Microbial mediated plant salt stress mitigation

MicroFunction Workshop

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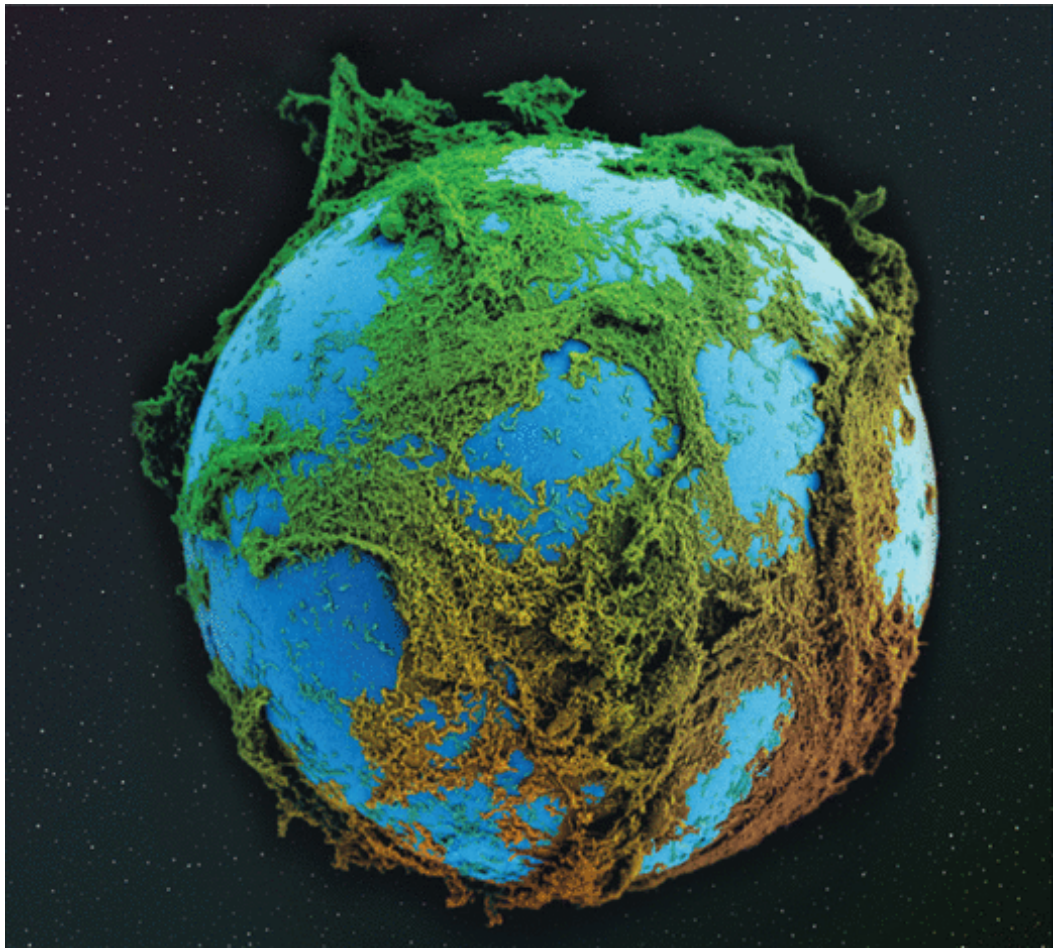
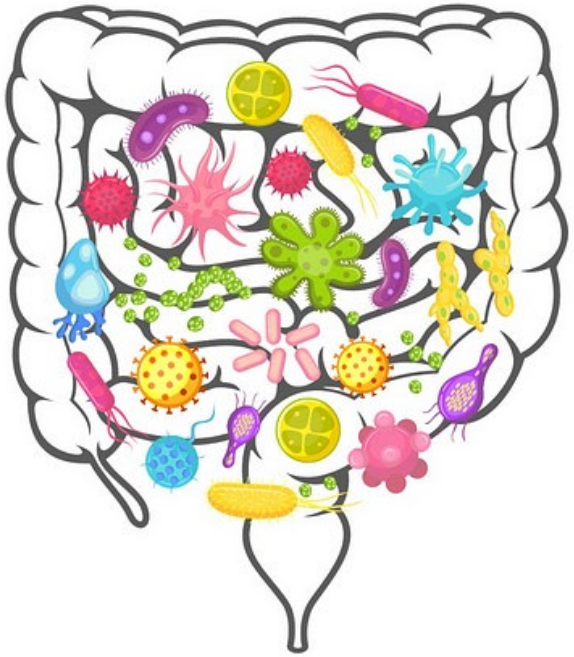
Yousef Jameel ACADEMIC PROGRAM

Microbes are skilled in dealing with fluctuating environmental conditions

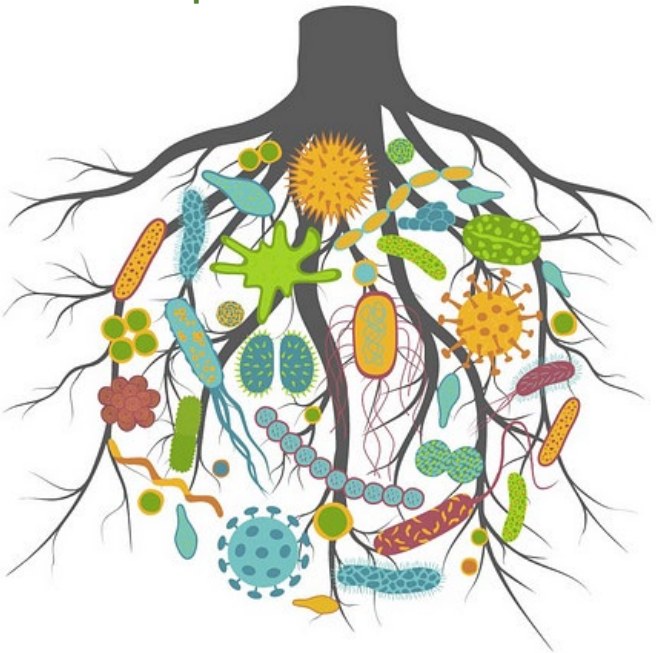


They persisted under harsh and changing conditions for billion years.

Gut Microbiome

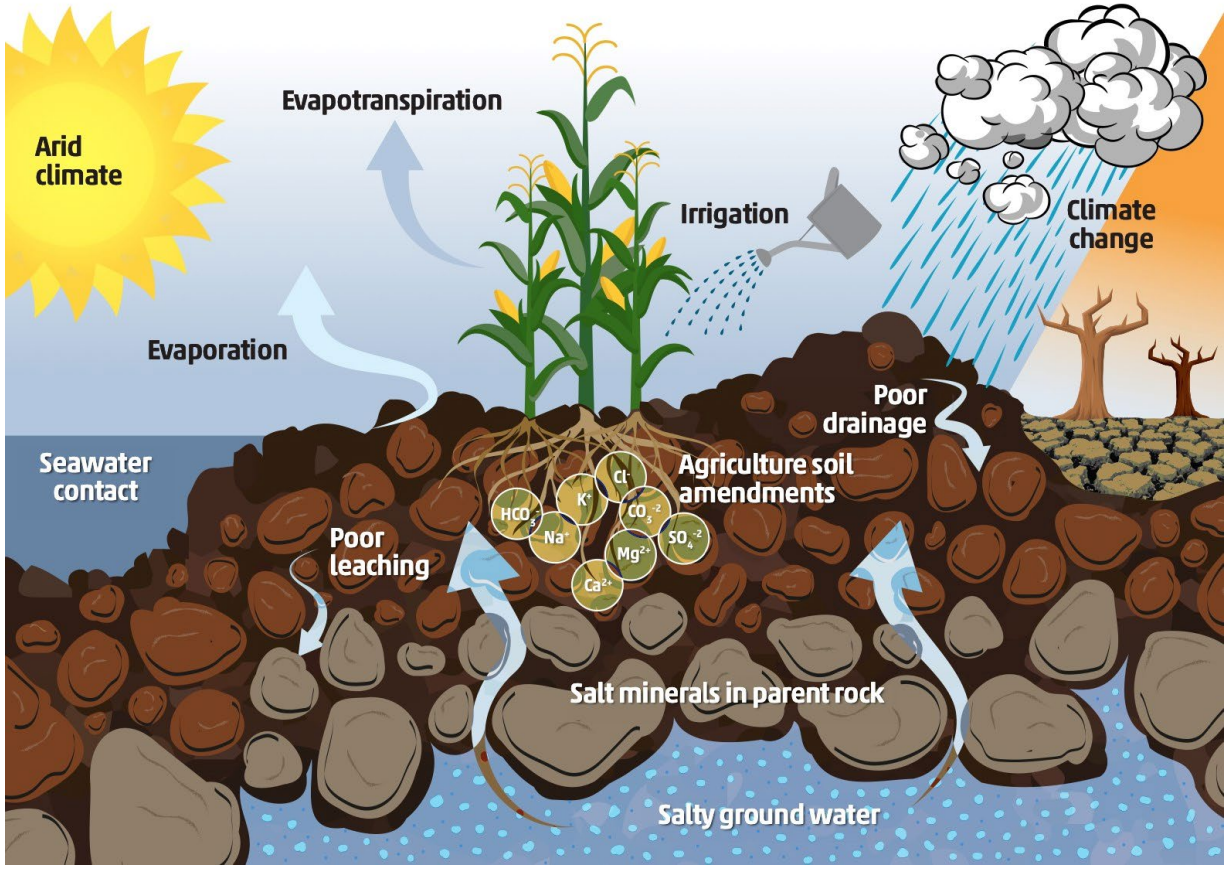


Rhizosphere Microbiome

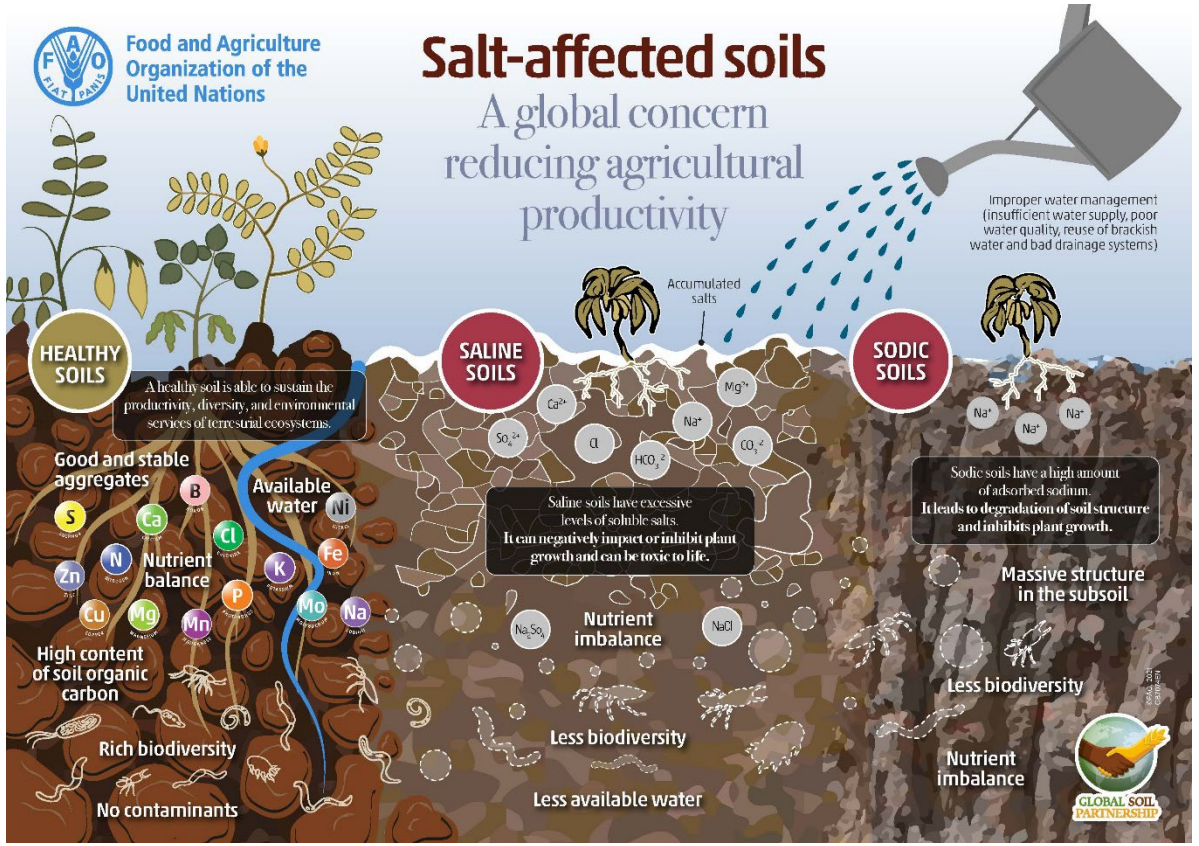


Illustrated by Author on Canva

Salinity stress poses a serious challenge



Impact of salts on plant growth



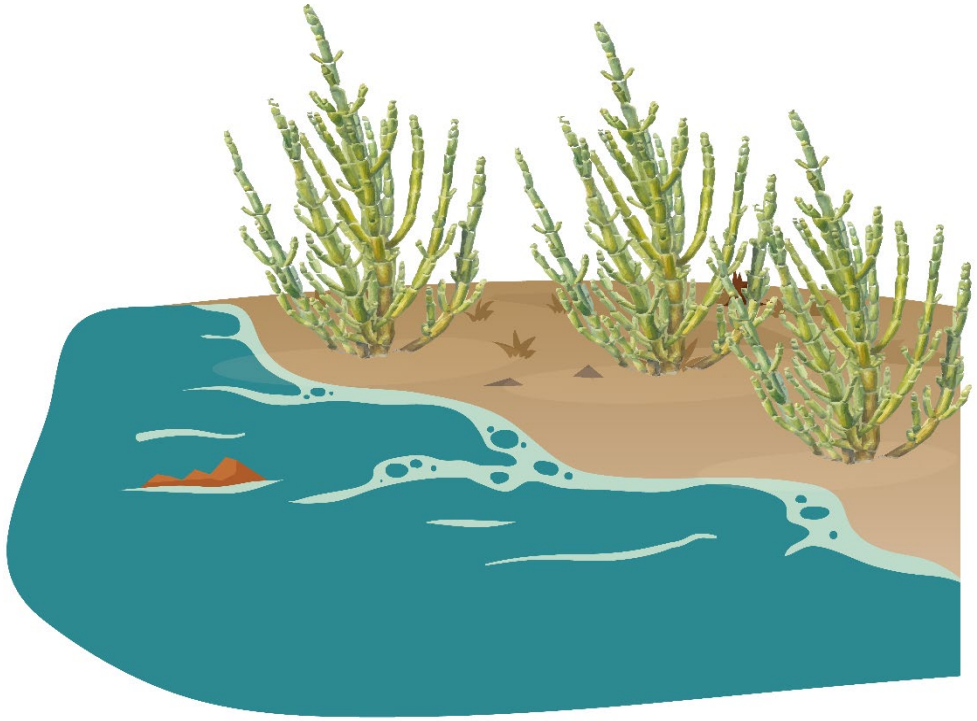
[Food and Agriculture Organization (FAO)]

Over 833 million hectares of soils worldwide are already salt-affected

Represent nearly 10% of the world's land surface

Naturally salt tolerant plants in our planet

Evolution of halophytes



Halophytes have evolved various adaptive salt-tolerance mechanisms to thrive in high-salinity environments.

Plant–microbe co-evolution

Have been co-evolved with their microbiota.

Plant cooperate with their microbes to alleviate stressors (‘cry for help’)

Influence of salinity on bacterial microbiome assembly of halophytes and crops

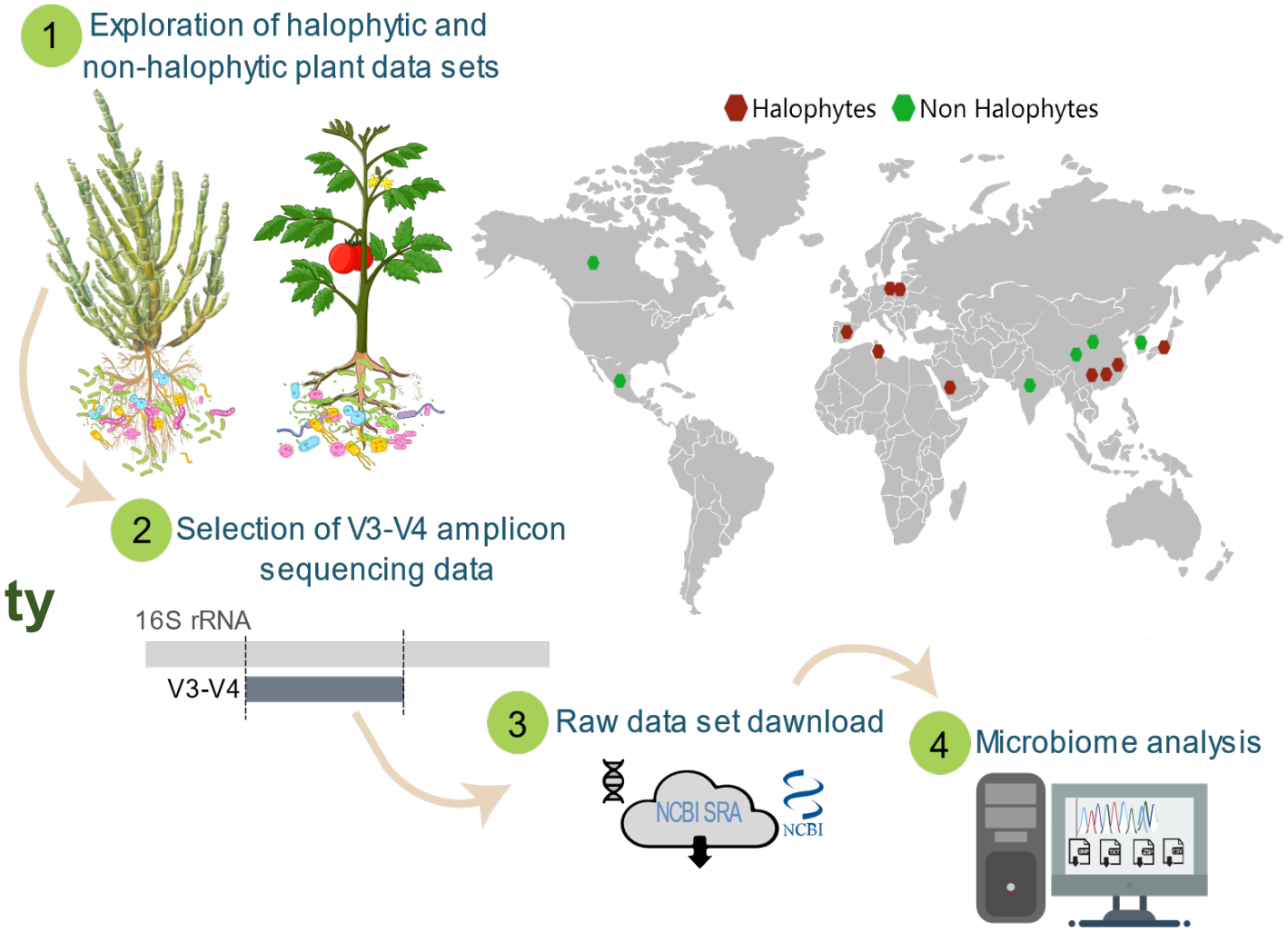
Main objectives

1- Untangle the microbiome structure between two halophyte groups and non-halophytes.

2- Identify marker taxa of high salinity adapted plants using three different approaches.

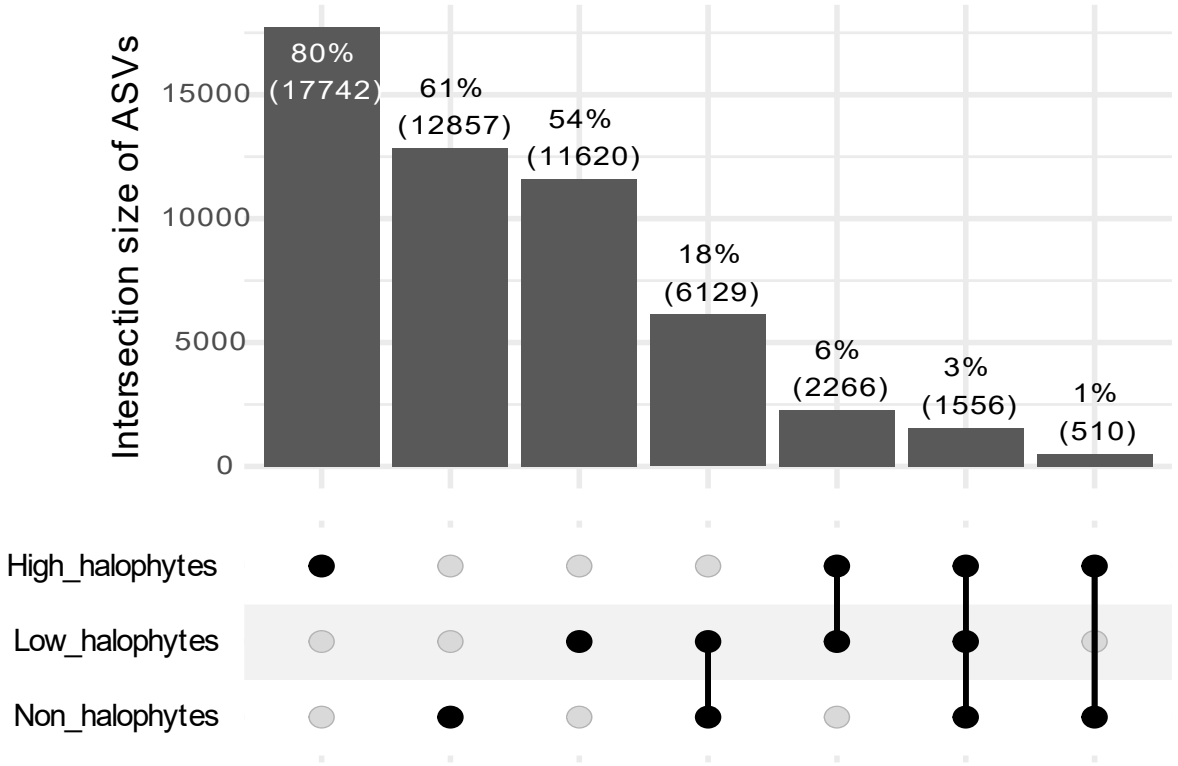
40 plants
15 microbiome studies

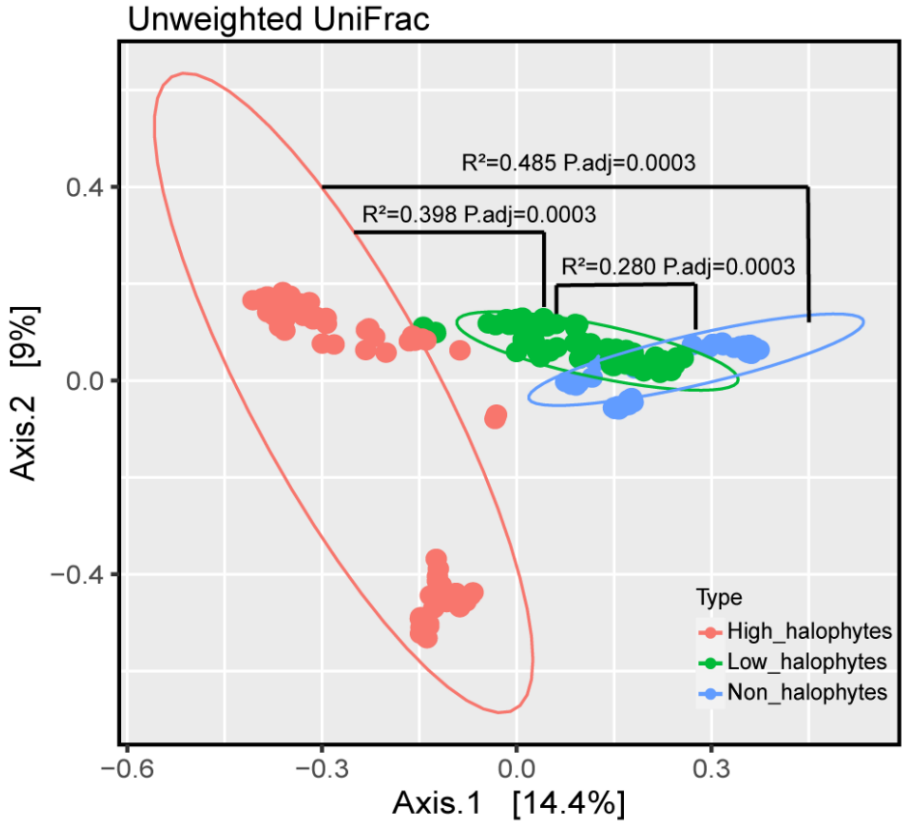
Meta-analysis study



Schematic overview of an experimental analysis workflow

Microbiome structure between high-halophytes, low-halophytes, and non-halophytes.



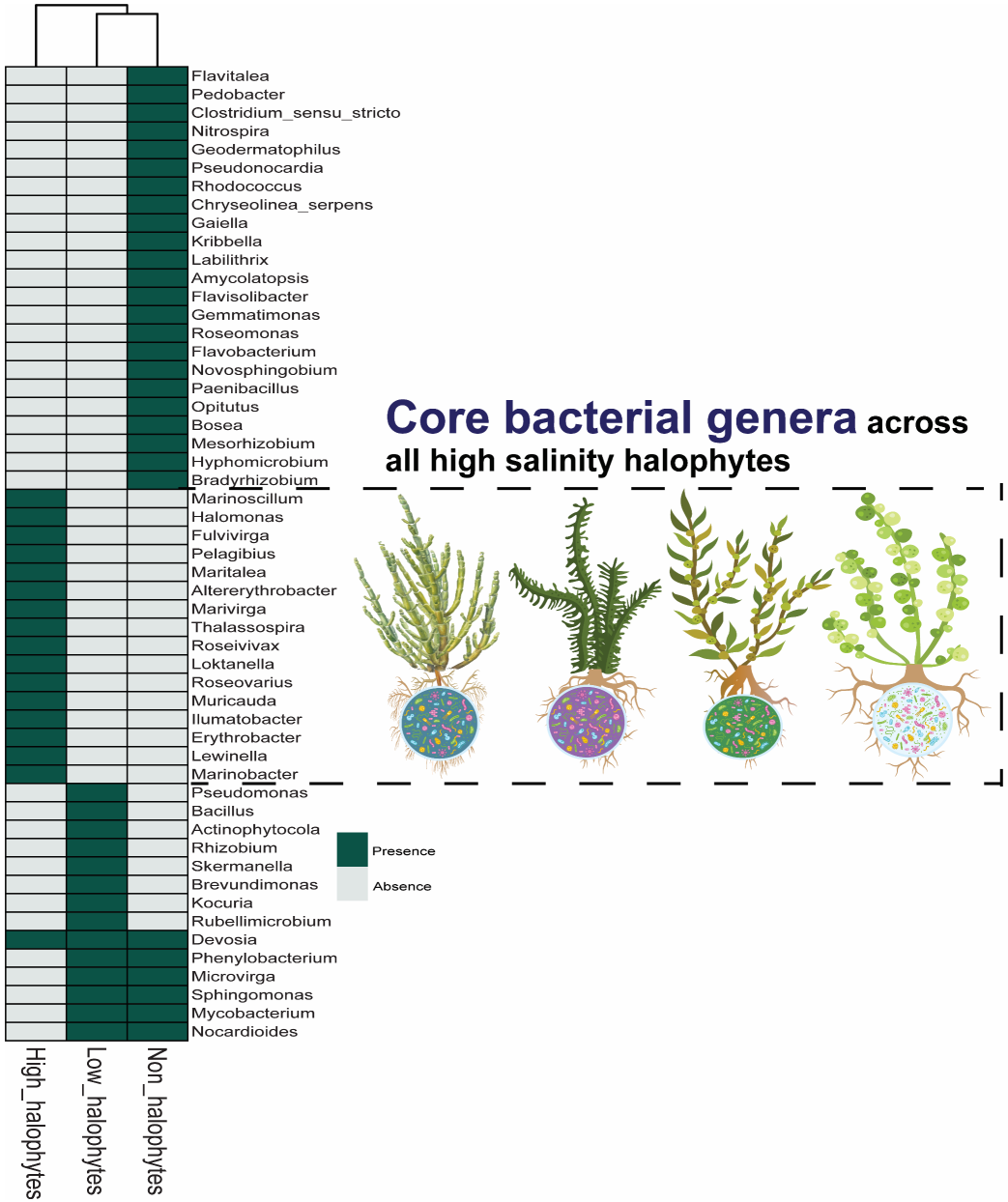


High-halophyte plants exhibit 80% unique taxa.

The most shared taxa are between low halophytes and non-halophytes 18%.

A clear pattern in diversity and overall microbiome composition for high-halophytes

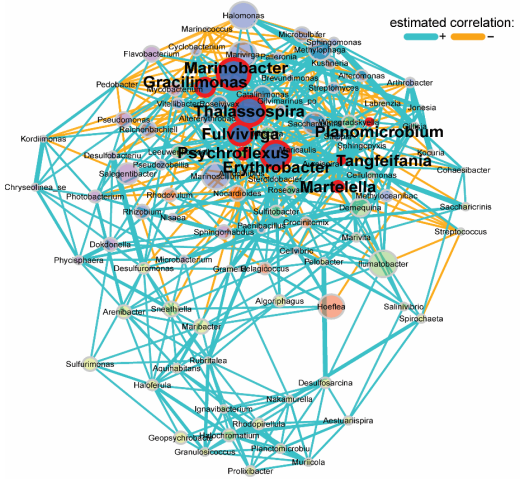
Identify marker taxa of high-halophytes using three different approaches



Core bacterial genera across all high salinity halophytes

Key hub taxa

high salinity halophytes



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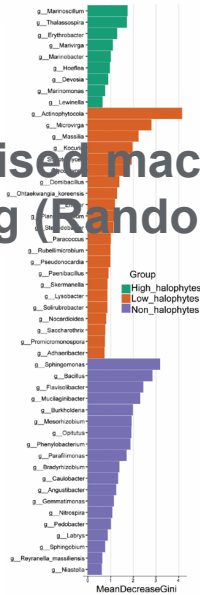
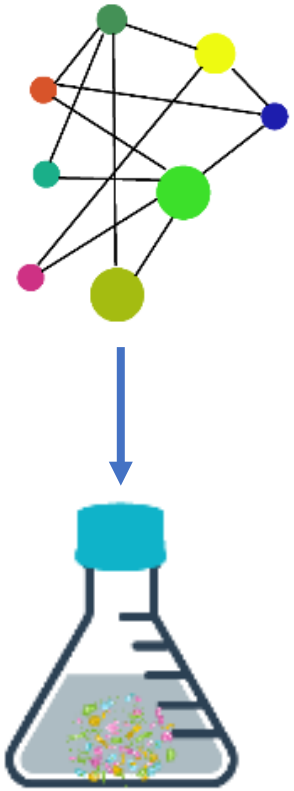


Supervised machine learning (Random forests)

Validate the potential of the SynCom and the whole rhizosphere microbiome of a plant of high halophytes.

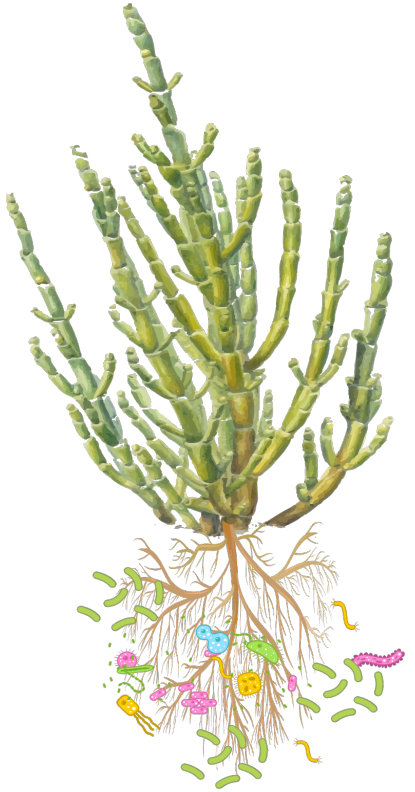
Overlap between the three approaches

SynCom construction



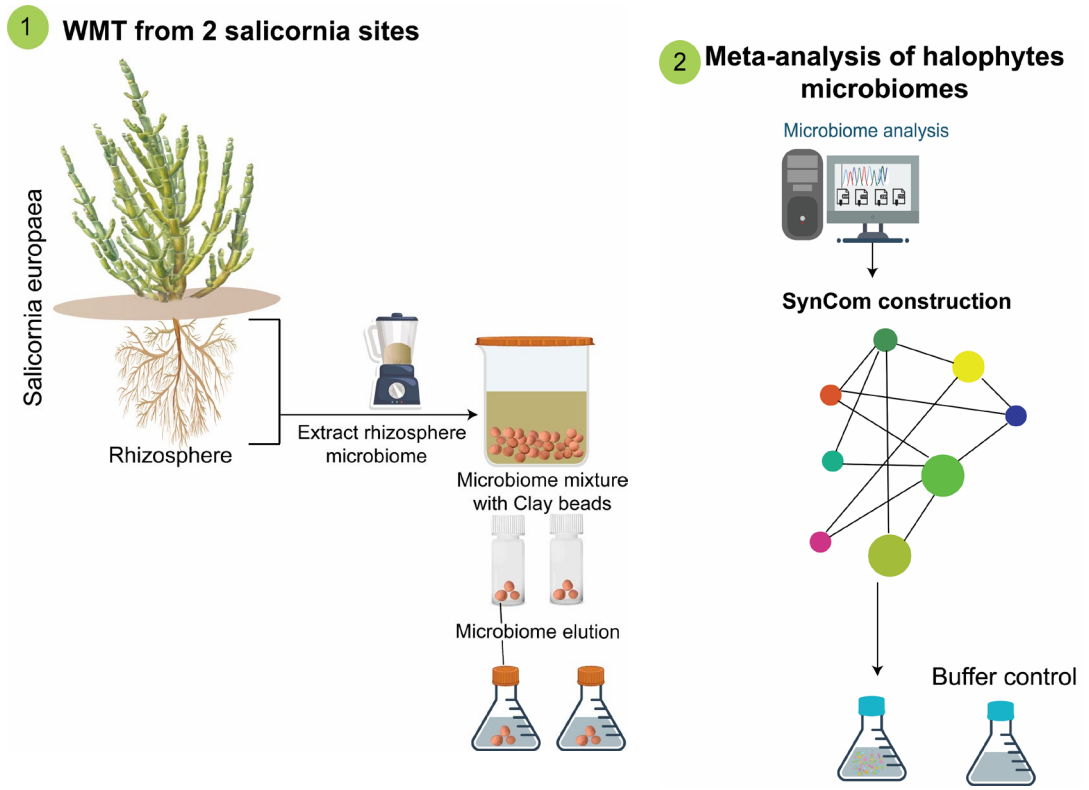
Whole Microbiome Transplantation (WMT)

Site 1



Site 2

Workflow of the experiment



Abdelfadil *et al*. under preparation ,(2024)

Hypothesis

1- Microbiome applications enhance growth and adaptation of salt-sensitive and raise the salinity tolerance threshold of tolerant tomatoes.

2- WMT and SynCom enhances colonization by halophytic communities in response to salinity.

Plant growth parameters

4 Treatments

-WMT inoculum: (2)

-Syn inoculum : (1)

-Untreated control: (1)

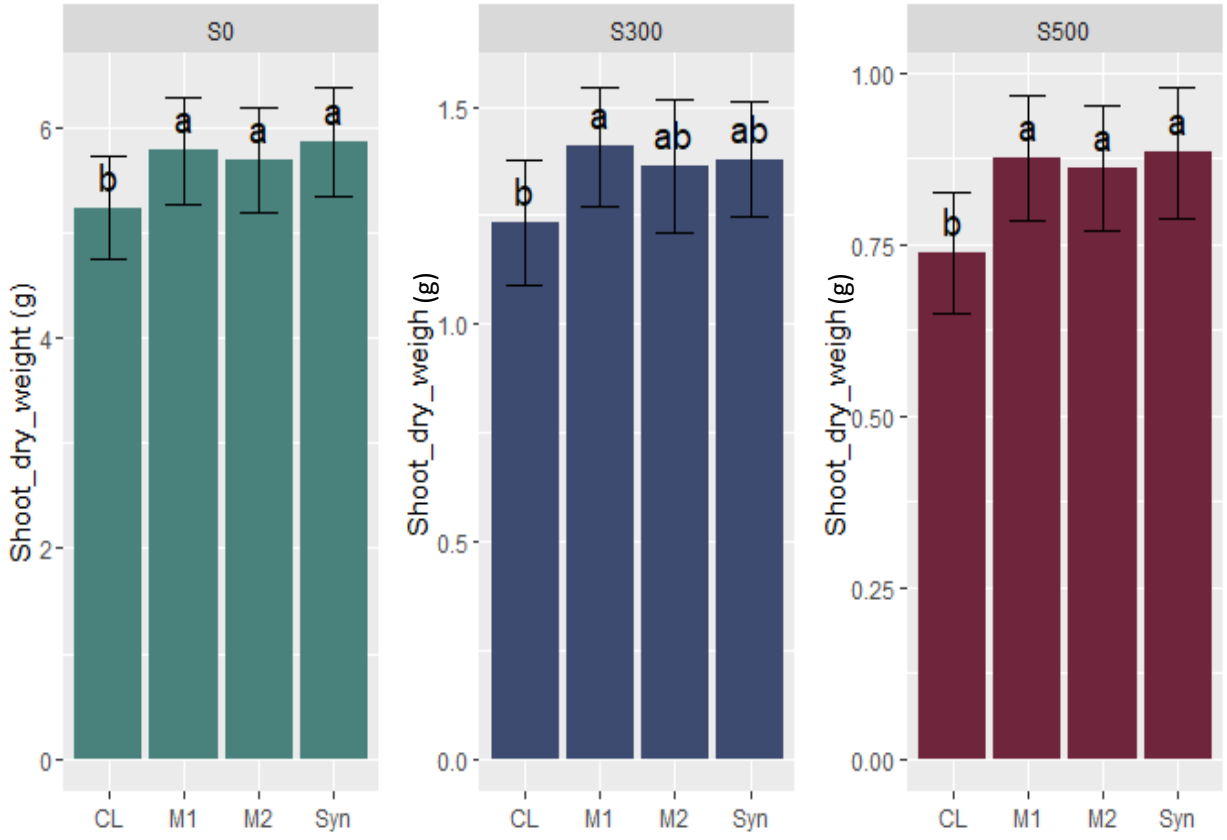
3 Salinity concentrations

-0 mM NaCl

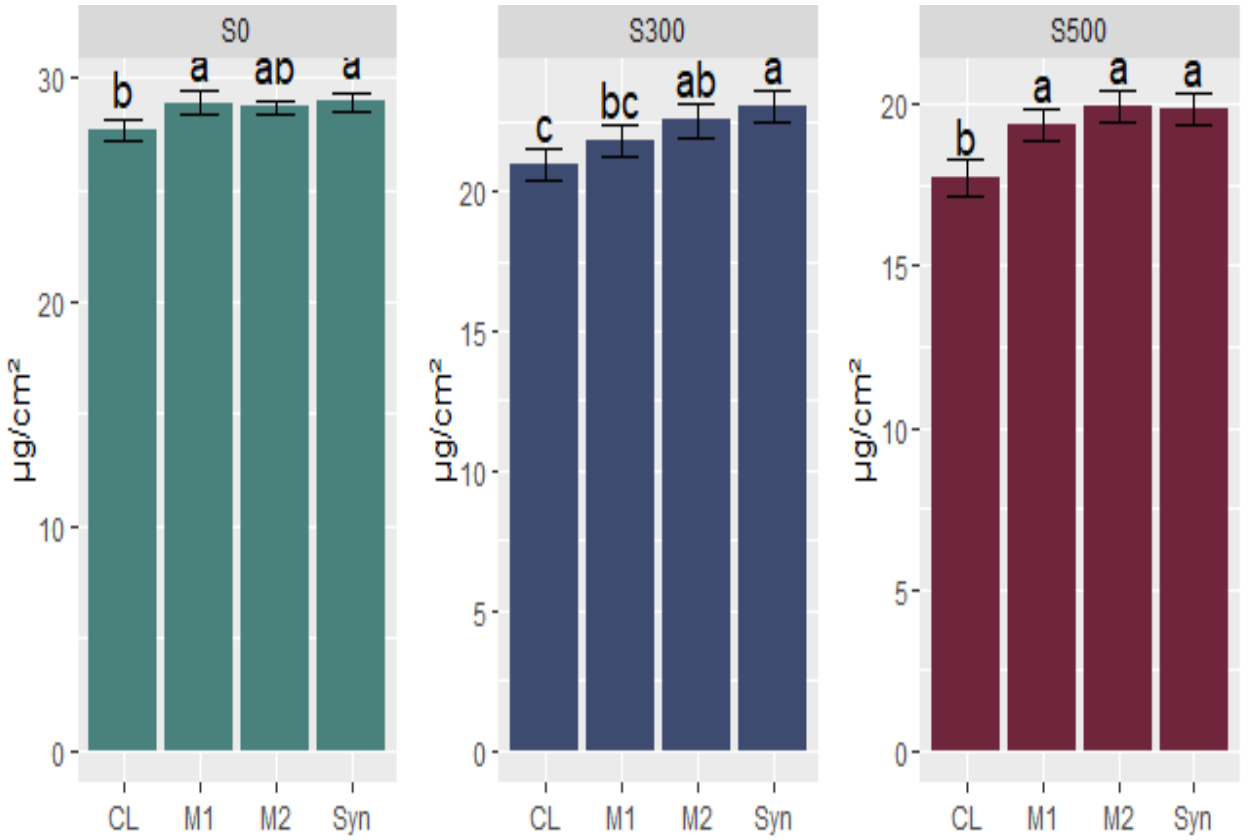
-300 mM NaCl

-500 mM NaCl

Shoot dry weight



Chlorophyll content

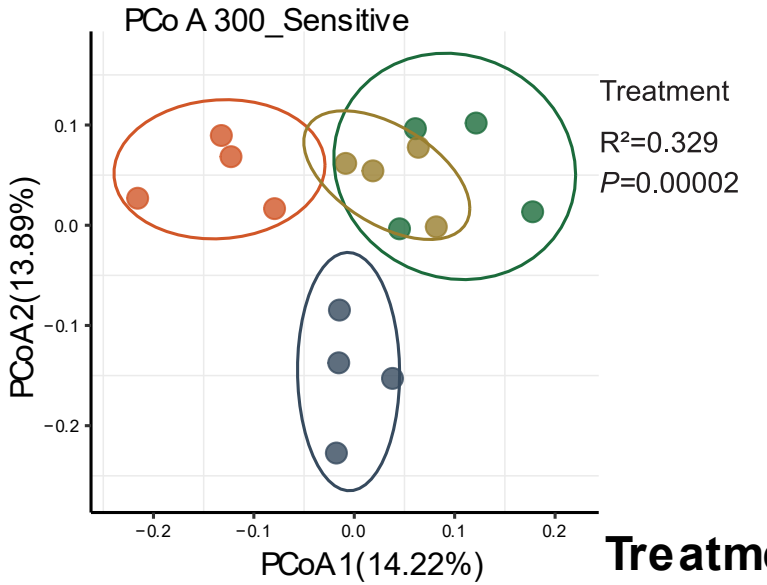


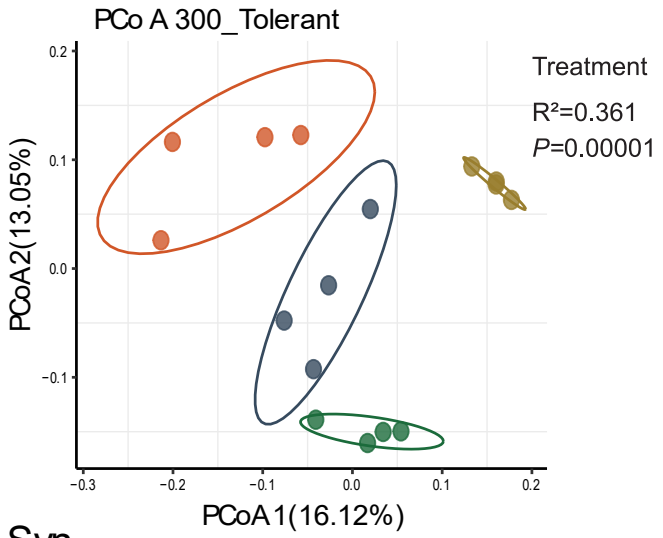
Alterations in microbiome composition

Sensitive

Tolerant

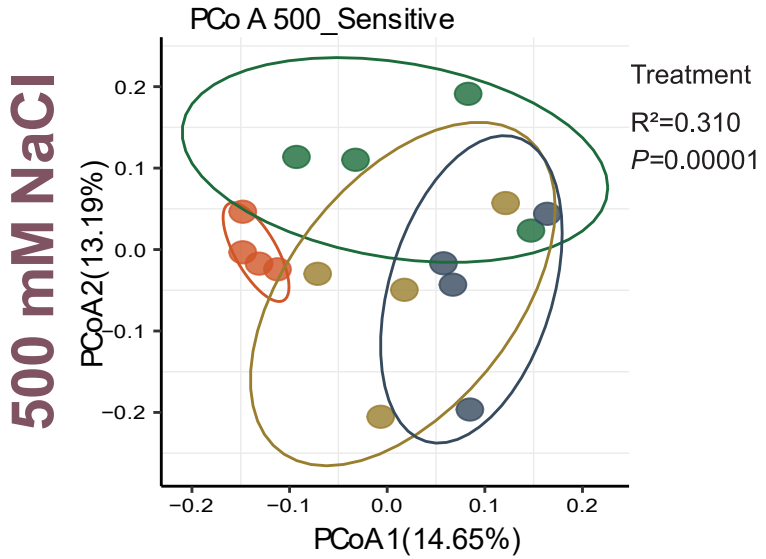
300 mM NaCl

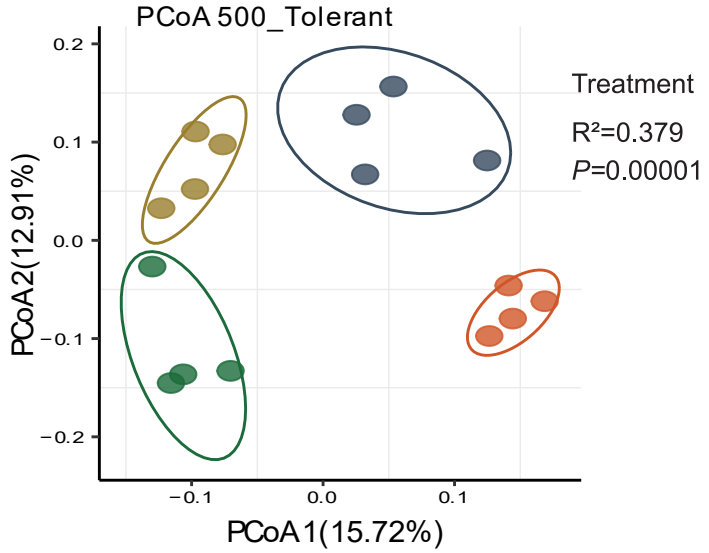




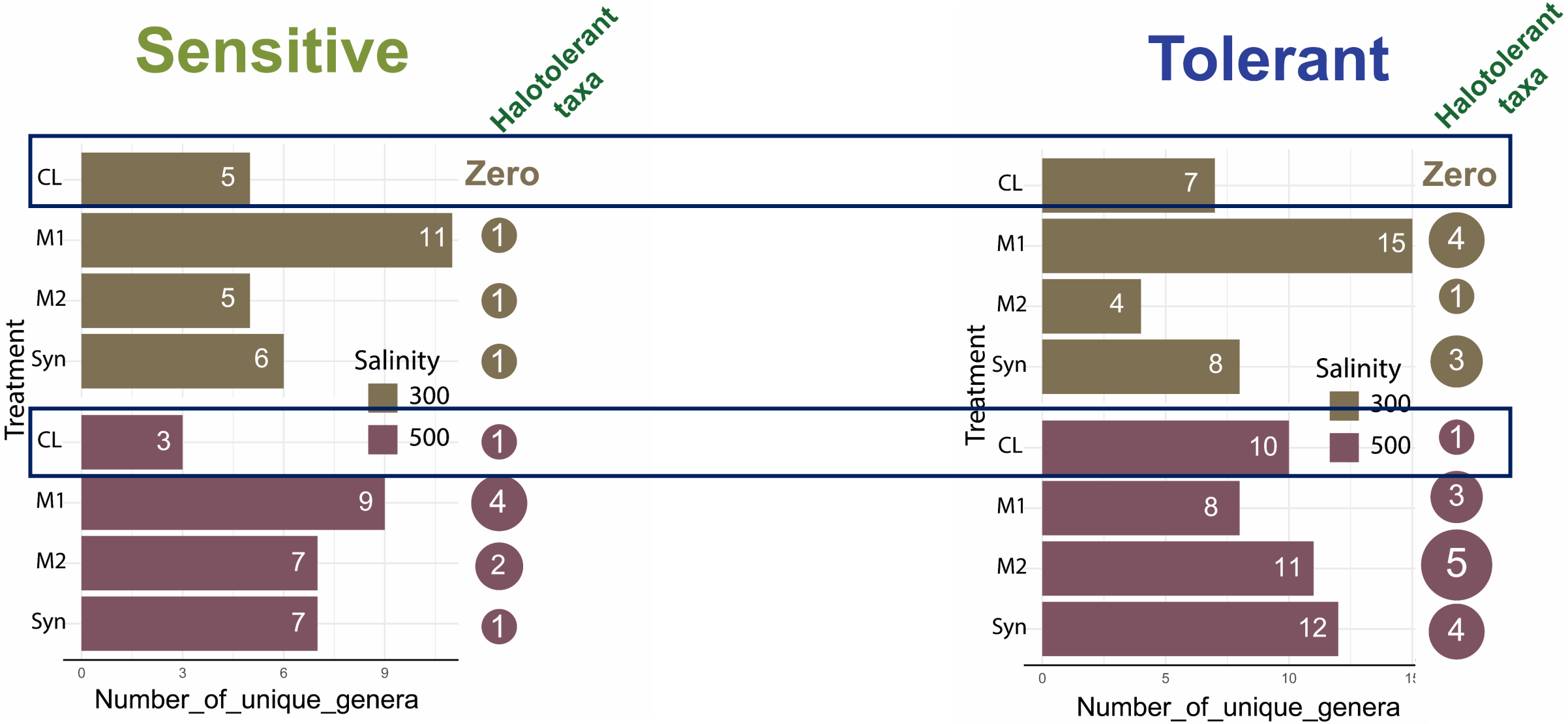
Treatment CL M1 M2 Syn

500 mM NaCl



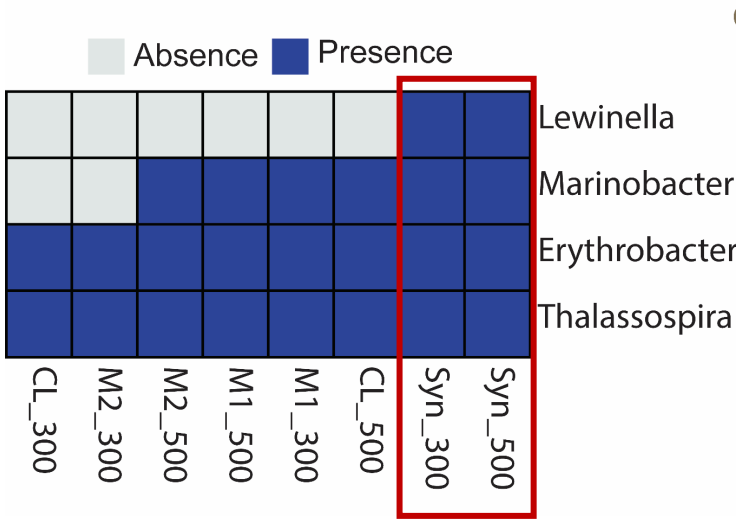


Applications enhances colonization by halophytic communities in response to salinity.

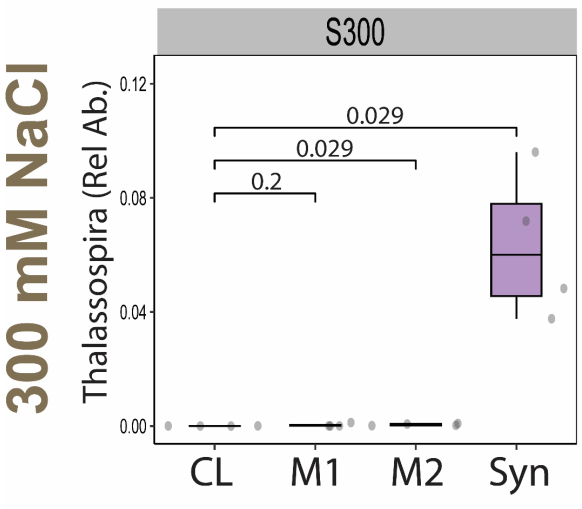


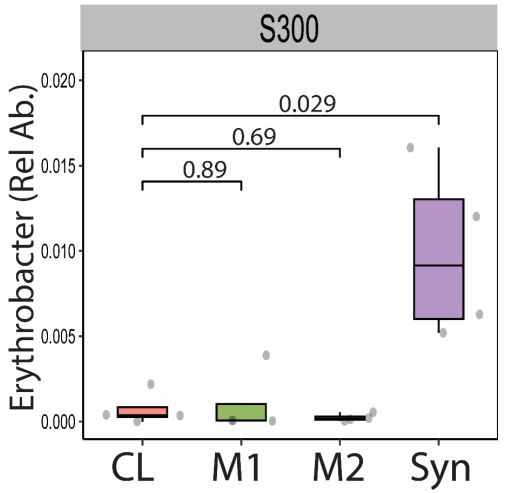
Selective taxa enrichment in tomato with SynCom

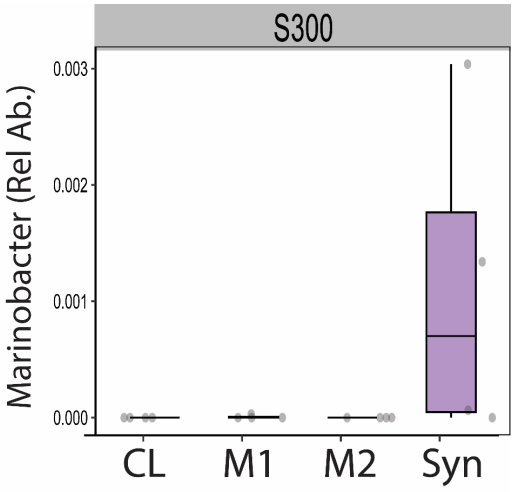
Sensitive



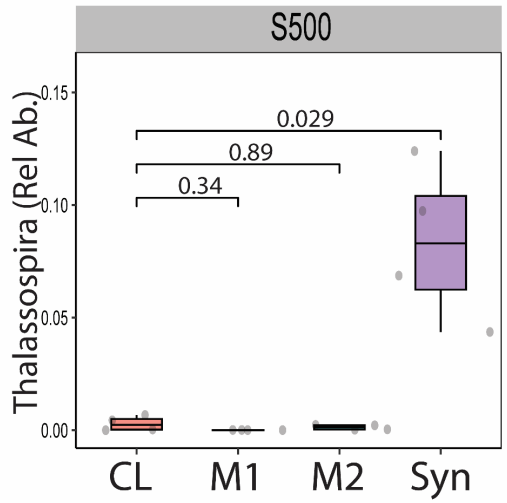
300 mM NaCl

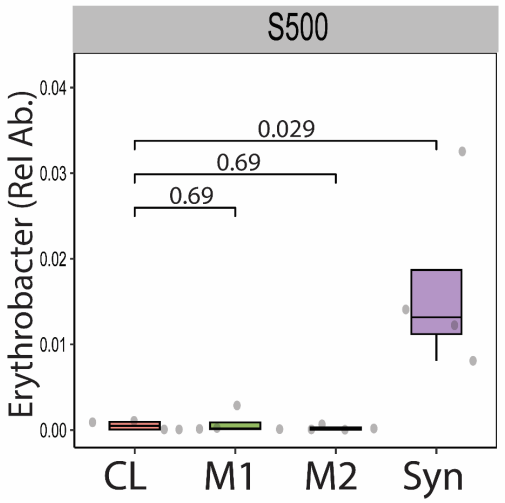


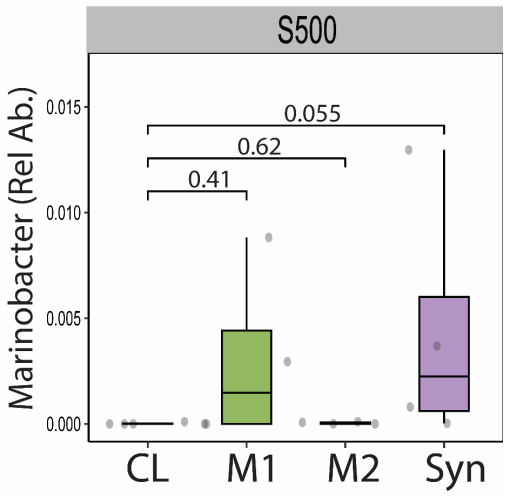




500 mM NaCl

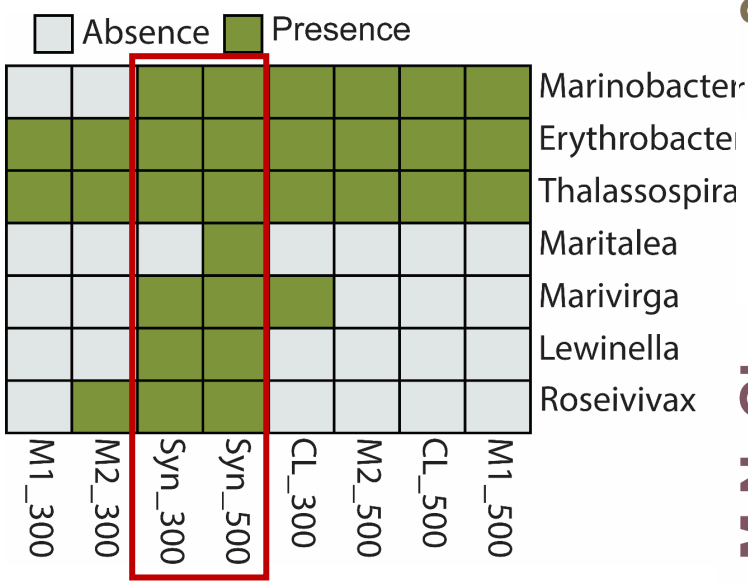


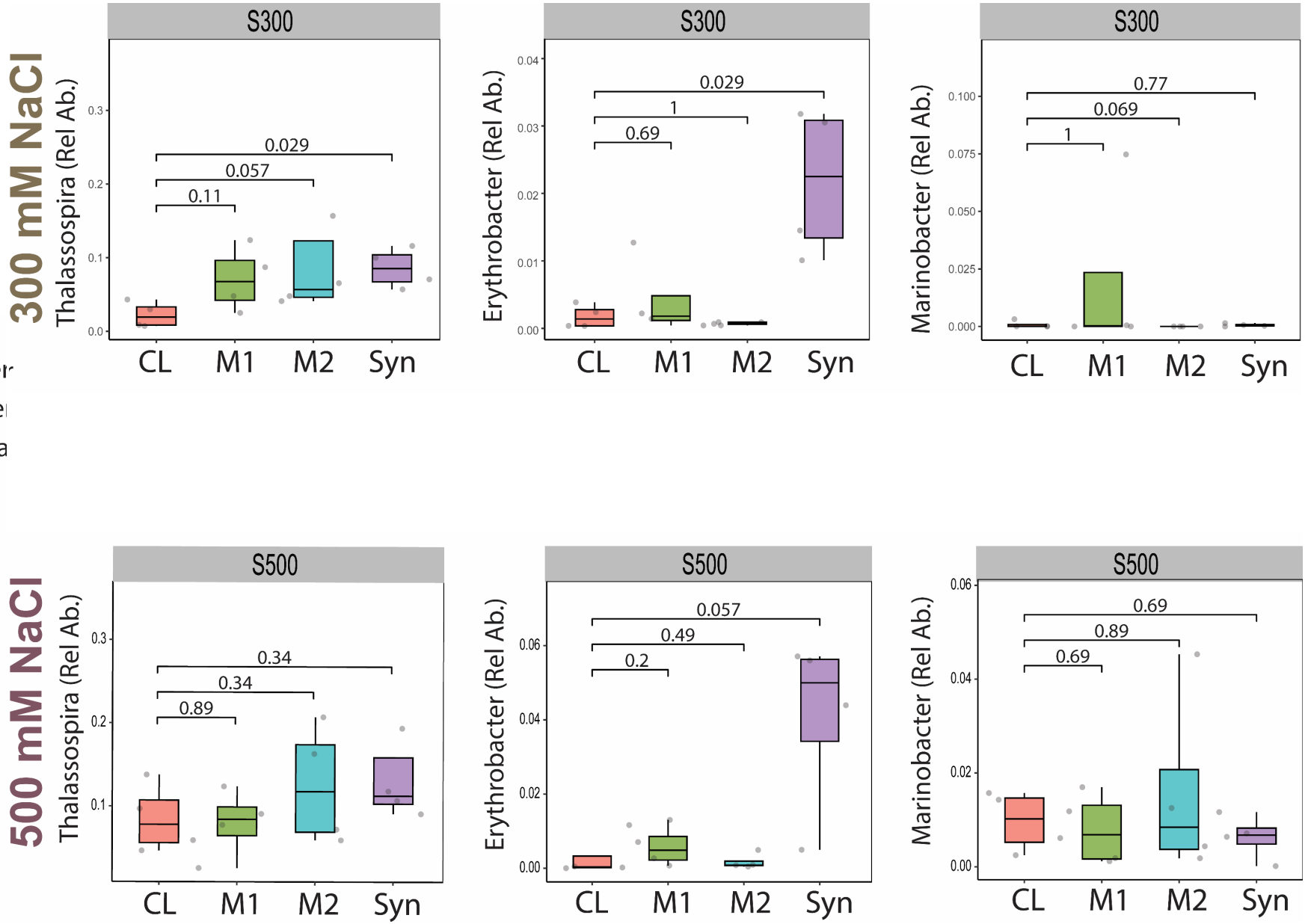




Selective taxa enrichment in tomato with SynCom

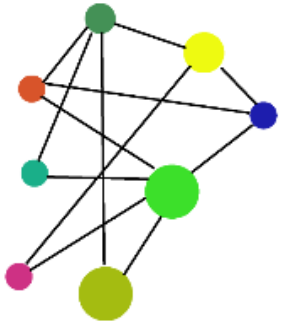
Tolerant





Take Home Messages

- Halophytes represent a repository of robust microbes that possess beneficial traits for other sensitive plants.



- *In silico* identification of shared patterns associated with plants with similar environmental conditions help to design effective SynComs.

- Microbiome-based applications such as WMT and Sync capable of rapidly improving the adaptation and resilience of non-halophytic plants to salt stress.

Thank you for your attention