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**

<table>
<thead>
<tr>
<th></th>
<th>Annual Value (Billions of $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen fixation</td>
<td>1.57 million T</td>
</tr>
<tr>
<td>Herbage production</td>
<td>15% of total</td>
</tr>
<tr>
<td>Enhanced value</td>
<td>10 of total diet</td>
</tr>
<tr>
<td>Seed production</td>
<td>5000 MT</td>
</tr>
<tr>
<td>Honey production</td>
<td>White clover contribution</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
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</table>
Clover productivity is impacted by invertebrates and pathogens

*Phytophthora* infection of clover

Grass grub *Costelytra zealandica*

Root galls caused by *Meloidogyne* nematodes
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
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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Published online 2016 Dec 26. doi: [10.3389/fpls.2016.01946](10.3389/fpls.2016.01946)
Results: (1) Clover Growth

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

Hakataramea

Kaeo
Results: (1) Clover Growth

- Most soils were less productive after sterilisation
Results: (1) Clover Growth

- One soil was more productive after sterilisation

Biotic

Hakataramea

Sterile

Kaeo
What’s going on in the microbiomes?
Results: (2) Microbiomes - FUNGI

Hakataramea control, rhizosphere
Biotic

Kaeo control, rhizosphere
Biotic

[Image of phylogenetic trees showing microbial communities]

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Results: (2) Microbiomes

Top 20 fungal genera – Biotic : Rhizosphere vs Endosphere
Results: (2) Microbiomes

Top 20 fungal genera – Rhizosphere: Control vs Irradiated
Results: (2) Microbiomes

Top 20 bacterial genera – Biotic : Rhizosphere vs endosphere
Results: (2) Microbiomes

Top 20 bacterial genera – Rhizosphere: control vs irradiated
**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”?
Results: (1) Soil microbiomes – (2) BACTERIA
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
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
Thank you