

INVESTIGATING THE APPLICATION OF COMPOST TEA AS A MICROBIAL INNOCULANT IN AN ORGANIC ARABLE SYSTEM

Dominic Amos (Organic Research Centre)

Simon Parfey (Soil Bio Lab)

Mark Pawlett (Cranfield)

Sophie Alexander (Hemsworth)

Evidence from 2015 and 2016 Trials

- No true replication within fields so evidence of effects very weak

- 2015 – Yield hike in Spring Barley?

(Control strip (untreated) compared to whole field yield – not a fair comparison)

- 2016 – Yields equivalent in Spring Oats

(Control strip compared to adjacent strip of equal size, in 2 fields – a more reliable comparison)

- 2016 - Boost to HLW? Maybe

- Reduction in *Microdochium nivale*? Maybe

(Saved seed 1.5% cf. commercial seed 18%)

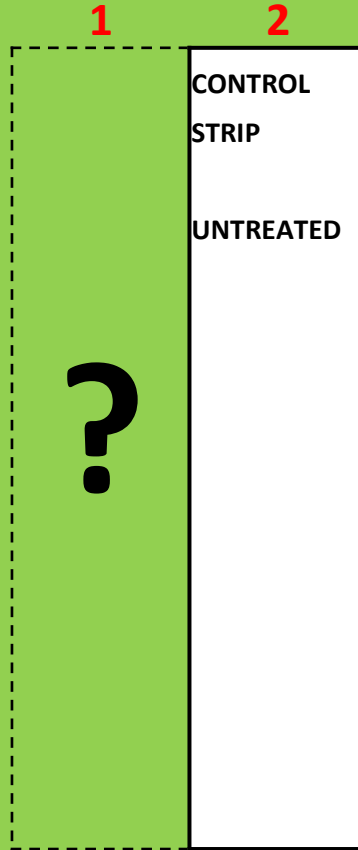
- 2017 – Effects? More certainty from a proper experimental design.....

2015

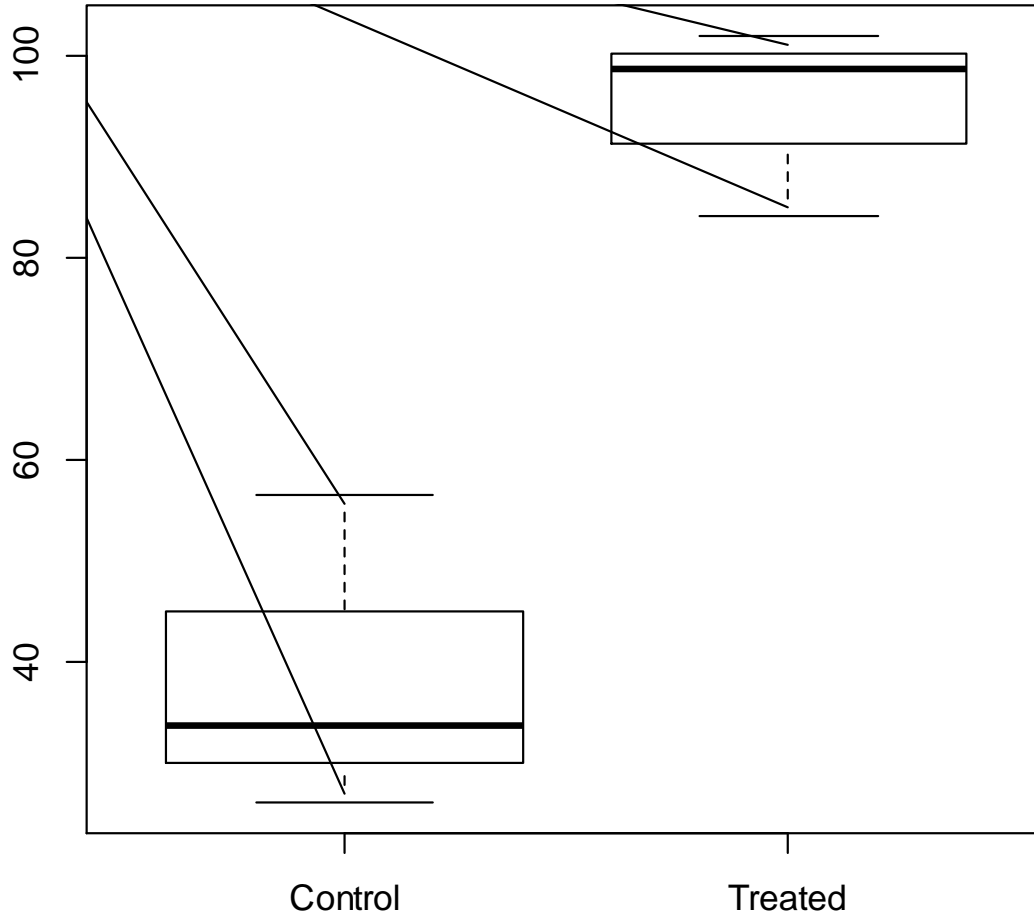
Whole Field (3) Treated with Compost Tea; Three Fields (Replicates)

Yield Comparison
between 2 and 3!!!!

Soil Sampling???

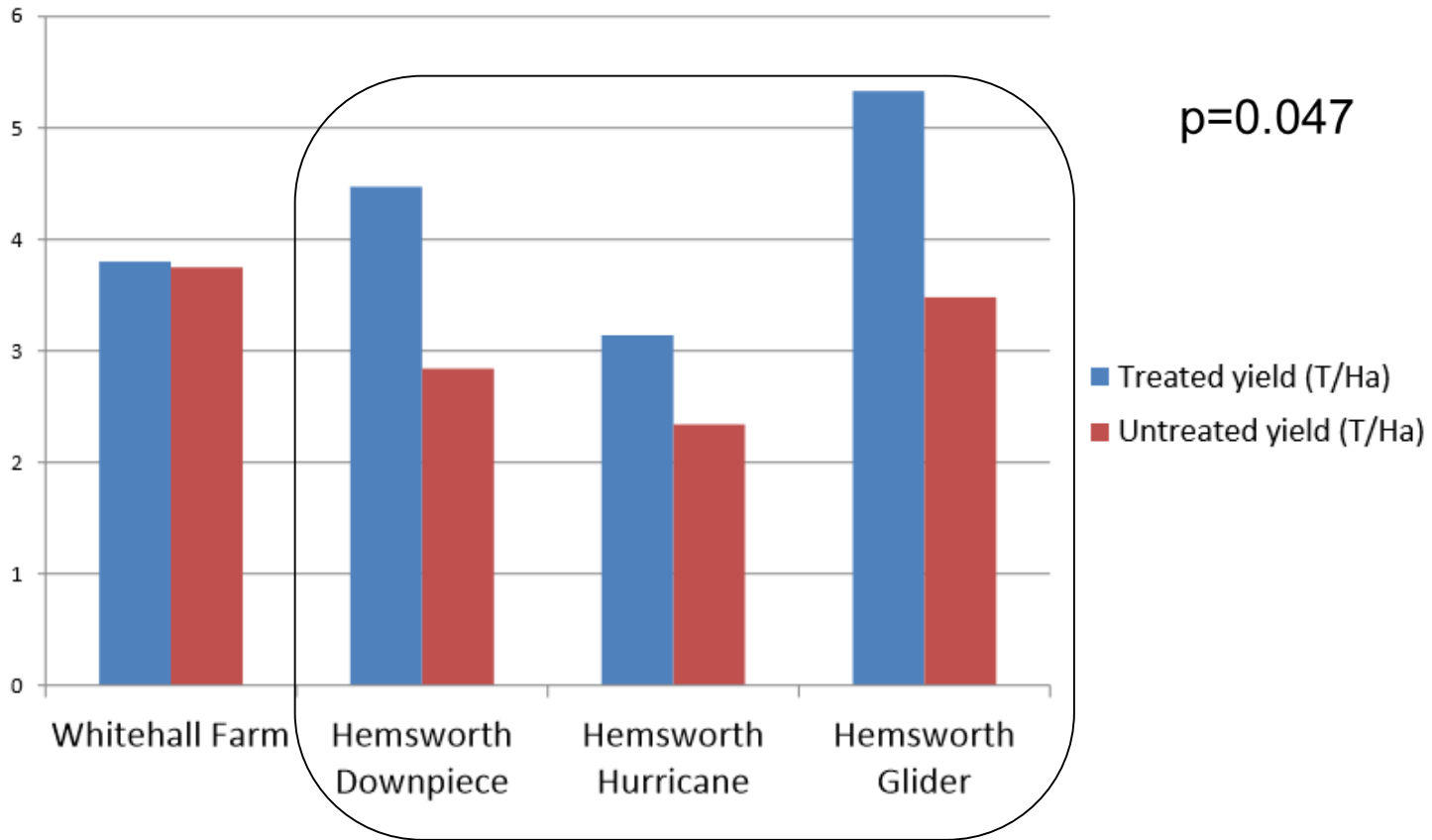


Total Fungi – Post Harvest



Treatment
 $p = 0.01$

2015 Yield Results



It should be noted that the yield data is based on close to 43 ha of treated crop and control areas of around 2 ha within each of the four fields.

2016

Whole Field (3) Treated with Compost Tea; Two Fields (Replicates)

Yield Comparison
between 1 and 2
(More
realistic/reliable
comparison)

Soil Sampling?
(1 and 2?)

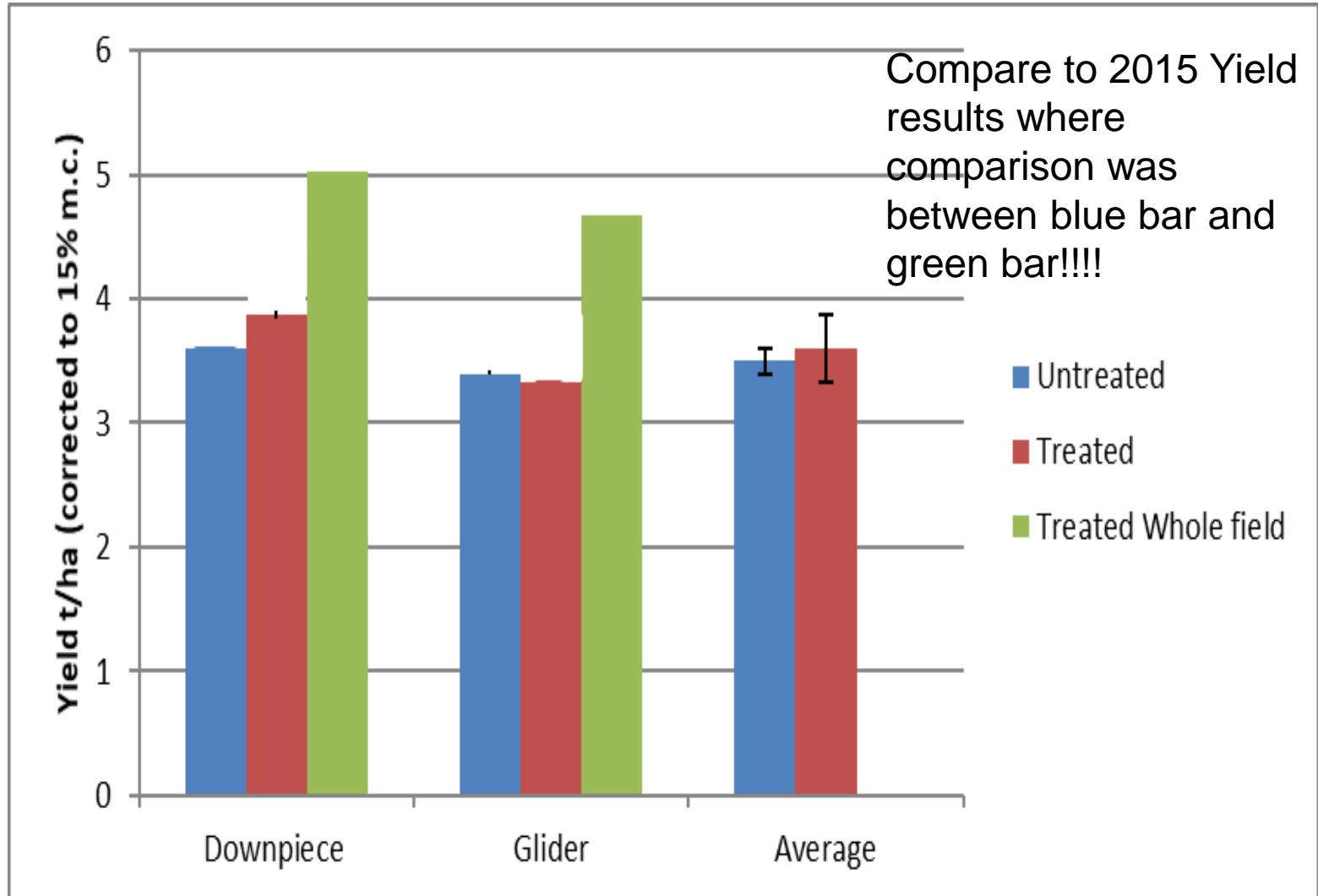
Crop Sampling
(1 and 2)

1

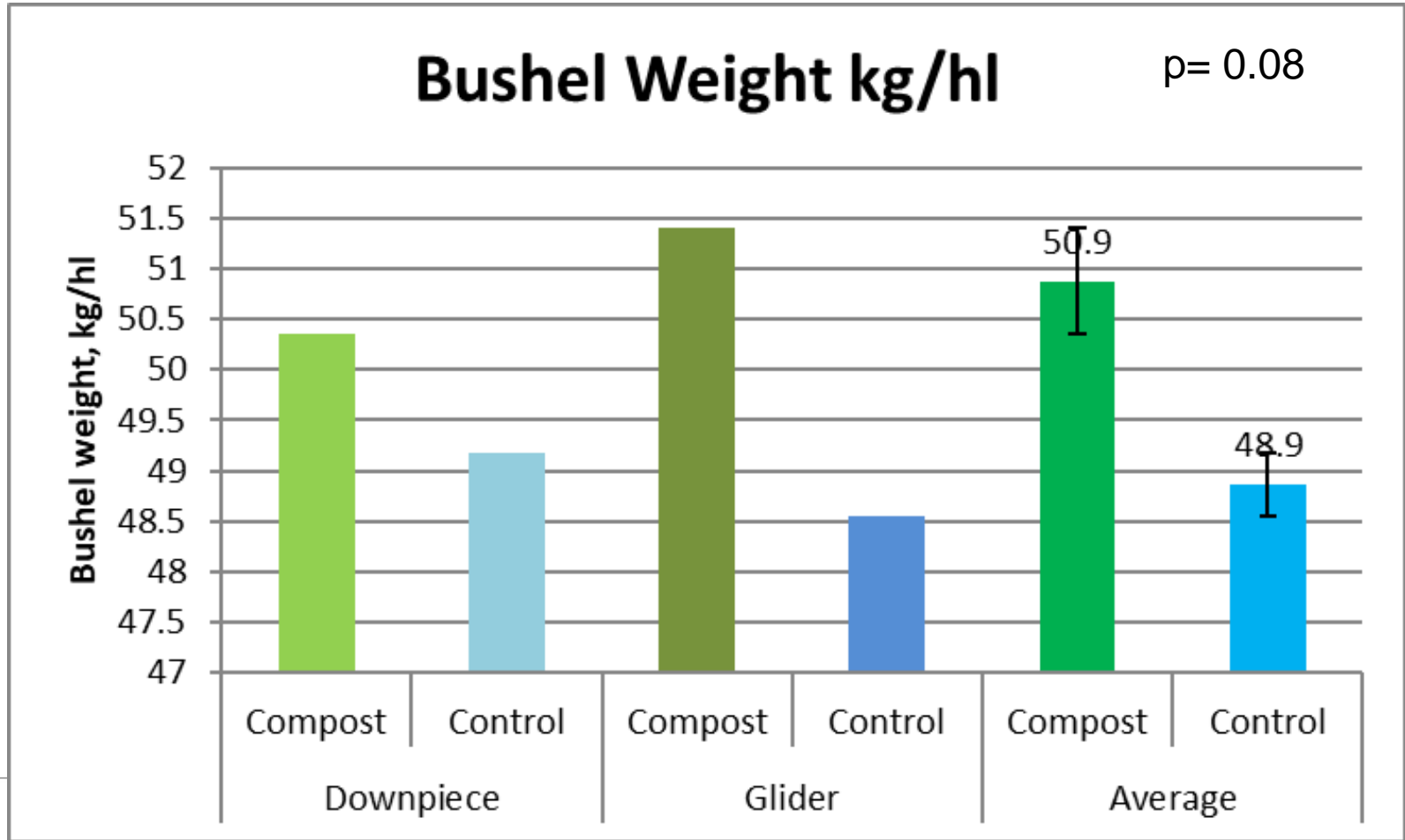
2

CT STRIP	CONTROL STRIP
TREATED	UNTREATED

Yield and Quality 2016

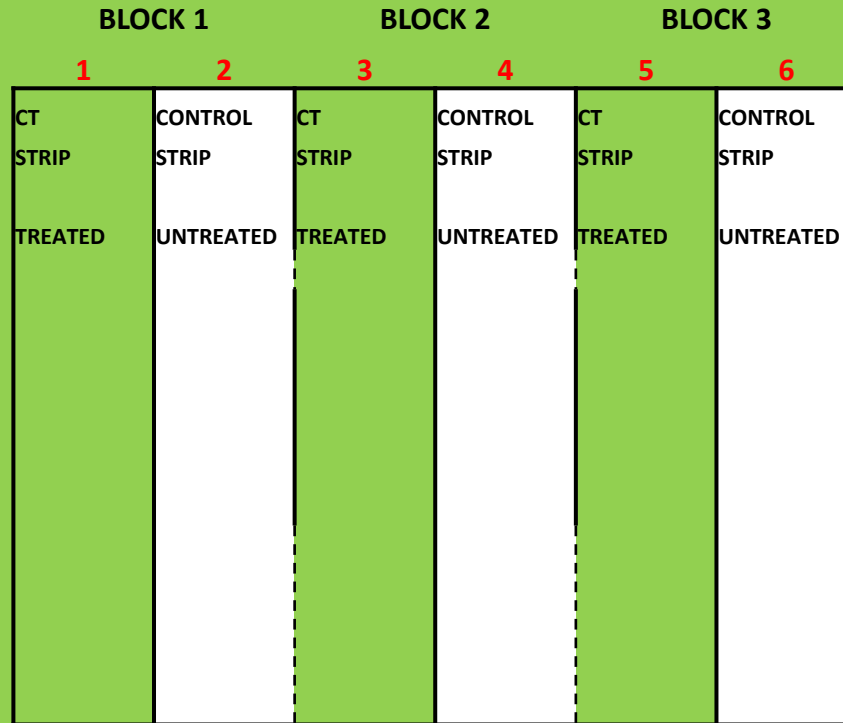


Yield and Quality 2016



2017

"Randomised" Complete Block; Two Fields, Three Replicates per Field



2017 Schedule

Applications

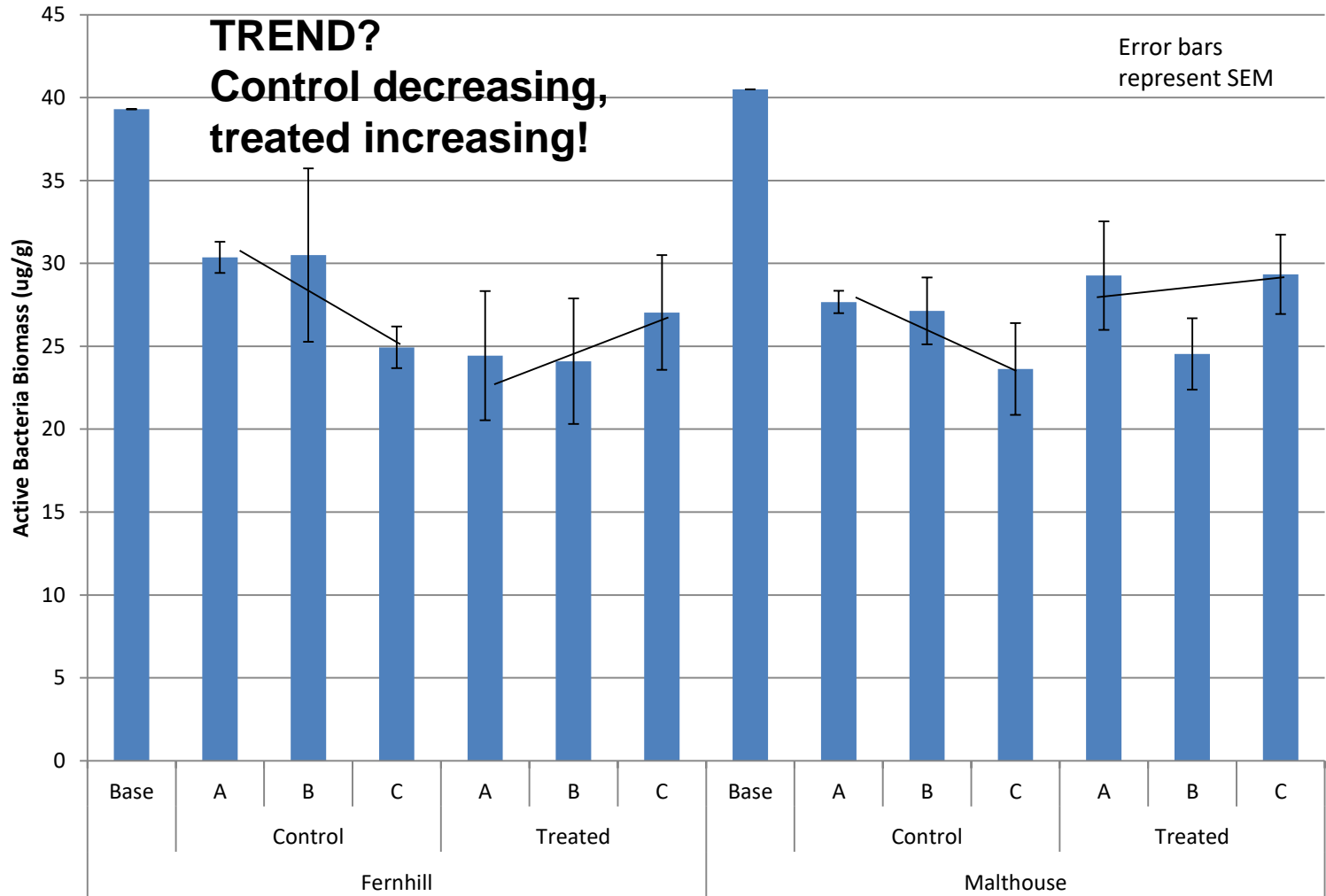
Applications	Date
A	28.03.17
B	12.04.17
C	09.05.17
D	24.05.17

Sampling

Soil Samplings	Date
Compost	pre-trial
Soil baseline	pre-trial
brewer + sprayer	29.03.17
First Full Sampling A	28.04.17
brewer+ sprayer	09.05.17
brewer+spayer Second Full Sampling B	24.05.17
Third Full Sampling C Compost	06.06.17

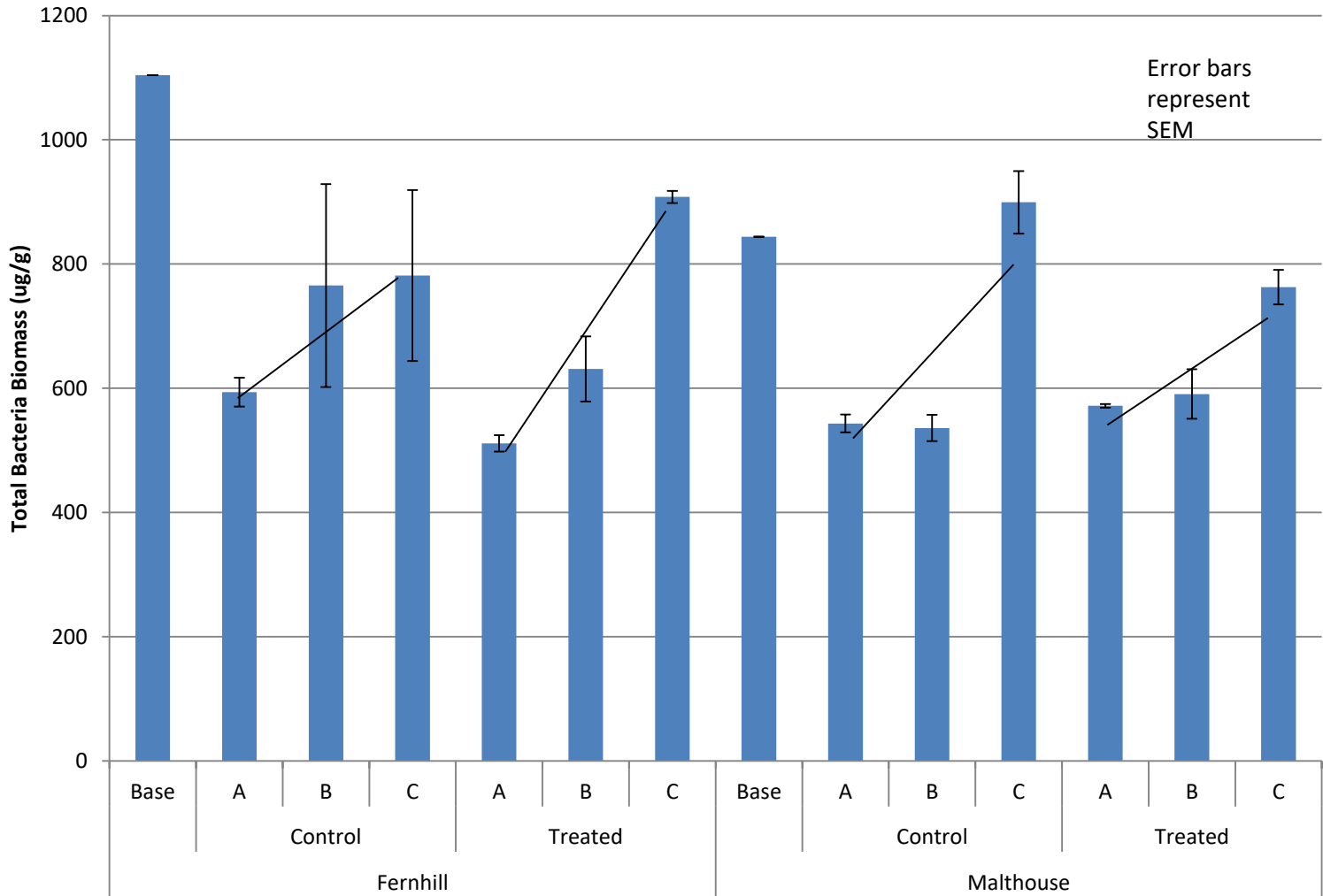
Active Bacteria 2017

Factor	Significance
treatment	n.s
time	n.s
treatment:time	n.s



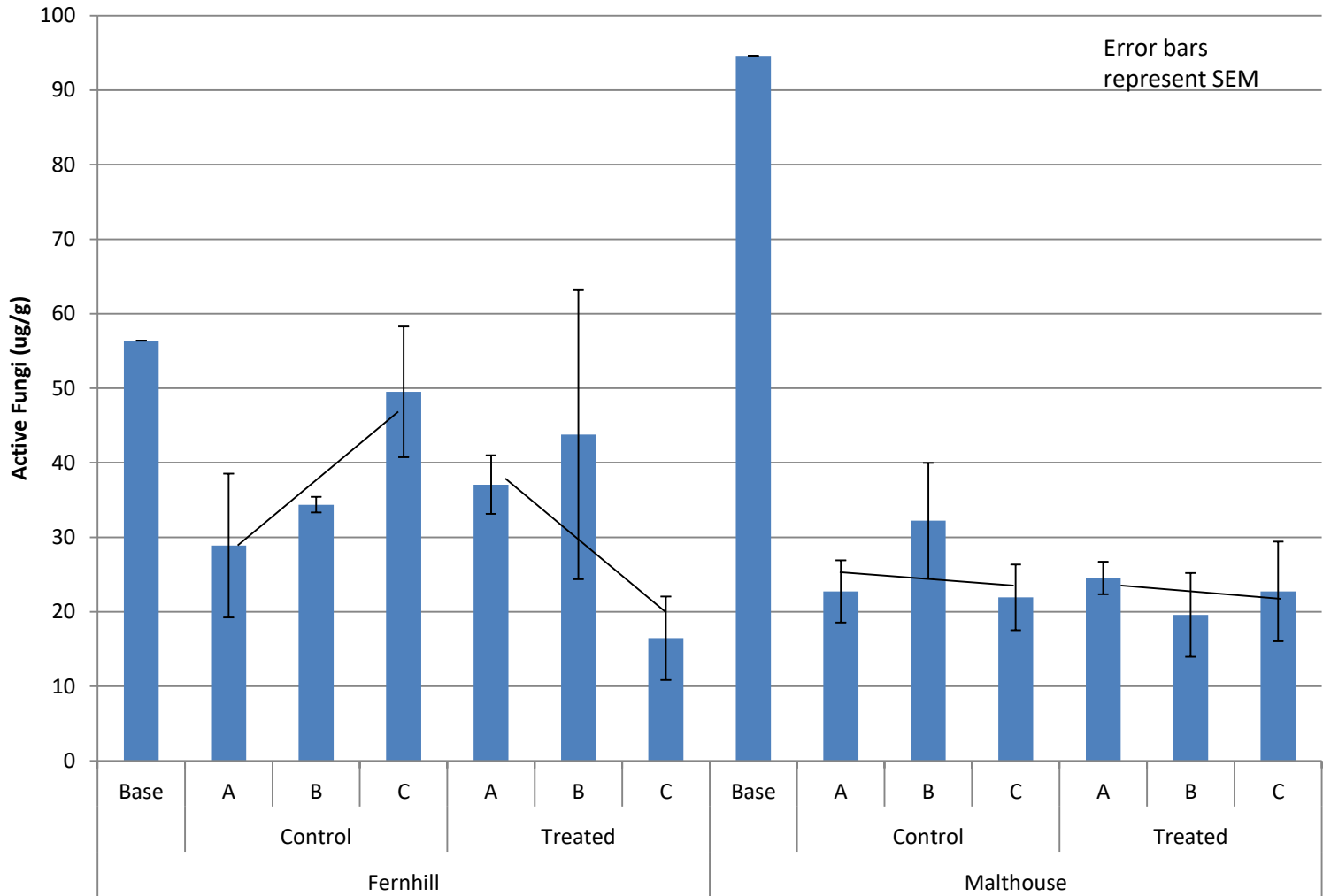
Total Bacteria 2017

Factor	Significance
treatment	n.s
time	<0.001
treatment:time	n.s



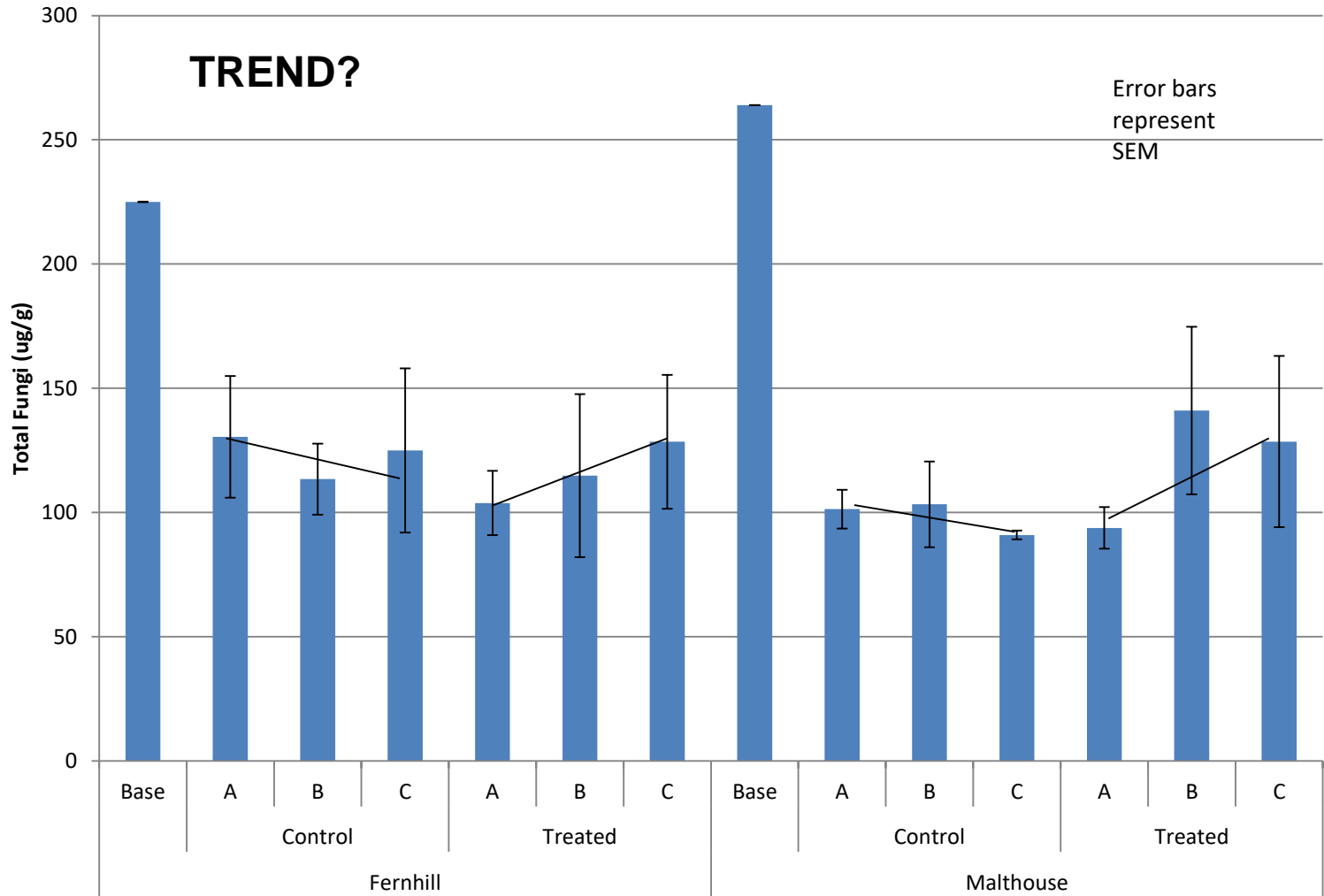
Active Fungi 2017

Factor	Significance
treatment	n.s
time	n.s
treatment:time	0.03



Total Fungi 2017

Factor	Significance
treatment	n.s
time	n.s
treatment:time	n.s



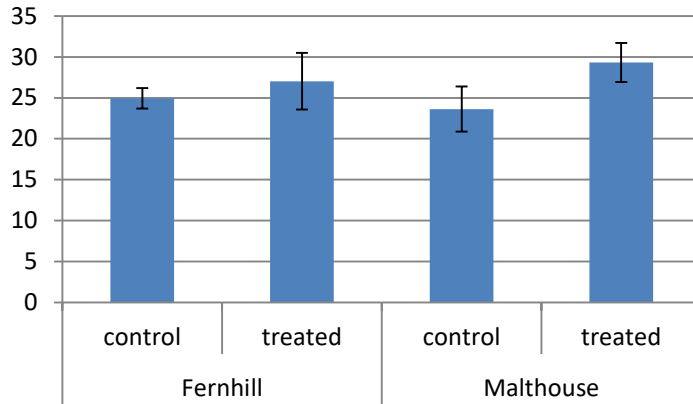
Final Application (D) - 24.05.17

The Organic Research Centre



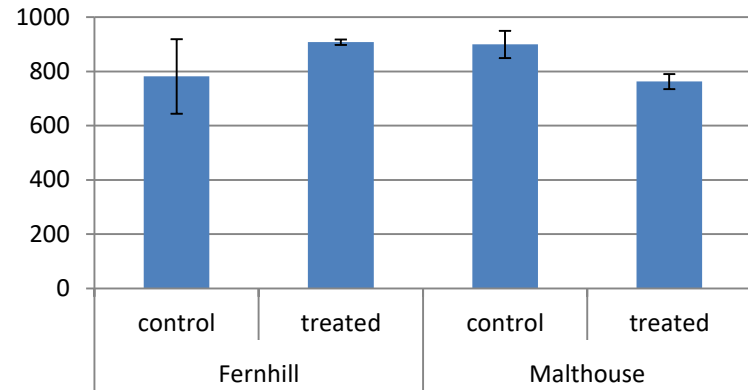
Sampling C - June

Active bacteria (ug/g)



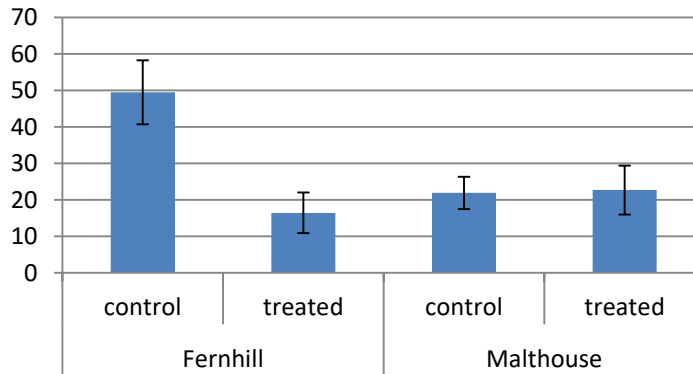
Treatment n.s ($p=0.09$)
Field n.s

Total Bacteria (ug/g)



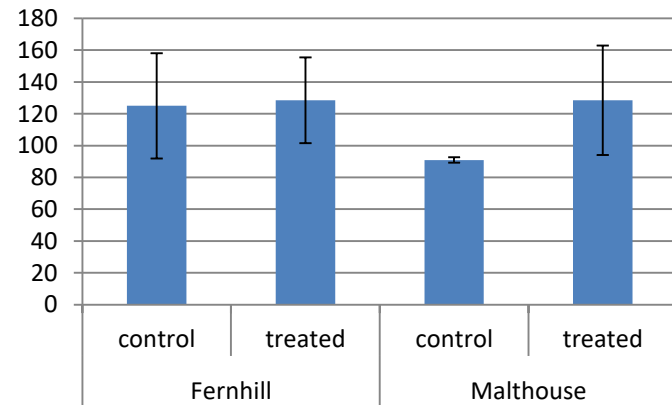
Treatment n.s
Field n.s

Active Fungi (ug/g)



Treatment n.s ($p=0.06$)
Field n.s
Field*Treatment significant ($p=0.05$)

Total Fungi (ug/g)



Treatment n.s
Field n.s

Nozzle Sample Application D - 24.05.17





Compost Tea Workshop



Cranfield
Environment
and Agrifood

- Dr Mark Pawlett

- 19th July 2017



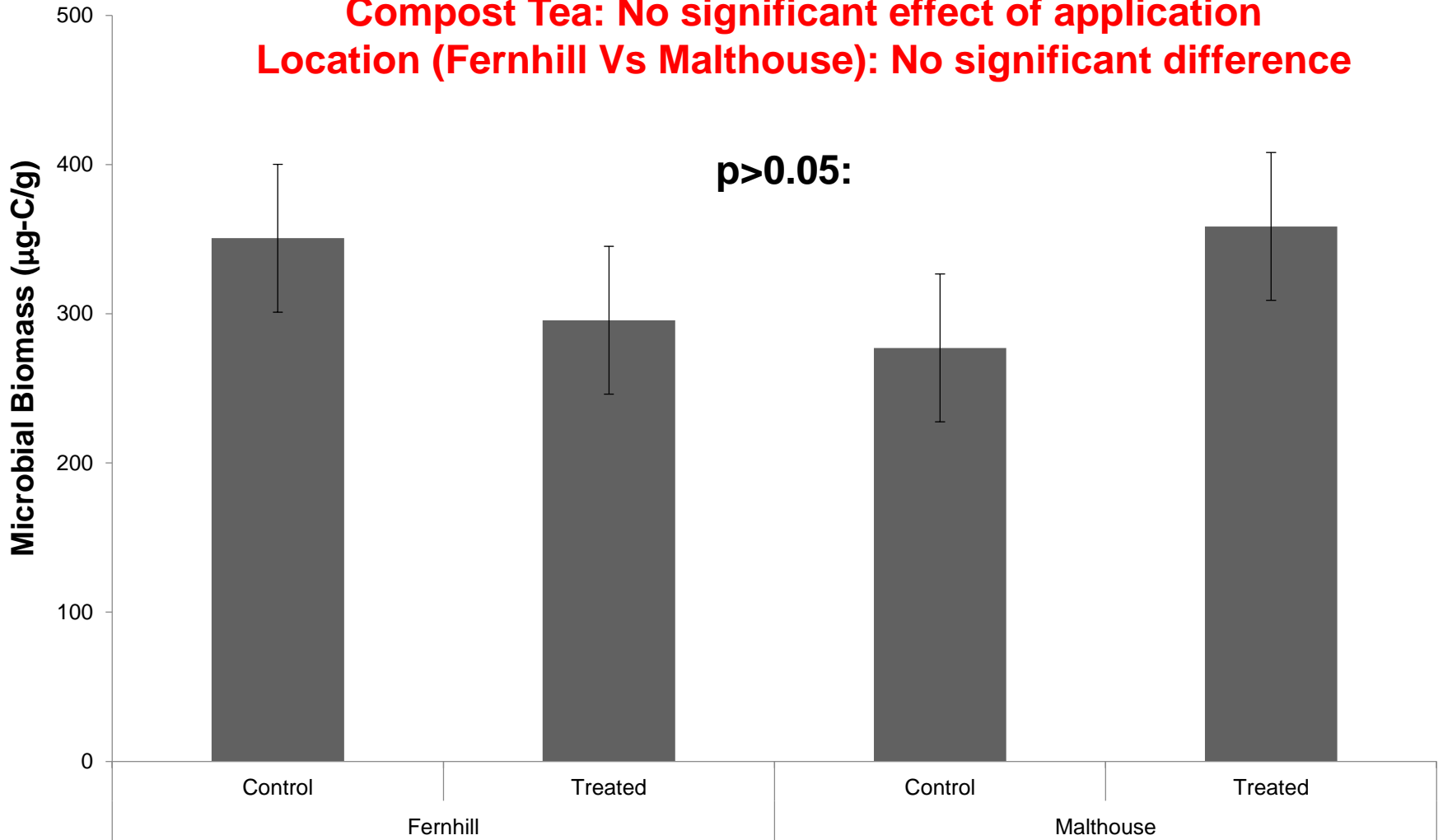
Microbial methods

- **Microbial Biomass:** Fumigation extraction
- **Basal Metabolic Rate (Respiration)**
- **Substrate (glucose) induced respiration**
- **Phospholipid fatty acid analysis**
 - Phenotypic profile
 - Fungi, bacteria (and Fungal/bacterial ratio)
- **Statistics:**
 - **Randomised field trial**
 - Analysis of Variance (ANOVA):
 - Field (2) x Treatment (2) x **Replicates (3)**
 - Principal Component Analysis (PCA)



Microbial Biomass

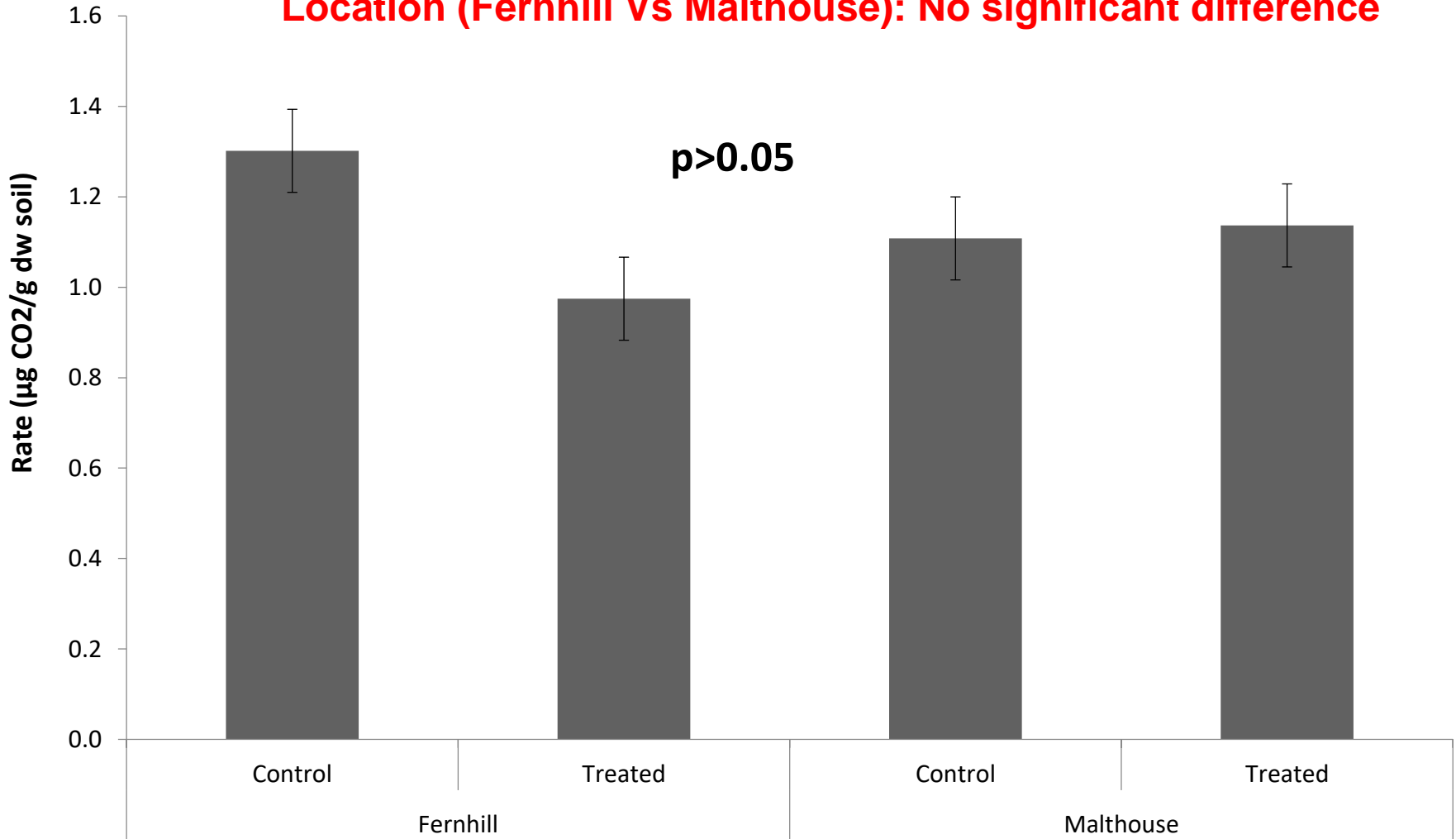
**Compost Tea: No significant effect of application
Location (Fernhill Vs Malthouse): No significant difference**





Basal Metabolic Rate

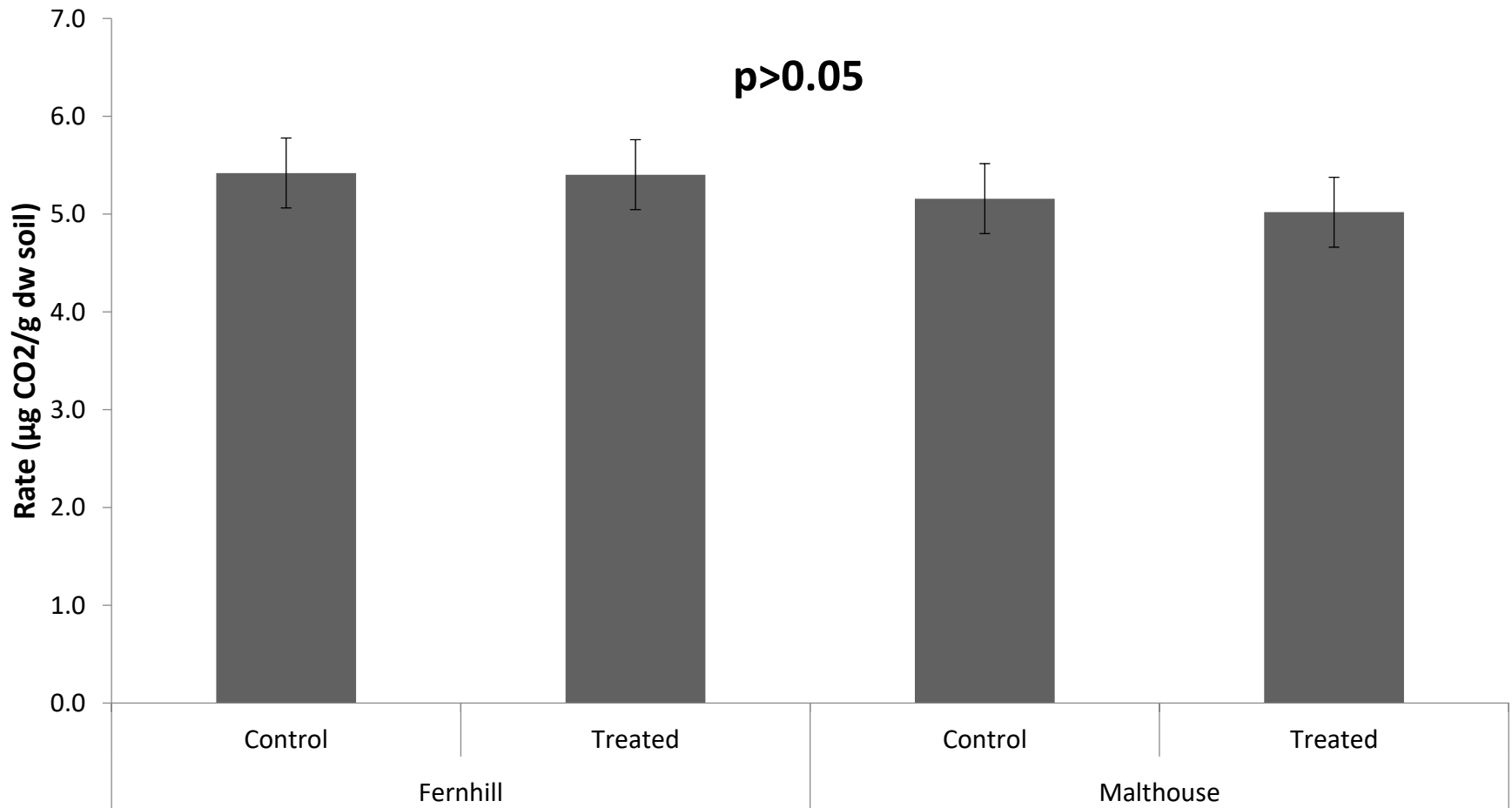
Compost Tea: No significant effect of application
Location (Fernhill Vs Malthouse): No significant difference





Substrate (Glucose) Induced Respiration

Compost Tea: No significant effect of application
Location (Fernhill Vs Malthouse): No significant difference

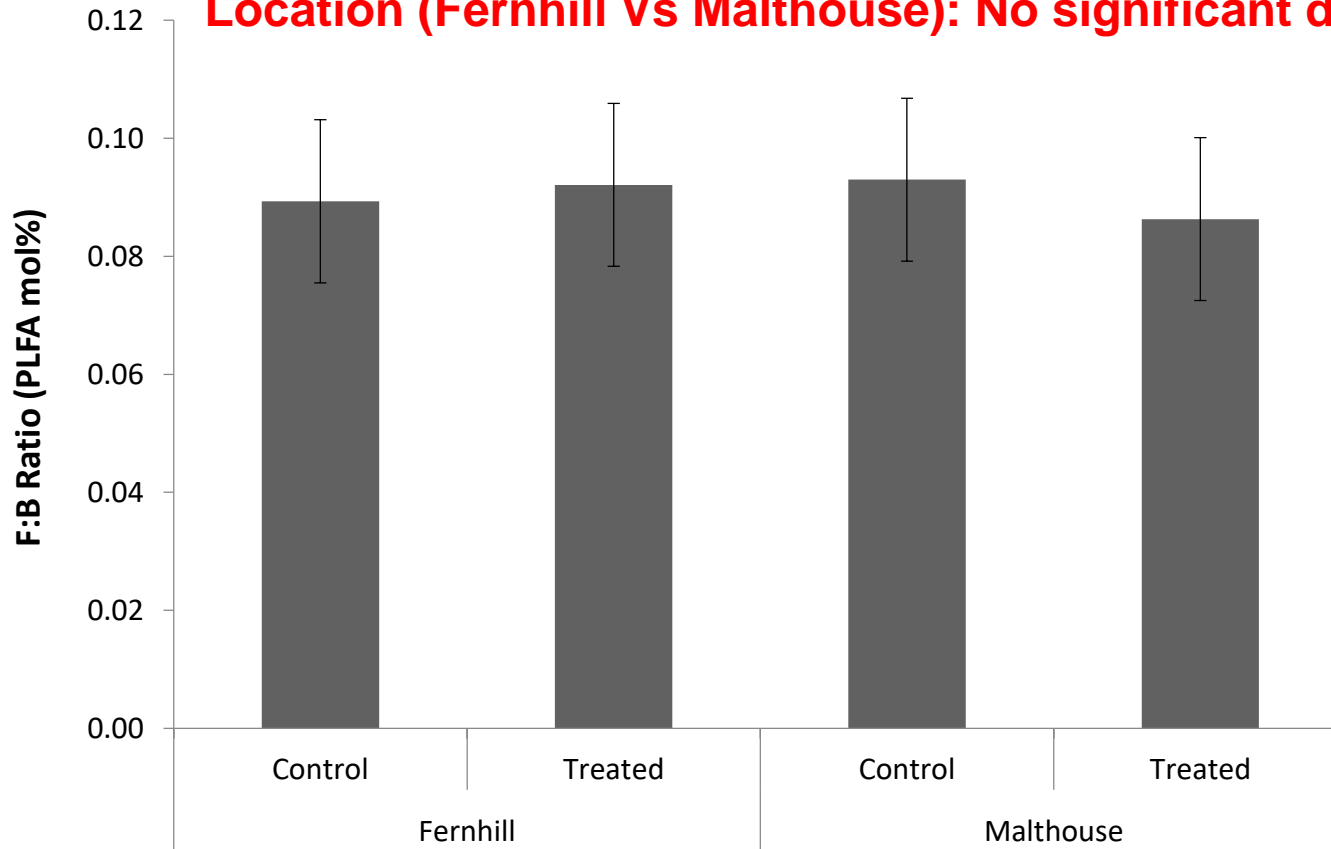




PLFA Biomarkers

	p value		
	Fungi	Bacteria	F/B ratio
Field	>0.05	>0.05	>0.05
Treatment	>0.05	>0.05	>0.05
Field*Treatment	>0.05	>0.05	>0.05

**Compost Tea: No significant effect of application
Location (Fernhill Vs Malthouse): No significant difference**





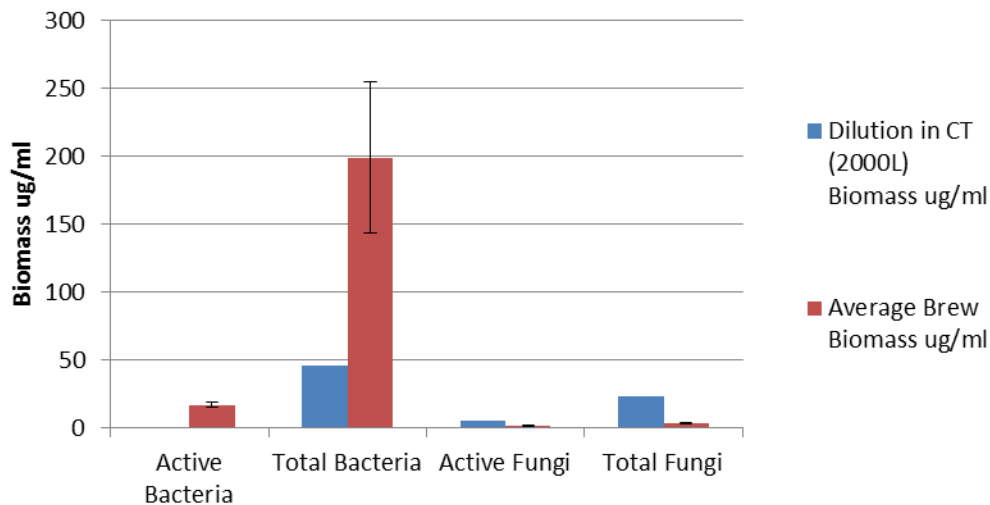
Trial Soil Microbiology Conclusions

- No evidence that compost tea affected the soil microbial community
- Different soil microbial community (PLFA composition between trials (Fernhill Vs Malthouse))
- No effect could be due to:
 - Time:
 - short length of time for the trial
 - Application time
 - Compost tea? Problems of brewing?
 - Method of application?
 - Dosage not high enough
 - Indigenous soil biology unresponsive?
 - Soil sampling depth?



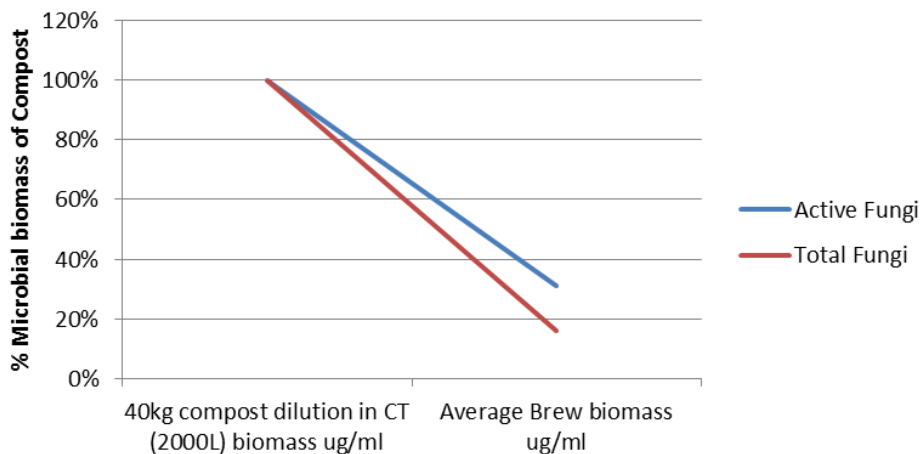
The Brewing Process – Extraction Efficiency?

Microbial Biomass added to Brewer vs Biomass Produced in Brewer

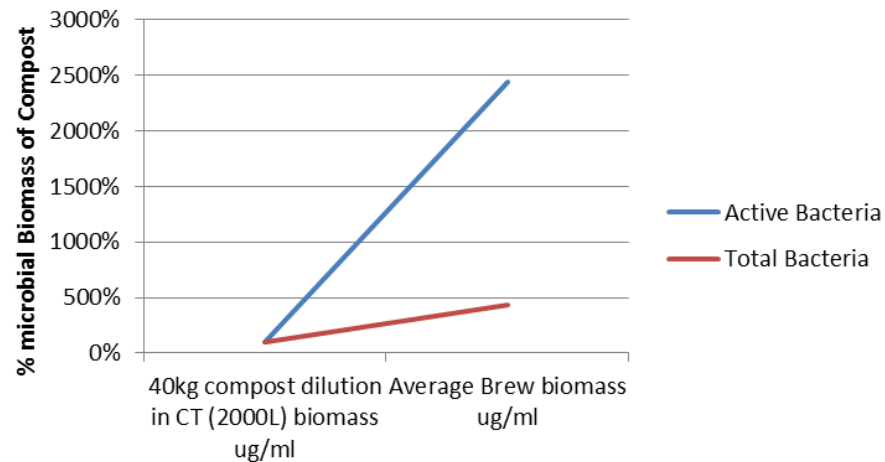


434% Total Bacteria
16% Total Fungi

Effect of Brewing on Fungal Biomass



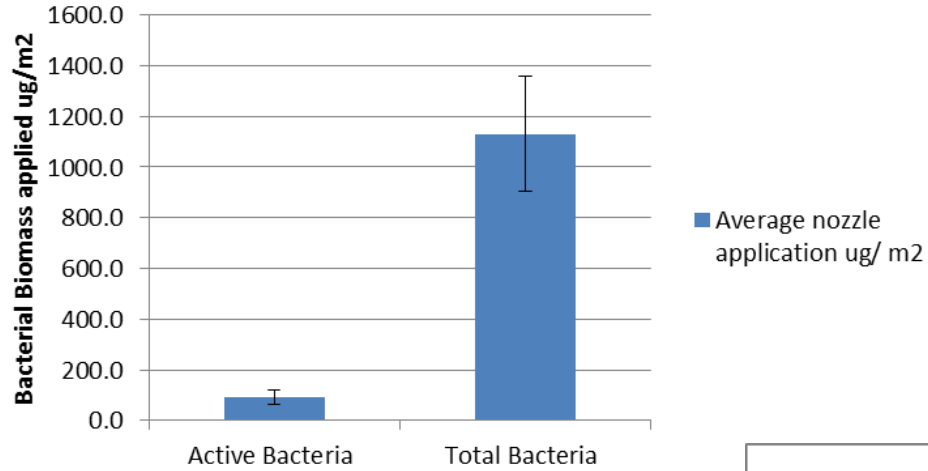
Effect of Brewing on Bacterial Biomass



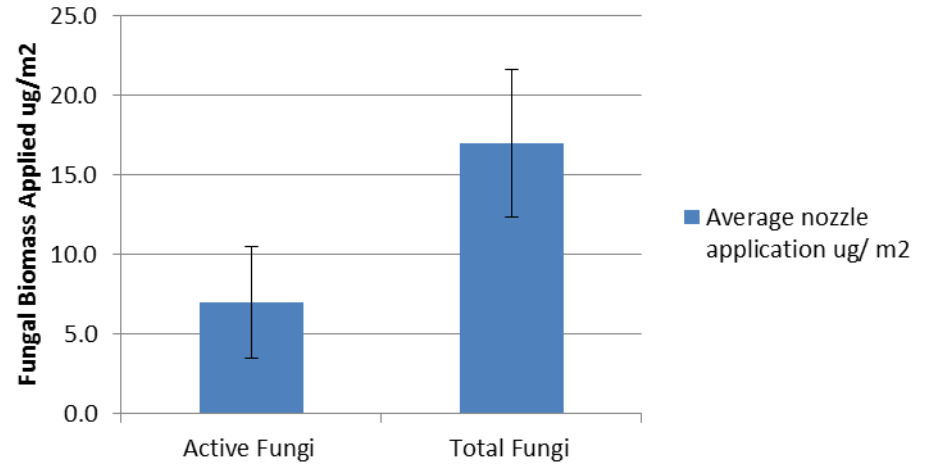
(Assuming 80L Compost added, 1L compost = 0.5kg)

Microbial Biomass Applied To The Soil/Crop

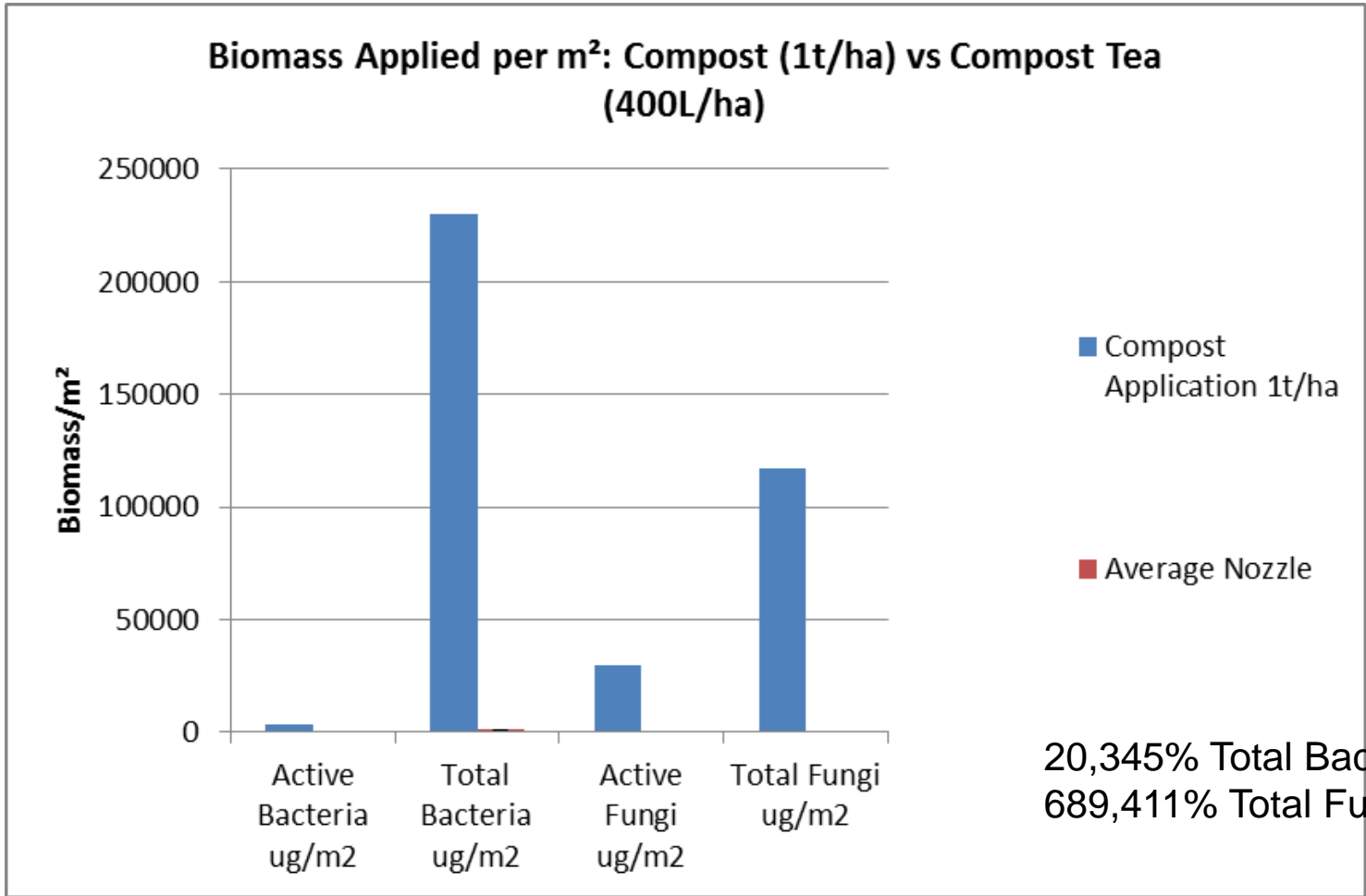
Average nozzle application ug/ m2



Average nozzle application ug/ m2



Microbial Biomass; Application of Compost vs Compost Tea (converted to Biomass ug/m²)



Assuming 400l/ha (40ml/m²) Compost Tea application rate and 1t/ha Compost (0.1kg/m²)

Microbial Biomass; Compost vs Compost Tea Comparison

- How much compost would need to be applied to match the average microbial biomass applied by a single Compost Tea application at Hemsworth in 2017?

	Active Bacteria	Total Bacteria	Active Fungi	Total Fungi
Compost Microbial Biomass ug/g	35	2299	295	1172
Average nozzle application ug/ m2	91.7	1130.0	7.0	17.0
Compost required g/m2	2.62	0.49	0.02	0.01

Compost				
kg/ha	26.19	4.92	0.24	0.15

N.B. Compost can be applied up to 30t/ha!

Microbial Biomass; Compost vs Compost Tea Comparison

- Compost contains **beneficial microorganisms** able to contribute to a healthy soil in terms of:
 - ◆ Improved nutrient cycling
 - ◆ Disease (soil borne) suppression
(competition, antagonism, parasitism, induced systemic resistance)
 - ◆ Soil aggregation
- Compost Tea is supposed to multiply these organisms in order to spread the benefits further (at an arable field scale)..... but it doesn't appear to be what's happening!

Additional Benefits of Compost.....

- **Plant nutrients:**
 - ◆ Slow release **nitrogen, phosphate** and **sulphur**. It contains readily available potash.....plus smaller but useful amounts of **magnesium, calcium** and **trace elements**

Organic Matter:

- ◆ improved **soil aggregation** and **structure**;
- ◆ improved **water infiltration** and **water holding capacity**;
- ◆ increased soil **CEC** in light soils;
- ◆ **reduced leaching** of nutrients.

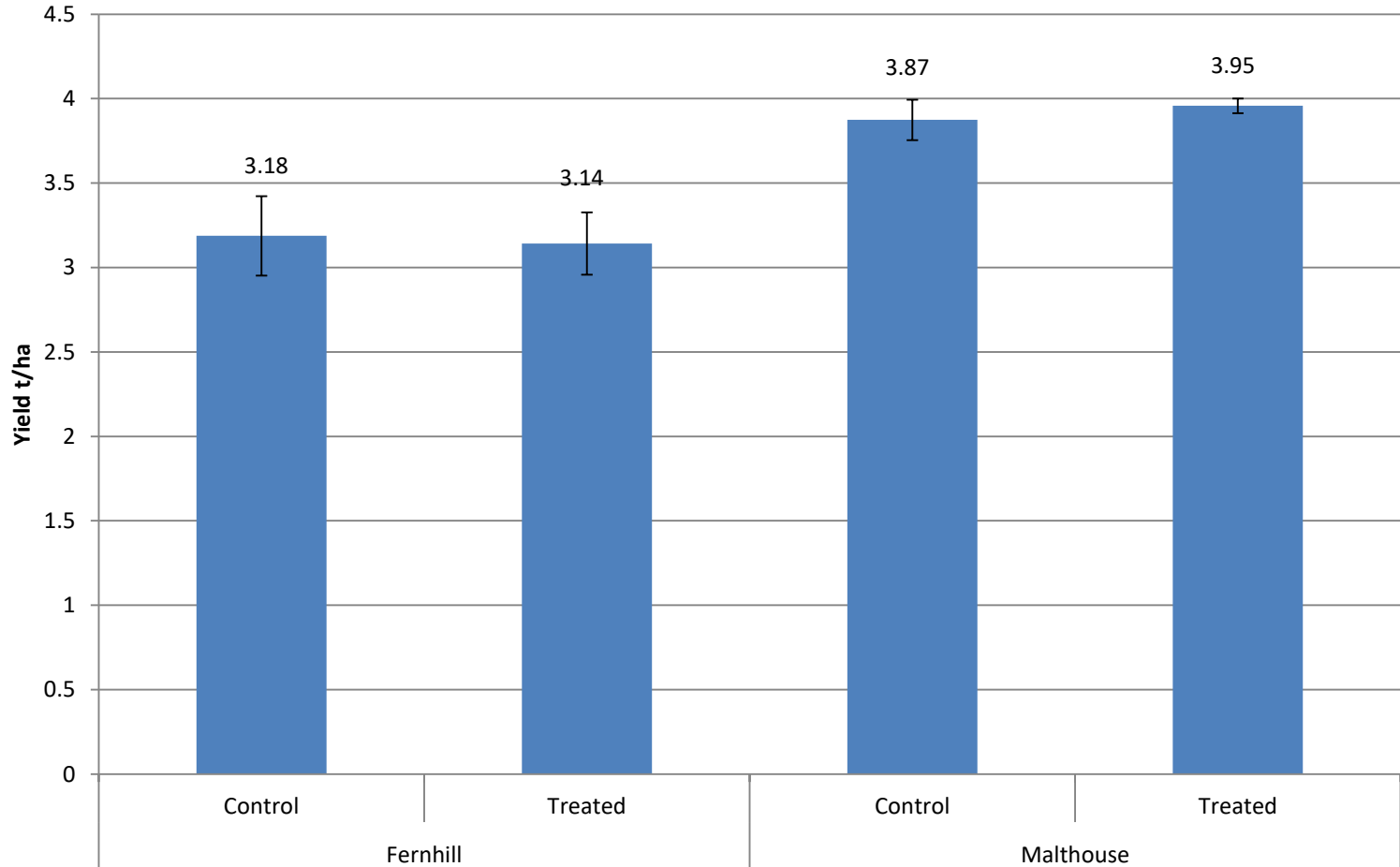
Harvest – 14/08/17



Yield and Quality 2017

Factor	Significance
treatment	n.s
field	p=0.002
treatment:field	n.s

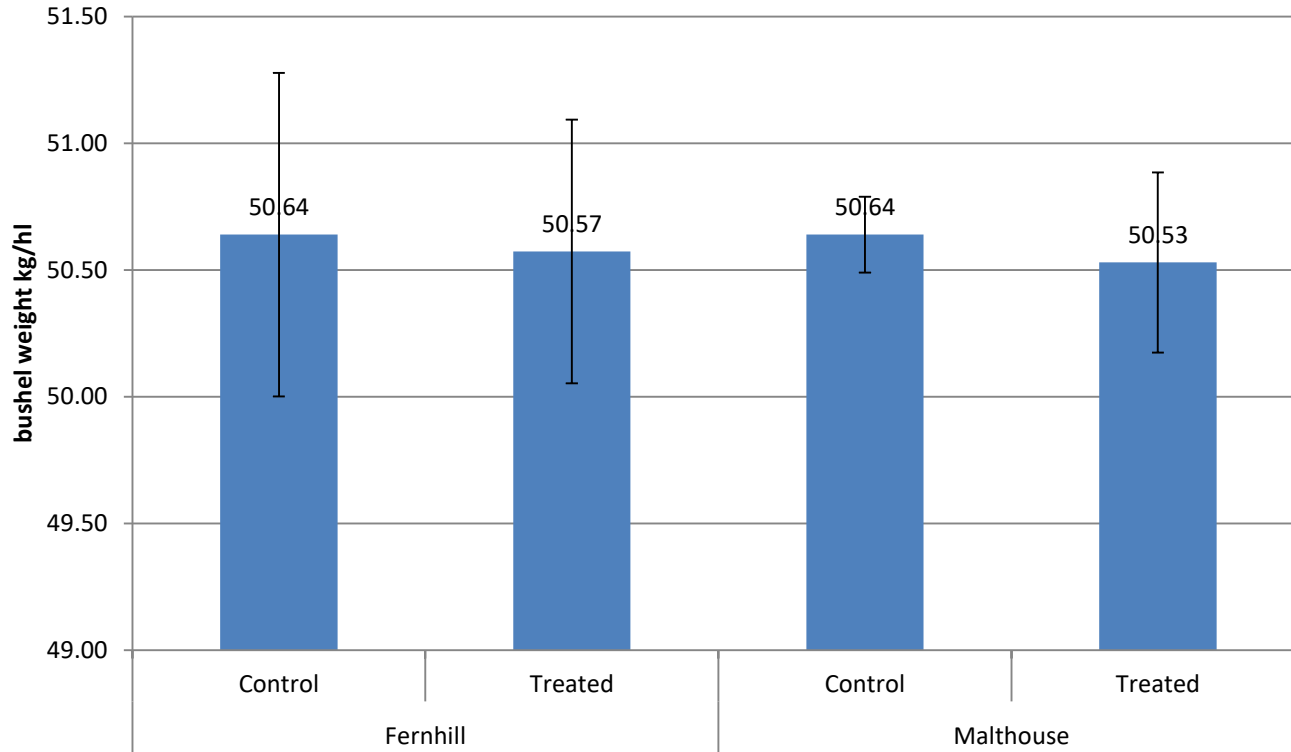
Yield t/ha @ 15% m.c.



Yield and Quality 2017

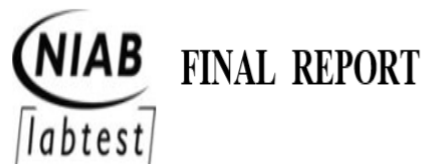
Factor	Significance
treatment	n.s
field	n.s
treatment:field	n.s

Bushel Weight kg/hl



Yield and Quality 2017

Pyrenophora and Microdochium



Mr D Ames
The Organic Research Centre
Hamstead Marshall
Newbury
Berkshire
RG20 0HR

Tests requested :
Pyrenophora and Microdochium

Date Received : 08/02/2018

Labtest Sample No : 141319

Sample Description : Oats Firth

Customer Reference : HEMSFA

Test	Result	Specification / Technique used
Pyrenophora and Microdochium	0.0 % of seeds infected with <i>M. nivale</i> (Fusarium)	In-house method based on published literature
	0.0 % of seeds infected with <i>P. avenae</i>	



Mr D Ames
The Organic Research Centre
Hamstead Marshall
Newbury
Berkshire
RG20 0HR

Tests requested :
Pyrenophora and Microdochium

Date Received : 08/02/2018

Labtest Sample No : 141320

Sample Description : Oats Firth

Customer Reference : HEMSFB

Test	Result	Specification / Technique used
Pyrenophora and Microdochium	0.0 % of seeds infected with <i>M. nivale</i> (Fusarium)	In-house method based on published literature
	0.0 % of seeds infected with <i>P. avenae</i>	

0.0% of seeds infected in control and treated!

Outcomes

- **No significant effect** from compost tea on soil microbiology in 2017 using Soil Food Web test (n.b. Active bacteria) or Cranfield Lab methods!
- Is the reason that compost tea doesn't work as a microbial inoculant or is it because the **composting/brewing/application** method wasn't **effective**?
- Compost is “high” in microbial biomass but this isn't translating into the brew.
- Dilution? Spray Volume? 150L/ha?
- Compost vs Compost Tea
- Sampling/Testing method?

The Crop – Spring Oats cv *Firth*

- **Effects on crop?**
 - ◆ **Improved nutrition?**
 - ◆ **Improved health?**
 - ◆ **Disease suppression; Foliar and Seed? – Field Assessment, NIAB tests**
 - ◆ **Improved root development?**
 - ◆ **Improved Yield? – Plot combine**
 - **No effect on crop yield in 2017**
 - ◆ **Improved grain quality; HLW? – Chondrometer**
 - **No effect on bushel weight in 2017**

Link between Power and Results?

- As the trials have developed from a simple and relatively unreliable design in year one, to a more realistic comparison in year two, and finally a fully replicated field trial in year three.....

.....Efficacy of Compost Tea has looked less and less!

But what desired result do we want?????????????????

What is Efficacy? Which Agro-Ecosystem Service?



The Future.....

- Asking the right questions?
- What do we want to achieve?
- The Composting/Brewing Process
- Benchmarking microbial biomass. How much do you need??? Setting a target. Knowing your soil.
- Compost vs Compost Tea

The Future.....

- **Same trial this year.....?**
 - ◆ Same 2 fields/Same areas/Different crop (Beans Y2, Wheat Y3)
 - ◆ No access to Commercial Sprayer!
- **New trials this year.....?**
 - ◆ New fields, new areas, smaller scale, new sites/systems
 - ◆ Plot scale? Smaller Brews. Easier to manage?
- **Testing the brewing method in the lab?** (Linking Research to Farm)

THE PROCESS (COMPOST TEA)

Composting

- Material/Method
- Conditions
- Quality/Maturity

Brewing

- Method (Time/System/Water)
- Extraction
- Dilution
- Catalysts (Recipe)

Spraying

- Sprayer
- Nozzles (Pressure/Size)
- Dilution
- Conditions

Field

- Timing/Number
- Conditions
- Crop Growth Stage (What service?)