GOA Trial Site Report

Phosphorous placement and its effect on canola establishment and performance.

Trail code: GONU00620-3

Season/year: Winter 2020

Location: Gollan, NSW

Collaborators: Nathan Simpson

Keywords

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

Key findings

- There was a strong response to phosphorus (P) rate, with the highest advantage for the first 10 kg/ha of P applied, however yields continued to increase with up to 40kg/ha of P applied.
- P rate had a greater effect on yield than P placement.
- Where the fertiliser was placed away from the seed, establishment improved. Placement of fertiliser with seed can impact germination, even at lower P rates. Growers should consider alternative placement or compensate by adjusting seeding rate.
- Within each P rate there was no significant yield difference between the different placement methods suggesting all had similarly effective fertiliser efficiency.
- 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

Background

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 relative 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.

Aims

To determine if varying placement and rate of P fertiliser can reduce the negative impacts on establishment, while maintaining the responsiveness of crops 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 by using the following methods
    - Below the seed - in a band ~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.
    - 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).
    - Untreated control (UTC) – 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. The balanced N used the same placement options as the P.

Table 1. Trial site details

Establishment date	Autumn 2020	**Seeding rate**	3 kg/ha
Crop and variety	Canola – V75-03	**Harvest date**	6/11/2020
Sowing date	22/4/2020	**Row spacing**	27.5 cm
Seedling equipment	Knifepoint press wheel	**Soil type**	Sandy clay loam
N fertilizer: Urea (kg/ha)	100- broadcast and IBS	**Previous crop**	Pasture
Site nutrition: Colwell P	0-10 cm: 23ppm 10-30 cm: 7ppm	**Pre-sowing stubble management**	Deep ripped and worked

Table 2: Gollan rainfall for 2020 and the long-term average (LTA).

Gollan rainfall													
Month	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	**TOTAL**
2020	40	123	128	117	27	31	116	43	47	88	17	160	**937**
LTA	71	58	57	41	44	46	45	46	45	55	58	56	**622**

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.

Plant Establishment

The average plant population for the trial sites was 18.4 plants/m^2. Placement of starter fertiliser with seed, including as a split application had a low establishment of less than 13 plants/m^2 (Figure 1.

Where the fertiliser was placed away from the seed the establishment was higher, achieving up to 30 plants/m^2.

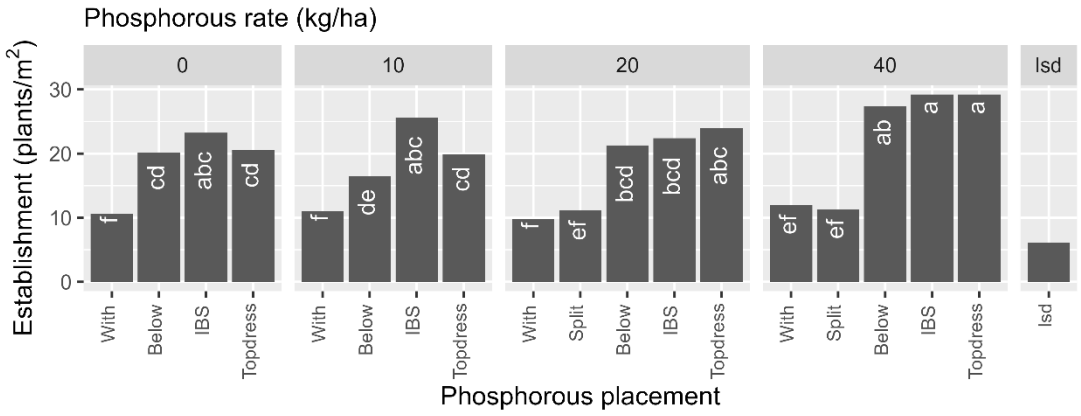

Figure 1. Plant establishment by rate of P and various placement options. Treatments with the same letter are not significantly different.

Yields

- The trial average yield was 2.7 t/ha (Figure 2).
- There was a very strong P rate response, with over 2 t/ha difference between the treatments of Nil P and the highest P rates.

- At any given rate of P, the alternate placements of P where either the same or higher than the traditional placement 'with' the seed.
- For the Nil P treatments- applied 'with' yielded less than the other placements.
- Where no P was applied (but balanced with urea), placing the urea 'with' the seed reduced yields compared to other placement options

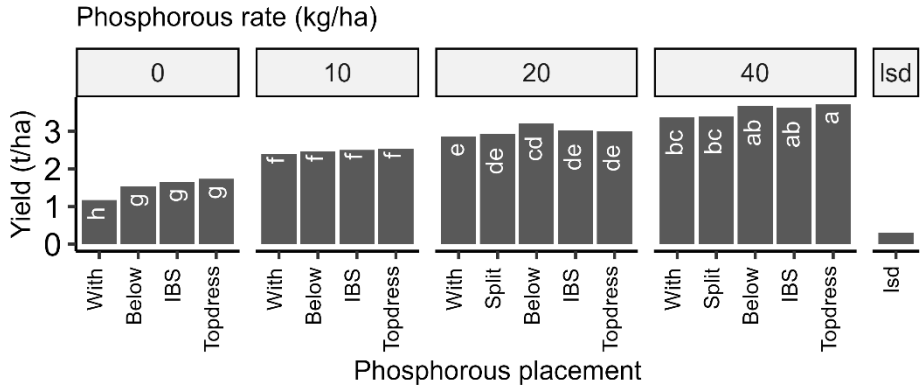

Figure 2. Yields for P application placement and rates. Treatments with the same letter are not significantly different.

Oil %

The average oil content was 42.3%. There was a minor treatment impact on oil (likely to be a yield dilution effect), the difference between the highest and lowest was less than 1.5%, with the higher oil contents tending to be where lower rates of P were applied and the lowest yields (see results in appendix 1).

Discussion

The site had low P levels (Colwell P of <24 ppm) in the surface layer (0-10 cm) and 7 ppm in the 10 – 30 cm layer. These levels of P were insufficient to optimise yields, and applying starter fertiliser had a big impact on both crop establishment and yields.

Under the Nil P treatment, the with treatment performed worse than the other placement methods. MAP that was used in this trial to apply the desired P application rate, also contains nitrogen (N), as the MAP rate changes so does the rate of applied N. To combat this, all rates of P had the N rate balanced out to a consistent rate of 18kg/ha of N applied by adding urea. This urea was applied by the same method that the P was applied.

It is well documented that N applied close to seed can damage establishments, like that of P. This resulted in some possibly unfair effects of N on some of the P rates- particularly the lower rates including the Nil P. This would explain the poor establishment form the Nil P 'with' as it would have been damages by an equivalent of 40kg of urea applied in close contact with the seed. The other placement methods had this N placed away from the seed, which minimised the impacts.

If considering the highest rate of P applied of 40kg/ha, when applied with the the canola populations was measured at 12 plants/m^2 when fertiliser was applied 'with' the seed but increased t029 when P was placed either 'below, top-dress or IBS', nearly tripling the population. The same effect was also seen at 20kg/ha of P and to a lesser extent with 10kg/ha of P.

However, the impact on the germination and crop populations had a varied impact on the final crop yield. At 10 kg/ha of P there was no impacts. At the higher rates of 20 or 40 kg/ha of P two treatments achieved higher yields. However, the key outcome was that none of the alternate placements of P resulted in any lower yields. This indicates that the alternate placements were just as effective in supporting cop yields as the more traditional placement.

The results also highlight the ability of crops to compensate under lower plant populations provided adequate nutrition is available.

The IBS and top dressed treatments, where P was evenly distributed on the surface, yielded as good as other placement options. This yield result, particularly from the top dress treatment, clearly demonstrates that canola can access P from the soil surface. It is noted that for this to happen the soil surface needs moisture, and at canopy closure this tends to be the case in all but the driest seasons.

The results of the 'split' treatments were promising in this trial. The base rate of 10 kg/ha P applied 'with' the seed effected establishment but did not affect the final yield (when compared to other treatments), and the crop was able to access the balance (that was applied IBS). Further testing of the split option with a lower rate of P (say 5 kg/ha) to further reduce impacts on establishment (and improve sowing efficiencies) is warranted.

The benefits of a 'split' starter fertiliser strategy include:

- Lowering the rate of P with the seed will improve establishment losses
- The P applied with the seed is likely to supply the plants requirements in a dry season, when the surface applied P may be less accessible
- 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.

At this site and in this season, the optimal P rate for maximum production may not have been reached, as yields increased to the highest rate of 40 kg/ha. Higher rates of P may have continued to increase yields but not necessarily optimise economic returns.

Conclusion

- In soils with low P, canola is likely to show yield responses to added fertiliser.
- Placement of starter fertiliser with seed can impact germination, even at lower rates. Where possible growers should consider split applications, alternative placement or compensate by adjusting the seeding rate.
- The alternate placement options in IBS, top-dress or below performed similarly to the traditional 'with' indicating fertiliser efficiency is maintained
- 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 3. 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%).

Rate (kg/ha)	Placement	Plant establishment (plants/m2)		Yield (t/ha)		Oil (%)	
0	With	10.64	f	1.17	h	42.69	ab
	Below	20.15	cd	1.53	g	42.45	abcde
	IBS	23.25	abc	1.66	g	42.75	abcd
	Topdress	20.53	cd	1.73	g	42.50	abcde
10	With	10.98	f	2.40	f	42.74	a
	Below	16.53	de	2.46	f	42.73	abcd
	IBS	25.59	abc	2.50	f	42.35	abcdef
	Topdress	19.93	cd	2.53	f	42.10	abcdef
20	With	9.74	f	2.86	e	41.90	cdef
	Split	11.10	ef	2.93	de	42.60	abcd
	Below	21.29	bcd	3.21	cd	42.60	abcd
	IBS	22.42	bcd	3.02	de	42.78	abc
	Topdress	24.00	abc	3.00	de	42.55	abcd
40	With	12.00	ef	3.37	bc	41.88	def
	Split	11.32	ef	3.40	bc	41.62	ef
	Below	27.40	ab	3.67	ab	41.53	f
	IBS	29.21	a	3.63	ab	41.93	bcdef
	Topdress	29.21	a	3.72	a	42.02	abcdef
lsd	lsd	6.12		0.31		0.87	