More than just plants: A study of biotic stress impacts on the root microbiomes of *Trifolium repens*

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Pasture plants are important to the NZ economy

Clover is one of the most important

Table 1: *Breakdown of the Financial Importance of Clover to the NZ Economy*

		Annual Value (Billions of $)
Nitrogen fixation	1.57 million T	1.49
Herbage production	15% of total	1.33
Enhanced value	10 of total diet	0.22
Seed production	5000 MT	0.03
Honey production	White clover contribution	0.03
TOTAL		3.10

www.ceresfarm.co.nz/clover.htm

Clover productivity is impacted by invertebrates and pathogens

Phytophthora infection of clover

Grass grub *Costelytra zealandica*

Root galls caused by *Meloidogyne* nematodes

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Therefore……

Productivity is enhanced when invertebrates and pathogens are discouraged

Can the soil microbiome assist in this process?

Clover growth is variable in different NZ soils

Influenced by environmental conditions: nutrients, soil structure and climate

Is there also a microbiome influence?

Experiment:
Clover growth vs Microbiome structure

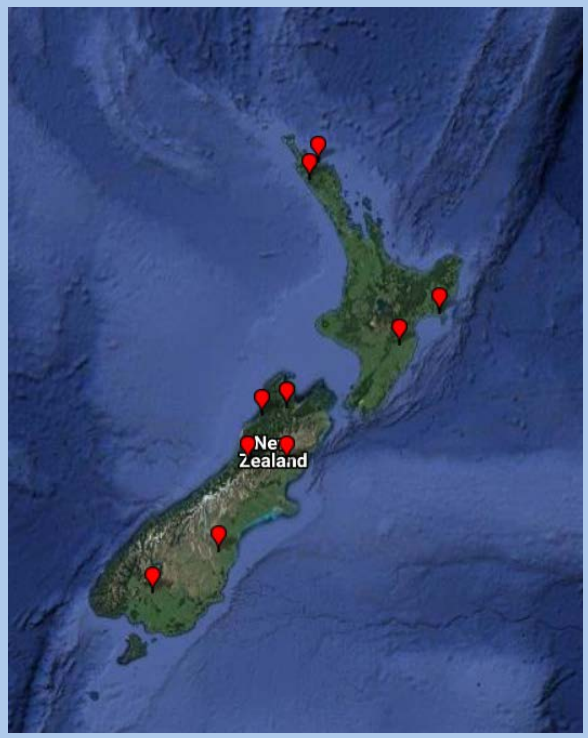
Soil samples from 10 Locations

1 2 3 4 5 6 7 8 9 10

biotic +clover
alone
+ nematodes
+ grassgrubs

sterile +clover
"
"
"

10 reps each



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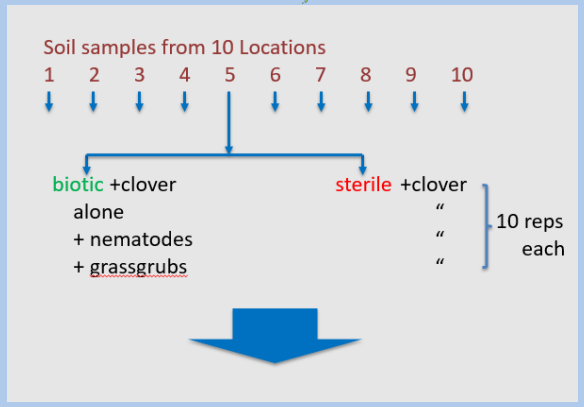
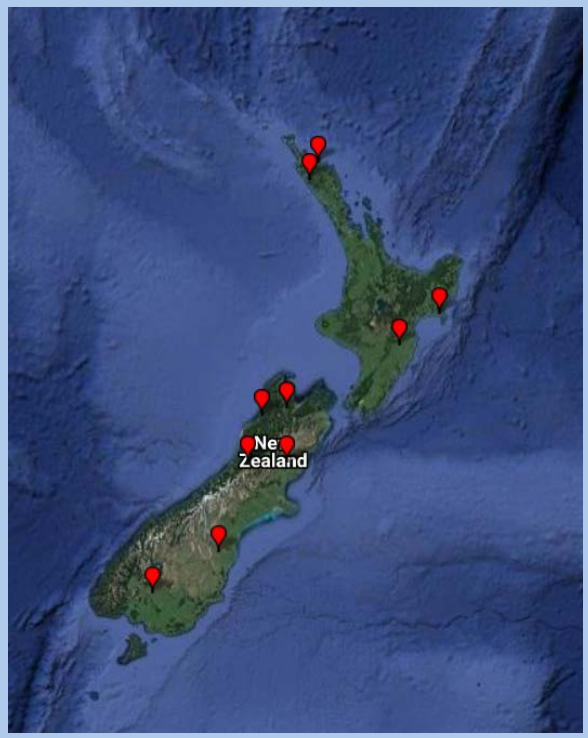


1. plants grown and harvested
2. scored for growth indicators (DW, shoot/root length)
3. scored for nematode activity (galling)
4. scored for grass grub grazing
5. soil scored for nutrients
6. microbiomes compared by NGS (16S, ITS)
   - rhizosphere
   - endosphere



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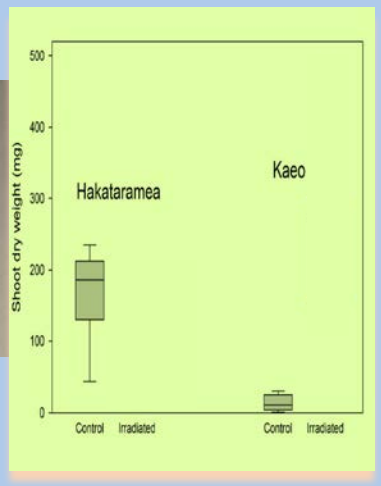
Results: (1) Clover Growth

- Better growth (root length, higher DW) in soils from some locations compared to others

Biotic

Hakataramea

Kaeo



Results: (1) Clover Growth

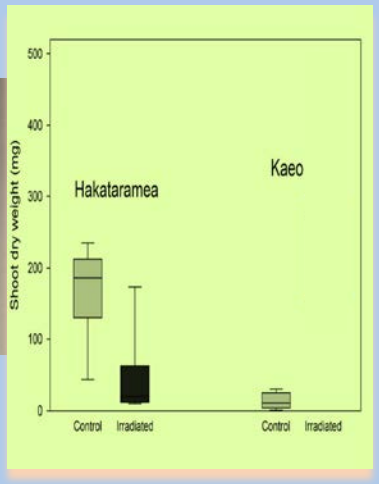
- Most soils were less productive after sterilisation

Biotic

Hakataramea

Sterile

Kaeo



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Results: (1) Clover Growth

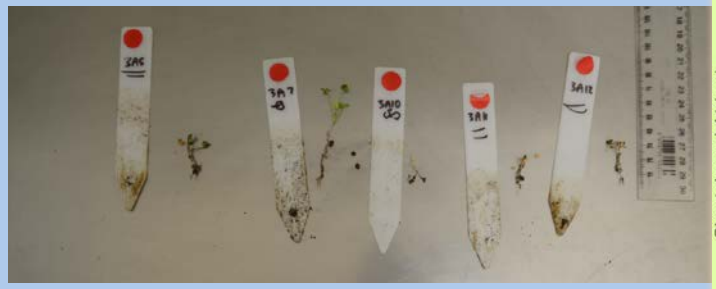
- One soil was more productive after sterilisation

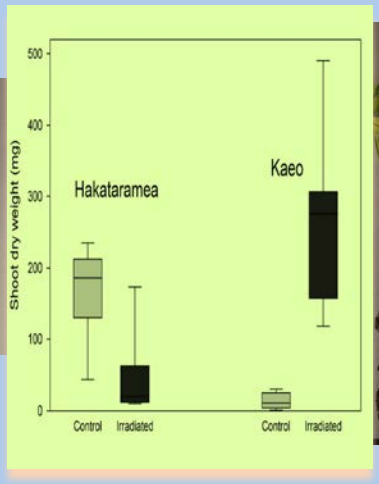
Biotic

Hakataramea

Sterile

Kaeo





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Results: (2) Microbiomes

What's going on in the microbiomes?

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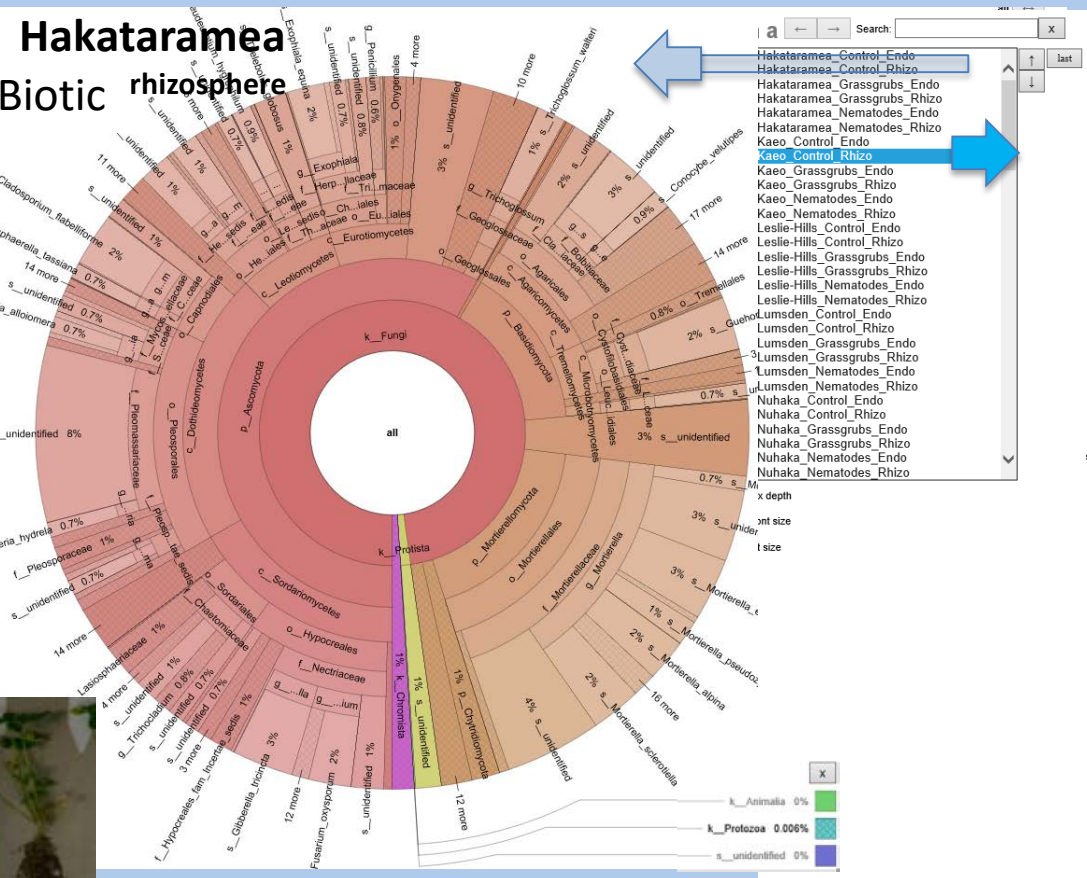
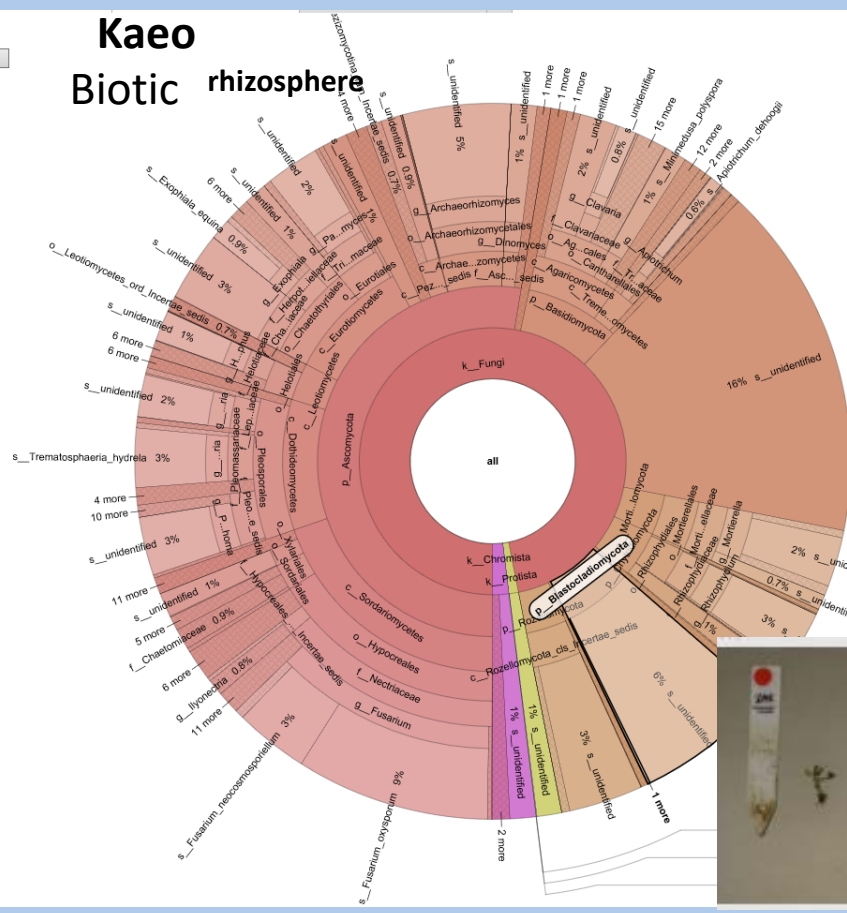
Results: (2) Microbiomes - FUNGI

Hakataramea
Biotic **rhizosphere**



Kaeo
Biotic **rhizosphere**



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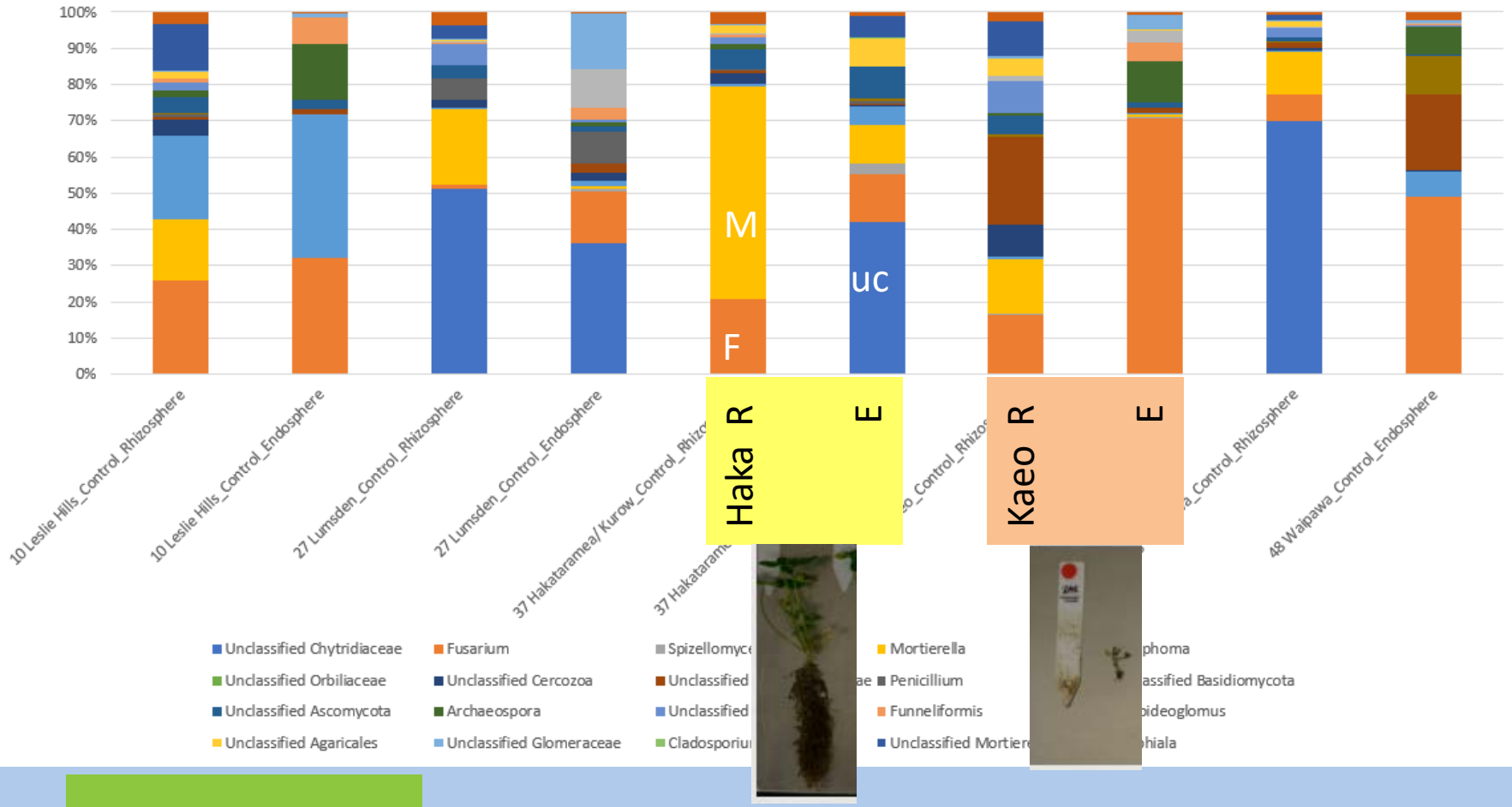
Results: (2) Microbiomes

Top 20 fungal genera – Biotic : Rhizosphere vs Endosphere



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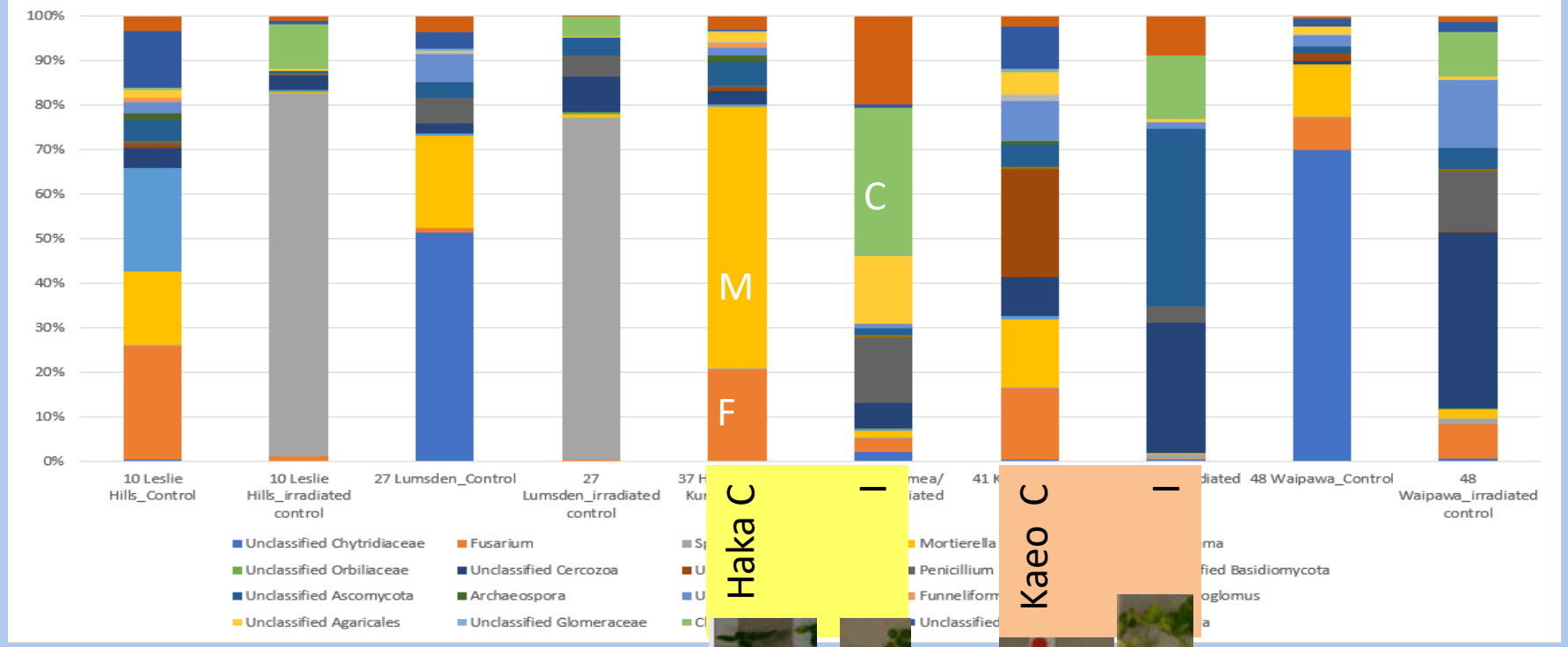
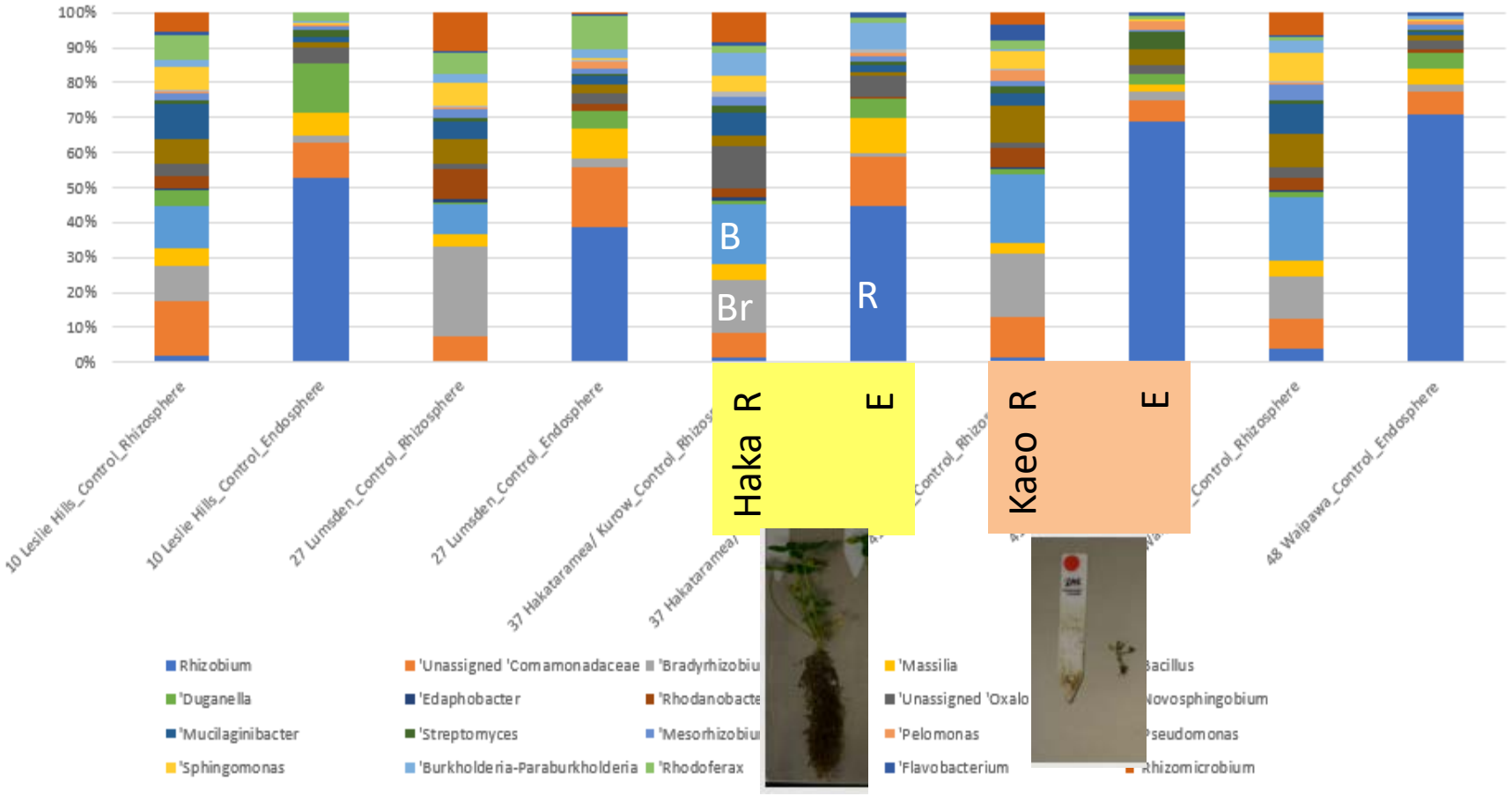
Results: (2) Microbiomes

Top 20 fungal genera – Rhizosphere: Control vs Irradiated



Results: (2) Microbiomes

Top 20 bacterial genera – Biotic : Rhizosphere vs endosphere



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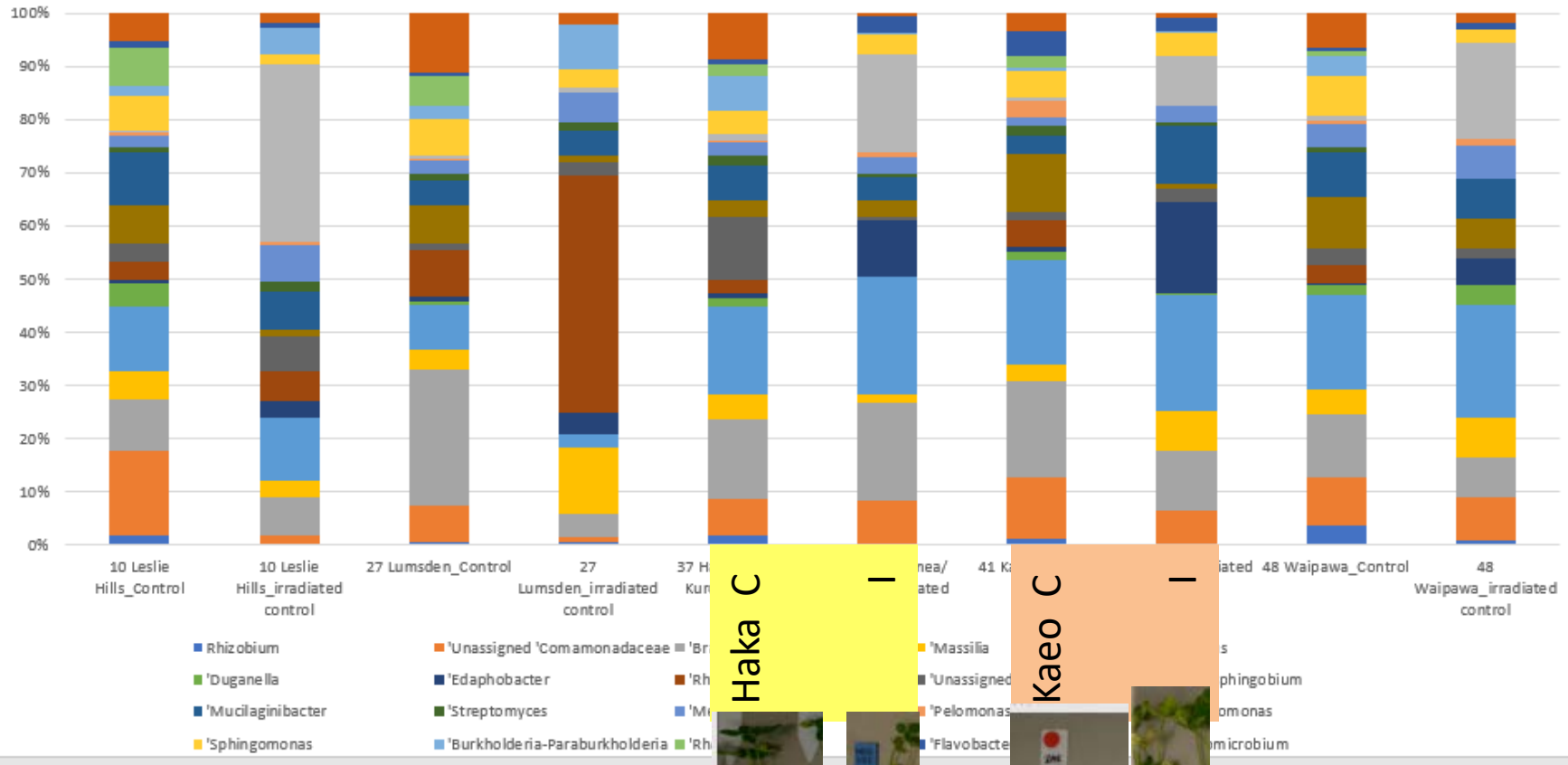
Results: (2) Microbiomes

Top 20 bacterial genera – Rhizosphere: control vs irradiated



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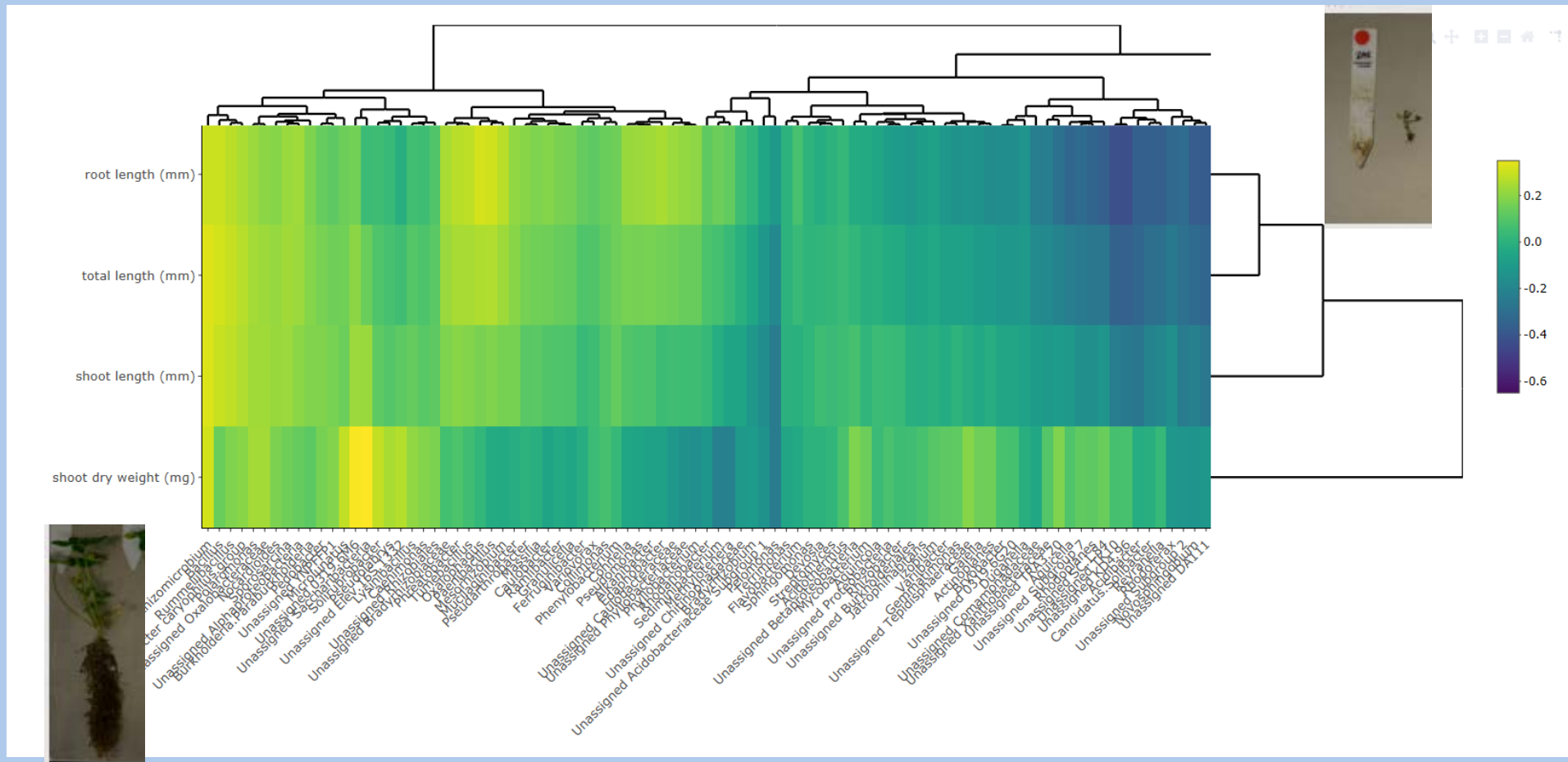
Summary

- **Microbiomes are different for each soil type**
- **Rhizosphere's tend to have greater microbial diversity than endospheres**
- **Recovered irradiated soils have similar diversity to biotic soils**
  - But makeup of that diversity is different

"Is there a relationship between diversity makeup and plant growth"?

Soil microbiomes – (2) BACTERIA

Results: (1) Soil microbiomes



Results: Soil microbiomes

- Work continues to drill deeper into understanding which groups of taxa are related to better or worse clover growth
- Such an understanding will lead to further trials leading hopefully to commercialisation of biotic soil conditioners

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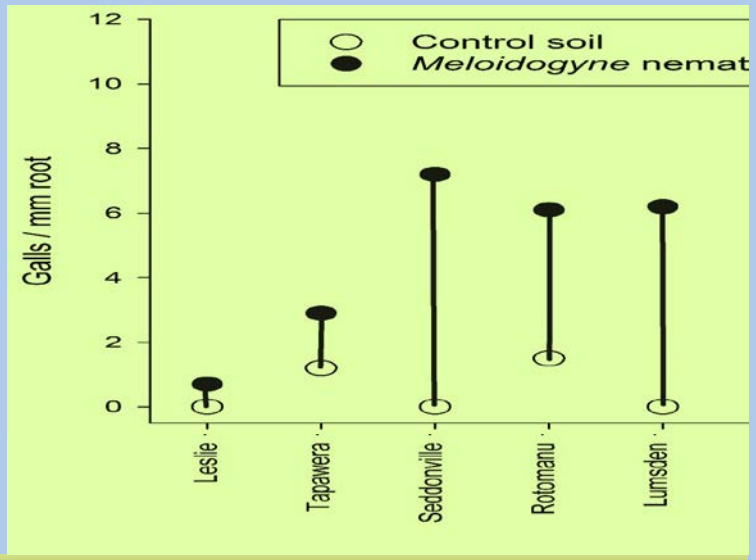
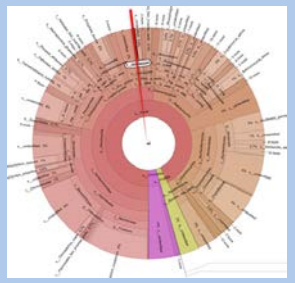
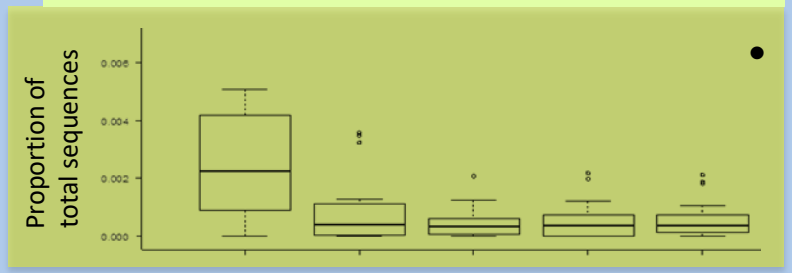
Something interesting:

- In some soils we observed suppression of *Meloidogyne* nematode galling



= fewer galls on clover roots in control soil and only small increase in galling when *Meloidogyne* added to soil





- More nematode trapping fungi (Orbiliomyces) sequences in soils where nematode suppression was observed

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Thank you