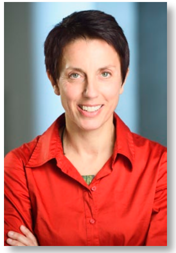
AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

THE PLANT MICROBIOME: FROM RHIZOSPHERE TO SEEDS AND APPLICATIONS TO IMPROVE CROP PERFORMANCE

Angela Sessitsch

IMPROVING PLANT PERFORMANCE

- Improving plant stress tolerance by understanding and modulating molecular mechanisms
- Molecular markers for smart breeding and selection

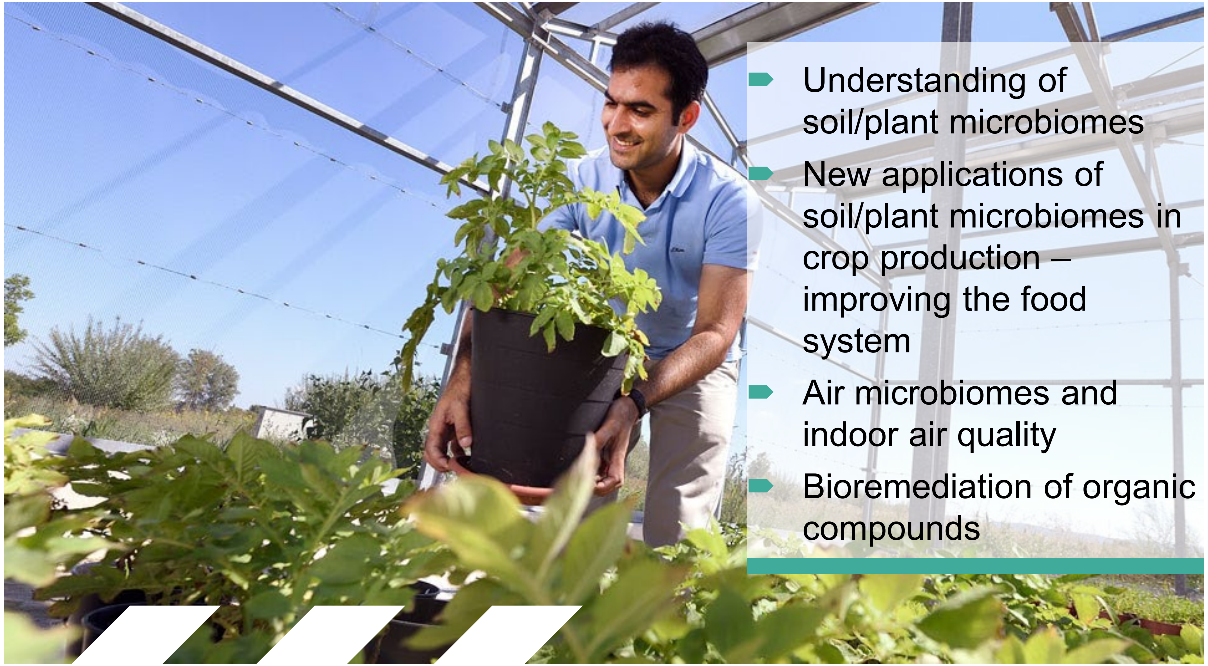


Claudia Jonak

Eva Maria Molin

Dominik Großkinsky

MICROBIOME SOLUTIONS



- Understanding of soil/plant microbiomes
- New applications of soil/plant microbiomes in crop production – improving the food system
- Air microbiomes and indoor air quality
- Bioremediation of organic compounds

Stéphane Compant

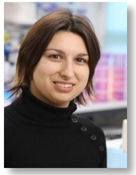
Claudia Preininger

Günter Brader

Markus Gorfer

Islam Abd-El Daim

Thomas Reichenauer



Tanja Kostic

Friederike Trognitz

The Soil (Plant) Microbiome

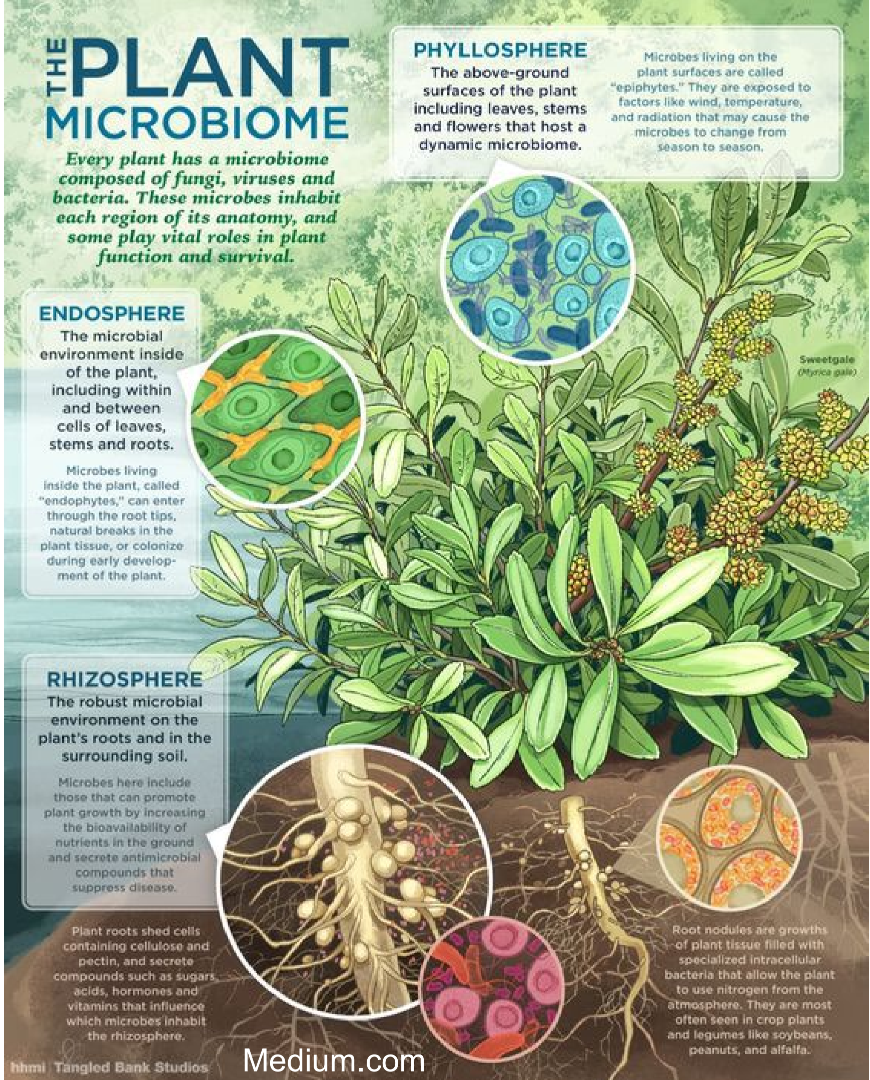
There's a lot more than dirt to the soil in which plants grow.

The Scientist, 2013

- Everything starts in the soil…
  - 100.000.000 bacterial cells in 1 g soil with ten thousands of species
- Selection and enrichment of microbes in the plant environment (roots)
- Root exudation – sugars, amino acids, sterols, etc. – up to 20% of the C obtained through photosynthesis
- Rhizosphere (zone around roots influenced by root exudates): hot spot of microbial activity
- The **Plant Holobiont**: plant and microbiome acting together

COMPARTMENTS OF MICROBIAL LIFE ON / IN PLANTS

- **Compartments**: soil, rhizosphere, root surface, root interior, phylloplane, stem/leaf interior, flowers, seeds, fruits
- **Plant physiology & niche environment** influence plant microbiome



KEY MODE OF ACTIONS AND INTERACTIONS

- Activities against plant diseases
- Improving abiotic stress
- Nutrient aquisition
- Degradation of toxins
- Improving nutritional composition
- Improving storability
- and more

Plant nutrient aquisition

Plant protection against pathogens / pests

Plant protection against abiotic stress

Food / plant quality improvement

Postharvest management

Phytoremediation

Environmental protection

Green infrastructure

TODAY…

- Grapevine and weed microbiomes
- Potato soil/tuber microbiomes – diversity and storability
- Microbiota of reproductive organs
- Seed-based microbial applications

GRAPEVINE AND WEED MICROBIOMES

GRAPEVINE AND WEED MICROBIOMES

Lepidium draba L.

Lamium amplexicaule L.

Veronica arvensis L.

Stellaria media L.

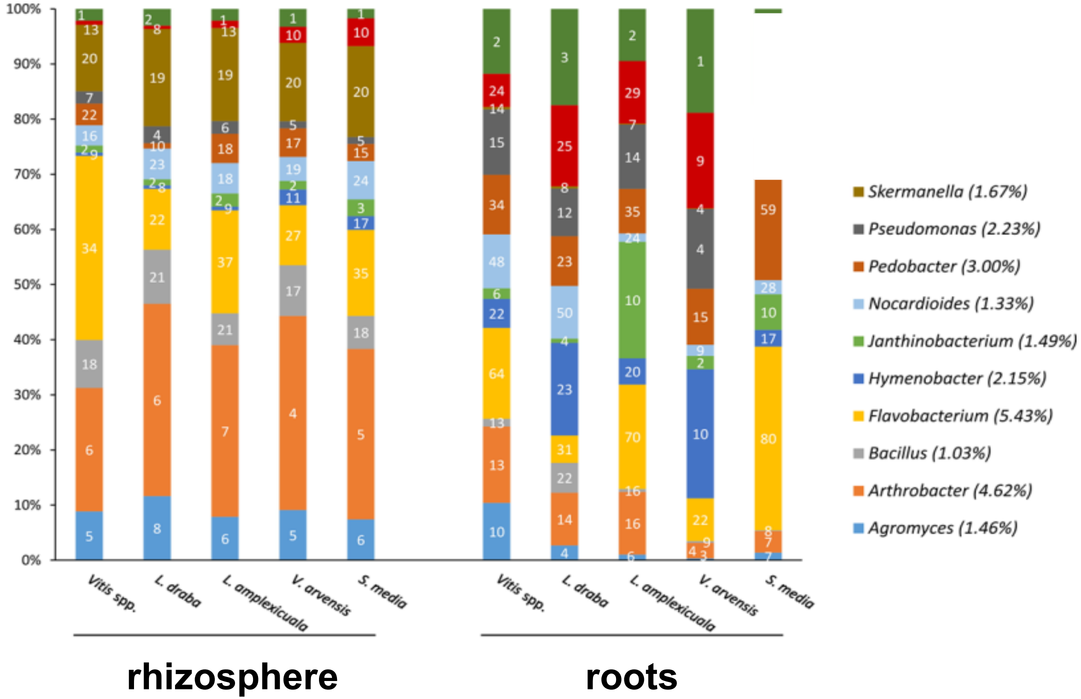
Sampling / analysis

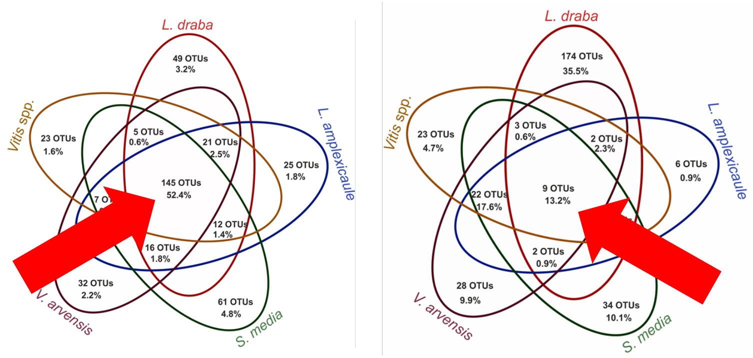
- Sampling time: April
- Rhizosphere and root endosphere
- 16S rRNA-based microbiome analysis (Illumina)
- Isolation of bacteria from grapevine and *L. draba*
- Characterization of isolates

Samad et al., Environ. Microbiol., 2017

Abdul Samad

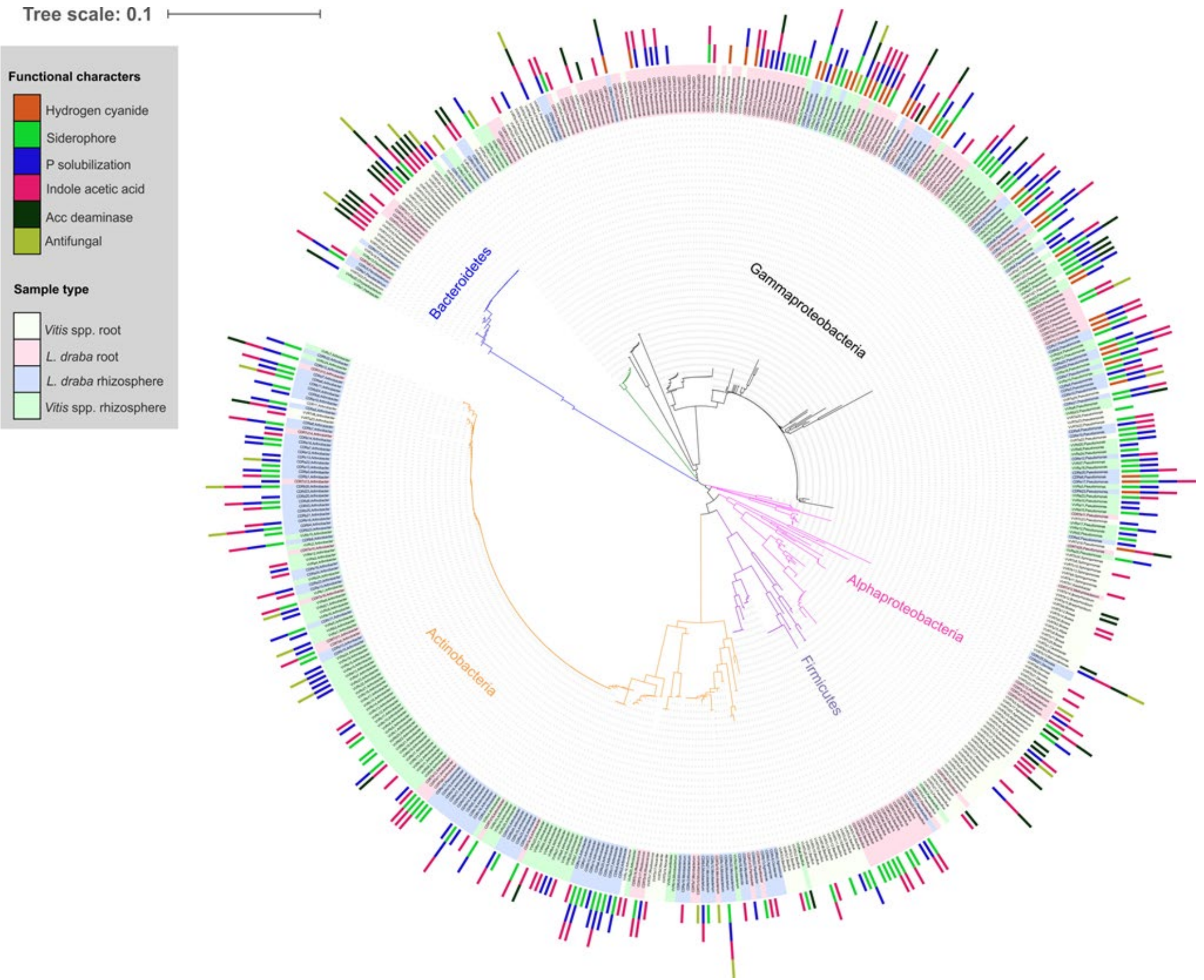
RHIZOSPHERE AND ENDOSPHERE MICROBIOMES ARE DIFFERENT





Samad et al., Env. Microbiol., 2017

BACTERIAL ISOLATES OF GRAPEVINE AND *L. DRABA*

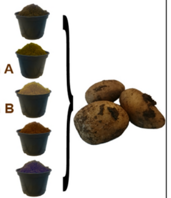
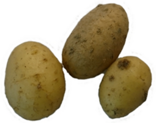
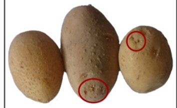


Samad et al., Env. Microbiol., 2017

POTATO STORABILITY

PLANT MICROBIOMES AND POTATO STORAGE

Franziska Buchholz

		Storage				
Sampling time point	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**
Description	after harvesting	two weeks after harvesting	five weeks after harvesting	ten weeks after harvesting	dormancy break	Sprouting
BBCH stage	**00**	**00**	**00**	**01**	**03**	**07**
Soil type/ potato tuber	potting soil Kettlasbrunn A Kettlasbrunn B Karnabrunn Tulln 					
Samples taken from:	**Tubers** of the varieties Agata, Fabiola, Hermes and Lady Claire cultivated in **five different soil types**	**Tubers** of the varieties Agata, Hermes and Lady Claire cultivated in **potting soil**	**Tubers** of the varieties Agata, Hermes and Lady Claire cultivated in **potting soil**	**Tubers** of the varieties Agata,Hermes and Lady Claire cultivated in **potting soil**	**Tubers** of the varieties Agata, Fabiola, Hermes and Lady Claire cultivated in **five different soil types**	**Tubers** of the varieties Agata, Fabiola, Hermes and Lady Claire cultivated in **five different soil types**

Aim: to better understand the ecology and functional role of post-harvest tuber microbiota and to identify isolates influencing sprouting behaviour

Buchholz et al., 2021, Scientific Reports

PLANT MICROBIOMES AND POTATO STORAGE

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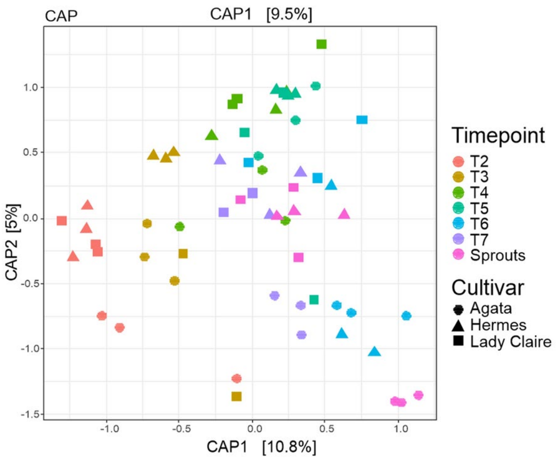
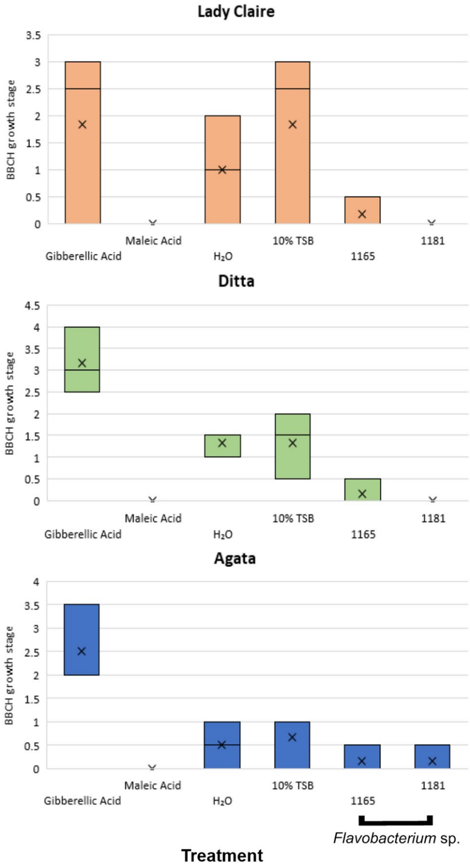


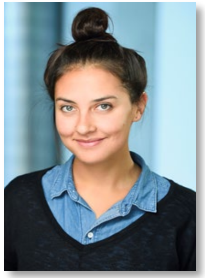


- Dynamic microbiota during storage, increase of taxa like *Staphylococcus*, *Proprionibacterium* and *Acinetobacter*
- Storage properties were soil- and cultivar-dependent
- Nine OTUs (e.g., OTU_14, a *Flavobacterium* sp.) associated with long storage stability, i.e., OTUs were significantly increased when dormancy break and sprouting started late
- Two strains of OTU_14 showed sprout inhibition

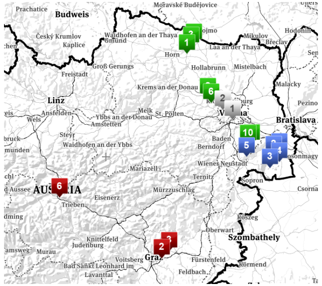
Buchholz et al., 2021, Scientific Reports

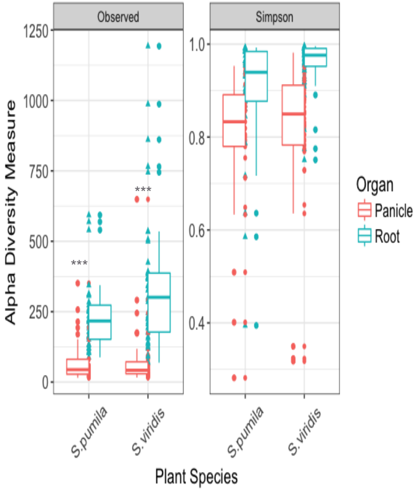
MICROBIOTA OF REPRODUCTIVE ORGANS & SEEDS AS VECTORS OF MICROBIAL INOCULANTS

HIGHLY DIFFERENT MICROBIOTA IN ROOTS AND PANICLES OF *SETARIA* SPP.

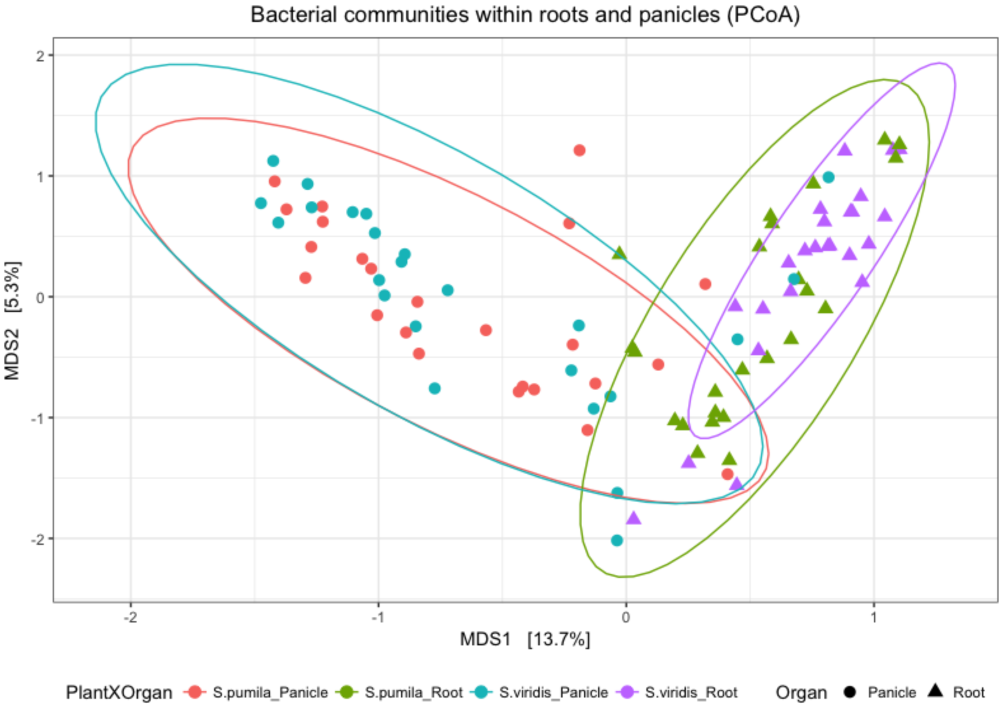


Carolina Escobar Rodríguez





16S rRNA gene-based microbiome analysis



Escobar Rodríguez et al. 2018 Front. Microbiol.

CORE TAXA

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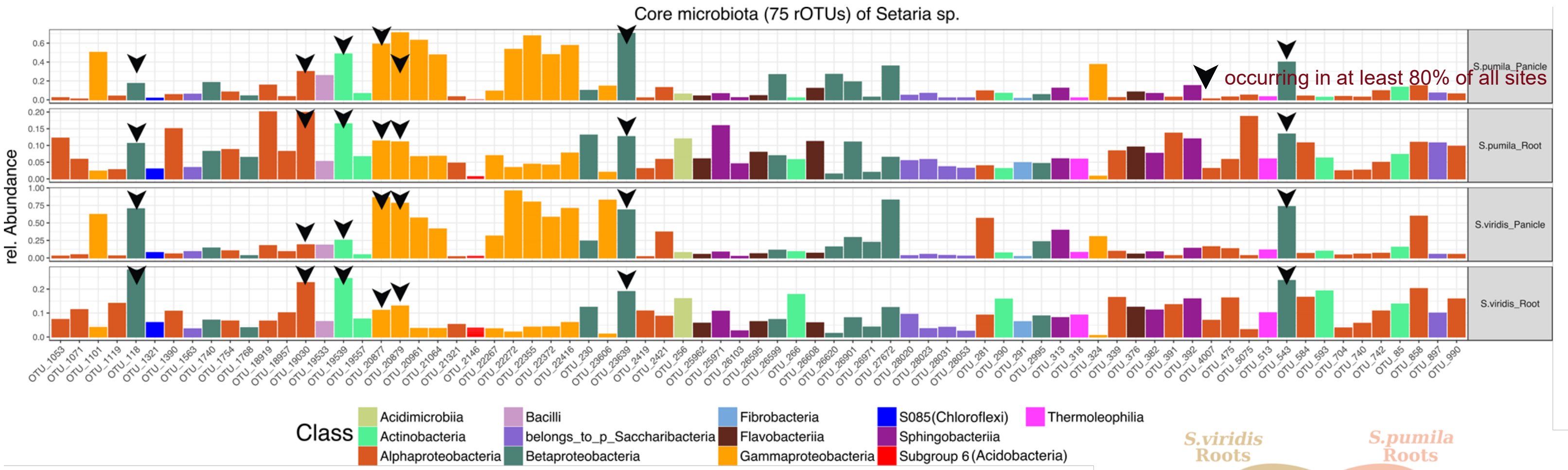
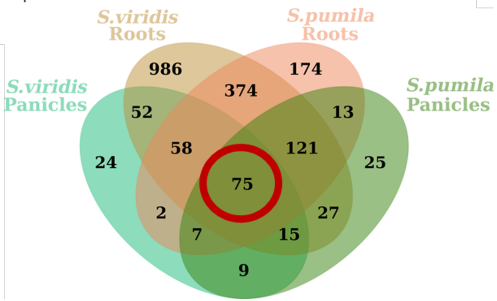
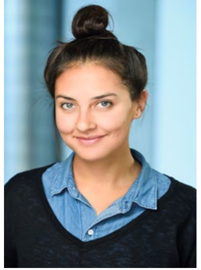




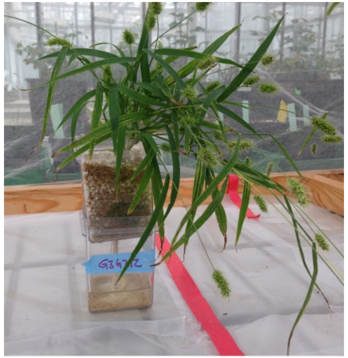
OTU_858 (100%) ***Sphingomonas***
OTU_19539 (100%) ***f_Microbacteriaceae***
OTU_339 (95%) ***Variibacter***
OTU_543 (90%) ***Massilia***
OTU_118 (85%) ***Burkholderia-Paraburkholderia***
OTU_20877 (85%) ***Psychrobacter***
OTU_23639 (85%) ***f_Oxalobacteriaceae***
OTU_290 (85%) ***Nocardioides***
OTU_19030 (85%) ***Rhizobium***
OTU_584 (85%) ***Hyphomicrobium***
OTU_256 (80%) ***f_Acidimicrobiaceae***

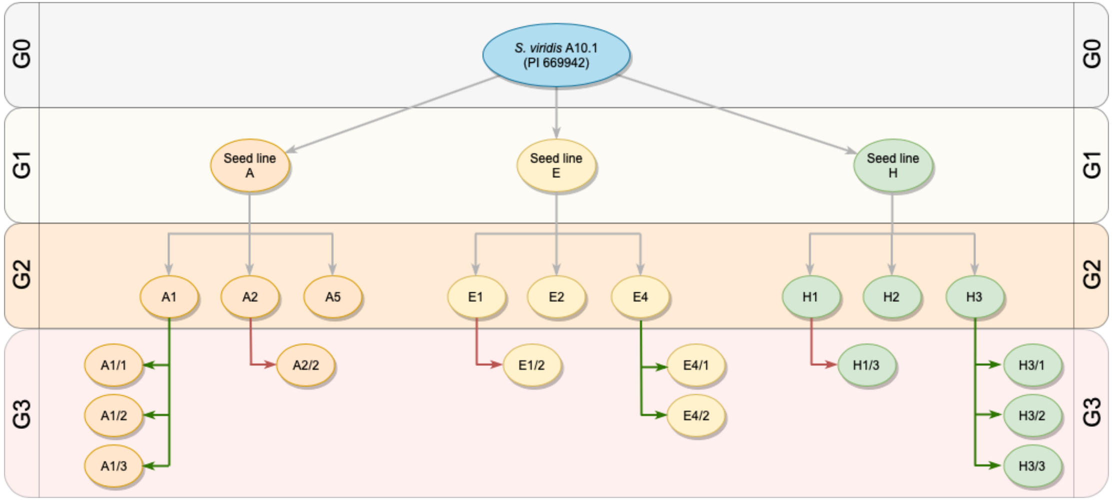
Escobar Rodríguez et al. 2018 Front. Microbiol.

FUNCTIONAL IMPORTANCE OF MICROBIOTA ASSOCIATED WITH *SETARIA VIRIDIS* SEEDS



Carolina Escobar Rodríguez





Cultivation over several generation in sterile growth substrate

Analysis of seed microbiomes

Plant performance / seed vigor

Escobar Rodríguez et al. 2020 Phytobiomes J.

FUNCTIONAL IMPORTANCE OF MICROBIOTA ASSOCIATED WITH *SETARIA VIRIDIS* SEEDS

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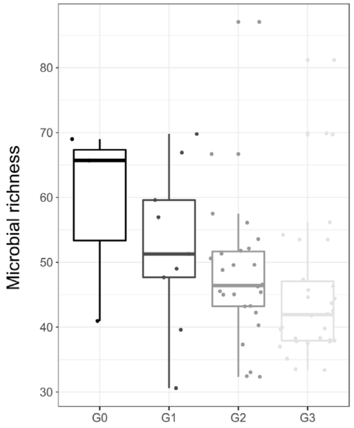
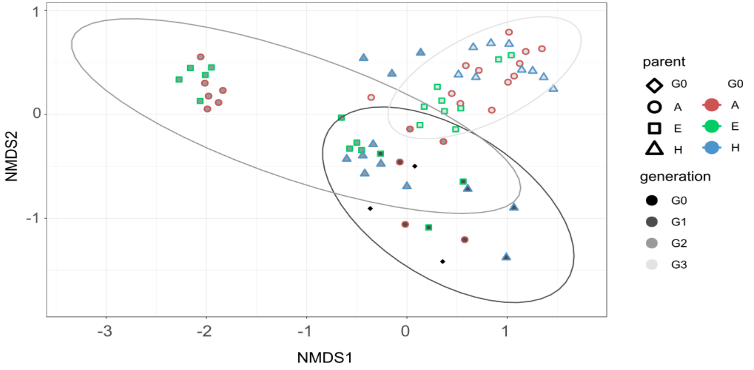
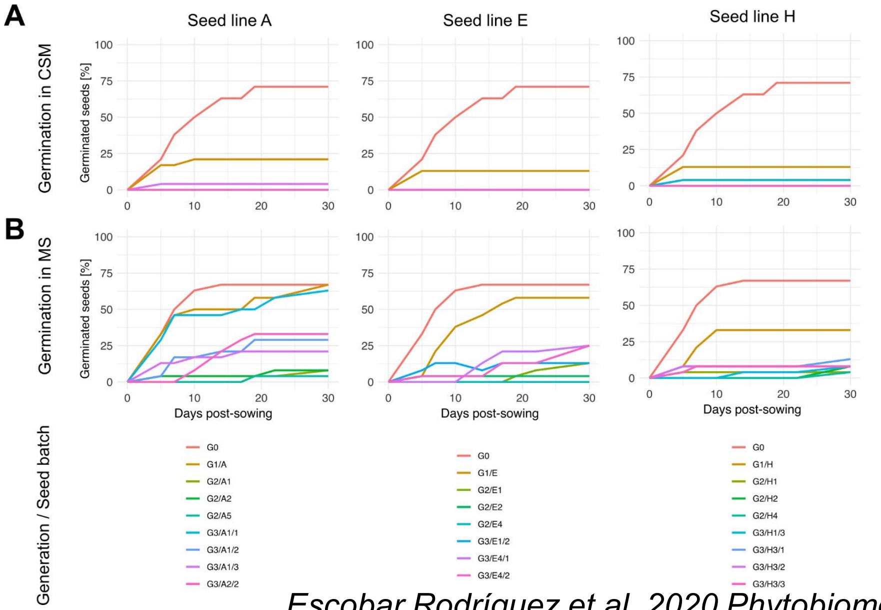


Loss of microbiome diversity at later generation seeds associated with severe functional loss in terms of seed germination, vigor and plant growth





Escobar Rodríguez et al. 2020 Phytobiomes J.

EndoSeed™ - A NEW TECHNOLOGY TO GENERATE ENDOPHYTE-IMPROVED SEEDS

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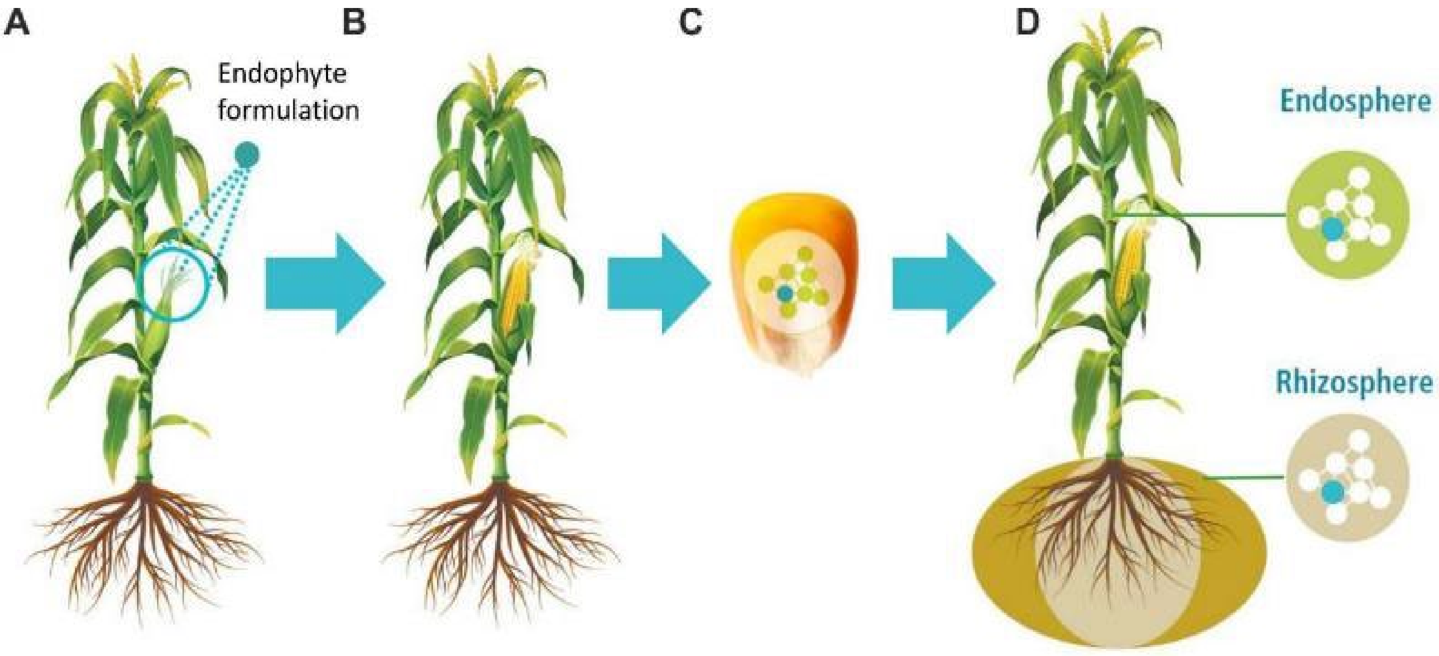
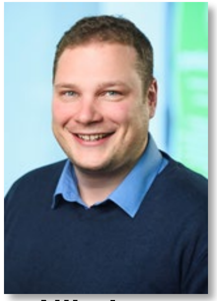


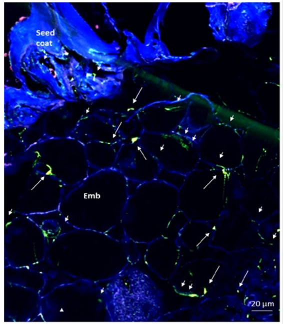


Nikolaus Pfaffenbichler

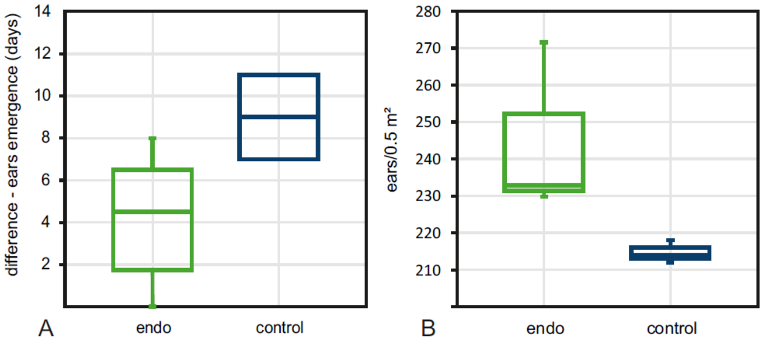
Birgit Mitter

Mitter et al., 2017. Front. Microbiol.

EndoSeed™ - A NEW TECHNOLOGY TO GENERATE ENDOPHYTE-IMPROVED SEEDS



- 95% of seeds contained *Paraburkholderia phytofirmans* PsJN after flower treatment
- Seeds showed better growth characteristics



Mitter et al., 2017. Front. Microbiol.

SEEDJECTION™ – SUCCESSFUL COLONIZATION AND NO IMPAIRMENT OF PLANT DEVELOPMENT

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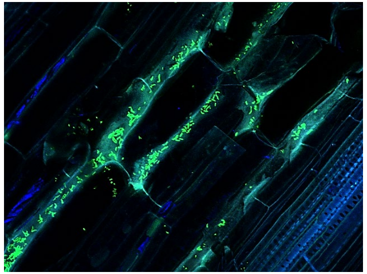


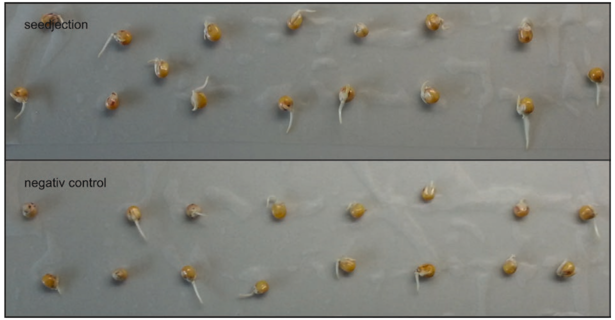
Grain maize hybrid *Chapalu* colonized by PsJN::*gfp*2x after 1 week of storage detected in the roots of 5 days old plantlets

Birgit Mitter

Nikolaus Pfaffenbichler

ENSEMO
INNOVATIVE AGRICULTURAL TECHNOLOGIES

- Normal germination and growth compared to untreated negative control seeds
- No impairment of plant development
- Better colonization of inoculant strain than when applied externally
- Tested with G+ and G- strains in the field



SeedJection treated plants compared with negative control, 2 days after sowing, 24°C

ACKNOWLEDGEMENTS

AIT

Franziska Buchholz

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Livio Antonielli

ensemo

Birgit Mitter

Nikolaus Pfaffenbichler

Thank you!

Forschung wirkt.