GOA Trial Site Report

Phosphorous placement and its effect on establishment and performance of canola

Trail Code: GONU00620-1

Season/year: Winter 2020

Location: Wongarbon

Collaborators: Maurie Street

Keywords

GONU006, phosphorus, deep banding, IBS, canola, germination, establishment, P rate, Wongarbon.

Key findings

- Placement of P with seed, including as a split application, significantly reduced plant population.
- 10 kg/ha P as MAP was enough to negatively impact germination of up to 70%.
- Alternate options to place the fertiliser away from the seed often reduced these establishment penalties to ~45%
- Alternate placements did not reduce the crops response to the applied rates of fertiliser compared to the more traditional placement of fertiliser with the seed.

Phosphorus (P) is an important nutrient in canola production at 2 key stages - establishment for root development and during biomass accumulation.

Traditionally P has been applied at planting and often is banded in closely to the seed. The theory being that P is relatively immobile in the soil and needs to be adjacent to developing root systems.

Damage to establishing canola crops by placing starter fertiliser close to seed is well established. Trials in 2013 conducted by NSW Department of Primary Industries[1] demonstrated significant establishment reductions with increasing P rates (up to 20 kg/ha). Yields also increased with increasing rates of P, despite emergence being suppressed. Problems with establishment can result in a variable plant stand, which makes targeting an ideal seeding rate difficult. If establishment effects are greater than predicted, very poor stands may eventuate, and crop yield affected.

Increasing the sowing rate can compensate for establishment losses. However, this can be expensive due expensive canola seed and does not necessarily result in an improvement in plant density.

The dilemma remains that canola crops require P to optimise yields, however placing P with the seed can lead to significant reduction in plant germination. There is little or no research investigating alternate P fertilizer placement options for canola crops.

Some modern sowing machines can band fertiliser below the seed. Growers can also top-dress P fertiliser either pre or post sowing. This trial aims to investigate if P application using these alternate methods could avoid damage to canola at establishment, while maintaining adequate levels of P fertiliser to match the crops demand.

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Aims

To determine if varying placement and rate of P fertiliser can reduce the negative impacts on establishment, while maintaining the responsiveness of canola yields to P.

Methods

Small plot, factorial randomised block design with 4 replicates.

Treatments were.

- **Rates:** Three rates of P as mono ammonium phosphate (MAP) were applied at 10, 20 and 40 kg/ha of P. These were compared to an untreated control with zero P. Treatments were balanced with urea (see Note below) to ensure all treatments received the same rate of N regardless of the MAP rate.
- **Placement:** P fertiliser was applied
    - Below the seed - in a band ~6 cm below the soil surface and 4 cm directly below the seed in the same pass.
    - With the seed - banded with the seed in the same pass.
    - Immediately before sowing (IBS) - broadcast onto the soil surface prior to sowing, incorporated by the seeder.
    - Top-dress -spread on the soil surface post-plant, 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.

Note: Nitrogen (N) component of the MAP was balanced with applications of urea to ensure that all treatments received the same N rate. The highest rate of P (40 kg/ha) contained ~18 kg N/ha all treatment received this applied by the same placement method as the P.

Table 1. Trial site details

Establishment date	Autumn 2020	**Seeding rate**	3 kg/ha
Crop and variety	Canola – 44Y90	**Harvest date**	19/11/2020
Sowing date	20/4/2020	**Row spacing**	27.5 cm
Seedling equipment	Knifepoint, press wheel	**Soil type**	Sandy clay loam
Nitrogen applied: Urea (kg/ha)	100	**Previous crop**	Barley
Site Nutrition: Colwell P	0-10 cm: 32ppm 10-30 cm: 5ppm	**Pre-sowing stubble management**	Standing stubble

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

The full results are presented in Appendix 1.

Plant establishment: The average population in the trial was 34.5 plants/m^2. Placement of P with seed, including as a split application, significantly reduced plant population

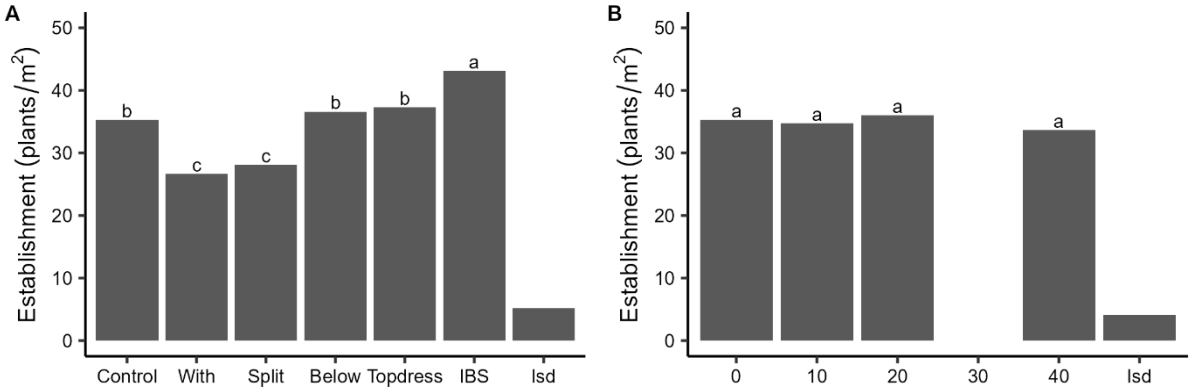

Figure 1. Where the fertilizer was placed away from the seed i.e. Below or top dress, the establishment improved from ~28 up to 35 plants/m^2.

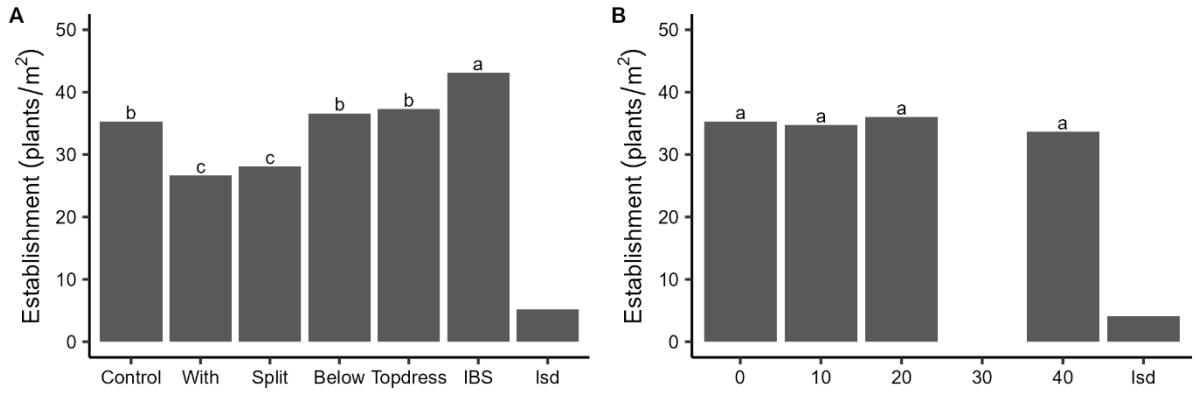

Figure 1. Plant establishment (plants/m^2) for P placement (A) and P rate (kg/ha) (B). Treatments with the same letter are not significantly different.

Yields:

- Average trial yield was 3.9 t/ha.
- This site was responsive to adding P with up to 200 kg/ha yield gain up to 20 kg/ha P
- There was no reduction in the yield response when P was applied by other methods than the standard 'with' treatment.
- The only treatment different to the standard 'with' placement was the control which received no P.

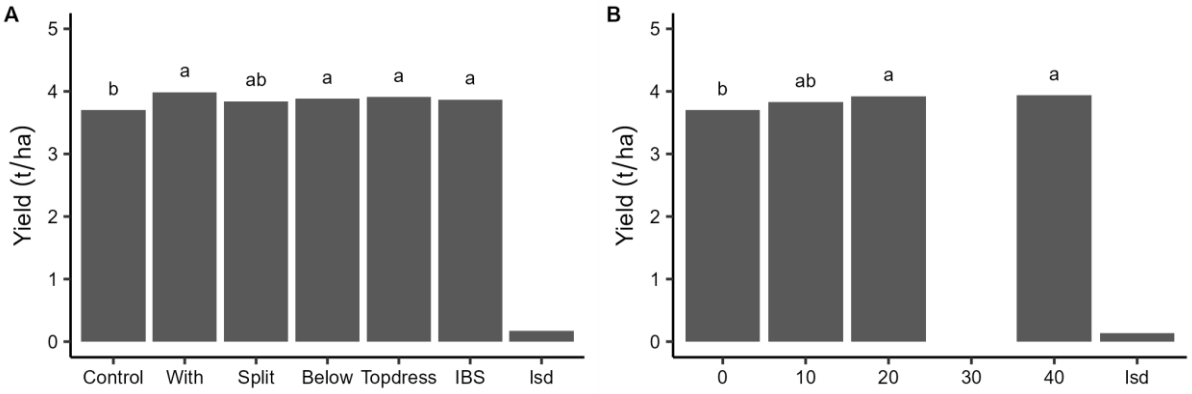

Figure 2. Yields (t/ha) for the various placement options (A) and 4 P rates (B). Treatments with the same letter are not significantly different

When comparing all treatments as illustrated in (Figure 3), at any given rate of P, no alternate placement is any different to the traditional with treatment, except 40kg/ha P split, which is less.

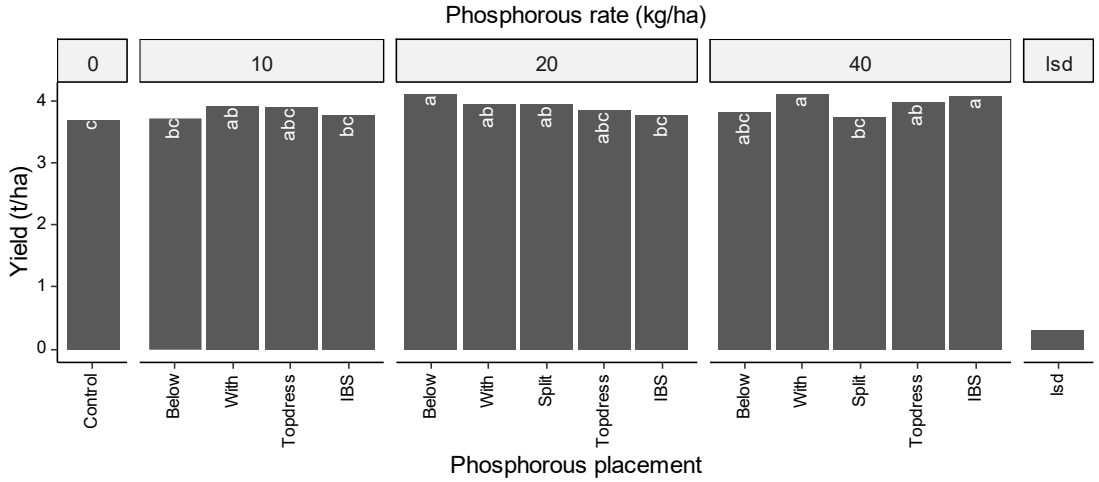

Figure 3. Yields (t/ha) for P application placements and rates. Treatments with the same letter are not significantly different

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

Discussion

The site had moderate P levels; Colwell P of ~32 ppm in the surface 10 cm layer and 5 ppm in the 10 – 30 cm layer. At this level the site has moderate level of P and maybe predicted to limit canola's potential to respond to added P. However, the site still responded to applied P gaining a modest 200kg/ha yield improvement.

There was a negative impact on plant establishment by placing fertiliser with the canola seed with as little as 10kg/ha of P applied as MAP was enough to reduce establishment by ~20%. At any given

rate there were options where fertiliser was placed away form the seed that avoided these establishment losses. But the benefits were not always consistent.

As MAP contains both N and P and both nutrient can impact on establishment, changing the rate of the product will change the N applied. As such all treatments had the N content balanced using urea. For the 'with' and the 'split' treatments, the balanced N (as urea) was applied with the seed (rather than IBS). It is possible that this urea and its placement also impacted establishment. Further development of the experimental approach might look to avoid this confounding artifact.

Ignoring the rate of fertiliser placement of the fertiliser with the seed (i.e. with the seed and split treatments), resulted in only ~28% establishment. Placement of fertiliser away from the seed (below, IBS or top-dressed) resulted in ~65% establishment. Despite establishment nearly halved yields for the same rate of P did not differ demonstrating canola's ability to compensate at lower plant populations. However, it also demonstrates the significant cost of seed purchased that did not establish a plant.

The split starter fertiliser treatment showed promise in this trial and worthy of further investigations. Applying a small amount with the seed and spreading the remaining P prior to sowing (IBS) proved effective. This treatment may be a viable alternative, as:

- the lower rate reduces establishment impacts
- the with the seed portion is likely to supply the plants requirements in a dry season, where surface applied P may become inaccessible
- the surface applied P is likely to be available in higher yielding seasons when soil surface is moister for longer periods
- there are likely to be sowing efficiencies when using lower fertiliser rates.

Refinement of this technique is required to determine a rate that can be applied with the seed that minimises the negative effects on establishment.

Conclusion

In soils with moderate P levels, canola yield responses from applied P may be modest, but placement of starter fertilisers away from the seed is an option to avoid establishment penalties. This work has suggested that there is reduction in the crop response to applied fertiliser, applied by these other placements.

A split application option where P broadcast ahead of sowing and at sowing warrants more investigation.

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				NDVI															
Rate	Placement	Plant establishment		Mid		Early		Yield		Oil		Protein		Admix		Test weight		Moisture	
(kg/ha)		(plants/m2)		(vegetation index)				(t/ha)		(%)						kg/hl		%	
0	Control	34.5	bcd	0.39	g	0.74	e	3.70	de	43.9	ab	21.2	b	0.8	de	65.0	b	5.2	ab
10	Below	33.5	bcde	0.47	bcd	0.80	ab	3.73	cde	43.6	ab	21.6	ab	1.0	abc	64.8	bc	5.2	ab
	IBS	44.4	a	0.45	bcde	0.79	ab	3.77	bcde	44.2	a	21.0	b	0.9	abcd	65.2	ab	5.5	ab
	Topdress	31.7	cde	0.46	bcde	0.80	ab	3.89	abcde	43.5	ab	22.1	a	0.9	abcd	64.7	bc	4.7	b
	With	27.7	ef	0.40	fg	0.74	de	3.91	abc	43.7	ab	21.3	ab	0.9	abcd	65.1	ab	5.2	ab
20	Below	36.9	abcd	0.50	abc	0.81	ab	4.11	a	43.4	ab	21.6	ab	0.8	de	65.0	ab	5.3	ab
	IBS	43.9	a	0.43	defg	0.79	bc	3.76	bcde	44.0	ab	21.3	ab	0.9	abcd	65.2	ab	5.5	ab
	Topdress	42.8	a	0.51	ab	0.81	ab	3.85	abcde	43.8	ab	21.4	ab	0.8	ce	65.0	ab	5.6	a
	Split	26.9	ef	0.41	efg	0.77	bcde	3.94	abc	43.5	ab	22.0	a	0.9	abcd	65.5	a	5.0	ab
	With	29.3	def	0.44	def	0.78	bcd	3.95	abc	44.0	ab	20.9	b	0.8	bcd	64.9	bc	5.4	ab
40	Below	39.4	abc	0.54	a	0.84	a	3.81	abc	43.5	ab	21.5	ab	1.0	a	64.3	c	5.3	ab
	IBS	41.0	ab	0.44	cdef	0.80	ab	4.07	ab	43.3	b	22.1	a	0.9	abcd	65.2	ab	5.2	ab
	Topdress	33.1	bcde	0.48	abcd	0.81	ab	3.96	abcd	43.8	ab	21.3	ab	0.8	ce	65.2	ab	5.1	ab
	Split	29.2	def	0.41	efg	0.80	ab	3.74	cde	43.6	ab	21.2	ab	1.0	ab	65.2	ab	5.7	a
	With	22.9	f	0.39	fg	0.74	cde	4.10	a	44.1	ab	21.4	ab	0.9	abcd	65.2	ab	5.1	ab
lsd	lsd	8.1		0.06		0.05		0.31		0.8		0.9		0.2		0.5		0.8	