GOA Trial Site Report

Phosphorous placement and its effect on establishment and performance of canola

Trail Code: GONU00618-1

Season/year: Winter 2018

Location: Wellington

Collaborators: Joe and Sam Mason

Keywords

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

Take home messages

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

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

In dry seasonal conditions, placement of P below seed is likely to yield best per unit of P, followed by placement with the seed.

A small yield response to surface applied P, even in this very dry year, suggests the option of splitting application between top-dress and with seed warrants more testing (reducing amount placed with seed and broadcasting the remained prior to sowing).

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 be based on the view that P is relatively immobile in the soil and needs to be placed close to developing canola root systems.

Damage to establishing crops from fertiliser placed close to seed has long been accepted. Trials in 2013 conducted by NSW Department of Primary Industries[1] found significant reductions in canola establishment with increasing rates of P (up to 20 kg/ha). As canola seed is generally expensive, particularly hybrid seed, this can result in a direct seed 'cost'.

Research also often showed yields also increased with increasing rates of P despite emergence suppression. However, unpredictability and variability of canola establishment population can make targeting an ideal seeding rate difficult if not impossible. Effect on establishment more than predicted can result in very poor stands with yield unable to recover. Increasing seeding rate can compensate for establishment losses but does not solve unpredictable establishments and comes at a significant grower cost.

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

The dilemma, therefore, exists that canola requires P to optimise yields, however, placing P with seed often leads to significant issues. NSW DPI trials, noted above, did not investigate alternate placement options for applying P fertiliser to canola crops.

Some modern seeding machines have 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 P application using these alternate methods could avoid seedling damage at establishment while maintaining a positive P fertiliser response.

Aims

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

Methods

The trial was a small plot, full factorial randomised complete block design with three replicates established in Autumn 2018.

The trial assessed rate of P applied and effect of P placement on germination and canola yield. All combinations with these three variables were designed to be assessed in the trial.

- **Rates:** Three P rates, in the form of triple superphosphate (Trifos) were applied at 0, 10, 20 and 40 kg/ha of P.
- **Placement:** P fertiliser was applied by three methods. All application methods were repeated for all treatments. P was applied as follows -
    - 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 - a base rate of 10kg/ha P applied with the seed and the remainder IBS
    - Control – no P applied, but all physical application methods used.

Table 1. Trial site details

Trial Establishment Date	Autumn 2018	**Seeding rate**	2.5 kg/ha
Crop and Variety	Canola – V7002CL	**Harvest Date**	20/11/2018
Sowing date	31/5/2018	**Row Spacing**	27.5 cm
Seedling equipment	Double Boot Tyne	**Soil type**	Sandy Clay Loam
Nitrogen Crop Nutrition Urea (kg/ha)	nil	**Previous Crop**	Wheat
Site Nutrition: Colwell P	0-10 cm: 20 ppm 10-30 cm: 7 ppm	**Pre-Sowing Stubble Management**	Standing stubble

Results were analysed using ASREML 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

Full results are detailed in table, Appendix 1.

Plant Establishment: Average population was 8 plants/m^2. Placement of P 'with' seed reduced plant establishment at 20 and 40 kg P/ha rates. At 40 kg/ha plant loss represented a 43% reduction compared to site average.

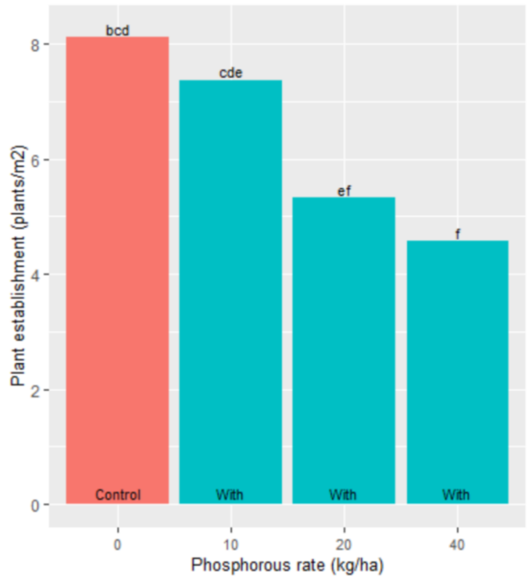

Figure 1. Plant establishment (plants/m^2) for control and 'with' placement treatments, Spicers Creek 2018.

Yields: Varied from 1.0 to 1.6 t/ha. Only 2 treatments had significantly different yield from the control. Where 20 kg/ha P was applied IBS yielded lowest (1.0 t/ha) and was 200 kg/ha lighter than the control. Where 20 kg/ha P was placed below the seed, yield was highest, 1.6 t/ha, 400 kg/ha more than the control (**Figure 2**).

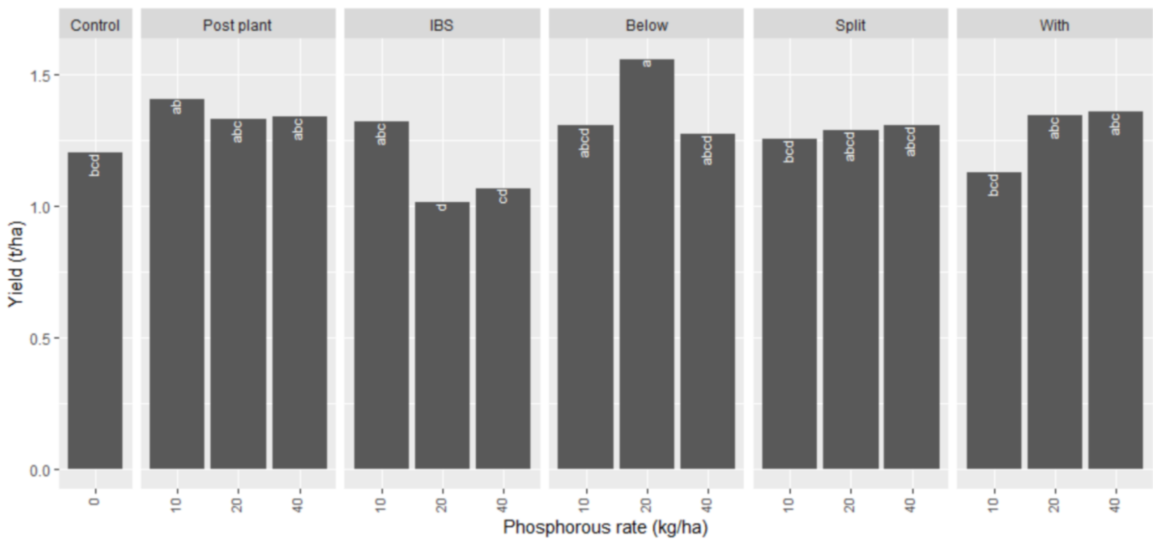

Figure 2. Yields (t/ha) for the four phosphorous application rates (kg/ha), Spicer Creek 2018.

There was a yield advantage when placing P Below, Split and Post plant. Placement of all P With, or by IBS was not significantly different to the control (**Figure 3**).

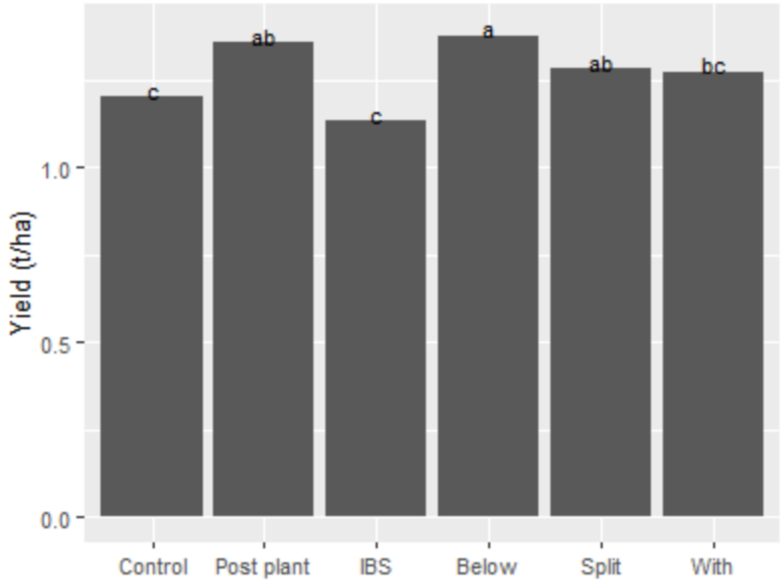

Figure 3. Yields (t/ha) for the various placement options (regardless of rate). Control is where no Phosphorous was applied.

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

Discussion

This site had low P levels, Colwell P of less than 20 ppm in the surface - 10 cm layer and ~ 7 ppm in the 10 – 30 cm soil layer. These low background P levels allowed for yield response to both P rate and placement.

2018 was a very dry season, particularly at the start. The ~40-60% lower yield response of surface applied P (compared to sub-surface banded treatments) probably is explained by insufficient rainfall to either allow adequate incorporation of fertiliser or for plants to develop and maintain sufficient root systems in the surface soil. Despite poorer performance, there was a response to surface applied P compared to nil P.

Placement of P with seed is likely to be the main method of application for many farmers in the GOA region. In this trial this proved to be a better option than applying P to the surface. Placement of P below the seed gave a greater response. Improved performance of P placed below the seed may also be explained by the dry season. Though differences in crop establishment were measured where P was applied with the seed, this effect did not carry through to yield, perhaps confirming that 4 plants per m is sufficient to achieve optimal yields in drier seasons.

Placement of P below seed was the best yielding treatment. It is likely that deeper placement (4-6 cm below the seed) placed fertiliser into soil that was moister for a longer period during the growing season, and hence, allowed longer access to fertiliser P. It would be interesting research to further explore if even deeper P application would allow for further yield gains. It is also plausible that having P evenly distributed in the surface 5-10 cm may also give yield improvements (as opposed to being banded or placed on the soil surface) though this was not tested in this trial. At this site, in this drought season, optimal P rate for maximising production was between 15 and 45 kg/ha, however, this may not necessarily reflect the optimal economic return.

Conclusion

In soils with low starting P, canola is likely to show a yield response to added P fertiliser, even in a drought year.

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

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

Given that there was a yield response, albeit small, to surface applied P even in very dry conditions, the option to broadcast P ahead of sowing warrants more testing and there may be an option to split applications.

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.

Phosphorous		Plant establishment (plants/m2)			Vegetation index (NDVI)			Yield (t/ha)			Admix (%)			Protein (%)			Test Weight (kg/hl)			Oil (%)		
Placement	Rate (kg/ha)	p.v.[1]	s1[2]	s2[3]	p.v.[1]	s1[2]	s2[3]	p.v.[1]	s1[2]	s2[3]	p.v.[1]	s1[2]	s2[3]	p.v.[1]	s1[2]	s2[3]	p.v.[1]	s1[2]	s2[3]	p.v.	s1	s2
Control																						
	0	8	bcd	a	0.65	ef	a	1.20	bcd	a	0.4	bc	a	24.0	cd	a	68.3	ab	a	40.8	a	a
IBS																						
	10	11	A	a	0.71	bcde	a	1.32	abc	a	0.5	abc	a	23.6	d	b	68.2	abc	a	40.7	ab	a
	20	8	Abcd	a	0.63	ef	b	1.01	d	b	0.4	bc	a	24.3	abcd	ab	68.3	abc	a	40.5	ab	a
	40	9	Abc	a	0.60	f	b	1.07	cd	ab	0.4	abc	a	24.6	abc	a	68.3	abc	a	40.0	b	a
Split																						
	10	9	Abcd	a	0.72	abcd	a	1.26	bcd	a	0.5	abc	a	24.1	bcd	a	68.4	ab	a	40.5	ab	a
	20	6	def	b	0.73	abcd	a	1.29	abcd	a	0.4	abc	a	23.9	abcd	a	68.3	abc	a	40.8	ab	a
	40	8	bcde	ab	0.72	abcd	a	1.31	abcd	a	0.4	bc	a	23.7	d	a	68.1	abc	a	40.3	ab	a
Below																						
	10	8	bcd	a	0.73	abcd	a	1.30	abcd	a	0.5	abc	a	24.2	abcd	a	68.1	abc	a	40.8	ab	a
	20	10	ab	a	0.80	a	a	1.56	a	a	0.2	c	b	23.8	cd	a	68.3	abc	a	40.9	a	a
	40	8	bcd	a	0.74	abc	a	1.27	abcd	a	0.6	a	a	24.3	abcd	a	68.0	abc	ab	40.1	ab	a
With																						
	10	7	cde	a	0.70	cde	a	1.13	bcd	a	0.6	ab	a	24.9	a	a	67.9	c	b	40.1	ab	a
	20	5	ef	ab	0.71	bcd	a	1.34	abc	a	0.5	abc	a	24.4	abcd	a	68.4	ab	a	40.7	ab	a
	40	5	f	b	0.65	def	a	1.36	abc	a	0.4	abc	a	24.6	ab	a	68.0	abc	a	40.5	ab	a
Post plant																						
	10	8	bcd	a	0.69	cdef	b	1.41	ab	a	0.5	ab	a	23.8	cd	b	68.4	a	a	40.8	ab	a
	20	9	abc	a	0.70	bcde	b	1.33	abc	a	0.5	abc	a	24.0	bcd	ab	68.1	abc	ab	40.4	ab	a
	40	8	bcd	a	0.78	ab	a	1.34	abc	a	0.5	abc	a	24.7	ab	a	67.9	bc	b	40.2	ab	a
lsd																						
	lsd	2			0.08			0.29			0.2			0.8			0.5			0.9		

[1] predicted value
[2] values with the same letter for each variable are not significantly different
[3] values with the same letter for each variable within each P Placement treatment are not significantly different