

# Canola Nutrition for the HRZ

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## Key Messages

- Canola yield increased significantly up to, but not above, 200 kg N/ha.
- There was little benefit to applying above 15P or any K, S or trace elements.
- Fertilisers (both banded and top-dressed) significantly decreased plant establishment and early growth.

## Aim

To determine whether other nutrition (P, K, S or trace elements) is limiting yield as canola growers target high yields with high nitrogen rates in the high rainfall zone of WA.

## Background

Canola growers in the high rainfall zone of WA are increasing N applications in response to increased paddock productivity, with up to 160 units of N being applied across paddocks (SEPWA, 2019). As higher yield potentials are being realised due to farming system improvements including soil amelioration and increasing nitrogen applications, there is increasing interest in the nutritional requirements of these larger crops and whether standard 'rules of thumb' or critical soil nutrient values continue to hold true in the HRZ.

## Trial Details

<b>Property</b>	Esperance Downs Research Station, GPS 33.60568 °S, 121.78601 ° E
<b>Plot size &amp; replication</b>	2.0 m centres x 20 m sown x 3 reps
<b>Soil type</b>	Grey deep sandy duplex
<b>Sowing date</b>	29 April 2020
<b>Seeding rate</b>	4.45kg/ha (to target 50 plants/m <sup>2</sup> at 5.07mg seed weight)
<b>Fertiliser</b>	As per treatment list
<b>Herbicides and insecticides</b>	IBS – 2 L/ha SpraySeed (135g/L paraquat + 115g/L diquat) + 1.5L/ha TriflurX (480g/L trifluralin) + 1.1kg/ha Atragranz (900g/kg atrazine) PSPE – 1L/ha Pyrinex Super (400g/L chlorpyrifos + 20g/L bifenthrin) Post-em – 10-June – 1.2kg/ha Farmozine 900WDG (900g/kg atrazine) + 1% Hasten. 25-June 500ml/ha Clethodim 240 (240g/L clethodim) + 100ml/ha Haloxyfop 520 (520g/L haloxyfop-P) + 500ml/ha Uptake oil. 7-August – 50ml/ha Transform (240g/L sulfoxaflor) + 500ml/ha Uptake oil. 16-October – 300ml/ha Dominex Duo (100g/L alpha-cyphermethrin) + 30ml/ha Trojan (150g/L gamma-cyhalothrin) 30-October - 3L/ha Reglone (200g/L diquat) + 0.16% BS1000.
<b>Fungicides</b>	15-June - 450ml/ha Prosaro (210g/L prothioconazole + 210g/L tebuconazole) 24-July – 800ml/ha Aviator Xpro (150g/L prothioconazole + 75g/L bixafen)
<b>Harvested</b>	10 <sup>th</sup> November 2020
<b>Growing season rainfall (April-October)</b>	425 mm

## Treatments

The trial consisted of three designs, made up of ten nutrition treatments applied across up to four N rates with three replicates (Table 1). The main design comprised of six nutrition treatments consisting of varying levels of phosphorous (P), potassium (K), sulphur (S) and trace elements (TE; copper [Cu], zinc [Zn] and manganese [Mn]) that were applied across all four N rates (15N, 100N, 200N and 300N) in a split plot design, with N rate as main plots and nutrition treatments as sub-plots. While treatment 1 consisted of high levels of all nutrients (P, K, S and TE), the other five treatments consisted of a reduced level of one (treatments 2 to 5) or all (treatment 6) of the other nutrients.

A supplementary design consisted of two additional treatments being applied within the 15N main plot, and these consisted of nil fertiliser (treatment 7) or 15N only (treatment 8; no P, K, S or TE). Another supplementary design consisted of two additional treatments being applied within the 100N, 200N and 300N

main plots, and these consisted of double (treatment 9) or triple (treatment 10) the levels of P, K and S that were applied to treatment 1.

At seeding, Nitrogen (N) and phosphorus (P) were applied using CSBP MAP (11N-23P-0K-1S-0Ca) and urea (46-0-0-0-0) banded below the seed. Potassium (K) and sulphur (S) were applied using CSBP MOP (0-0-50-0-0) and gypsum (0-0-0-18-22) top-dressed immediately after seeding. Calcium (Ca) was controlled through lime (0-0-0-0-24) top-dressed immediately after seeding to plots that received no gypsum. Trace elements (TE) of copper, zinc and manganese were applied as a foliar spray at the 7-8 leaf stage using a combination of copper, zinc and manganese sulphate to provide a total of 200g/ha Cu, 355g/ha Zn, 1270g/ha Mn and 1010g/ha of S. The 100N, 200N and 300N plots received additional nitrogen top-dressed as urea applied in split applications across four timings (immediately after sowing, and at 4, 8 and 12 weeks after sowing [WAS]) in such quantities that an equal proportion of N was applied at each of the four application timings (except for treatments 9 and 10, which had a higher proportion applied through banded fertiliser at seeding with reduced rates top-dressed at seeding and at 4WAS as required).

Table 1: Rates of nutrients (kg/ha) applied for each of the ten nutrition treatments and the N rates to which they were applied.

Nutrition Treatment	N rates	N <sup>1</sup>	P <sup>1</sup>	K <sup>2</sup>	S <sup>2</sup>	Ca <sup>2</sup>	TE <sup>3</sup>
1. All	All	15	31	50	31	37	Yes
2. Minus P	All	15	15	50	31	37	Yes
3. Minus K	All	15	31	0	31	37	Yes
4. Minus S	All	15	31	50	2	37	Yes
5. Minus TE	All	15	31	50	31	37	No
6. Base	All	15	15	0	2	37	No
7. Nil fert.	15N only	0	0	0	0	0	No
8. 15N only	15N only	15	0	0	0	37	No
9. Double All	Except 15N	30	62	99	62	74	Yes
10. Triple all	Except 15N	45	93	149	93	111	Yes

<sup>1</sup>banded at seeding. <sup>2</sup>top-dressed immediately following seeding. <sup>3</sup>Cu, Zn and Mn applied at 8-leaf stage.

## Results

After close to average summer rainfall, the 2020 growing season was characterised by slightly below average rainfall from April through June before almost 250mm of rainfall through July and August. Overall, the growing season rainfall was 425mm, well above the 369mm average (Figure 1)

The trial was sown on 29 April 2020 into moist top-soil. Soil testing was completed at seeding with soil test results indicating that P, K and S levels were close to or exceeding critical levels to achieve 90% of yield potential (Table 2, Brennan and Bolland 2006, Brennan and Bolland 2006, Brennan and Boland 2007). Although Colwell P levels in the top 10cm were slightly below the critical level of 20mg/kg, levels in the next 10cm were slightly higher and the PBI was generally low, suggesting only small yield responses to P may be achievable. Potassium was close to critical levels in the top 10cm although increased at depth, suggesting a low likelihood of a K response. Aggregated sulphur levels in the top 30cm were around the critical level of 30mg/kg, suggesting a low likelihood of deficiency.

The crop decision tool, *Select your Nitrogen*, was used to predict the response of the site to nitrogen. With the low levels (0.85%) of organic carbon present at the site, the site was expected to be very responsive to N. From a basal fertiliser of 15N, crop yield was expected to increase from 1.7t/ha with no additional N and begin to plateau just above 200kg of N per hectare for a crop with 4t/ha potential, although would not plateau until around 300kg of N per hectare for a crop with 5t/ha potential.

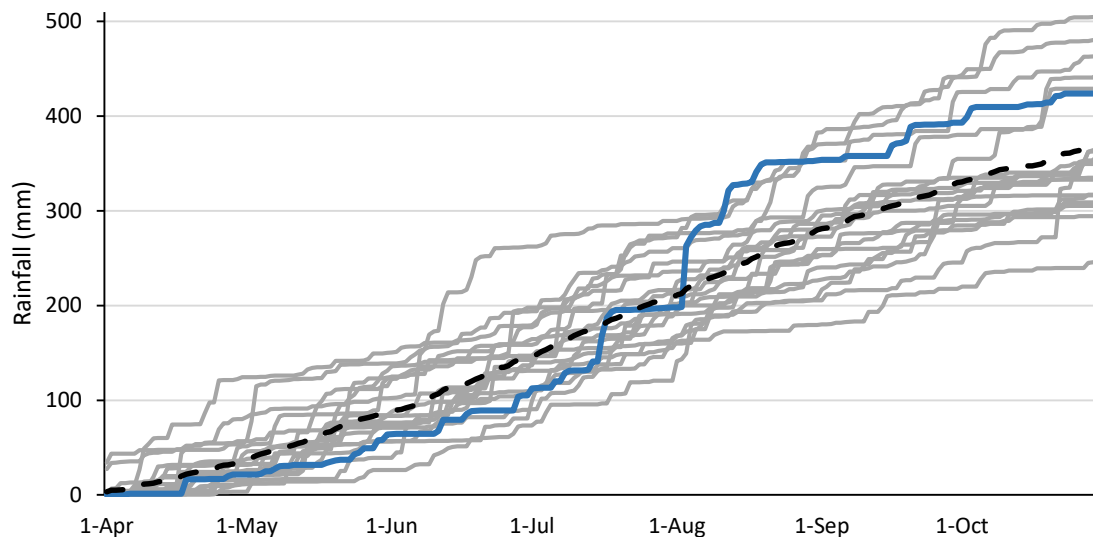


Figure 1: Cumulative growing season (Apr-Oct) rainfall from 2001-2020 at EDRS (DPIRD weather station). Blue line = 2020, dotted line = average, grey lines = all other years.

Table 2: Soil test results taken at seeding at 10cm incremental depths.

Soil group: Grey deep sandy duplex

Depth	0-10cm	10-20cm	20-30cm	30-40cm	40-50cm	50-60cm
pH (CaCl <sub>2</sub> )	5.3	5.1	5.0	5.3	5.4	5.7
pH (water)	6.1	6.0	6.0	6.3	6.4	6.6
P (HCO <sub>3</sub> ) (µg/g)	13	21	14	7	5	3
K (HCO <sub>3</sub> ) (µg/g)	59	62	103	155	206	177
N (NH <sub>4</sub> ) (µg/g)	5	4	3	2	2	2
N (NO <sub>3</sub> ) (µg/g)	32	11	8	5	4	3
S (µg/g)	9.0	6.2	12.2	16.0	19.0	19.1
Organic carbon (%)	0.85	0.85	0.68	0.49	0.37	0.37
PBI	6.7	19.8	46.5	79.0	111.5	117.6
Conductivity (dS/m)	0.098	0.048	0.039	0.033	0.046	0.036
Soil colour	LTGR	LTGR	BRGR	LTBR	LTBR	LTBR
Hand texture	1.0	1.0	1.0	2.0	2.0	2.0
Gravel (% by weight)	3%	41%	62%	57%	55%	55%
DTPA Copper	0.37	0.33	0.25	0.17	0.16	0.17
DTPA Iron	35.70	65.80	69.20	49.10	30.90	19.70
DTPA Manganese	4.39	2.41	2.15	1.28	0.69	0.23
DTPA Zinc	1.22	0.95	0.53	0.55	0.69	0.28
Exc. Aluminium	0.060	0.070	0.070	0.070	0.070	0.110
Exc. Calcium	3.85	1.96	1.57	1.40	1.76	1.81
Exc. Magnesium	0.42	0.26	0.27	0.32	0.48	0.72
Exc. Potassium	0.14	0.13	0.23	0.36	0.44	0.41
Exc. Sodium	0.10	0.05	0.06	0.07	0.12	0.20
Boron Hot CaCl <sub>2</sub>	0.39	0.43	0.42	0.54	0.46	0.74

### Establishment and in-season growth

The canola emerged within 9 days and plant establishment counts were conducted on 20 May when the canola was at the 2-leaf stage. Compared with the 15N and 100N rates, plant establishment was reduced at the higher N rates of 200N and 300N, indicating the impact of the additional 35N or 60N top-dressed as urea at seeding applied to the 200N and 300N rate plots (Figures 2 and 3). By 6WAS the 15N plots began to show visual N deficiency, and by 8WAS the 100N rate plots were showing N deficiency relative to the higher N rates.

Among the six nutrition treatments applied to all N rates, there was very little difference in establishment, early vigour and growth during the season. However, the nil fertilizer treatment at the 15N rate had significantly higher plant establishment than the other treatments, indicating that any banded fertiliser (be it MAP or urea) reduced plant establishment and early vigour significantly (Figures 2 and 3). The higher banded MAP rates in the Double All and Triple All treatments also significantly reduced plant establishment by 20-50% and these showed delayed development throughout the season. By 10WAS, the nil fertiliser had visually less biomass than the 15N only treatment, itself exhibiting a smaller canopy than the other treatments.

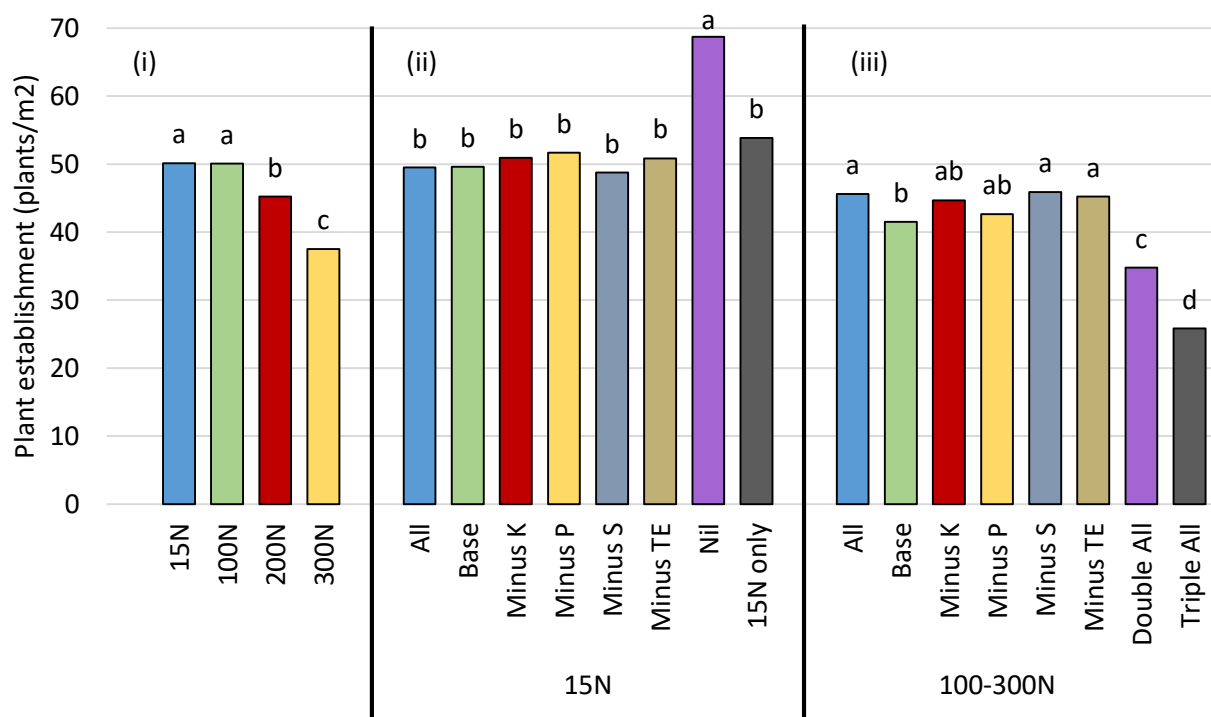


Figure 2: Plant establishment (plants/m<sup>2</sup>) (i) averaged across N rates, (ii) at eight nutrition treatments at the 15N rate, and (iii) at eight nutrition treatments averaged across the 100-300N rates. Different letters denote values are significantly different.

### End of season canopy

Plant height increased from 126cm at the 15N rate, to 162cm at the 300N rate. Lodging also increased with increasing N rates, becoming a significant issue at or above 200N with collapsed canopy evident in some areas of the trial. In terms of other nutrition, the nil fertiliser treatment (treatment 7) had significantly reduced height compared with the other treatments, while treatments 9 and 10 were significantly taller than the other nutrition treatments, although whether this is due to reduced plant establishment this is not clear. The higher N rates also delayed development, with the 300N rate generally being 1-2 weeks behind the 15N rate in terms of development (start of flowering, full bloom, pod colour change etc.).

### Grain yield

The highest grain yields were achieved by applying 200N or 300N (3.6t/ha), with both yielding higher than 100N (3.2t/ha) or 15N (2.3t/ha) (Figure 4). There was no significant difference between the yields of the first six nutrition treatments. At the 15N rate, the nil fertiliser and the 15N only treatments yielded less than the other six treatments. At the 100-300N plots, the Double All and Triple All treatments had slightly higher yields than some, but not all, of the first six nutrition treatments.

These changes in grain yield generally reflected changes in biomass, with biomass at maturity rising from 8.6t/ha to 12.5t/ha across the four N rates (data not shown). Whilst nitrogen affected crop biomass, other nutrients had little effect with crop biomass being rarely influenced by P, K, S or trace element nutrition treatments, although the Triple All treatment did have slightly higher biomass overall. Overall, changes in yield were most likely influenced by total biomass, with significant impacts on harvest index unlikely based on preliminary measurements taken.



Figure 3: Plant establishment on 28 May for 300N rate (top) and 15N rate (bottom) plots, with lower and higher establishment and vigour in the 'Triple All' (red) and 'nil fertiliser' (black) plots evident.

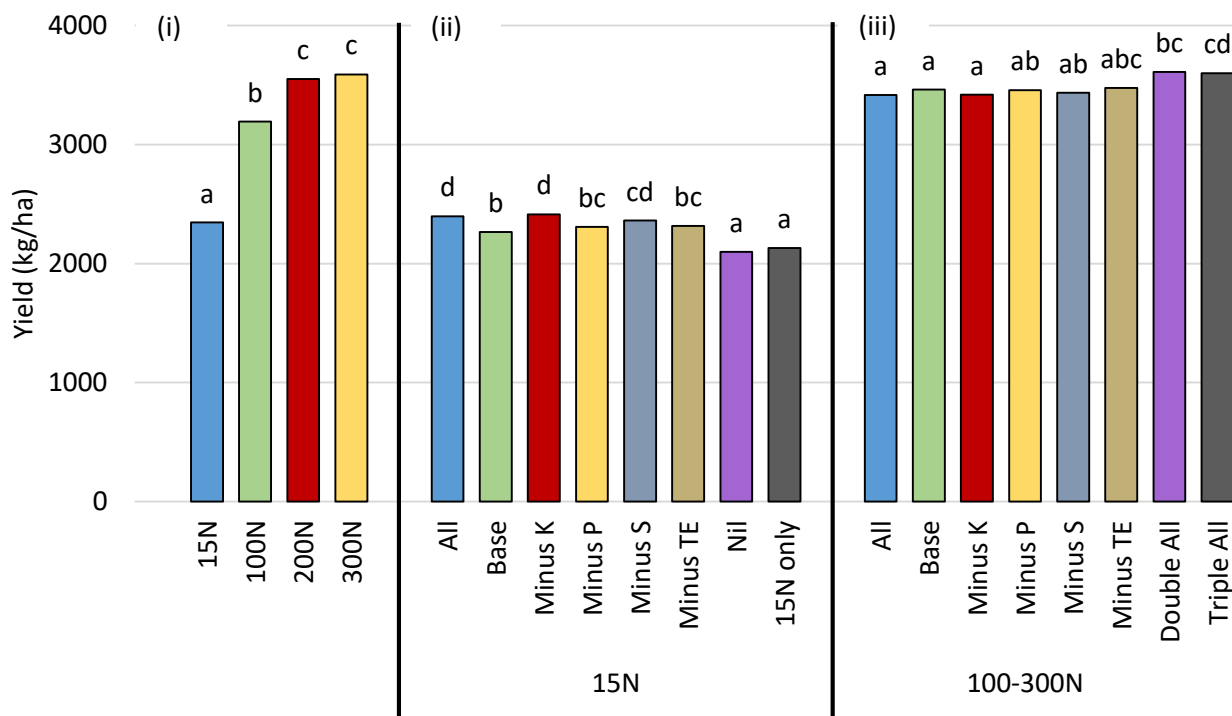


Figure 4: Grain yield (i) averaged across N rates, (ii) at eight nutrition treatments at the 15N rate, and (iii) at eight nutrition treatments averaged across the 100-300N rates. Different letters denote values are significantly different.

#### Grain quality

The relationship between nitrogen and protein and oil has been well documented and reflects that seen in this trial, whereby higher N rates increased protein and reduced oil (data not shown). Protein ranged from 17.2% at 15N to 20.4% at 300N, while oil ranged from 45.5% at 15N to 42.5% at 300N. No nutrition treatments had any impact on protein or oil. Grain weight was also largely unchanged by either N rate or nutrition treatment.

#### Nitrogen ROI

At a canola price of \$550/t, urea cost of \$500/t, spreading cost of \$8.50/ha per application and an oil premium/discount (42% basis) of 1.5%, the highest returns were achieved by applying 200N. Compared to applying 100N, the additional \$109 of urea costs resulted in an increased return of \$62, an ROI of 57%. Applying 300N did not increase final income and so the increased nitrogen costs reduced final returns relative to the 200N rate, and even reduced the gross margin below the 100N rate. As with yield, optimum N rates for gross margin would likely have been between 100N and 200N.

#### Post-experimental modelling

Once again, the decision support tool, *Select Your Nitrogen*, was used to retrospectively assess the response to N at this site. Based upon a 3.8t/ha yield potential (equivalent to the highest yielding treatment in the trial), for the 15N rate plots to have achieved 2.3t/ha of yield, the soil organic nitrogen was expected to have provided 94 units of N, almost double that which was predicted in the pre-experimental modelling based on the organic carbon levels of 0.85% in the soil. However, once this higher than predicted soil organic nitrogen was taken into account, predicted yield responses to N were extremely close to the actual yields, with total N rates of 100N, 200N and 300N expected to achieve 3.18t/ha, 3.60t/ha and 3.74t/ha, respectively.

#### Conclusion

As with most of the Esperance sandplain that has been regularly cropped over recent years, the site was expected to be very responsive to applications of N. Applying 100N (as per approximate standard district practice) increased yields to above 3t/ha, while further increases to 200N lifted yield to 3.5t/ha. These yield increases reflected an increase in biomass achieved with higher N rates, although came with associated increases in plant height and lodging.



Soil test results did not indicate significant deficiency of P, K or S. Higher rates (33P, 50K, 31S) of P, K and S did not increase yield when compared to the base treatment (15P, 0K, 0S), suggesting grower practice of applying some starter P at seeding appears to be sufficient to grow high yielding (>3.5t/ha) crops in soils that are not severely deficient. Applying no P at seeding, as in the 15N only treatment, did, however, reduce yield even at this low N rate.

Despite some separation between the seed and banded fertiliser, the presence of banded fertiliser (urea or MAP) significantly impacted plant establishment and early vigour, while top-dressed N at seeding also impacted plant establishment at higher rates (e.g. 76kg/ha urea and above). By targeting a recommended plant density of 50 plants/m<sup>2</sup>, even with reduced plant establishment due to fertiliser, plant numbers were unlikely to have reduced yield significantly, although it may still be a consideration for growers wishing to keep their establishment high.

For other reports related to this trial visit GRDC's on-farm trial web site at <https://www.farmtrials.com.au>

### Acknowledgements

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