GOA Trial Site Report

Phosphorous placement and its effect on establishment and performance of canola

Trail Code: GONU00619-9

Season/year: Winter 2019

Location: Gilgandra

Collaborators: Kevin and John Kilby

Keywords

GONU006, phosphorus, deep banding, IBS, canola, germination, establishment, P rate, Gilgandra

Take home messages

In soils with low phosphorus (P), canola is likely to show yield responses to added P fertiliser.

Placement of fertilizer with seed can impact germination, even at lower P rates. Where possible growers should consider alternative placement or compensate by adjusting seeding rate.

In dry seasonal conditions, placement of P below the seed is likely to provide the greatest yield benefit, followed by placement with the seed.

A 'split' application, where some P applied with the seed and some on the surface, is likely to be a good option for growers who do not have machinery able to place P below the seed and warrants further research.

Background

Phosphorus (P) is an important nutrient in canola production at two key stages; establishment to support root development and during biomass accumulation.

Traditionally, P has only been applied at planting and often is banded in close proximity to the seed. This approach is based on the belief that P is relative immobile in the soil and needs to be placed close to developing crop root systems.

Damage to establishing crops by placing starter fertiliser close to seed is known. Trials in 2013 conducted by NSW Department of Primary Industries[1] demonstrated significant reductions in canola establishment with increasing rates of P (up to 20 kg/ha). Yields also increased with increasing rates of P despite suppression in emergence. A consequence of adverse effect on establishment is the unpredictability and variability of the canola stand, which makes targeting an ideal seeding rate difficult if not impossible. If the effect on establishment is more than predicted, very poor stands may eventuate, and crop yield can be greatly impacted.

Increasing seeding rate can compensate for establishment losses. However, this strategy can be costly and does not necessarily improve ability to aim for a specific plant density.

[1] https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/02/Canola-agronomy-research-in-central-west-NSW

The dilemma remains that canola crops require P to optimise yields. However, placing P with the seed can lead to significant issues. There is little or no research investigating alternate placement options for applying P fertiliser to canola crops.

Some modern seeding machines possess the ability to band fertiliser below the seed. There is also the opportunity with any sowing equipment to broadcast fertiliser P either pre or post seeding. This trial is designed to investigate if application of P using these alternate methods could avoid canola damage at establishment while maintaining a positive P fertiliser response.

Aims

Determine if varying placement and rate of P fertiliser can reduce negative impacts on establishment, while maintaining P yield responsiveness of canola.

Methods

The trial was a small plot, factorial randomised block design with three replicates established in Autumn 2019.

The following treatments were tested

- **Rates:** Three rates of P in the form of mono ammonium phosphate (MAP) were applied at 10, 20 and 40 kg/ha of P. These were compared to a control where no P was applied.
- **Placement:** P fertiliser was applied by using the following methods-
  - Below the seed - in a band approximately 6 cm below the soil surface and 4 cm directly below the seed, applied in the same pass
  - With the seed - banded with the seed in the same pass
  - IBS - Broadcast onto the soil surface prior to seeding to be incorporated by the seeder (IBS)
  - Broadcast - on the soil surface post planting with no incorporation
  - Split - base rate of 10kg/ha P with seed and the balance via IBS (only at 20 and 40 total P rates)
  - Control – no P applied, but all application methods used.

Table 1. Trial site details

Trial Establishment Date	Autumn 2019	**Seeding rate**	2.5 kg/ha
Crop and Variety	Canola – BONITO	**Harvest Date**	29/10/2019
Sowing date	26/4/2019	**Row Spacing**	27.5 cm
Seedling equipment	Double Boot Tyne	**Soil type**	Sandy Clay Loam
Nitrogen Crop Nutrition Urea (kg/ha)	60 IBS	**Previous Crop**	Barley
Site Nutrition: Colwell P	0-10 cm: 24 ppm 10-30 cm: 9 ppm	**Pre-Sowing Stubble Management**	Direct drilled

Results were analysed using ANOVA for the analysis of variance and results compared by using a least significant difference (LSD) method with a 95% confidence interval. Any references to differences between treatments should be assumed to be statistically different unless otherwise stated.

Results

A table of the full results is contained in Appendix 1 at the end of the document.

Plant Establishment: Average population was 16.4 plants/m^2. Placement of P with seed reduced plant population by 22%, 55% and 67% respectively where 10, 20 and 40 kg P/ha was placed with seed compared to control (no applied P) **Figure 1**.

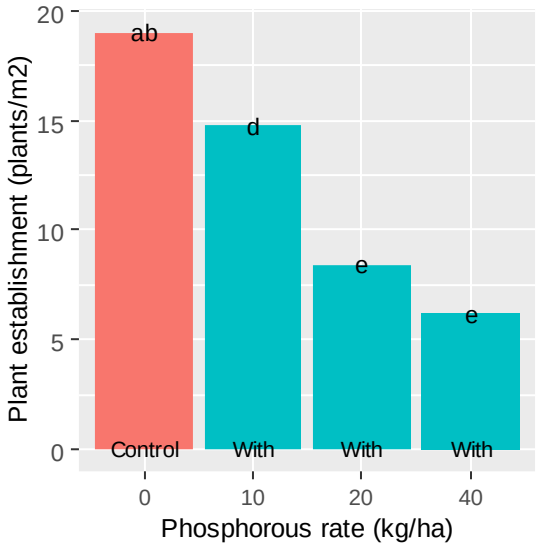

Figure 1. Plant establishment (plants/m^2) for 'control' and 'with' placement treatments, Gilgandra 2019.

Yields: Average trial yield was 0.77 t/ha. 'IBS' and 'With' showed no yield gains over the nil P control. Fertiliser P applied 'Below', 'Split' and 'Post plant' all had significantly better yields than control (and 'With' and 'IBS'). P rate yield response (regardless of fertiliser placement), at all rates were greater than Control (though not different from each other). (**Figure 2**).

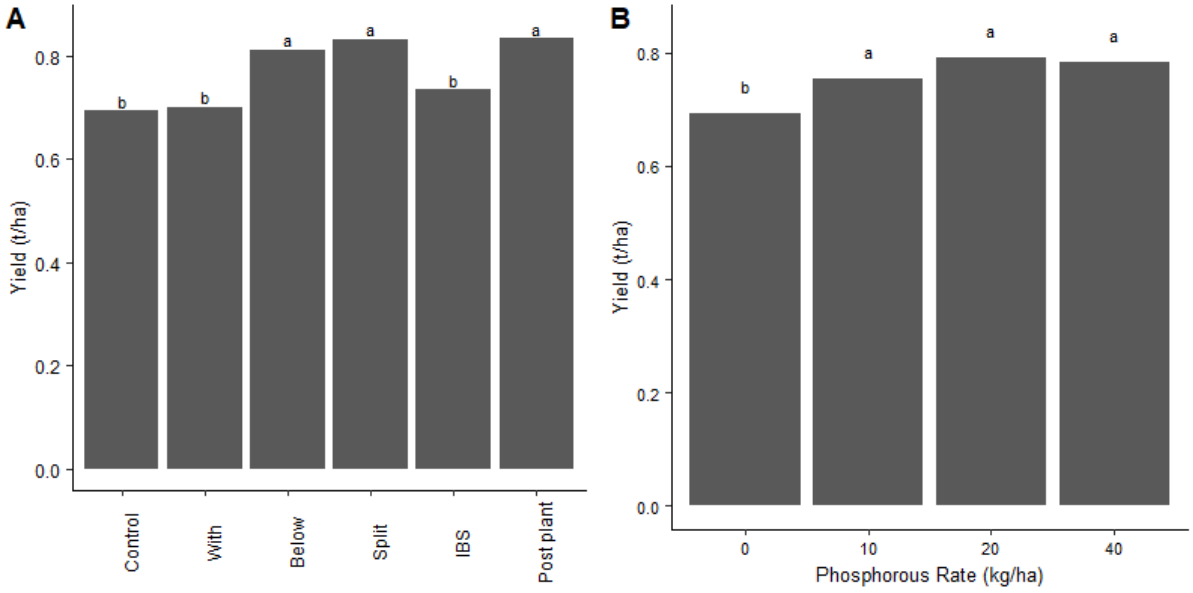

Figure 2. Yields (t/ha) for the various 'Placement' options (A) and four application rates (B).

Looking at the interaction between placement and rate (Figure 3), yields in the '40 With" treatment was the same as the control and significantly lower than all other treatments. The post plant treatment was also better than the with treatment at the 20kg P/ha rate (Figure 3).

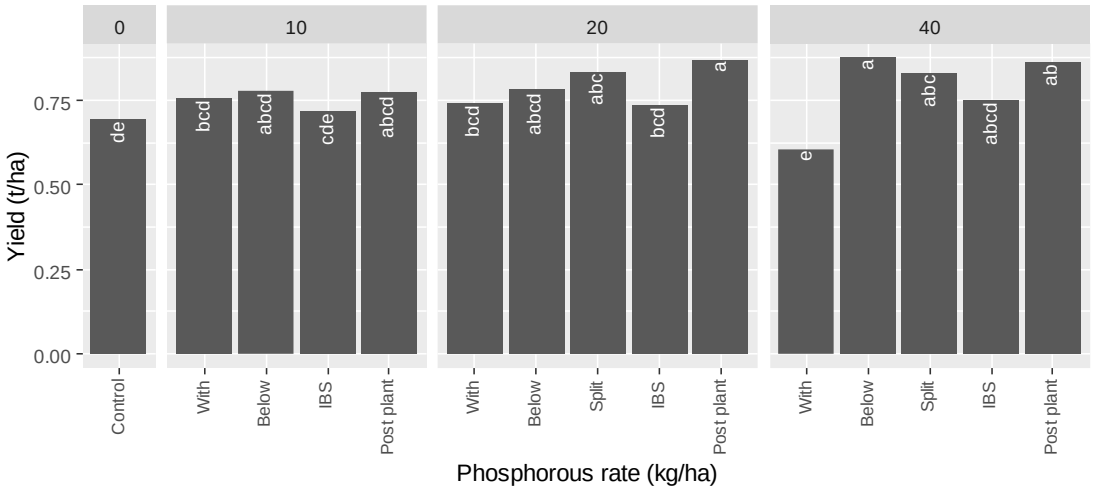

Figure 3. Yields (t/ha) for the phosphorous application placements and rates.

Oil %: There was no influence of P rate or placement on oil percentage.

Discussion

The site had low P levels; Colwell P of less than 25 ppm in the surface 10 cm layer and 9 ppm in the 10 – 30 cm soil layer. These levels of P allowed for significant yield responses to both P rate and P placement.

There was an impact on plant establishment by P placement with seed, at the highest rate this was a reduction of 67% when compared to the untreated control, and this carried through to yield. P placement by any other means (below, IBS, post planting or split application (with seed plus top-dress) did not affect germination.

Broadcasting P straight after sowing and placing P below the seed, tended to have the best overall yields, indicating that there was surface root activity. It is this characteristic that the split application is looking to exploit. In contrast the response where P was applied IBS was not always as strong, this may be because its P was displaced during sowing concentrating it between sowing rows.

Placement of P with seed is likely to be the main application method for many farmers in the GOA region. In this trial placement of fertilizer with seed, particularly at the higher P rate, clearly showed that alternative options are required. Where 40 kg/ha was placed with the seed, lack of yield response suggests that the crop was unable to recover and compensate for the reduced plant establishment.

Placement of P below seed was one of the best performing treatments. It is likely that deeper placement (4-6 cm below the seed) placed fertiliser P into soil where there was moisture for a longer period during the growing season, and hence allowed a longer access to the P source. Future study is postulated to see if an even deeper application would allow for even further yield gains.

Broadcast treatment, where P was evenly distributed on the surface also gave yield improvements. Perhaps this suggests a broader area from which canola can access P may also be effective (in contrast to bands). At this site (and in this season) optimal P rate for maximising production was about 20 kg/ha, however, this may not necessarily reflect the optimal economic return.

Testing of a Split P fertiliser treatment, where a basal rate is placed with seed and the remainder broadcast showed some promise in this trial. A basal rate of 10 kg/ha P with seed (the 'with' seed portion of the split treatment did effect germination by about 22%, however it did not affect final yields (when compared to other options). Spreading the remaining P portion of the split treatment prior to sowing (IBS) proved effective. It is hypothesised that this treatment may be an excellent option, as i. the lower rate reduces impact on germination, ii. The IBS portion is likely to supply the plants requirements in a dry season (where surface applied P may become inaccessible), iii. The surface applied P is likely to be available in higher yielding seasons when soil surface is moist for longer periods. There are likely to be sowing efficiencies when using lower fertilizer rates at sowing. Further trails looking at the potential benefit from 'split' P application are warranted.

Conclusion

In soils with low P, canola is likely to show yield responses to added fertiliser.

Placement of P fertilizer with seed can impact germination, even at lower rates. Where possible growers should consider alternative placement or compensate by adjusting the seeding rate.

In dry seasonal conditions, placement of P below the seed is likely to provide the most benefit, followed by placement with seed (though take note of comment above).

The option to split application between a P broadcast ahead of sowing and at sowing warrants more research.

Acknowledgements

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Appendix

Table 2. Impact of P rates and P placement on plant establishment and yield of canola. Results followed by the same letter are not significantly different (95%).

Phosphorous		Plant establishment		Yield		Admix		Protein		Test Weight		Oil	
Placement	Rate	(plants/m2)		(t/ha)		(%)		(%)	(%)	(kg/hl)		(%)	
	(kg/ha)	p.v.[1]	s1[2]	p.v.[1]	s1[2]	p.v.[1]	s1[2]	p.v.[1]	s1[2]	p.v.[1]	s1[2]	p.v.	s1
Control													
	0	19	ab	0.69	def	0.7	bc	21.6	a	62.9	ab	44.0	a
IBS													
	10	21	ab	0.71	cdef	0.8	abc	21.6	a	62.3	abc	43.7	a
	20	19	abcd	0.74	cde	0.9	abc	21.7	a	62.8	abc	43.7	a
	40	17	bcd	0.75	abcd	1.0	ab	21.5	a	62.9	abc	43.8	a
Split													
	20	15	cd	0.83	abc	0.8	abc	21.7	a	63.0	abc	43.7	a
	40	14	cd	0.83	abc	0.5	c	21.6	a	63.4	a	43.6	a
Below													
	10	18	abcd	0.78	abcd	0.7	bc	21.6	a	61.7	c	43.8	a
	20	17	bcd	0.78	abcd	1.2	a	21.5	a	61.9	bc	44.0	a
	40	22	a	0.87	a	0.6	bc	21.8	a	62.1	abc	43.7	a
With													
	10	15	d	0.75	cde	0.6	bc	22.0	a	62.5	abc	43.9	a
	20	8	e	0.74	bde	0.7	bc	21.4	a	62.7	abc	44.0	a
	40	6	e	0.60	f	1.0	ab	21.8	a	62.4	abc	43.9	a
Post plant													
	10	19	abc	0.77	abcde	0.9	abc	21.6	a	62.9	abc	44.0	a
	20	21	ab	0.87	a	0.6	bc	21.9	a	63.2	ab	43.6	a
	40	14	cd	0.86	ab	0.9	abc	21.9	a	63.2	ab	44.0	a
lsd													
	lsd	5		0.12		0.5		0.6		1.4		0.5	

[1] predicted value

[2] values with the same letter for each variable are not significantly different