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Editorial

The plant microbiome: Exploration of plant-microbe interactions for improving agricultural productivity

The compelling question of "how microorganisms and microbial communities contribute to the feeding of the world" gains in importance and becomes an exciting frontier of research. The way of interaction between the plant corms and its inhabiting microbial community mainly defines the well-being, growth and finally yield and quality of crop products. Therefore, this special issue compiles main aspects of plant-microbe interactions which were raised at the international symposium "The Plant Microbiome: Exploration of Plant-Microbe Interactions for Improving Agricultural Productivity" held in El Gouna-Hurghada, Egypt, in November 2018. The conference (https://www.pgpmicrobiome2018.com/) was organized within the framework of Alexander von Humboldt Foundation symposium series, and in cooperation with the German Research Foundation-DFG, German Academic Exchange Service-DAAD, the Technical University of Berlin-Camps El Gouna, the Leibniz Institute of Vegetable and Ornamental Crops-IGZ, the Japan Society for the Promotion of Science-JSPS, and Cairo University and its Journal of Advanced Research-JAR.

Sustainable crop production worldwide needs novel methods and production systems which help to reduce mineral fertilization and agrochemical applications to protect soil fertility and water quality. Microbial communities or selected organisms may contribute to such improved future plant production systems. In the present special issue main aspects of plant microbial communities composition, their functioning, plant colonization strategies and competition as well as novel methods used to deeper understanding these complex systems are reviewed.

While molecular genetic and metagenomic techniques have revealed the great diversity and functional richness of resources of the plant microbiota, as it is highlighted in the review of Hartmann et al, cultivability of these communities and isolation of novel plant growth-promoting microbes is lagging very much behind. Nevertheless, successful agricultural applications of plant beneficial microbes and possibilities to improve their effectiveness were already achieved. The review of Sarhan et al. aims to better resolve the plant microbiome repertoire and it's *in vitro* cultivability. The retrieval of the missing unculturable plant microbiota will significantly promote the potential utilization and ability for applications in tomorrow's agriculture.

Compant et al. highlight in their review the importance to understand the functioning of selected microbial strains or mixed communities to further improve environmental tailored and plant species adapted biological preparations and microbial inoculants. That topic is further deepened in the aspect of archaeal functioning in the plant *Eruca sativa* by Gabriele Berg. Hrynkiewicz and coworkers evaluate how specific salt-tolerant diazotrophic nitrogen fixing bacteria promote the development and survival of halophytic plants in adverse salt impacted areas. The daily agricultural practice clearly shows the increasing market demand of biological products and their successful application in many examples. Unfortunately, there is still a big gab in the understanding of variations observed in application efficiencies. One of the most important topics for a successful biofertilizer or biopesticide application is the ability of the respective microorganisms or microbial groups to colonize the plant and express a high competence to the native microbial community. In the present special issue, factors influencing these properties are reviewed by Schlechter et al. and Akifumi et al. More specific bacterial traits, which are supporting the colonization ability and competence against native bacteria living in the same environment of the plant, are investigated and reviewed by Patz et al. The volatiles-based crosstalk between the plant, a beneficial mycorrhizal fungus and a root pathogen is shown in the article of Dreher et al. Furthermore, improved colonization of a plant beneficial bacterium can be stimulated by the application of osmolytes at salt-challenged conditions as reported by Cruz et al. Future studies of complex functional microbe-plant interactions need the consequent and efficient use of molecular genetic techniques and their rapid improvement. Here, we provide a short selection of novel methodological ideas described by Huschek and

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Witzel. The critical review of Fricke et al. highlights the tremendous challenges of sequencing-based microbiome studies, and points to eye-opening novel insights as well as methodological pitfalls and limitations.

In this special issue, we bring together summarized information on major achievements and challenges of microbial applications in agricultural practice for improving sustainable production systems. Some new ideas and techniques were highlighted, which may inspire scientists working in this area. Finally, we would like to express our gratitude to all colleagues contributing to this special issue, the anonymous reviewers, and to the JAR editors for their time to make this special issue a reality.

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