EPS-based solutions to increase soil structure and resilience to drought

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Motivation

Although several studies demonstrated the potential of different substrates applications such as organic amendments (OA) (Figure 1), to improve microbial diversity, as well as soil structure and aggregate stability [1], [6], it has been estimated that almost 40% of the total agricultural land in Europe is prone to soil degradation at a moderate or higher level of severity [4]. Increasing temperatures due to climate change, with more scarce and intense rainfall, accentuates these processes further lowering the capability of soils to store and release water and nutrients and support plant growth. Microorganisms and their metabolic products affect soil structure by binding loose soil particles into water-stable aggregates[3]. In particular, extracellular polymeric substances (EPS), produced by soil microorganisms, are known to have numerous, positive effects on soils, including improved water retention and aggregate stability[2]. Gaining insight into the mechanisms regulating EPS formation in soil and their role in determining soil properties can enable solutions to prevent soil degradation. Therefore, this research project aims to develop engineering strategies to enhance EPS production and increase soil structure and resilience to drought.

Technological challenges

Despite decades of research on the industrial potential of EPS (e.g., bio-lubricants, thickeners, and preservatives) [5]:

- The use of EPS in agriculture is still very limited
- Our knowledge of EPS composition, structures, and functions is far from complete.
- Our understanding of the mechanisms involved in the biosynthesis and degradation of EPS in soil and their role in determining soil properties is still unclear (Figure 1).

This knowledge gap hampers the possibility of developing effective agricultural strategies able to enhance EPS formation in soil.

Figure 1. Practical sources of soil organic amendments.

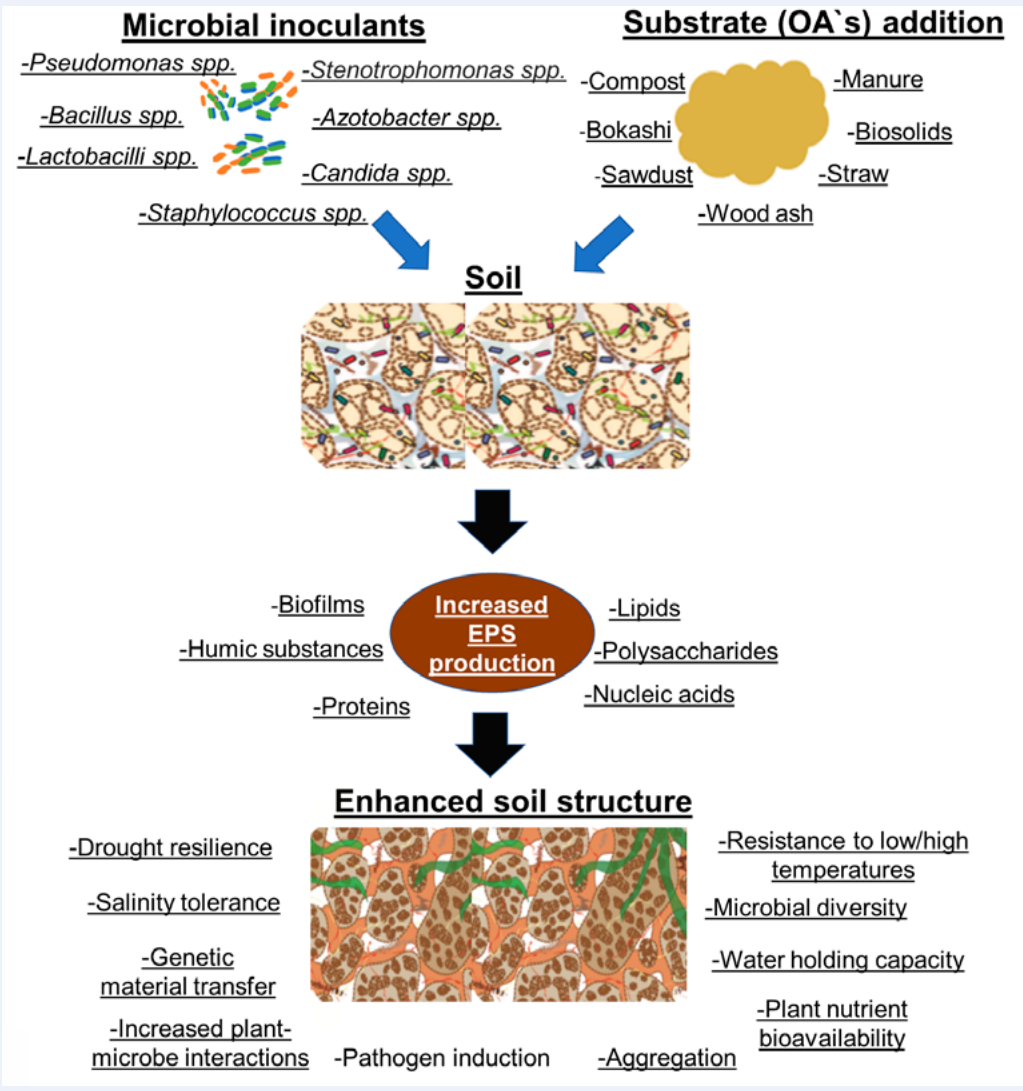

Figure 2. Modified conceptual framework of the research approach [3].

Research goals

The project's ultimate goals are to develop nature-based management strategies to increase soil structure and resilience to drought via EPS stimulation (Figure 2). To develop a fundamental understanding of the EPS production mechanisms in soil, the research will be targeting the following research questions:

1: What is the role of OAs and C/N ratio in soil EPS production?
2: What is the role of EPS in soil aggregation?
3: What is the relationship between EPS and drought resistance of the soil?
4: What are the effects of OA-induced EPS on different types of soils?

References

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