IMPACTS OF MANAGEMENT ON SOIL MICROBES IN FLORIDA VEGETABLE PRODUCTION

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Soil & Water SCIENCES

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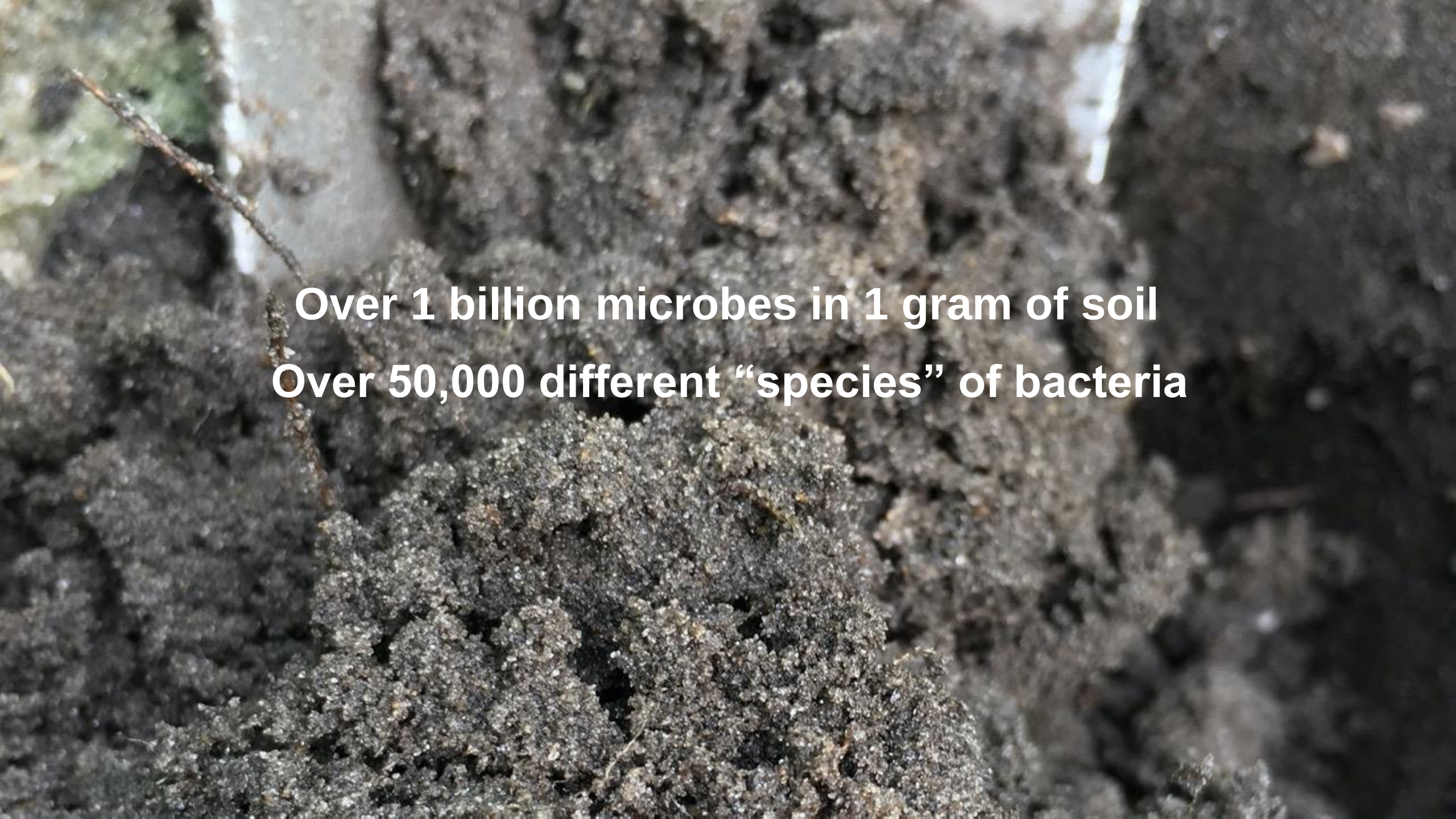
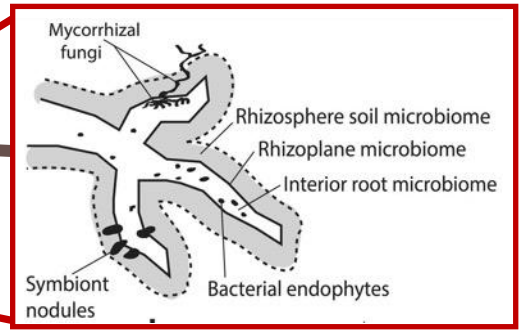

Over 1 billion microbes in 1 gram of soil
Over 50,000 different “species” of bacteria

Why are soil microbes important?

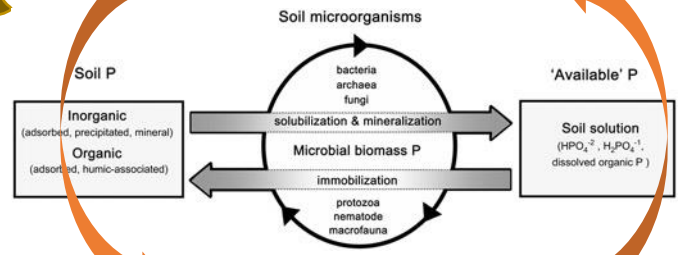
Soil organic matter

Disease suppression



Root growth

Nutrient availability



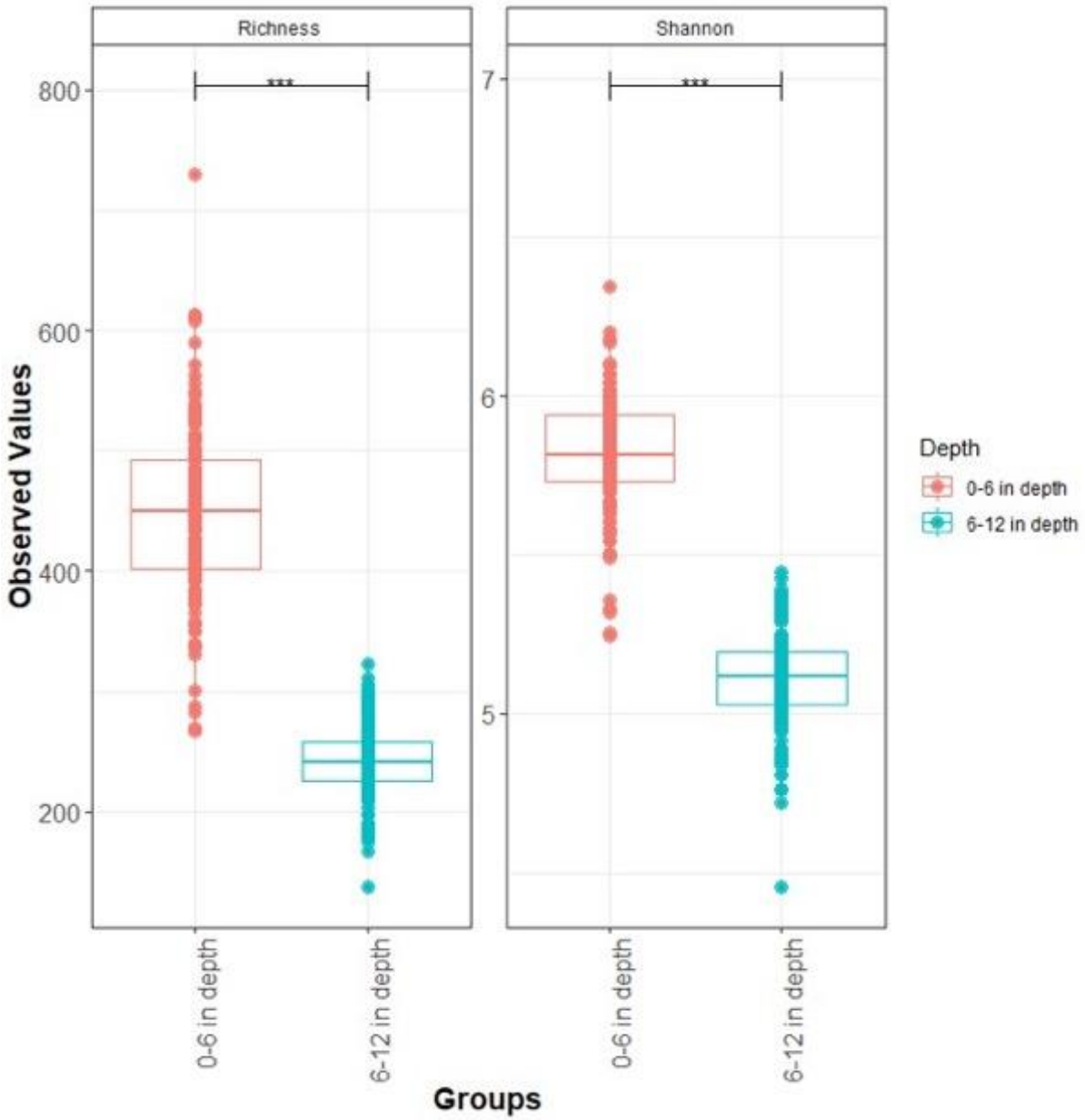
Nutrient cycling

Management practices can influence soil microbes

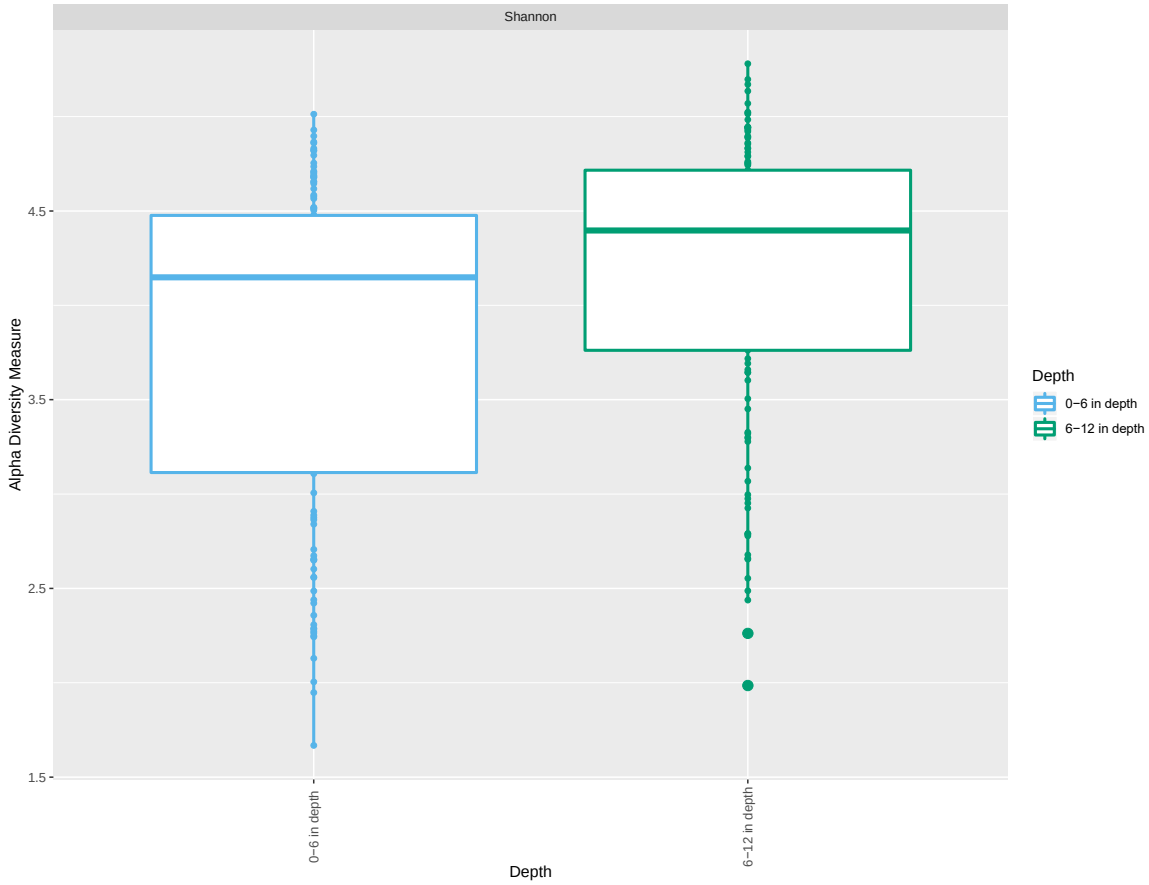
- Raised beds
- Fumigation
- Soil amendments

What happens to soil microbes in a raised bed?

Bacteria



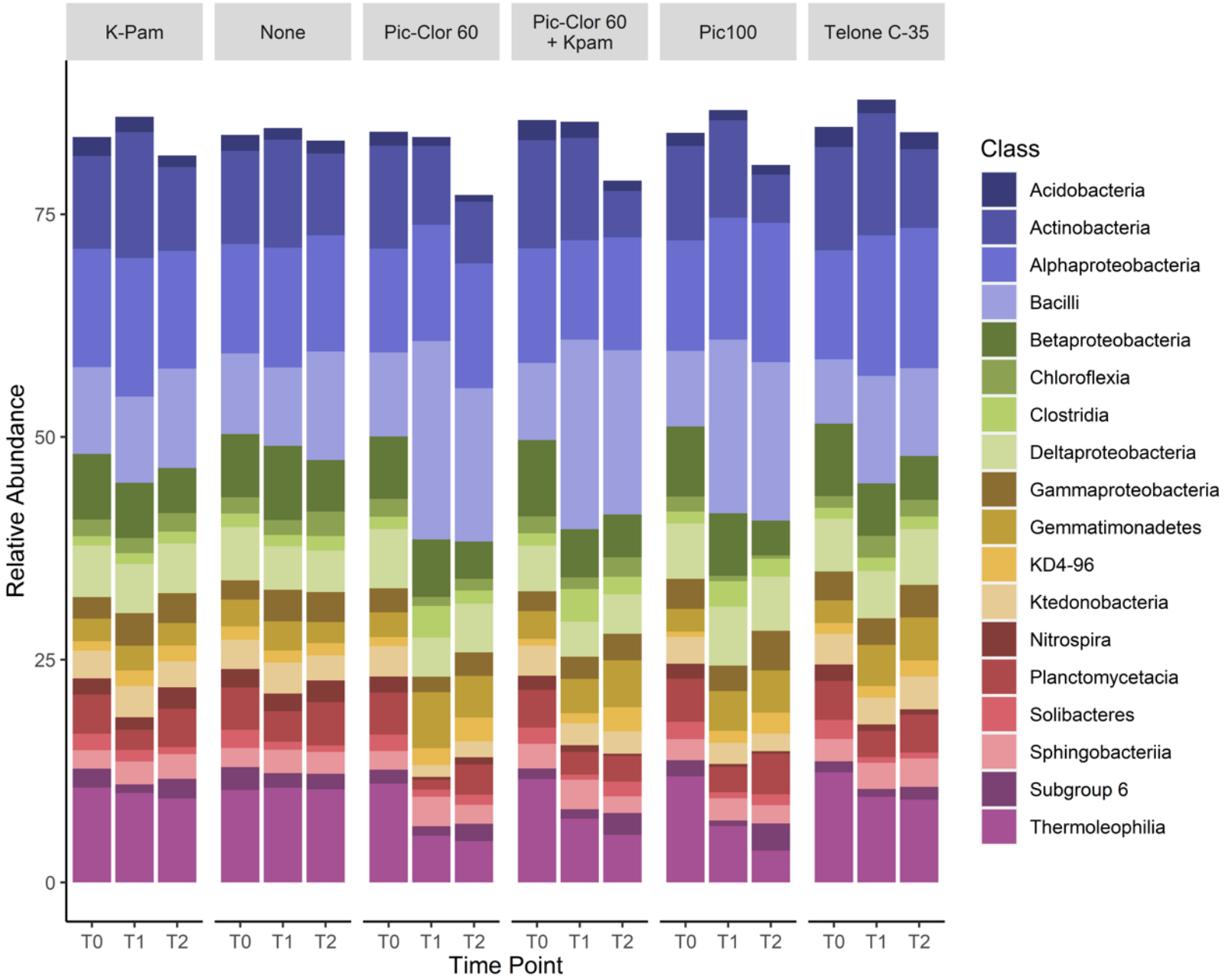
Fungi

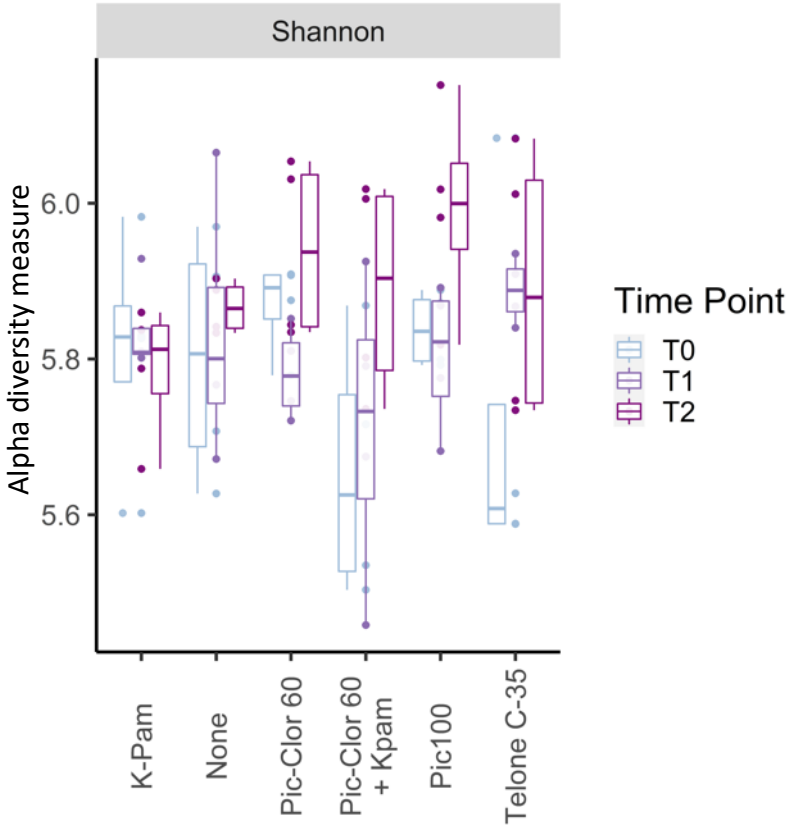


Management practices can influence soil microbes

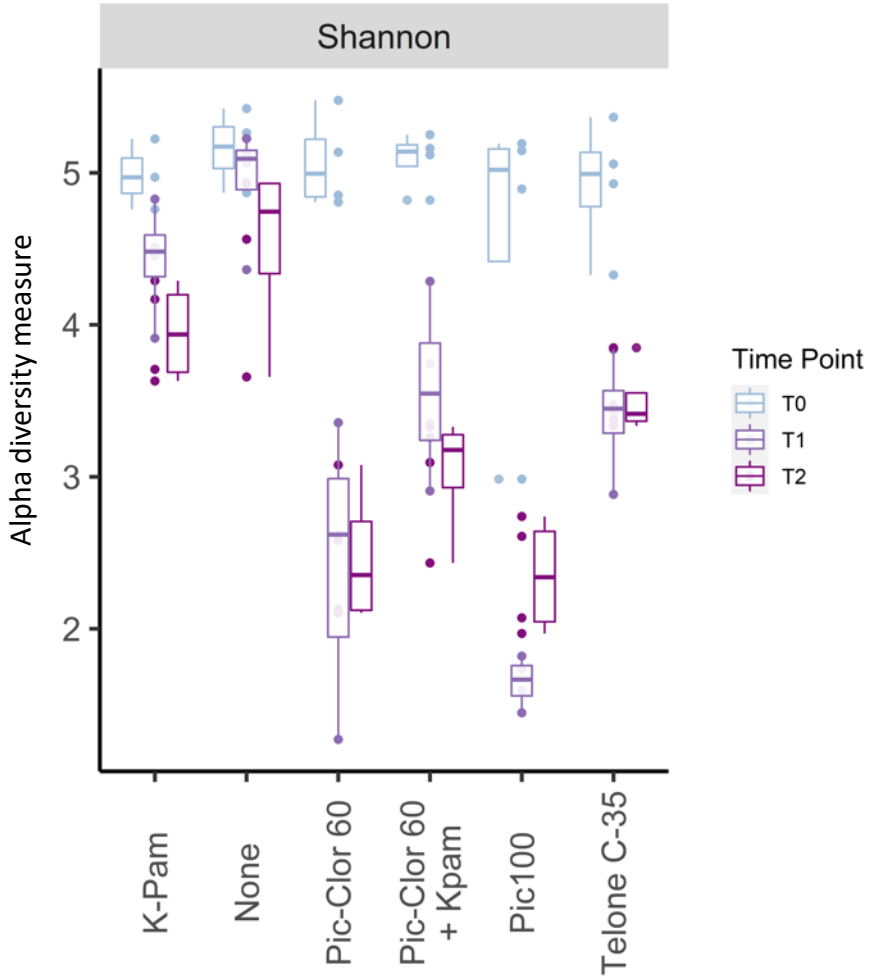
- Raised beds
- Fumigation
- Soil amendments

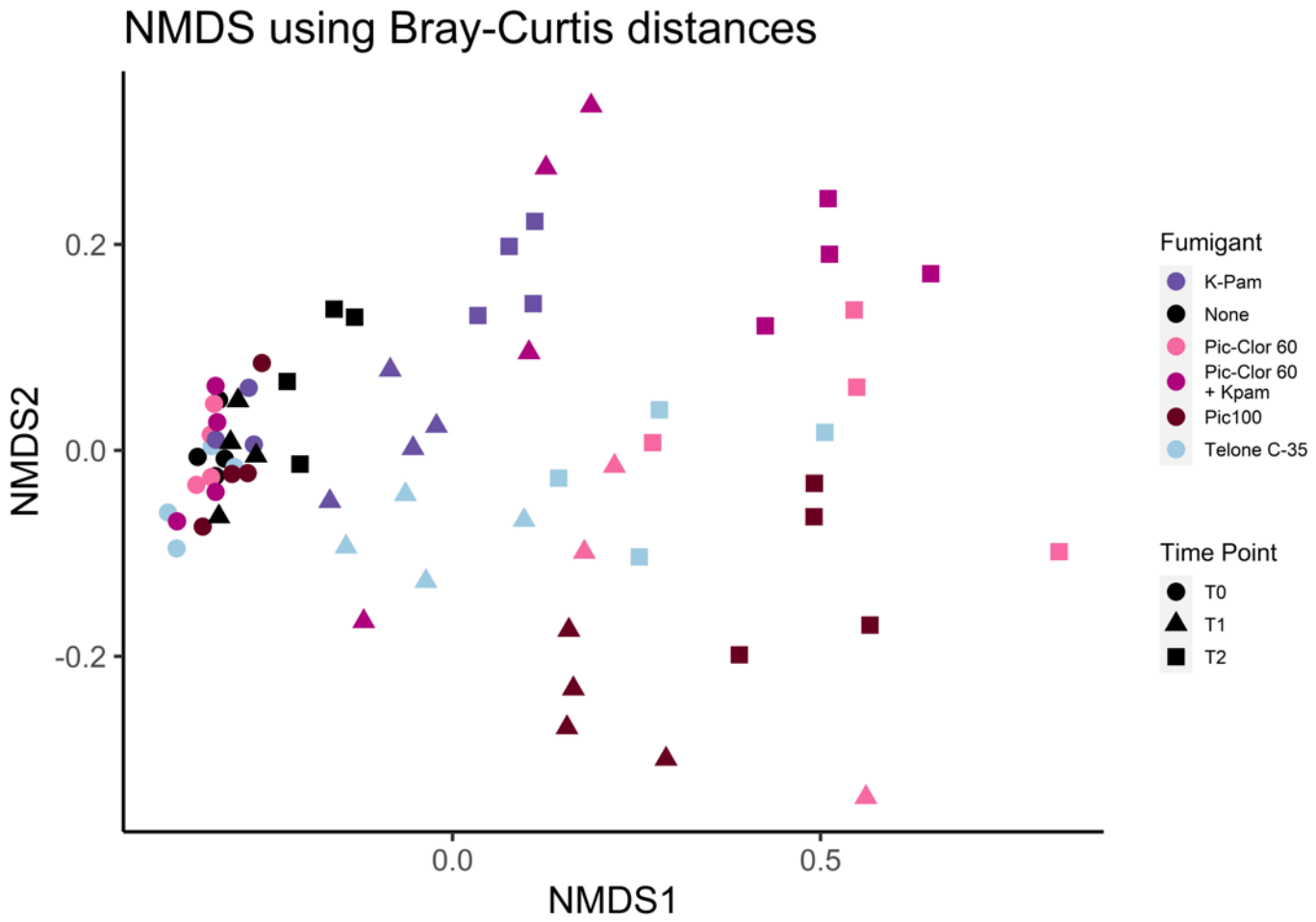
Fumigant had significant impacts on soil bacteria





Fumigant had significant impacts on soil fungi





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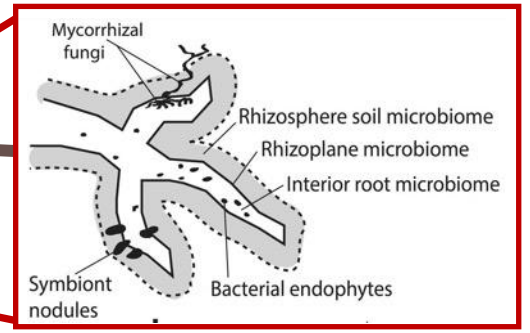
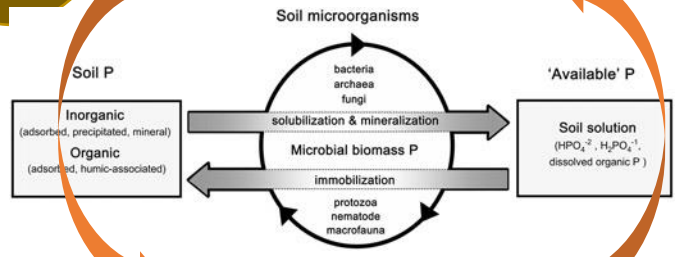
Soil organic matter

Disease suppression



Root growth

Nutrient availability



Nutrient cycling

Difficulties with SOM in Florida

Building soil organic matter in Florida: compost

Benefits

- Availability
- Nutrient source

Difficulties

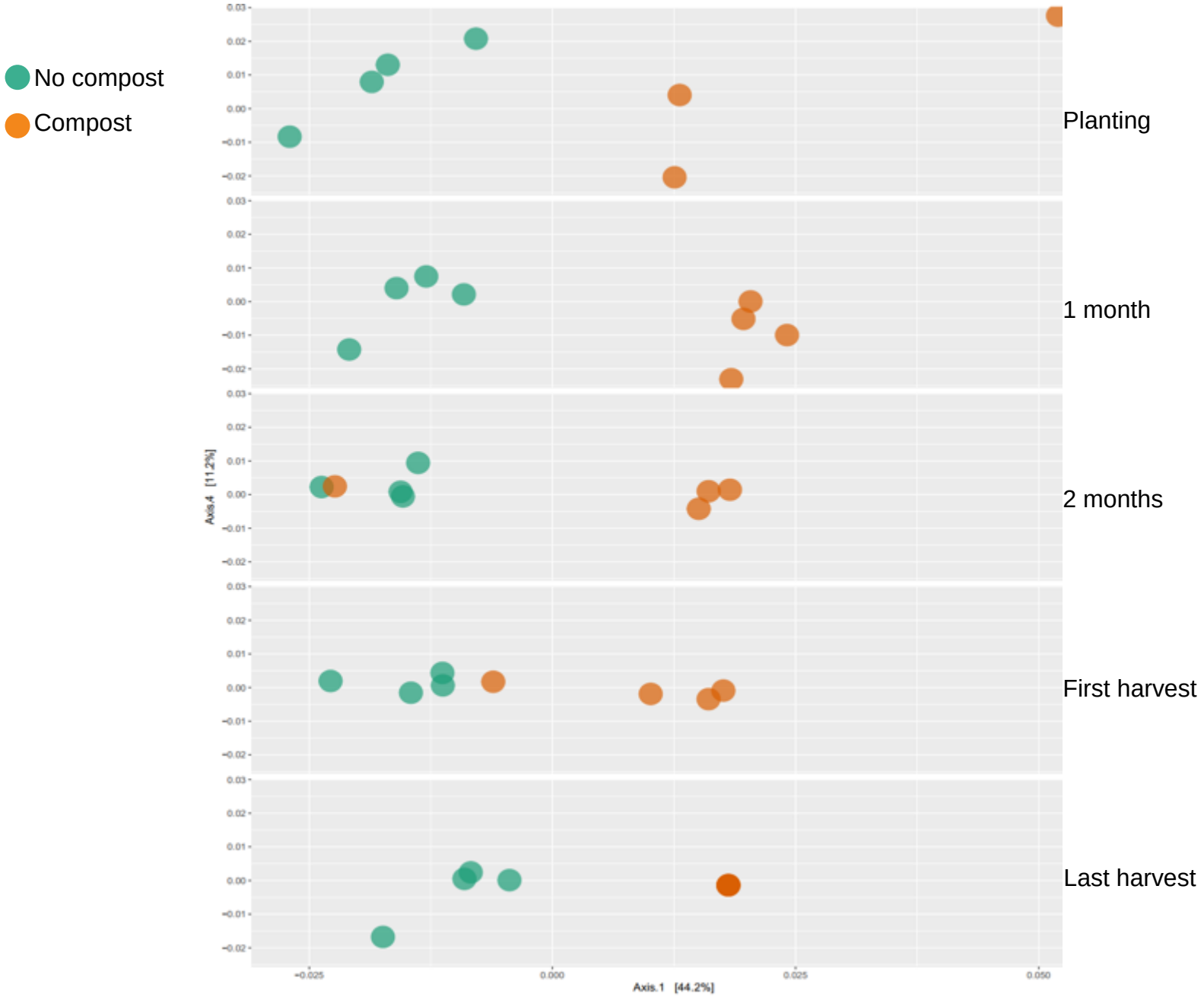
- Expensive
- Application rate
- Availability
- Variability
- Potential source of weed seed

Adding carbon to improve soil microbial health : compost

Compost Tomato Trial:

- Plant-based compost applied at bedding:
  - No compost
  - 10 tons/acre
  - 40 tons/acre
- Beds fumigated with Pic-Clor 60
- Soil samples collected every 30 days

Significant differences in bacterial community composition



Building soil organic matter in Florida: cover crops

- Cover crops = crops planted to benefit the soil, generally not harvested for profit

- Lots of benefits to soil (and farmer):
  - Provide N – either by N—fixation from legumes, or by scavenging extra N from previous crop
  - Reduce weeds
  - Reduce soil erosion
  - Reduce soil compaction
  - Increase soil moisture
  - Increase soil organic matter

Cover crops and management practices

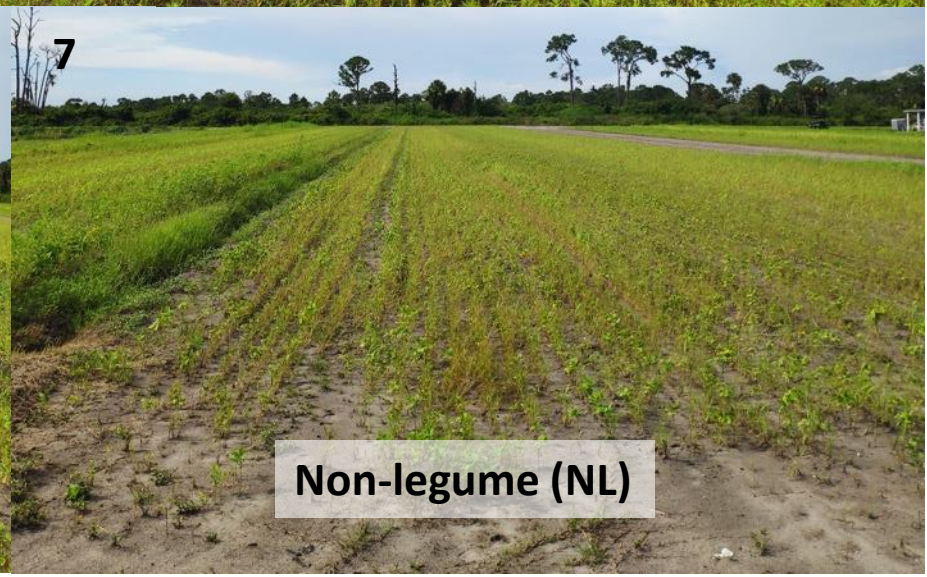
- Increasingly common practice for grains, cotton, corn, soybean farmers, but also used with some vegetable production
- Cover crops planted during fallow season
- Cover crop use more frequently combined with conservation or no-tillage management practices

Symbiotic N_2-fixation: Rhizobia

- Soil bacteria that attach and colonize legume roots
- Fix N for plants
- Plants provide carbon for the bacteria
- N_2-fixation requires low or no oxygen, so nodules formed
  - 1 nodule can contain up to 10^9 rhizobia
  - Use leghaemoglobins
    - O_2-buffering proteins similar to the hemaglobins in our blood

- Nevins 2019

Cover crop mix optimization



Cover crops species provide different benefits

Legume cover crops:

- Cowpeas (*Vigna unguiculate*)
- Vetches (*Vicia* spp.)
- Crimson clover (*Trifolium incarnatum)*

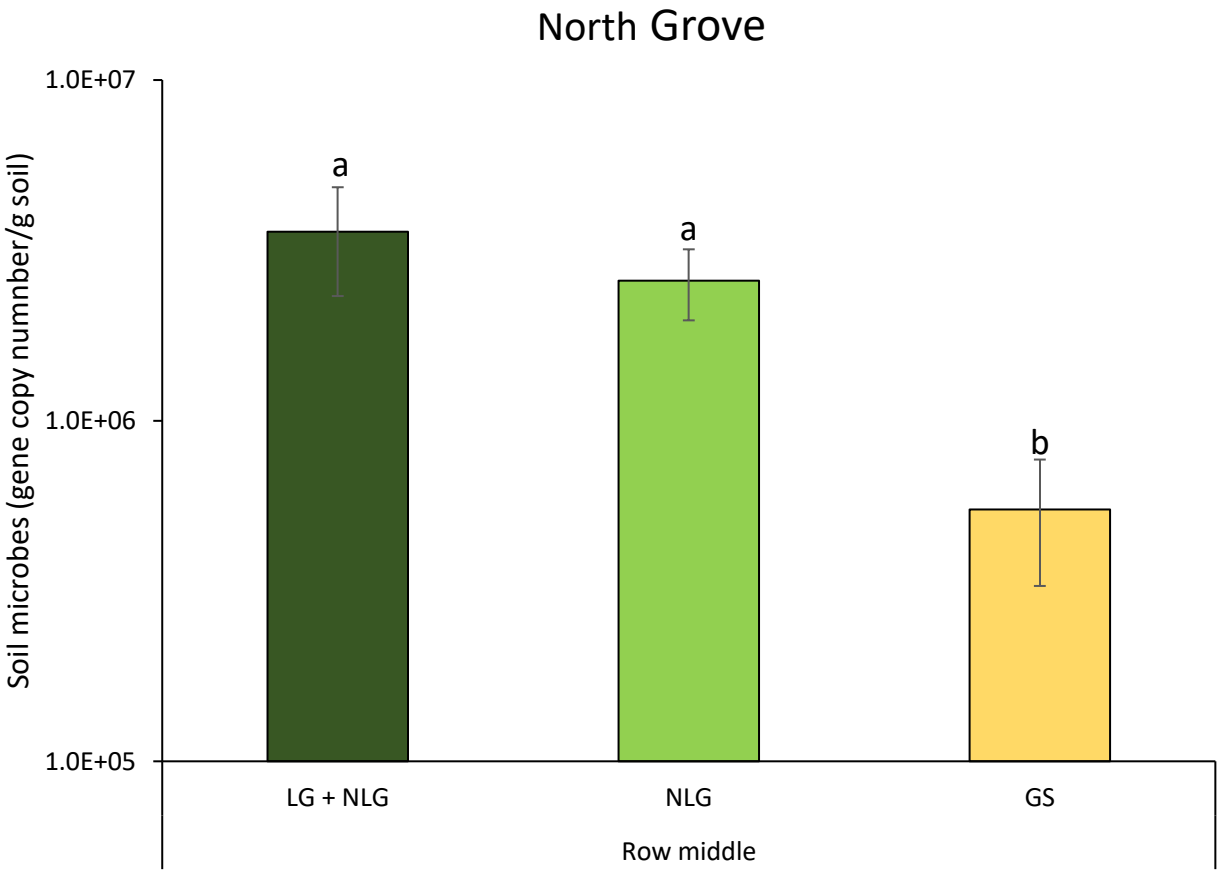
Nematode management (non-host plants):

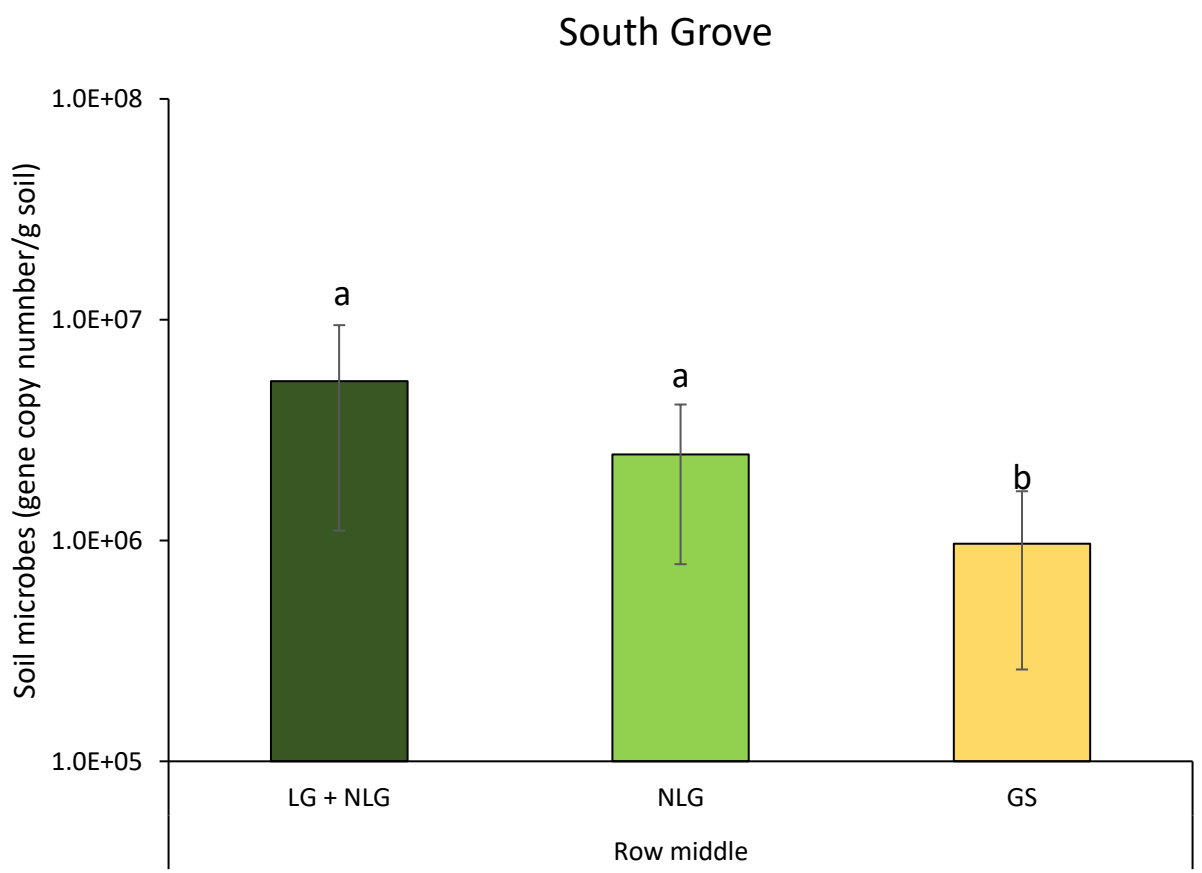
- Cereal rye (*Secale cereale)*
- Wheat (*Triticum aestivum)*
- Crimson clover (*Trifolium incarnatum)*

Weed suppression:

- Subterranean clover (*Trifolium subteraneum)*
- Buckwheat (*Fagopyrum esculentum)*
- Sorghum-sudangrass

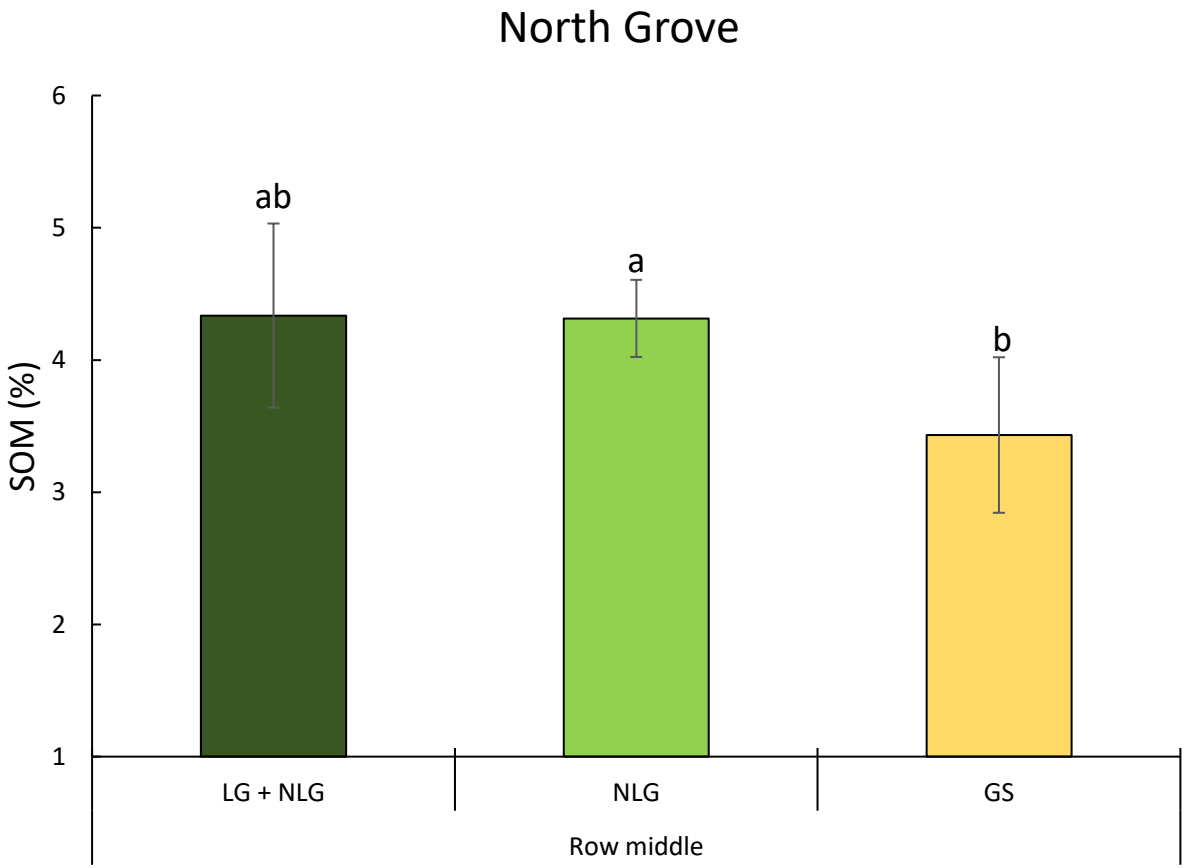
Soil microbes increased with cover crops

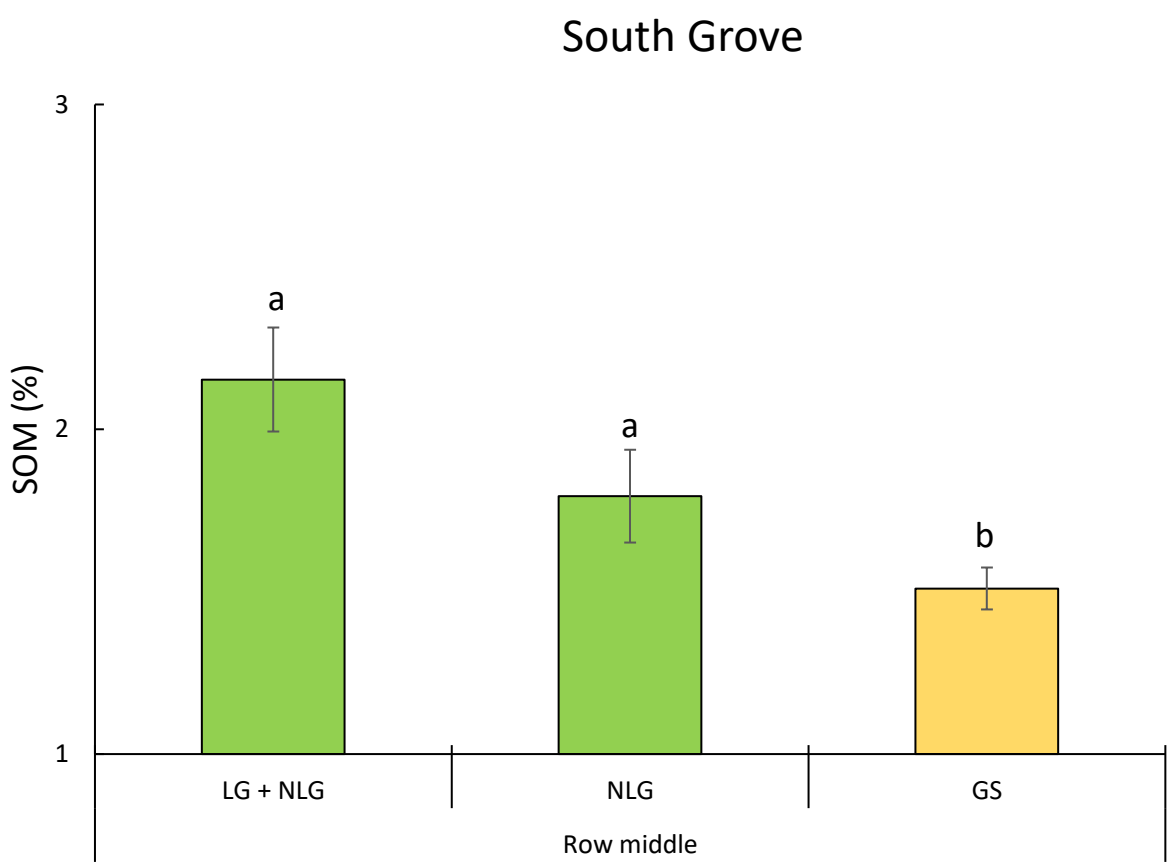




LG + NLG: legume + non-legumes cover crops
NLG: non-legume cover crops
GS: grower-standard

SOM increased after 1 year of cover crops





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fruit de la passion
946 mL
Tropicana essentials PROBIOTICS
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fraise et banane
946 mL

Differences between human gut and soil microbiome

- Similar concentration of bacteria, but vastly different levels of diversity:
- Human gut:
  - **1,000 species**, with approximately 160 “common” species *(Qin et al. 2010)*
- Soil:
  - **10,000 to 50,000 species**, unknown how many are “common”
- Even in the well-characterized human gut, nearly 50% of the genes are uncharacterized *(Lloyd-Price et al. 2016)*

Difficulties with soil microbial amendments

- Beneficial taxa can be very crop and/or environment specific

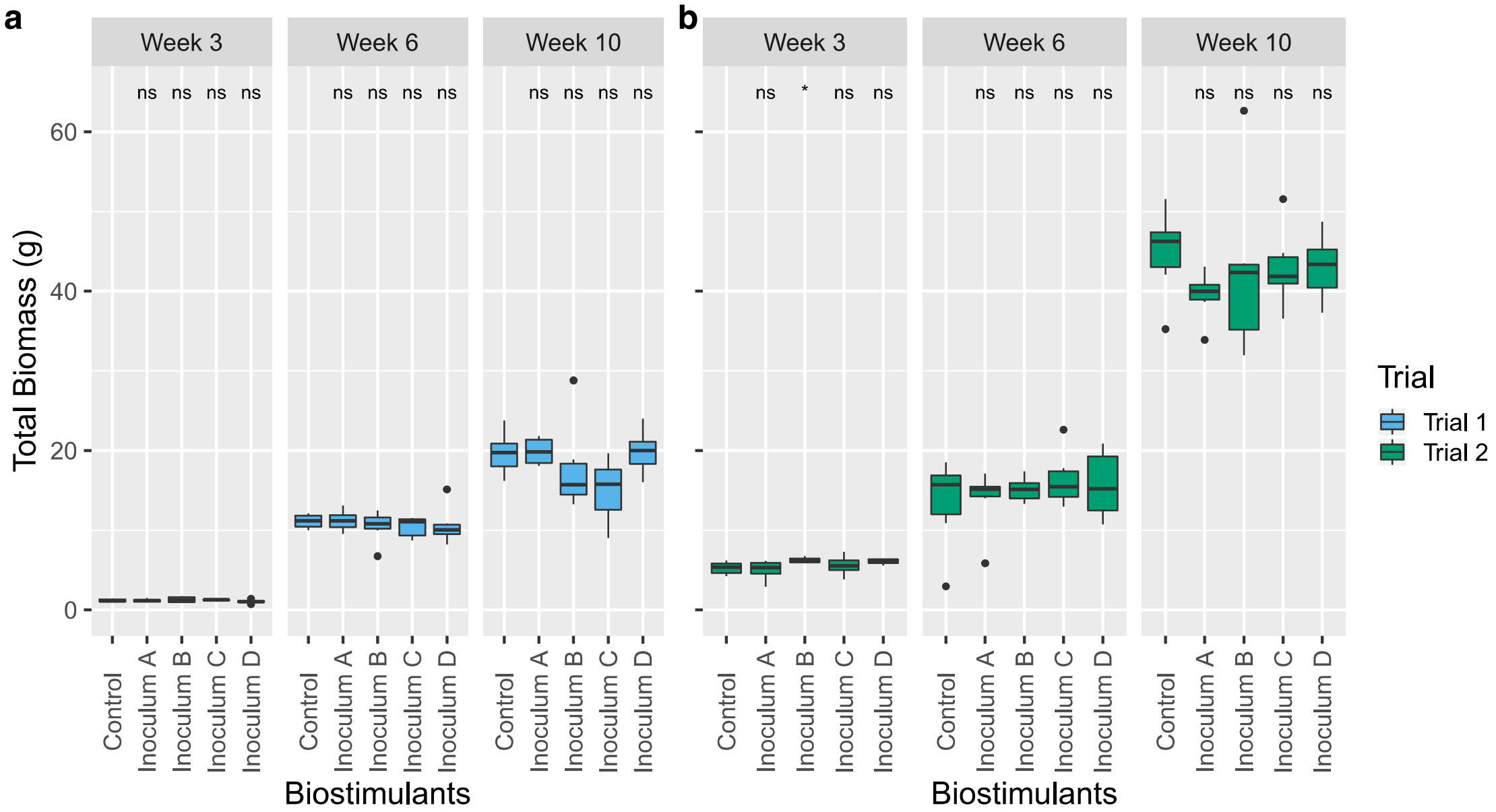
- Unknown how management interacts with added microbes:
  - How will introduced organisms interact with native organisms?
  - What conditions are necessary to keep introduced organisms alive and increasing in number?

- Things to consider when evaluating products:
  - What organisms are being added?
  - What is the concentration?
  - What other compounds are being added?
  - What conditions are required for inoculation?
  - How often does inoculation need to occur?

Soil type impacts on microbial amendments

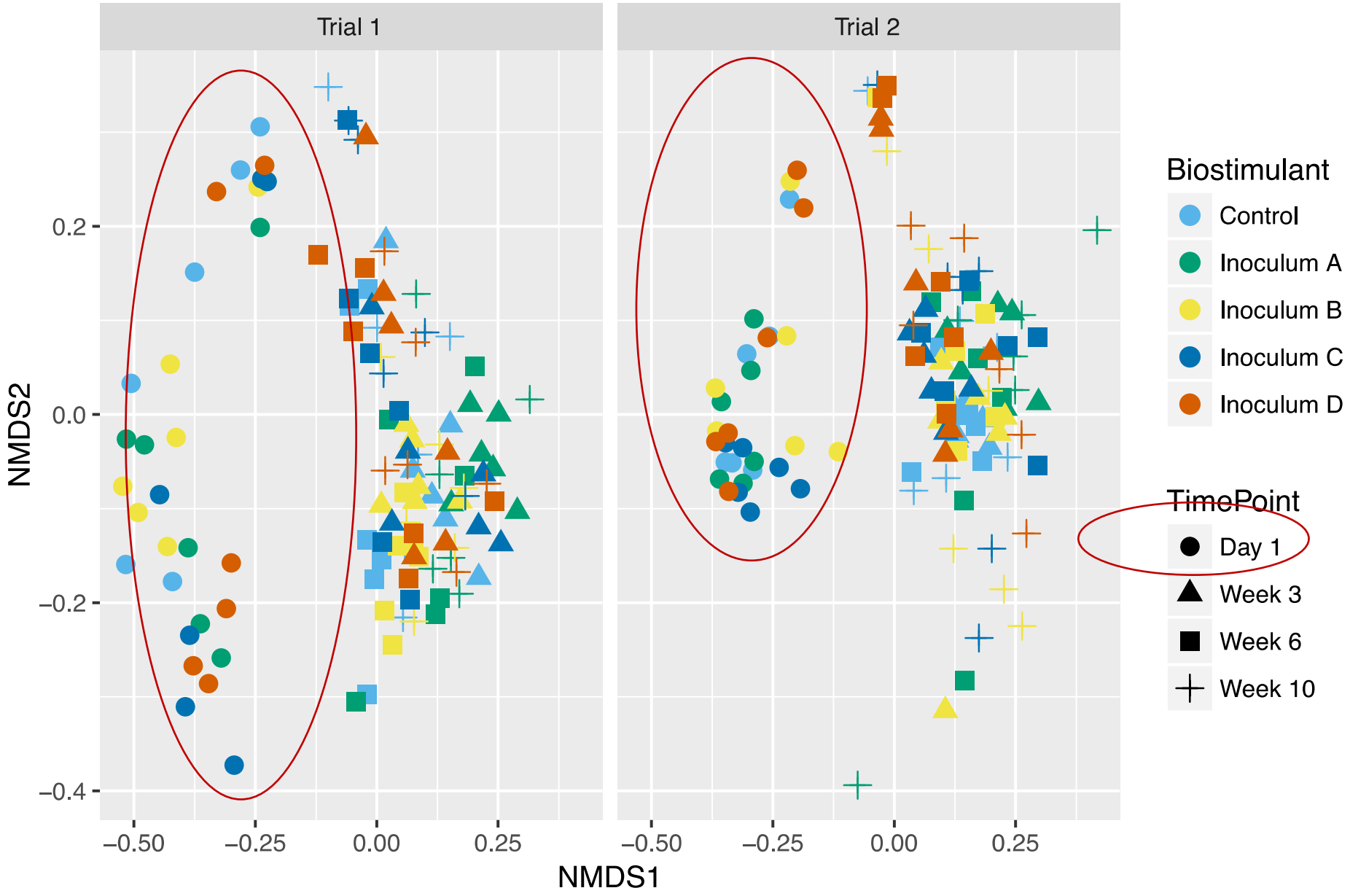
- Greenhouse trial with tomato
- Four treatments:
  - Bio-1: Mychorrhizae
  - Bio-2: Azospirillum sp., Bacillus sp., Pseudomonas sp., Tricoderma sp.
  - Bio-3: Lactobacillus sp., yeasts
  - Bio-4: Bacillus sp.
- Applied at recommended rates
- Planted in Florida field soil
- Repeated twice

Microbial additions did not impact plant growth



Nuzzo et al. (2020)

Microbial additions did not impact microbial community composition



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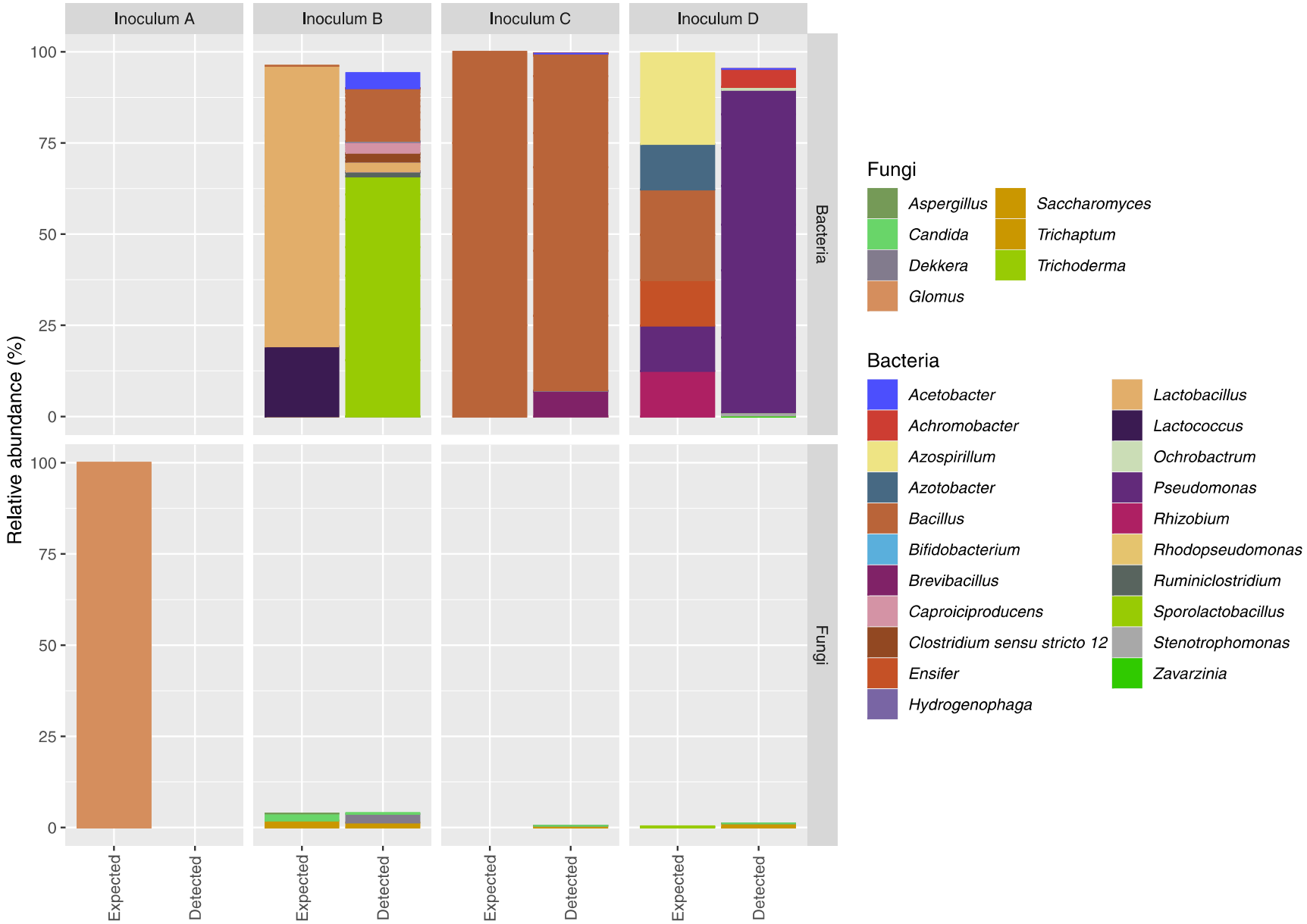
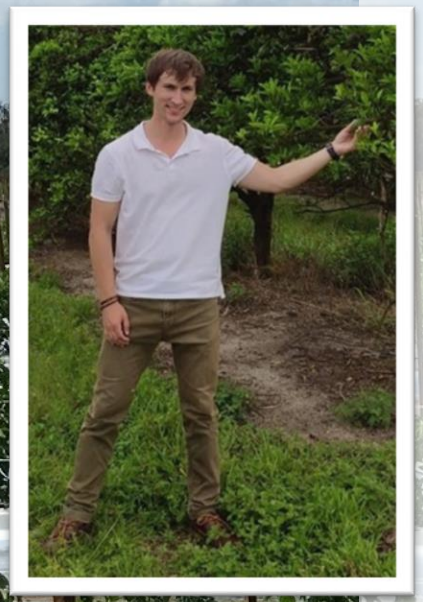


Nuzzo et al. 2020

Summary

- Soil microbes are important parts of a healthy soil
- Management practices can impact the soil microbial community, but changes can be specific to the crop, soil conditions, and management practice
- We are just beginning to understand the diversity and complexity of soil microbes and their interactions with each other and the environment



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