

Harnessing the power of deserts to make plants resistant to drought, heat and flooding

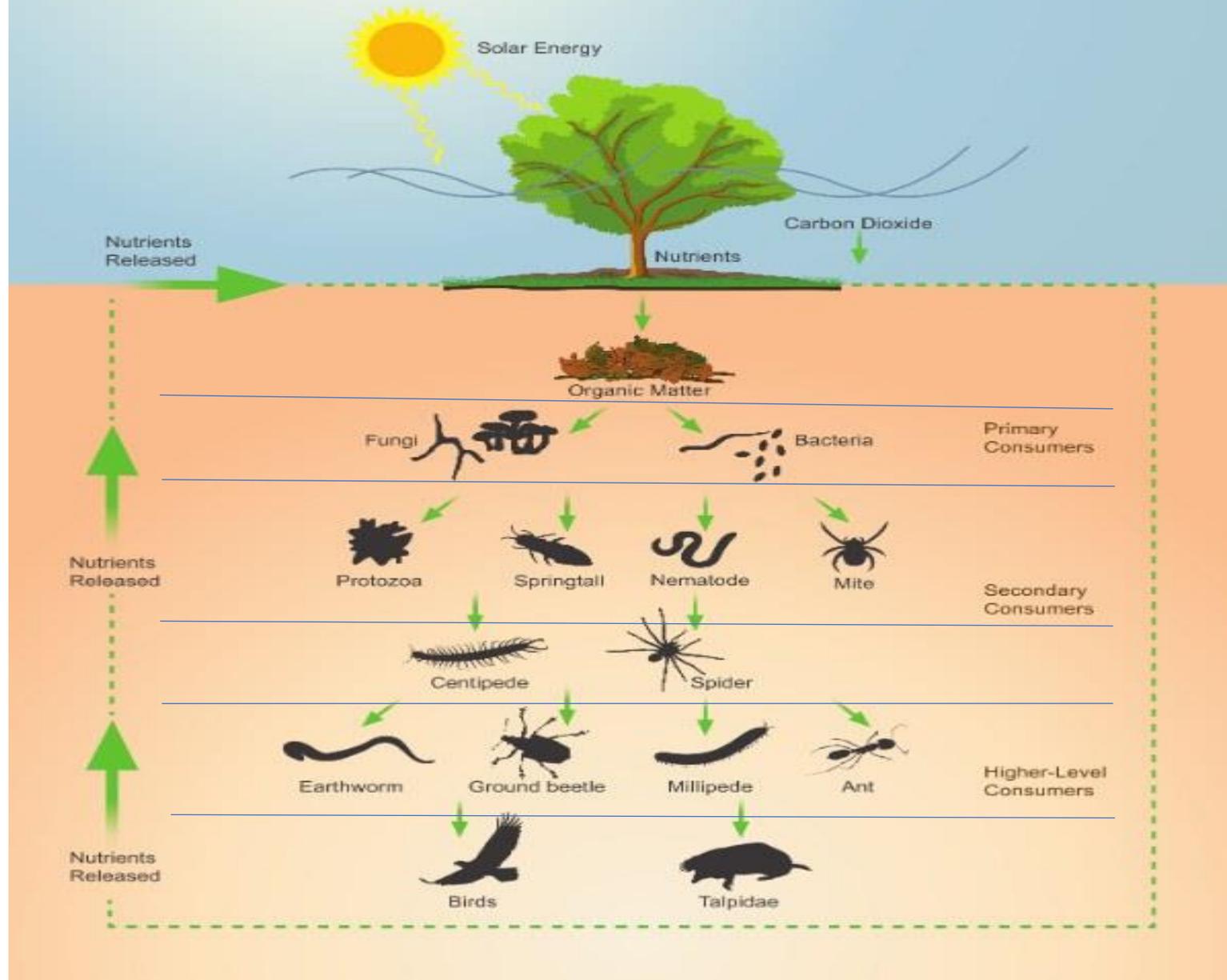
Heribert Hirt

Desert Research Initiative

KAUST, Saudi Arabia



The Soil Food Web





NATIVE GENOME PROJECT

Desert Microbial Biobank

Tree scale: 10 |-----|

Taxonomy

- Bacteroidetes: Sphingobacteria
- Proteobacteria: Alpha, beta, gamma
- Firmicutes: Bacilli
- Actinobacteria: Actinomycetia

Compartments

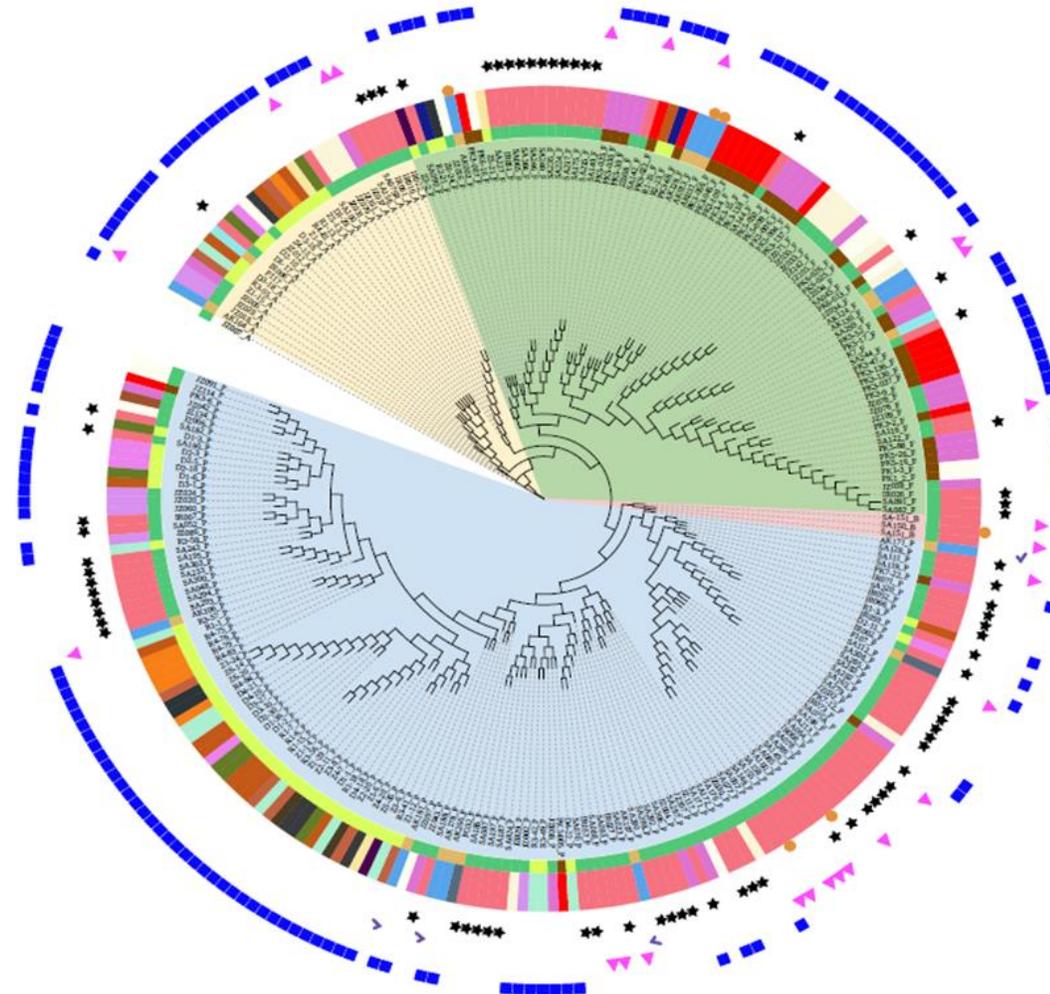
- Bulk Soil
- Nodules
- Rhizoplane
- Rhizosphere
- Root Endophyte

Geographic Location

- Jizan, KSA
- Jordan
- Pakistan
- Thuwal, KSA

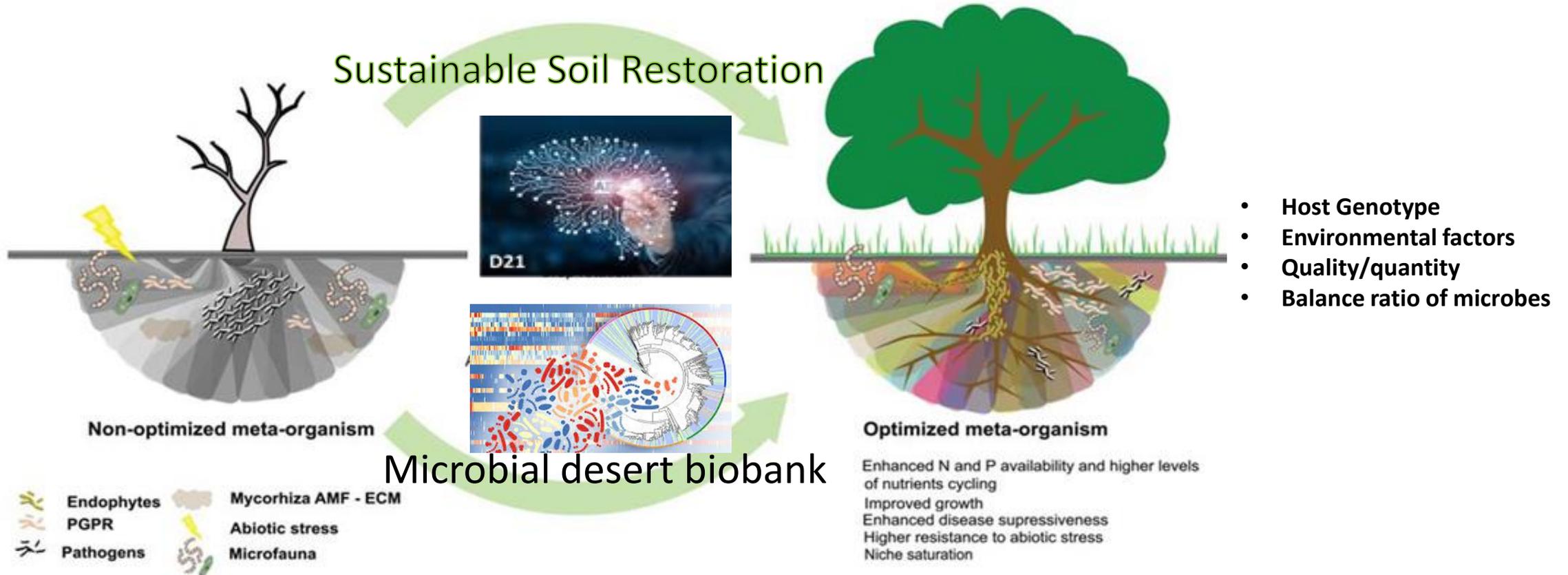
Host

- Asteriscus pygmaeus*
- Astragalus tribuloides*
- Avicennia marina*
- Bassia eriophora*
- Cyperus conglomeratus*
- Dactyloctenium aristatum*
- Erodium acaule*
- Erodium hirtum*
- Euphorbia granulata*
- Filago palaestina*
- Gagea reticulata*
- Halothamnus bottae*
- Halothamnus lancifolius*
- Ifloga spicata*
- Indigofera argentea* Burm.f.
- Panicum antidotale*
- Panicum turgidum*
- Plantago cretica*
- Plantago cylindrica*
- Tribulus terrestris*
- Zygophyllum simplex*
- Unidentified



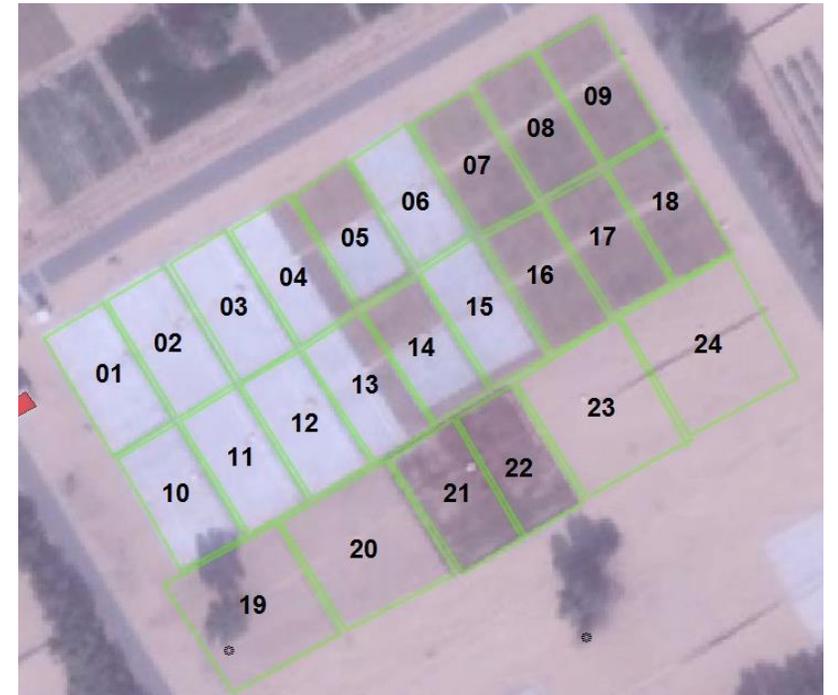
Microbial biobank of > 10 000 culturable isolates from desert soils and plants

Sustainable Intervention Strategy Development



Enterobacter sp. SA187 Enhances Heat Resilience of Crops

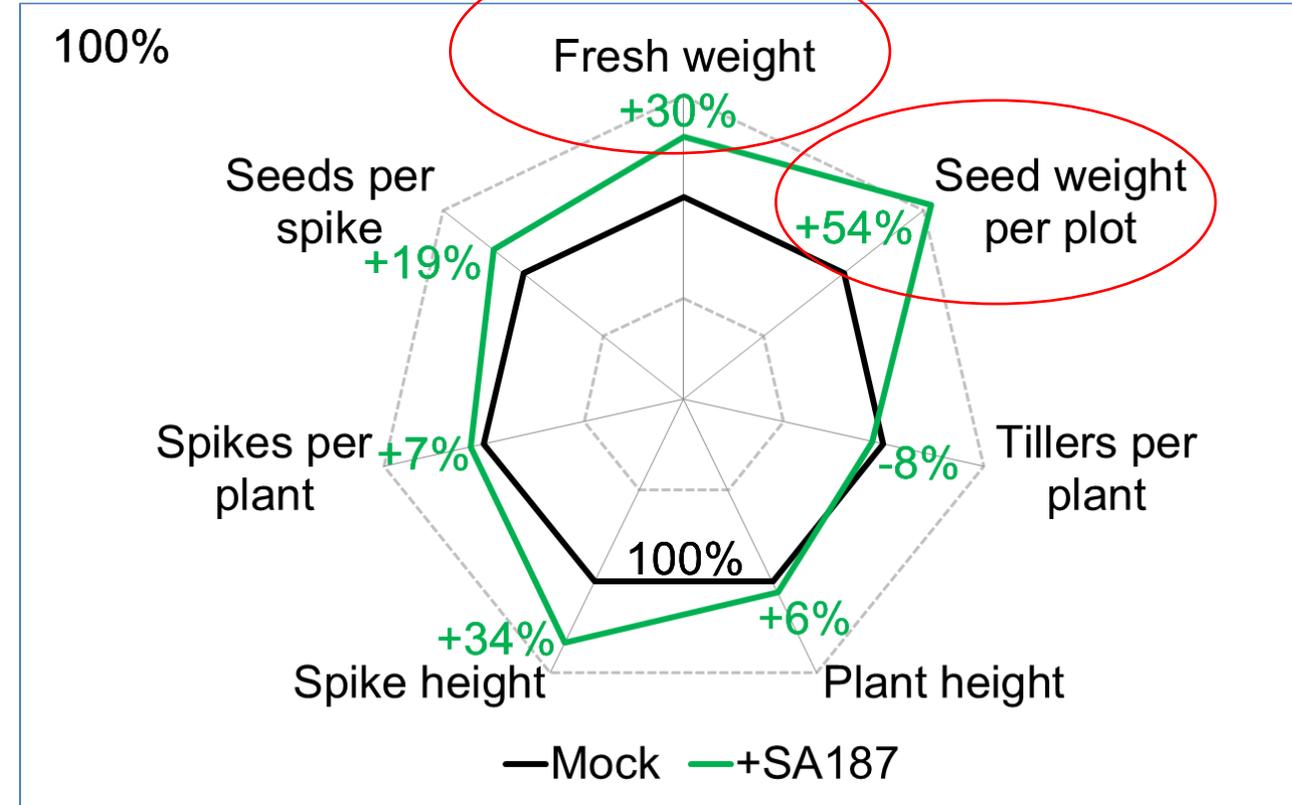
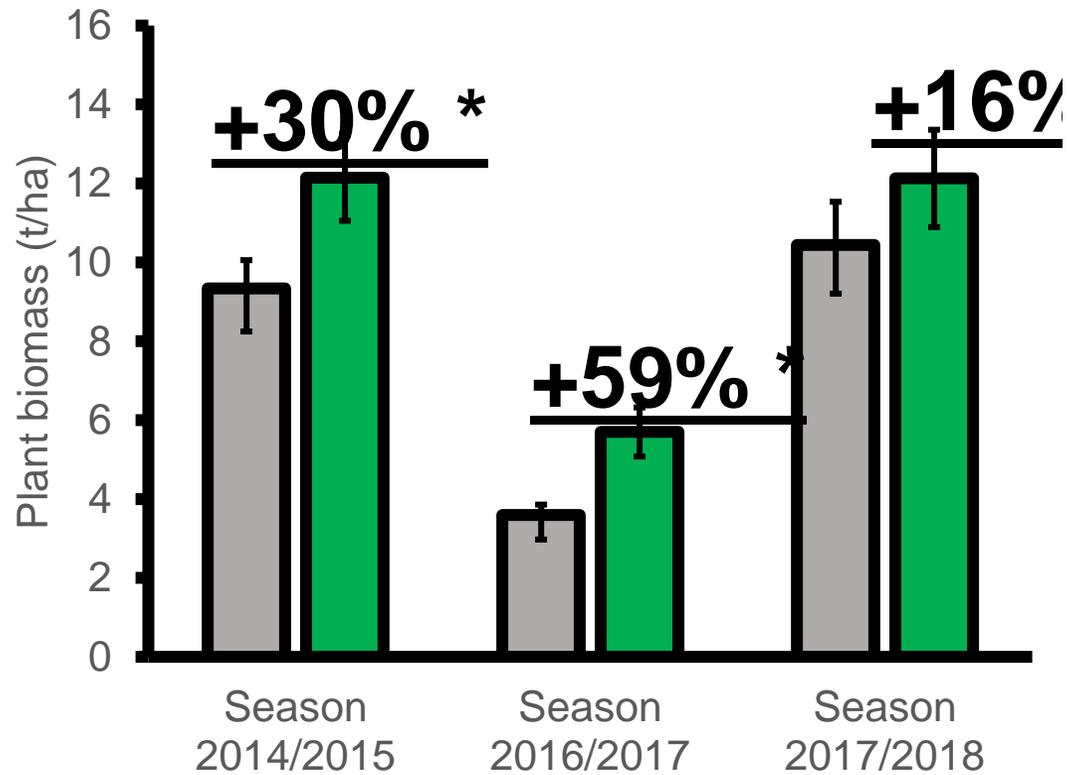
Microbiome treated Crops in Field Trials



Microbiome Field Trials: Wheat, Barley and Alfalfa

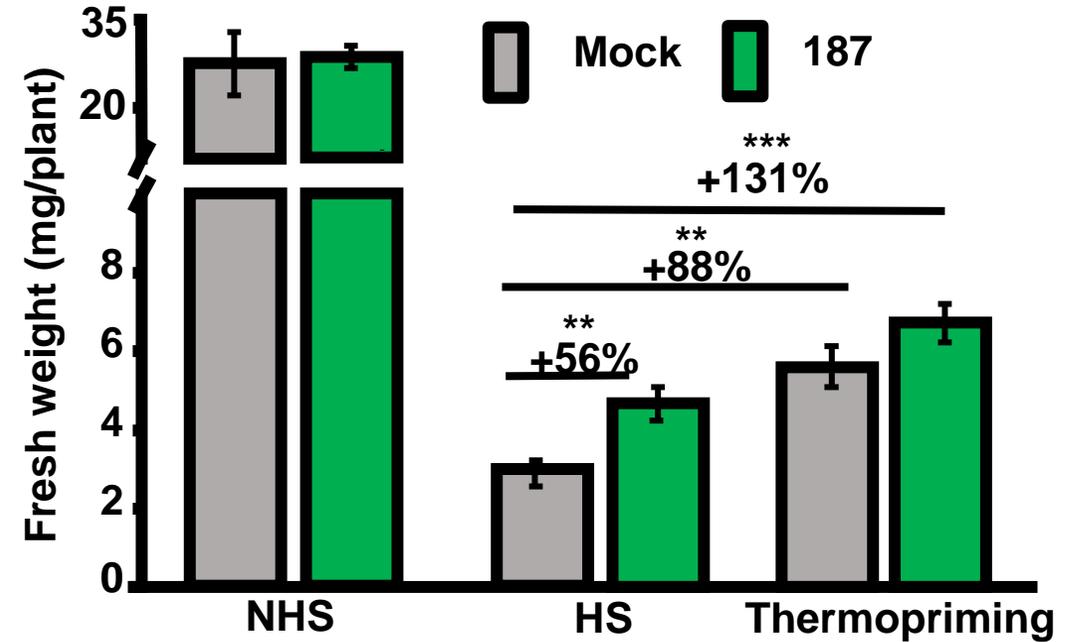
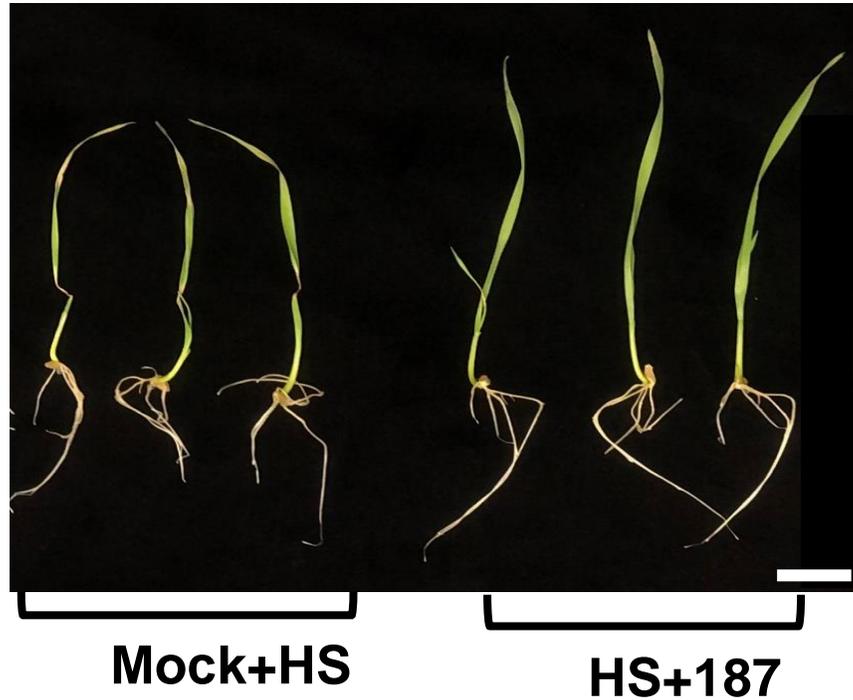


Enterobacter sp. SA187 Wheat Field Trials



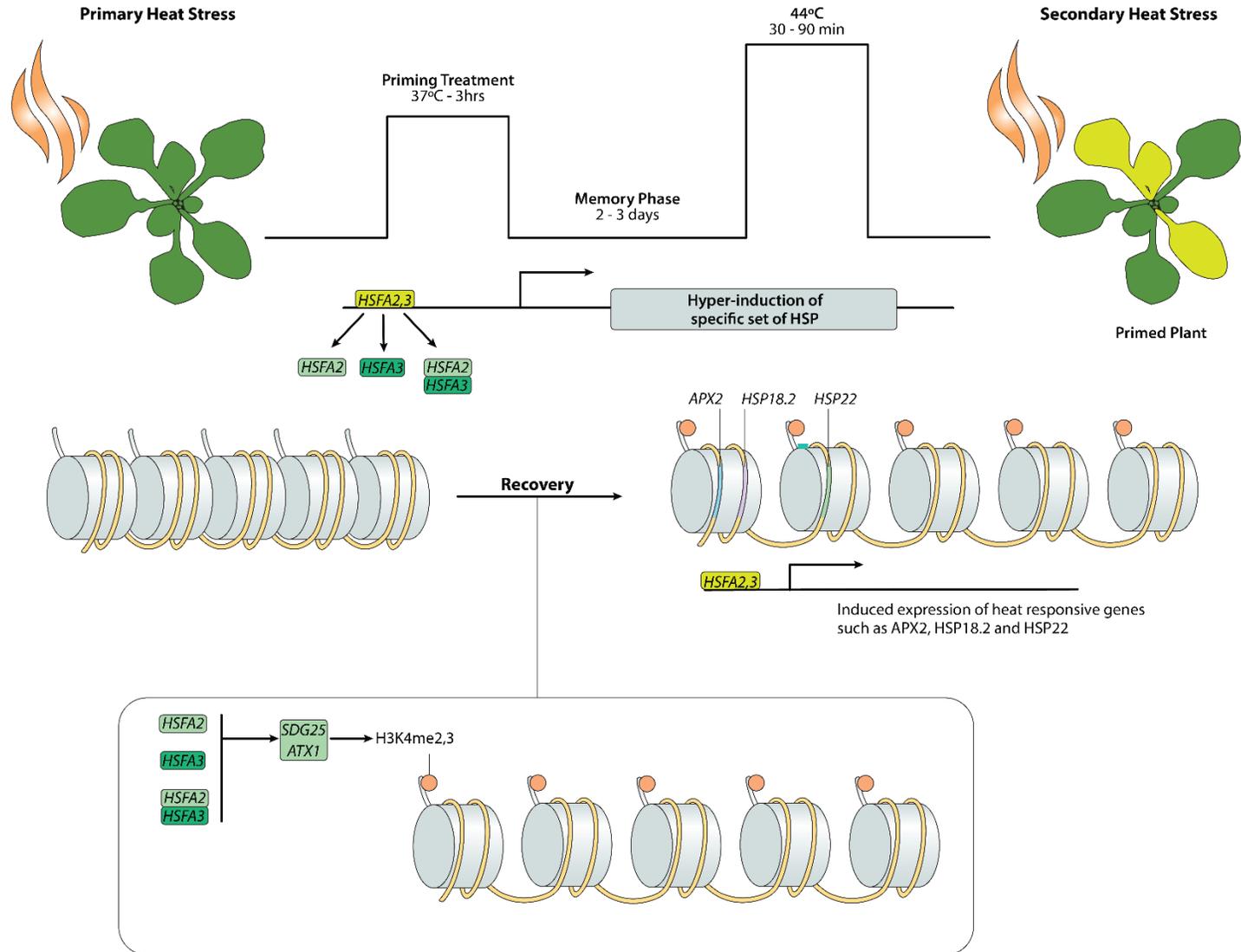
SA187 enhances wheat biomass and yield under conventional desert agriculture

SA187 enhances heat tolerance of wheat

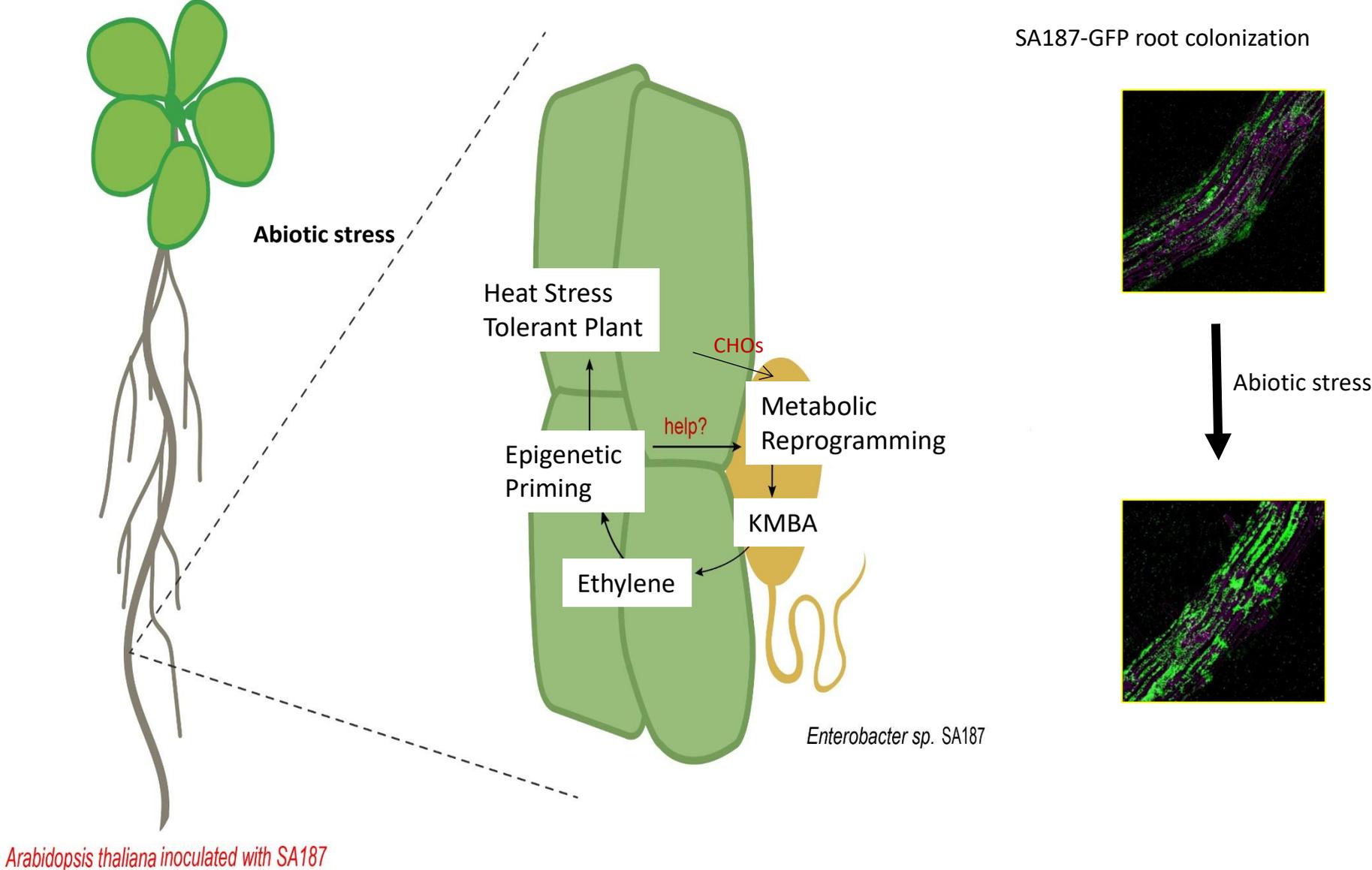


SA187 enhances heat tolerance of wheat in the laboratory to a similar extent as thermopriming

Thermopriming and heat tolerance in Arabidopsis



Mechanism of *Enterobacter* sp. SA187 induced Plant Heat Stress Tolerance



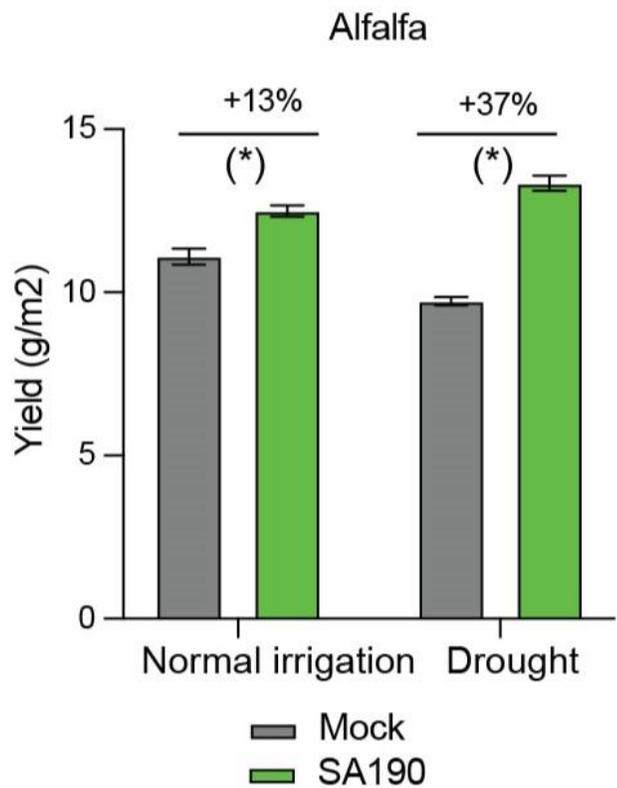
Arabidopsis thaliana inoculated with SA187

Andres-Barrao et al., 2017
De Zelicourt et al., 2018
Andres-Barrao et al., 2021
Synek et al., 2021
Shekhawat et al., 2022

***Pseudomonas argentinensis* SA190 Enhances Drought Resilience and
Water Use Efficiency of Crops**

SA190 induces drought tolerance in *Medicago sativa*

I



Normal irrigation

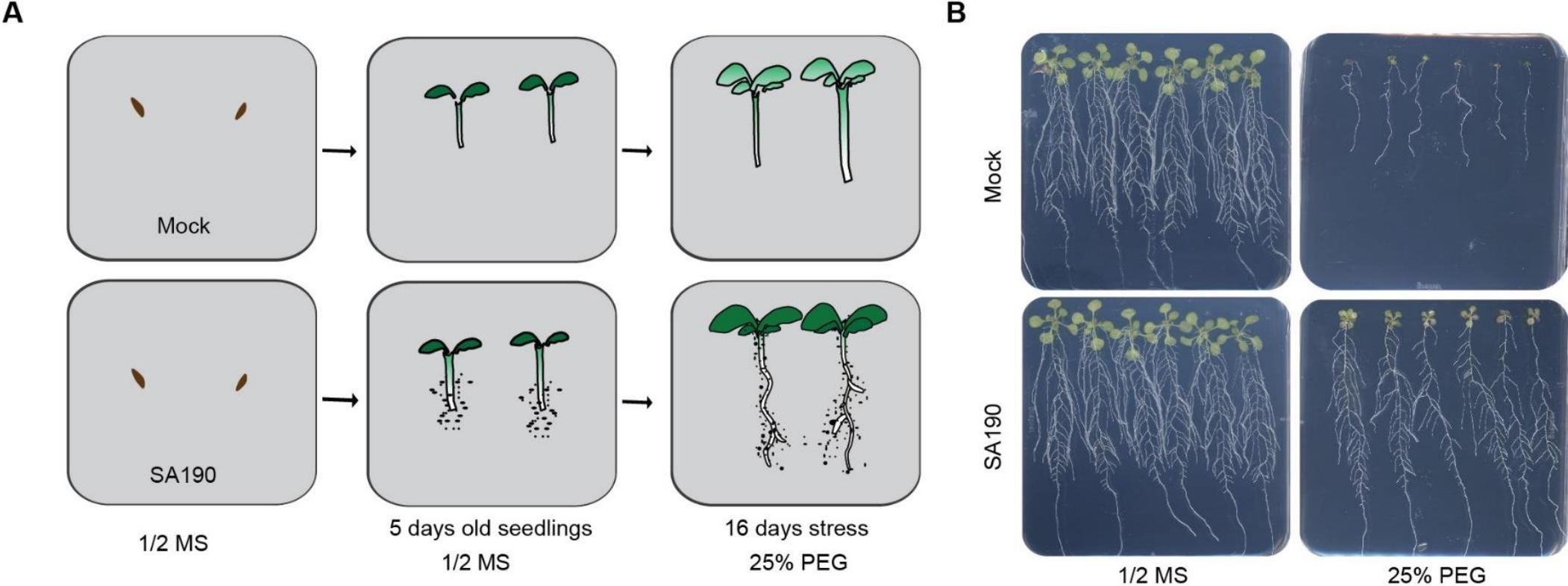
Drought

Mock

SA190

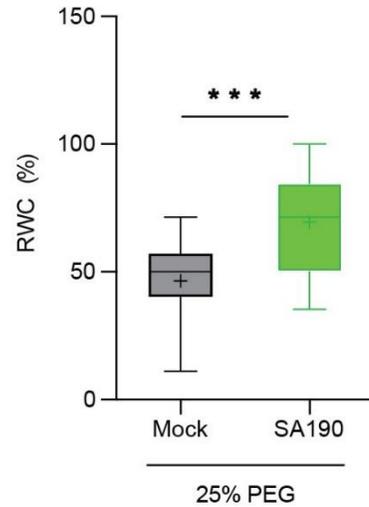


SA190 induces drought tolerance in Arabidopsis

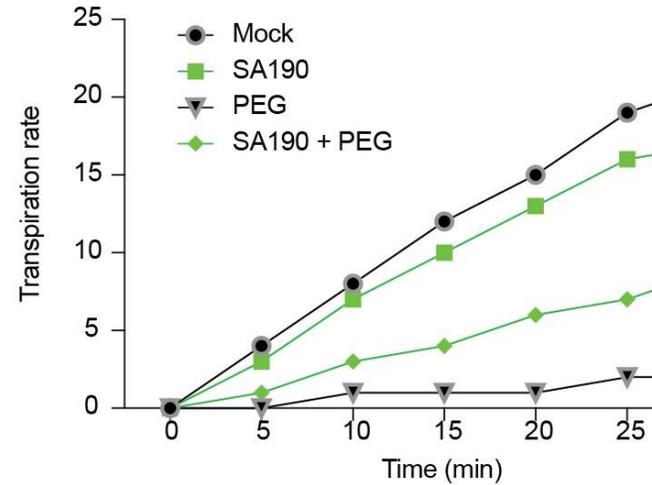


SA190 enhances *Arabidopsis* water use efficiency under drought conditions

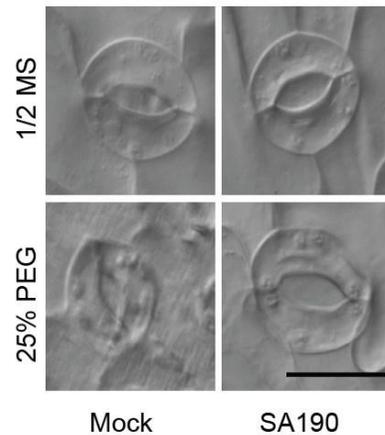
F Relative Water Content



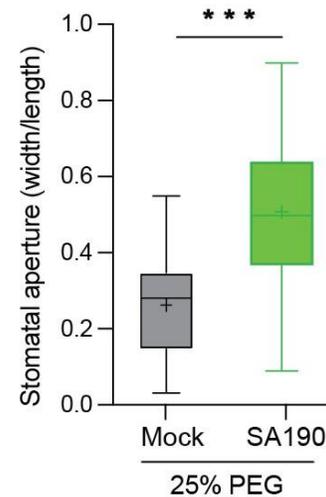
G Transpiration



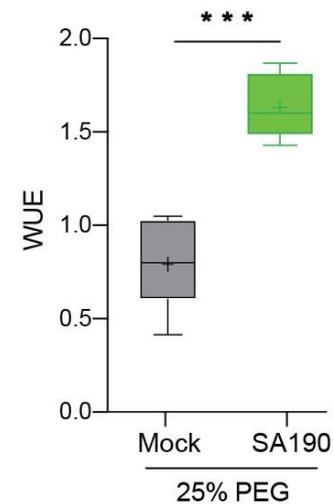
H Stomata



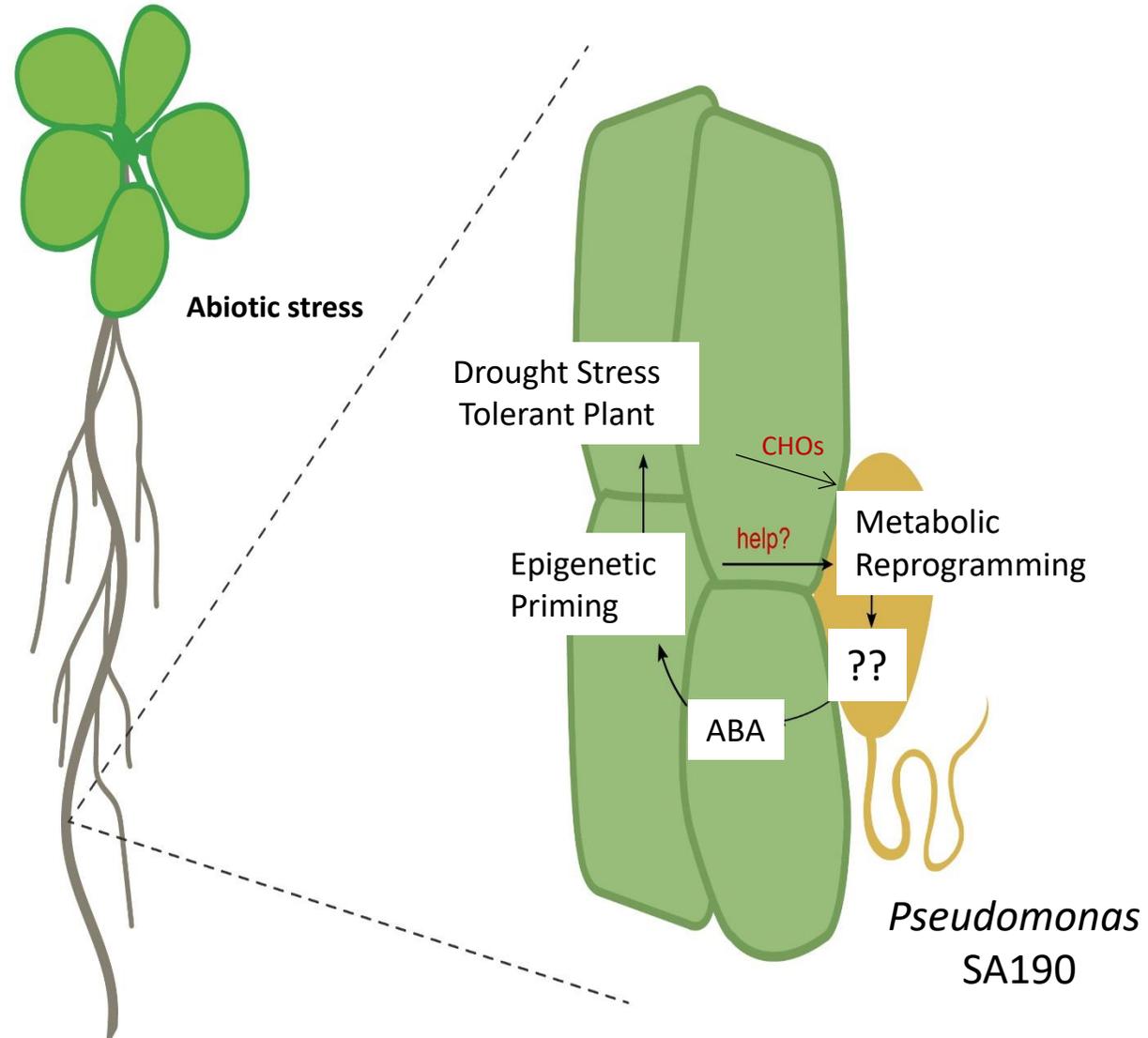
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J Water Use Efficiency



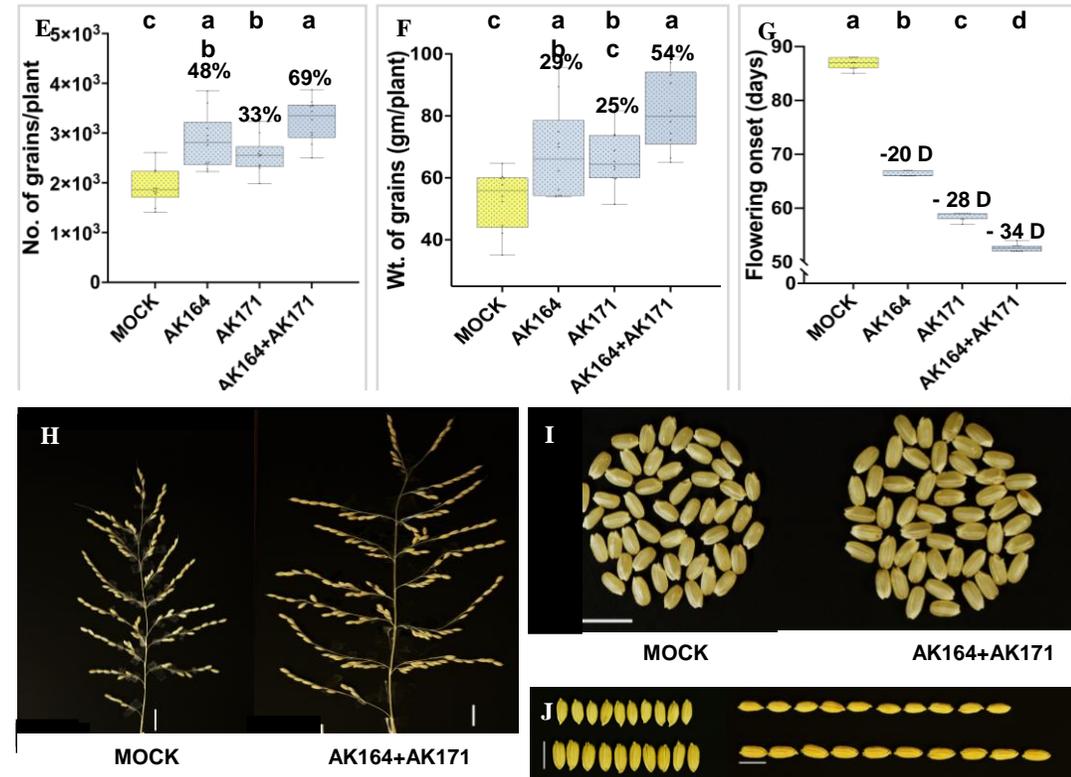
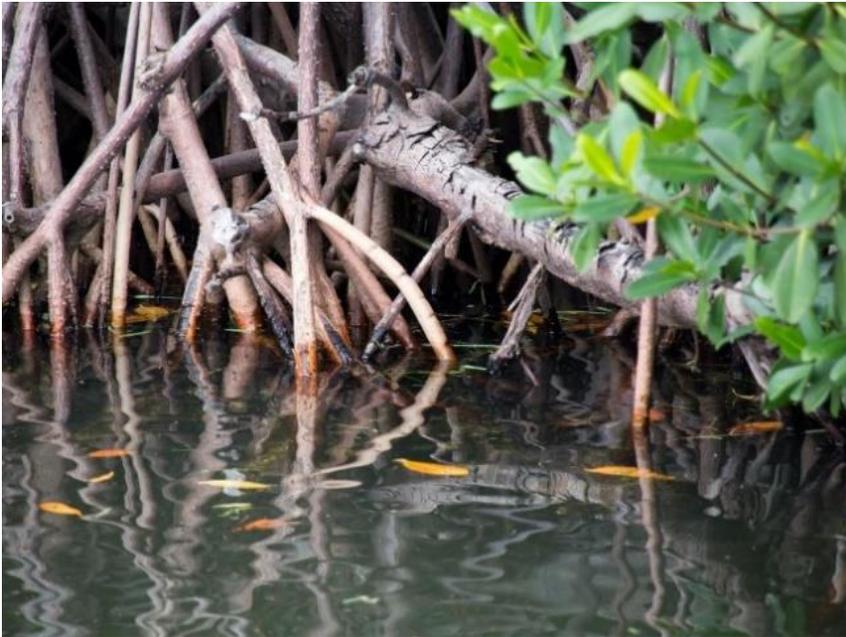
Mechanism of *P. argentinesis* SA190 induced Plant Drought Resilience



Arabidopsis inoculated with SA190

Mangrove bacteria enhance flooding and salt stress resilience to crops

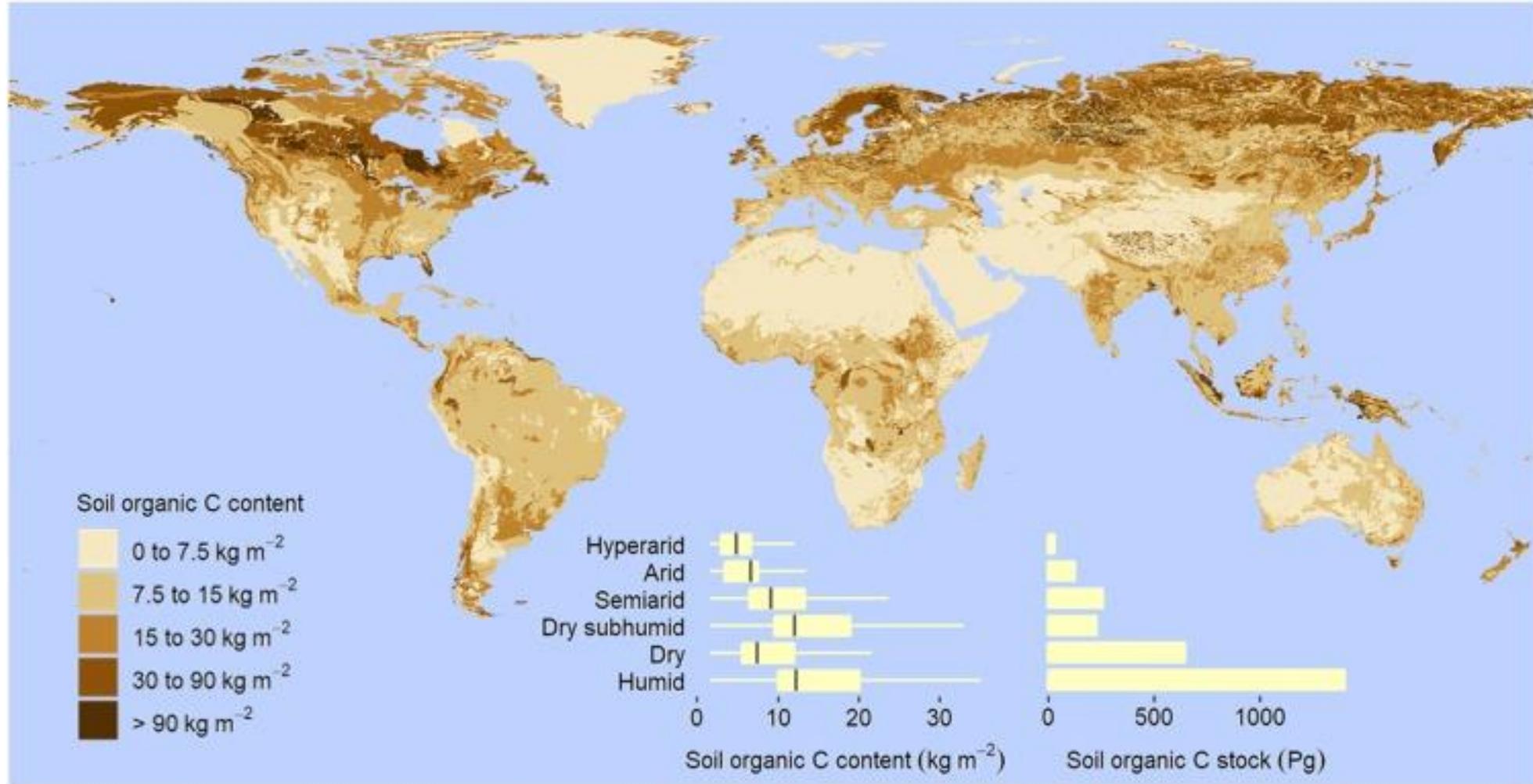
Mangrove Microbiome Project



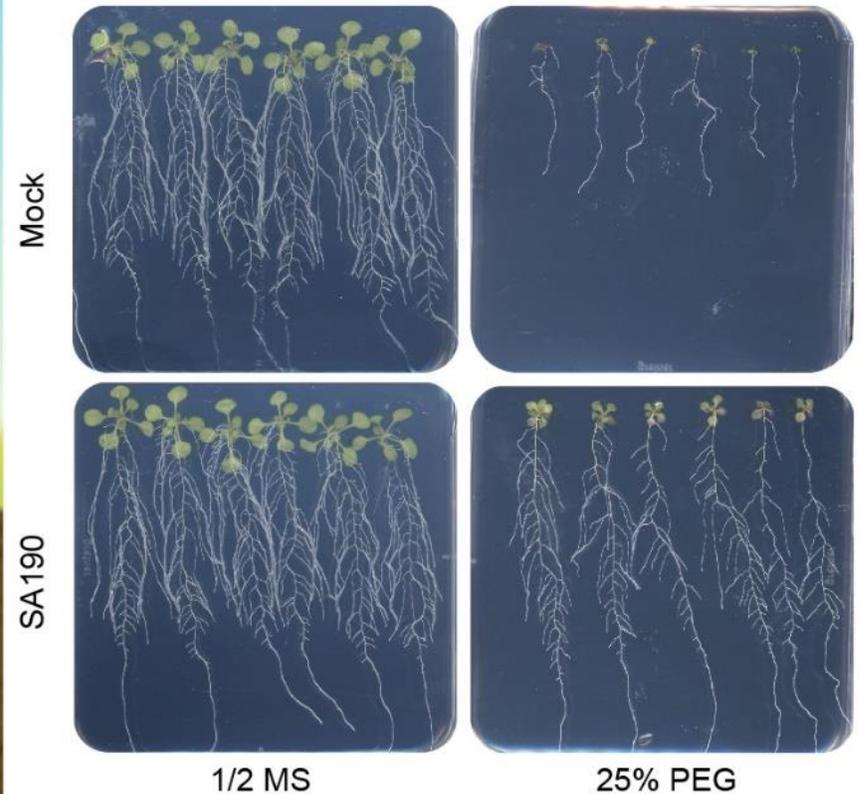
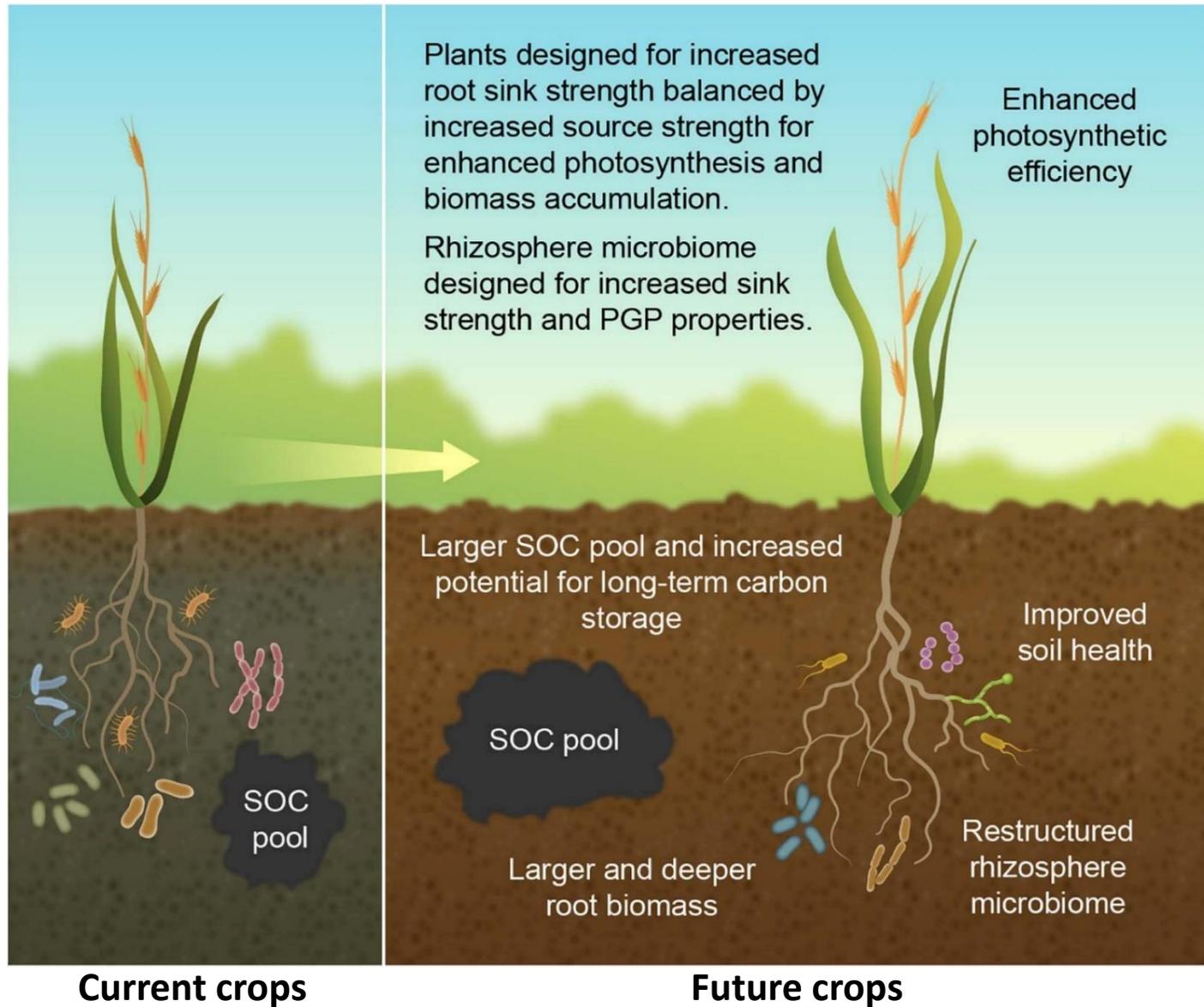
Enhanced productivity and shortening of life cycle of *O. sativa* cv. Nipponbare by AK164 and AK171

Increase soil carbon sequestration on arid lands

Soil Organic Carbon Contents by Country

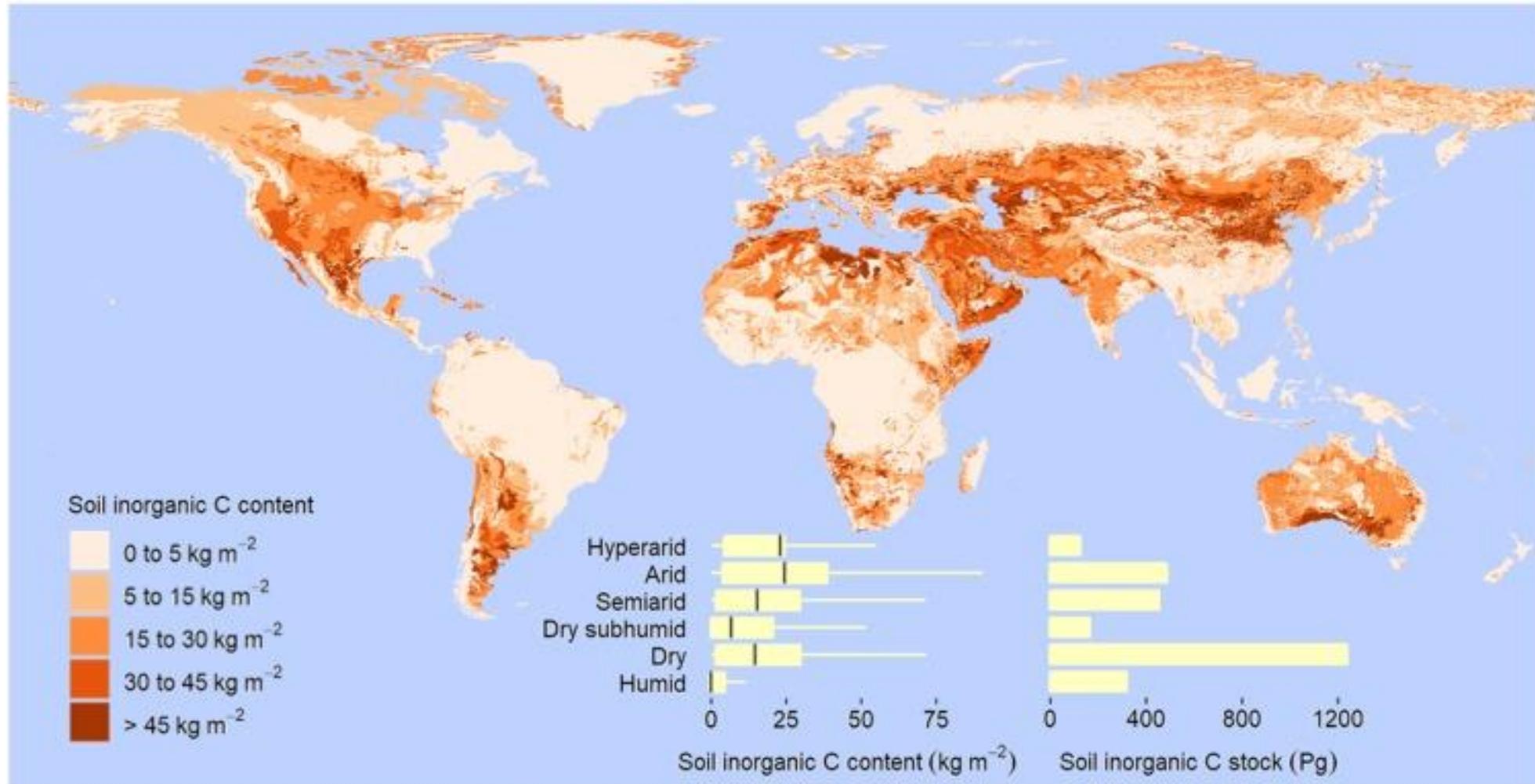


Designing Soil-Plant-Microbe Ecosystems for Carbon Capture

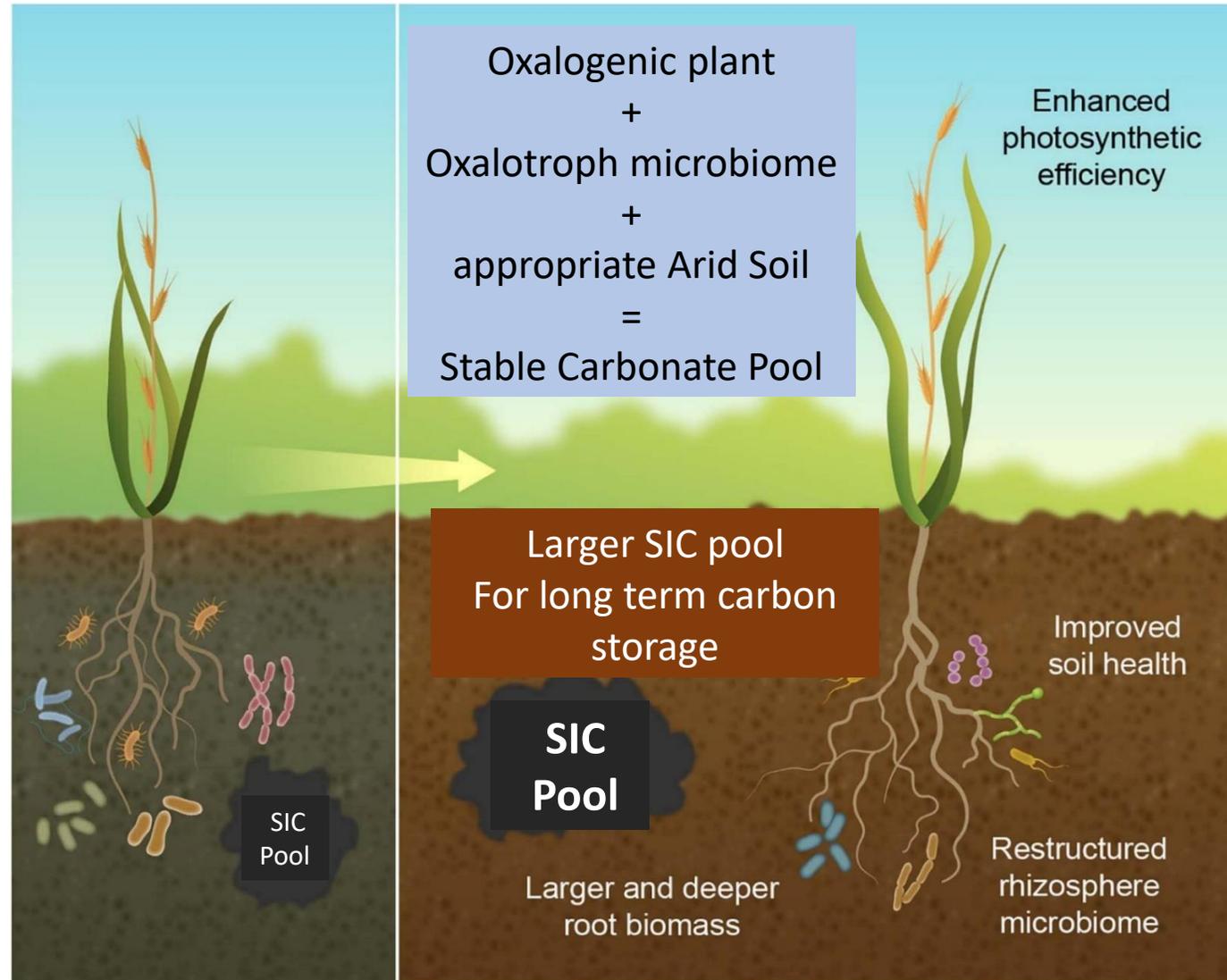


SA190 induces massive root growth under water limiting conditions

Soil Inorganic Carbon Contents by Country



Designing Soil-Plant-Microbe Ecosystems for Carbon Capture on Arid Lands



4-8 % of total annual emitted CO₂ could be captured globally oxalogenic Engineering

Hirt et al. 2023

Agriculture and climate change : Challenges and opportunities

PlantACT! Initiative

<https://www.plant-act.org>

