

Phosphorous placement and its effect on establishment and performance of canola

Trail /code: GONU00620-2

Season/year: Winter 2020

Location: Gilgandra

Collaborators: Jon and Tex Kilby

Keywords

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

Key findings

- Placing fertilizer below the seed improved establishment when compared to placing it with the seed.
- Placement on the soil surface, either as an IBS or top-dress immediately after sowing produced the highest yields mostly due to the reduced impact on establishment.
- Increasing the rate of P did not increase yields, due the moderate levels of Colwell P in the soil.
- Placing starter fertilizer with the canola seed compounded the problem of a low plant stand.

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 Industries¹ 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	21/4/2020	Row spacing	27.5 cm
Seedling equipment	Knifepoint press wheel	Soil type	light sandy clay
Nitrogen applied as urea (kg/ha)	100- Applied IBS	Previous crop	Barley
Site nutrition: Colwell P	0-10 cm: 38 ppm 10-30 cm: <5 ppm	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 contained in Appendix.

Plant Establishment: Establishment at this site was poor with an average population was 11 plants/m². Placement of P with seed (including as a split application) significantly reduced plant population (Figure 1) to 4 plants/m². Where the fertilizer was placed on the soil surface, as an IBS or top-dress the establishment was 15 and 17 respectively (regardless of rate).

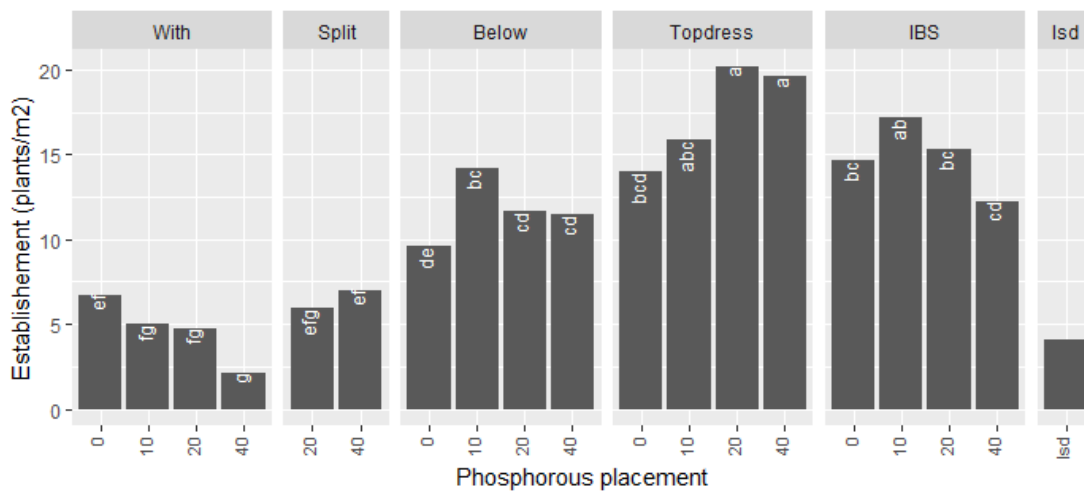


Figure 1. Plant establishment (plants/m²) for 4 P rates and various placement options. Treatments with the same letter are not significantly different.

Yields: The average yield of the trial was 2.1 t/ha. At any given rate of P the alternate placements of P (below, top-dress or IBS) either yielded the same or better than the traditional with, placement.

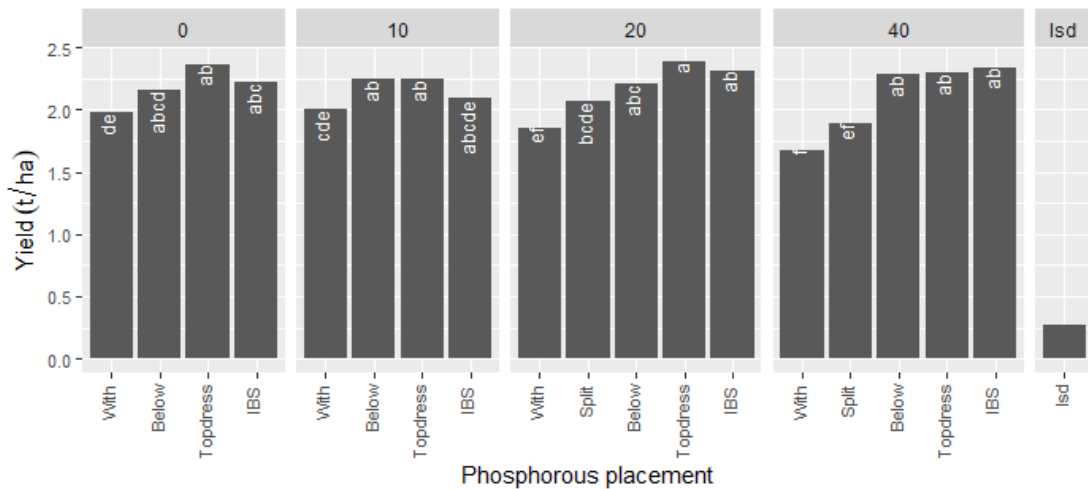


Figure 2. Yields (t/ha) for P application placements and rates. Treatments with the same letter are not significantly different.

Oil %: There were minor (<1%) differences in oil% that appear to be driven primarily by yield dilution, where lower yielding treatments had higher oil contents and vice versa. Full results are in Annex 1.

Discussion

It should be noted that this trial was hit by a hailstorm. It was co-located with a canola NVT trial that was not harvested due to the severity of the damage, however this trial was sown a week later and while it suffered hail damage with visible shattering it was still harvested. It is suggested that readers read the yield results with some caution.

The site had moderate P levels; Colwell P of 38 ppm in the surface 10 cm layer and less than 5 ppm in the 10 – 30 cm layer. Arguably levels were sufficient to sustain a higher yielding crop (assuming ~10 kg P/ha grain and stubble removal¹) and may not be very P responsive.

This trial used farmer retained seed, which was not tested prior to sowing. There was some question as to the seed viability and the low establishment rate (~11 plants/m²) in the trial and the surrounding paddock would tend to support this. However, there were still treatments in this trial that achieved plant populations in excess of 20 plant/m², indicating that the effects of P fertiliser placement can still be substantial.

It should also be noted that all treatments had the N balanced regardless of the rate of MAP that was applied. That resulted in 18kg/ha of N applied as either MAP or urea in all treatment. Any amount of urea to balance the N rates was applied by the same method as the P would have been.

¹ Grow Notes – Canola [GrowNote-Canola-North-5-Nutrition.pdf](http://grdc.com.au/GrowNote-Canola-North-5-Nutrition.pdf) (grdc.com.au)

This probably resulted in some unfair impacts of N in some low P treatment where high amounts of urea was needed. This is very evident in the low establishments even in the Nil P where urea was placed with the seed. N is well documented in its potential to reduce seedling establishment

As the establishment was already low (~11 plants/m²), placing starter fertilizer with the canola seed further exacerbated the problem, and at the highest rate of P (40 kg/ha) establishment was @ plants/m². That there was also an effect on establishment in the OP treatments that were balanced with urea, this clearly reinforces the fact that N can also impact establishment. The alternative of placing fertilizer below the seed improved establishment compared to when placed with the seed, while placing fertilizer on the soil surface, either IBS or top-dressed achieved a better establishment than with or below. The split treatment where 10 kg/ha was placed with the seed had a similar establishment to the 'with' treatment (first 10 kg P/ha was placed with the seed). In situations where conditions are considered less than ideal for sowing, the effects of fertilizer placement should be given a higher consideration.

There was no yield response at this site to P rate (most likely due to sufficient background soil P), there was however a response to P placement. Placing fertilizer (P or N) with the seed reduced yields, which appeared to be directly related to plant establishment. Where establishment was low (with and split), yield was low. Where better establishment was achieved, yield was increased (IBS and top-dress). It is not clear if optimal yields were achieved in the surface applied treatments, as the populations in these treatments were still borderline (15-17 plants/m²).

Placement of P with seed is likely to be the main application method for many farmers in the GOA region. The combined effects of co-locating starter fertilizer with the seed on establishment and yield are evident even at the lower rate tested. 10 kg P/ha is equivalent to 46 kg MAP/ha, which is arguably the lower end of farmer practice in the Orana region, and well below the general recommendation of ~15–20 kg P/ha².

These results highlight the risk of placing fertilizer with the seed and the same time offer viable alternate placement options. In this trial the alternative to split the application was tested, however was not an improvement to the "with the seed" treatment. It is suggested that this be further tested with lower rates placed with the seed. Placement on the soil surface, either as an IBS or top-dress immediately after sowing produced the highest yields, not necessarily because of crop access to P, but mostly due to the reduced impact on establishment.

Conclusion

Placement of P fertilizer or urea with seed can impact germination, even at low rates. This effect maybe compounded where sowing conditions are marginal. Where possible growers should consider alternative placement or compensate by adjusting the seeding rate.

Placement of P fertilizer away from the seed reduces the impact on germination and subsequent yield. The option to split application between a P top-dress ahead of sowing and at sowing warrants more research.

Acknowledgements

The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and support of the Grains Research and Development Corporation (GRDC). The authors would like to thank them for their continued support. Special thanks to Tex and Jon Kilby, Gilgandra, who hosted this trial.

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	NDVI		Yield	Oil	Protein	Admix	Test weight	Moisture
Rate	Placement		Mid	Early						
(kg/ha)		(plants/m ²)	(vegetation index)		(t/ha)	(%)			kg/hl	%
0	With	6.7 ^{ef}	0.24 ^{def}	0.18 ^{de}	2.0 ^{ef}	42.8 ^{bcd}	21.6 ^{efg}	1.0 ^b	65.6 ^c	6.3 ^{bcde}
	Below	9.6 ^{de}	0.34 ^{abcd}	0.22 ^{abc}	2.2 ^{abcde}	42.3 ^{efg}	22.0 ^{cdef}	1.1 ^{ab}	66.2 ^{abc}	6.5 ^{abcde}
	Topdress	14.0 ^{bcd}	0.36 ^{ab}	0.22 ^{ab}	2.4 ^a	42.4 ^{cdefg}	21.5 ^{efg}	1.2 ^{ab}	66.0 ^{abc}	6.3 ^{abcde}
	IBS	14.6 ^{bc}	0.35 ^{ab}	0.22 ^{ab}	2.2 ^{abc}	42.5 ^{cdef}	21.9 ^{cdef}	1.0 ^{ab}	66.1 ^{bc}	6.5 ^{abcde}
10	With	5.0 ^{fg}	0.23 ^{ef}	0.17 ^{de}	2.0 ^{def}	43.1 ^{ab}	21.7 ^{efg}	1.1 ^{ab}	66.0 ^{bc}	6.3 ^{de}
	Below	14.2 ^{bc}	0.34 ^{abcd}	0.22 ^{ab}	2.2 ^{abc}	42.2 ^{efg}	22.8 ^a	1.1 ^{ab}	66.1 ^{bc}	6.3 ^{abcde}
	Topdress	15.9 ^{abc}	0.33 ^{abcde}	0.21 ^{abcd}	2.2 ^{abc}	42.7 ^{bcde}	22.4 ^{abcd}	1.3 ^a	66.4 ^{ab}	6.8 ^{ab}
	IBS	17.2 ^{ab}	0.33 ^{abcd}	0.22 ^{abc}	2.2 ^{abc}	42.2 ^{efg}	22.5 ^{abc}	1.0 ^{ab}	65.5 ^c	6.4 ^{abcde}
20	With	4.8 ^{fg}	0.24 ^{cef}	0.17 ^{de}	1.8 ^{fg}	43.0 ^{abc}	21.4 ^{fg}	1.3 ^a	65.9 ^{bc}	6.7 ^{abcde}
	Split	5.9 ^{efg}	0.28 ^{bcdef}	0.19 ^{abcde}	2.1 ^{bcdef}	42.1 ^{fg}	22.8 ^{ab}	1.0 ^{ab}	65.7 ^{bc}	6.6 ^{abcde}
	Below	11.6 ^{cd}	0.32 ^{abcde}	0.22 ^{ab}	2.2 ^{abcd}	42.3 ^{defg}	22.3 ^{abcd}	1.2 ^{ab}	66.2 ^{abc}	6.8 ^a
	Topdress	20.2 ^a	0.40 ^a	0.23 ^a	2.4 ^a	43.1 ^{abc}	21.9 ^{cdefg}	1.2 ^{ab}	65.9 ^{bc}	6.3 ^{abcde}
	IBS	15.3 ^{bc}	0.30 ^{abcdef}	0.19 ^{bcde}	2.3 ^{ab}	42.5 ^{cdefg}	22.1 ^{bcde}	1.3 ^a	65.9 ^{bc}	6.4 ^{abcde}
40	With	2.1 ^g	0.19 ^f	0.16 ^e	1.7 ^g	43.4 ^a	21.2 ^g	1.1 ^{ab}	65.9 ^{bc}	6.2 ^e
	Split	7.0 ^{ef}	0.27 ^{bcdef}	0.18 ^{cde}	2.0 ^{cdef}	42.6 ^{cdef}	21.9 ^{defg}	1.0 ^{ab}	65.9 ^{bc}	6.2 ^{ce}
	Below	11.4 ^{cd}	0.34 ^{abc}	0.21 ^{abc}	2.1 ^{abcde}	42.0 ^{fg}	22.7 ^{ab}	1.3 ^a	66.5 ^{ab}	6.4 ^{abcde}
	Topdress	19.6 ^a	0.36 ^{ab}	0.22 ^{abc}	2.3 ^{abc}	41.9 ^g	22.8 ^a	1.1 ^{ab}	65.8 ^{bc}	6.7 ^{abcd}
	IBS	12.2 ^{cd}	0.28 ^{bcdef}	0.19 ^{abcde}	2.3 ^a	42.3 ^{defg}	22.1 ^{bcde}	1.1 ^{ab}	67.0 ^a	6.8 ^{abc}
lsd	lsd	4.1	0.11	0.04	0.2	0.6	0.6	0.3	0.8	0.5