

## Phosphorus carryover after a crop failure and the implications for phosphorus rates in the following wheat crop.

Grain Orana Alliance

2022-12-08

**Trial code:** GONU02220-3  
**Season/year:** Autumn 2019-20  
**Location:** Roseneath, Tottenham  
**Trial partners:** Gordon Larkins  
**Trial establishment date:** 9/07/2019

### Keywords

GANU022, phosphorous, nutrition, Collwell P, drought, crop failure, carry over, residual nutrition, stratification, Tottenham

### Key findings

- Phosphorous applied during a drought was still available for the subsequent crop, even where a crop was established.
- Halving the rate in the subsequent crop did not result in yield reductions.
- In a very low P site, more than 20 kg P/ha (regardless of timing) was required.
- Consider the implications on longer term yields of very low P paddocks.

### Background

During the 2017-19 drought, many crops failed in central west of NSW. Post drought, growers and advisers often question fertiliser strategies for the next crop, as it is highly likely that only a small amount of the fertiliser was used by the failed crop. It is possible that some of that fertiliser may be available for the next crop and fertiliser rates could be reduced or none applied.

There are both old and current post-drought fertiliser recommendations for phosphorous (P). Older rules of thumb recommended that farmers “apply half the normal P rate following a failed crops (where

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droughted crops produced little growth and yielding less than 0.5t/ha”<sup>1</sup>. More recent recommendations state that “one third of average crop P replacement can be applied down to a base level of not less than 5 kg P/ha in low yielding environments” and more where the soil levels are below the critical thresholds (35-42 mg P/kg)<sup>2</sup>.

The above recommendations have been made on a small number of research trials and discussions with several nutritional experts have also indicated there is little in field validation of these rules of thumb.

This topic headlined the discussion forum at the 2019 Dubbo Grains Research and Development Corporation (GRDC) Grower Update and has been endorsed at Grain Orana Alliance’s (GOA) Local Research Update Meetings, where growers expressed the need for further clarification of optimal phosphorus rates following droughts. The issue was raised as to how much P to apply in 2020, given the 2018 and 2019 crops failure with minimal nutrient export in grain from these crops. As droughts are typically low-income years, growers were also looking to save money wherever possible.

## Aims

- Validate current recommendations regarding P requirement following a drought year (either low yielding or crop failure) in terms of yield and grain quality.
- Determine by how much a farmer might be able to reduce P following a failed crop.

## Methodology

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

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<sup>1</sup> Edwards, J., and Roberts, K. 2006. Soi-Phosphorous after drought. NSW DPI

<sup>2</sup> <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>

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## Site Selection:

This site was selected because it should be responsive. Soil testing (Table 1) showed that the topsoil had critically low levels of Colwell P and was below detection levels deeper in the profile.

**Table 1:** Soil P

Location	Assay	Unit	0-10 cm	10-30 cm	30-60 cm	60-90 cm
Tottenham	Phosphorus (Colwell)	mg/kg	10	<5	<5	<5
Tottenham	Phosphorus (BSES)	mg/kg	13	7	7	5
Tottenham	Phosphorus Buffer Index		45	59	66	79

## Treatments

### Drought year (Year 1 (Y1))

P applied on 9/07/2019 sowing:

- 4 rates of P (as MAP); 10, 20, 30, 40 kg/ha. Crop sown and P drilled with seed
- untreated plots (0 P)
- conditions at this site in 2019 were very dry, and the crop was terminated in September 2019.

### Subsequent year (Year 2 (Y2))

P applied at sowing on 23/04/2020:

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

The N component of the MAP was balanced with urea.

**Table 1:** 2020 Tottenham rainfall and long-term average (LTA).

Month	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	TOTAL
<b>2020</b>	6	91	141	119	23	48	56	56	27	40	17	60	684
<b>LTA</b>	52	51	49	41	36	35	34	32	32	45	45	42	494

## Results

### Yield:

The highest yields were achieved where the highest rates applied in both years, i.e 60-70 kg P/ha, increased yields by >0.85t/ha.

- Where no P was applied in Y1, yields peaked where 20 kg P/ha was applied in Y2.
- Where 10 kg P/ha was applied in Y1, yields peaked where 15 kg P/ha was applied in Y2.
- Where 20 kg P/ha was applied in Y1, yields peaked where 5 kg P/ha was applied in Y2.
- Where 30 kg P/ha was applied in Y1, yields peaked where 5 kg P/ha was applied in Y2.
- Where 40 kg P/ha was applied in Y1, application of more P in Y2 did not increase yields.

### Halving the rate in Yr2

- Across all rates tested, halving the rate in Y2 yielded similar to maintaining the rate across both years.

### No P in Y1

- Yield maximized where 20 kg/ha P was applied in Y2, approximately 0.45 t/h better than where no P was applied in either year.

### 10 kg/ha P applied in Y1

- Yield was maximized where 15 kg/ha was applied in Yr2, approximately 0.44 t/h better than where only 10 kg/ha applied in Y1, and none in Y2.

### 20 kg/ha P applied in Y1

- Yield was maximized where 20 kg/ha was applied in Yr2, approximately 0.61 t/h better than where only 20 kg/ha applied in Y1, and none in Y2.

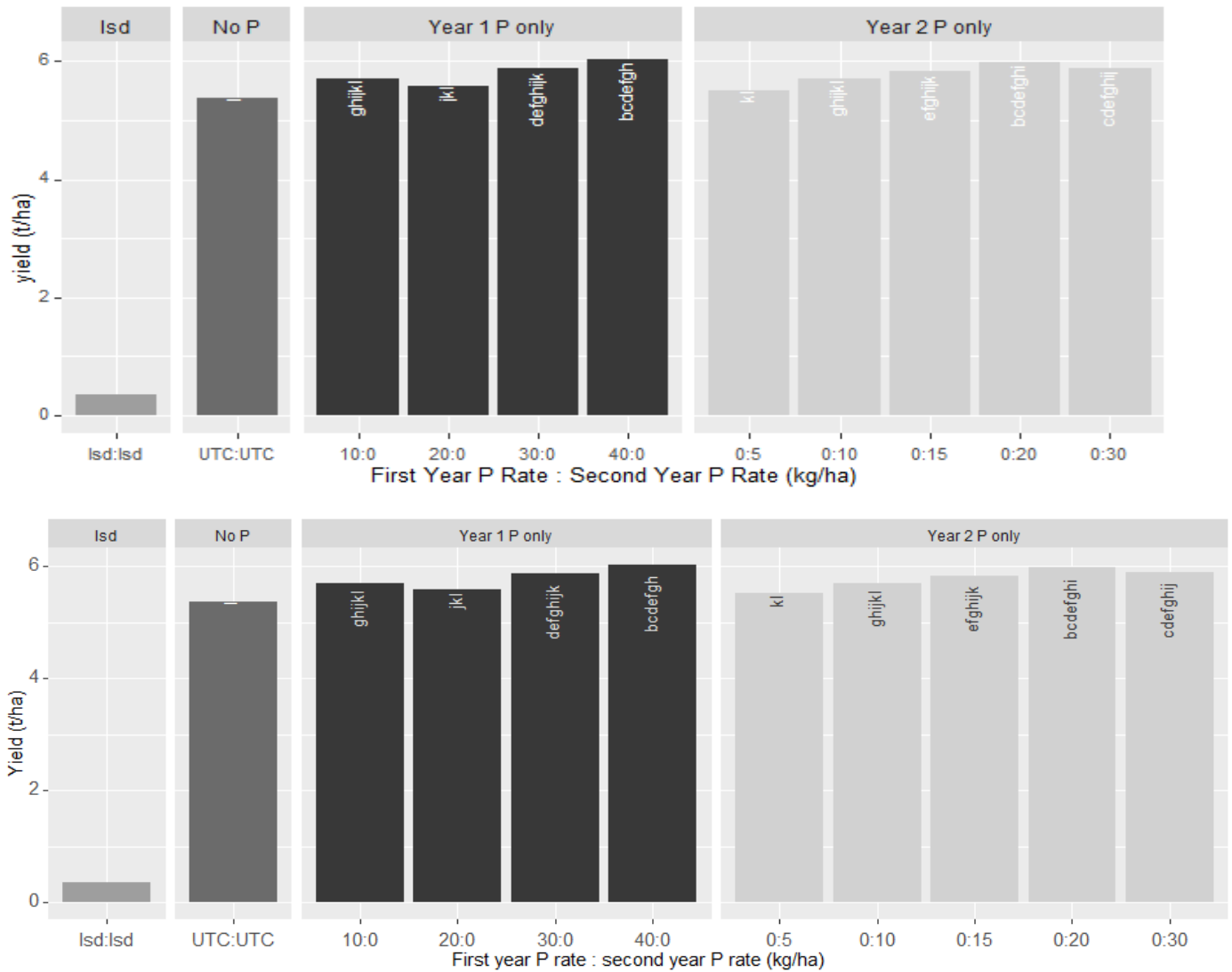
### 30 kg/ha P applied in Y1

- Yield was maximized where 30 kg/ha was applied in Yr2, approximately 0.56 t/h better than where only 30 kg/ha applied in Y1, and none in Y2.

### 40 kg/ha P applied in Y1

- Application of P in Y2 did not result in increased yields when 40 kg/ha P was applied in Y2.

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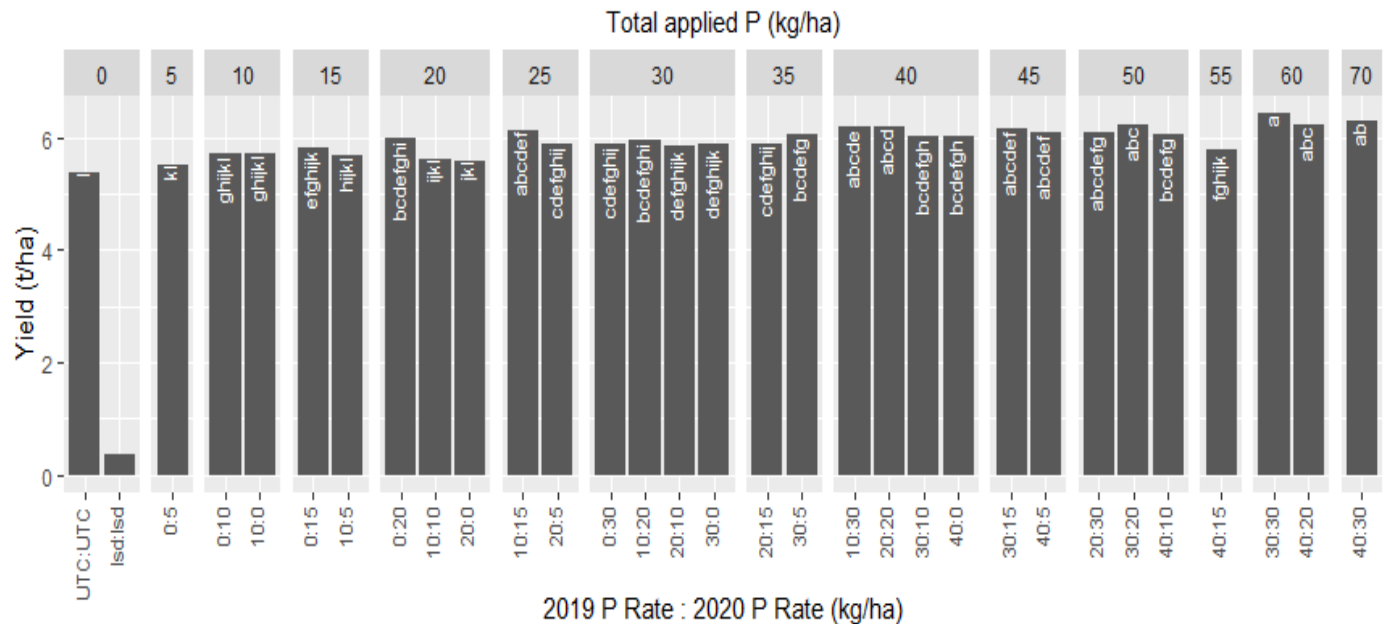


**Figure 1:** Wheat yield (t/ha) in 2020 where P was applied in only one year (either 2019 or 2020). Treatments with the same letter are not significantly different.

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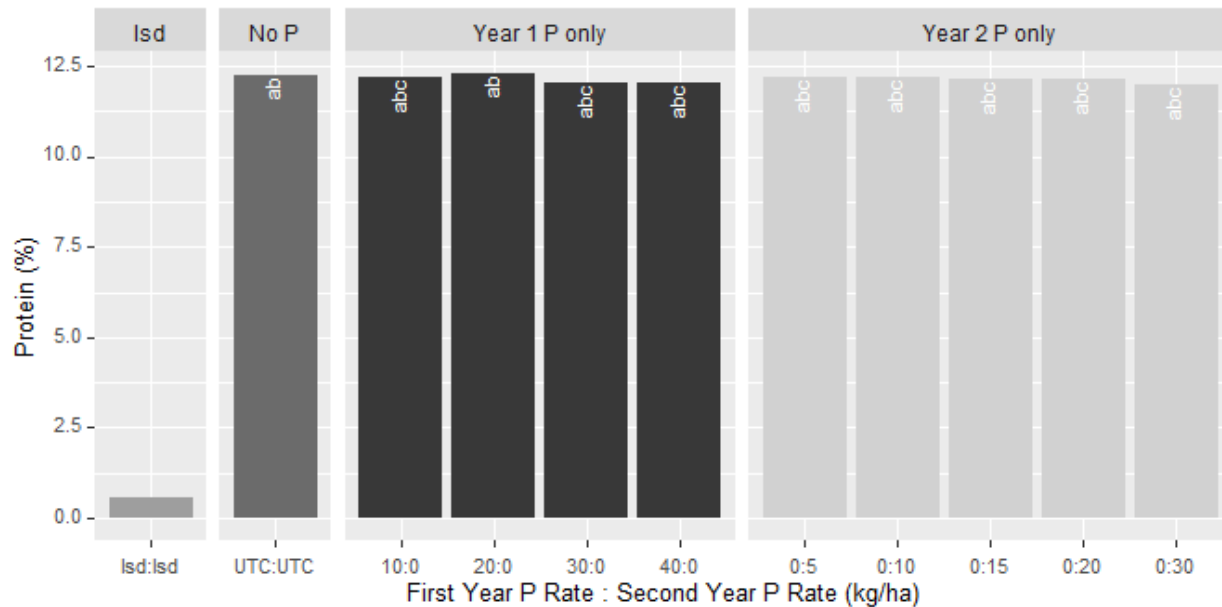
**Figure 2:** Wheat yield (t/ha) in 2020 by P rate (kg/ha). Treatments with the same letter are not significantly different.



**Figure 3:** Wheat yield (t/ha) in 2020 by total P (kg/ha). Treatments with the same letter are not significantly different.

## Protein:

- There were no treatment effects on protein.



**Figure 4:** Wheat protein (%) in 2020 where no P was applied in either 2019 or 2020. Treatments with the same letter are not significantly different.

## Discussion

Rainfall for 2020 was well above average (Table 1), resulting in a high yielding wheat crop. The average site yield was 6 t/ha (Figure 1) and average protein levels were 12%. Crop P removal ranged from 16-19 kg/ha (based on 3 kg/t removal in grain<sup>3</sup>).

This site had very low background levels of P, with Colwell P of 10 ppm in the 0-10 cm soil layer, even after an extended dry period with mineralisation potential. Not surprisingly the site was very P responsive with over 1 t/ha difference between the best yielding treatment and the untreated.

Halving the application rate in the year following the drought did not result in lower yields than where the same rate was used in the drought year. However, as there was very low background P (and high yield potential) yield was possibly forgone where a total rate of 20 kg P/ha or less was applied (regardless of when).

There was benefit topping up the P in the subsequent crop, except for where very high levels of P were applied in the drought year (~40 kg P/ha). The highest yield was achieved where the highest total rates of

<sup>3</sup> [GRDC-GrowNotes-Canola-Northern.pdf](https://grdc.com.au/__data/assets/pdf_file/0029/240887/GRDC-GrowNotes-Canola-Northern.pdf)

[https://grdc.com.au/\\_\\_data/assets/pdf\\_file/0029/240887/GRDC-GrowNotes-Canola-Northern.pdf](https://grdc.com.au/__data/assets/pdf_file/0029/240887/GRDC-GrowNotes-Canola-Northern.pdf)

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P were applied (Figure 3). This is likely to be an artefact of the very low starting soil P combined with an exceptional season.

The question could be raised whether a big upfront investment in P (say similar to that of lime to adjust pH) may be warranted, as P could be limiting and yield foregone in high yielding seasons until background levels are improved.

## Conclusions

- Phosphorous applied during a drought was still available for the subsequent crop, even where a crop was established.
- Halving the rate in the subsequent crop did not result in yield reductions.
- In a very low P site, more than 20 kg P/ha (regardless of timing) was required.
- Consider the implications on longer term yields of very low P paddocks.

## Acknowledgements

The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the (GRDC), the authors would like to thank them for their continued support. Special thanks go out to Gordon Larkins who hosted this trial.

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## Appendix

### Results

Table 2: Trial results 2020

Phosphorous rates									
2019	2020	Yield		Test weight		Protein		Screenings	
(kg/ha)	(kg/ha)	(t/ha)	(t/ha)	(kg/hl)	(kg/hl)	(%)	(%)	(%)	(%)
0	5	5.5	kl	78.9	bcdefg	12.2	abc	1.6	abcd
	10	5.7	ghijkl	78.5	fg	12.2	abc	1.6	abcd
	15	5.8	efghijk	79.2	abcdef	12.1	abc	1.5	d
	20	6.0	bcdefg hi	79.1	bcdefg	12.1	abc	1.6	abcd
	30	5.9	cdefghi j	78.9	bcdefg	12.0	abc	1.6	abcd
10	0	5.7	ghijkl	78.7	efg	12.2	abc	1.7	abcd
	5	5.7	hijkl	79.4	abcde	12.0	abc	1.6	abcd
	10	5.6	ijkl	78.9	bcdefg	12.2	ab	1.7	abcd
	15	6.1	abcdef	79.3	abcde	11.6	c	1.7	abcd
	20	6.0	bcdefg hi	79.4	abcde	11.9	abc	1.7	abcd
	30	6.2	abcde	79.4	abcde	11.9	abc	1.4	d
20	0	5.6	ijkl	79.2	abcdefg	12.3	ab	1.5	bcd
	5	5.9	cdefghi j	78.7	efg	11.6	c	1.7	abcd
	10	5.8	defghij k	78.9	bcdefg	11.7	bc	1.5	cd
	15	5.9	cdefghi j	78.8	cdefg	12.4	a	1.8	abc
	20	6.2	abcd	79.1	abcdefg	11.9	abc	1.7	abcd
	30	6.1	abcdef g	79.1	abcdefg	12.1	abc	1.9	a
30	0	5.9	defghij k	78.3	g	12.0	abc	1.8	ab
	5	6.0	bcdefg	79.0	bcdefg	11.9	abc	1.6	abcd
	10	6.0	bcdefg h	78.6	efg	12.4	a	1.8	ab
	15	6.2	abcdef	79.2	abcdefg	11.8	bc	1.5	bcd
	20	6.2	abc	79.7	ab	11.9	abc	1.7	abcd
	30	6.4	a	79.6	abcd	11.8	bc	1.7	abcd
40	0	6.0	bcdefg h	79.4	abcde	12.0	abc	1.6	abcd
	5	6.1	abcdef	78.8	defg	12.0	abc	1.7	abcd
	10	6.0	bcdefg	79.3	abcdef	11.9	abc	1.7	abcd
	15	5.8	fghijk	79.0	bcdefg	12.2	abc	1.7	abcd
	20	6.2	abc	79.6	abc	11.9	abc	1.5	d
	30	6.3	ab	79.9	a	11.8	abc	1.7	abcd
UTC	UTC	5.4	l	78.4	fg	12.2	ab	1.8	abc
lsd	lsd	0.4		0.9		0.6		0.3	