Below the plastic: what happens to soil microbes after fumigation

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SOIL, WATER, AND ECOSYSTEM SCIENCES

Crop management for high-intensity specialty crops

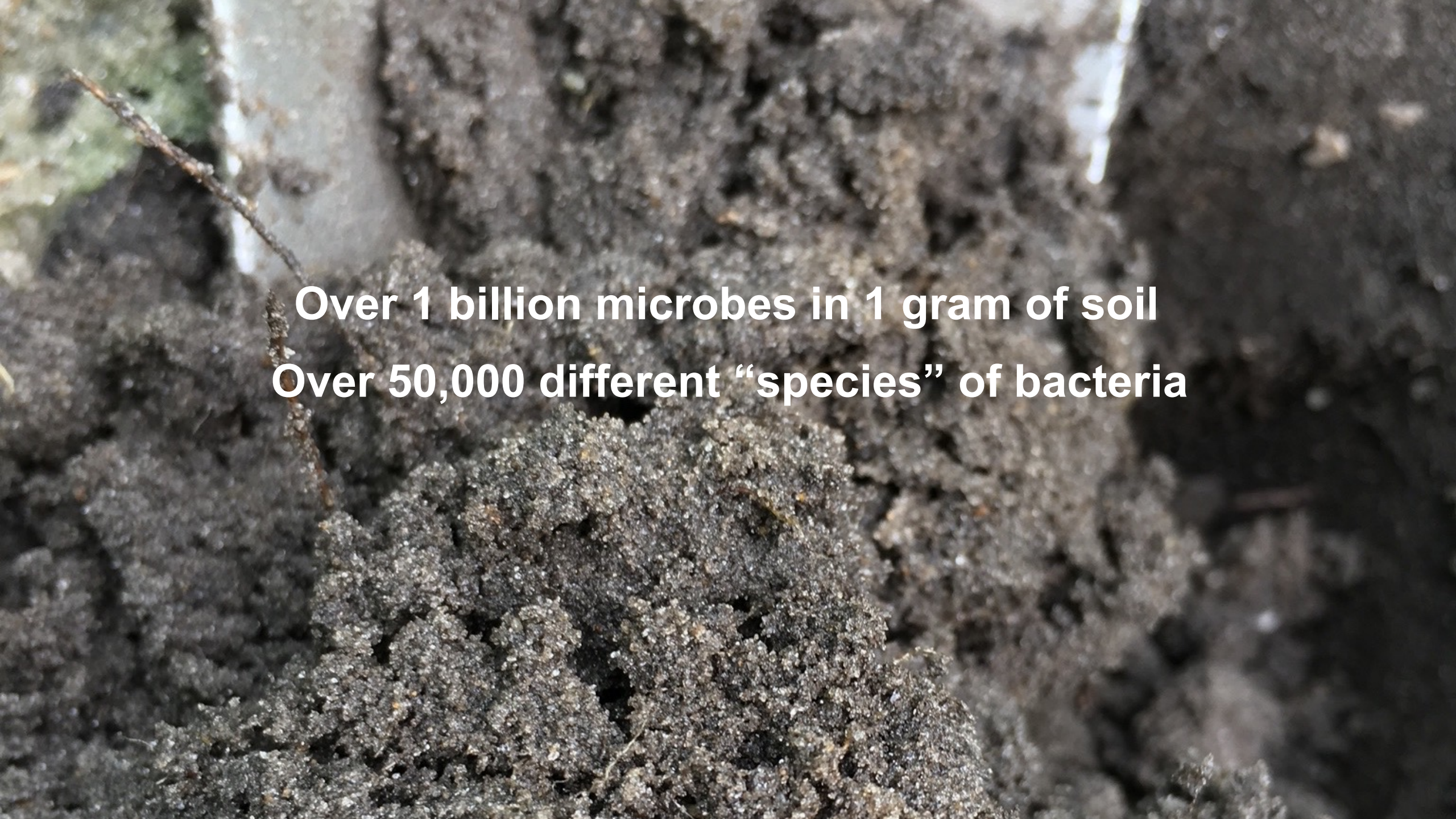

- N Boyd

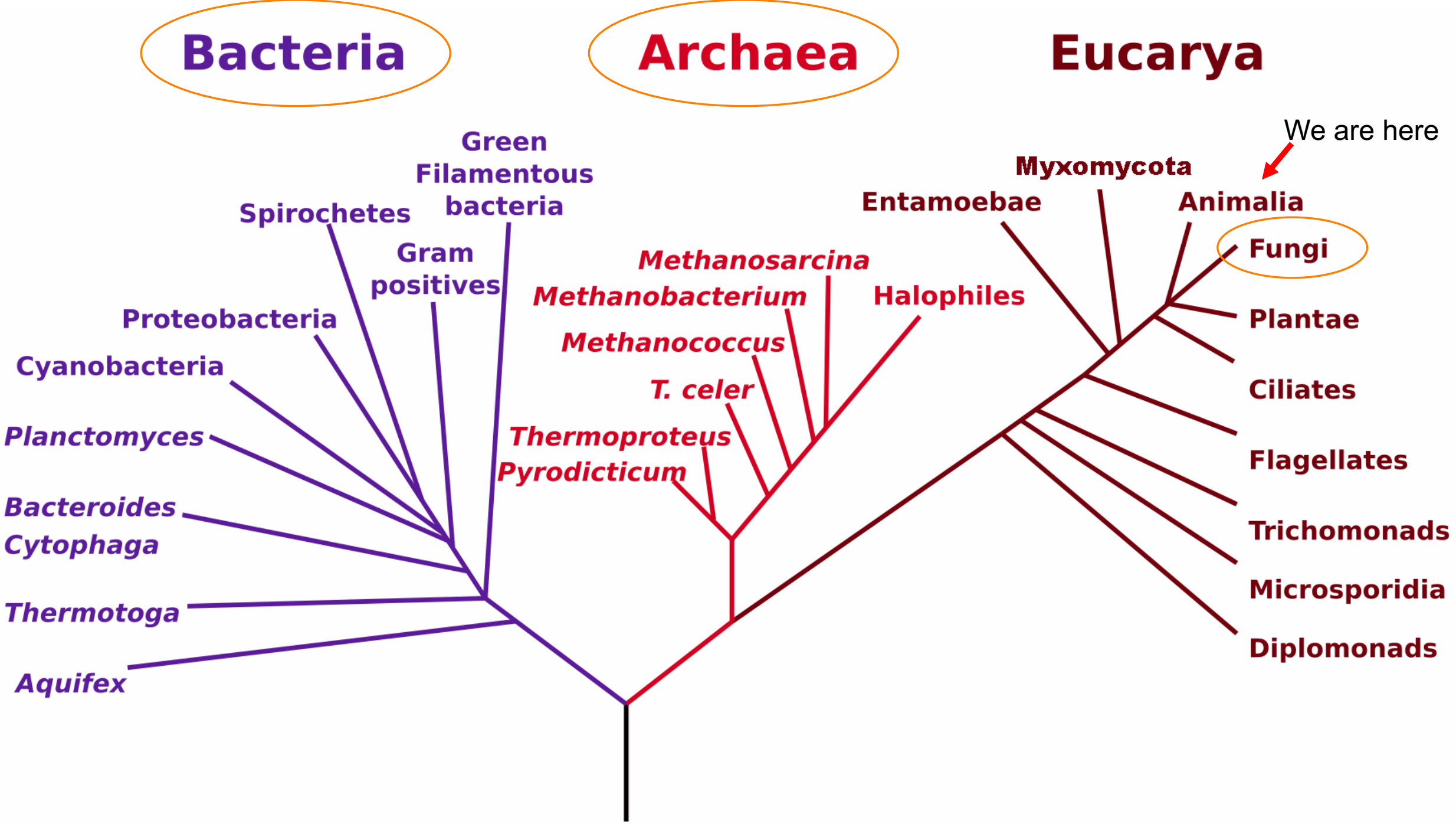

- SL Strauss


- SL Strauss

Reasons for fumigation*

- Disease control
  - Phytophthora root rot
  - Verticillium dahlia
  - Rhizoctonia
  - Fusarium wilt
- Nematode control
  - Root lesion nematode
  - Dagger nematode
- Weed control

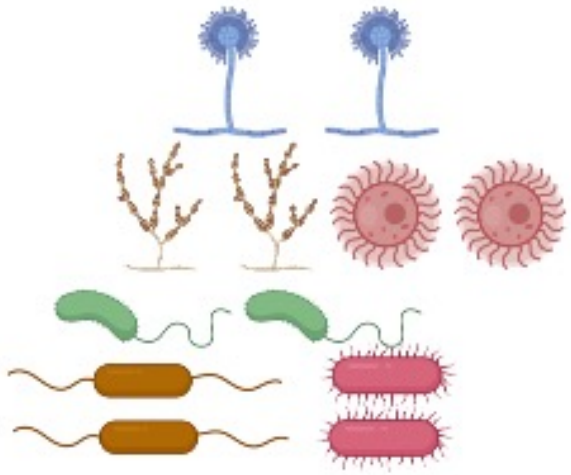

Over 1 billion microbes in 1 gram of soil
Over 50,000 different “species” of bacteria


Bacteria
Archaea
Eucarya
We are here
Green Filamentous bacteria
Spirochetes
Gram positives
Proteobacteria
Cyanobacteria
Planctomyces
Bacteroides
Cytophaga
Thermotoga
Aquifex
Methanosarcina
Methanobacterium
Methanococcus
T. celer
Thermoproteus
Pyrodicticum
Halophiles
Myxomycota
Entamoebae
Animalia
Fungi
Plantae
Ciliates
Flagellates
Trichomonads
Microsporidia
Diplomonads

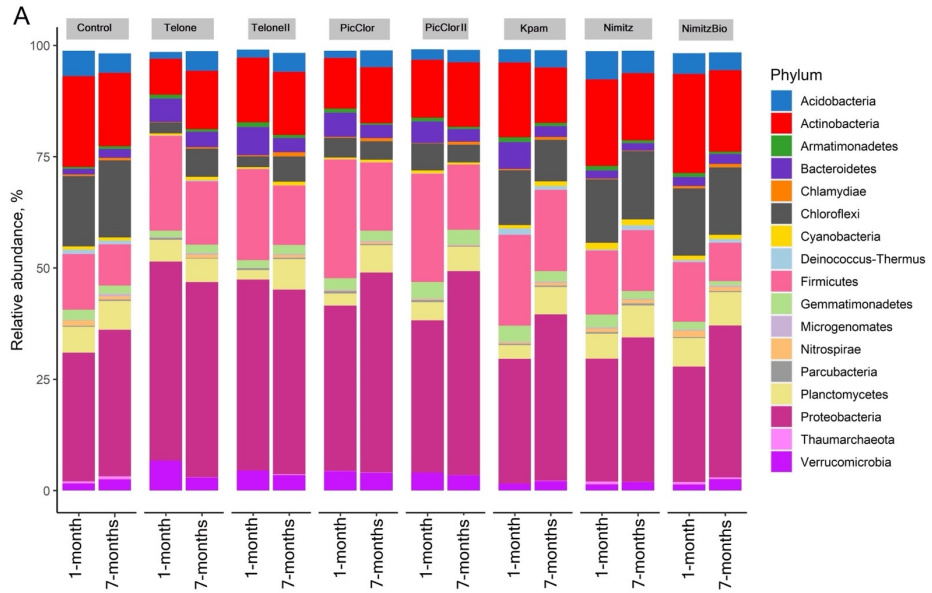
How do we study soil microbes?


Only 1% of soil microbes can be cultured
Shutterstock

Microbial composition and functions

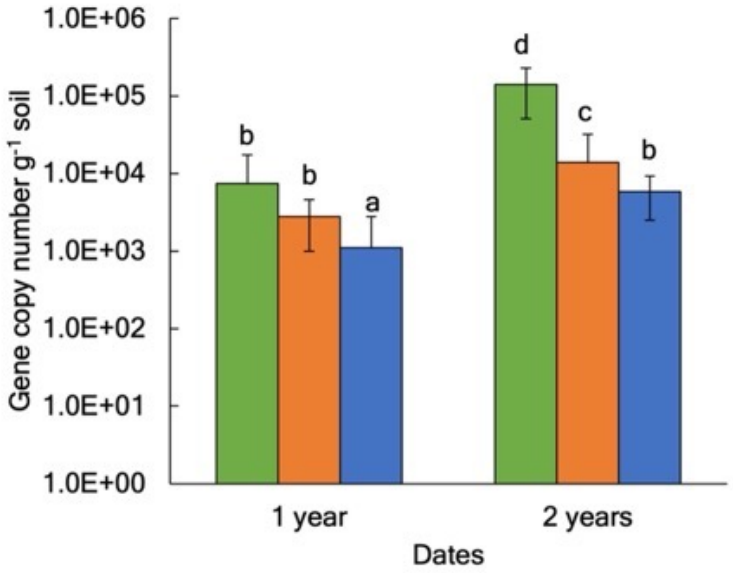


Diversity:
number and relative abundances of taxa



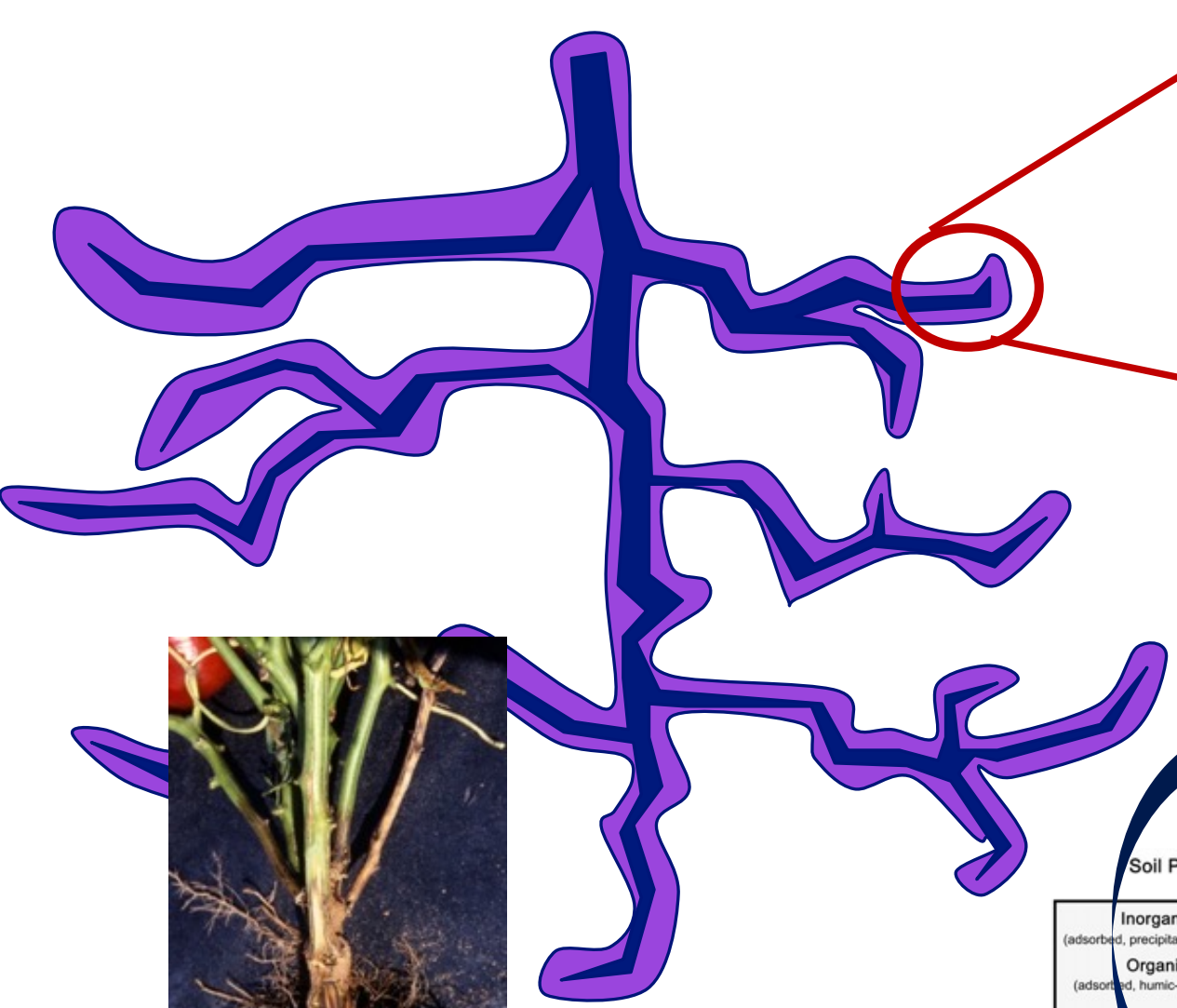
Composition: who's there

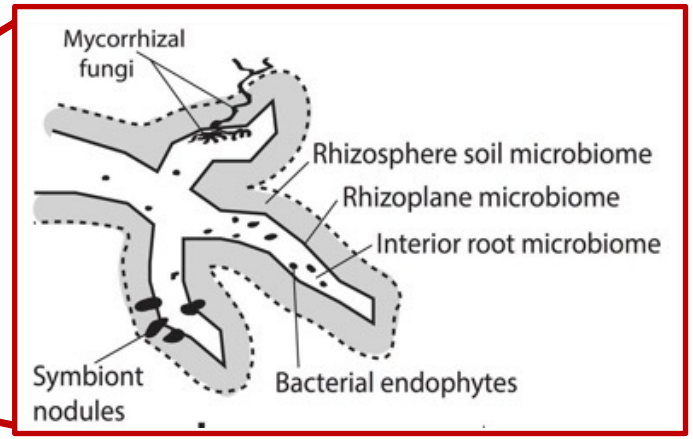
Functions:
what are they doing



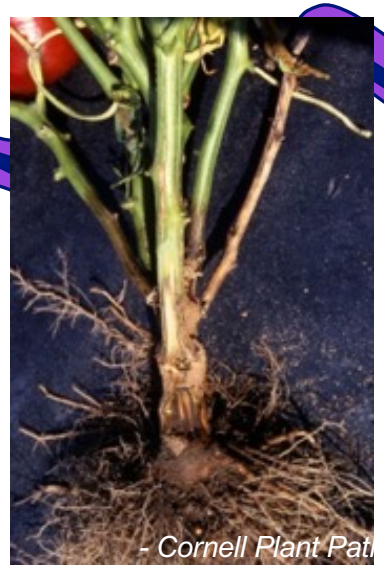
Why are microbes important for soils?

Soil microbes and plant health





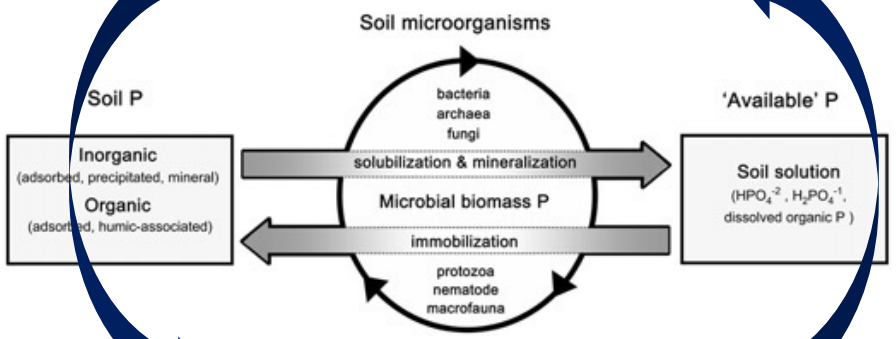
Root growth



- Cornell Plant Pat

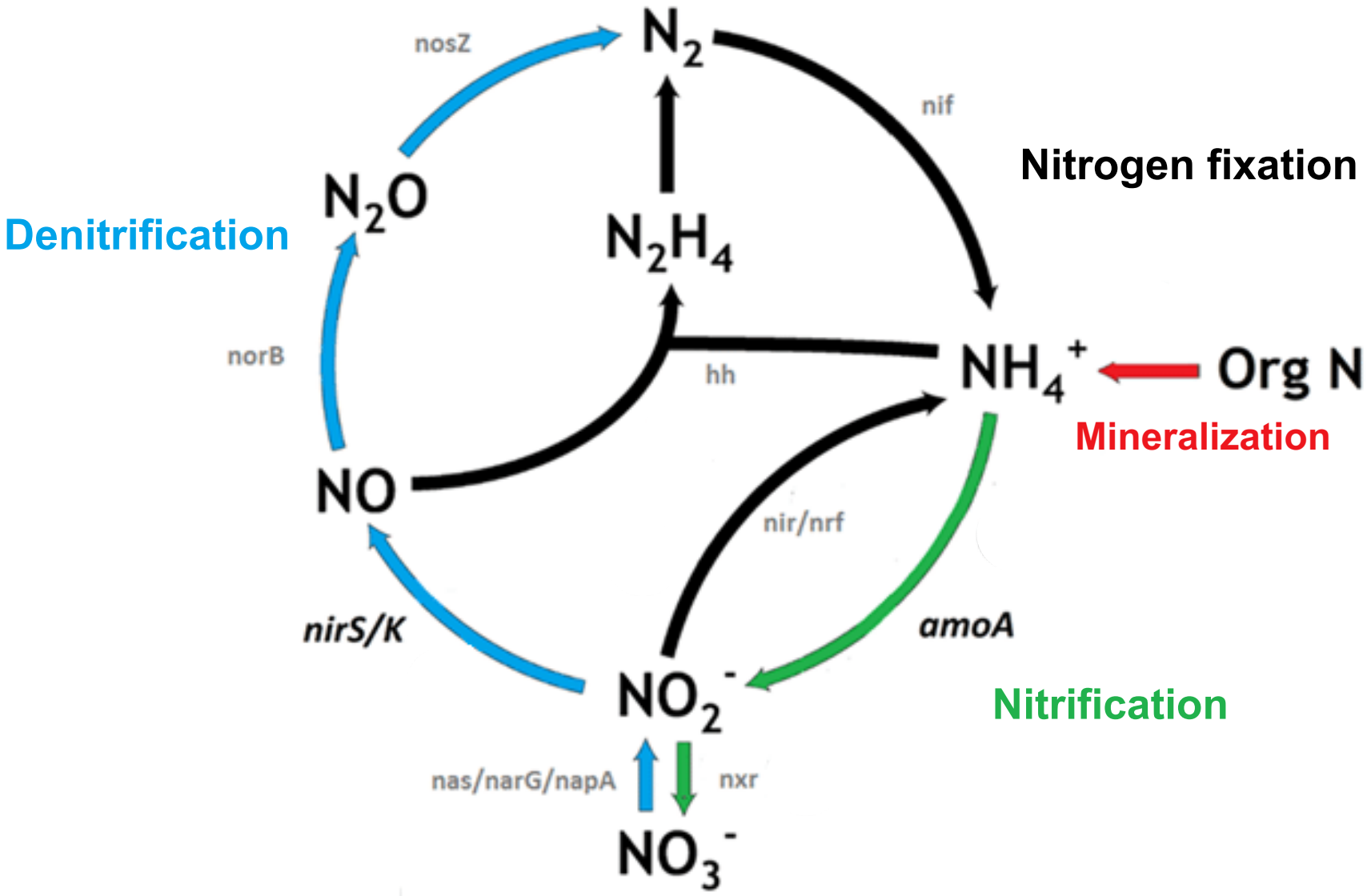
Disease suppression

Nutrient availability



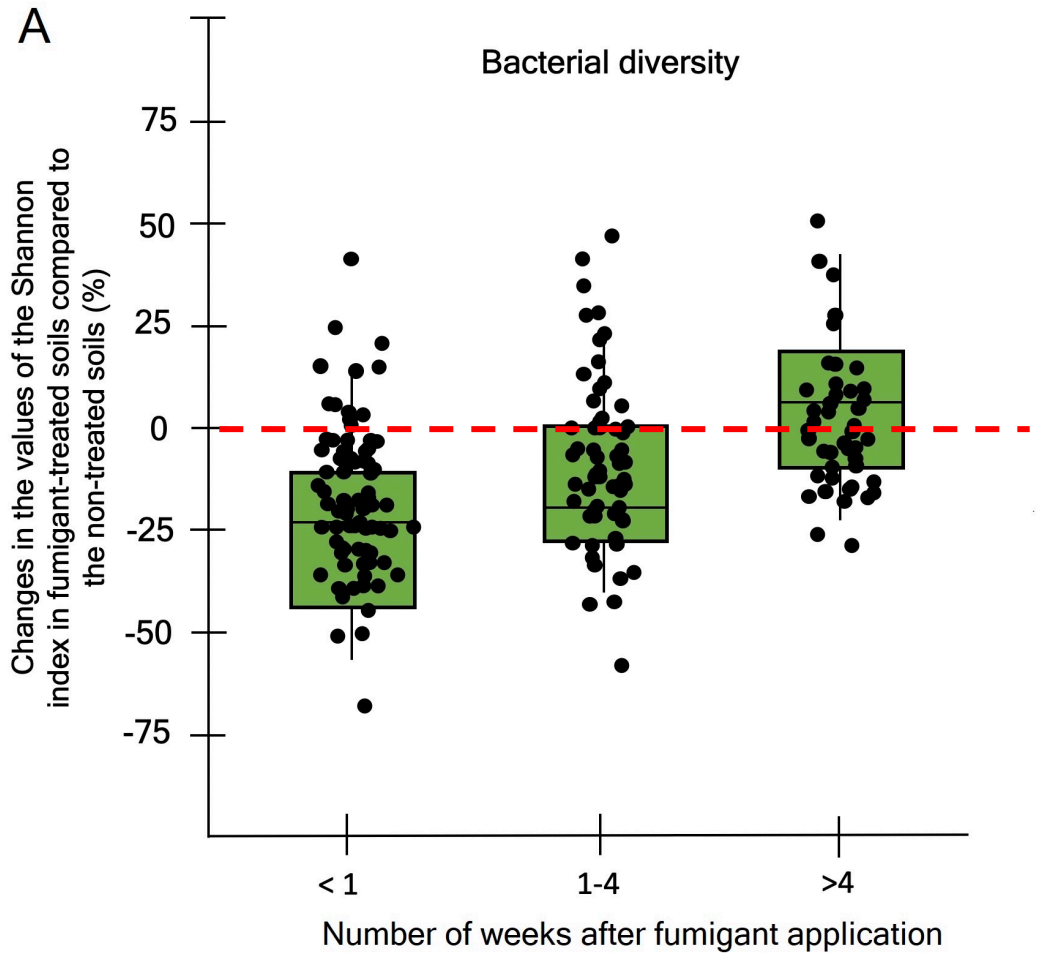
Nutrient cycling

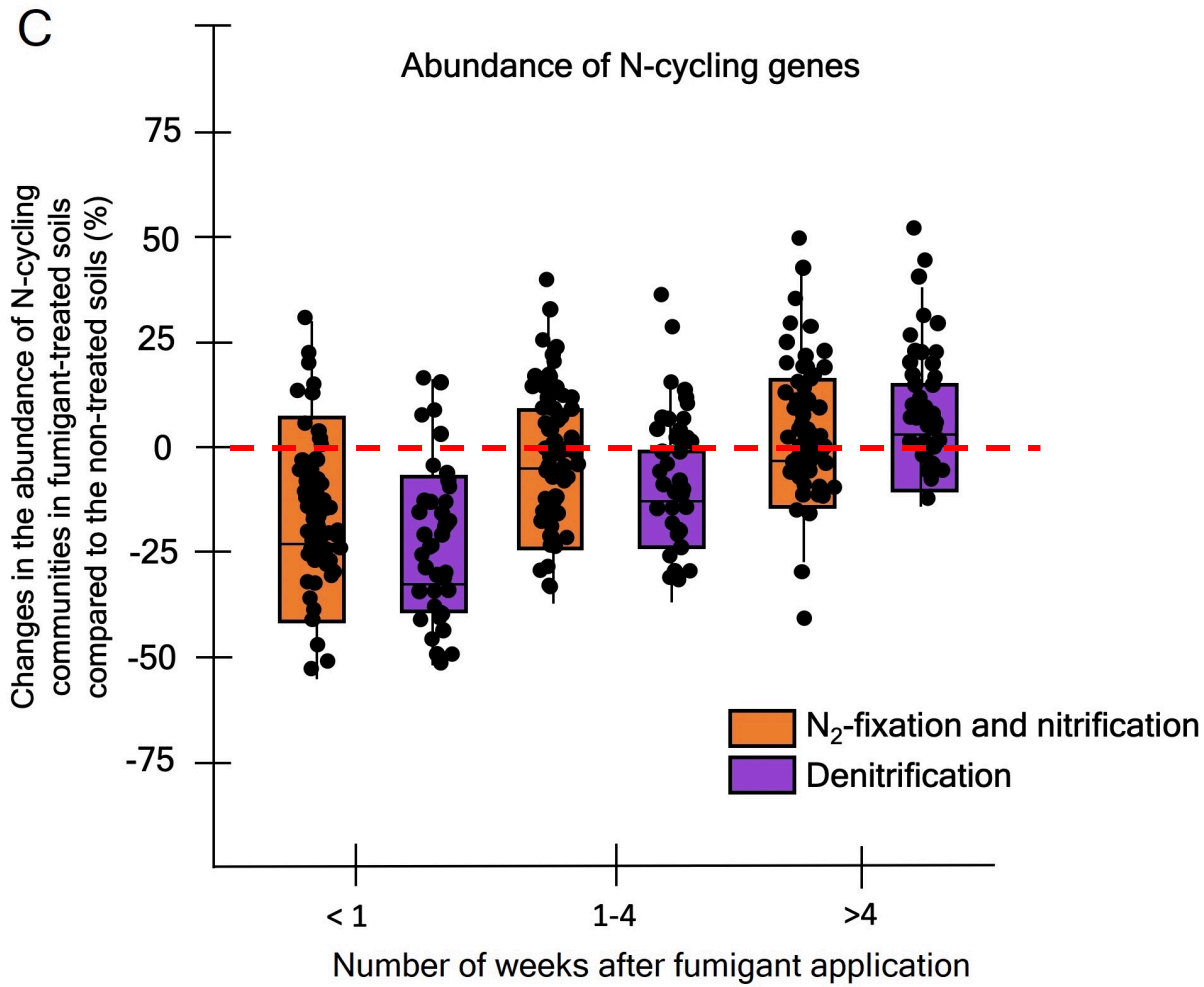
Microbes and nitrogen cycling



What happens to all the other soil microbes when we fumigate?

Fumigant impacts on non-target microbiome?



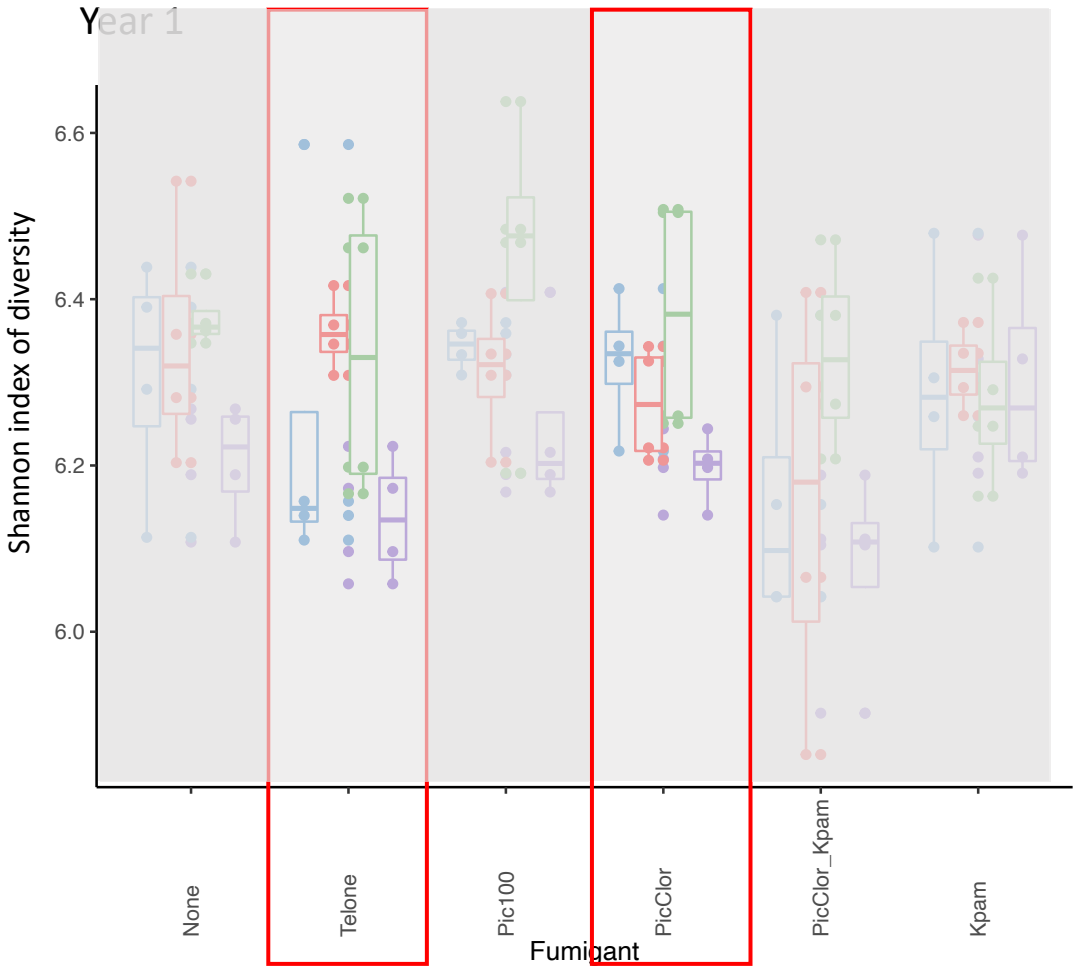


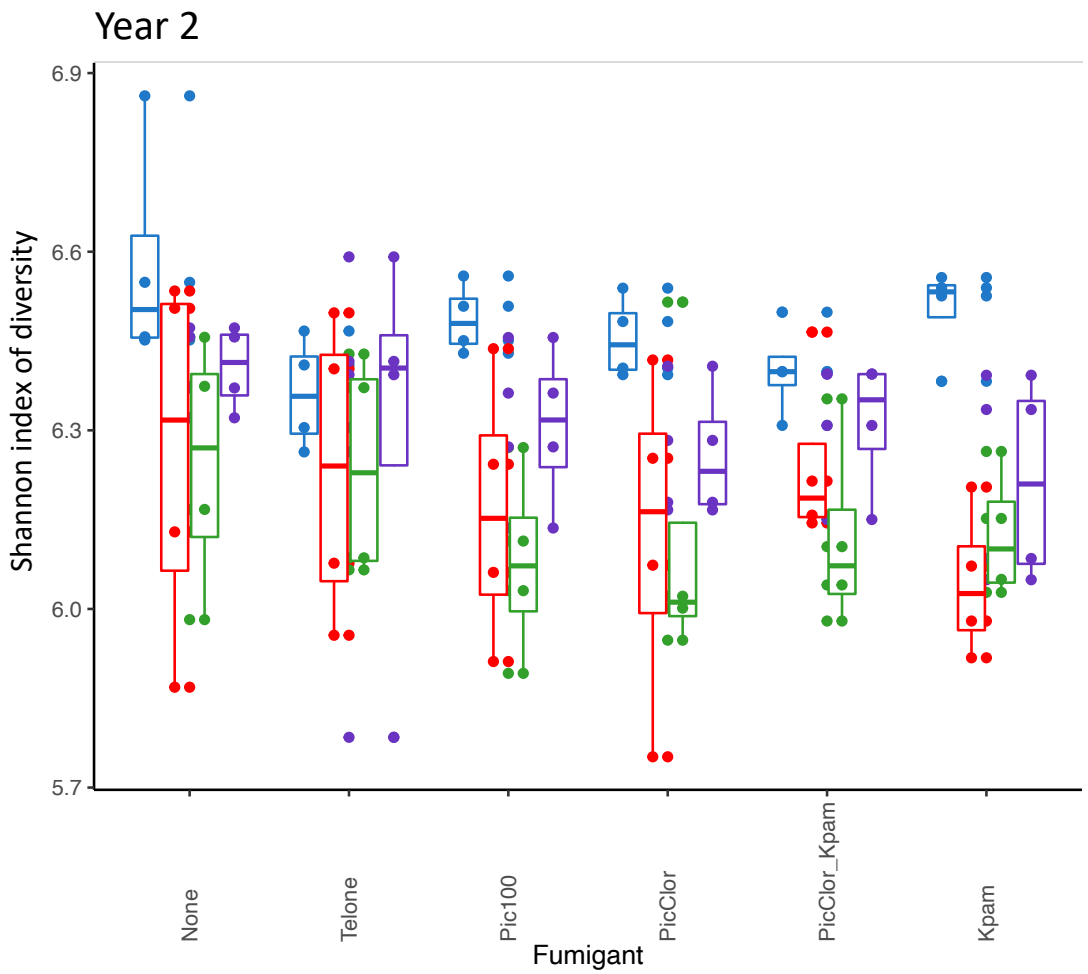
- Castellano-Hinojosa et al. 2022

Assessing fumigant impacts on the soil microbiome

Fumigant	Rate (lbs/acre)	Composition
Control	NA	
Telone C35	225	64% 1,3-dichloropropene + 35% chloropicrin
Pic-Clor 60	275	40% 1,3-dichloropropene + 60% chloropicrin
Pic100	300	100% chloropicrin
K-pam	424	Potassium N-methyldithiocarbamate
Pic-Clor 60 + Kpam	275+40	

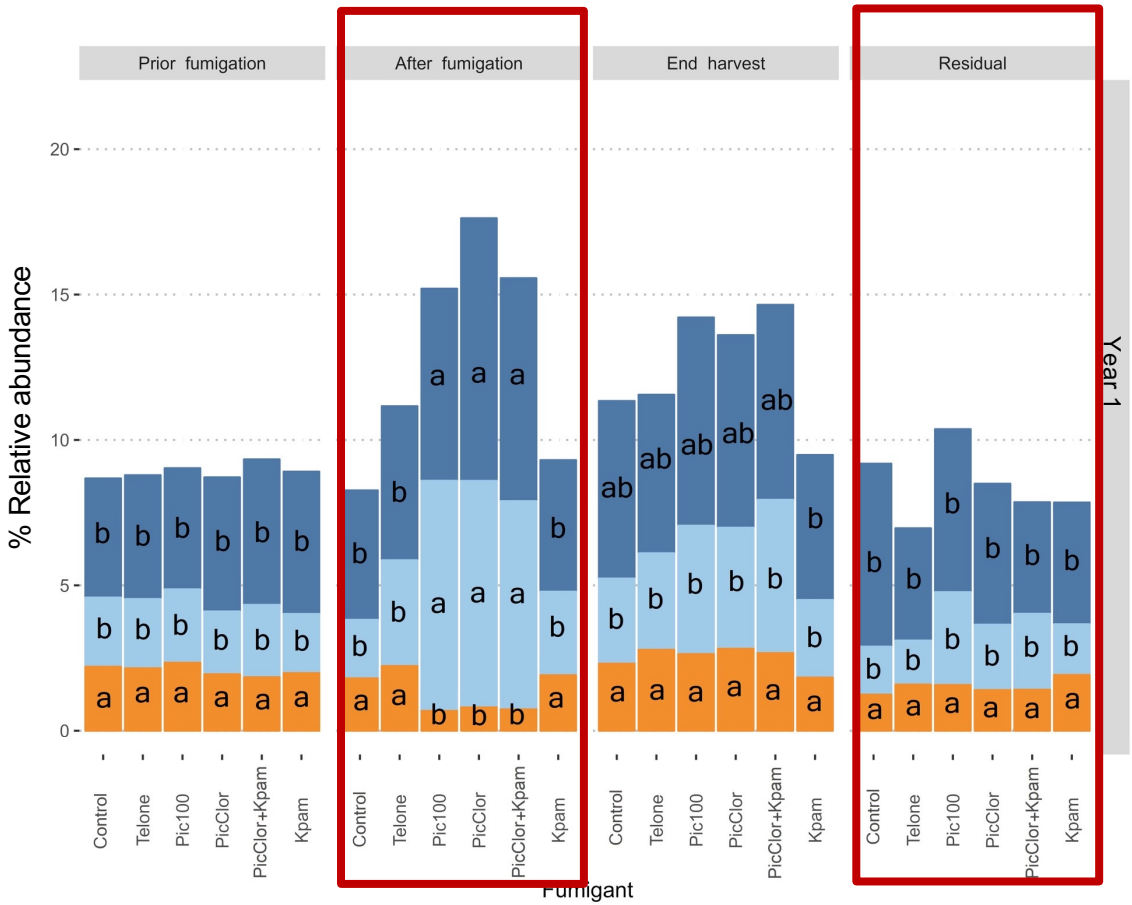
Fumigation had no significant effects on bacterial diversity

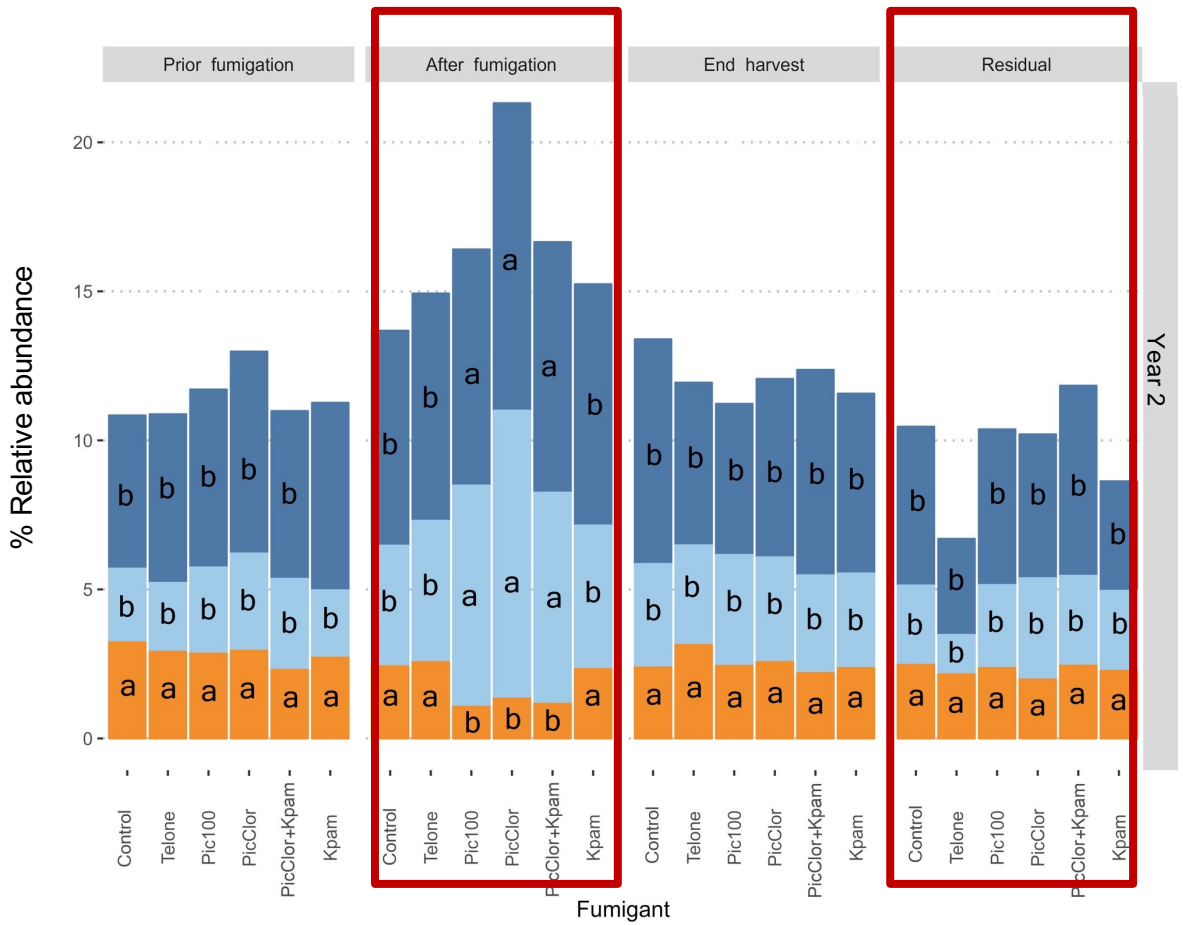




Before fumigation
1 month after fumigation
4 months after fumigation (harvest)
6 months after fumigation (fallow)

Fumigation temporarily impacted specific taxa



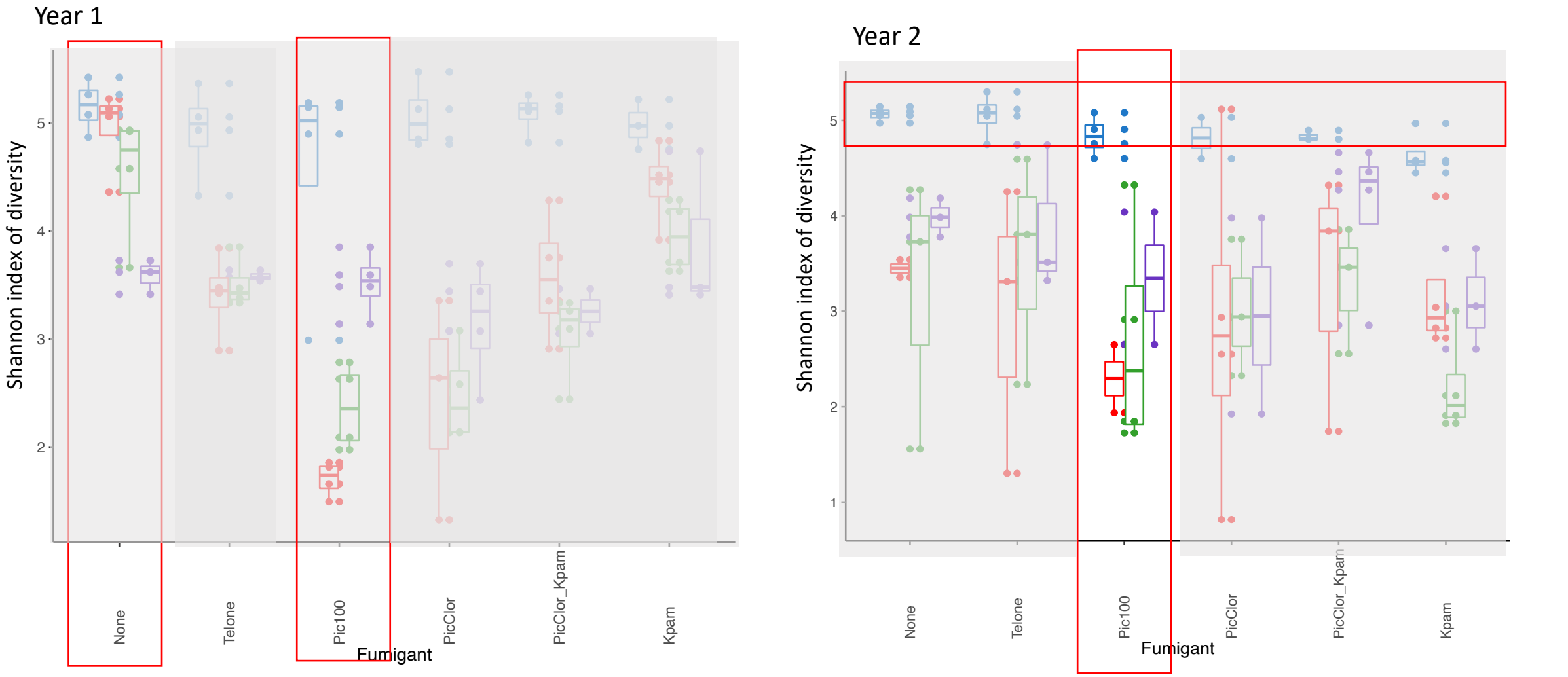


Genus

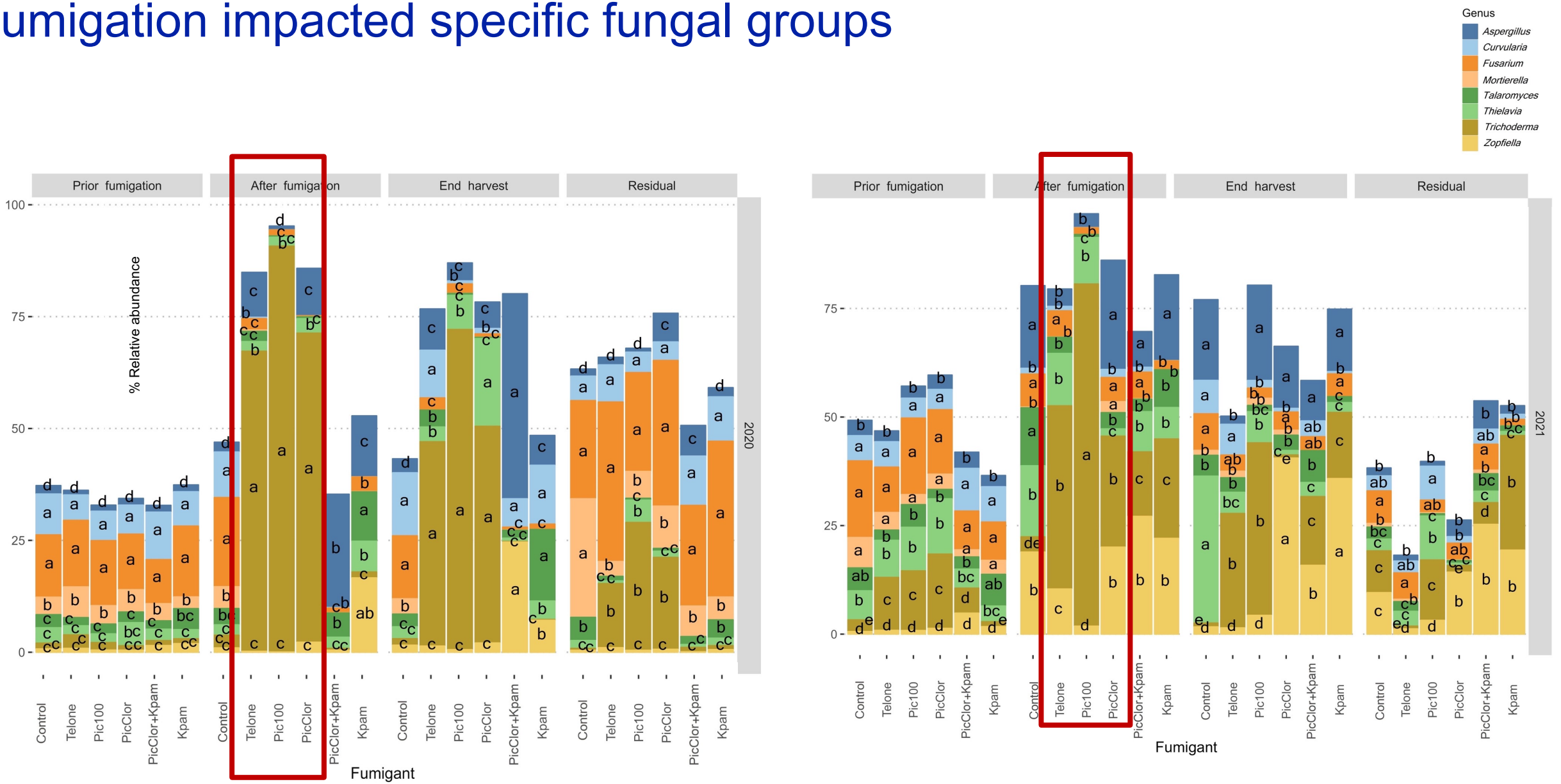
- *Bacillus*
- *Paenibacillus*
- *Roseiflexus*

- Castellano-Hinojosa et al. 2024

Fungal diversity was impacted by all fumigants throughout the growing season

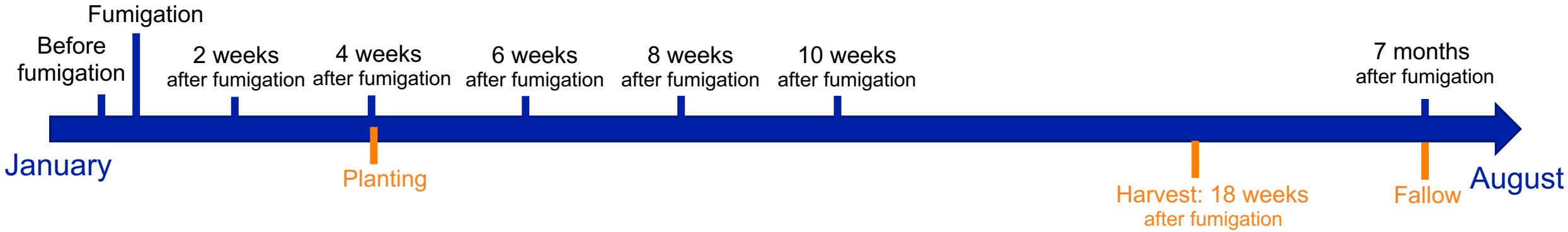


Fumigation impacted specific fungal groups



- Castellano-Hinojosa et al. 2024

Assessing fumigant impacts on the soil microbiome



Locations:

"Old" field: Higher SOM,
fumigated 3x previously

"New" field: Lower SOM
no previous fumigation

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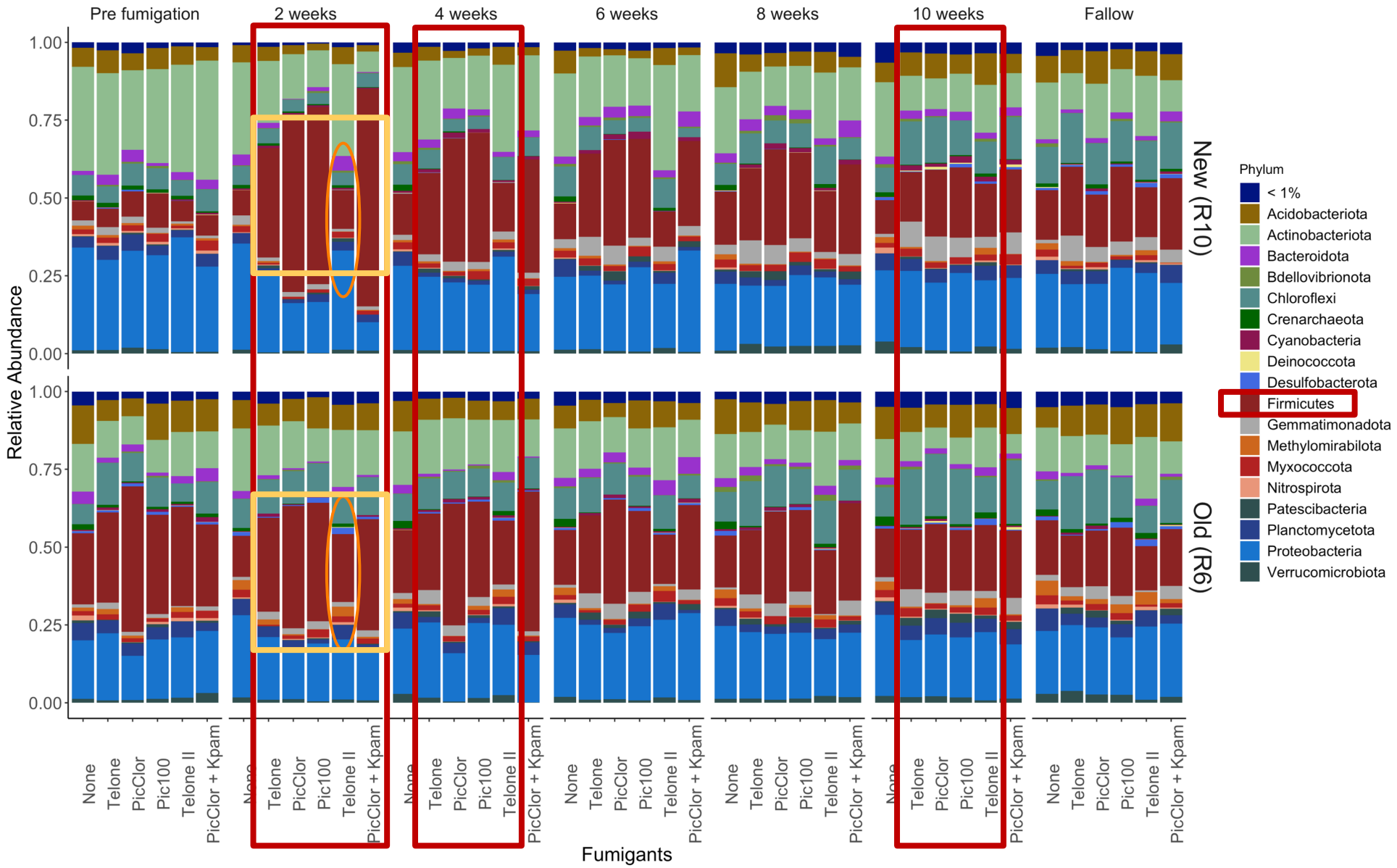
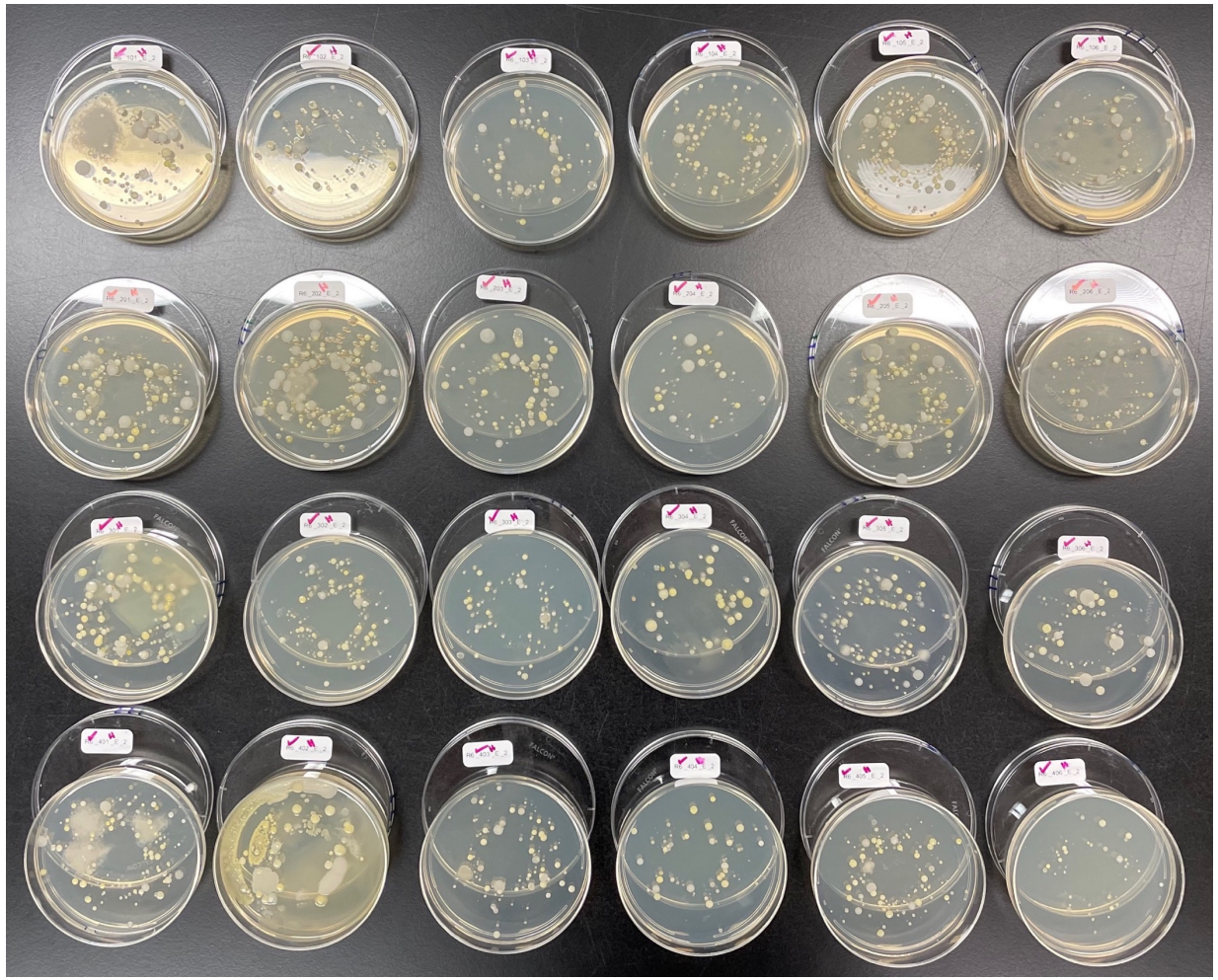
Fumigation temporarily impacted bacterial community composition



- Karlsen-Ayala et al. in preparation

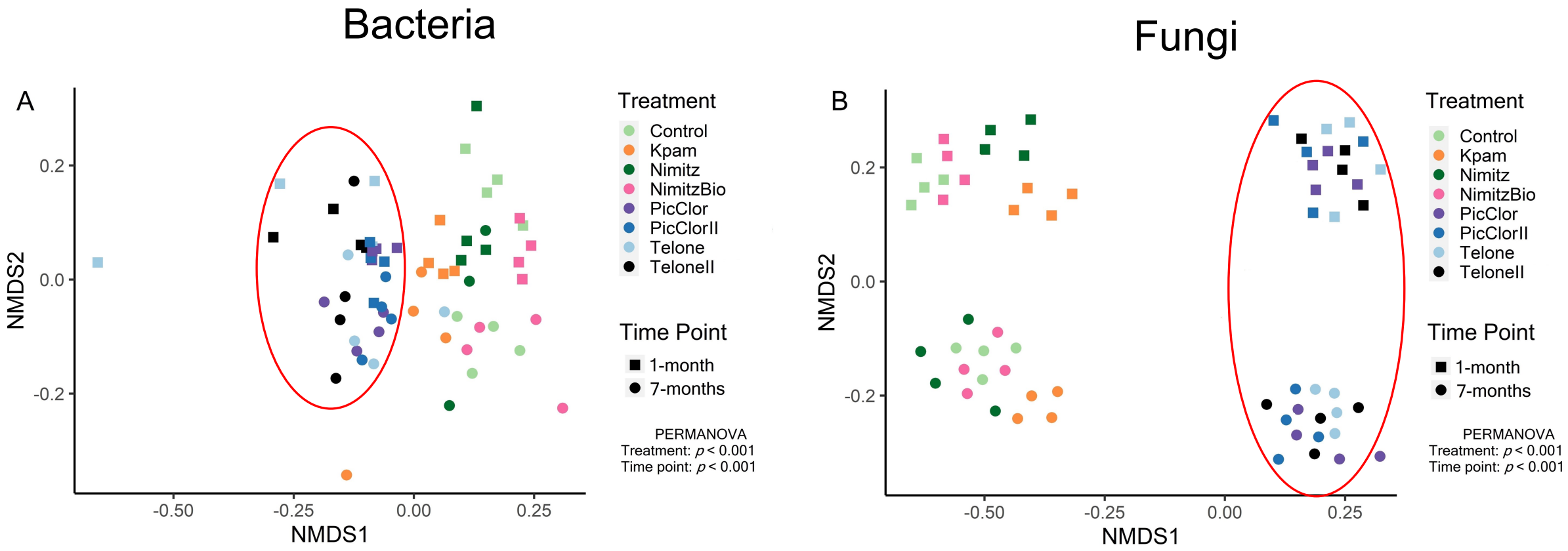
Next steps: identify differences in bacterial functions

- Bacterial isolates collected from each time point
- Identifying isolates using Oxford Nanopore sequencing
- Test potential plant-growth-promoting functions of specific isolates
- **This approach is critical to allow us to link how soil fumigation impacts soil microbiome functions with potential impacts crop yield and production**
- Trials have started in commercial tomato and strawberry fields



- Karlsen-Ayala

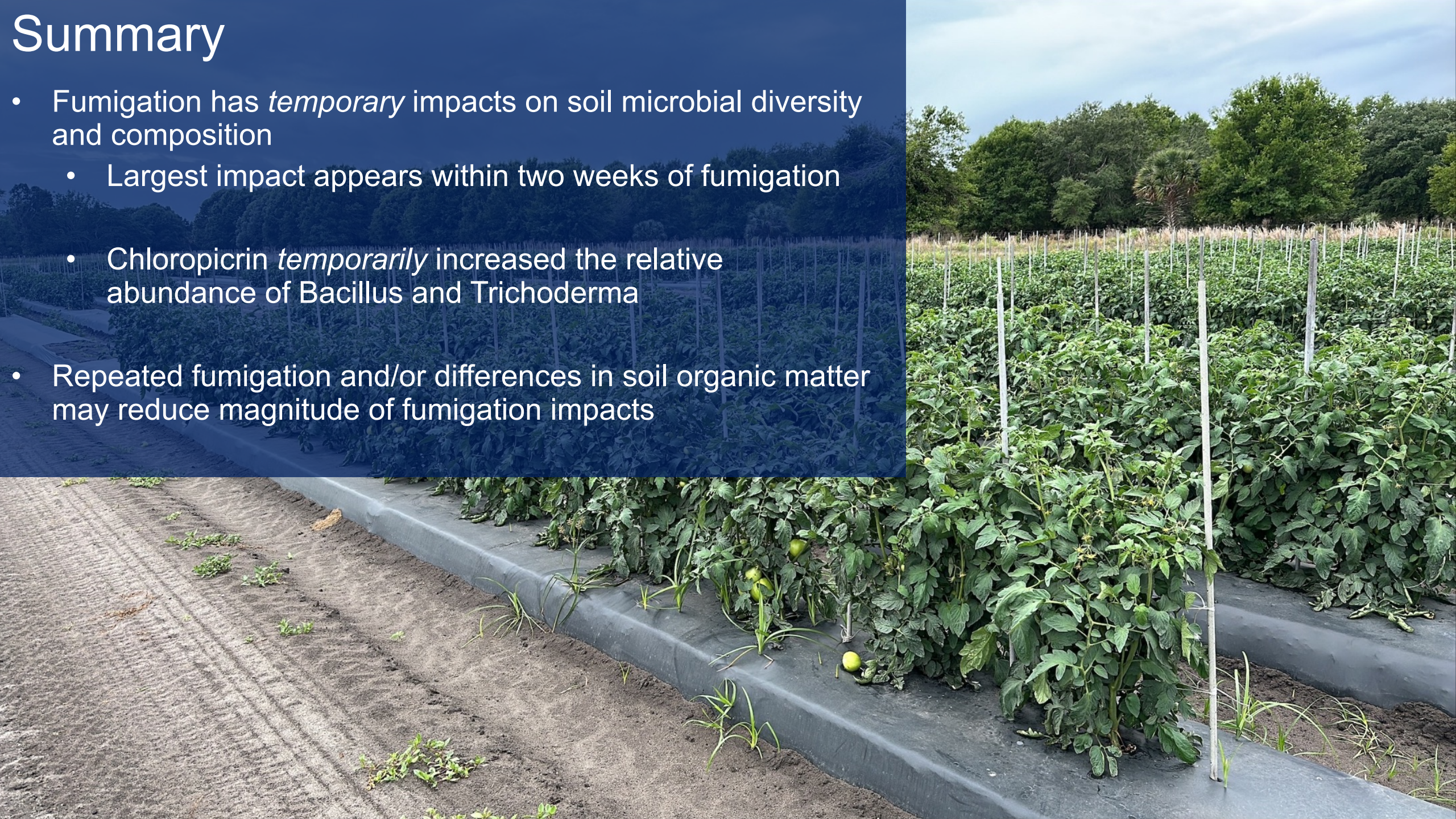
Fumigant impacts on bacteria and fungi in strawberry



- Castellano-Hinojosa et al. 2022

Summary

- Fumigation has *temporary* impacts on soil microbial diversity and composition
  - Largest impact appears within two weeks of fumigation
  - Chloropicrin *temporarily* increased the relative abundance of Bacillus and Trichoderma
- Repeated fumigation and/or differences in soil organic matter may reduce magnitude of fumigation impacts



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Funding:
Tri-Est Ag Group, Inc.
USDA-NIFA Award #: 2022-67019-36958

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