70 years of SPPS – outlook by Early-Career Principal Investigators

Saijaliisa Kangasjärvi

Molecular Plant Biology, Department of Biochemistry, University of Turku, Finland
e-mail: saijaliisa.kangasjarvi@utu.fi

This year the Scandinavian Plant Physiology Society SPPS is celebrating its 70 successful years in promoting plant sciences and publishing the journal Physiologia Plantarum as a central part of its research activities. In 2014, a group of SPPS Early-Career Principal Investigators (SPPS-ECPIs) established a network of next generation scientists to ensure the continuity of excellent plant sciences in the Nordic region. The SPPS-ECPI network today forms a highly collaborative interest group that promotes SPPS, Physiologia Plantarum and plant sciences in general. The main scientific objectives of SPPS-ECPI include resolving timely challenges arising from the climate change, food security and the need for a sustainable society. In this special issue, members of the ECPI network summarize recent developments in different areas of basic research and provide insights into how the basic information can be translated from model systems to crop species and photosynthetic microbes.

Plant research and traditional breeding methods have long been successfully applied to forward agriculture in the Nordic region. Understanding plant nutrition is critical, since appropriate fertilization allows minimization of environmental impacts while maximizing plant productivity. Nitrogen, for example, is commonly limiting for plant growth in the field and forms a main component of fertilizers that are heavily used in modern agriculture. Notably, however, over-application of nitrogen may repress flowering and hence reduce crop yield. Weber and Burow (2018) seek for better understanding of how nitrogen affects the onset of flowering. They report a meta-analysis of publicly available gene expression datasets to identify candidate genes and pathways that integrate nitrogen responses and flowering time in the model plant *Arabidopsis thaliana*.

Adopting currently available methodologies of gene technology offers significant prospects in future crop improvement, but utilization of targeted genome editing in breeding programs may be hindered by a doubtful public opinion. Monitoring end-user acceptance, as well as tight communication with potential future interest groups, decision makers and the general public is therefore increasingly important in plant science. This important matter is highlighted by Eriksson et al. (2018), who discuss the current and future progress in the application of plant gene technologies in Denmark, Norway, Sweden and Finland. Yet another key aspect that will facilitate the transition towards a bio-based economy is sustainable production of biofuels and other valuable compounds in photosynthetic organisms. Stensjö et al. (2018) address the

possibility to harness photosynthetic cyanobacteria as production platforms and summarize the recent progress in developing tools for efficient "cyanofactories", focusing especially on transcriptional regulation of gene expression.

Manufacturing of value-added products in photosynthetic organisms necessitates deep understanding of the photosynthetic reactions, their bottle-necks and interconnections with other metabolic pathways. Photosynthetic light reactions form a powerful series of redox reactions, which allow extraction of electrons from water, but render the photosynthetic machinery vulnerable for light-induced oxidative damage. In their article, Tikkanen and Grebe (2018) focus on Photosystem I (PSI) and introduce a theoretical framework for a novel methodology to analyze photoinhibition of PSI *in vivo*. Koskela et al. (2018) in turn focus on soluble redox components and report novel characteristics of a Ferredoxin-$NADP^+$ oxidoreductase-like (FNRL) protein in the chloroplast stroma. Besides the increasing understanding of chloroplast redox biology, studies have started to reveal the enzymatic pathways underlying the biosynthesis of complex metabolites in plants. In this context, Rahikainen et al. (2018) review the current understanding of the activated methyl cycle and its critical role in determining trans-methylation reactions essential in metabolic and regulatory activities in plants.

Many of the plant-derived specialized metabolites originally evolved to protect plants against biotic stress agents. Plants live in a world where they are constantly challenged by abiotic and biotic stresses. Identification of the regulatory steps in defense signaling has seen much progress in recent years and points of cross-talk within signaling networks have become an increasing theme in plant biology. Overmyer et al. (2018) illustrate an important consideration noting that even though measurement of alterations in gene expression is a suitable assay to monitor defense regulation, it can also inadvertently provide overstated conclusions about interaction among signaling pathways. Annacondia et al. (2018) in turn provide insights into the complex regulatory networks that determine appropriate distribution of resources between developmental programs and defensive measures and focus on the regulation of stress responses by epigenetic mechanisms of gene regulation.

Besides pathogenic micro-organisms, plants may also be challenged by parasitic weeds that can cause significant losses in crop yield. Using the parasitic flowering plant genus *Cuscuta* (dodder) as an experimental model, Krause et al. (2018) report identification of tomato introgression lines that display enhanced susceptibility or increased resistance to infection by parasitic giant dodder (*Cuscuta reflexa*). These differentially resistant lines provide a valuable resource for future identification of the key loci involved in plant resistance to parasitic weeds and will aid the development of strategies to enhance resistance to infection in crop species.

We hope these articles will provide insights into the achievements and future directions of research in plant biology and how it will facilitate the identification of enzymes, compounds and regulatory pathways to be utilized for construction of innovative agricultural and biotechnological applications.

References

Annacondia ML, Magerøy MH, Martinez G (2018) Stress response regulation by epigenetic mechanisms: changing of the guards. Physiol Plant 10.1111/ppl.12662.

Eriksson D, Brinch-Pedersen H, Chawade A, Holme I, Hvoslef-Eide TAK, Ritala A, Teeri TH, Thorstensen T (2018) Scandinavian perspectives on plant gene technology: applications, policies and progress. Physiol Plant doi: 10.1111/ppl.12661.

Koskela MM, Dahlström KM, Goñi G, Lehtimäki N, Nurmi M, Velazquez-Campoy A, Hanke G, Bölter B, Salminen TA, Medina M, Mulo P (2018) Arabidopsis FNRL protein is an NADPH-dependent chloroplast oxidoreductase resembling bacterial ferredoxin-$NADP^+$ reductases. Physiol Plant doi: 10.1111/ppl.12621.

Krause K, Johnsen HR, Pielach A, Lund L, Fischer K, Rose JKC (2018) Identification of tomato introgression lines with enhanced susceptibility or resistance to infection by parasitic giant dodder (*Cuscuta reflexa*). Physiol Plant doi: 10.1111/ppl.12660.

Overmyer K, Vuorinen K, Brosché M (2018) Interaction points in plant stress signaling pathways. Physiol Plant doi: 10.1111/ppl.12639.

Rahikainen M, Alegre S, Trotta A, Pascual J, Kangasjärvi S (2018) Trans-methylation reactions in plants: focus on the activated methyl cycle. Physiol Plant doi: 10.1111/ppl.12619.

Stensjö K, Vavitsas K, Tyystjärvi T (2018) Harnessing transcription for bioproduction in cyanobacteria. Physiol Plant doi: 10.1111/ppl.12606.

Tikkanen M, Grebe S (2018) Switching off photoprotection of photosystem I - a novel tool for gradual PSI photoinhibition. Physiol Plant doi: 10.1111/ppl.12618.

Weber K, Burow M (2018) Nitrogen - essential macronutrient and signal controlling flowering time. Physiol Plant doi: 10.1111/ppl.12664.