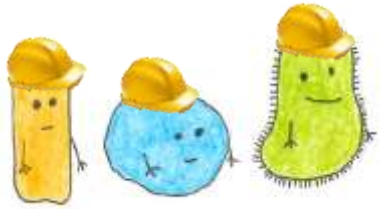
In one teaspoon of soil there are more microbes than there are people on earth.

In that same teaspoon there is endless potential.



# Putting the Microbes to Work

## Monitoring microbial functional and structural diversity for management of disease suppressive soils

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Queensland Government

# The Power of One or the Power of Many? Natural Soil Disease Suppression

Biocontrol research is often focused on identifying key beneficial organisms.

## However…

- All soils possess the ability to suppress disease due to the presence and activity of soil microbial communities.
- Soil microbial communities can be manipulated by soil management (e.g. N inputs, groundcover).
- There are gaps in our ability to identify and characterize beneficial microbial communities.
- Holistic approach to monitoring soil microbial communities through structural and functional diversity indicators.

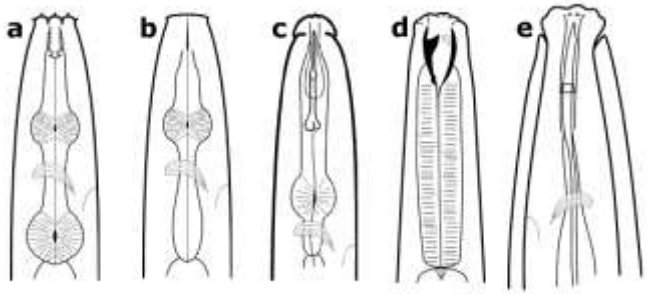
# Field Sites

| | Site 1 | Site 2 |
|---|---|---|
| **Location** | East Palmerston<br>17º 35' 33"S 145º 49' 57"E | South Johnstone<br>17º 36' 19"S 145º 59' 55"E |
| **Trial Establishment** | December 2014 | March 2015 |
| **Soil Sampling (month)** | 0, 6, 12, 20 | 0, 6, 12 |
| **Soil Type** | Ferrosol | Dermosol |
| **Banana Varieties** | Cavendish<br>Williams | Highgate<br>Hom Thong Mokho |
| **Ground Cover Treatments** | Bare, Vegetated (pinto peanut) | |
| **N Fertilizer Treatments** | 180kg N $ha^{-1}ratoon^{-1}$; 180kg N+E $ha^{-1}ratoon^{-1}$;<br>350kg N $ha^{-1}ratoon^{-1}$ | |
| **Trial Structure** | randomised complete block design (4 reps of 6 treatments) | |

# Soil Functional Biology- Nematode Communities

Soil Extraction for Nematodes

Nematode Identification

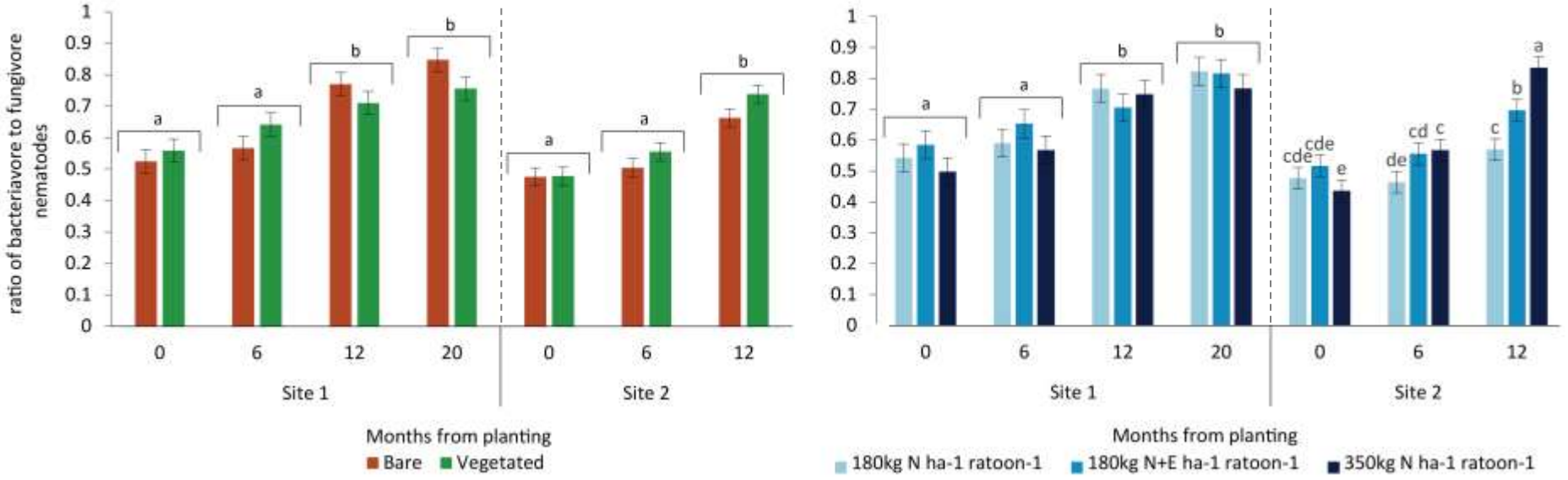



*(a) bacterial feeder (b) fungal feeder*
*(c) plant feeder (d) predator (e) omnivore.*

RESULTS
Bacterivore:Fungivore Ratio

(B/(B+F))

# Nematode Communities- RESULTS




Soil nematode ratio of bacteriavore to fungivore. Treatments with the same letter are not significantly different according to Fisher's 95% protected least significant difference. Grouped treatments (indicated by bracket) with different letters are significantly different for each variable of time (months from planting).

# Soil Functional Biology- β-glucosidase Enzyme Assay

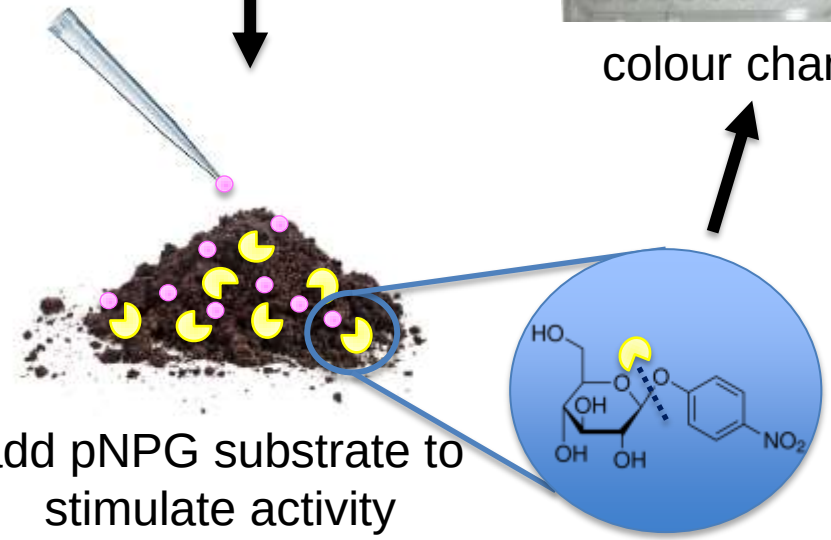
soil sample with enzymes

colour change

absorbance at 410nm

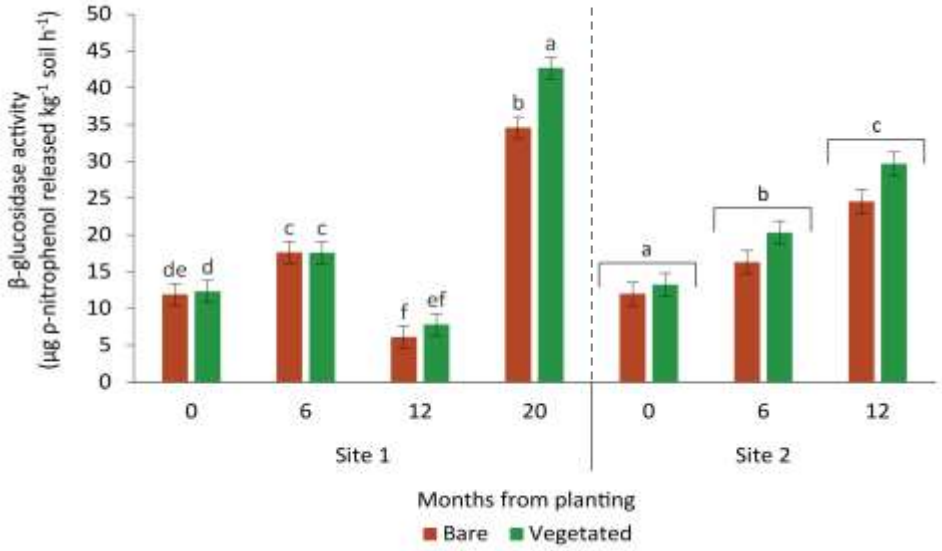
**RESULTS**

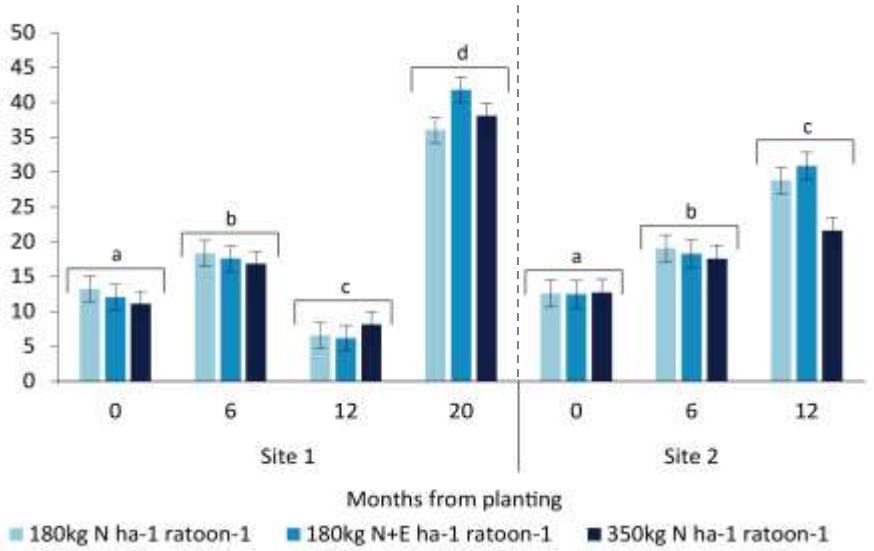
µg ρ-nitrophenol released $kg^{-1}$ soil $h^{-1}$




add pNPG substrate to stimulate activity

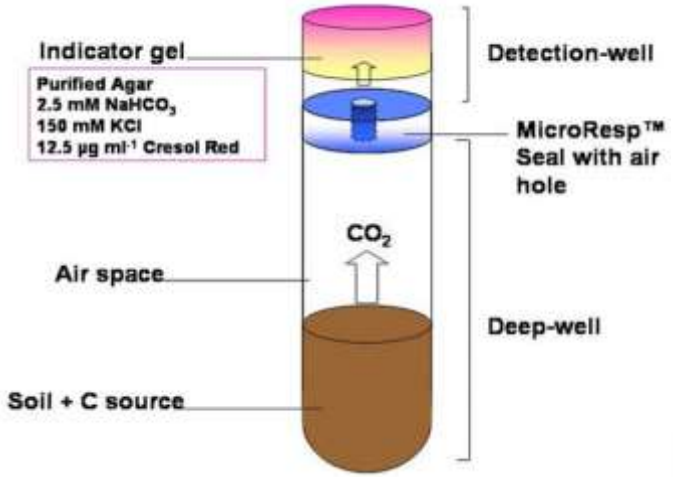
# β-glucosidase Enzyme Assay- RESULTS




β-glucosidase enzyme activity. Treatments with the same letter are not significantly different according to Fisher's 95% protected least significant difference. Grouped treatments (indicated by bracket) with different letters are significantly different for each variable of time (months from planting).

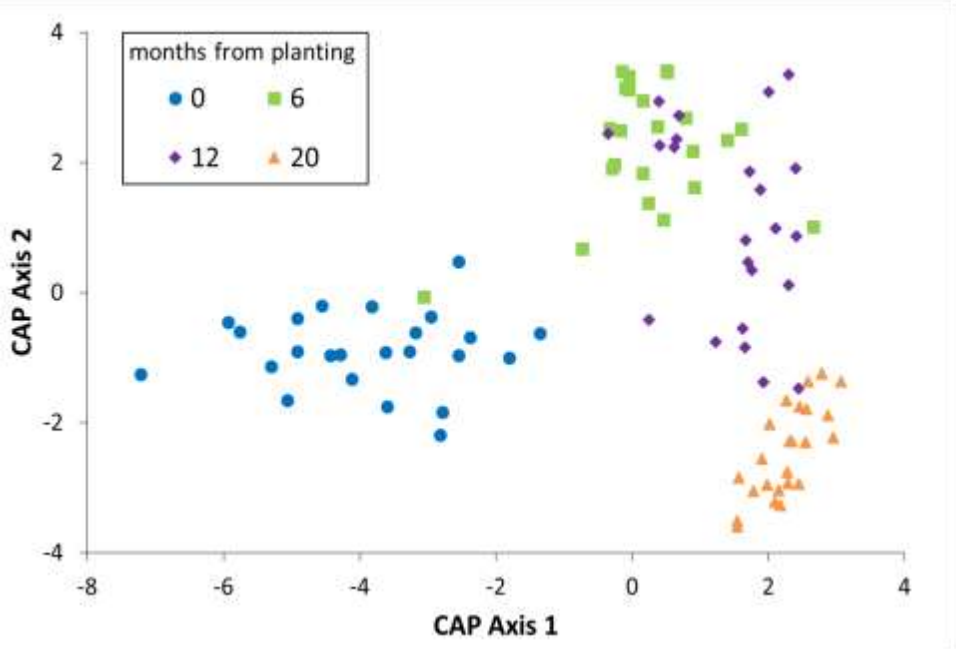
# Soil Functional Biology- Community Level Physiological Profiles

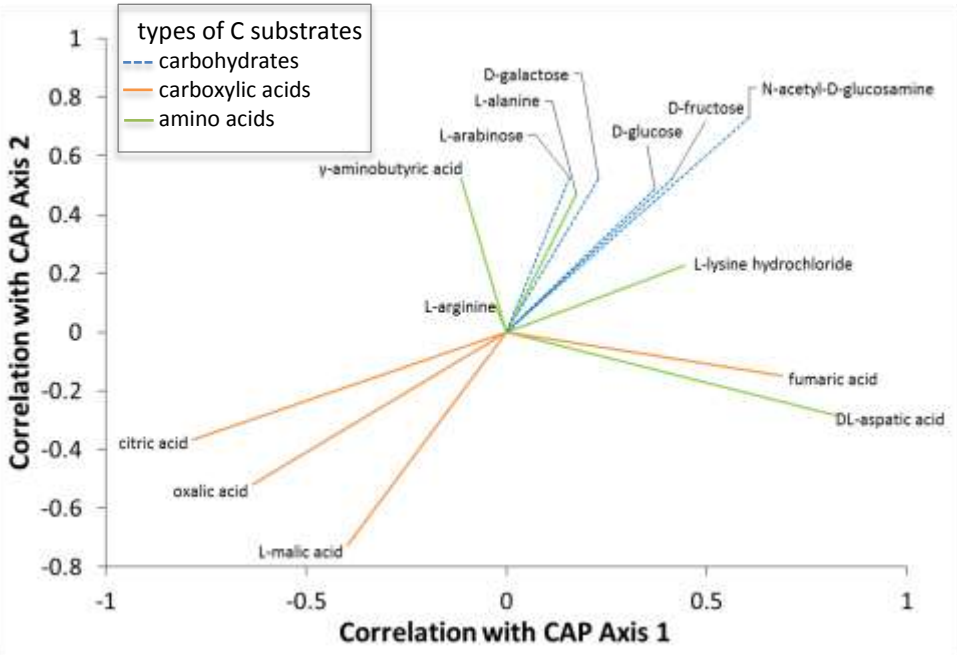



## MicroResp™ SETUP

1. soil at 45% MWHC
2. pre-incubated for 7 days
3. soil inoculated with 15 carbon sources
4. sealed colorimetric $CO_2$-trap
5. incubated for 6 h
6. $CO_2$-trap absorbance measured at 590nm

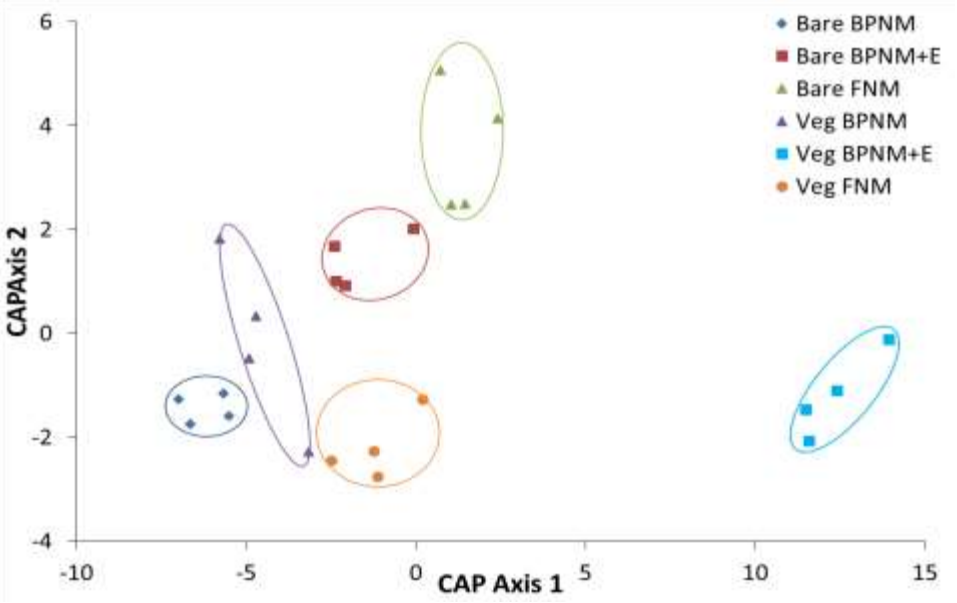
# Community Level Physiological Profiles- RESULTS

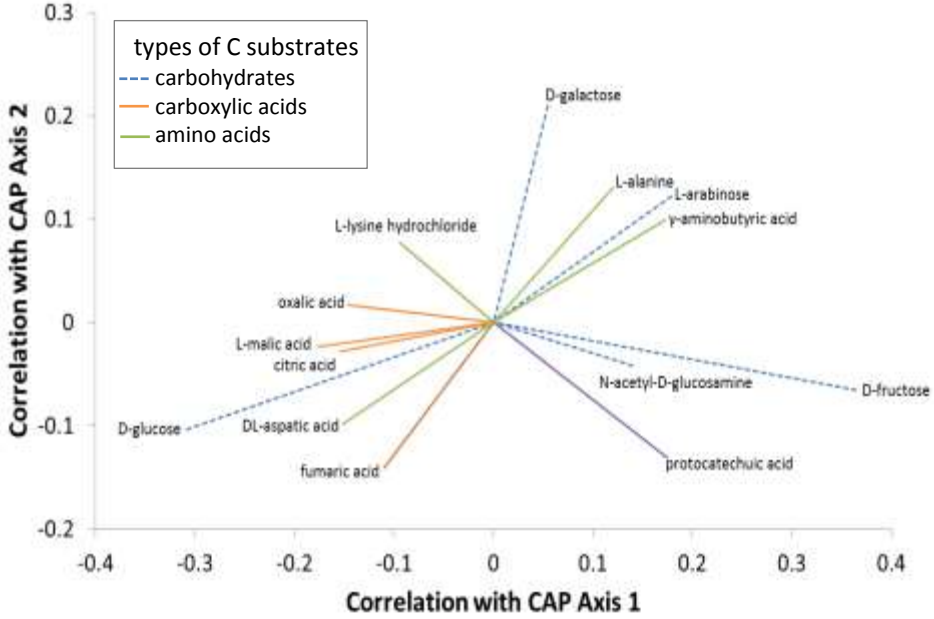



Canonical analysis of principal co-ordinates (CAP) of CLPP of Site 1. Vectors show Pearson correlations with substrates as variables. Substrates grouped by coloured lines (orange: carboxylic acids, blue: carbohydrates, green: amino acids).

# Community Level Physiological Profiles- RESULTS



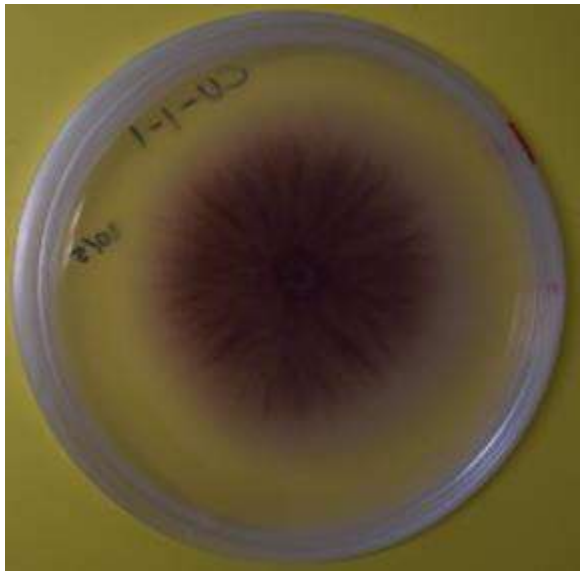

Canonical analysis of principal co-ordinates (CAP) of CLPP of Site 1, sampling date 20 months from planting. Distinct groupings of soil management practices shown and is associated with a leave-one-out correct classification rate of 54.2%.

# *Foc* R1 Soil Baiting Bioassay

inoculate soil with *Foc* R1, incubate 7d

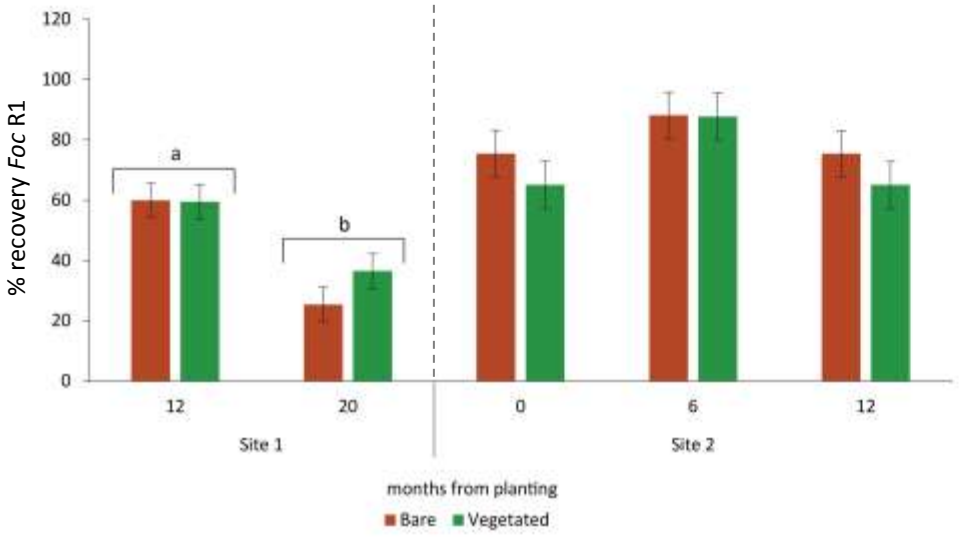
section discs (3) from pseudostem

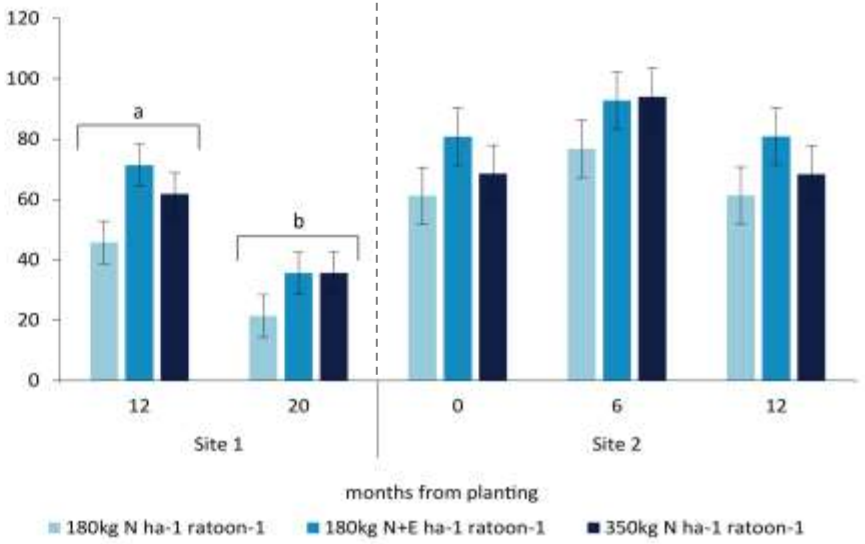
7 sub-samples from each discs plated & incubate 5d



Sub culture colonies sampled & plated for identification

# *Foc* R1 Soil Baiting Bioassay- RESULTS




Soil *Foc* R1 baiting bioassay reported as % recovery *Foc* R1 from inoculated field soil. Grouped treatments (indicated by bracket) with the same letter are not significantly different according to Fisher's 95% protected least significant difference for each variable of time (months from planting).
Site 1 has a significant N fertiliser treatment effect (not indicated on graph).

# Conclusions

Significant N fertilizer treatment effects resulted in:

- ↓ bacterivore : fungaviore ratio with ↓ N fertilizer rates.
- ↓ % *Foc* R1 recovery with ↓ N fertilizer rates.

Significant groundcover treatment effects resulted in:

- ↑ β-glucosidase enzyme activity under vegetated groundcover management.

CLPP powerful tool to identify changes in soil microbial community functional diversity.

Next step… Next generation sequencing