elongation and growth in shoot biomass during complete submergence were greater in *O. glaberrima* than in *O. sativa*. To clarify the mechanism of rapid shoot elongation under submergence of *O. glaberrima*, we studied the effects of root aerenchyma formation and photosynthetic activity of leaves under submergence on post-submergence recovery. *O. glaberrima* cv. TOG6876, *O. sativa* cv. REXMONT and *O. sativa* cv. MILYANG23 were used. TOG6876 and REXMONT exhibit shoot elongation in response to submergence. MILYANG23 elongated slowly when submerged. Twenty-day old seedlings were submerged for 7 days. During submergence, the shoot elongation rates were higher in TOG6876 than in REXMONT and the lowest in MILYANG23. In submerged TOG6876 and MILYANG23, the increase of shoot biomass during post-submergence was significantly larger than in REXMONT. During submergence, the maximal quantum yield of photosystem II (*Fv/Fm*) of the upper developed leaf decreased earlier in REXMONT than in TOG6876 and MILYANG23. At 3 days after submergence, root aerenchyma formation was observed in TOG6876 and REXMONT but not in MILYANG23. The physiological mechanism responsible through the chlorophyll breakdown and photodamage in submerged leaves of *O. glaberrima* might be different from the shoot-elongation cultivar in *O. sativa*.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-36] Hypoxic Tolerance of Four Millets is Attributable to Constitutive Aerenchyma Formation and Root Hair

Development of Adventitious Root

○Asana Matsuura[1], Yasuyuki Kato[1], An Ping[2] (1.School of Agriculture, Tokai University, Japan, 2.Arid Land Research Center, Tottori University, Japan)

The purpose of this study is to elucidate the hypoxic tolerance mechanism of four millet species by focusing on the oxygen acquisition mechanism of adventitious roots. Four species of millets were hydroponically cultivated for 27 days in the control where aeration was continued and a hypoxic treatment where nitrogen gas was aerated to reduce the oxygen concentration. From the stress susceptibility index based on the individual plant growth rate, it was clarified that *E. tef* and *E. utilis* had stronger hypoxic tolerance than *B. ramosa* and *S. italica*. Since the net assimilation rate and mean leaf area of millets with susceptible to hypoxic stress were reduced by hypoxic treatment, both were the determinants of the interspecific difference in plant growth rate. Root growth, nitrogen content of leaf and stem, and sodium content per plant of higher hypoxic-tolerant millet species did not change with hypoxic treatment. Whereas in hypoxic-susceptible millet species, root growth, nitrogen content of leaf and stem decreased, and the sodium content of whole plant increased. The proportion of the stele area of the adventitious root of the hypoxic-tolerant millet species was smaller than that of the hypoxic-susceptible millet species, and the constitute aerenchyma was developed. Furthermore, root hair development was observed up to the vicinity of the root tip in hypoxic -tolerant millet species. From the above, the hypoxic tolerance of the millet species is that the constitutive aerenchyma of adventitious roots develops, the proportion of the stele is small, so oxygen consumption is low, and oxygen is efficiently supplied to the root tips. Development of root hair also contributed to nutrient absorption.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-37] Contrasting Rice Cultivars Responses to Increasing CO_2 Levels and Temperature

*Nominated for Presentation Awards

○Nene Furukawa[1], Murat Aycan[2], Nahar Lutfun[1], Toshihiro Nagamori[1], Eckart Priesack[3], Bertrand Gakière[4], José Luis Araus[5], Iker Aranjuelo[6], Marouane Baslam[2], Toshiaki Mitsui[1,2] (1.Dept. of Life and Food Sciences, Graduate School of Science and Technology, Niigata University, Japan, 2.Laboratory of Biochemistry, Faculty of Agriculture, Niigata University, Japan, 3.Institute of Biochemical Plant Pathology, Helmholtz Center-Munich, Germany, 4.Institute of Plant Sciences Paris-Saclay (IPS2), CNRS University Paris-Saclay, France, 5.Integrative Crop Ecophysiology Group, University of Barcelona, Spain, 6.Agrobiotechnology Institute, Spanish National Research Council, Spain)

The changing global climate is a major threat to rice production. We aim to identify rice crop cultivars management practices conferring high nutrient use efficiency to ensure sustainable agricultural and biomass production adapted to the predicted climate change scenarios. To characterize the crops with higher/lower yield and grain quality characteristics, we investigated the agronomical, physiological, and biochemical response patterns in 10 rice cultivars (selected based on their tolerance/susceptibility under a previous drought field experiment) grown under three conditions of control (CT), high-temperature (HT), and combination of high-temperature + elevated CO_2 (HT+ECO_2). The metric measurements and correlation analyses among the studied traits allowed to systematically break down the divergent behavioral phenotypes of rice genotypes under stressful environment. As a result, the seed-set and yield were reduced while chalkiness increased by high tissue temperature. ECO_2 increases some physiological

traits, spikelet, and seed number, while it decreased the grain traits, and can compensate to some extent the temperature, but the HT+ECO_2 undermines the grain characteristics and quality traits.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-38] Introgression of Dormant Gene *Sdr4-k* Improves Grain Quality of Sake Rice

*Nominated for Presentation Awards

○Shinya Kanazawa[1], Maiko Iwano[1], Marouane Baslam[2], Shigeru Hanamata[2], Murat Aycan[2], Isao Hanashiro[3], Kazuhiko Sugimoto[4], Toshiaki Mitsui[1,2] (1.Graduate School of Science and Technology, Niigata University, Japan, 2.Faculty of Agriculture, Niigata University, Japan, 3.Faculty of Agriculture, Kagoshima University, Japan, 4.Institute of Crop Science, National Agriculture and Food Research Organization, Japan)

Rice is one of the most important factors in determining the quality of sake. The grain kernel of sake rice cultivars is characterized by the possession of a white cloudy tissue at the center, termed 'white core'. The white core is a critical trait that affects, among others, water absorbability for sake production, yet the mechanism of controlling the tissue formation of the white-core remains not fully understood.
In this study, we focused on *Seed dormancy 4* (*Sdr4-k*) — derived from *indica* rice "kasalth"— as a potential regulator of seed dormancy as well as high temperature (HT)-induced grain chalkiness reduction at the ripening stage. Using a biotron speed-breeding system — with controlled light, temperature, tiller removal, and embryo rescue—, we precisely introgressed the *Sdr4-k* gene into the sake rice varieties "Koshitanrei" and "Gohyakumangoku", and we developed a BC_3 population, named "Koshitanrei *Sdr4-k*" and "Gohyakumangoku *Sdr4-k*" in six generations and 17 months.
Field assessment, gene expression, and brewing characteristics data indicated that plants carrying the *Sdr4-k* gene had similar brewing traits to the WT. Koshitanrei *Sdr4-k* subjected to HT had significantly higher grain quality and seed dormancy than the WT. Our data revealed that HT induced alteration of starch-related gene expression in Koshitanrei *Sdr4-k* and Gohyakumangoku *Sdr4-k* ripe seeds than WT.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-39] Effects of Jasmonic Acids on Rice Flower Opening Time and Fertility under High Temperature Conditions

○Kazuhiro Kobayasi[1], Ramin Taheri[2], Masato Tsurumi[3], Yuki Mizokane[3], Fumihiko Adachi[1], Kazuhiro Ujiie[1], Akio Tanaka[4], Taku Tanogashira[4], Hitoshi Ogiwara[5] (1.Institute of Agricultural and Life Sciences, Shimane University, Japan, 2.Graduate School of Natural Science and Technology, Shimane University, Japan, 3.Faculty of Life and Environmental Sciences, Shimane University, Japan, 4. Kagoshima Prefectural Institute for Agricultural Development, Japan, 5.National Agriculture and Food Research Organization, Japan)

Global warming is a serious problem that may increase heat-induced floret sterility (HIFS) in rice, thereby reducing its yield. Flower opening in the early morning helps avoid HIFS. In this study, the effects of two kinds of jasmonic acids (methyl jasmonate [MeJA] and prohydrojasmon [PDJ]) on flower

opening time (FOT) and fertility were examined. The rice panicles (cultivar 'Hinohikari') grown in a greenhouse for heat treatment in Kagoshima Prefecture were subjected to 4 or 0.4 mM MeJA and PDJ at 0900 during the heading stage. By taking photographs of the panicles at 10-min intervals, FOT was determined. The percentage of anther dehiscence at the basal part, number of pollinated pollen grains, and fertility percentage on the treatment day were also examined. The maximum air temperature in the greenhouse was over 36℃, high enough to induce HIFS. The application of 4 mM MeJA advanced FOT by more than 3 hours, whereas the application of 0.4 mM MeJA and 4 and 0.4 mM PDJ did not. Both kinds of jasmonic acids did not affect fertility percentage, number of pollinated pollen grains, and percentage of anther dehiscence, however. In conclusion, MeJA advanced FOT under high temperature, whereas PDJ did not. Moreover, MeJA did not reduce sterility through advancing FOT. Although jasmonic acids are thought to be related to fertility and pollen maturation, the effects of MeJA in avoiding HIFS through an artificial advancement of FOT were offset by some harmful effects of premature flowering on pollen physiological processes that induced mature pollen grain reduction.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-40] The Effect of N-application on cpHSP70-2 Accumulation to Improve Rice (*Oryza sativa* L.) Grain Chalkiness

○Olusegun Idowu, Tomoyuki Katsube-Tanaka （Graduate School of Agriculture, Kyoto University, Japan）

High temperature (HT) increases chalky rice grains which lower grain quality, market value, and substantial yield. Although nitrogen (N) application is a promising technique to enhance transpiration, carbohydrate supply, and then reduce chalkiness but it lowers eating and cooking quality as well. Thus, the underlying molecular mechanism of chalkiness along with N nutrition should be clarified. Recently we isolated conditional chalky grain mutant *flo11-2*, its causative gene encodes amyloplast molecular chaperone (cpHSP70-2) and found a negative correlation between its expression and chalkiness. In this study, we examined the effect of N-application on chalkiness and cpHSP70-2 accumulation using near-isogenic lines with an erect panicle (EP) trait showing low available carbohydrate per spikelet, and a non-EP (NEP) trait. Experiments were conducted in Kyoto, 2020 using 7 cultivars; Aki(EP, NEP), LG5(EP, NEP), *flo11-2*, Nipponbare, and Kinmaze under pot and field conditions with low and high (ambient) temperatures (LT, HT) and/or different N levels, namely low and high N (LN, HN) for pots and 0, 6, 20 gN m^{-2} (0N, 6N, 20N) for fields. The results showed *flo11-2* had the highest chalky ratio under HT, while early heading cultivars [Aki(EP), Aki(NEP)] had the lowest due to escaping from a HT season. LN-HT and 0N treatments produced the highest chalky ratio. Chalky ratio was positively correlated with averaged daily maximum temperature during 20 days after flowering. N-application reduced chalky ratio and tended to increase cpHSP70-2 accumulation irrespective of genotypic differences.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-41] Genetic Analysis of Drought Response Index in a *Temperate Japonica* Rice Mapping Population

*Nominated for Presentation Awards

○Poornima Ramalingam[1,2], Ha-An Thi Nguyen[1], Kamoshita Akihiko[1] （1.Department of Plant Biotechnology, Tamil Nadu Agricultural University, India, 2.Asian Research Center for Bio-Resources and

Environmental Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 3.Asian Research Center for Bio-Resources and Environmental Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

Drought response index (DRI), a unique indicator of drought tolerance, was evaluated in a *temperate japonica* mapping population (97 recombinant inbred lines (RILs) from Otomemochi (OTM) and Yumenohatamochi (YHM)) in 2011 and 2012 under temperate monsoon climate conditions with the different extent of drought intensity during reproductive stage to flowering (i.e., July to August). Relationships between grain dry weight under drought with either 50% flowering date or grain dry weight under control (i.e., as regarded as potential yield) were not strong. DRI in the prolonged intense drought in 2011 (ranging from -6.4 to 15.9) was positively correlated with grain dry weight deriving from panicles that emerged after rewatering. Three genomic regions were identified as QTLs for DRI with phenotypic variation explained ranging from 10.3 % to 26.3% (1) RM3703-RM6911 on chromosome 2 detected in the severer drought year 2011, also in the combined analysis of the 2 years, with its positive allelic contribution from YHM, was co-located with QTLs for drought recovery ability after rewatering and for harvest index. (2) RM3703-RM6379 on chromosome 2 detected in the combined analysis was located relatively close to the first region but with its allelic contribution coming from OTM. (3) RM8102-RM7023 on chromosome 6 detected only in 2012 was co-located with grain dry weight under drought as well as root dry weight under control, with their allelic contribution all from OTM. Relative contribution of QTL x E was larger than main effect QTLs indicating the importance of defining the target environment for drought tolerance.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-42] Contribution of the Chromosome 11 of a Salinity-Tolerant Rice Variety Nona Bokra to High Dry Matter Production under Salinity and Its QTL Mapping

○Yumika Yamamoto[1], Masaki Uchida[1], Mana Kano-Nakata[2], Akira Yamauchi[1], Shiro Mitsuya[1] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.International Center for Research and Education in Agriculture, Nagoya University, Japan）

Rice is a popular crop in the world especially Asia . In Asia, salinity is a serious problem especially in the coastal areas. Rice is one of salinity-sensitive crops, and salinity causes rice yield reduction. Therefore, it is important to produce a high-yielding rice variety under salinity. Mitsuya et al. (2019) have succeeded in screening a salt-tolerant Koshihikari/Nonabokura Chromosome Segment Substitution Lines (CSSLs) that shows high yield and growth in a salinized paddy field. The genetic background of the CSSLs is mostly Koshihikari (salinity-sensitive) whereas some parts are substituted by the salinity-tolerant Nona Bokra chromosome. Within 44 lines, CSSL538 showed a higher yield than Koshihikari in the consecutive 2-year experiments. CSSL538 has a segment of Nona Bokra chromosome 11. We determined the physiological mechanism of salt tolerance of CSSL538. We found that CSSL538 maintained dry matter production and leaf areas under salinity at not only the early ripening stage but vegetative stage in comparison to Koshihikari. However, the salt concentration in shoots not always explained the growth difference between two genotypes. Also, we hypothesized that there are QTLs for high dry matter production under salinity in the segment of Nona Bokra chromosome 11. We will show the identified QTLs for high dry matter production under salinity in the CSSL538, in the conference.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-43] Genotypic Variation in Root Morpho-Anatomical Traits of Rice Cultivars with High and Low Adaptability under Multi-Stress Environment

○Maria Corazon Julaton Cabral[1,2], Via Ann Candelaria Marcelo[3], Roel Rodriguez Suralta[3], Jonathan Manito Niones[3], Antoinette Soriano Cruz[3], Hiroshi Ehara[1,2], Yoshiaki Inukai[1,2], Akira Yamauchi[1], Mana Kano-Nakata[1,2] (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)

Drought and salinity are the most common coexistent abiotic stress factors impacting rice yield and productivity. Roots has an important role for the plant's adaptation to abiotic stresses. Plant breeding programs must include developing new cultivars with multiple stress tolerance and improved root traits. Hydroponic experiments were conducted in 20 OryzaSNP cultivars in control (non-stress), drought, saline, combined saline + drought stress and vice versa to determine the changes in root morpho-anatomical characteristics of cultivars with high and low adaptability and stability to abiotic stresses. Shoot biomass was significantly decreased in all cultivars followed by saline, saline + drought, drought and drought + saline. The root morpho-anatomical features were significantly influenced by genotype, treatments and their interactions. The root size in terms of anatomical traits were increased in all treatments compared to the non-stress condition. The variation in root diameter was due to the change in size and width of cortex and stele diameter. The correlation between agronomic and root morphological traits indicate strong and positive correlation however, mostly no correlation with root anatomical traits. AMMI (Additive Main Effects and Multiplicative Interaction) and BLUP (Best Linear Unbiased Prediction) model identified Dom-sufid and FR13A as cultivars with high stability, adaptability and productivity under multi-stress environments. An in-depth analysis encompassing histochemical analysis is on-going.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-44] Heavy Flooding Effects on Productivity of Paddy Rice Cultivar 'Nanatsuboshi'

○Hideki Okamoto[1], Junji Fujikura[2], Katsuhiro Furukawa[2] (1.Tenpoku Sub-centre, Dairy Research Centre, Hokkaido Research Organization, Japan, 2.Kamikawa Agricultural Experiment Station, Hokkaido Research Organization, Japan)

Pot experiments were conducted for three years to elucidate effects of heavy flooding on paddy rice productivity and quality. Every year, three mature seedlings were transplanted onto paddy soil under water of 0.05 m depth in Wagner's pots in late May. Mature rice was harvested in mid-September. Treatments were set as 3 depth levels, 5 growth stages, and 3 flooding durations. We defined 'reducing' as a relative value of gross brown rice weight to control of less than 0.7.
As the averages assessed over three years, 5 days of treatment in booting stage with upper leaf

submergence show a reducing plot. Moreover, under complete submergence, 5 days of treatment in panicle formation stage and more than 3 days of treatment in the booting and heading stage showed as reducing plots. Results show that gross brown rice yield reductions by heavy flooding occurred from panicle formation to the heading stage, and especially during the booting and heading stage.
Yield components of brown rice were affected by submergence treatment from the panicle formation stage to heading. Correlation coefficients between the gross brown rice weight and each yield component show that the number of ears had high positive correlation in the tillering and panicle formation stage, and that grain numbers per ear had high positive correlations in the booting and heading stage. Therefore, rice productivity reduction because of heavy flooding can explain that of ear-numbers until panicle formation stage, and the reduction of grain numbers per ear from booting stage.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-45] Root Anatomical Traits Related to Root Oxygen Consumption and Transportation between Upland Rice and Lowland Rice Varieties

*Nominated for Presentation Awards

○Shotaro Tamaru[1], Keita Goto[1], Phanthasin Khanthavong[1], Shin Yabuta[2], Jun-Ichi Sakagami[1,2] (1.The United Graduate School of Agricultural Sciences, Kagoshima University, Japan, 2.Faculty of Agriculture, Kagoshima University, Japan)

Root oxygen transportation is important traits to maintain the oxygen consumption to roots under hypoxia. Many studies focused on the aerenchyma formation, in these days anatomical study of root tissue such as narrower stele and larger cortex is revealed to benefit for waterlogging adaptation (Sundgern et al. 2018, Yamauchi et al. 2019). We aimed to investigate the difference of adaptive strategy for waterlogging in upland and lowland rice on physiological and anatomical aspects. We evaluated the anatomical traits in seminal root to seedlings of 6 rice varieties , then we evaluated the physiological and anatomical traits among 4 varieties include Sensho showing lowest CSR (Cortex to stele ratio) in seminal root. Our analysis observed narrower stele and higher CSR in IR42 and Koshihikari. It was considered to benefit adaptation to continuous hypoxia condition such as paddy field because of lower root oxygen consumption per plant. On the other hand, Sensho showed the lowest CSR and porosity, larger stele compered to lowland varieties, but this variety had highest oxygen transportation ability. It may relate the shoot activity because Sensho had highest estimated stomatal contribution to roots. As a result of comparing lowland and upland rice variety, oxygen consumption per plant and stele area were significant higher in upland rice variety than in lowland rice variety. It was considered that this higher oxygen demand was compensated by high CSR and porosity in Black Gora, and by high oxygen transportation in Sensho.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-46] Roles of Root Plasticity to Growth and Yield of Quinoa under Different Soil Water Regimes

*Nominated for Presentation Awards

○Dinh Thi Ngoc Nguyen[1], Cuong Van Pham[1], Thiem Thi Tran[1], Akira Yamauchi[2] （1.Faculty of Agronomy, Vietnam National University of Agriculture, Vietnam, 2.Faculty of Agronomy, Vietnam National University of Agriculture, Vietnam, 3.Faculty of Agronomy, Vietnam National University of Agriculture, Vietnam, 4.Graduate School of Bioagricultural Sciences, Nagoya University, Japan）

Recent studies indicated new perspectives on the morphology and architecture of the quinoa root system, its intraspecific diversity and plasticity in response to drought. This study therefore aimed to evaluate wherether promoted development of root system due to the plasticity triggered by drought stress would contribute to increased growth, and yield of quinoa. The experiment was designed with Split-plot method with 3 replications. The main plots were Green (G1) and Red (G2) genotypes and sub-plots were three soil moisture treatments: 30% soil moisture content (SMC (w/w)) (Well-watered, W1) as control, 20% SMC (mild drought, W2), and 15% SMC (severe drought, W3). The results showed that the growth of genotypes was significantly affected by the different soil water regimes. The root traits such as total root length, total nodal root length, total lateral root length, and nodal root numbers under drought treatments (W2 and W3) were significantly higher as compared with those under control. Furthermore, the root plasticity was expressed in both G1, G2 genotypes, which resulted in significantly increased water use, shoot dry matter, and consequently increased yield and yield components. In addition, the positive and significant relationships were observed among measured traits (total root length and water uptake, water uptake and shoot dry weight, and shoot dry weight and yield) of two genotypes under different water regimes. These results prove that in both genotypes, root plasticity was triggered by drought, which enhanced root systems development contributing to increased water uptake, shoot dry weight and yield.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 3 (Poster))

[P3-47] Integrated Transcriptome and Proteome Analysis Reveals Complex Regulatory Mechanism of Maize (*Zea mays* L.) in Response to Zinc Deficiency Stress

Jinyao Zhang[1,3], Shuhui Song[1], Yinghong Pan[2], Fangsen Xu[3], ○Hong Wang[1] （1.Institute of Agriculture Resources and Regional Planning, Chinese Academy of Agricultural Sciences, China, 2.The National Key Facility for Crop Gene Resources and Genetic Improvement, Institute of Crop Science, Chinese Academy of Agricultural Sciences, China, 3.College of Resources and Environment, Huazhong Agriculture University, China）

Zinc (Zn) is one of the essential micronutrients for plant growth and development. To investigate the molecular mechanism of maize response to Zn-deficiency stress, maize variety ZD958 was used to perform transcriptome and proteome integrated analysis. Through transcriptome analysis in maize roots under Zn-deficiency stress for 10 days (10DAT) and 15 days (15DAT), we identified 271 and 519 differentially expressed genes (DEGs) at 10 and 15 DAT, while 2048 and 2380 DEGs were identified in leaves at 10 and 15 DAT, respectively. A total of 1258 and 1099 differentially abundant proteins (DAPs) were found from roots and leaves at 10 DAT in proteome data, while 627 and 1553 DAPs at 15 DAT, respectively. DEGs or DEPs involved in ROS, carbohydrate metabolic process, signal transduction, phenylpropanoid biosynthesis and nitrogen metabolism were enriched in roots, while photosynthesis including chlorophyll synthesis, metabolic process of carbohydrate, reactive oxygen species (ROS),

cellular amino acid and gene expression were changed among the identified DEGs or DEPs in maize leaves. Detail analysis of the DEGs or DEPs revealed that complex metabolism, such as photosynthesis, mitogen-activated protein kinase (MAPK) signaling cascade, activation of antioxidant and nitrogen metabolism, were participated in regulating Zn deficiency response in maize. Information provided in this omics research advanced our understanding of the molecular response mechanisms to Zn-deficiency, and further research is needed to cognize the new response genes.

[P4] Crop Genetics and Physiology

Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster) (Crop Genetics and Physiology)

[P4-01] Genetic Variation of Rice Germplasm Including *Oryza sativa* and *O. glaberrima* in Guinea

○Yoshimichi Fukuta[1], Seiji Ynagaihara[2], Nhai Nguyen[3], Oanh Nguyen[3], Narry Mamadou[4], Diawara Souleymane[4], Bah Oumar[4] (1.TARF, Japan International Research Center for Agricultural Sciences, Japan, 2.GRPH, Japan International Research Center for Agricultural Sciences, Japan, 3.AGI, Vietnam, 4.IRAG, Guinea)

12:15 PM - 1:00 PM

[P4-02] Genetic Diversities of Traits Associated with Culm Strength Using a *Temperate Japonica* Rice Varieties

○Koki Chigira[1], Natsuko Kojima[1], Masanori Yamasaki[2], Shunsuke Adachi[3], Taiichiro Ookawa[1] (1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Food Resources Education and Research Center, Graduate School of Agricultural Science, Kobe University, Japan, 3.College of Agriculture, Ibaraki University, Japan)

1:15 PM - 2:00 PM

[P4-03] Histone Acetyltransferase GCN5 Regulates the Expression of *OsRBCS3* and *OsRBCS5*, Rubisco Small Subunit Genes, in Response to Nitrogen Supply in Rice (*Oryza sativa* L.)

○Shicheng Feng[1], Fumiya Miyamoto[2], Sakae Agarie[3], Kazuyuki Saitou[4] (1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, China, 2.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 3.Faculty of Agriculture (Graduate School), Kyushu University, Japan, 4.Faculty of Agriculture (Graduate School), Kyushu University, Japan)

12:15 PM - 1:00 PM

[P4-04] Visualizing Aleurone Layers in Mature Rice Grains by a Modified Half-Cut Method

○Thi Mai Phuong Nguyen[1], Tomomi Abiko[2], Ohn Mar Khin[3], Toshihiro Mochizuki[2] (1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Faculty of Agriculture, Kyushu University, Japan, 3.Department of Agricultural Research, Ministry of Agriculture, Livestock and Irrigation, Myanmar)

1:15 PM - 2:00 PM

[P4-05] Regulation of the Expression of *OsRBCS3*, a Rubisco Small Subunit Gene, by Histone Deacetylase *HDA713* under Nitrogen Deficiency in Rice

○Fumiya Miyamoto[1], Shicheng Feng[2], Sakae Agarie[3], Kazuyuki Saitou[4] (1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 3.Faculty of Agriculture(Graduate School), Kyushu University, Japan, 4.Faculty of Agriculture(Graduate school), Kyushu University, Japan)

12:15 PM - 1:00 PM

[P4-06] Estimation of Canopy Transpiration Rate in Rice after Heading Stage by Extracting Leaf Temperature in Thermal Images

○Rintaro Kondo, Yu Tanaka, Tatsuhiko Shiraiwa (Graduare School of Agriculture, Kyoto

University, Japan）
1:15 PM - 2:00 PM

[P4-07] Engineering CAM Traits into C3 crops

○Aoi Saito[1], Mie Wakabayashi[2], Shiori Terai[2], Shiori Yamabe[2], Satoko Kobayashi[2], Kazuyuki Saito[3], John C. Cushman[4], Sakae Agarie[3] （1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Faculty of Agriculture, Kagawa University, Japan, 3.Faculty of Agriculture, Kyushu University, Japan, 4.Department of Biochemistry and Molecular Biology, University of Nevada, United States）
12:15 PM - 1:00 PM

[P4-08] Assessment of Geographical Distribution and Genetic Diversity of Five Sorghum Taxa Collected in Taiwan

○Wei-hsun Hsieh[1], Yi-tzu Kuo[1], Han-hsuan Chin[1], Hsien-chun Liao[2], Chih-hui Chen[2], Yann-rong Lin[1] （1.Agronomy, National Taiwan University, Taiwan, 2.Experimental Stations Research, Endemic Species Research Institute, Taiwan）
1:15 PM - 2:00 PM

[P4-09] Resistant Loci to Physiological Disorder Cupping in Chinese Cabbage (*Brassica rapa* var.*Pekinensis*)

○Haruto Takamori[1], Osamu Kawaide[3], Tokuko Sakaguchi[1], Minami Nakazawa[1], Natsuki Ito[1], Ayuka Furukubo[2], Minami Amaike[2], Takashi Ito[5], Fumio Azuhata[3], Mashiro Okada[2], Seiji Chino[5], Hideo Matsumura[4], Satoshi Niikura[3], Nobuaki Hayashida[2] （1., Shinshu University, Japan, 2.Division of Applied Biology, Faculty of Textile, Shinshu University, Japan, 3.TOHOKU SEED CO., LTD., Japan, 4.Gene Research Center, Shinshu University, Japan, 5.Engineering Department, Faculty of Textile, Shinshu University, Japan）
12:15 PM - 1:00 PM

[P4-10] Genetic Diversity of Foxtail Millet (*Setaria italica*) Landraces of Taiwan

Yen-chiun Chen[1], Yong-pei Wu[2], Yee-ching Chong[1], ○Yann-rong Lin[1] （1.Department of Agronomy, National Taiwan University, Taiwan, 2.Department of Agronomy, Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan）
1:15 PM - 2:00 PM

[P4-11] Branched-Chain Amino Acid Aminotransferases (BCATs) Play Important Roles for the Induction of Autophagy in Leaf Senescence of Soybean

○Tung Tuan Do[1,3], Takaaki Ishibashi[2], Takashi Yuasa[2] （1.Interdisciplinary Graduate School of Agriculture and Engineering, University of Miyazaki, Japan, 2.Faculty of Agriculture, University of Miyazaki, Japan, 3.Faculty of Agronomy, Thai Nguyen University of Agriculture and Forestry, Vietnam）
12:15 PM - 1:00 PM

[P4-12] DGAT1s from Different Plant Species Show Different Triacylglycerol Biosynthesis Activities

○Tomoko Hatanaka[1], Wakana Miyashita[1], Kouki Shibutani[2], Daisuke Matsuoka[1], 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）
1:15 PM - 2:00 PM

[P4-13] Genome Wide Association Study for Leaf Photosynthetic Properties in 166 *Temperate Japonica* Rice Cultivars

○Yoshiaki Seki[1], Kentaro Hayami[1], Tomohiro Nomura[1], Yu Tanaka[2], Taiichiro Ookawa[1], Makoto Matsuoka[3], Shunsuke Adachi[1] （1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Graduate School of Agriculture, Kyoto University, Japan, 3.Bioscience and Biotechnology Center, Nagoya University, Japan）

12:15 PM - 1:00 PM

[P4-14] Assessment of Genetic Diversity and Relatedness in Citrus Fruits Using RAPD Markers

○Nihar Ranjan Saha, Jarina Binte Jalil, Muhammad Shahidul Haque （Department of Biotechnology, Bangladesh Agricultural University, Bangladesh）

1:15 PM - 2:00 PM

[P4-15] Pyramiding of Disease Resistance Genes into Popular Rice Varieties of Bangladesh

○Tapas Kumer Hore, Corinne Mira Marfori-Nazarea, Mary Ann Inabangan-Asilo, Ratna Wulandari, BP Mallikarjuna Swamy （RGDV Platfrom, International Rice Research Institute, Philippines）

12:15 PM - 1:00 PM

[P4-16] Genetic Analysis of Agronomic and Biofortification Traits in Multiple Rice Populations

○Tapas Kumer Hore, Mary Ann Inabangan Asilo, Gaurav Joshi, Amery Amparodo, BP Mallikarjuna Swamy （RGDV Platfrom, International Rice Research Institute, Philippines）

1:15 PM - 2:00 PM

[P4-17] Meta-QTLs and Candidate Genes Associated with Grain Zinc Content in Rice

○Gaurav Joshi[1,2], B. P. Mallikarjuna Swamy[1], Indra Deo Pandey[2], Yan Paing Soe[3], Jose E. Hernandez[4], Chau Thanh Nha[5], Alvin Palanog[6], Mark Ian Calayugan[4], Mary Ann Inabangan Asilo[1], Amery Amparado[1], Tapas Kumer Hore[1] （1.Rice Breeding Innovations, International Rice Research Institute, Philippines, 2.Genetics and Plant Breeding, Govind Ballabh Pant University of Technology and Agriculture, India, 3.Seed Division, Department of Agriculture, Myanmar, 4.Institute of Crop Science, University of the Philippines Los Baños, Philippines, 5.Genetics and Plant Breeding Department, Cửu Long Delta Rice Research Institute, Vietnam, 6.Research and Development, Philippine Rice Research Institute, Philippines）

12:15 PM - 1:00 PM

[P4-18] Global Analysis of a Rice Panel to Identify QTLs and Genotypes Useful for Rice Breeding

○Gaurav Joshi[1,2], B. P. Mallikarjuna Swamy[1], Mona Liza Jubay[1], Indra Deo Pandey[2], Maria Camila Rebolledo[10, 11], Dmytro Chebotarov[1], Kenneth McNally[1], Rakesh Kumar Singh[9], Hei Leung[1], Sunil Kumar Verma[4], Satish B. Verulkar[4], Shuhha Banerjee[4], Hsu Myat Noe Hnin[3], Rollin de Ocampo[1], Federico Molina[5], Bertrand Muller[11], Justine Bonifacio[1], Eliel Petro Paez[10], Adin Blokounon[7], Kazuki Saito[7], Khady Nani Dramé[8], Stephen Klassen[1], Narne Chamundeswari[6], P. V. Satyanarayana[6] （1.Rice Breeding Innovations, International Rice Research Institute, Philippines, 2.Department of Genetics and Plant Breeding, Govind Ballabh Pant University of Technology and Agriculture, Pantnagar, India, 3.Institute of Crop Science, University of the Philippines Los Baños, Philippines, 4.Department of Plant Molecular Biology and Biotechnology, Indira Gandhi Agricultural University, Raipur (Chhattisgarh), India, 5.Rice Breeding, National Institute of Agricultural Research of Uruguay, Uruguay, 6.Plant Breeding, Regional

Agricultural Research Station, Maruteru, India, 7.Sustainable Productivity Enhancement Program, Africa Rice Center, Côte d'Ivoire, 8.Capacity Development, Africa Rice Center, Côte d'Ivoire, 9.Crop Diversification and Genetics, International Center for Biosaline Agriculture, United Arab Emirates, 10.Rice Program, International Center for Tropical Agriculture (CIAT), Colombia, 11.Centre de Coopération Internationale en Recherche Agronomique Pour le Dé veloppement (CIRAD), France）

1:15 PM - 2:00 PM

[P4-19] A Metabolite Profiling to Explore the Physiological Function of *Short Panicle 1* during Panicle Formation of Rice

Yifan Lin[1], Ryutaro Morita[1], Masaki Okamura[2], Junko Yamagishi[1], ○Naohiro Aoki[1] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Central Region Agricultural Research Center, National Agriculture and Food Research Organization, Japan）

12:15 PM - 1:00 PM

[P4-20] Assessment of *Indica* Rice Cultivars for the Use of Whole Crop Silage

Yoshikage Goto, Junko Yamagishi, ○Naohiro Aoki （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

1:15 PM - 2:00 PM

[P4-21] Morphological Characteristics Related to the Accumulation of Non-Structural Carbohydrates in Stems of Rice at Heading Stage

○Yu Wakabayashi, Ryutaro Morita, Junko Yamagishi, Naohiro Aoki （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

12:15 PM - 1:00 PM

[P4-22] Comparative Analysis of Sugar Metabolism in Rice Leaves under Field and Controlled Environments

○Yoichi Hashida[1], Ayumi Tezuka[2], Mari Kamitani[3], Makoto Kashima[4], Yuko Kurita[3], Atsushi J. Nagano[3,5] （1.Faculty of Agriculture, Takasaki University of Health and Welfare, Japan, 2.Research Institute for Food and Agriculture, Ryukoku University, Japan, 3.Faculty of Agriculture, Ryukoku University, Japan, 4.College of Science and Engineering, Aoyama Gakuin University, Japan, 5.Institute for Advanced Biosciences, Keio University, Japan）

1:15 PM - 2:00 PM

[P4-23] A Metabolite Profiling to Seek the Molecular Determinant of Spikelet Number in Rice

○Ryutaro Morita[1], Masaki Okamura[2], Shiori Yabe[3], Hiroe Yoshida[4], Satoru Sukegawa[4], Hiroshi Nakagawa[4], Naohiro Aoki[1] （1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Central Region Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 3.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 4.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan）

12:15 PM - 1:00 PM

[P4-24] Contribution of Several Source Organs to Dry Matter Accumulation into Panicles after Heading of Hulless Barley Sown at Different Terms

○Takuya Araki[1], Yasuhiro Kondo[2], Takato Yano[2], Ryo Kodani[2], Yukina Sakamoto[2] （1.Graduate School of Agriculture, Ehime University, Japan, 2.Faculty of Agriculture, Ehime University, Japan）

1:15 PM - 2:00 PM

[P4-25] Analysis on the Roles of Vacuolar Invertase Isoform, *OsINV3* in Root Development of Rice

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

12:15 PM - 1:00 PM

[P4-26] The Purification of Recombinant TGW6, which Limits Grain Size in Rice

○Tatsuki Akabane[1], Nobuhiro Suzuki[2], Wataru Tsuchiya[2], Etsuko Katoh[2], Naoki Hirotsu[1]
（1.Graduate School of Life Sciences, Toyo University, Japan, 2.Structural Biology Team, Advanced Analysis Center, National Agriculture and Food Research Organization, Japan）

1:15 PM - 2:00 PM

[P4-27] Analysis of Genotype and Environment Interaction, and the Response of Grain Yield of Lowland Rice (*Oryza sativa* L.) to Nitrogen Application Under Different Environment in the Philippines

○Kim Nyka Caraan Perdiguerra[1,2], Pompe Campoy Sta. Cruz[1], Shiro Mitsuya[2], Akira Yamauchi[2]
（1.Institute of Crop Science, College of Agriculture and Food Science, University of the Philippines Los Baños, Philippines, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan）

12:15 PM - 1:00 PM

[P4-28] Morphological Characteristics of Mealy and Translucent Endosperm Cells of Hulless Barley (*Hordeum vulgare* var. *nudum*) During the Ripening Stage

○Yuto Hatakeyama[1, 2], Ryo Kotani[3], Yukina Sakamoto[3], Kosuke Haraguchi[3], Nana Matsui[3], Takuya Araki[1] （1.Faculty of Agriculture, Ehime University, Japan, 2.Japan Society for the Promotion of Science Research Fellow, Japan, 3.Graduate School of Agriculture, Ehime University, Japan）

1:15 PM - 2:00 PM

[P4-29] Effect of Silicon Application on Grains of *Sorghum bicolor* under Drought Conditions

○Ryoichi Araki[1], Yuka Takano[1], Hidetoshi Miyazaki[2], Hiroyuki Ii[3], Ping An[4], Teru Tanaka[5]
（1.Faculty of Education, Wakayama University, Japan, 2.Research unit, The Global Environmental Forum, Japan, 3.Faculty of Systems Engineering, Wakayama University, Japan, 4.Arid Land Research Center, Tottori University, Japan, 5.Faculty of Agriculture, Setsunan University, Japan）

12:15 PM - 1:00 PM

[P4-30] Relationship between Non-Destructive Measurement Parameters and Yield in Sweet Potatoes

○Masayuki Kadowaki[1], Tomohiro Araki[2], Risa Umehara[2], Sokichi Shiro[1], Shingo Matsumoto[1]
（1.Institute of Agricultural and Life Sciences Academic Assembly, Shimane University, Japan, 2.Faculty of Life and Environmental Science, Shimane University, Japan）

1:15 PM - 2:00 PM

[P4-31] Heat Stress Impact on Heading and Ripening in Major Korean Rice Variety

○Woonha Hwang, Chungkeun Lee, Jaehyeok Jung, Hyeonseock Lee, Seoyeong Yang, Yeonhwa Lim, Myeonggu Choi （Crop Production and Physiology Division, National Institute of Crop

Science, Korea）
12:15 PM - 1:00 PM

[P4-32] Genetic Variations of Rhizome Yield, Essential Oil Content and Constituents in *Curcuma* Species and Strains

○Akira Miyazaki[1], Yukari Shiino[1], Hiroshi Hayakawa[2], Yoshito Ohtani[1], Yoshinori Yamamoto[1]
（1.Faculty of Agriculture and Marine Science, Kochi University, Japan, 2.Museum of Natural and Environmental History, Shizuoka, Japan）
1:15 PM - 2:00 PM

[P4-33] Relationship between Pre-Harvest Sprouting Variation and Physicochemical Properties in Varieties of Rice Flour

○Chae Min Han, Jong Hee Shin, Jung Bae Kwon, Jong Gun Won （Division of Crops Research, Gyeongsangbuk-do Provincial Agricultural Research & Extension Services, Korea）
12:15 PM - 1:00 PM

[P4-34] Physicochemical Properties of Rice Varieties Adapted to a Mountainous Region in Mid-South Korea

○Chae Min Han, Jong Hee Shin, Jung Bae Kwon, Jong Gun Won （Division of Crop Research, Yeongsangbuk-do Provincial Agricultural Research & Extension Services, Korea）
1:15 PM - 2:00 PM

[P4-35] Marker-Assisted Selection to Develop the High Nutrition Rice, Giant-Golden-Purple Rice, PFR32, and Giant-Golden-Red Rice, RFR13

○Yu-Chia Hsu[1], Yu-Chien Tseng[1], Yu-Chi Cheng[2], Bing-Nan Lin[1], Yong-Pei Wu[2] （1.Department of Agronomy, National Chiayi University, Taiwan, 2.Department of Agronomy, Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan）
12:15 PM - 1:00 PM

[P4-36] Genetic and Morphological Mechanisms for Soil-Surface Roots Originated from a New Plant Type Cultivar in Rice (*Oryza sativa* L.)

○Asami Tomita[1,2], Hiroki Saito[2], Yoshimichi Fukuta[2] （1.Graduate School of Environmental and Life Science, Okayama University, Japan, 2.Tropical Agriculture Research Front, Japan International Research Center for Agricultural Sciences, Japan）
1:15 PM - 2:00 PM

[P4-37] Development and Genetic Analysis of Compensatory Growth of Lateral Roots in Rice

○Tsubasa Kawai[1, 3], Misuzu Nosaka-Takahashi[2], Yutaka Sato[2], Yinglong Chen[3], Kadambot H. M. Siddique[3], Hirokazu Takahashi[1], Mikio Nakazono[1], Akira Yamauchi[1], Yoshiaki Inukai[4]
（1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.National Institute of Genetics, Japan, 3.The UWA Institute of Agriculture, The University of Western Australia, Australia, 4.International Center for Research and Education in Agriculture, Nagoya University, Japan）
12:15 PM - 1:00 PM

[P4-38] Daytime or Nighttime: When Plant Roots Uptake Nitrogen?

○Md Mehedi Hasan[1], Maya Matsunami[2], Hiroyuki Shimono[2] （1.United Graduate School of Agricultural Sciences, Iwate University, Japan, 2.Faculty of Agriculture, Iwate University, Japan）
1:15 PM - 2:00 PM

[P4-39] Maintaining Higher Leaf Photosynthesis After Heading Stage Contributes to Higher Biomass Accumulation in Rice

○Sotaro Honda[1], Satoshi Ohkubo[2], Nan Su San[2], Anothai Nakkasame[2], Kazuki Tomisawa[2], Keisuke Katsura[2], Taiichiro Ookawa[2], Atsushi J. Nagano[3], Shunsuke Adachi[2,4] （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.Faculty of Agriculture, Ryukoku University, Japan, 4.College of Agriculture, Ibaraki University, Japan）

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[P4-40] Genetic Analysis of Root Vascular Traits in a Population from Two *Temperate Japonica* Rice Ecotypes

○Ha-An Thi Nguyen[1], Akihiko Kamoshita[1], Poornima Ramalingam[1,2], Phoura Y[1] （1.Asian Research Center for Bioresources and Environmental Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Department of Plant Biotechnology, Tamil Nadu Agricultural University, India）

1:15 PM - 2:00 PM

[P4-41] CO_2-Responsive CCT Protein Interacts with 14-3-3 Proteins and Regulates the Expression of Starch Synthesis-Related Genes

○Fumihiro Miyagawa, Naoki Shibatani, Aiko Koudou, Daisuke Sasayama, Tomoko Hatanaka, Tetsushi Azuma, Hiroshi Fukayama （Graduate School of Agricultural Science, Kobe University, Japan）

12:15 PM - 1:00 PM

[P4-42] CRISPR/Cas9 — Based Genome Editing of *GCN5*, a Histone Acetyltransferase Gene, in Rice (*Oryza sativa* L.)

○Shu Takakura[1], Fumiya Miyamoto[1], Shicheng Feng[1], Sakae Agarie[2], Kazuyuki Saitou[2] （1.Graduate School of Bioresource and Bioenviroment Sciences, Kyushu University, Japan, 2.Faculty of Agriculture (Graduate School), Kyushu University, Japan）

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12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-01] Genetic Variation of Rice Germplasm Including *Oryza sativa* and *O. glaberrima* in Guinea

○Yoshimichi Fukuta[1], Seiji Ynagaihara[2], Nhai Nguyen[3], Oanh Nguyen[3], Narry Mamadou[4], Diawara Souleymane[4], Bah Oumar[4] (1.TARF, Japan International Research Center for Agricultural Sciences, Japan, 2.GRPH, Japan International Research Center for Agricultural Sciences, Japan, 3.AGI, Vietnam, 4.IRAG, Guinea)

Genetic variations of rice including *Oryza sativa* and *O. glaberrima* in Guinea were clarified based on the polymorphism data of SSR markers and heading date.
Cluster analyses were performed with the basis of the polymorphism data of 12 SSR markers, and accessions were classified into three cluster groups; Ia, Ib and II. *O. glaberrima* were mainly classified into cluster Ia, and *O. sativa* were clusters Ib and II. *japonica* Group cultivar, Nipponbare, and *indica* Group cultivar, Kasalath, were categorized into clusters Ib and II, respectively.The days to heading of *O. sativa* were later than*O. glaberrima*. The days to heading in the accessions of cluster II were the latest among three groups.
These results indicated that *O. sativa* and *O. glaberrima*were cultivated widely, and *O. glaberrima* was still conserved in Guinea. The genetic variation of days to heading in *indica* Group accessions was wider than those of *japonica* Group, and the accessions in the late heading type in *japonica* Group were limited. These of *O. glaberrima* also showed similar variation, but they included more late heading accessions in compared with these of *japonica* Group. The accessions of *O. sativa* were mainly classified into cluster groups Ib and II, and these of *O. glaberrima* were into cluster group Ia. The genetic variations of *O. glaberrima* was limited in compare with those of *O. sativa*, might be corresponded with the results of variation in heading date.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-02] Genetic Diversities of Traits Associated with Culm Strength Using a *Temperate Japonica* Rice Varieties

*Nominated for Presentation Awards

○Koki Chigira[1], Natsuko Kojima[1], Masanori Yamasaki[2], Shunsuke Adachi[3], Taiichiro Ookawa[1] (1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Food Resources Education and Research Center, Graduate School of Agricultural Science, Kobe University, Japan, 3.College of Agriculture, Ibaraki University, Japan)

Lodging is a serious problem in rice production, leading to yield loss and low grain quality. Having lodging resistance, modern varieties with semi-dwarfism have contributed to increasing rice productivity. However, their low biomass production and lodging under extreme weather (e.x. super typhoon hitting) have been still challenging for developing high yielding varieties. For next generation rice, the breeding of new type varieties with strong culms is a promising strategy. In this research, we cultivated a *temperate japonica* population composed of 135 varieties and evaluated the traits associated with culm strength over two years. We also detected the region associated with these traits by genome-wide association studies (GWAS). Large variances were observed in the traits for culm strength among the varieties, indicating that there were causal genes responsible for culm strength. The two remarkable landraces named 'Kameji' and 'Omachi' had superior traits for culm strength, and have been rarely used in

modern breeding programs. The GWAS revealed 55 candidate regions associated with the traits, and the most likely association with culm thickness was detected on chromosome 5. From gene-based GWAS, some candidate genes which might be involved in cell division were detected in this region. Several landraces could have beneficial alleles for increasing culm diameter and culm strength. We need to identify causal genes and elucidate their physiological functions. The information obtained from this study will be useful for breeding new varieties with strong culms.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-03] Histone Acetyltransferase GCN5 Regulates the Expression of *OsRBCS3* and *OsRBCS5*, Rubisco Small Subunit Genes, in Response to Nitrogen Supply in Rice (*Oryza sativa* L.)

*Nominated for Presentation Awards

○Shicheng Feng[1], Fumiya Miyamoto[2], Sakae Agarie[3], Kazuyuki Saitou[4] (1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, China, 2.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 3.Faculty of Agriculture (Graduate School), Kyushu University, Japan, 4.Faculty of Agriculture (Graduate School), Kyushu University, Japan)

Nitrogen is a primary component of plant substances. Nitrogen deficiency leads to slow and stunted growth and chlorosis. Five Ribulose-1,5-bisphosphate carboxylase/oxygenase small subunit (RBCS) genes identified in the rice genome are designated as *OsRBCS1,2,3,4* and *5*. In this study, we investigated the relationship between the expression of *GCN5*, a GNAT-type histone acetyltransferase gene, and RBCS genes. *OsRBCS1* transcripts were not detectable. The mRNA levels of *OsRBCS2*, *OsRBCS3*, *OsRBCS4*, and *OsRBCS5* in leaf blades were increased by nitrogen supply, but the incremental ratio of *OsRBCS5* was much lower than those of other RBCS multigene family members. The mRNA level of *GCN5* was increased by nitrogen supply. To study whether GCN5 regulates the expression of RBCS genes, we produced overexpression transformants of *GCN5* under the control of the maize ubiquitin promoter and the CaMV 35S promoter, and knockdown transformants of *GCN5* by RNAi. The expression of *GCN5* doesn't correlate with that of *OsRBCS2* or *OsRBCS4*, but it has a significant positive correlation with that of *OsRBCS3* and *OsRBCS5*. Furthermore, under the same expression level of *GCN5*, the expression level of *OsRBCS3* was higher than that of *OsRBCS5*. These results suggest that GCN5 regulates the expression of *OsRBCS3* and *OsRBCS5* specifically in response to nitrogen supply.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-04] Visualizing Aleurone Layers in Mature Rice Grains by a Modified Half-Cut Method

*Nominated for Presentation Awards

○Thi Mai Phuong Nguyen[1], Tomomi Abiko[2], Ohn Mar Khin[3], Toshihiro Mochizuki[2] (1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Faculty of Agriculture, Kyushu University, Japan, 3.Department of Agricultural Research, Ministry of Agriculture, Livestock and Irrigation, Myanmar)

Rice bran, a byproduct of rice milling process, is utilized to produce rice bran oil. Larger embryo size or increased aleurone layer thickness are effective on amount of bran oil. So far, mutants of giant embryo mutated by N-methyl-N-nitrosourea have been developed. However, varieties having thickened aleurone have not considerably established due to difficulty in screening methods. In this study, a simple method was established to screen the aleurone layer's thickness from a larger number of rice grains.
Total of 100 of half-cut brown rice (*Oryza sativa* L.) were embedded in one plate by acrylic resin and soaked into water overnight at room temperature, then subsequently stained with two solutions (1) new MG solution diluted 1:2 with methanol (99.8%) and (2) iodine solution. The sample sections were observed under digital microscope (MSX-500Di, Moritex Schott) and analyzed by software (WinROOF 2018, Mitani Corporation).
The method was successfully established by combination with preparation of half-cut samples on plate, staining and clear observation under a digital microscope. After staining, aleurone layer was detected clearly by light blue, whereas, starchy endosperm was distinguished by purple. This modified method can generate a massive number of seeds of 100 halved grains staining at the one-time cut. Besides, when seeds are attached on plates one day beforehand, screening aleurone layer thickness of about 700 seeds is achievable on the next day.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-05] Regulation of the Expression of *OsRBCS3*, a Rubisco Small Subunit Gene, by Histone Deacetylase *HDA713* under Nitrogen Deficiency in Rice

*Nominated for Presentation Awards

○Fumiya Miyamoto[1], Shicheng Feng[2], Sakae Agarie[3], Kazuyuki Saitou[4] (1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 3.Faculty of Agriculture(Graduate School), Kyushu University, Japan, 4.Faculty of Agriculture(Graduate school), Kyushu University, Japan)

Histone modifications represent key epigenetic mechanisms that regulate gene expression. The expression of Rubisco genes is enhanced in response to nitrogen supply. However, histone modification events regulating the expression of Rubisco genes are not well understood. In the study, we investigated the relationship between the expression of *HDA713*, a RPD3/HAD1-type histone deacetylase gene, and the expression of *OsRBCS3*, a Rubisco small subunit gene, in rice. The mRNA level of *HDA713* was decreased and that of *OsRBCS3* was increased by nitrogen supply. To examine whether *HDA713* regulates the expression of *OsRBCS3*, we produced overexpression transformants of *HDA713* under the control of the maize ubiquitin promoter and CaMV 35S promoter, and knockdown transformants of *HDA713* by RNAi. There was no correlation between the expression of *HDA713* and *OsRBCS3* under nitrogen sufficiency. Surprisingly, a significant positive correlation was found between the expression of *GCN5*, a GNAT-type histone acetyltransferase gene, and *OsRBCS3*. Under nitrogen deficiency, there was a significant positive correlation between the expression of *HDA713* and *OsRBCS3*, whereas there was no correlation between the expression of *GCN5* and *OsRBCS3*. These results indicate that the expression of *OsRBCS3* is regulated by GCN5 under nitrogen sufficiency and by HDA713 under nitrogen deficiency.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-06] Estimation of Canopy Transpiration Rate in Rice after Heading Stage by Extracting Leaf Temperature in Thermal Images

*Nominated for Presentation Awards

○Rintaro Kondo, Yu Tanaka, Tatsuhiko Shiraiwa （Graduare School of Agriculture, Kyoto University, Japan）

To understand biomass production process in rice, long-term monitoring of canopy transpiration rate (E) is useful. E before heading stage can be estimated using thermal imaging techniques and heat balance model (Monteith 1973) modified by aerodynamic resistance under windless condition (r_a*, Kondo et al. 2018). However, this technique is not applicable after heading stage because panicle surface temperature is higher than leaf temperature in the daytime. In this study, we aimed to extract leaf temperature in thermal images after heading stage, and to estimate E based on extracted leaf temperature. In 2019, cultivar 'Koshihikari' and 'Takanari' was cultivated. On August 11th (86 days after transplanting), 201 thermal images and micro meteorological data was recorded. Canopy temperature was extracted for each pixel and separated based on the assumption that it was composed of two normal distributions. Lower mean value of the distributions was assumed to be the representative of leaf temperature. Estimated E based on this leaf temperature was significantly higher in Takanari than Koshihikari. However, in both cultivars, estimated E based on the current protocol seems to be overestimated compared with the previous study. The source of the error might be the shaded region of leaves or panicles, which is not assumed in the heat balance model. Optimization of protocols to take thermal images and/or algorithms to extract leaf temperature is needed for the accurate estimation of E after heading stage.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-07] Engineering CAM Traits into C3 crops

○Aoi Saito[1], Mie Wakabayashi[2], Shiori Terai[2], Shiori Yamabe[2], Satoko Kobayashi[2], Kazuyuki Saito[3], John C. Cushman[4], Sakae Agarie[3] （1.Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Japan, 2.Faculty of Agriculture, Kagawa University, Japan, 3.Faculty of Agriculture, Kyushu University, Japan, 4.Department of Biochemistry and Molecular Biology, University of Nevada, United States）

Crassulacean acid metabolism (CAM) is a carbon fixation pathway that evolved as an adaptation to limited water availability. CAM species exhibit extremely high water-use efficiency. CO_2 is fixed during the night by phosphoenolpyruvate carboxylase (PEPC) and produced malic acid is accumulated in the vacuole. PEPC is activated by phosphorylation, which is catalyzed by PEPC kinase (PPCK). During the day, the malic acid is decarboxylated to release CO_2 by NADP-malic enzyme (NADP-ME). The PEPC, PPCK, and NADP-ME were encoded by *McPpc1*, *McPPCK* and *Mod1*, respectively. We isolated intron-containing genes (with and without promoter region), cDNA and antisense cDNA of those genes from *Mesembryanthemum crystallinum*. We constructed vectors including the cDNA of *McPpc1* and *McPPCK*, which were fused to a promoter of circadian clock associated1 (CCA1), which regulates gene expression at night, and *Mod1*, which was fused to the promoter of Chlorophyll a-b binding protein (Cab), which regulated gene expression at day. These promoters were isolated from *Arabidopsis thaliana*. We obtained transgenic

Arabidopsis that expressed *McPpc1* and *McPpck* during the night at a higher level. The expression levels of these genes were about 6 and 3 times higher than those in *M. crystallinum*, respectively. The PEPC activity of *McPpck* transgenic *Arabidopsis* was about 2 times higher than that of non-transformants. We applied the same strategy to rice to confer CAM traits.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-08] Assessment of Geographical Distribution and Genetic Diversity of Five Sorghum Taxa Collected in Taiwan

*Nominated for Presentation Awards

○Wei-hsun Hsieh[1], Yi-tzu Kuo[1], Han-hsuan Chin[1], Hsien-chun Liao[2], Chih-hui Chen[2], Yann-rong Lin[1]
（1.Agronomy, National Taiwan University, Taiwan, 2.Experimental Stations Research, Endemic Species Research Institute, Taiwan）

The genus *Sorghum* comprises a few C_4 species which are important resources for food, feedstock, and biofuel; instead, some of them are noxious weed. In Taiwan, abundant morphological diversity of five taxa, *S. bicolor*, *S. propinquum*, *S. halepense*, *S. bicolor* subsp. *verticilliflorum* and *S. vulgare* var. *technicum* were observed. These taxa can be found on wastelands, ditches, and farmlands where certain geographical distribution was observed, indicating different features of spreading within different types of sorghum. The cultivated- and wild-type sorghum were quite distinct. The panicle shape of *S. bicolor* subsp. *verticilliflorum* was also distinguishable. Yet, it was difficult to identify them based on plant and panicle architectures easily due to the existence of intermediate types. This study aims to survey the geographical distribution of five sorghum taxa in Western Taiwan and to investigate genetic diversity and clustering analysis among subpopulations estimated from 122 wild collections with 25 highly polymorphic SSR markers. *S. halepense* subpopulation displayed the highest genetic diversity. *S. bicolor* subsp. *verticilliflorum*, possessed the lowest diversity, was separated from the other taxa revealed by principal coordinate analysis, consistent with the result of the neighbor-joining tree. Finally, morphological identification mostly corresponded to the clades shown in the phylogenetic tree. Our study laid a foundation for evolutionary research of *Sorghum*.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-09] Resistant Loci to Physiological Disorder Cupping in Chinese Cabbage (*Brassica rapa* var.*Pekinensis*)

*Nominated for Presentation Awards

○Haruto Takamori[1], Osamu Kawaide[3], Tokuko Sakaguchi[1], Minami Nakazawa[1], Natsuki Ito[1], Ayuka Furukubo[2], Minami Amaike[2], Takashi Ito[5], Fumio Azuhata[3], Mashiro Okada[2], Seiji Chino[5], Hideo Matsumura[4], Satoshi Niikura[3], Nobuaki Hayashida[2] （1., Shinshu University, Japan, 2.Division of Applied Biology, Faculty of Textile, Shinshu University, Japan, 3.TOHOKU SEED CO., LTD., Japan, 4.Gene Research Center, Shinshu University, Japan, 5.Engineering Department, Faculty of Textile, Shinshu University, Japan）

Chinese cabbage (*Brassica rapa* var. *pekinensis*) is one of the major crops in the Brassicaceae, showing form of leafy heads at the later growth stage. Cupping is one of the problematic physiological disorder in Chinese cabbage, caused by the environmental stresses as calcium deficiency. Also, defect of calcium

causes other multiple disorder or disease like tip burn and soft rot, leading degradation of its quality. Therefore, we evaluated genetic cupping resistance in Chinese cabbage, as a novel indicator of calcium deficiency, in different environments. Progeny derived from a cross between two Chinese cabbage lines, showing different properties of cupping resistance, were prepared. One thousand of F1-S2 seedlings were grown in the cultivation room for phenotypic observation. Cupping phenotypes at the heading stage were evaluated in the field with replication for four years, resulting that thirty-two hundreds of F1-S2 individuals were scored. Based on these scores and genotyping data obtained from the RAD-seq analysis, QTL analysis was performed. Interestingly, independent QTL peaks appeared in different linkage group (LG) between seedling and heading stages. Unique major peak of the QTL was detected in LG2 for the phenotype at seedling stage. For headings stage, QTLs were found in LG1, LG3, and LG7. Candidate genes for cupping resistance are involved in these QTLs, which expected to contribute to genetic improvements in Chinese cabbage. Also, these genes will be helpful for understanding the mechanisms in various calcium-related traits.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-10] Genetic Diversity of Foxtail Millet (*Setaria italica*) Landraces of Taiwan

Yen-chiun Chen[1], Yong-pei Wu[2], Yee-ching Chong[1], ○Yann-rong Lin[1] (1.Department of Agronomy, National Taiwan University, Taiwan, 2.Department of Agronomy, Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan)

Foxtail millet (*Setaria italica*), a symbolic crop for indigenous peoples in Taiwan, has been cultivated for more than 5,000 years. Through a long term of adaptation to various environments of different altitudes and latitudes and of preferences for food and cultural applications, the landraces preserved by in indigenous peoples exhibit great diversity revealed by plant morphology and grain quality. The aim of this study is to understand the genetic diversity of Taiwan landraces revealed by molecular markers. A diversity panel of 211 foxtail millet accessions, including 154 Taiwan landraces, 8 Taiwan cultivars, and 49 India landraces, were sequenced by the genotype-by-sequencing (GBS) method, and 13,720 high-quality SNPs were obtained. After eliminating high genetic similarity because of repeated collection, a core population of 153 accessions was further selected for genetic diversity analysis. Taiwan landraces exhibited high levels of genetic diversity and moderate population structures, while Indian accessions were much differentiated from Taiwan landraces. Three major genetic subpopulations were constructed which were in concordance with geographical regions and the accessible breeding histories. An obvious phylogeographic relationship and gene flow could be observed in our study, for which the samples collected from boundary regions were admixed. This study revealed the genetic diversity of foxtail millet landraces of Taiwan is highly diverse, providing good germplasm for foxtail millet breeding.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-11] Branched-Chain Amino Acid Aminotransferases (BCATs) Play Important Roles for the Induction of Autophagy in Leaf Senescence of Soybean

*Nominated for Presentation Awards

○Tung Tuan Do[1,3], Takaaki Ishibashi[2], Takashi Yuasa[2] (1.Interdisciplinary Graduate School of Agriculture and Engineering, University of Miyazaki, Japan, 2.Faculty of Agriculture, University of Miyazaki, Japan, 3.Faculty of Agronomy, Thai Nguyen University of Agriculture and Forestry, Vietnam)

We previously reported that autophagy plays an important role in nitrogen translocation from leaf senescence to sink organs in higher plants under starvation conditions (Nang et al 2011). Intracellular levels of free branched chain amino acids (BCAA) pool appeared to be involved in autophagy regulation in yeast and animal cells via the mTOR pathway. In this study, we focused on BCAA specific aminotransferase (BCAT), which catalyzes the last transamination step in the pathway of synthesis and initial step of degradation of BCAA, the induction of senescence and autophagy of shaded leaf. Leaf shading treatments resulted in a significant reduction of leaf chlorophyll content and photosynthesis II activity. We examined the roles of soybean BCAT in leaf senescence and autophagy of soybean. The expression profiles of mitochondrial and chloroplast BCAT genes and ATG-related genes in soybean are examined. GmBCATX and GmBCAT2 that localized in mitochondria, were significantly induced under shading leaves. Resultantly, the levels of BCAA pool under shading treatments decreased significantly. The Bispyribac sodium (BIS) treatment resulted in a reduction of proline contents due to the upregulation of ProDH expression. Amylase activities of vacuolar proteases were upregulated in soybean seedling in response to BIS treatment. It is suggested that the induction of GmProDH and vacuolar proteases are regulated in the same manner with autophagy induction via a reduced pool of BCAA. Immunoblot, immunoprecipitation of soybean tissue extracts by anti-BCAT antibodies will be discussed.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-12] DGAT1s from Different Plant Species Show Different Triacylglycerol Biosynthesis Activities

○Tomoko Hatanaka[1], Wakana Miyashita[1], Kouki Shibutani[2], Daisuke Matsuoka[1], 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)

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 plant oil accumulation. In our former study, the *DGAT1* cDNAs obtained from Arabidopsis (*Arabidopsis thiliana*), soybean (*Glycine max*), castor bean (*Ricinus communis*), and Vernonia (*Vernonia galamensis*) were introduced into Arabidopsis. All Vernonia *DGAT1* expressing lines showed a significantly higher seed oil content compared to the wild type followed by soybean*DGAT1*, castor bean *DGAT1* and Arabidopsis *DGAT1*. These results reflected our previous results from the yeast microsome assay (Hatanaka et al. 2016).
In this study, in addition to the above four *DGAT1*s, cDNAs of *DGAT1* were cloned from sunflower (*Helianthus annuus*), Jatropha (*Jatropha curcas*) and sesame (*Sesamum indicum*). The sunflower DGAT1 has one of the closest amino acid sequence to Vernonia DGAT1. In regards to Jatropha and sesame DGAT1s, it has been reported that they were effective to increase seed oil contents of Arabidopsis (Misra et al. 2013, Wang et al. 2014). These *DGAT1* genes from seven species were introduced into the TAG biosynthesis defective yeast mutant (H1246). In the yeast expression culture, DGAT1s from Arabidopsis, castor bean or soybean did not increase TAG content in the yeast significantly, however, DGAT1s from

Vernonia, sunflower, Jatropha and sesame remarkably increased TAG content more than 10 times higher than the former three DGAT1s.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-13] Genome Wide Association Study for Leaf Photosynthetic Properties in 166 *Temperate Japonica* Rice Cultivars

*Nominated for Presentation Awards

○Yoshiaki Seki[1], Kentaro Hayami[1], Tomohiro Nomura[1], Yu Tanaka[2], Taiichiro Ookawa[1], Makoto Matsuoka[3], Shunsuke Adachi[1] （1.Graduate School of Agriculture, Tokyo University of Agriculture and Technology, Japan, 2.Graduate School of Agriculture, Kyoto University, Japan, 3.Bioscience and Biotechnology Center, Nagoya University, Japan）

Intraspecific genetic variation of leaf photosynthetic capacity is a promising resource for crop improvements. Although a lot of QTL studies for leaf photosynthesis have been reported elsewhere, few attempts of genome wide association study (GWAS) have been made. This is partly due to the low efficiency of photosynthetic measurements and the influence of environmental fluctuations on photosynthesis in the field. In this study, using 166 cultivars of temperate *japonica* rice grown in the field, we conducted GWAS for leaf photosynthetic properties in our original procedure enabling multiple photosynthetic evaluations under laboratory settings. We found a wide range of difference in CO_2 assimilation rate (*A*) among the varieties by 125.6% and 85.8% in 2019 and 2020, respectively. From the combined analysis across the years to extract genotypic effects, we found GWAS peaks for *A* on chromosomes 3, 4, 7, and 10, which overlapped with most of the peaks of stomatal conductance, mesophyll conductance, and electron transport rate, the values of which positively correlated with *A*. Among these peaks, the peak on chromosome 4 was located on *NAL1*, a well-known gene associating photosynthesis, while the other peaks seemed to be uncharacterized genetic factors. These results show that our procedure enables evaluation of photosynthetic diversity in rice cultivars and estimations of novel genetic factors for photosynthetic properties. Determinations of genes underlying these peaks should lead to understand new molecular mechanisms for the photosynthetic control.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-14] Assessment of Genetic Diversity and Relatedness in Citrus Fruits Using RAPD Markers

*Nominated for Presentation Awards

○Nihar Ranjan Saha, Jarina Binte Jalil, Muhammad Shahidul Haque （Department of Biotechnology, Bangladesh Agricultural University, Bangladesh）

Citrus fruits are the most economically important fruit crops widely cultivated in subtropical and tropical regions of the world including Bangladesh. They comprise one of the largest fruit crops in the world. In order to have comprehensive information about the extent of genetic variability between and within various Citrus species, a combined approach involving morphological, and molecular approaches were adopted. Genetic diversity and inter-relationship among thirty one citrus fruits were analysed by using morphological characters as per the descriptors (Biodiversity International, Rome, Italy) and RAPD

markers. Out of twenty five morphological traits studied, the analysis of variance for the quantitative traits revealed statistically significant differences for the fourteen characters studied among tested genotypes. Total twenty six random markers were used in molecular study, which produced 261 bands, of which 257 were polymorphic. The size of the amplified products ranged from 150-3352 bp with an average of 3-15 bands per primer. A pair-wise similarity value between cultivars ranged from 0.08 to 0.56. A dendrogram generated based on UPGMA discriminated all the cultivars into two Major clusters. It was revealed that the first main cluster consists with orange and malta. The other main cluster in turn divided into two sub-clusters, the first sub-cluster was formed with lemon while the second sub cluster consisted with jambura (pomelo) and satkara (Citrus macroptera). These results suggest that RAPD based markers are useful for genetic characterization of Citrus Fruits and useful in germplasm classification and introgression studies.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-15] Pyramiding of Disease Resistance Genes into Popular Rice Varieties of Bangladesh

*Nominated for Presentation Awards

○Tapas Kumer Hore, Corinne Mira Marfori-Nazarea, Mary Ann Inabangan-Asilo, Ratna Wulandari, BP Mallikarjuna Swamy （RGDV Platfrom, International Rice Research Institute, Philippines）

Rice is the major staple food of Bangladesh, contributing to 65-70% of the daily caloric intake. Its stable production is essential to meet the food and nutritional demands. However, rice production is affected by several biotic constraints such as bacterial blight, blast and tungro. Most of the popular rice varieties released during the last two decades are becoming susceptible to major diseases, so pyramiding disease resistance genes by marker-assisted backcrossing is a fast-track approach to address biotic stresses. We introgressed bacterial blight (*Xa5*, *Xa13* and *Xa21*) and blast genes (*Pi9*, *Pita2* and *Pi35*) into BRRI dhan28, BRRI dhan63 and BRRI dhan81 rice varieties. We also introgressed tungro resistance gene tsv1 into BRRI dhan71 rice variety. Materials have been advanced to BC_3 generation and homozygous lines selection is in progress using gene-specific markers. While twenty-three BC_3F_3 tungro resistance homozygous lines phenotypically similar to recipient parent have been selected and field evaluated. The overall results of the work will be presented during the conference.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-16] Genetic Analysis of Agronomic and Biofortification Traits in Multiple Rice Populations

*Nominated for Presentation Awards

○Tapas Kumer Hore, Mary Ann Inabangan Asilo, Gaurav Joshi, Amery Amparodo, BP Mallikarjuna Swamy （RGDV Platfrom, International Rice Research Institute, Philippines）

Malnutrition is a major global health problem that affects more than two billion people, especially children and women. Iron and Zinc deficiencies cause anemia, stunting, diarrhea, reduced immunity, poor cognitive function, etc. These problems are highly prevalent in rural populations without access to adequate nutrition. Most of the popular high-yielding rice varieties are a poor source of micronutrients;

hence, the biofortification of rice varieties with essential micronutrients is a popular intervention to tackle hidden hunger. Understanding the genetic basis of agronomic and biofortification is vital to develop high-yielding micronutrient-rich rice varieties. We characterized two biparental and two multi-parental populations for agronomic, yield, and micronutrient traits over two seasons at the International Rice Research Institute. Populations were genotyped using 7K SNP chip and genotype by sequencing. Wider variations were observations for all the traits in both the seasons and all the populations. Zn content ranged from 13.14–35.65 mg/kg and 6.58–41.24 mg/kg in biparental and multi-parental populations, respectively. QTL analysis showed prominent and consistent QTLs for grain Zn content on chromosomes 5 and 7, explaining a phenotypic variance of 11.4% and 10.4%, respectively. Further analysis is in progress.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-17] Meta-QTLs and Candidate Genes Associated with Grain Zinc Content in Rice

*Nominated for Presentation Awards

○Gaurav Joshi[1,2], B. P. Mallikarjuna Swamy[1], Indra Deo Pandey[2], Yan Paing Soe[3], Jose E. Hernandez[4], Chau Thanh Nha[5], Alvin Palanog[6], Mark Ian Calayugan[4], Mary Ann Inabangan Asilo[1], Amery Amparado[1], Tapas Kumer Hore[1] (1.Rice Breeding Innovations, International Rice Research Institute, Philippines, 2.Genetics and Plant Breeding, Govind Ballabh Pant University of Technology and Agriculture, India, 3.Seed Division, Department of Agriculture, Myanmar, 4.Institute of Crop Science, University of the Philippines Los Baños, Philippines, 5.Genetics and Plant Breeding Department, Cửu Long Delta Rice Research Institute, Vietnam, 6.Research and Development, Philippine Rice Research Institute, Philippines)

Zinc and Iron deficiencies affect more than half of the global population. Rice is the major source of calories but a poor source of nutrition in its milled form. Biofortification of major staple crops with essential micronutrients has emerged as one of the prominent tools to address malnutrition. However, grain yield and micronutrient traits are genetically complex and significantly influenced by the environmental factors. So, identification of stable QTLs and their use in marker assisted breeding fast track the development of biofortified rice varieties. Recently there has been significant progress in mapping QTLs for grain Zn and to breed Zn biofortified rice. We carried out a comprehensive genome-wide meta-analysis of Zn QTLs reported from 25 different studies in rice. Results revealed 51 meta-QTLs (MQTLs) distributed across the 12 rice chromosomes. A total of 415 transcripts/genes related to Iron and Zinc homeostasis were shortlisted, which were found to be involved in oxidation reduction process, trans-membrane transport, cell redox homeostasis, cation/metal ion binding etc. Haplotype analysis of 20 well characterized genes related to Zinc and Iron metabolism were further studied using the 3K rice genome panel. Results showed that 19 out of 20 genes had haplotypes ranging from 2 to 7. The results will be useful for designing markers for the precise and faster development of Zn biofortified rice varieties.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-18] Global Analysis of a Rice Panel to Identify QTLs and Genotypes Useful for Rice Breeding

*Nominated for Presentation Awards

○Gaurav Joshi[1,2], B. P. Mallikarjuna Swamy[1], Mona Liza Jubay[1], Indra Deo Pandey[2], Maria Camila Rebolledo[10, 11], Dmytro Chebotarov[1], Kenneth McNally[1], Rakesh Kumar Singh[9], Hei Leung[1], Sunil Kumar Verma[4], Satish B. Verulkar[4], Shuhha Banerjee[4], Hsu Myat Noe Hnin[3], Rollin de Ocampo[1], Federico Molina[5], Bertrand Muller[11], Justine Bonifacio[1], Eliel Petro Paez[10], Adin Blokounon[7], Kazuki Saito[7], Khady Nani Dramé[8], Stephen Klassen[1], Narne Chamundeswari[6], P. V. Satyanarayana[6] (1.Rice Breeding Innovations, International Rice Research Institute, Philippines, 2.Department of Genetics and Plant Breeding, Govind Ballabh Pant University of Technology and Agriculture, Pantnagar, India, 3.Institute of Crop Science, University of the Philippines Los Baños, Philippines, 4.Department of Plant Molecular Biology and Biotechnology, Indira Gandhi Agricultural University, Raipur (Chhattisgarh), India, 5.Rice Breeding, National Institute of Agricultural Research of Uruguay, Uruguay, 6.Plant Breeding, Regional Agricultural Research Station, Maruteru, India, 7.Sustainable Productivity Enhancement Program, Africa Rice Center, Côte d'Ivoire, 8.Capacity Development, Africa Rice Center, Côte d'Ivoire, 9.Crop Diversification and Genetics, International Center for Biosaline Agriculture, United Arab Emirates, 10.Rice Program, International Center for Tropical Agriculture (CIAT), Colombia, 11.Centre de Coopération Internationale en Recherche Agronomique Pour le Développement (CIRAD), France)

Rice as a major staple plays an important role in global food and nutritional security. Hence, its sustainable production is essential to meet the food and nutritional demands of rapidly increasing human population. But climate change induced risks pose a major challenge to food production; so there is an urgent need to provide solutions that can improve the resilience of rice food systems. The Global Rice Array Project helps to address climate change through characterization of diverse germplasm, identification of donor lines, genetic dissection of major traits and by better understanding of genotype, environment and crop management interactions. We successfully evaluated a subset of MAGIC *indica* population at 12 locations across Asia, Africa and Latin America during 2018 to 2020. MAGIC *indica* population was created using 8 Founders with desirable traits for biotic and abiotic stress tolerance, yield, and grain quality. A total of 21 data sets have been generated on yield and yield related traits. The population has been genotyped by sequencing. Preliminary analysis showed that IR13V902, IR13V924, IR13V1268 and IR13V1357 genotypes are stable and high yielding. Moreover, GGE Biplots showed that Uruguay is an environment good for selecting specifically adapted genotypes. Genome wide association study using 27041 markers showed consistent marker-trait association for flowering and plant height on chromosomes 6 and 1 respectively. Further analysis using weather, soil and crop management parameters is in progress. The results will help in understanding the complexity of interactions between genotype, environment and crop management and will lead to identification of traits, QTLs/genes and genotypes useful for breeding climate resilient rice varieties.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-19] A Metabolite Profiling to Explore the Physiological Function of *Short Panicle 1* during Panicle Formation of Rice

Yifan Lin[1], Ryutaro Morita[1], Masaki Okamura[2], Junko Yamagishi[1], ○Naohiro Aoki[1] (1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Central Region Agricultural Research Center, National Agriculture and Food Research Organization, Japan)

The rice inflorescence architecture, which is determined by the length and number of branches, has a great agronomic value and therefore also attracted much attention in the past years. The Short Panicle 1

(*SP1*) is categorized in the Nitrate Transporter 1/Peptide Transporter gene family and the knock-out mutant (*sp1*) displays a short-panicle phenotype with fewer rachis-branches. Previous studies reported that *SP1* functions in the vasculature of young panicles after primordia initiation, but the molecular mechanism underlying its effect on panicle formation remains unclear. In the present study, the *sp1* mutant and wild type (cv. "Nipponbare") were grown in paddy fields and compared to investigate the physiological function of *SP1*. From 28 to 14 days before the heading date, we sampled a 3-cm bottom part of stem including young panicle, and conducted a metabolite profiling by using an ion chromatography and a high performance liquid chromatography. Among sugar phosphates and carboxylic acids involved in the primary metabolism, mannose-6-phosphate (M6P) and 2-oxoglutaric acid (2OG) were accumulated in the *sp1* mutant at significantly higher levels, compared with the wild type. M6P can be converted into GDP-mannose, which is related to cell wall formation. 2OG is known to be a key metabolite in amino acid synthesis, providing the carbon skeleton for nitrogen assimilation. Thus, the higher accumulation of M6P and 2OG may imply that the cell wall formation and nitrogen assimilation pathways are inhibited in *sp1* mutant.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-20] Assessment of *Indica* Rice Cultivars for the Use of Whole Crop Silage

Yoshikage Goto, Junko Yamagishi, ○Naohiro Aoki （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

Whole crop silage (WCS) is a fermented roughage for which the whole plant of grass species, including panicles, leaves, and stems, are harvested at the late ripening stage and used for silage preparation. In Japan, the cultivation of WCS rice (*Oryza sativa* L.) has been promoted from the viewpoints of more efficient use of paddy field, improvement of self-sufficient ratio of livestock feed, and promotion of integrated farming system of rice cultivation and cattle raising. Thus, breeding of new rice cultivars for the use of WCS has grown attention to researchers and breeders. In particular, it would be useful to select genetic resources on the basis of WCS-related traits. Here we report an assessment of two *indica* rice cultivars, 'Calotoc' and 'Anjana Dahn', as for the use of WCS. These two *indica* cultivars and existing WCS cultivars, 'Tachiayaka', 'Tachisuzuka', and 'Leafstar' were grown in paddy fields in the Institute for Sustainable Agro-ecosystem Services, The University of Tokyo, Japan, and compared in light of biomass production, lodging resistance, spikelet number, sugar content, and water content, all of which are traits related to WCS aptitude. From the results, we found that 'Calotoc', rather than 'Anjana Dahn', has some traits suitable for WCS, and could be a genetic material for WCS breeding.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-21] Morphological Characteristics Related to the Accumulation of Non-Structural Carbohydrates in Stems of Rice at Heading Stage

*Nominated for Presentation Awards
○Yu Wakabayashi, Ryutaro Morita, Junko Yamagishi, Naohiro Aoki （Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan）

Non-structural carbohydrates (NSC) stored in stems before heading are the important carbohydrate source for the grain development of rice. In the present study, the dynamics of NSC were analyzed in each part of stems to clarify the morphological factors related to the NSC accumulation in stems at heading stage.
Field experiments were conducted in two consecutive years using "Tequing (*O. sativa* L. spp. *indica*)" and "Momiroman (*O. sativa* L. spp. *japonica*)", which have different accumulation patterns of NSC in stems. From the day of young panicle formation, internodes and leaf sheaths of main stem were divided into five parts based on the node, and internode length, culm diameter, leaf sheath length, and NSC content were measured.
In both varieties, NSC stored in leaf sheath until about 10 days before heading were preferentially used for the elongation of 1st and 2nd internode than that of 4th and 5th internodes. The amounts of stem NSC in heading stage were larger in "Tequing" than in "Momiroman". Compared to "Momiroman", length and culm diameter of 4th and 5th internodes were larger, while length of 1st and 2nd internodes were shorter in "Tequing". In the case of Momiroman with long upper internodes, NSC accumulation in stems tended to be suppressed for about 10 days before heading. From our studies, it was considered that rice varieties with larger lower internodes and shorter upper internodes are suitable for increasing NSC accumulation in stems at heading stage.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-22] Comparative Analysis of Sugar Metabolism in Rice Leaves under Field and Controlled Environments

○Yoichi Hashida[1], Ayumi Tezuka[2], Mari Kamitani[3], Makoto Kashima[4], Yuko Kurita[3], Atsushi J. Nagano[3,5] （1.Faculty of Agriculture, Takasaki University of Health and Welfare, Japan, 2.Research Institute for Food and Agriculture, Ryukoku University, Japan, 3.Faculty of Agriculture, Ryukoku University, Japan, 4.College of Science and Engineering, Aoyama Gakuin University, Japan, 5.Institute for Advanced Biosciences, Keio University, Japan）

Environmental factors such as irradiance and temperature fluctuate under field environments while those in conventional growth chamber (GC) are usually regulated as square-wave condition, which are constant during the day and the night, and abruptly transited at dawn and dusk. To clarify the differences in the sugar metabolism of rice leaves under fluctuating environments and GC condition, we compared sugar and starch content and diurnal transcriptome of rice leaves grown in field and GC condition, and simulated field condition by SmartGC, a high-performance growth chamber that can control light, temperature and relative humidity by 1-minute resolution. In the field, sucrose content in leaves rose gradually after dawn, reached plateau and started to fall before dusk. Starch content in leaves also increased gradually after dawn and reached plateau before dusk. Similar trends were observed in conditions simulating fluctuation of light by SmartGC, although the sucrose and starch content in leaves tended to be higher in the field. On the other hand, sucrose and starch content in GC condition rose earlier after dawn than in the field and did not fall until dawn. The difference in the expressions of genes related to sugar metabolism between conditions was mainly found before dusk, which is consistent with the difference in sugar status of leaves. Overall, these results indicate that the

difference in sugar metabolism of rice leaves in field and GC condition mainly derive from diurnal change of irradiance and is remarkable around dawn and dusk.

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[P4-23] A Metabolite Profiling to Seek the Molecular Determinant of Spikelet Number in Rice

○Ryutaro Morita[1], Masaki Okamura[2], Shiori Yabe[3], Hiroe Yoshida[4], Satoru Sukegawa[4], Hiroshi Nakagawa[4], Naohiro Aoki[1] (1.Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan, 2.Central Region Agricultural Research Center, National Agriculture and Food Research Organization, Japan, 3.Institute of Crop Science, National Agriculture and Food Research Organization, Japan, 4.Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization, Japan)

The number of spikelets is a key determinant of the grain yield of rice. Generally, the number of spikelets is determined by the nitrogen accumulation up to 2-weeks before heading and carbon supply during 2-week period preceding heading. However, the metabolic pathway involved in the determination of spikelet number is not fully understood. In this study, to clarify the relationship between the number of spikelets and metabolism of rice, we conducted the field experiment using the two rice cultivars "Nipponbare", "Koshihikari", and the *taw1-D2* mutant lines for each cultivar, which exhibits increased spikelet number per panicle in the two sites in Japan. From 40 days before heading to the heading stage, a basal part of stem including the shoot apical meristem of rice was sampled to analyze the metabolite contents an ion chromatography and a high-performance liquid chromatography. As reported in previous studies, the number of spikelets was highly proportional to the shoot nitrogen content. Among measurable 50 metabolites, the iso-citrate contents were positively while the shikimate contents at 28 days before heading were negatively correlated with the number of spikelets. The number of spikelets is divided into two components, i.e., the panicle number and the spikelet number per panicle. The inorganic phosphate content and fructose-6-phoshate content were highly correlated with the panicle number and the spikelet number per panicle, respectively. Based on the results, the key metabolites determining the number of spikelets will be discussed.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-24] Contribution of Several Source Organs to Dry Matter Accumulation into Panicles after Heading of Hulless Barley Sown at Different Terms

○Takuya Araki[1], Yasuhiro Kondo[2], Takato Yano[2], Ryo Kodani[2], Yukina Sakamoto[2] (1.Graduate School of Agriculture, Ehime University, Japan, 2.Faculty of Agriculture, Ehime University, Japan)

Barley has several sources for dry matter into panicles not only leaves and nonstructural carbohydrate (NSC), accumulating into a column during vegetative stage, but also awns and lemma. In this study, we considered contribution of these sources to dry matter accumulation into panicles of hullless barley (*Hordeum vulgare* L.) cv. Haruhimeboshi and Mannenboshi sown at different sowing terms. These cultivars

were sown on 12th November and 15th December, which are standard sowing (SS) and late sowing (LS) terms, respectively. The contribution of photoassimilates of awns to dry matter increase of panicles was calculated by the difference of dry matter increase of panicles between non-removed and removed awns. To evaluate the contribution of photoassimilates of lemma to dry matter increase of panicles, panicles were covered with black plastic films to restrict carbon dioxide assimilation. NSC content showed maximum at 20 days after heading, when that of Haruhimeboshi in SS was the highest. Dry matter increase in panicles derived from awn and lemma was higher in LS than that in SS of both cultivars. The ratio of source contribution to the dry matter increase in SS was 55%, 31% and 14% in leaves, NSC and awns and lemma, respectively. In LS, the ratio of awns and lemma showed 23%, which was higher than that in SS. The higher contribution of awns and lemma in LS was implied that source activity of awns and lemma was higher due to higher integrated temperature after heading in LS. From these results, awns and lemma has important role in dry matter accumulation in panicles.

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[P4-25] Analysis on the Roles of Vacuolar Invertase Isoform, *OsINV3* in Root Development of Rice

*Nominated for Presentation Awards

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

Root system is the only organ to absorb water and nutrient from soil, therefore it is an important factor for crop growth and yield. Carbon required for root development is supplied exclusively from shoot, however, the relationship between root development and metabolism of photoassimilates has been yet unknown. Here, we analysed the sugar metabolism in the root of rice *inv3* mutant, in which *OsINV3* a vacuolar invertase gene, is knocked out. The mutant was compared with wild-type (cv. Nipponbare) to clarify the role of sucrose degradation in root development.
Fresh weights of shoot, main roots and lateral roots were significantly smaller in *inv3*, while fresh weight of root tips was almost same level as wild-type. Non-structural carbohydrate (starch and soluble sugars) contents of main roots were not different in both lines. Although the sucrose contents in root tips and lateral roots of the mutant were more than twice that of the wild-type the glucose content in lateral roots of *inv3* was significantly lower in the mutant than in the wild-type. Moreover, the fructose content in root tips and lateral roots of the mutant decreased to approximately one-seventh and one-third, respectively, compared to the wild-type. Whole root length in *inv3* was also shorter than in the wild-type. These results imply that *OsINV3* functions especially in lateral roots and root tips for their elongation.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-26] The Purification of Recombinant TGW6, which Limits Grain Size in Rice

○Tatsuki Akabane[1], Nobuhiro Suzuki[2], Wataru Tsuchiya[2], Etsuko Katoh[2], Naoki Hirotsu[1] （1.Graduate School of Life Sciences, Toyo University, Japan, 2.Structural Biology Team, Advanced Analysis Center, National Agriculture and Food Research Organization, Japan）

THOUSAND-GRAIN WEIGHT 6 (*TGW6*) encodes an indole-3-acetic acid (IAA)-glucose hydrolase. By the function of native TGW6, the number of endosperm cells and the weight of grains are limited. Otherwise, the 1-bp deletion allele of *tgw6* cloned from the Indian landrace rice Kasalath loses the function and enhances the grain size as well as yield. We hypothesized that the chemical intervention strategy for the specific inhibition of TGW6 might increase the grain size and yield. However, we do not have the information for the structure of the TGW6 protein to design the antagonist.
In this study, we purified the recombinant TGW6 through the *Escherichia coli* expression system. We cloned full-length *TGW6* from Nipponbare by PCR and inserted it into pET-32b. The constructs were transformed into Rosetta-gami 2 (DE3). The *E.coli* cells contained a pET-32b expression plasmid for TGW6 were grown at 37℃ in LB minimal medium. Isopropyl-1-thio-β-d-galactopyranoside was added to induce the expression of the TGW6 construct. After harvesting the cells, we extracted the recombinant TGW6 by sonication and purified using Ni-affinity chromatography. However, most of the recombinant TGW6 expressed as insoluble forms. Then, we cloned *TGW6* truncated 30 amino acid sequences from N-terminus with the same experimental condition. We could improve the solubility by truncation of N-terminus amino acids and purify the recombinant TGW6. Further, we will report on the enzyme activity of the recombinant TGW6.

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[P4-27] Analysis of Genotype and Environment Interaction, and the Response of Grain Yield of Lowland Rice (*Oryza sativa* L.) to Nitrogen Application Under Different Environment in the Philippines

○Kim Nyka Caraan Perdiguerra[1,2], Pompe Campoy Sta. Cruz[1], Shiro Mitsuya[2], Akira Yamauchi[2] （1.Institute of Crop Science, College of Agriculture and Food Science, University of the Philippines Los Baños, Philippines, 2.Graduate School of Bioagricultural Sciences, Nagoya University, Japan）

Philippines rice growing areas have different climatic and edaphic characteristics resulting to difference in the performances of rice genotypes across different regions. Grain yield of rice (*Oryza sativa* L .) varies across genotypes and environments caused by genotype by environment (GxE) interactions, which is further affected by management (GxExM). Analysis of these interactions helps in the identification of genotypes with high stability, most adaptable environment, and the most suitable management. In this study, three rice genotypes namely: PSB Rc18, NSIC Rc222 and NSIC Rc202H were planted with and without nitrogen fertilizer application in 14 different environments which included all the dry seasons (DS) and wet seasons (WS) of Bukidnon, North Cotabato, Davao Del Sur, Isabela, Laguna, Oriental Mindoro, and Nueva Ecija. Environment accounted for the largest variability in grain yield (72.3%), followed by the genotype (25.3%) and their interaction (2.3%). Among the environments, dry season of Nueva Ecija with N fertilizer application had the highest mean grain yield (5.9 t ha^{-1}), while wet season of North Cotabato with zero N fertilizer application had the lowest mean grain yield (2.13 t ha^{-1}). The response of the genotypes across all environment also varied. Among the genotypes, NSIC Rc202H had the highest increase in yield as response to N application in DS Nueva Ecija compared to the other

environments. This shows that variation of grain yield and yield response is affected by genotype, environment and management (GxExM).

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-28] Morphological Characteristics of Mealy and Translucent Endosperm Cells of Hulless Barley (*Hordeum vulgare* var. *nudum*) During the Ripening Stage

*Nominated for Presentation Awards

○Yuto Hatakeyama[1, 2], Ryo Kotani[3], Yukina Sakamoto[3], Kosuke Haraguchi[3], Nana Matsui[3], Takuya Araki[1]
(1.Faculty of Agriculture, Ehime University, Japan, 2.Japan Society for the Promotion of Science Research Fellow, Japan, 3.Graduate School of Agriculture, Ehime University, Japan)

Glassiness rate is one of the important indices for grain quality of hulless barley (*Hordeum vulgare* var. *nudum*), and the high glassiness rate declines the processing efficiency and market value of the grain. The glassiness represents the ratio of the mealy and translucent areas in the endosperm of the grain. Although it was reported that the glassiness was involved in the protein matrix (protein bodies) and structure of starch granules in the endosperm cell, the differences in the development process of these organelles between putative mealy and translucent cells during the ripening stage remain unclear. In this study, using a right microscope and transmission electron microscope, the endosperm cells of two hulless barley cultivars, Haruhimeboshi and Mannenboshi, at the eight ripening stages were observed. At maturation, the percentage of glassy grain which translucent endosperm area occupied more than 70 % of the whole cross-section area of grain was less than 20 % in Haruhimeboshi, whereas that was more than 80 % in Mannenboshi. The protein bodies and amyloplasts developed especially after 20 days after flowering, and the area of protein bodies at maturation became larger in Mannenboshi than Haruhimeboshi. Moreover, the area of protein bodies in the outer endosperm where the glassy cell was observed with high frequency was larger than that in the middle and inner endosperm. These results suggested that the development of protein bodies at the later ripening stage could be involved in the glassy formation of hulless barley grains.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-29] Effect of Silicon Application on Grains of *Sorghum bicolor* under Drought Conditions

○Ryoichi Araki[1], Yuka Takano[1], Hidetoshi Miyazaki[2], Hiroyuki Ii[3], Ping An[4], Teru Tanaka[5] (1.Faculty of Education, Wakayama University, Japan, 2.Research unit, The Global Environmental Forum, Japan, 3.Faculty of Systems Engineering, Wakayama University, Japan, 4.Arid Land Research Center, Tottori University, Japan, 5.Faculty of Agriculture, Setsunan University, Japan)

The positive effects of silicon on plant growth are well known. To date, it has been reported that stress conditions such as drought enhanced the effect of silicon treatment in various plant species. In this study, we investigated the mineral contents in sorghum under drought stress conditions with or without silicon to reveal the effects of silicon application on sorghum (Sorghum bicolor cv. K8) grains. Silicon

treatment changed the mineral contents of the grains under drought stress conditions. Especially, the application of silicon to sorghum grown under drought stress significantly increased iron content in the grain, although plant biomass was decreased. On the other hand, the silicon application did not considerably affect the plant biomass under our experimental conditions. These results suggested that silicon application enhanced iron accumulation in grains under drought stress conditions, although the plant biomass was not affected. To further elucidate the accumulation of iron in grains, RNA-seq analysis was performed on sorghum leaves grown in pots. RNA-seq analysis showed that about 2,500 genes were significantly up-regulated by drought stress, and about 1,000 genes were significantly up-regulated by silicon treatment under drought conditions. In contrast, less than 100 genes were up-regulated in the non-drought treatment. These expression patterns indicated that the silicon treatment had a significant effect on gene expression under drought stress conditions.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-30] Relationship between Non-Destructive Measurement Parameters and Yield in Sweet Potatoes

○Masayuki Kadowaki[1], Tomohiro Araki[2], Risa Umehara[2], Sokichi Shiro[1], Shingo Matsumoto[1] (1.Institute of Agricultural and Life Sciences Academic Assembly, Shimane University, Japan, 2.Faculty of Life and Environmental Science, Shimane University, Japan)

The purpose of this study was to elucidate in detail the relationship between non-destructive measurement parameters such as plant coverage rate and yield in sweet potatoes.
The experiment was conducted at the Jinsai Sandy Dune Farm, Shimane University. Fertilizer application was set at 5 kg N, 14 kg P_2O_5, and 14 kg K_2O per 10 a in 2019, and three levels of nitrogen fertilization were set at 0 kg, 5 kg, and 15 kg per 10 a in 2020. Twenty varieties of sweet potato were used as experimental materials. Transplanting was done in late June. Yield was measured at about 100 days after planting. Plant coverage rate and NDVI values were also measured until 30 days after transplanting. Above-ground traits were measured in July 2019.
There was a significant positive correlation between plant coverage rate in early growth period and yield in both years. Multiple regression analysis of the relationship between above-ground traits and plant coverage rate in early growth showed a relationship between the number of branches and branch nodes and planting rate. There was a significant positive correlation between NDVI value and yield at 1% level. Furthermore, NDVI value and plant coverage rate were also found to be significantly positively correlated. The average plant coverage rate of all varieties increased with increasing nitrogen fertilization. However, the relationship between plant coverage rate and yield was almost constant regardless of the increase or decrease in nitrogen fertilization.
A part of this work was supported by Grant-in-Aid for Scientific Research(C)(18K05596).

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-31] Heat Stress Impact on Heading and Ripening in Major Korean Rice Variety

○Woonha Hwang, Chungkeun Lee, Jaehyeok Jung, Hyeonseock Lee, Seoyeong Yang, Yeonhwa Lim, Myeonggu Choi （Crop Production and Physiology Division, National Institute of Crop Science, Korea）

Heat stress is one of big stress in rice cultivation. Even mean temperature is gradually increasing and extremly high tempertaure even is also increasing in Korea. In these condition, the understanding of heat stress impact on rice is important to harvest stable yield and quality. Therefore, we checked heat stress impact on rice flowering, heading and ripening stage using major Korean varieties. To check flowering characters of rice, we used 11 Korean varieties. After cultivation under natural condition until heading, the pots were transported in green house which temperature was controlled. Until 30 degree of mean temperature, the flowering time did not changed. However, in 33 degree of mean temperature, flowering time changed earlier then other temperature condition. Fertility also changed under 33 degree, significant reduced. Under 33 degree, anthor viobility and germination rate were significantly reduced. In high temperature condition, heading time also changed. The growth days from transplanting to heading reuced about 3.5 days under 1 degree of mean temperature changed. In ripening stage, heat stress impact on 1000 brown rice wieght, rice quality and protein content. 1000 brown rice weight was reduced about 0.02 g according to 1 degree of mean temperature. The bigger rice showed more reduction in heat stress. And head rice rate was reduced about 5% and immature rice rate was increased about 1.9% by 1 degree of mean temperature.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-32] Genetic Variations of Rhizome Yield, Essential Oil Content and Constituents in *Curcuma* Species and Strains

○Akira Miyazaki[1], Yukari Shiino[1], Hiroshi Hayakawa[2], Yoshito Ohtani[1], Yoshinori Yamamoto[1] （1.Faculty of Agriculture and Marine Science, Kochi University, Japan, 2.Museum of Natural and Environmental History, Shizuoka, Japan）

Rhizomes in *Curcuma* species, used as spices, dyes and medicines, contain essential oil (terpenoid) as medicinal properties. It is reported that essential oil ratio and constituent are different with species and strains. Therefore, the characteristics of essential oil ratio and constituent were compared between Japanese and foreign *Curcuma* species and strains. Foreign turmeric had a lower rhizome yield but a higher essential oil ratio than Japanese turmeric and yellow zedoary. This resulted in no significant difference among these three groups in essential oil content amount, expressed as a product of ratio and rhizome yield. However, some foreign turmeric had a high rhizome yield with a low essential oil ratio, showing a similar character to Japanese turmeric. Major constituents of essential oil shown as relative area percentages were ar-turmerone (25.4-45.7%) and zingiberene (6.8-39.5%) in Japanese turmeric, ar-turmerone (15.5-74.2%) in foreign turmeric, and 1,8-cineole (19.0-63.4%) in yellow zedoary. Detected constituent patterns were different between the Japanese and foreign turmeric, however some foreign turmeric indicated a similar pattern to Japanese turmeric. Differences of rhizome yield, essential oil ratio and constituent pattern among these *Curcuma* species and strains were consistent with a classification indicated by a network analysis from DNA sequence in 4 regions of a chloroplast.

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[P4-33] Relationship between Pre-Harvest Sprouting Variation and Physicochemical Properties in Varieties of Rice Flour

○Chae Min Han, Jong Hee Shin, Jung Bae Kwon, Jong Gun Won （Division of Crops Research, Gyeongsangbuk-do Provincial Agricultural Research & Extension Services, Korea）

This study was conducted to examine the influence of pre-harvest sprouting variation on rice quality and starch properties (morphology and pasting properties) of rice varieties that may be used for the production of rice flour. Pre-harvest sprouting refers to seed germination during ripening, due to loss of dormancy before harvest, which is an important trait of varieties of rice flour. In this study, we investigated four varieties of rice flour with different genetic backgrounds to determine whether their starch is suitable for producing high-quality, dry-milled rice flour. Until now, 'Seolgaeng', 'Hangaru', 'Shingil', and 'Garumi-2' have been varieties developed for the production of dry-milled rice flour developed in Korea. The changes in the rice yield, yield components, and viviparous germination rates in the four varieties of rice flour are investigated. 'Shingil' variety produced the highest comparative grain yield and lowest pre-harvest sprouting rate. On the other hand, 'Garumi-2' produced the highest pre-harvest sprouting rate. The rice grains were ground in a mixture grinder and stored properly at room temperature prior to their use in the actual experiment and investigated for its starch and quality characteristics. Amylose and protein content, amylopectin short-branch chain and pasting properties of rice flours were measured. The pasting and thermal properties of rice flours determined by rapid-visco analyser (RVA) and differential scanning calorimeter (DSC). The morphology of the starch granule of the varieties was determined by SEM.

1:15 PM - 2:00 PM （Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster)）

[P4-34] Physicochemical Properties of Rice Varieties Adapted to a Mountainous Region in Mid-South Korea

○Chae Min Han, Jong Hee Shin, Jung Bae Kwon, Jong Gun Won （Division of Crop Research, Yeongsangbuk-do Provincial Agricultural Research & Extension Services, Korea）

With global warming, the cultivation period by climate zone for major food crops is expected to change, so the crops' growth and production variations need to be evaluated. In this research, we studied the changes in rice starch properties of the varieties adapted to the changing climate in the mountainous mid-South region in Korea and provided palatability data of major crops. The post-harvest rice starch of varieties such as Ilpum, Saechucheong, Samkwang, Chilbo, and Dasomssal was evaluated for its physicochemical properties. All varieties used in this study were harvested by Gyeongsangbuk-do Agricultural Research and Extension Services in 2020. The sowing date was April 20th and transplanting was done on May 20th. The sample rice flour was harvested, milled after drying to reach 14% moisture content, and passed through a 100-mesh sieve, from which the starch was separated using alkaline immersion. The protein amylose content of the white rice was measured non-destructively and the distribution of particle sizes was analyzed. The pasting properties, gelatinization properties, and crystallinity were measured by RVA, DSC, and XRD to examine starch properties, respectively. In the analysis of particle size distribution, the particle size (D50) of Saechucheong was the largest, while that of Chilbo was the smallest. The damaged starch content was the highest in Chilbo and the lowest in Ilpum. In examining the pasting properties, the peak viscosity was the highest in Samkwang and the lowest in Chilbo. The BD value was the highest in Samkwang but the lowest in Ilpum.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-35] Marker-Assisted Selection to Develop the High Nutrition Rice, Giant-Golden-Purple Rice, PFR32, and Giant-Golden-Red Rice, RFR13

○Yu-Chia Hsu[1], Yu-Chien Tseng[1], Yu-Chi Cheng[2], Bing-Nan Lin[1], Yong-Pei Wu[2] (1.Department of Agronomy, National Chiayi University, Taiwan, 2.Department of Agronomy, Chiayi Agricultural Experiment Station, Taiwan Agricultural Research Institute, Taiwan)

Rice (*Oryza sativa* L.) is one of the most important crops in the world. Functional rice can help people quickly gain nutrition and improve the health condition. CNY103108 and CNY103107, are two rice lines with purple waxy, golden endosperm and giant embryo. They were utilized as the donor parents in this study. In Taiwan, CNY922401, an elite purple waxy rice line and TNGSW26, a *indica* red waxy rice variety with high yield, which were used as the recurrent parents. The progenies were foreground selected by OsALDH7 (rice aldehyde dehydrogenase 7) and ge2 (giant embryo gene 2) functional markers and consequently background selected by molecular markers to recover their recurrent parent's background genome. The MAS results showed on purple rice population (CNY922401 / CNY103108), the recovery of recurrent parental genome was 91.3% and on red rice population (TNGSW26 / CNY103107), the recovery of recurrent parental genome was 89.8%. Through observing the grain appearance of brown rice from two populations, the progenies showed that they have the same color of pericarp with the recurrent parents, and have the larger embryo than the recurrent parents. After three-year yield trials in the field, PFR32 and RFR13 were selected from purple rice and red rice population, respectively. They have similar yield as the recurrent parents with golden endosperm and giant embryo. These results indicated that these lines can be grown in the fields for cultivation, and have been successful introgressed two genes, OsALDH7 and ge2 to the recurrent parents using marker-assisted selection. The new functional rice varieties will be developped and suitable for rice production in Taiwan and the world.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-36] Genetic and Morphological Mechanisms for Soil-Surface Roots Originated from a New Plant Type Cultivar in Rice (*Oryza sativa* L.)

○Asami Tomita[1,2], Hiroki Saito[2], Yoshimichi Fukuta[2] (1.Graduate School of Environmental and Life Science, Okayama University, Japan, 2.Tropical Agriculture Research Front, Japan International Research Center for Agricultural Sciences, Japan)

Soil-surface roots of rice might be useful for the stresses under reduced soil in Tropical region, such as iron, manganese toxicity and salinity field. The QTLs for soil-surface root have been already detected on the three regions of chromosomes (chr.) 2, 5, and 7 originated from a New Plant Type (NPT) cultivar, IR 65600-87-2-2-3, with the genetic background of an *indica* Group cultivar IR 64. NPT alleles of these QTLs increased soil-surface roots. Seven chromosome segment lines (CSL) harboring and combined from single to three QTLs' regions with the IR 64 genetic backgrounds were developed. Using these CSLs,

these effects of each and pyramided QTL(s) were evaluated, and that of chr. 5 particularly played a role for supporting the effect with the others. And these lost the gravitropic response of seminal root partially under dark condition. Therefore, these QTLs for soil-surface roots were occurred by partial losing of root gravitropic response and these accumulations in the NPT cultivar. These CSLs for QTLs will be useful materials for genetic and physiological studies for understanding the root architecture of rice, and for resources of rice breeding.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-37] Development and Genetic Analysis of Compensatory Growth of Lateral Roots in Rice

*Nominated for Presentation Awards

○Tsubasa Kawai[1, 3], Misuzu Nosaka-Takahashi[2], Yutaka Sato[2], Yinglong Chen[3], Kadambot H. M. Siddique[3], Hirokazu Takahashi[1], Mikio Nakazono[1], Akira Yamauchi[1], Yoshiaki Inukai[4] (1.Graduate School of Bioagricultural Sciences, Nagoya University, Japan, 2.National Institute of Genetics, Japan, 3.The UWA Institute of Agriculture, The University of Western Australia, Australia, 4.International Center for Research and Education in Agriculture, Nagoya University, Japan)

Soil compaction is a major problem limiting crop production. Compacted soils limit root system development, causing significant reduction in water and nutrient uptake from the soil, and resulting in yield loss. Mechanical impedance on primary roots caused by soil compaction triggers compensatory lateral root (LR) growth in various plant species. Maintenance of sufficient total root length contributes to continued shoot growth under compacted soils. Therefore, improving compensatory LR growth is a strategy for developing crop plants that tolerate soil compaction. To reveal the mechanisms of compensatory LR growth in rice, a method for root tip excision was established to induce the compensatory LR growth. To identify the genes regulating the compensatory LR growth, a novel rice mutant (T3-7-1) was isolated for its altered root phenotype and response pattern to root tip excision. The mutant produced fewer LRs under water culture and produced thicker LRs in response to root tip excision. Through characterization of the mutant and RNA-seq analysis in LR primordia captured with laser microdissection, molecular mechanisms underlying compensatory LR growth is being investigated. Furthermore, phenotypic traits related to the degree of compensatory LR growth is being examined in rice genotypes using a semi-hydroponic system.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-38] Daytime or Nighttime: When Plant Roots Uptake Nitrogen?

*Nominated for Presentation Awards

○Md Mehedi Hasan[1], Maya Matsunami[2], Hiroyuki Shimono[2] (1.United Graduate School of Agricultural Sciences, Iwate University, Japan, 2.Faculty of Agriculture, Iwate University, Japan)

When plant roots uptake nitrogen (N)? for this question, limited information is available. To answer this question, we monitored N uptake rate and transpiration during daytime and nighttime. Rice cultivar Hitomebore (*Oryza sativa*. L) was grown hydroponically in growth chamber (12h light; daytime and 12h dark; nighttime) under 26° C &60~70% humidity. NH_4Cl was used as N source and two treatments were

conducted as "Full N" (1mM N for 24h fed), "Half N" (0.5mM N for 24h fed) for 31~32 days in two cycles. N uptake rate (per plant) increased with days either during daytime or nighttime as plant growth progress. The N uptake rate in nighttime was slightly lower than daytime by 17~39% for "Full N" and 24~31% for Half N. There are close and positive correlation between N uptake rate and transpiration rate for each daytime and nighttime, but the slope of the relation differed between daytime and nighttime, because transpiration rate in nighttime was significantly lower than daytime by 78~79% for "Full N" and 80~81% for "Half N". In conclusion, rice plants absorbed N more in daytime than nighttime, and there is great difference in contribution of transpiration to N uptake between daytime and nighttime.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-39] Maintaining Higher Leaf Photosynthesis After Heading Stage Contributes to Higher Biomass Accumulation in Rice

*Nominated for Presentation Awards

○Sotaro Honda[1], Satoshi Ohkubo[2], Nan Su San[2], Anothai Nakkasame[2], Kazuki Tomisawa[2], Keisuke Katsura[2], Taiichiro Ookawa[2], Atsushi J. Nagano[3], Shunsuke Adachi[2,4] (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.Faculty of Agriculture, Ryukoku University, Japan, 4.College of Agriculture, Ibaraki University, Japan)

Leaf photosynthetic rate changes across the growing season as crop plants age. Most studies of leaf photosynthesis focus on a specific growth stage, leaving the question of which pattern of photosynthetic dynamics maximizes crop productivity unanswered. In this study, we obtained high-frequency data of photosynthesis from two elite rice cultivars and 76 inbred lines across the growing season and analyzed associations between leaf CO_2 assimilation rate (A) dynamics and crop growth rate (CGR). A brand-new device "MIC-100", which enables high-throughput gas exchange examination, was used for A measurements (Tanaka, Adachi et al. 2021). The A values decreased as plants aged but small increase was found at around heading stage with a genetic variation. The integrated A value from heading to harvest was positively associated with CGR, but that before heading was not. A curve-smoothing analysis of A after heading showed that accumulated A at >80% of its maximum (A_{80}) was positively correlated with CGR in analyses of all lines mixed and of lines grouped by genetic background, while the maximum A was less strongly correlated with CGR. These results suggest that maintaining high A after heading, rather than having high maximum A, is a potential target for enhancing rice biomass accumulation. We propose that multiple examinations of A with the high-throughput gas exchange device will achieve the screening of high-yielding crops with high photosynthetic capacity.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-40] Genetic Analysis of Root Vascular Traits in a Population from Two *Temperate Japonica* Rice Ecotypes

*Nominated for Presentation Awards

○Ha-An Thi Nguyen[1], Akihiko Kamoshita[1], Poornima Ramalingam[1,2], Phoura Y[1] (1.Asian Research Center for Bioresources and Environmental Sciences, Graduate School of Agricultural and Life Sciences, The

University of Tokyo, Japan, 2.Department of Plant Biotechnology, Tamil Nadu Agricultural University, India）

The genetic basis for root vascular traits in rice, despite its direct impacts on root axial and radial hydraulic conductivity, has not been widely studied compared with deep rooting traits. We used five phenotyping datasets (i.e., from maturity stage grown in upland field in 2013, and from vegetative and maturity stages grown in upland and lowland fields in 2019) to quantify the genotypic variations and genomic regions of root vascular traits in a *temperate japonica* mapping population (from lowland Otomemochi and upland Yumenohatamochi). Yumenohatamochi had larger stele transversal area (STA) and total late metaxylem area (LMXA), as well as higher deep root ratio and total root length at deeper layers (>30 cm) than Otomemochi. Root vascular traits were significantly different among progenies in each dataset, and the sum square of each component of genotype-by-environment interactions was less than genotypic variation but their total sum was comparable. From the combined analysis of all five datasets, five out of 13 genomic regions related to root vascular traits were found collocated with deep rooting traits, although no root vascular traits were positively correlated with any of deep rooting traits. Two key genomic regions were (1) RM3703-RM6379 in Chromosome 2 for STA, collocated with a previously reported *qSTA-2* in an *indica* x *japonica* population, and (2) RM1388-RM5503 in Chromosome 4 for STA, LMXA and root transversal area collocated with deep rooting traits. This study is the first report of genomic regions of root vascular traits in a *temperate japonica* mapping population.

12:15 PM - 1:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-41] CO_2-Responsive CCT Protein Interacts with 14-3-3 Proteins and Regulates the Expression of Starch Synthesis-Related Genes

*Nominated for Presentation Awards

○Fumihiro Miyagawa, Naoki Shibatani, Aiko Koudou, Daisuke Sasayama, Tomoko Hatanaka, Tetsushi Azuma, Hiroshi Fukayama （Graduate School of Agricultural Science, Kobe University, Japan）

CO_2-responsive CCT protein (CRCT) is a positive regulator of starch synthesis-related genes such as *ADP-glucose pyrophosphorylase large subunit 1* and *starch branching enzyme I* particularly in the leaf sheath of rice (*Oryza sativa* L.). RNA-seq analysis and subsequent RT-qPCR analysis showed that sucrose treatment induced the expression of *CRCT*, which in turn induced starch synthesis-related genes in WT. However, this induction did not occur in *CRCT* knock out mutants. A chromatin immunoprecipitation (ChIP) using a FLAG-CRCT overexpression line and subsequent qPCR analyses showed that the 5'-flanking regions of some starch synthesis-related genes were enriched by ChIP, indicating that CRCT can bind to the promoter regions of these genes. A bimolecular fluorescence complement (BiFC) assay revealed that CRCT interacts with a 14-3-3 protein in the nucleus. These results suggests that CRCT responds to sugar and regulates starch synthesis by directly binding to the promoter region of starch synthesis-related genes and interacting with 14-3-3 protein.

1:15 PM - 2:00 PM (Thu. Sep 9, 2021 12:15 PM - 2:00 PM Room 4 (Poster))

[P4-42] CRISPR/Cas9 — Based Genome Editing of *GCN5*, a Histone Acetyltransferase Gene, in Rice (*Oryza sativa* L.)

*Nominated for Presentation Awards

○Shu Takakura[1], Fumiya Miyamoto[1], Shicheng Feng[1], Sakae Agarie[2], Kazuyuki Saitou[2] (1.Graduate School of Bioresource and Bioenviroment Sciences, Kyushu University, Japan, 2.Faculty of Agriculture (Graduate School), Kyushu University, Japan)

Nitrogen is a primary component of plant substances. The expression of Rubisco genes is enhanced in response to nitrogen supply. Histone acetylation regulates gene expression in diverse biological processes, but histone acetylation events regulating the expression of Rubisco genes are not well understood. In this study, to examine whether the rice histone acetyltransferase GENERAL CONTROL NON-REPRESSED PROTEINS (GCN5) regulates the expression of Rubisco genes, we produced *GCN5* knockout rices using the CRISPR/Cas9 system. We choosed two guide RNA spacer sequences corresponding to nucleotides 65-83 and 203-221 of the *GCN5* coding region. The two sequences were inserted into CRISPR/Cas9 expression vector pRGEB32 and designed as *KO1-GCN5* plasmid and *KO2-GCN5* plasmid, respectively. The plasmids were introduced into rice calluses through *Agrobacterium tumefaciens* (strain EHA105). Fourteen (6.4%) of 218 calluses infected with the Agrobacterium harbored the *KO1-GCN5* plasmid redifferentiated. Eight (57%) of the 14 redifferentiated individuals had mutations in the *GCN5* gene. The mutations included deletions of one to 159 bases and insertions of one or two bases. Five individuals (62.5%) of the eight mutants had frameshift mutations in one *GCN5* allele, and one individual (12.5%) had frameshift mutations in both *GCN5* alleles. The same results were obtained in calluses introduced the *KO2-GCN5* plasmid. There was no obvious phenotypic difference between the heterozygous knockout rice and the wild-type rice. Tiller number of the homozygous knockout rice was fewer than that of the wild-type rice. The homozygous knockout rice was smaller than the wild-type rice, suggesting that GCN5 regulates the growth of rice.

Closing /Award Ceremony

Closing /Award Ceremony

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

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

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

ACSAC11 Representative 11:55 AM - 12:00 PM

Award Ceremony 12:00 PM - 12:45 PM