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Agronomic assessment of biosolids biochar produced by Pyrocal's CCT at Loganholme WWTP

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Emerging Contaminants Workshop, 21 – 22 November

Project Funders

- Funded by ARC Nutrients in Circular Economy (NiCE) Hub Industry Transformation Hub

Australian Government
Australian Research Council

NiCE
NUTRIENTS IN A CIRCULAR ECONOMY

WP1:Evaluation and demonstration of Urine derived fertilisers in field trials

WP2: Loganholme Biosolids Gasification Project

- WP 2 funded by industry partners:

PYROCAL

LOGAN WATER

CITY OF LOGAN

UniSQ Project Team

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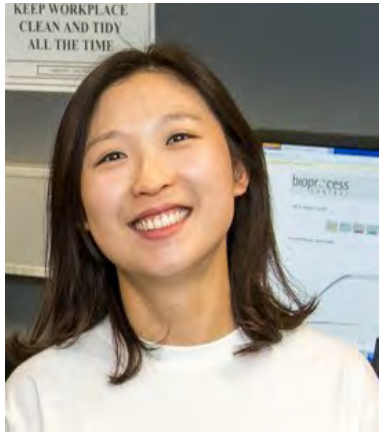
Mr Tim Johnson



Ms Seonmi Lee (PhD student)

Project Scope and objectives

1. Understand the effect of conversion technology on nutrients and heavy metals content and mobility in the by-product

    a. Potential risk due to heavy metals release into soil
    b. Phosphorus leaching in soil treated with by-product

2. Determine the suitability of the by-product (biochar) as a fertiliser

    a. Nutrient availability of N, P and K from by-product to soil
    b. Study agronomic value of biochar as a fertiliser in glasshouse and field trials

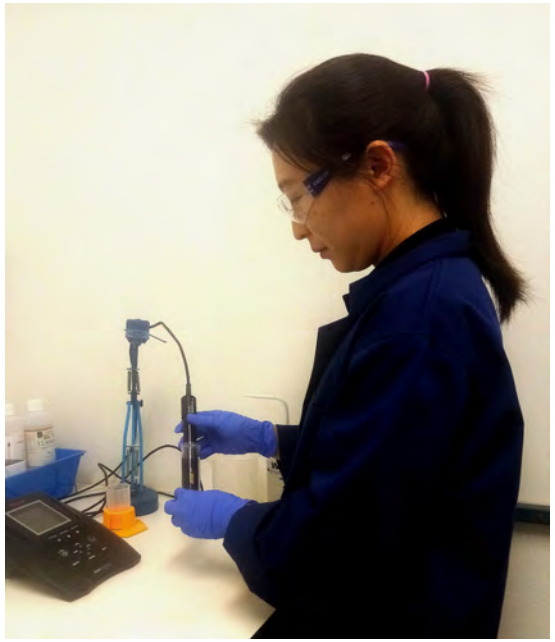
Overview of Project Activities

1. Laboratory analysis all materials for nutrient content
2. Leaching and incubation laboratory study to preliminary assess nutrients release characteristics of used biochar
3. Glasshouse experiment
4. Field scale experiment over 3 years
5. Develop guidelines for efficient and safe use of biochar as a fertiliser/soil amendment

1. Laboratory analysis of materials

Biosolids

Biochar



Laboratory analysis of raw materials

Image source: UniSQ research

Characteristics of raw biosolids and biochar

Properties	Units	Biosolids	Biochar	Maximum allowable Contaminant concentration
pH	-	6.9	8.3	
EC	dS/m	8.86	1.05	
Total C	%	38.6	32.1	
Total N	%	6.2	4.7	
Total P	%	5.6	7.8	
Soluble P	g/kg	7.13	0.13	
Total Zn	mg/kg	891	1300	2500
Soluble Zn	mg/kg	1.64	0.23	
Total Cu	mg/kg	257	307	2000
Soluble Cu	mg/kg	0.04	0.02	
Total Cr	mg/kg	67	93	500
Soluble Cr	mg/kg	0.36	0.02	

2. Incubation laboratory study and leaching tests

Incubation experiment

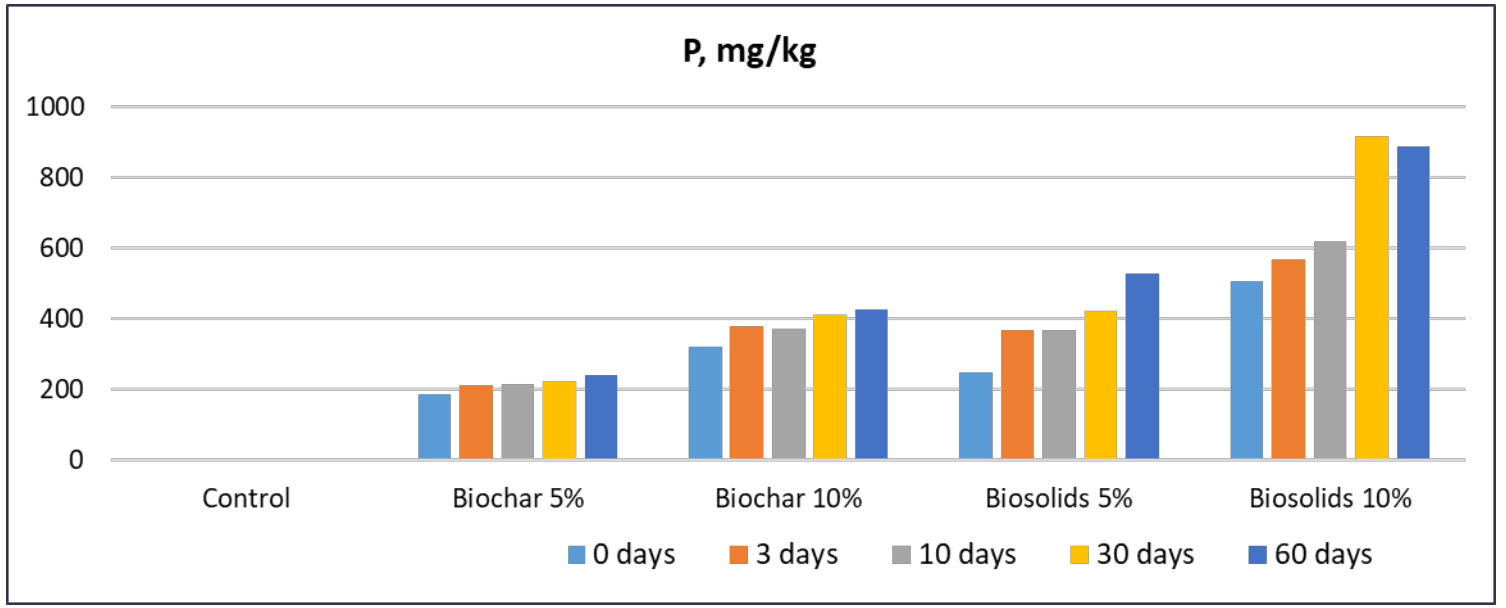
To monitor release of phosphorus and heavy metals from biosolids and biochar into soil under elevated temperature condition

Leaching experiment

To determine phosphorus and heavy metal leachability from biosolid and biochar under elevated moisture condition

Results: Incubation experiment

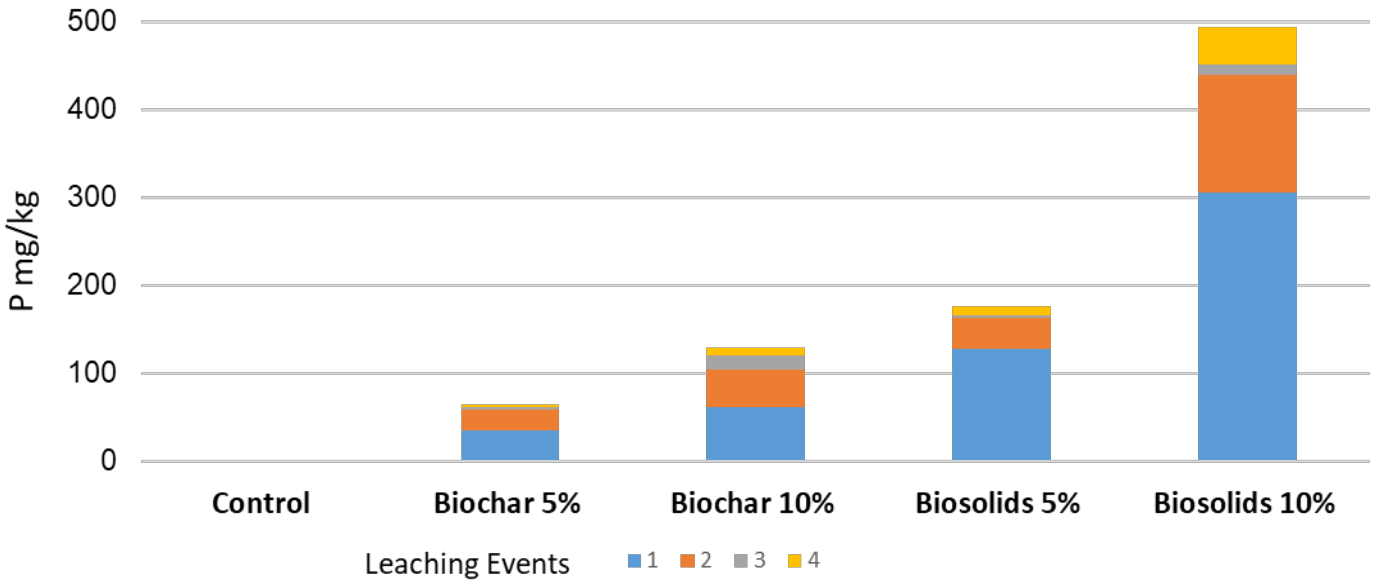
Phosphorus



Sample ID	0 days	3 days	10 days	30 days	60 days
Control	6	3	3	0	0
Biochar 5%	187	213	217	222	243
Biochar 10%	320	380	372	411	425
Biosolids 5%	248	368	369	425	530
Biosolids 10%	507	568	620	917	887

Results: Leaching experiment - P availability

Cumulative amount of phosphorus leached after 60 days of experiment

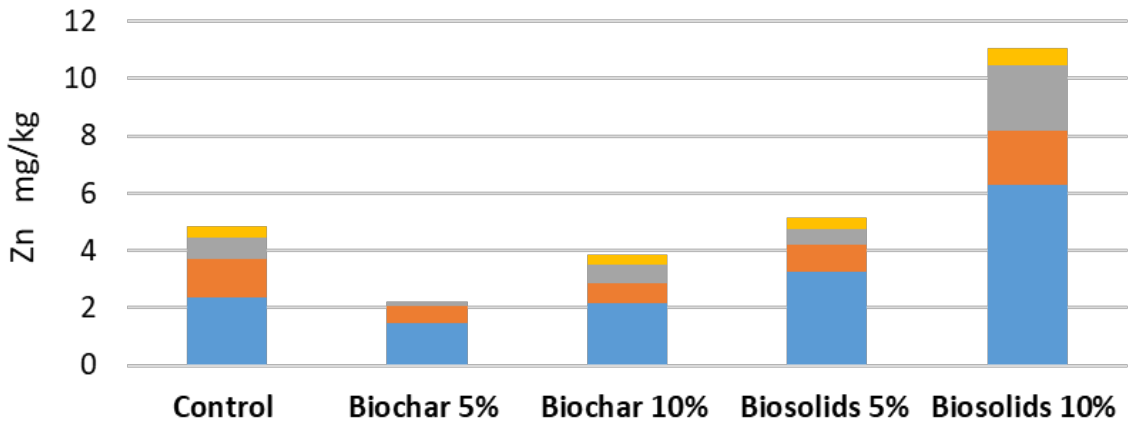


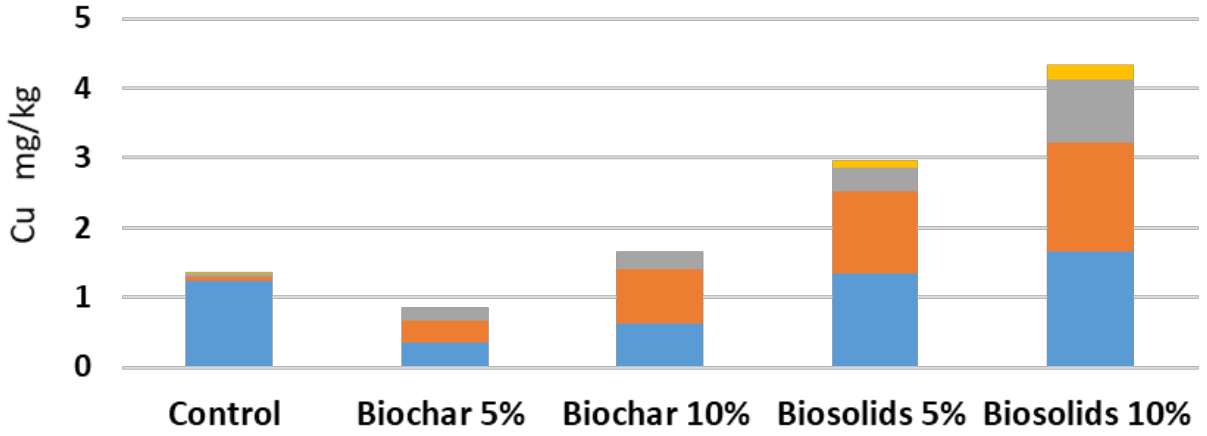
Leaching phosphorus (mg/kg of soil) for each sampling events

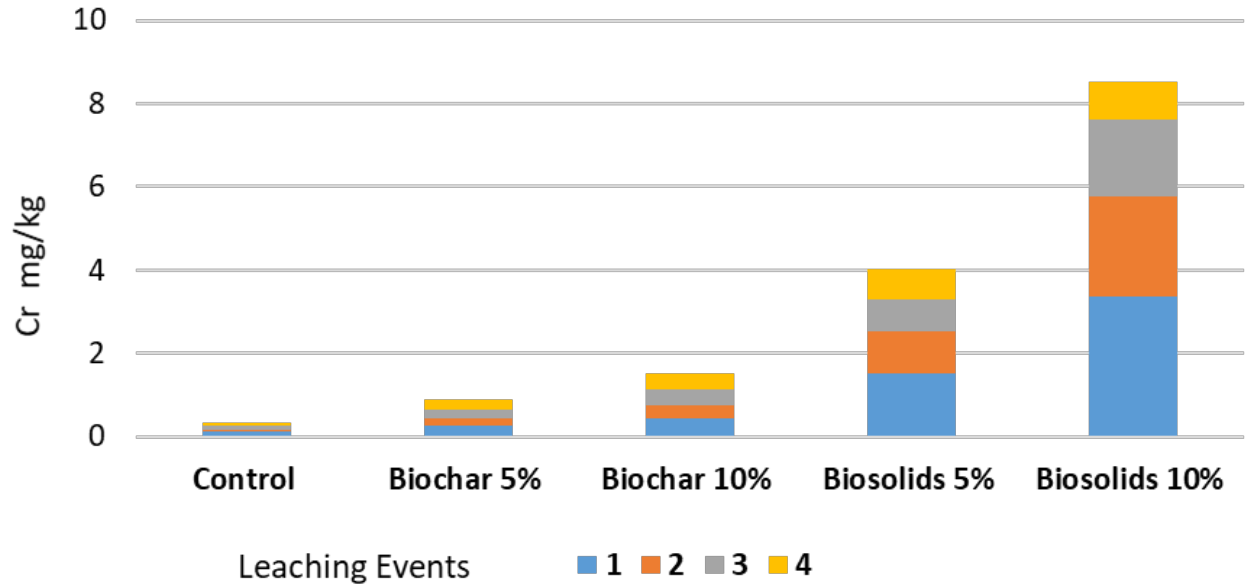
Leaching Events	Control	Biochar 5%	Biochar 10%	Biosolids 5%	Biosolids 10%
1	0.1	35	61	127	305
2	0.1	24	42	36	134
3	0.1	3	17	2	11
4	0.2	3	9	12	43

Results: Leaching Experiment – Heavy Metals

Cumulative amount of zinc, copper and chromium leached after 60 days of experiment







3. Glasshouse Experiment and Field Trial

To evaluate the biosolids derived biochar as a replacement of phosphorous fertiliser

To determine the fertiliser replacement value of biochar derived from biosolids in a winter wheat crop (yield)

Methods: Glasshouse Experiment

Application Rates

Monopotassium phosphate (P=22.5%)

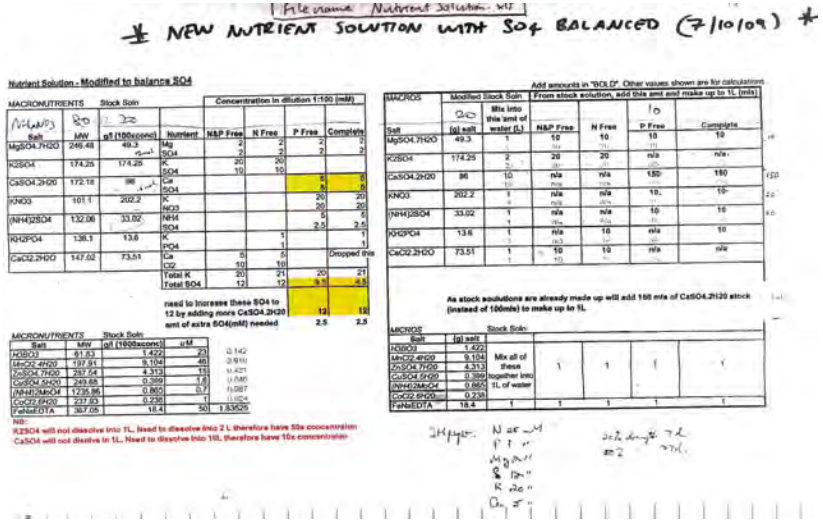
P, kg/ha	g/pot
0	0.00
20	0.05
40	0.11
80	0.21
250	0.67

Biochar (P+7.8%)

P, kg/ha	g/pot
40	0.31
80	0.62
120	0.93
250	1.93
350	2.70

Enrichment of soil with P-free nutrient basal solution prior to experiment.

Plants emergence



Composition of the nutrient solution

Methods: Field Trial

Field-scale trial winter cropping 2023

Location

Soil - non-cracking Red Ferrosol

Soil samples ID	Depth	pH	EC	Ammonia, mg/kg	Colwell Ph, mg/kg	Available K, mg/kg	Cl, mg/kg	CEC, meq/100g	Clay, %
1	0-15	5.0	0.06	5	7	92	7	12.2	52
	15-30	5.1	0.07	8	0	50	7	13.3	55
2	0-15	5.4	0.05	8	3	74	5	12.4	52
	15-30	5.6	0.06	7	0	36	5	13.5	53
3	0-15	5.6	0.05	7	0	60	5	10.8	53
	15-30	5.4	0.04	7	0	37	5	11.9	56

Methods: Field Trial

Trial plot configuration and application rates

Treatments:

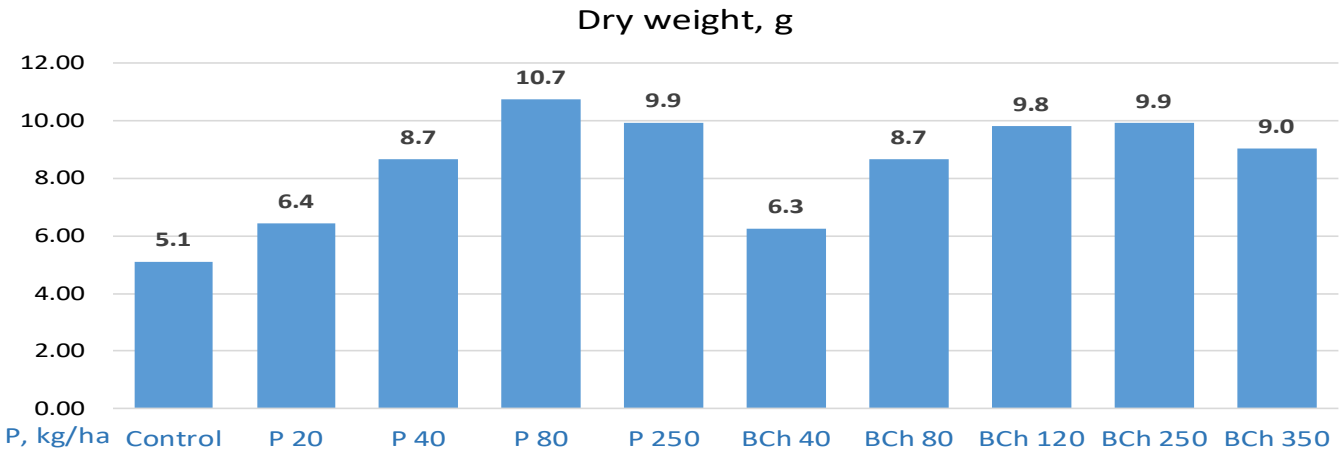
Treatment Code	*Treatment*	*total N* (kg/ha)	*N Urea* (kg/ha)	*N organic* (kg/ha)
1	Control	0	0	0
2	Urea	140	140	0
3	Biosolids	140	0	140
4A	Biochar 70	70	0	70
4B	Biochar 140	140	0	140
4C	Biochar 210	210	0	210
4D	Biochar Control	0	0	0
5A	Biochar&Urea 70	210	70	140
5B	Biochar&Urea 140	280	140	140
5C	Biochar&Urea 210	350	210	140
5D	Biochar&Urea Control	0	0	0

Trial plot layout 2023-24 with randomised design

P12(5C)	P24(5B)	P36(5D)
P11(5A)	P23(4C)	P35(1)
P10(4A)	P22(3)	P34(2)
P09(Blank)	P21(4B)	P33(4D)
P08(4A)	P20(5C)	P32(5A)
P07(1)	P19(4D)	P31(Blank)
P06S(2)	P18(4C)	P30(3)
P05(5B)	P17(4B)	P29(5D)
P04(5B)	P16(5D)	P28(1)
P03(4C)	P15(5C)	P27(Blank)
P02(3)	P14(4B)	P26(5A)
P01(2)	P13(4D)	P25(4A)

Results: Glasshouse Experiment I

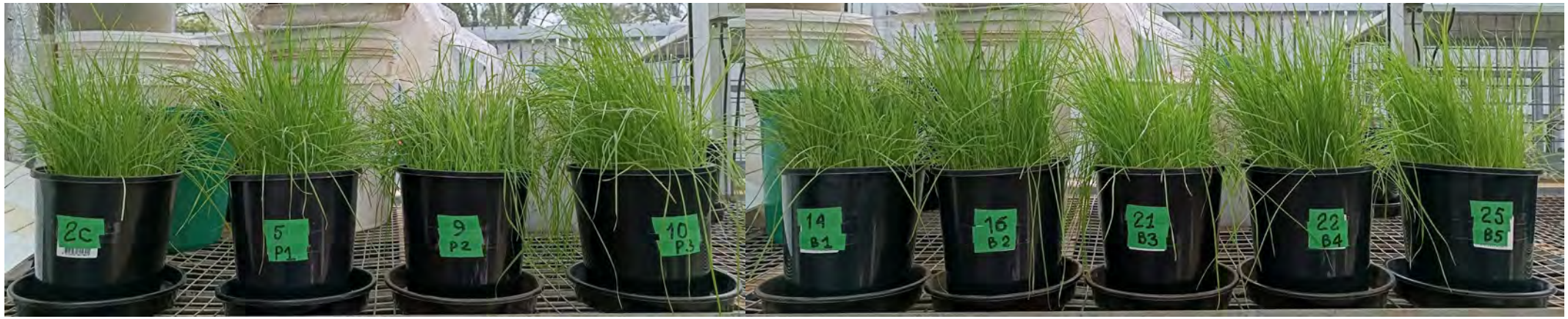
MP or Biochar, t/ha	0	0.09 MP	0.180 MP	0.36 MP	1.11 MP	0.51 Biochar	1.03 Biochar	1.54 Biochar	3.21 Biochar	4.49 Biochar



Colwell P in soil after harvest, mg/kg	7	13	21	29	43	15	25	33	54	69

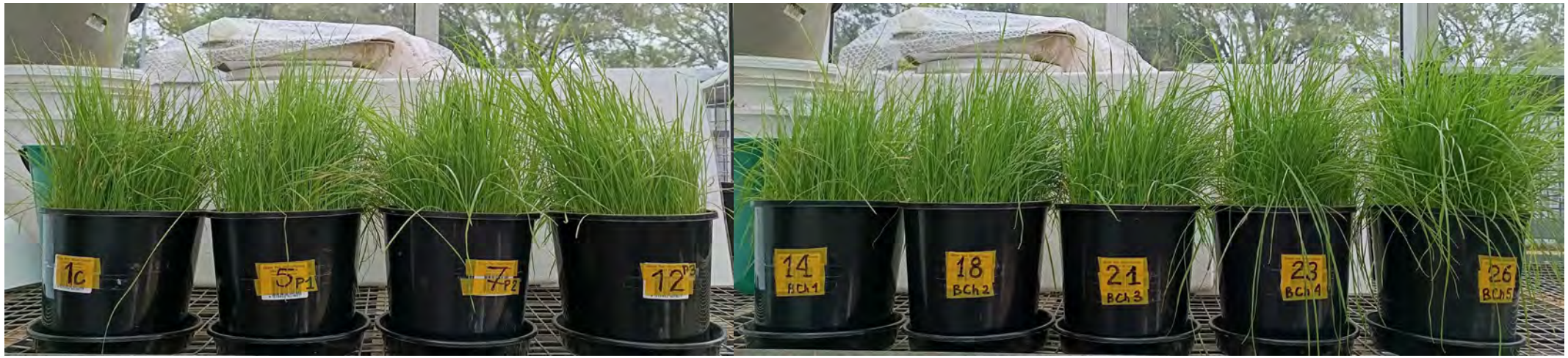
Results: Glasshouse Experiment II

Tenterfield granite loam



	Control	MP	MP	MP	Biochar	Biochar	Biochar	Biochar	Biochar
P, kg/ha	0	20	40	80	20	40	80	120	250
Material, kg/ha	0	89	178	356	256	513	1026	1538	3205

Gatton sandy loam



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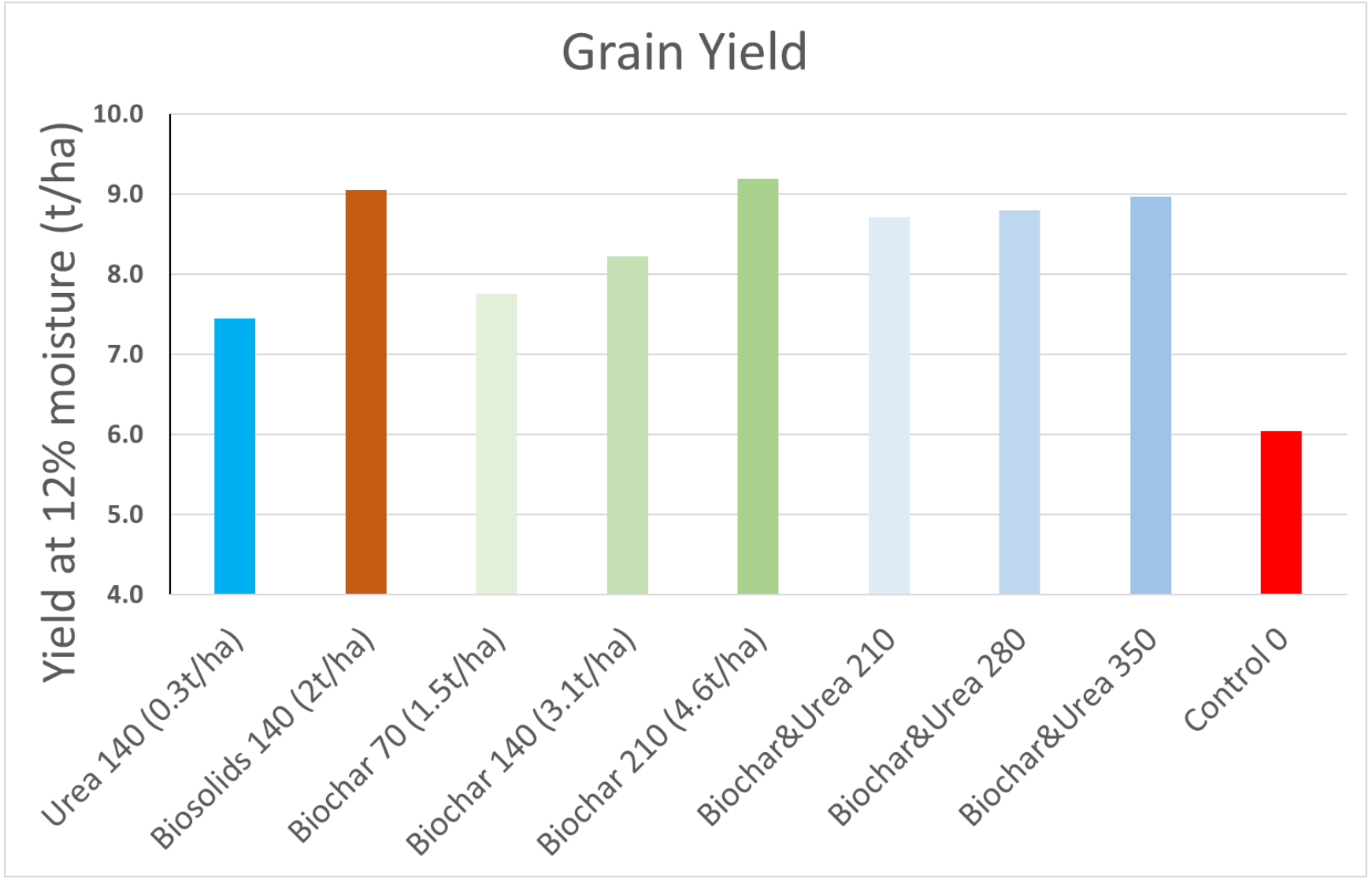
Results: Field Trial Yr 1



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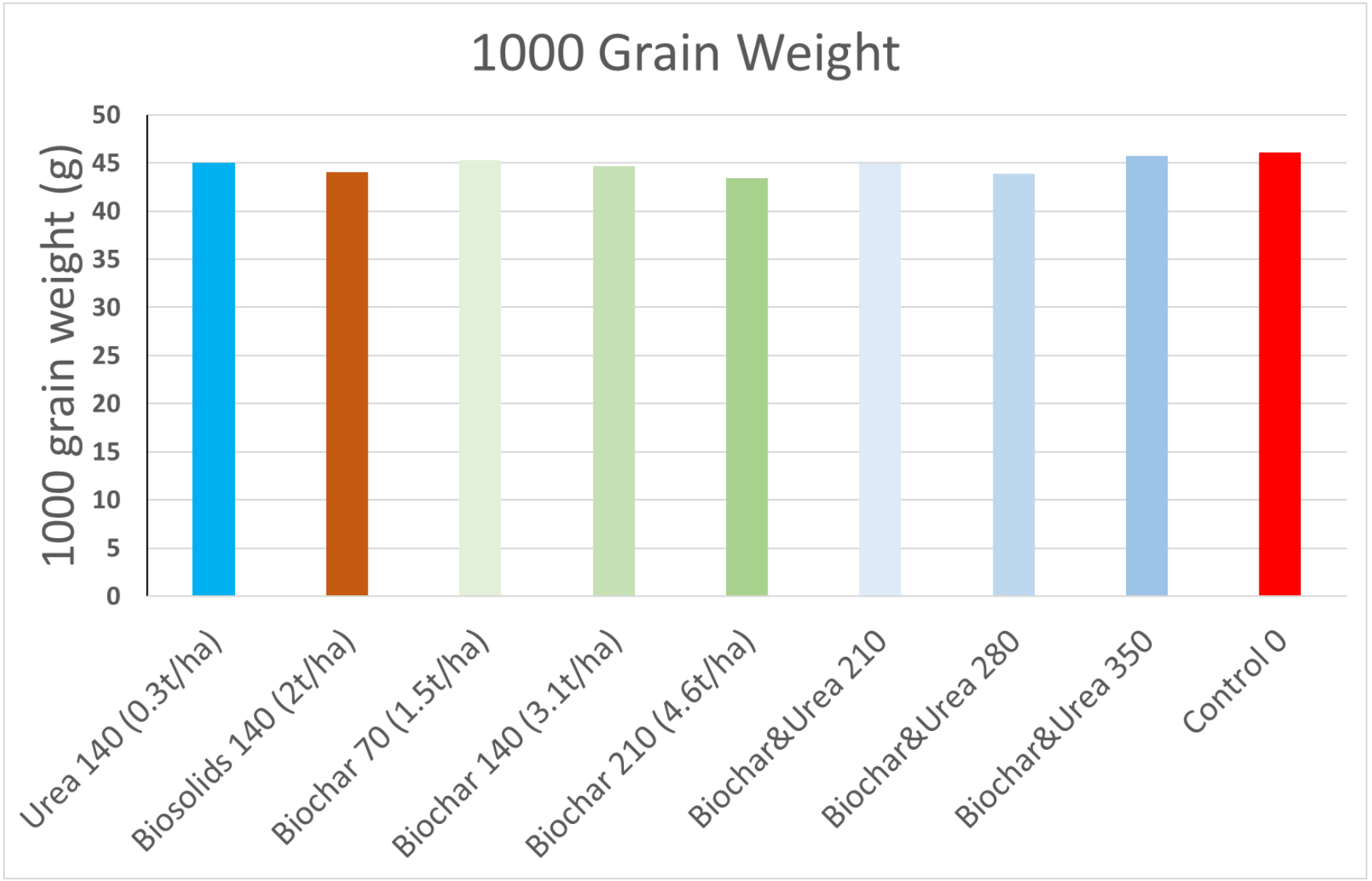
Results: Field Trial Yr 1



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Thank you

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