University of Reading

Forest Research

Soil Enzyme Activity and oak health

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BAC-STOP

STOP BAD BACTERIA ON OAK

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Background

- Soil enzymes catalyse key biogeochemical processes in the decomposition of soil organic matter and the recycling of nutrients

- Their potential activity can be used to measure plant health, productivity and wider ecosystem function

- As nutrient status of soil has been shown to be different between trees with AOD symptoms and those without, soil extracellular enzyme activity may be able to provide early information on soil-oak feedback and cause and effect in AOD

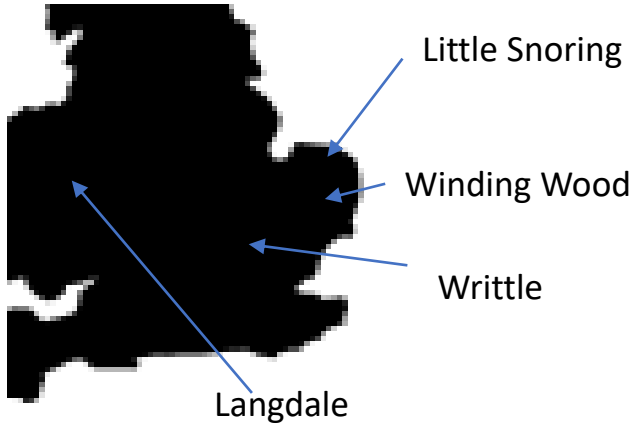
Fluorometric Enzyme assays

	Extracellular Enzyme	Abb	Function	Fluorometric Substrate
C	β glucosidase	G	Catalyses the hydrolysis of terminal 1,4-linked b-D-glucose residues from b-D-glucosides.	4-MUB-b-D-glucoside
	Cellobiohydrolase	CB	Catalyses the hydrolysis of 1,4-b-D-glucosidic linkages in cellulose	4-MUB-b-D-cellobioside
N	β -N-acetyl-glucosaminidase	NAG	N-acquiring chitin and peptidoglycan degradation	4-MUB-N-acetyl-b-D-glucosaminide
	Leucine amino peptidase	LAP	Catalyses the hydrolysis of leucine and other amino acid residues from the N-terminus of peptides. Amino acid amides and methyl esters are also readily hydrolysed.	L-Leucine-7-amino-4-methylcoumarin
P	Acid phosphatase	P	Mineralizes organic P into phosphate by hydrolyzing phosphoric (mono) ester bonds under acidic conditions	4-MUB-phosphate

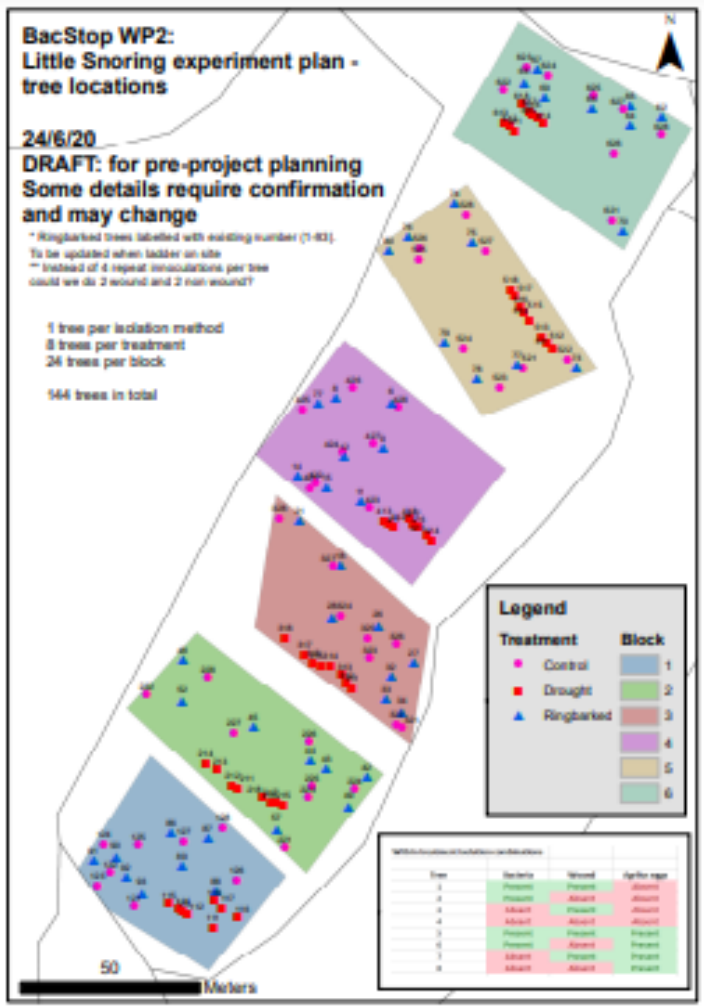
Sinsabaugh. R.L et al. 2008. Stoichiometry of soil enzyme activity at global scale. Ecology Letters, (2008) 11: 1252–1264 doi: 10.1111/j.1461-0248.2008.01245.x.

Field sites

Site	Number of trees	EEA measurement	Other testing	pH
Bacstop field experiment investigating predisposition factors and inoculation treatments				
Little Snoring, Norfolk	36 (6 x 6 replicates)	Autumn 20 (baseline) Autumn 21 Spring 22 Autumn 22 Ongoing	Ectomycorrhiza (72 trees)	3.63-4.25
FPPH sites – baseline EEA to tree health/AOD symptoms				
Langdale, Malvern	12	Sept 22	Soil chemistry	4.70-5.59
Winding Wood, Suffolk	12	Sept 22	Soil chemistry	3.14-3.73
Longitudinal study to link EEA to tree health/AOD symptoms				
Writtle, Essex	30 trees	Autumn 21 Spring 22 Autumn 22 Ongoing	NO3/NH4 – KCl extraction Available P – Mehlich Total P etc – Acid digest Cations - BaCl extraction Labile C – hot water Total C/N - flash	3.59-4.98



BacStop Little Snoring – trees selected



Replication	Environmental predisposition Factors	Biological inoculation treatments
Block 1 (24 trees)	Drought (8 trees)	All treatments (1) (Wound/Agrilus/bacteria)
Block 2	Control (8 trees)	None (1)
Block 3	Ringbarked (8 trees)	Wound/bacteria (1)
Block 4		No wound/bacteria (1)
Block 5		Wound/Agrilus (1)
Block 6		No wound/Agrilus (1)
		No wound/Agrilus/bacteria (1)
		Wound only (1)

Total 36 trees – 6 per block, 3 predisposition factors, 2 biological inoculation treatments

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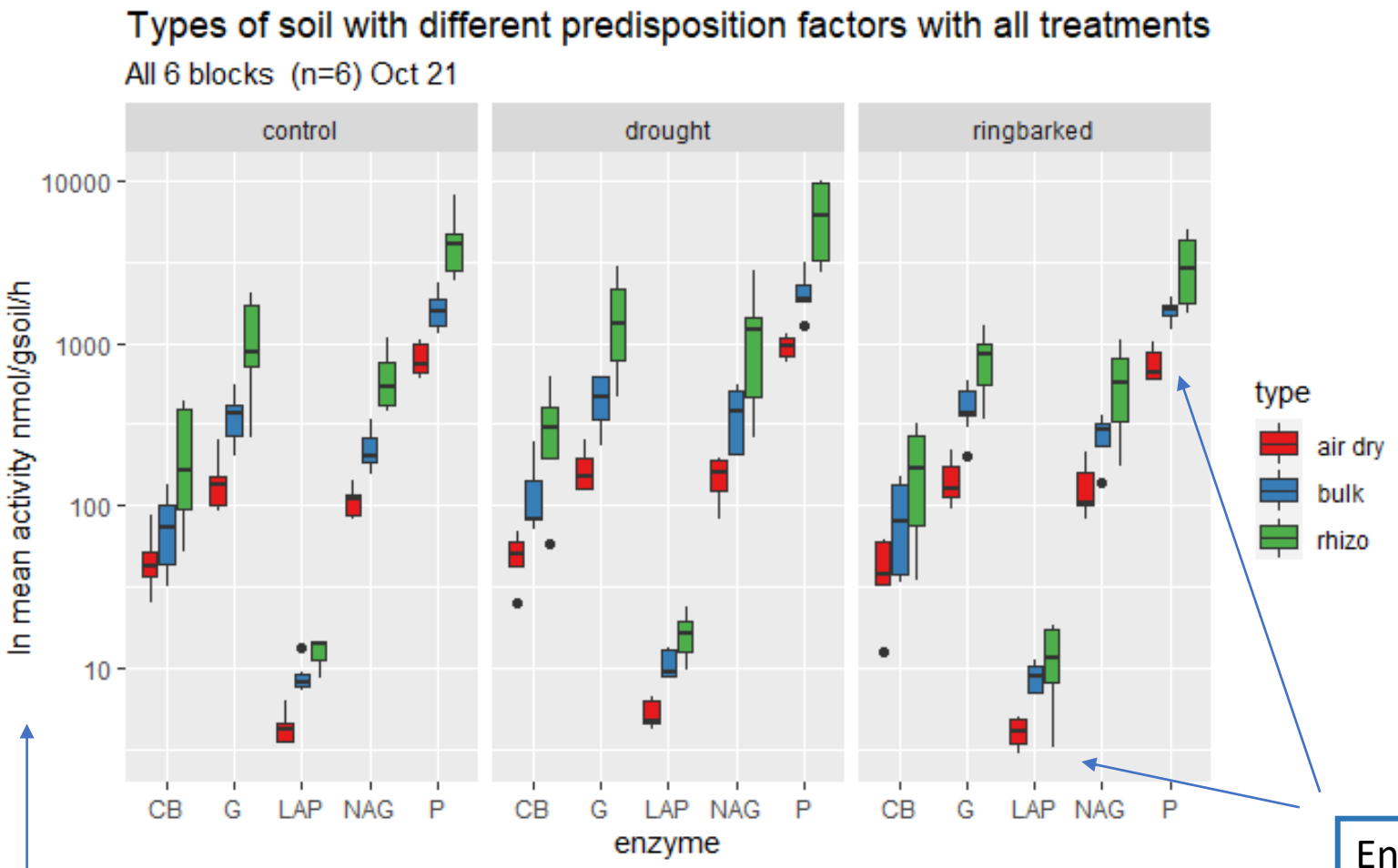


Types of soils collected at Little Snoring

Rhizosphere – most influenced by the tree by being attached to roots. Stored at field moisture in freezer

Bulk – soil collected from vicinity of roots. Stored at field moisture in freezer

Air dried bulk

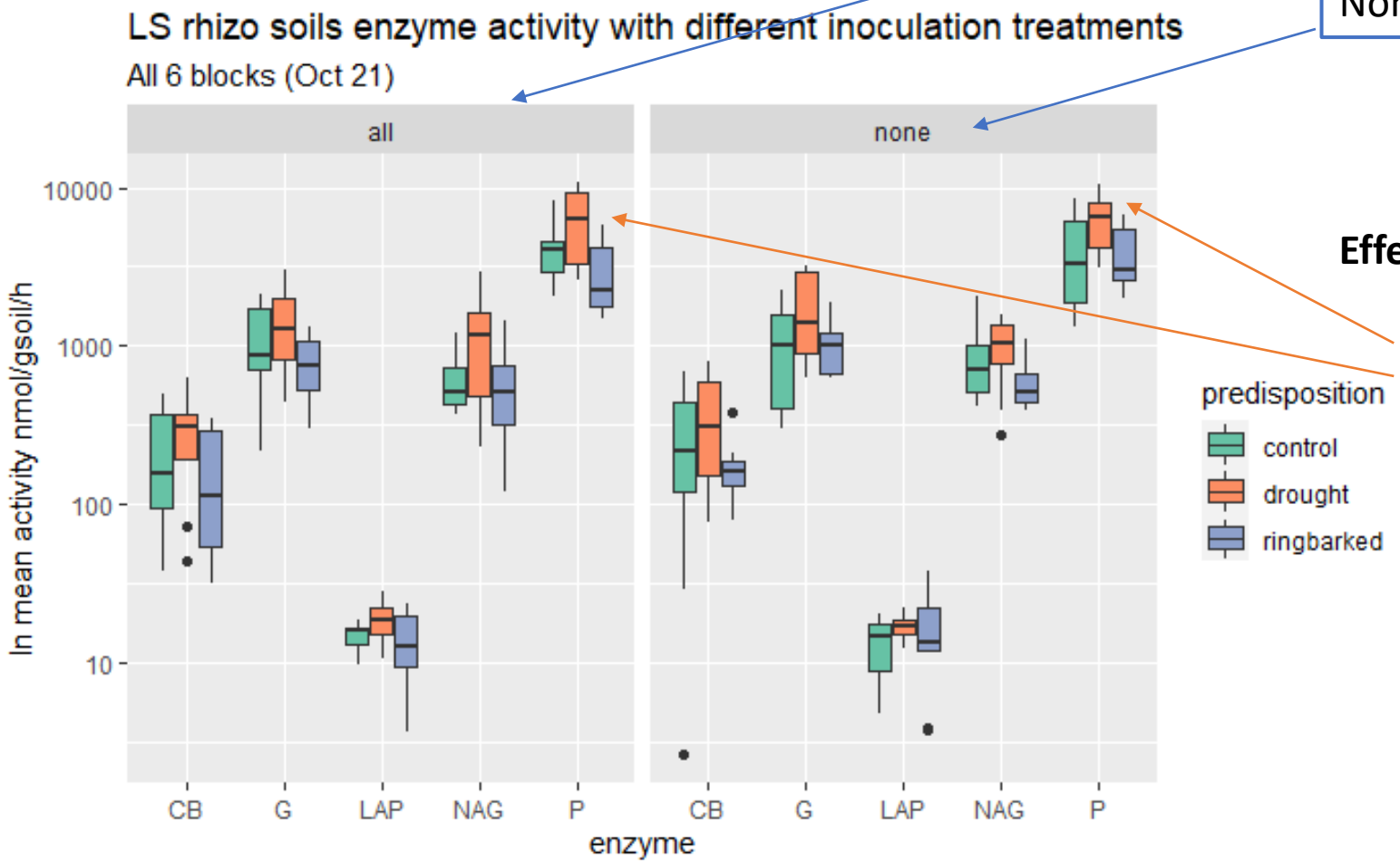
Log scale

Soil types have different levels of extracellular enzyme activity (EEA)

Enzymes have different activities P the most, LAP the least

All inoculation treatments = Wound/Agrilus larvae/bacteria

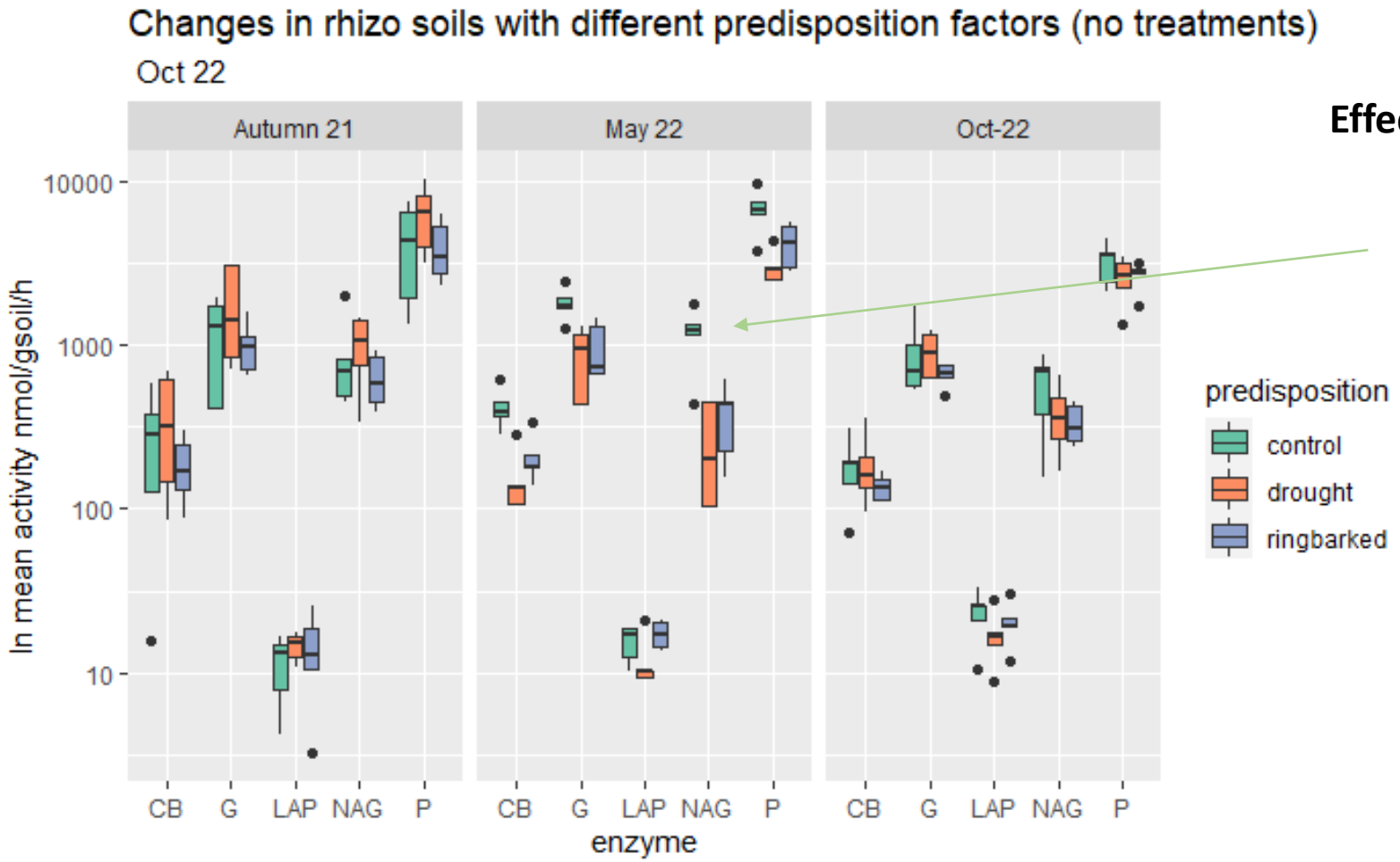
None = no inoculation treatments



Autumn 21

Effect of environmental predisposition factors (1)

- Drought had the most affect on potential enzyme activity giving highest values for,
  - all enzymes, and for
  - both inoculated and non-inoculated trees
- Consistent with other research on oak under water stress



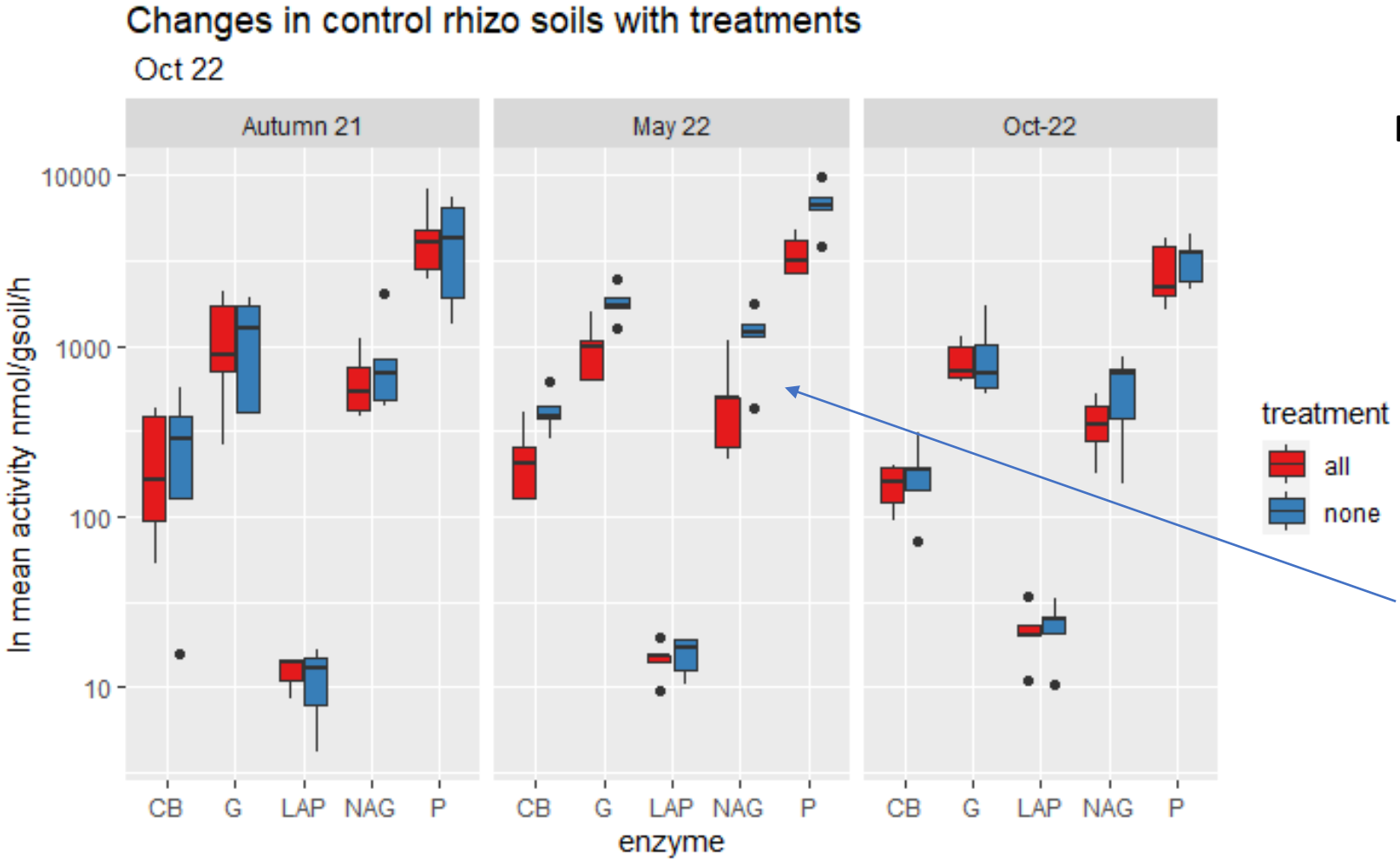
Effect of environmental predisposition factors (2)
No inoculation treatments

May 22 – bud burst

- More activity in control trees
- Less activity in ringbarked/drought
- Pre-disposition factors are depressing activity

Autumn 22

- Less activity than previous autumn
- All trees in drought?



Effect of biological inoculation treatments

- On control trees with no predisposition environmental factors
- All inoculation treatments = wound/Agrilus larvae/bacteria
- None = inoculation
- Effect of inoculation treatments most pronounced in Spring

Next steps in project

More soil sampling …

Little Snoring

- Combine enzyme results with
  - Tree talker data
  - Environmental data
  - Soil chemistry
- Ectomycorrhizal analysis

FPPH sites and Writtle

- Combine enzyme results with
  - Physical AOD tree health
  - Soil chemistry