



European Plant Science Organisation
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Report and recommendations

EPSO Workshop Implementing a Plants and Microbiomes Strategy in Europe

Online, 13-14 January 2021

Brussels, 1.9.2021

1. Background

The third workshop of the WG Plants and Microbiomes had two aims. First, present first highlights from (multi-)national plants and microbiomes research and innovation and increase collaborations between the working group members (via e.g. COST action, Coordination & Support Actions, initiate more collaborations both bi-and multi-lateral).

Second, based on previous workshops two themes were further elaborated: 'Addressing R&D bottlenecks' (discussing recommendations 3, 4, 5 and 7), and 'Research infrastructure' (considering recommendations 15 and 17) to assess the state of art and provide advice to Horizon Europe and (multi-)national research strategies.

2. First highlights from (multi)national plants and microbiomes initiatives

There are major national initiatives going on, reported were those from Germany (by Paul Schulze-Lefert), Denmark (by Mette Haubjerg Nicolaisen) and the Netherlands (by Harro Bouwmeester). ► These need to be better linked and complemented by Europe-wide initiatives under Horizon Europe, for example by calls in cluster 6 and openings to be created in the Biodiversity partnership and the Soil Mission.

R1 - Diverse crops with diverse microbiomes for diverse diets for human and animal health and resilient production systems

► Diversity matters increasingly, this suggestion should be most welcome and supported with high priority to achieve the UN Sustainable Development Goals, e.g. SDG 2 'Zero hunger', SDG 3 'Health and wellbeing', SDG 12 'responsible consumption and production', SDG 13 'Climate action', SDG 15 'Life on land' and to implement the EU 'Farm to Fork' and 'Biodiversity' strategies, the EU Soil mission.

3. Update recommendations 3, 4, 5, 7, 15 and 17 from the 1st and 2nd workshops

R3 - Moving from correlation to causation under lab, greenhouse and field conditions

- We need to consider larger time and spatial scales covering the whole growth cycle, different growth cycles, multi-annual studies, different locations etc. This would require project lengths of at least 5 – 10 years.
- Model plants and crop plants are needed to elucidate different aspects. To understand host factors and mechanisms model plants are needed as we can make use of plant genetics. At the same time, we also have to understand field performance and mechanisms of microbiomes together with their crop hosts.
- Understanding of rhizosphere competence and persistence of microorganisms in the field is required, which can be investigated using reductionist approaches as well as field scale experiments. Elucidating the role of invasion and persistence for stabilizing the function of a beneficial association is needed.
- Genetic as well as computational tools and making better use of existing culture collections are required to move from correlation to causation and to improve understanding.
- For improving field performance, different microbial communities for different plant hosts and abiotic conditions should be considered. Also, plant stress conditions should be applied to validate microbial traits and plant phenotypes before going to the field.
- We need to further strengthen collaboration between 'genetic/molecular' and 'ecological' scientists to make progress in conceptual approaches and competences.

R4 - More understanding on the complexity of the ecosystem-plant-microbiome system is needed

- There is a need to establish a better link between basic and applied science and to pull in different aspects and methodologies to understand the system, also to further develop the link between 'reductionistic' and 'ecological' scientific communities. Sustainability issues (e.g. greenhouse gas emissions) should be taken into consideration.
- We recommend applying a 'hierarchical approach' to link field and lab, e.g. how do microbiomes assemble in association with different plant species (approaches from the plant and microbiome perspective). Food web implications and interactions with other organisms (e.g. insects) are required to understand microbiome structure ('interkingdom') and function in the long run. We also need to look at the full growth plant cycle (and not only at early growth stages).
- There is a need to link plant diversity with microbial diversity, the transition from mono- to poly-culture (agroforestry) is a new challenge for holobiont studies.
- The effect of inoculant strains on the resident microflora in relation to nutritional aspects needs to be understood. Also, soil health understanding is needed to assess the effect of agronomic practices including the use of microbial inoculants.
- Develop and promote crop management advice to improve microbiota-plant interactions for stakeholders / farmers

R5 - Plant mechanisms to attract / interact with microbiota require understanding

- We need plant molecular markers for breeding - root exudate engineering, and root exudates as a breeding target. Understanding microbial interactions that change root exudates and better understand the linkage between microbiomes and root traits. Breeding currently ignores microbiome functions.
- A combined plant-microbiota metabolism approach is key for understanding interactions as well as technologies like ionome and metabolome (including computational approaches for predictions).

R7 - Precompetitive research should address the identification of microbiome-based plant health and resilience indicators and microbiome understanding needed by the industry

- We need inoculant predictability (including rhizosphere competence) and best practices for application in the field.
- There is high potential to integrate microbiomes in precision farming, here more statisticians, mathematicians and access to raw data / metadata are required
- We recommend developing a toolbox combining strains, plants, soil and abiotic conditions for specific regions / applications considering variability.
- Standards for microbial products need to be set.
 - ◆ To be further discussed in a follow-up working group meeting.

R17 - European infrastructure recommended for plant microbiome research

- Common repository for culture collections: Establish a common EU metadata for each strain "strain passport" deposited on national culture collection to facilitate access to strains; consider the development of a genome-based culture collection
 - ◆ To be followed-up by Paul Schulze-Lefert and Angela Sessitsch.
- EU phenotyping platforms for microbiome research: Use the currently available Plant Phenotyping networks (EPPN, national PNs) to use and adapt the existing facilities more for microbiomes related experiments and if needed, establish new systems
 - ◆ To be followed-up by Robert Koller (Paul Schulze-Lefert).
- Metabolomics: develop common protocols
 - ◆ To be followed-up by Harro Bouwmeester.

R15 - Open access databases integrating (plant) microbiome and meta-data are required

- Establishing a common EU database to deposit tools and bioinformatics pipelines used for microbiome analysis (as e.g. Elixir)
 - ◆ To be followed-up by Corné Pieterse et al.

The report was written by Angela Sessitsch, Karin Metzloff, Paul Schulze-Lefert and Corné Pieterse with input from the EPSO workshop participants.

This 'Report with recommendations' as well as the 'Annex to the report' are available at <https://epsoweb.org/working-groups/plants-and-microbiomes/> .

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Useful links

EPSO Plant and Microbiomes Working Group including report from 1st and 2nd workshop

<https://epsoweb.org/working-groups/plants-and-microbiomes/>

EPSO news: <https://epsoweb.org/news/>

EPSO members: <https://epsoweb.org/about-eps/eps-members/>

EPSO representatives: <https://epsoweb.org/about-eps/representatives/>

About EPSO

EPSO, the European Plant Science Organisation, is an independent academic organisation that represents more than 200 research institutes, departments and universities from 32 countries, mainly from Europe, and 2.700 individuals Personal Members, representing over 26 000 people working in plant science. EPSO's mission is to improve the impact and visibility of plant science in Europe, to provide authoritative source of independent information on plant science including science advice to policy, and to promote training of plant scientists to meet the 21st century challenges in breeding, agriculture, horticulture, forestry, plant ecology and sectors related to plant science. <https://epsoweb.org/> EU Transparency Register Number 38511867304-09