

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

Grain Orana Alliance

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<b>Trial code:</b>	GONU02220-4
<b>Season/year:</b>	Autumn 2019-20
<b>Location:</b>	Condo Park, Condobolin
<b>Trial partners:</b>	Rob Neal
<b>Trial establishment date:</b>	17/10/2019

### Keywords

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

### Key findings

- Phosphorous (P) applied during the drought in previous years was available for the following crop.
- The site was very P responsive, with over 1 t/ha difference between the highest yielding and the untreated treatment.

### Background

The drought conditions of the 2017-2019 caused multiple crop failures in central west NSW, leading to questions around fertiliser strategies for the subsequent crops. With a crop failure, it is highly likely that only a small amount of the applied fertiliser that year was used and the remainder should be available for the next year's crop allowing for reduction of fertiliser rates or even none applied.

This logic is supported in old and current post drought fertiliser recommendations for P. Old rules of thumb recommended half the normal P rate be applied following failed crops (i.e. crops that produced little growth and yielded <0.5 t/ha)<sup>1</sup>. More recent recommendations state that "one third of average crop

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

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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>.

These recommendations have been made based on a 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 Grains Research and Development Corporation (GRDC) Grower Update and has been endorsed at Grain Orana Alliances (GOA) Local Research Update Meetings, where growers wanted 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 in the subsequent crop.
- Qualifying the P carryover following crop failures in marginal yield environments.

## Methodology

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

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<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 should have been P responsive. Soil testing (Table 1) showed moderate Colwell P levels in the topsoil, which declined to very low levels further down the profile. Current research suggests that a Colwell P in red chromosols of 30 ppm is required to achieve 90% of maximum wheat grain yield<sup>3</sup>.

**Table 1:** Soil P

Location	Assay	Unit	0-10 cm	10-30 cm
Condobolin	Phosphorus (Colwell)	mg/kg	17	<5
Condobolin	Phosphorus (BSES)	mg/kg	22	<5
Condobolin	Phosphorus Buffer Index		63	91

**Table 2:** Rainfall for Condobolin in 2019 and 2020 and long-term average (LTA).

Month	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	TOTAL
<b>2019</b>	13	38	15	0	16	16	19	6	4	2	12	5	<b>146</b>
<b>2020</b>	17	113	109	124	7	43	46	59	48	36	40	27	<b>669</b>
<b>LTA</b>	49	43	43	32	35	33	36	34	32	48	44	40	<b>469</b>

## Treatments

### Drought year, 2019 – Year 1 (Y1).

Phosphorus applied on 2/10/2019:

- 4 rates of P (as MAP); 10, 20, 30, 40 kg/ha (balanced with urea)
- crop not sown (too dry), sowing simulated using plot seeder
- P applied using knife point press wheel (KPPW) seeder
- untreated plots (0 P).

### Subsequent year, 2020 – Year 2 (Y2).

Phosphorus applied at sowing:

- 5 rates of P (as MAP); 5, 10, 15, 20, 40 kg/ha (balanced with urea)
- P applied using knife point press wheel (KPPW) seeder
- untreated plots (0P)
- 90 kg/ha nitrogen (N) applied at sowing as urea, 90 kg/ha N applied in crop as UAN.

<sup>3</sup> [Balancing risk and reward with high phosphorus and nitrogen input costs - GRDC](#)

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## Results

### Yield:

There was a yield response to P. The highest yielding treatment had more than 1.5 t/ha more yield than where no P was applied. 20 kg P/ha applied in Y2 yielded 0.55 t/ha more than where 20 kg P/ha was applied in Y1.

- Application of 5 kg P/ha in Y2 yielded similar to the highest rate of P (40 kg/ha) applied in Y1 (Figure 1).
- Halving the P rate in Y2 did not reduce yields (when compared to applying the same rate in both years).
- Reducing the P rate in Y2 to 5 kg P/ha did not reduce yields (when compared to applying the same rate in both years)
- Applying no P in Y2 did result in a lower yield where a low rate of P was applied in Y1

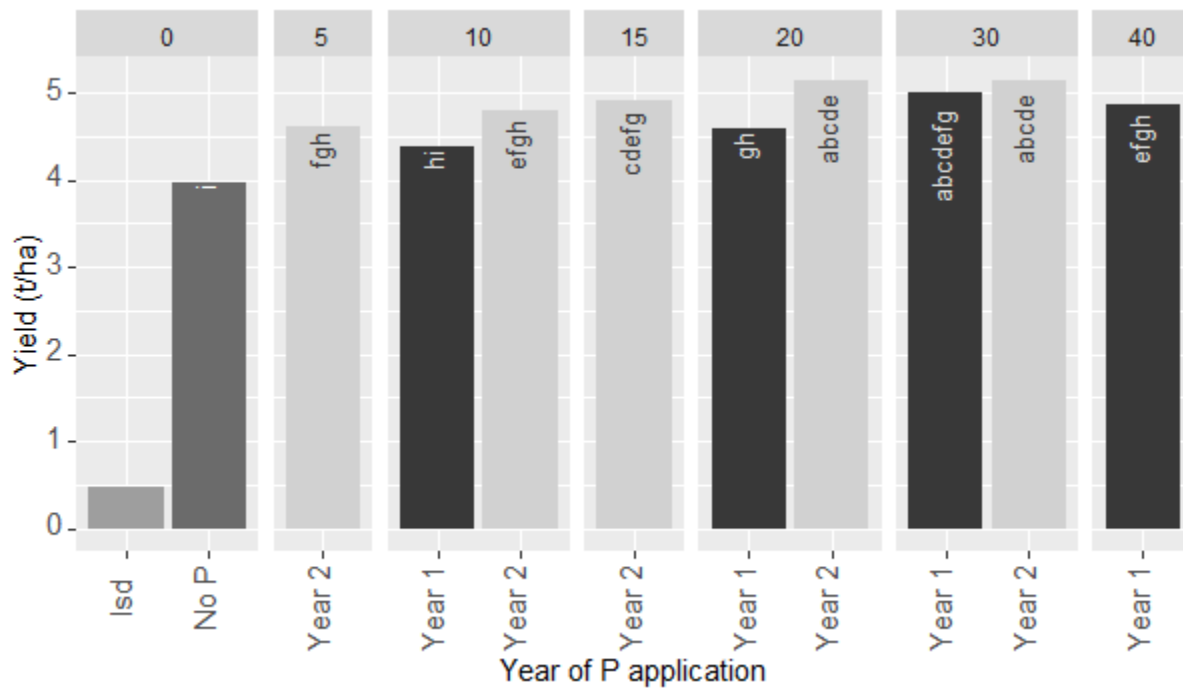
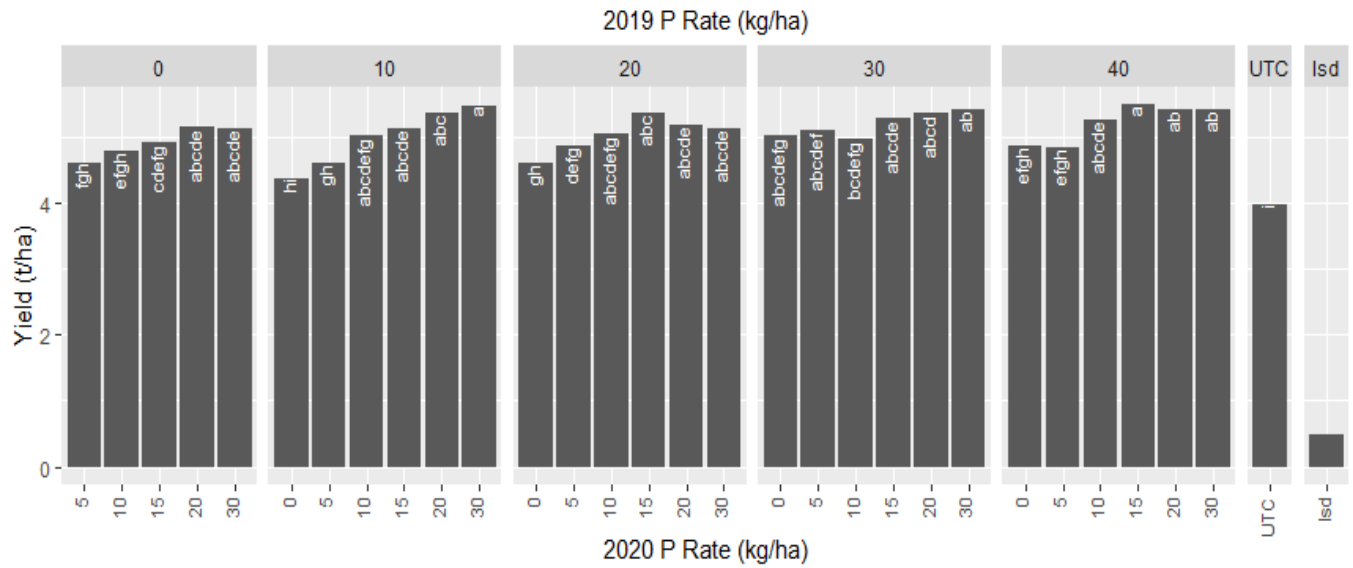
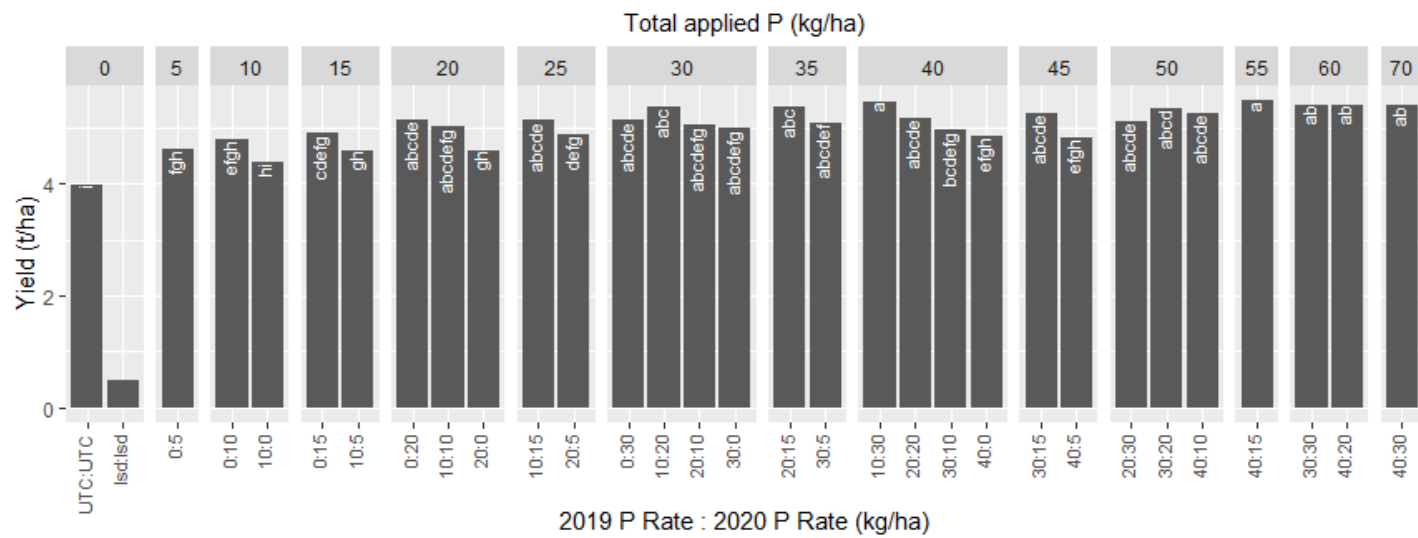


Figure 1: Wheat yield (t/ha) in 2020 where no P was applied in either Year 1 (2019) or Year 2 (2020). Treatments with the same letter are not significantly different.

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



There was little effect on screenings, protein or test weight.

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## Discussion

The 2020 crop was high yielding averaging 5 t/ha (Figure 1) across the site, with average protein levels of 12% (Figure 4). Crop P removal ranged from ~12-16 kg/ha (based on 3 kg/t removal in grain<sup>4</sup>).

Prior to sowing, this site was flooded by local runoff on several occasions and may have been underwater for some time (1-2 days). This may have affected the availability of P (and the N component of the MAP, note that all the N component of MAP was balanced with urea). In addition, 90 kg/ha urea was applied at sowing and a further 200 kg/ha UAN in August.

This site had very low background levels of P, with Colwell P of 17 ppm in the 0-10 cm soil layer. Not surprisingly the site was very P responsive with over 1 t/ha difference between the best yielding treatment and the untreated.

There was a benefit to applying additional P in 2020, following the drought conditions of 2019. The exception was where very high levels of P were applied in the previous drought year (~30 kg P/ha).

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. Neither did reducing the P rate in Y2 to 5 kg P/ha. 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).

The highest yields were with the highest total P rates (50 kg/ha) and greater (Figure 3). This is likely due to the very low starting soil P levels. When looking at the total P over the 2 years, yields increased as the portion P applied in 2020 increased (Figure 3), a good example of this is where a total of 40 kg/ha was applied, a ratio of 10 and 30 in 2019 and 2020 respectively out-yielded by 0.5 t/ha the inverse ratio (i.e. 30 and 10 in 2019 and 2020 respectively).

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

## Conclusions

- Phosphorous applied during the drought was still available for the following crop, although there may be events that reduce its availability (i.e. such as flooding).
- Halving the rate in the subsequent crop did not result in yield reductions Reducing the application rate to 5 kg P/ha for the subsequent crop did not reduce yields.
- Consider higher fertiliser rates in very low P paddocks until critical levels are reached to maximise yields in very good seasons.

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<sup>4</sup> [GRDC-GrowNotes-Canola-Northern.pdf](https://grdc.com.au/data/assets/pdf_file/0029/240887/GRDC-GrowNotes-Canola-Northern.pdf)

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## Appendix

### Results

Table 3: Trial results 2020

P rates									
2019	2020	Yield		Test weight		Protein		Screenings	
(kg/ha)		(t/ha)		(kg/hl)		(%)		(%)	
0	5	4.6	fgh	78.4	abcdefg	12.1	bc	2.7	ghi
	10	4.8	efgh	78.9	abc	12.1	bc	3.0	defghi
	15	4.9	cdefg	78.5	abcdefg	12.6	ab	3.8	abcdefg
	20	5.1	abcde	78.7	abcde	12.4	abc	3.5	abcdefg
10	30	5.1	abcde	78.9	abc	12.4	abc	3.3	bcdefghi
	0	4.4	hi	77.5	h	12.3	abc	4.0	abcd
	5	4.6	gh	78.5	abcdef	12.4	abc	4.0	abcde
	10	5.0	abcdefg	78.9	abc	12.6	ab	3.2	cdefghi
	15	5.1	abcde	78.5	abcde	12.3	abc	3.2	bcdefghi
20	20	5.4	abc	79.1	ab	12.6	ab	2.9	fghi
	30	5.5	a	78.4	abcdefg	12.5	ab	3.7	abcdefg
	0	4.6	gh	78.2	bcdefgh	12.4	abc	3.6	abcdefg
	5	4.9	defg	78.7	abcd	12.4	abc	3.5	abcdefg
	10	5.0	abcdefg	78.3	abcdefg	12.5	abc	3.2	cdefghi
30	15	5.4	abc	78.6	abcde	12.4	abc	3.0	defghi
	20	5.2	abcde	78.6	abcde	12.3	abc	3.0	efghi
	30	5.1	abcde	79.1	a	12.6	ab	2.5	hi
	0	5.0	abcdefg	79.0	abc	12.1	abc	3.2	bcdefghi
	5	5.1	abcdef	78.4	abcdefg	12.6	ab	3.2	bcdefghi
40	10	5.0	bcdefg	77.7	fgh	12.5	ab	4.3	ab
	15	5.3	abcde	77.9	efgh	12.7	a	4.2	abc
	20	5.4	abcd	78.5	abcdefg	12.6	ab	3.5	abcdefg
	30	5.4	ab	78.6	abcde	12.5	abc	3.4	bcdefghi
	0	4.9	efgh	77.9	defgh	12.5	ab	3.7	abcdefg
UTC	5	4.8	efgh	78.6	abcde	12.3	abc	3.6	abcdefg
	10	5.3	abcde	78.3	abcdefg	12.7	a	3.8	abcdefg
	15	5.5	a	79.1	a	12.6	ab	2.4	i
	20	5.4	ab	78.0	cdefgh	12.7	a	4.4	a
	30	5.4	ab	78.2	cdefgh	12.5	ab	4.2	abc
UTC	UTC	4.0	i	77.7	gh	11.9	c	3.9	abcdef
Isd	Isd	0.5		0.9		0.5		1.0	