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1. Preface

Welcome to the last magazine issue in this fiscal year. I think everyone has been working very hard, completing this year with plenty of satisfaction and ideas for the next year! In this last volume, we provide our regular columns, as well as updates on most recent events, such as the 2022 IPSR Stress Symposium, which took part just a few days ago.

2. Report from the 37th IPSR symposium: 夢が広がる新植物の作出へ

In Google Translate 夢が広がる新植物の作出へ means "To create new plants that spread dreams". Yet another reason to avoid Google for your translations! I think it is for scientists to spread knowledge and fulfill our dreams about plants. Indeed, talks in this symposium have been inspirational and, as so, we would like to highlight some of the main points presented by our invited speakers.

In opening talks, a progress in genome editing of plants have been described. As one of main take home messages, new tools are required for a more precise gene targeting and reduction of "off target" mutations. As introduced by Dr. Y. Osakabe, a newly developed CRISPR/Cas genome editing tool, named TiD, shows a significantly lower rate of unwanted mutations, specifically due to its use of a longer guide RNA sequence (35-36nt). (https://doi.org/10.1038/s42003-020-01366-6)

Next, we learned that precise gene targeting is particularly important for development of functional foods to promote human health and reduce risk of diseases. As you all may already know, the first approved genome-edited crop has just been released in Japan in 2021. Sanatech Seed offers tomato fruits with a higher GABA content that is expected to exert health benefits through a positive effect of GABA on relaxation and lowering blood pressure. The (long) way to commercialization and release of "Sicilian Rouge High GABA" was introduced by Dr. H. Ezura, highlighting the importance of a long-term basic research that provided detailed information on biosynthesis of GABA, hinting that removal of C-terminal autoinhibitory domain in the key enzyme in GABA biosynthesis, glutamate decarboxylase (GAD), could increase its enzymatic activity.

(https://doi.org/10.1038/s41598-017-06400-y)

Importantly, even recalcitrant crops, i.e. those difficult for transformation, such as barley, are now becoming accessible targets for genome editing, among others, due to working progress of Dr. H. Hisano, staff member of Barley and Wild Plant Resource Center at IPSR. In a pilot study recently released from the Center, highly dormant barley seeds with reduced pre-harvest sprouting have been produced by genome editing of Qsd1 and Qsd2 genes, using CRISPR/Cas9 vector system in barley.
(https://doi.org/10.1111/pbi.13692)

So, while precise tailored modifications of plant genomes are becoming reality, which will hopefully accelerate breeding of edible crop, transgenic technology also gained much attention in the horticulture field and production of ornamental plants. However, although Chrysanthemum is widely cultivated in Japan, major problems in commercial use of genetically modified flowers still exist. As we learned from Dr. K. Sasaki's talk, for example, a large number of commercial Chrysanthemum varieties used in Japanese market makes it difficult to choose the right targets for genetic modifications. Furthermore, hexaploid genome of Chrysanthemum is naturally an extremely challenging target for genome manipulations.
(https://doi.org/10.1093/pcp/pcw222)

Elimination of toxic genes is another important target in crop improvement. Here, Dr. T. Muranaka has introduced their progress in reduction of α-solanine steroidal glycoalkaloids (SGA) that accumulate in potato tubers during a well-known process of sprouting/greening. As one striking observation, genome edited potato could be obtained through transient TALEN expression during Agrobacterium infection, thus avoiding any need for stable transformation and later elimination of transgenes from the genome-edited crop. Secondly, reduced α-solanine plants could be achieved by targeting the sterol side chain reductase 2 (SSR2) involved in biosynthesis of α-solanine. As pointed out in the following discussion, it should be determined if tomato plants with reduced SGAs will still hold their resistance against pests in the field, as these and other toxins have originated as natural defense compounds in plants, no need to say, well before domestication and use of potato for human consumption.
(https://doi.org/10.5511/plantbiotechnology.20.0525a)
(https://doi.org/10.1105/tpc.114.130096)
(https://doi.org/10.5511/plantbiotechnology.19.0805a)

And then, what a surprise! *Nicotiana benthamiana* tobacco can produce flowers on Arabidopsis rootstock! Striking but possible grafts between distant species of plants have been reported in a refreshing talk delivered by Dr. M. Notaguchi. A key player that turns *N. benthamiana* into "superhero of grafting" appears to be a specific β-1,4-glucanase that is secreted into the extracellular regions, where it facilitates the process of cell wall reconstruction.
(https://doi.org/10.1126/science.abc3710)

A rice gene providing a broad-spectrum resistance to specific class of herbicides was introduced by Dr. Y. Tozawa. The β-triketone herbicide was recognized as a "double-edged rice paddy herbicide" that kills Momiroman and Habataki rice plants which, eventually, appear to lack the activity of *HIS1* gene, which is an Fe(II)/2-oxoglutarate-dependent oxygenase required for hydroxylation and deactivation of this class of herbicides.
(https://doi.org/10.1126/science.aax0379)

Dr. Y Kawano from IPSR explained the role of OsRac1 in plant immunity. This small GTP-binding protein is activated by GEF protein, OsSKP1, during rice immune response to rice blast attack. Although transgenic plants with constitutive active defense pathway could better resist rice blast fungus, this transformation event was associated with growth and yield costs in the field trials in China. Apparently, scientists need to seriously take into consideration the possibility of growth penalty caused by increased plant defense capacity. No wonder, plants took millions of years to optimize their defenses for high fitness! For more Kawano's group work, please visit the homepage of the Plant Immune Design Group at IPSR.
(https://www.rib.okayama-u.ac.jp/plant_design/)

We have learned much about viruses in the last few years, due to infamous SARS-CoV-2. Apparently, even fungi can suffer from viral diseases that can be, however, explored by people as tools for their control. Advances in design of "virocontrol" agents for fungal pathogens have been introduced by Dr. N. Suzuki. For more details, see group homepage.
(https://www.rib.okayama-u.ac.jp/pmi/index-j.html)

Hybrid vigor (heterosis) is a commonly used tool for increasing biomass and yield in hybrid crops. A set of 5 genes has been identified by Dr. T. Sazuka in sorghum that allowed a construction of sorghum plants that successfully mimicked most of the F1 hybrid phenotypes.
(https://doi.org/10.1038/s41598-021-84020-3)

In the final presentation of this meeting, Dr. R. Terauchi from Kyoto University told us that NLR genes work as pairs in immunity of plants, such as the Pik-1 and Pik-2. The Pik-1's HMA module works as a sensor that recognizes the effector molecule, Avr-Pik, from rice blast. It was proposed that by constructing NLRs with modified sensor domains, it might be possible to open a new way to plant resistance against various plant pathogens in the future.
(https://doi.org/10.1101/2020.12.01.406389)
(https://doi.org/10.1016/j.jbc.2021.100371)

I hope my brief digest have already inspired you to attend the next IPSR symposium. Stay tuned for Spring series in 2023!

3. Recently released publications

Structural analysis revealed a novel conformation of the NTRC reductase domain from Chlamydomonas reinhardtii
Marchetti, G.M., Fusser, F., Singh, R.K., Brummel, M., Koch, O., Kummel, D., Hippler, M.
JOURNAL OF STRUCTURAL BIOLOGY 214 (1): 107829 (2022)
https://doi.org/10.1016/j.jsb.2021.107829

Role of calcium signaling in aluminum tolerance in Arabidopsis (Comment)
Huang, S., Ma, J.F.
NEW PHYTOLOGIST 233 (6): 2327-2329 (2022)
https://doi.org/10.1111/nph.17953

Integrated view of plant metabolic defense with particular focus on chewing herbivores
Wari D., Aboshi T., Shinya T., Galis I.
JOURNAL OF INTEGRATIVE PLANT BIOLOGY 64 (2): 449-475 (2022)

https://doi.org/10.1111/jipb.13204

Decades-long phylogeographic issues: complex historical processes and ecological factors on genetic structure of alpine plants in the Japanese Archipelago
Ikeda, H.
JOURNAL OF PLANT RESEARCH: 135: 191-201 (2022)
https://doi.org/10.1007/s10265-022-01377-w

Characterization of photosystem II assembly complexes containing ONE-HELIX PROTEIN1 in Arabidopsis thaliana
Maeda, H., Takahashi, K., Ueno, Y., Sakata, K., Yokoyama, A., Yarimizu, K., Myouga, F., Shinozaki, K., Ozawa, S-I., Takahashi, Y., Tanaka, A., Ito, H., Akimoto, S., Takabayashi, A., Tanaka, R.
JOURNAL OF PLANT RESEARCH: 135: 361-376 (2022)
https://doi.org/10.1007/s10265-022-01376-x

A novel victorivirus from the phytopathogenic fungus *Neofusicoccum parvum*
Khan, HA., Sato, Y., Kondo, H., Jamal, A., Bhatti, MF., Suzuki, N.
ARCHIVES OF VIROLOGY: 167: 923-929 (2022)
https://doi.org/10.1007/s00705-021-05304-7

A pericycle-localized silicon transporter for efficient xylem loading in rice
Huang, S., Yamaji, N., Sakurai, G., Mitani-Ueno, N., Konishi, N., Ma, JF.
NEW PHYTOLOGIST: 234(1): 197-208 (2022)
https://doi.org/10.1111/nph.17959

Mutation in BEIIb mitigates the negative effect of the mutation in ISA1 on grain filling and amyloplast formation in rice
Nagamatsu, S., Wada, T., Matsushima, R., Fujita, N., Miura, S., Crofts, N., Hosaka, Y., Yamaguchi, O., Kumamaru, T.
PLANT MOLECULAR BIOLOGY: 108: 497-512 (2022)
https://doi.org/10.1007/s11103-022-01242-3

4. International Joint Research introductions * 84-th series *
This month, Dr. Muryono describes his research experience and collaboration with the IPSR laboratory, sponsored by the International Joint Usage/Research program.

My name is Mukhammad Muryono, and I am a researcher and lecturer at the Biology Department at the Institute Technology of 10 November (Institut Teknologi Sepuluh Nopember), Indonesia. I am an early career scientist in Indonesia, since being back for good from a doctoral course in 2017, majoring in Functional Ecology.

Starting learning on my own, my ideas began to form. I view agro-ecology as an advance in functional ecology that provides pivotal knowledge on the ecological intensifications in soil management, and my ideas acknowledge the fact that crop field is an ecosystem. Meanwhile, in Indonesia, environmental degradation factors, such as erratic rainfall, drought and floods, and soil salinity have affected the production and cultivation of crops. Among these, soil salinity is one of the most devastating environmental stresses, which causes a major reduction in cultivated land areas, crop productivity, and quality. Thus, my ideas began to focus on molecular, physiological, and environmental regulation of salinity in rice.

In 2019, the program with Joint Usage/Research Center, Institute of Plant Science and Resources (IPSR) was announced, and I was fortunate to get it. I feel a deep gratitude to Professor Maki Katsuhara and his associates for hosting me for 2 (two) weeks for an exciting research collaboration in his laboratory.

I was approved to work in the Plant Molecular Physiology Group, with Professor M. Katsuhara as the head of the group. My project was entitled “Evaluation of rice cultivars with differing salt tolerance and the role of Na+ and K+ transporters in salt stress adaptation”, which took place under generous assistance, constant support, and help from Prof. Katsuhara’s team. Specifically, our investigations focused on the unique attributes of the HKTs and PIPs, which have been identified as members of gene family relevant to salt stress tolerance in plants. In contrast, our studies in Indonesia are more focused on morphological adaptations, to address important traits for salt tolerance performance. Professor M. Katsuhara, says, " In-plant salinity tolerance, the problems caused by soil salinity and molecular mechanisms that protect plants from salinity stress naturally combine the knowledge from morphological traits and responses of plants to osmotic and ionic stresses".

Among Indica and Japonica types, OsHKT1;1 and OsPIP2;4 have been detected in shoots and roots. Our results revealed that both shoots and roots differ in expression level among genes and rice types. It implies that the potential roles and gene responses in Indica and Japonica under salt stress might be quite different. Compiling evidence from morphological traits and molecular evaluation in shoots and roots suggests that Nipponbare is a likely candidate for Japonica type for salt tolerance, while FL-478 for Indica type. Different amounts of transcript abundance in shoots and roots of OsHKT1;1 and OsPIP2;4 reveals novel organ ion transport activity targets for further research in salt tolerance. This may also mean that a single salt tolerance gene might not be sufficient to mitigate into susceptible commercial rice variety for a significant increase in grain yield under saline field conditions.

Our present work now consists of taking a leap of faith to advance plant breeding in rice and maize. In 2021, we have been collaborating with a national maize seed company, and released a new hybrid variety of maize, performing high yield, and drought tolerance. Therefore, in the future, our research ambitions are to enhance the understanding of genetic basis of salinity and nitrogen use efficiency (NUE) via morphological, physiological, biochemical traits, and use of molecular markers linked to salinity and NUE as selection criteria, to find genetic materials for development of new maize and rice genotypes.

Finally, I wish to thank you so much! This was an incredible experience, and hopefully, I want to further encourage this relationship, by research finding opportunities, which may enhance thinking skills and enrich the knowledge of people.

5.Student recruitment - Online Graduate School Briefings

The Institute of Plant Science and Resources (IPSR) is one of the outstanding places for graduate students to engage in various aspects of plant research, in particular stress-related topics. The Institute will have two online briefing sessions via Zoom on the following dates:

28-March 2022 (Friday) 13:00〜16:00
29-March 2022 (Monday) 13:00〜16:00

Registration page (Japanese):
https://www.rib.okayama-u.ac.jp/nucleus/Daigakuin/setsumeikai.html
Information page (English):
https://www.rib.okayama-u.ac.jp/nucleus/Daigakuin_E/Top.html

[Q&A] (English - Japanese)
Daisuke Saisho, Institute of Plant Science and Resources,
Okayama University
TEL： (086)434-1245 E-mail： saisho@okayama-u.ac.jp

6. Posting request

In the PSSNet E-mail magazine and website, we aim to share various information resources related to research in plant (stress) science. We cordially invite all PSSNet subscribers to contribute various information, such as their latest publications, meetings and seminars, staff, postdoc, and student recruitments, etc. Please send your information directly to [pssnet-admin@okayama-u.ac.jp] E-mail address. You can also distribute your information via mailing list of the PSSNet.

7. Postscript from the issue Editor

For a long time, I was choosing the words for ending this issue. But only one idea comes -- all over again -- into my mind. Today, it is 11th-March 2022, and I utterly wish peace for all people on this planet!

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