GOA Trial Site Report

Phosphorus carryover after a crop failure: implications for fertiliser rates in the following wheat crop, Trangie.

Grain Orana Alliance

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Trial code:	GONU02220-1
Season/year:	Autumn 2019-20
Location:	Gordon Park, Trangie
Trial partners:	Andrew Freeth
Trial establishment date:	2/10/2019

Keywords

GANU014, phosphorous, nutrition, Collwell P, drought, crop failure, carry over, residual nutrition, stratification

Key messages

- Phosphorous (P) applied during a drought was still available for the subsequent crop.
- P yield responses were surprisingly low, particularly given the crops' high yields and low starting P levels.
- High rates of MAP suppressed yields.

Background

The dry conditions of the 2017-2019 drought caused many crop failures in the central west of NSW, with the question arising around fertiliser strategies for the subsequent crops. With a crop failure, it is highly likely that only a small amount of the applied fertiliser is utilised. It could be that fertiliser may be available for the next crop and fertiliser rates could be reduced or none applied.

This logic is supported in old and current post drought fertiliser recommendations for phosphorous (P). Old rules of thumb recommended that farmers apply half the normal P rate following failed crops (where droughted crops produced little growth and yielding less than 0.5t/ha). More recent recommendations

are for a minimum of 5 kg P/ha be applied and more applied where the soil balance is below the critical thresholds[1].

These recommendations have been made on a very small number of research trials and discussion with several nutritional experts has indicated there is little field validation of these recommendations.

This topic was headlined in the discussion forum at the 2019 Dubbo GRDC Grower Update and has been endorsed at GOA's Local Research Update Meetings, where growers expressed the need for further clarification of optimal P rates following droughts.

When preparing for the 2020 crop, many farmers were considering their P requirements. The issue was raised as to how much P to apply after 2018 and 2019 failed crops. Growers were also looking to save on input costs after the low income, drought years.

Aims

- Validate current recommendations regarding P requirement following a drought year, either low yielding or crop failure, in terms of wheat yield and grain quality.
- Determine how much P rates may be reduced P in the subsequent crop.
- Qualifying the P carryover following crop failure in marginal yield environments.

Methodology

Trial design		
	Type	Small plot (~12m x 2 m)
	Design	Randomized split plot
	Replications	3
	Analysis	ASREML
	Confidence interval	95%

Site Selection:

This site was selected as it should have been P responsive. Soil testing (Table 1) revealed moderate levels of Colwell P in the topsoil, which declined to very low levels down the profile. Current research suggests that in red chromosol soil, a Colwell P of 30ppm is required to achieve 90% of maximum wheat grain yield[2].

[1] https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2020/03/budgeting-phosphorus-in-medium-and-lower-rainfall-zones-of-southern-nsw

[2] Balancing risk and reward with high phosphorus and nitrogen input costs - GRDC

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Table 1: Soil P

Location	Assay	Unit	0-10 cm	10-30 cm	30-60 cm	60-90 cm
Gin Gin	Phosphorus (Colwell)	mg/kg	21	5	<5	<5
Gin Gin	Phosphorus (BSES)	mg/kg	24	<5	<5	<5
Gin Gin	Phosphorus Buffer Index		67	62	100	140

Table 2. Trangie rainfall (2019 and 2020 versus long term average (LTA)).

Trangie rainfall													
Month	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	**TOTAL**
2019	58	17	18	0	19	6	10	3	5	2	20	2	**160**
2020	5	96	113	118	18	16	68	38	40	29	12	77	**630**
LTA	52	51	49	41	36	37	34	32	31	45	45	42	**495**

Treatments

Drought year (2019)

P applied on 2/10/2019:

- 4 rates of P (as MAP) 10, 20, 30, 40 kg/ha
- P applied using knife point, press wheel (KPPW) seeder, no seed sown
- untreated plots (UTC): 0 P.

Following year (2020)

P applied at sowing with seed using KPPW seeder:

- 5 rates of P (as MAP); 5, 10, 15, 20, 40 kg/ha
- untreated plots (UTC): 0 P.

Results

Yield:

There were very high yields at this site. Where P was applied in 2019, there was only a response in the 2020 crop detected where 20 kg P/ha was applied. However, when P was applied in 2020 there was a response to 15 kg P/ha and higher**.**

Application of 15 kg P/ha in 2020 improved yield over the UTC, however further increasing P rate did not increase yields. There was no additive effect statistically from topping up the 2019 rates with P in 2020.

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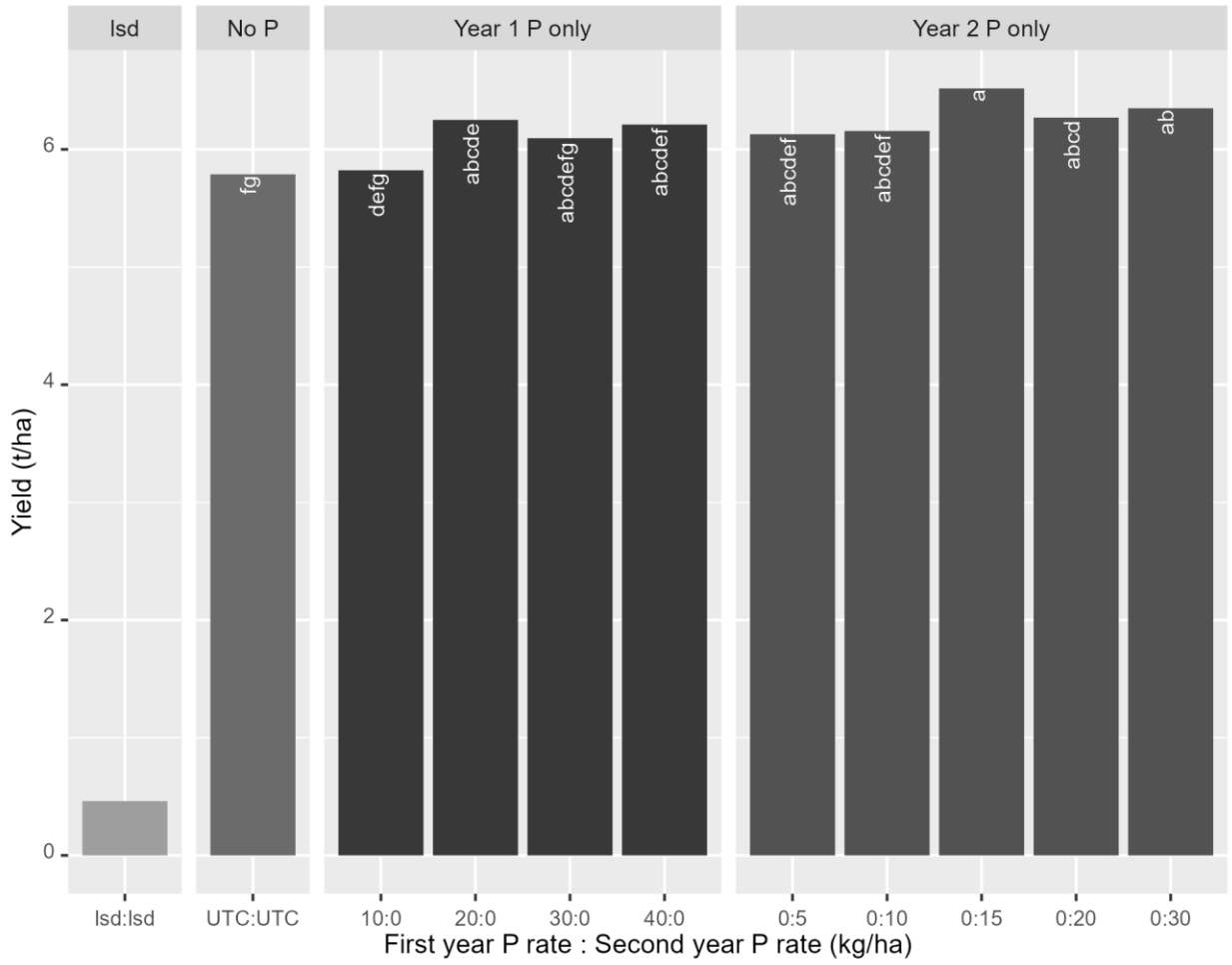

Figure 1: Wheat yield (t/ha) in 2020 for selected treatments. Treatments with the same letter are not significantly different.

Protein:

The protein levels at this site were high enough for all treatments to make Australian Prime Hard (APH), i.e. > 13% (Figure 2). There was a statistical trend for increasing P rates applied in 2020 to increase protein where no P was applied in 2019.

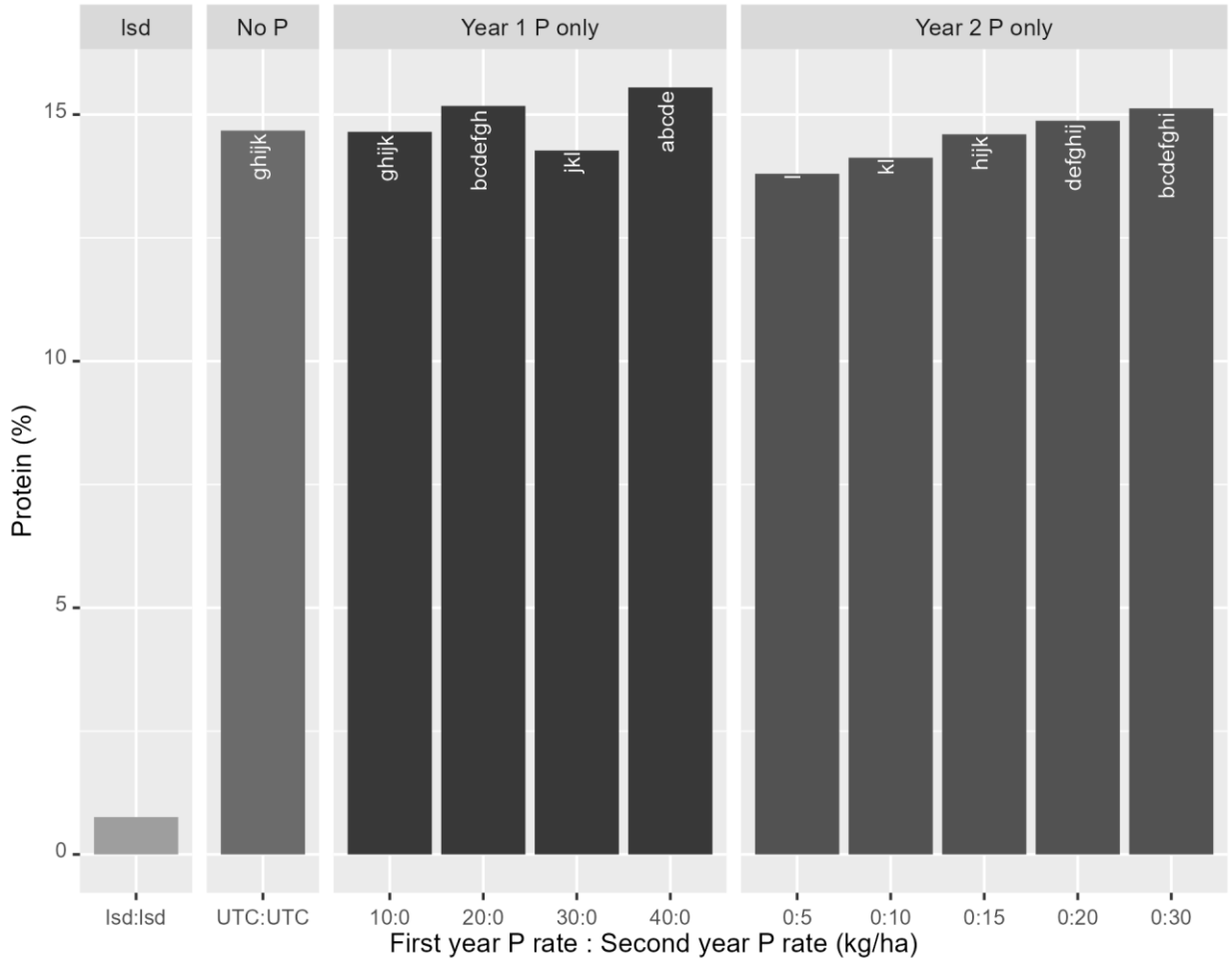

Figure 2: Wheat protein (%) in 2020 for selected treatments. Treatments with the same letter are not significantly different.

Discussion

High wheat yields were achieved in 2020, with an average site yield of 6.1 t/ha (Figure 1) and protein levels of 15% (Figure 2).

Conditions at this site in 2019 were too dry to allow for a crop to be sown, so the MAP was applied using a planter in October (Table 2).

Although the site was predicted to be responsive to P, only a few treatments resulted in yields higher than where no P was applied.

Application of 10 kg P/ha in 2019 only, did not result in any yield increase in the subsequent crop, whereas 20 kg P/ha did.

Application of 15 kg P/ha in 2020 improved yield over the UTC, however further increasing P rate did not increase yields. There was no additive effect statistically from topping up the 2019 P rates with extra P in 2020.

The P yield responses were surprisingly low, particularly given the crops' high yields and low starting P levels. This may indicate that a combination of mineralisation during the drought and the good seasonal conditions in 2020, allowing more P to be available to the plants and the plants being more effective at exploring the soil profile for P.

It did appear that in some cases application of high rates of MAP did suppress yields, mostly where 40 kg P/ha was applied in 2019 combined with rates in 2020 >10 kg P/ha (i.e. totals of 50 kg P/ha and above). Although these rates are not commercial, it may be worth monitoring crops sown on tramlines where P is drilled in the same slot every year.

The protein levels at this site would indicate that nitrogen was not a limiting factor as (all treatments would have made APH. The highest protein levels were achieved where high levels of P were applied in both years although these may not have been the most economic as there was no higher protein grade increment.

Conclusions

- Phosphorous applied during the drought, where no crop was established, was still available for the subsequent crop.
- Topping up P rates did not necessarily improve yields, however application of a small amount of P at sowing (~5 kg P/ha) is still recommended.

Acknowledgements

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Appendix

Results

Table 3: Trial results 2020

P rates									
Year 1	**Year 2**	**Yield**		**Test weight**		**Protein**		**Screenings**	
(kg/ha)		**(t/ha)**		**(kg/hl)**		**(%)**		**(%)**	
0	5	6.1	abcdef	74.6	ab	13.8	l	7.4	cde
	10	6.2	abcdef	74.9	a	14.1	kl	6.8	e
	15	6.5	a	74.7	ab	14.6	hijk	7.0	e
	20	6.3	abcd	74.0	abcd	14.9	defghij	8.4	bcde
	30	6.3	ab	74.0	abcd	15.1	bcdefghi	7.5	cde
10	0	5.8	defg	74.1	abcd	14.7	ghijk	7.9	bcde
	5	6.2	abcdef	74.6	ab	14.4	ijkl	7.5	cde
	10	6.2	abcdef	74.1	abcd	15.0	cdefghij	8.3	bcde
	15	6.0	bcdefg	74.7	ab	15.1	bcdefghij	7.5	bcde
	20	5.9	bcdefg	73.7	bcd	15.7	abc	7.6	bcde
	30	6.1	abcdefg	73.5	cde	15.6	abcde	8.1	bcde
20	0	6.3	abcde	73.5	de	15.2	bcdefgh	8.9	bcd
	5	6.2	abcdef	73.8	bcd	14.8	fghijk	8.0	bcde
	10	6.2	abcdef	73.7	bcd	15.2	bcdefgh	8.1	bcde
	15	6.3	abc	74.3	abcd	14.9	efghijk	7.6	bcde
	20	6.1	abcdefg	73.8	bcd	15.6	abcd	7.6	bcde
	30	6.0	bcdefg	73.7	bcd	15.5	abcdef	8.1	bcde
30	0	6.1	abcdefg	74.0	abcd	14.3	jkl	8.3	bcde
	5	6.2	abcdef	74.5	abc	15.4	abcdefg	7.2	e
	10	6.2	abcdef	74.0	abcd	15.4	abcdefg	7.6	bcde
	15	6.2	abcdef	73.5	cde	15.2	bcdefghi	8.3	bcde
	20	5.9	cdefg	73.3	de	15.6	abcd	9.1	bc
	30	6.1	abcdefg	73.8	bcd	15.3	abcdefgh	8.2	bcde
40	0	6.2	abcdef	74.1	abcd	15.6	abcde	7.4	de
	5	6.2	abcdef	73.6	bcde	15.2	bcdefgh	9.2	b
	10	5.8	efg	73.7	bcd	16.0	a	8.3	bcde
	15	5.8	fg	73.7	bcd	15.6	abc	7.6	bcde
	20	5.9	cdefg	73.7	bcd	15.0	bcdefghij	8.4	bcde
	30	5.7	g	73.9	abcd	15.7	ab	7.5	bcde
UTC	UTC	5.8	fg	72.5	e	14.7	ghijk	11.5	a
lsd	lsd	0.5		1.1		0.8		1.7	