Contribution ID : **19** Type : **Poster**

Physiological and Transcriptomic Responses of Spirodela polyrhiza to Distinct Colonization Strategies by Plant Growth-Promoting Bacteria

martedì 29 settembre 2026 17:55 (20)

Duckweeds (Lemnaceae) are rapidly growing aquatic plants with potential as sustainable feedstocks for human nutrition, animal feed, biofuel production, and wastewater bioremediation. In natural environments, duckweed coexists with diverse microbial communities, forming a complex host-microbiome assemblage known as a holobiont. Within this assemblage, duckweed-associated plant growth-promoting bacteria (PGPB) play a critical role in enhancing duckweed growth through direct and indirect mechanisms. However, the specific mechanisms driving strain-specific growth promotion remain largely uncharacterized. Therefore, this study aimed to elucidate these mechanisms by comparing the effects of two PGPB with distinct colonization strategies—*Terrimicrobium* sp. PS02 and *Aeromicrobium* sp. PS05—on the growth, biochemical composition, and transcriptomic profile of the giant duckweed, *Spirodela polyrhiza*. Under SEM observation, strain PS02 attached to the duckweed surface through the aggregation of 1–3 cells, while strain PS05 formed filamentous extracellular polymeric substance (EPS)-mediated microcolonies. These distinct colonization strategies aligned with bacterial cell density, where PS05 established approximately one order of magnitude higher bacterial populations than PS02. Both PGPB strains enhanced duckweed biomass, yielding 1.2- and 1.4-fold increases, respectively. Markedly, both strains enhanced starch accumulation and turion formation without reducing protein or photosynthetic pigment content. Transcriptomic profiles demonstrated that PS05 regulated carbohydrate biosynthesis and carbon allocation. This study provides integrated evidence linking bacterial colonization strategy, biomass production, and host transcriptomic regulation, allowing us to better understand the mechanisms required for engineering high-performance duckweed–microbiome systems for sustainable biomass production.

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Scientific Session

Microbiome & Interactions

Keywords

plant-growth promoting bacteria, Spirodela polyrhiza

References

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Session Classification : Poster Session I