



# Intercropping alfalfa into young tree nut orchards; belowground impacts of alfalfa in tree rows and middles

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# Enhancing soil health to improve water use efficiency in agronomic production

## Challenges

- Water scarcity
- Low SOC
- Poor air quality
- Costly inputs (labor and agrochemical)
- Acreage moving out of forage primarily to nut crops
- Benefits of soil health management can many years to accrue



# Successful Growers Informed Project Design

- Dual irrigation systems
- Had buyers and harvest contractors for alfalfa
- Focused on tonnage, versus quality
- Ranged from 4 to 7 cuts per year, typically in the first 2- 3 years
- Avoided planting alfalfa against berms
- Trees where alfalfa had been look healthier, are bigger, and have fewer mites



# Research Team



# Research Field site



- Alfalfa + flood
- Alfalfa + flood +last chop left as green manure
- Bare + flood
- Bare non-irrigated (Control)

# Research objectives

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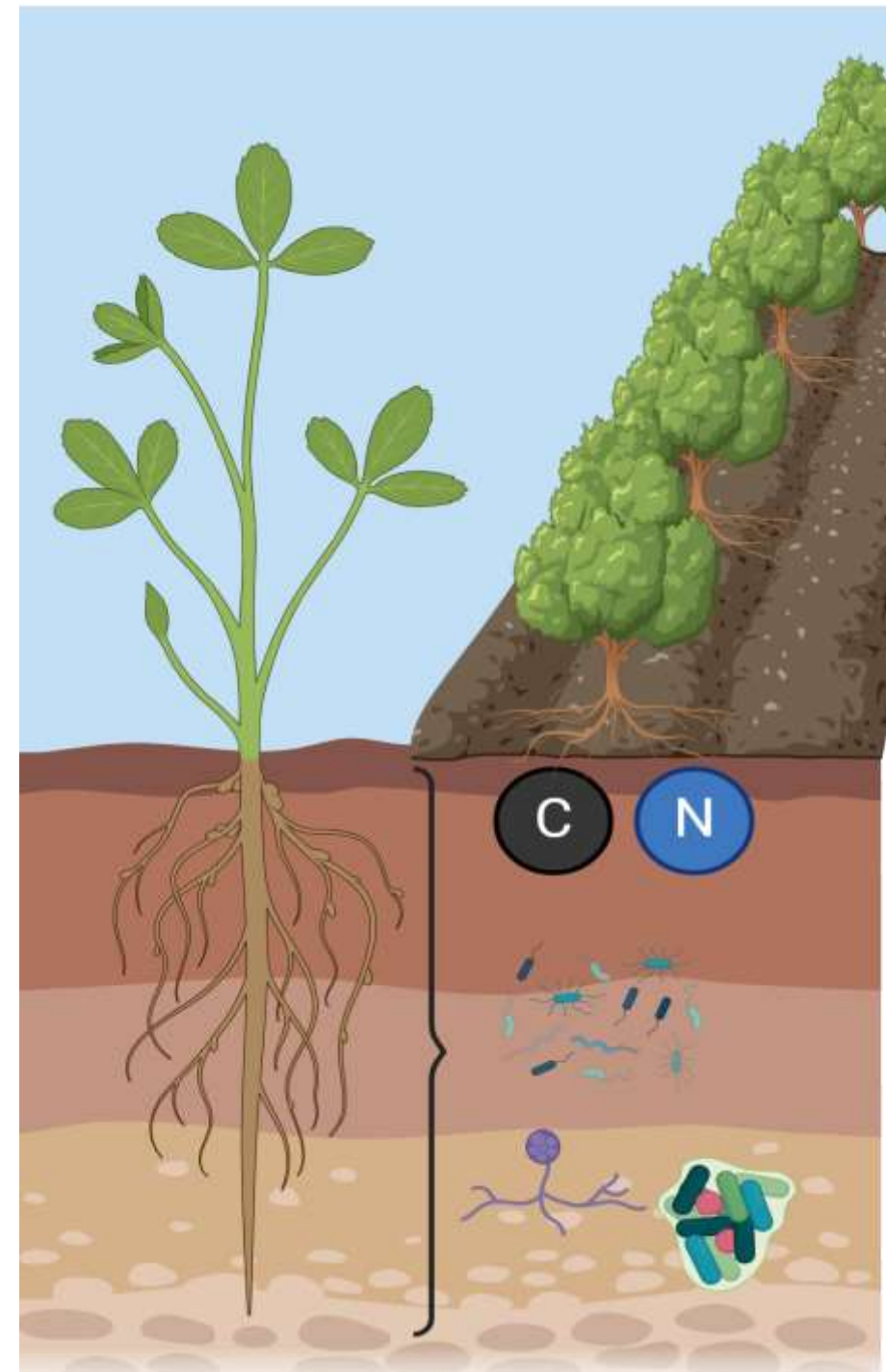
Determine if alfalfa can impact soil health in 2–3-year period and if notable, evaluate if this impact is significant in berm soils as well.



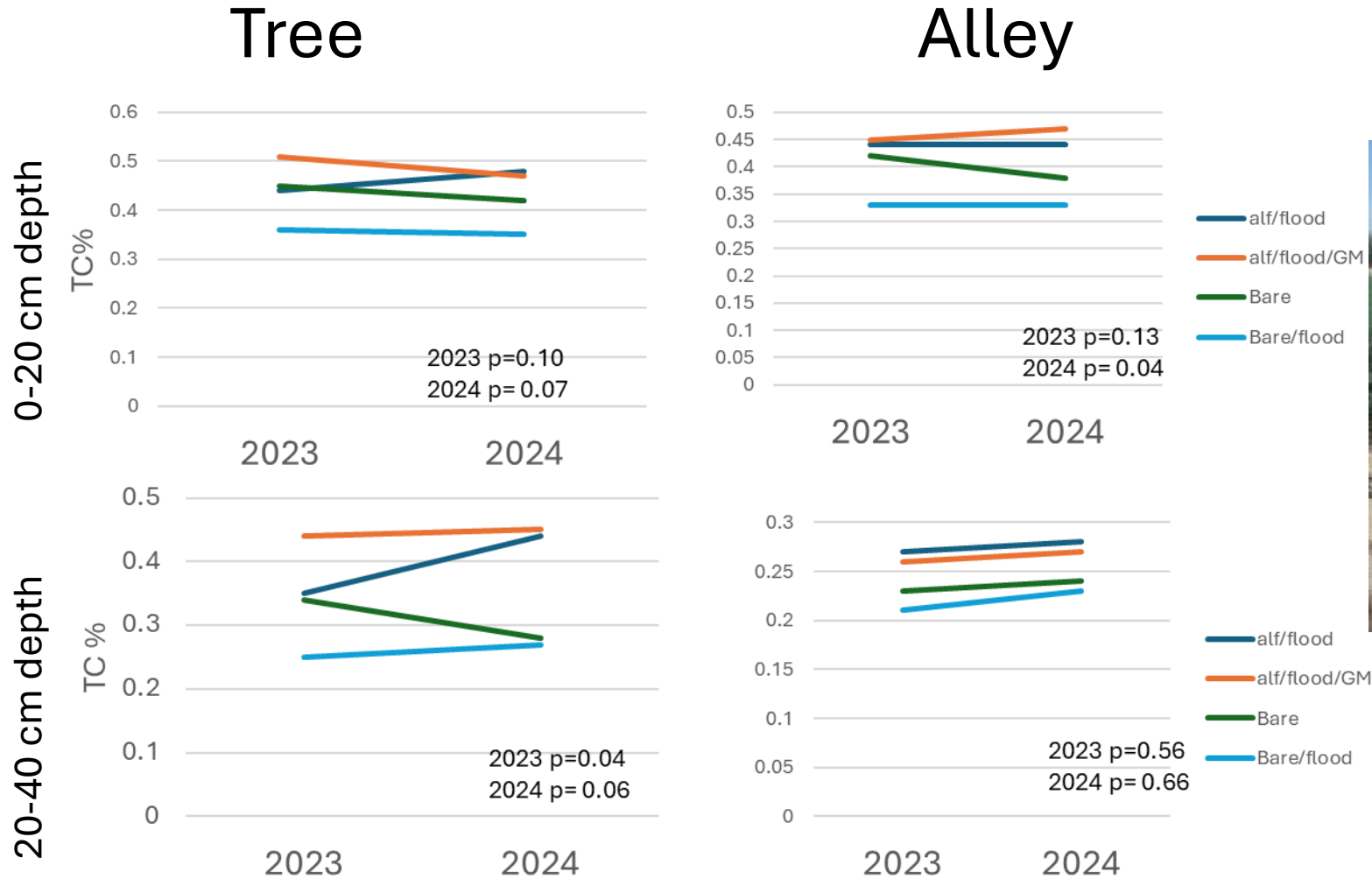
Reveal potential detrimental impacts of alfalfa on soil properties

## Soil health metrics used to evaluate impacts of alfalfa in young almond

- Soil carbon and nutrient accumulation
- Promotion of soil biological activity associated with increased microbial biomass
- Increases in soil arbuscular mycorrhizal fungi
- Microbial community compositions indicative of higher resource availability or less disturbance
- Improvements to soil structure (e.g. aggregate stability)

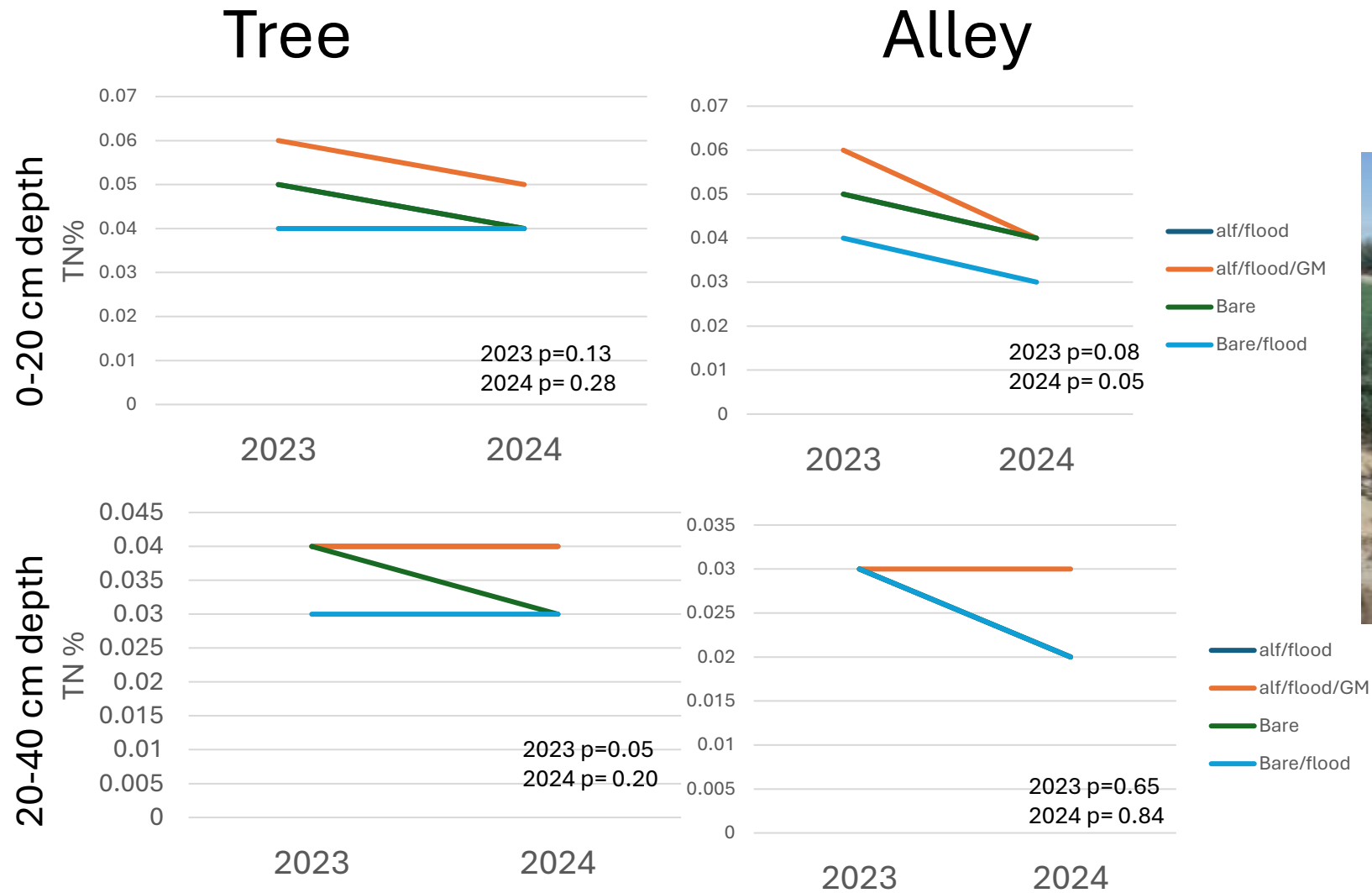


# Soil carbon is marginally higher in alfalfa treatments and is consistently lowest in bare + flood conditions





# Soil nitrogen is lowest in bare + flood conditions



For more details: Thao et al., Intercropping Alfalfa During Almond Orchard Establishment Reduces Winter Soil Nitrogen and Water Losses, Provides On-farm Revenue, 2025, *Agrosystems, Geosciences & Environment*

# Interrow alfalfa had no to marginal impacts in soil microbial biomass in first season

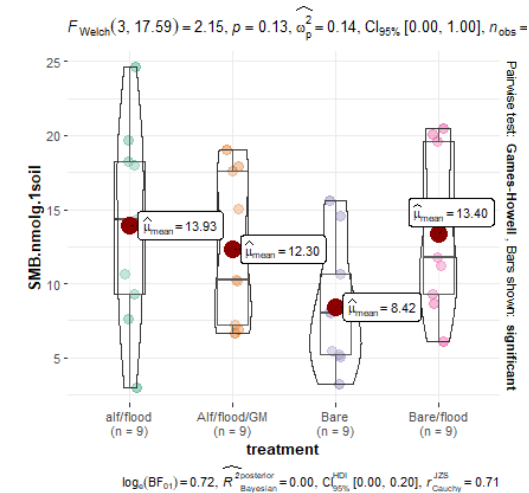
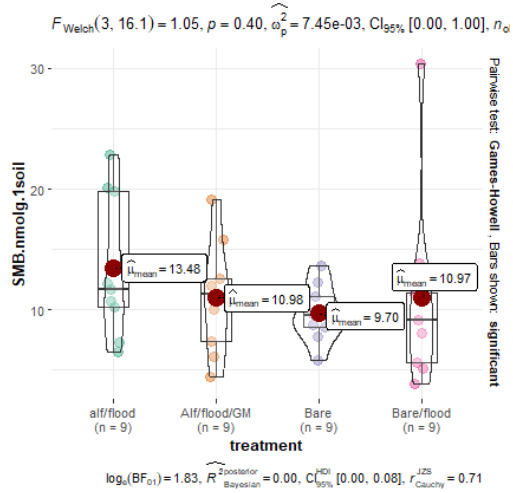
## 2023



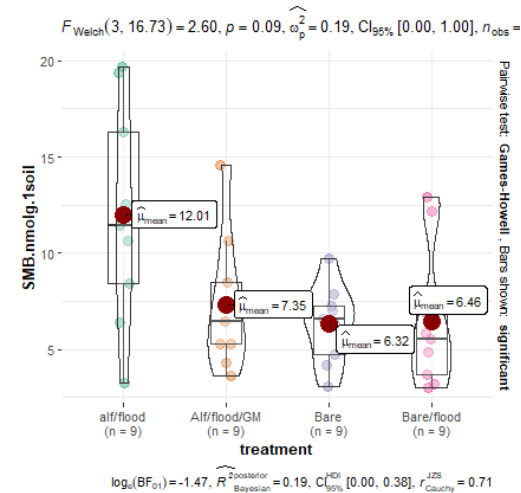
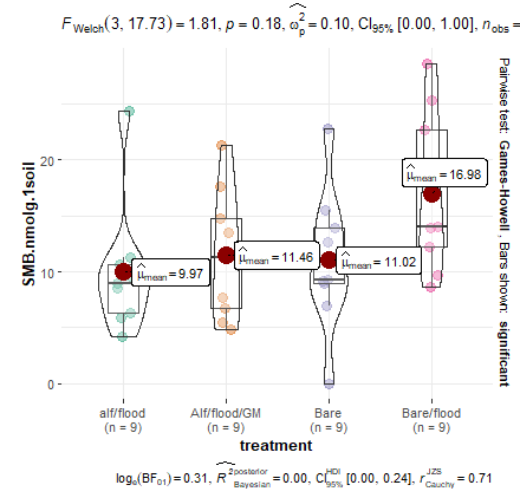
0-20 cm depth

20-40 cm depth

### Tree



### Alley



# In second year, we begin to see marginal to significant increases in soil microbial biomass in alfalfa treatments

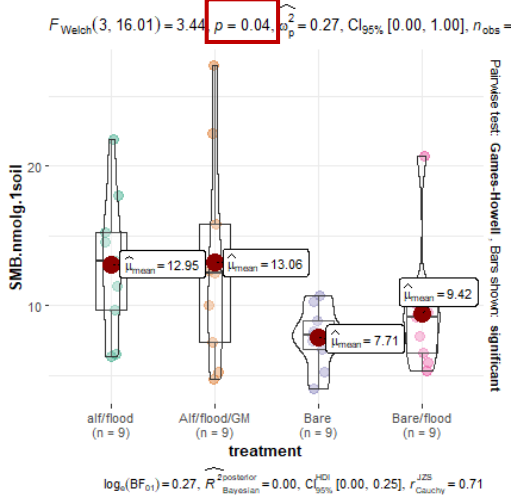
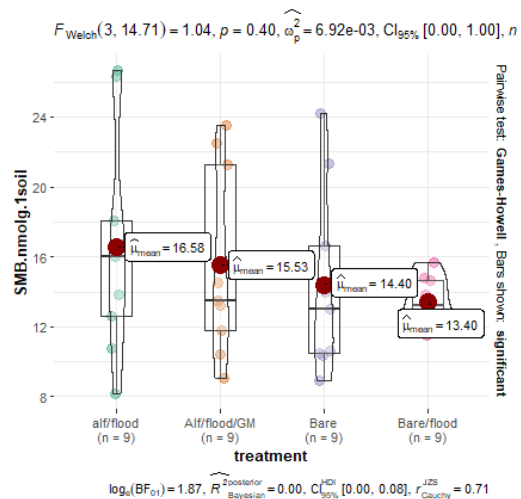
# 2024



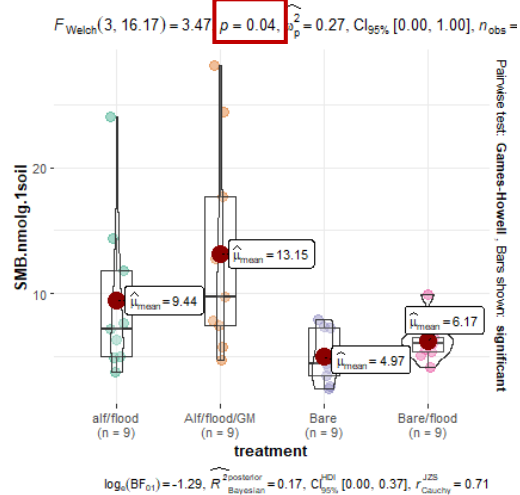
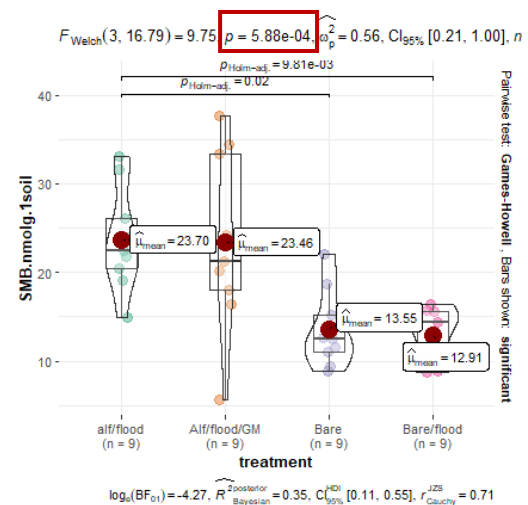
0-20 cm depth

20-40 cm depth

## Tree



## Alley



# Soil AM Fungi are enhanced with flooding, a treatment effect that extends into the tree berms in year 2

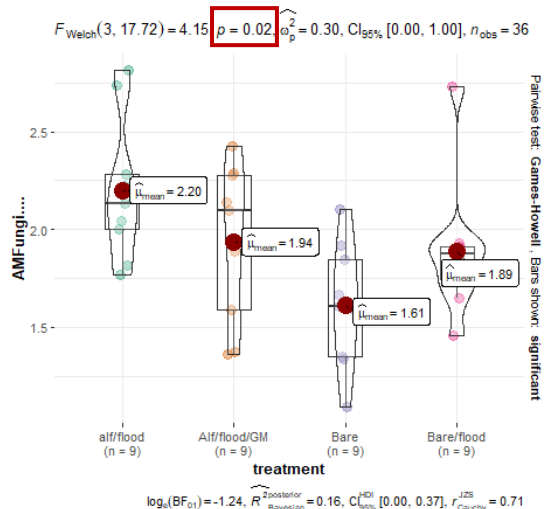
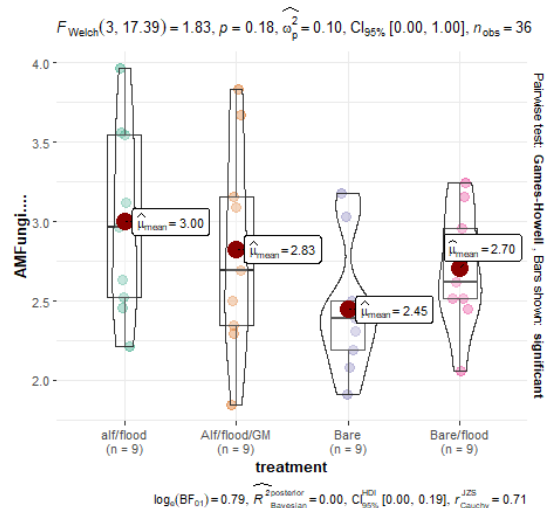
# 2024



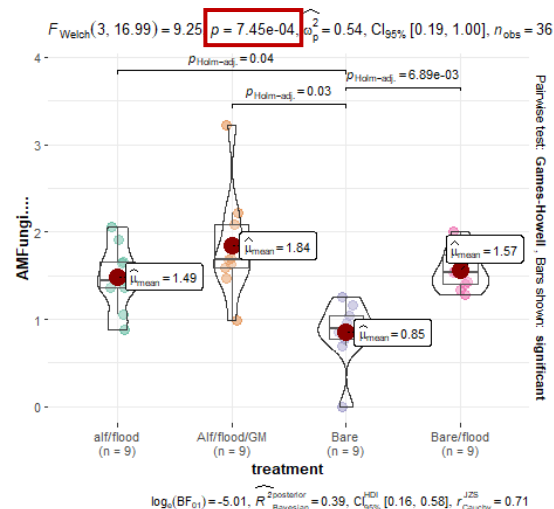
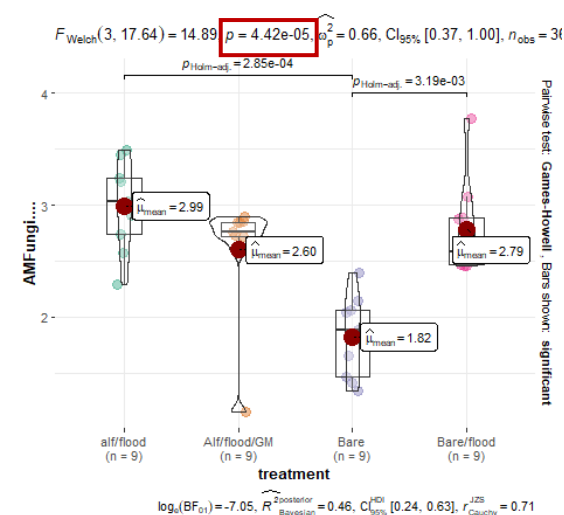
0-20 cm depth

20-40 cm depth

## Tree



## Alley



# In second year, we begin to see marginal to significant impacts of alfalfa on microbial functional guilds

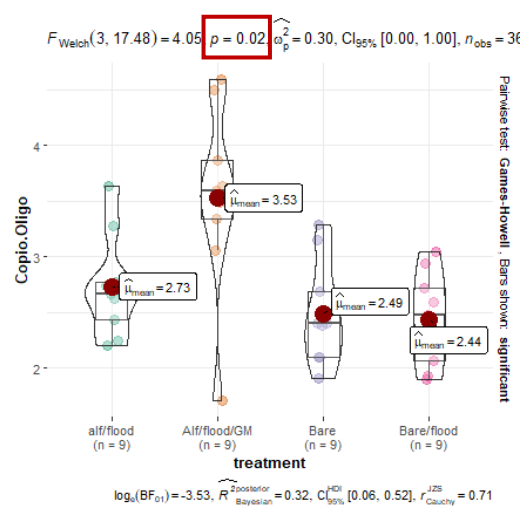
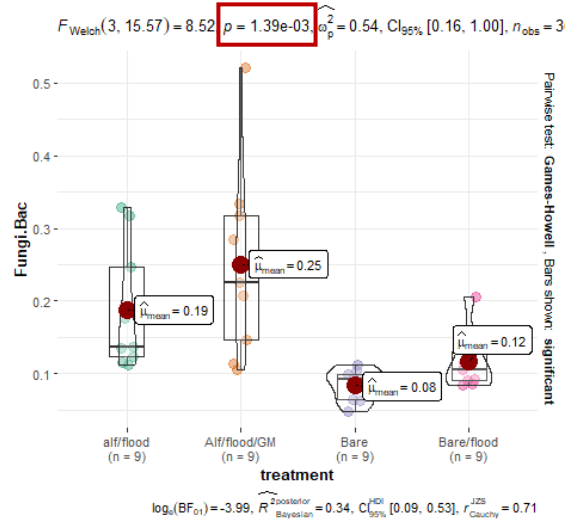
## 2024

### F:B ratio Alley

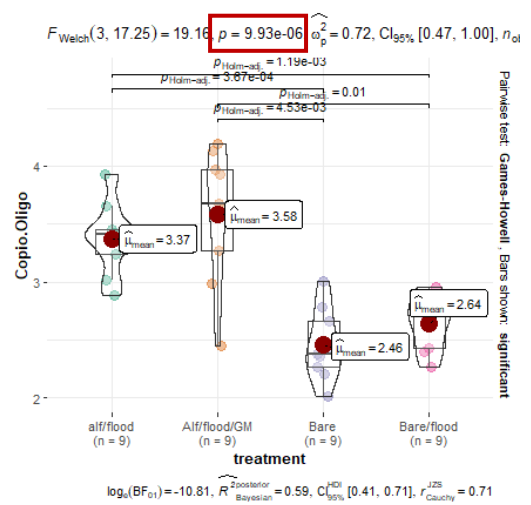
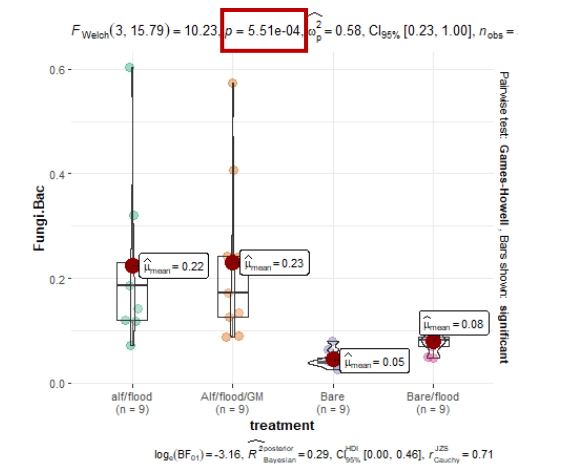
### Copio: oligo ratio Alley



0-20 cm depth



20-40 cm depth

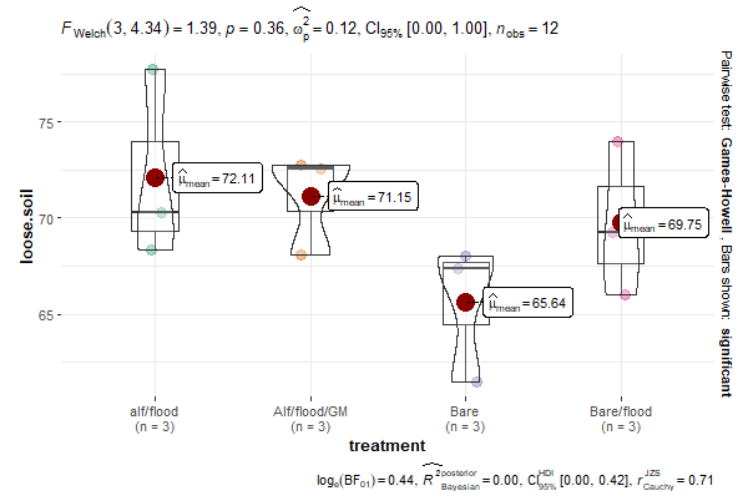
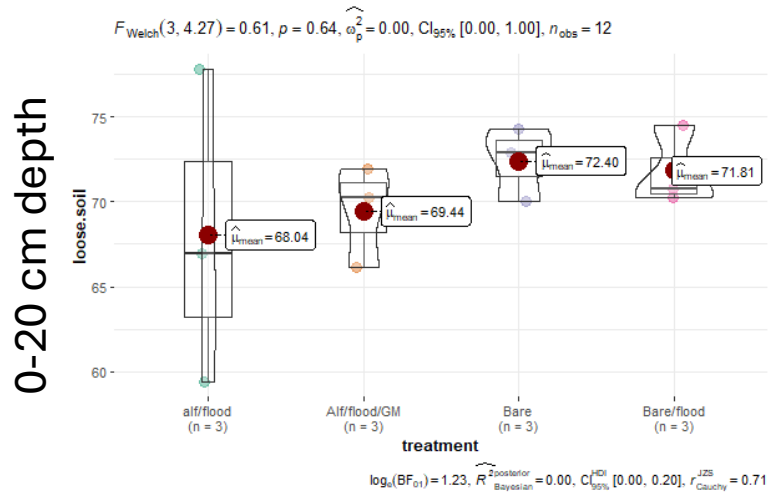


# Aggregate stability did not vary based on treatment

# 2024

## Tree

## Alley



# Ongoing and Future Research Plans

- Evaluate system across 3 years
- Sequence soil fungal biomarkers to evaluate presence of pathogens (e.g. *Phytophthora spp.*) in soil
- Evaluate legacy effects of alfalfa on almond production
- Assess intercropping in varying tree crops



# Key takeaways

- Most alfalfa induced changes in soil health metrics were insignificant until year two.
- In two years, alfalfa did not increase soil C or N, but potentially reduced soil C and N losses under flood conditions
- Except for some alley compaction, most soil health impacts of the alfalfa have been positive.
- Many soil health metrics were improved in both alleys and berms, but alley impacts of alfalfa were more notable

