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Lifting canola yields in the high rainfall zone on the south coast of Western Australia

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Key messages

- The impact of nitrogen rate and fungicide strategy on canola grain yield and seed quality was investigated at two field sites.
- Increasing nitrogen rate decreased oil % in seed.
- 280kg/ha nitrogen increased protein compared with the 100kg/ha treatment.
- There was no impact of fungicide applications although the season was not conducive to disease development. Observations failed to detect disease in either trial.
- Analysis of coarse and fine stubble fractions showed increasing N concentration and yield of each fraction with increasing N rate.

Aims

- To maximise canola yields in the high rainfall zone, with a combination of high nitrogen rates and full fungicide protection.
- Determine nitrogen distribution at crop maturity between the different mature plant material fractions; coarse material, fine and pod material and seed.

Background

Industry workshops conducted during 2019 highlighted constraints and opportunities facing grain growers in WA. For canola grown in the high rainfall zone these included the impact of disease on bulky crop, disease management and nitrogen (N) rates and timing. This trial protocol was developed to understand these two areas of canola agronomy in the high rainfall zone.

Two trials were located in South Stirling, 70km north-east of Albany on the south coast of Western Australia, in the winter growing season of 2020. The trials were established in paddocks that were in barley in 2018 and sub clover-based pastures in 2019, estimated to have produced 5t/ha of biomass.

Figure 1. Aerial image of location of the two trial locations: 1. HyTTec Trophy® (blue dot, left). 2. InVigor R 4022P (green dot, middle). (Site at red dot, right, was not used). Thomson Drive runs horizontally through the image.

Method

Treatments

Nitrogen and fungicide treatments (table 1) were applied to each of the two trial paddocks on the same farm. A hybrid Triazine Tolerant canola variety (HyTTec Trophy®) was compared with a glyphosate resistant variety (InVigor R 4022P), both with similar crop maturity and sowing date (early May).

Table 1. Trial treatments for both canola varieties

Treatment number	Nitrogen rate (kg/ha)	Fungicide % bloom
1	100	Nil
2	100	30% bloom
3	100	30% +50% bloom
4	180	Nil
5	180	30% bloom
6	180	30% +50% bloom
7	280	Nil
8	280	30% bloom
9	280	30%+50% bloom
10	280	30% + >50% bloom (Late)

Trial establishment

Due to COVID19 restrictions the trials were unable to be sown using a trial seeder; instead the plots were set up in grower-sown crops.

Table 2. Herbicide tolerances, maturity, blackleg rating and sowing date for both canola varieties

Variety	Herbicide tolerance	Maturity	Blackleg rating	Sowing date
InVigor R 4022P	Glyphosate tolerant TruFlex® type	Early-mid	Moderately resistant	02/05/2020
HyTTec Trophy®	Triazine tolerant	Early-mid	Resistant	09/05/2020

Table 3. Nitrogen amounts, product and date applied at different times throughout the growing season for both canola varieties

Timing of N	N applied for 100N treatments (kgN/ha)	N applied for 180N treatments (kgN/ha)	N applied for 280N treatments (kgN/ha)	N Product used	Date applied for HyTTec Trophy®	Date applied for InVigor R 4022P
Sowing	12.5	12.5	12.5	Macro Pro	9/05/2020	2/05/2020
Four leaf	44.5	44.5	44.5 (*+40)	NKS21 and *Urea	11/06/2020	11/06/2020
Early rosette	43	43	83	Urea	31/07/2020	14/07/2020
Yellow bud	0	80	100	Urea	6/08/2020	31/07/2020
Total N rate	**100**	**180**	**280**			

*NKS21 was spread by the grower and an extra 40kgN/ha of urea spread by Kalyx on 280N plots.

Fungicide regime

In 2020 the conditions were not conducive to sclerotinia; however fungicide was applied by Kalyx as per the timing shown in Table 4. The trials were assessed for disease but no disease was found at either trial site.

Table 4. Timing of fungicide application at both trial sites

Trial	Timing	Date applied	Actual growth stage (canola BBCH scale)
InVigor R 4022P	30% bloom	31/07/2020	GS59/65 (Ranging from first flower opening to 50% flowering)
	50% bloom	6/08/2020	GS65 (50% flowering)
	>50% bloom	20/08/2020	GS69 (end of flowering)
HyTTec Trophy®	30% bloom	6/08/2020	GS63 (30% flowering)
	50% bloom	20/08/2020	GS65 (50% flowering)
	>50% bloom	30/08/2020	GS65-68 majority 67 (50% to end of flowering)

Harvest processing

Two methods were used to assess the yield of plots:

1. Hand cuts were taken at crop maturity — on 4 November (InVigor R 4022P) and 12 November (HyTTec Trophy®). Two hand-cut quadrats with four rows (row spacing 30cm) of canola crop 50cm long were cut at ground level. For each hand-cut sample, N content was analysed in the seed, fine material and coarse material. The seed was thrashed out of the pods and the plants processed to separate into sections for further analysis. The fine material was pods and thinner branches. The coarse material was the stem base from ground level to the lower branches.

2. Whole plots were harvested by a trial header cutting 2m from each plot.

Results

Soil test results

Both trials were gravelly sand over clay at depth of 20–30cm. The basal nutrition of the trial was seed nutrient replacement for a 3t/ha target yield. The fertilisers were Macro Pro Plus, Urea and NKS21.Phosphorous was applied at 17kg/ha, potassium 30kg/ha and sulphur 20kg/ha. Yield was unlikely to be limited by nutrients. The pH of both sites were below the targets of 5.5($CaCl_2$) for 0–10cm and 4.8($CaCl_2$) for subsoil (Table 5)

Table 5. Soil test results for the HyTTec Trophy® and InVigor R 4022P paddocks

Name		HyTTec Trophy®						InVigor R 4022P		
Depth	**cm**	0-10	10-20	20-30	30-40	40-50	50-60	0-10	10-20	20-30
Gravel	**%**	0	5	15-20	45-50	45-50	45-50	5	5	75-80
Ammonium Nitrogen	**mg/kg**	10	4	3	3	2	2	26	12	8
Nitrate Nitrogen	**mg/kg**	16	10	5	3	3	4	14	8	4
Phosphorus Colwell	**mg/kg**	15	22	18	4	3	< 2	14	13	12
Potassium Colwell	**mg/kg**	106	42	43	58	40	75	56	25	26
Sulfur	**mg/kg**	12.4	5.1	5.2	26.2	46.6	27.5	7.0	5.5	7.7
Organic Carbon	**%**	2.11	0.81	0.62	0.54	0.39	0.24	2.76	1.62	0.96
Conductivity	**dS/m**	0.084	0.059	0.041	0.045	0.053	0.048	0.102	0.049	0.036
pH (CaCl2)		4.7	4.5	4.7	5.2	5.7	5.7	5.1	4.6	4.6
PBI		13.5	17.1	26.6	114.1	153.6	146.6	31.2	32.8	35.5

NB: Sampling times were June (HyTTec Trophy®) and August (InVigor R 4022P). The InVigor R 4022P site was sampled to 30cm only.

Rainfall and seasonal conditions

At South Stirling there was a dry start to the 2020 season followed by 46mm in May, more than the June and July rainfall combined (Figure 2). The 134mm rainfall that mostly fell in the first three days of August provided much needed water to the crop. The season had a soft finish and yields in this area were better than expected. The total growing season rainfall (1 April to 30 October) was 295mm. Total rainfall was 468mm, below the 40-year annual average for Kojaneerup (502mm).

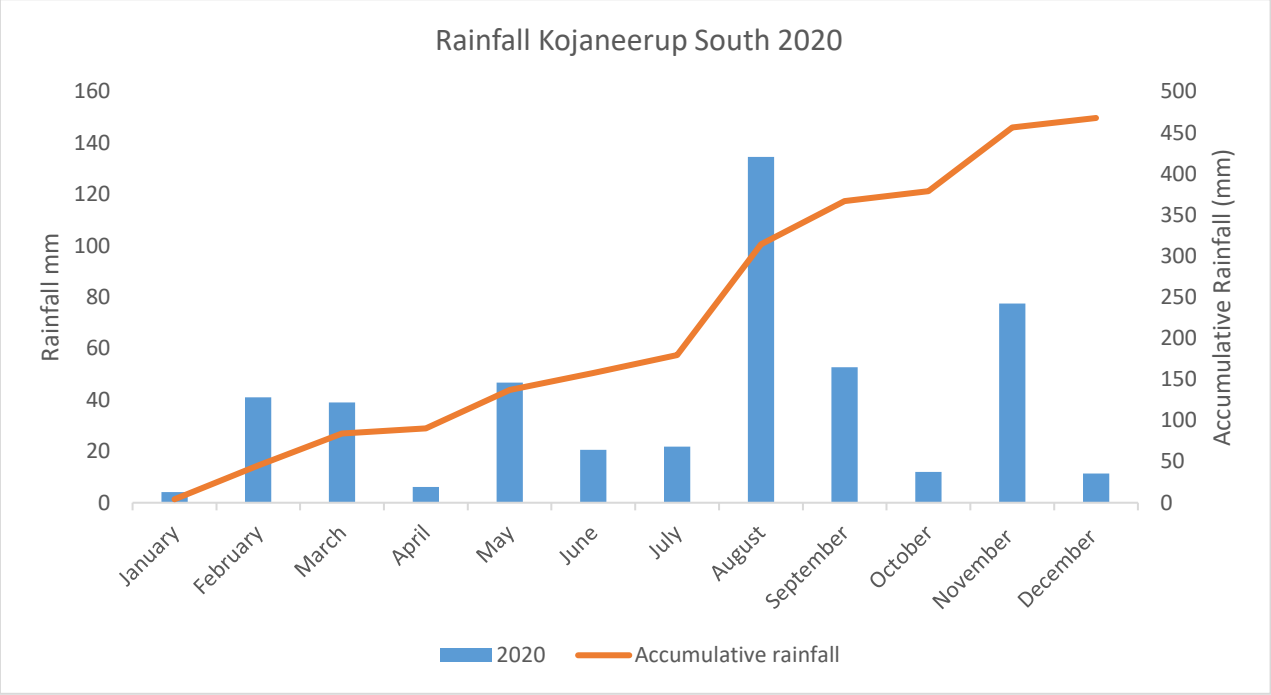

Figure 2. Monthly and cumulative rainfall at DPIRD's Kojaneerup South weather station, located in the same paddock as the InVigor R 4022P trial

Plant counts

Plant counts assessed on 9 July were similar for all treatments at both sites (Table 6) and below the optimum range of 40-60 plants/m^2. There was no statistical difference between treatments in either trial. Both sites had patchy germination, however plant growth compensated well for the uneven establishment. Each trial site paddock was sown with the same N rates; the different trial treatment N rates started at the early rosette stage.

Table 6. Plant counts and growth stage for each canola variety (sown at the rates shown)

Variety	Sowing rate	Growth Stage	Plant/ m^2
InVigor R 4022P	2.5kg/ha	Budding	28
HyTTec Trophy®	2.8kg/ha	6-8 leaf	37

PreDictaB Results

PreDictaB testing indicated high levels of crown rot and pythium root rot detected in the InVigor R 4022P paddock but no high yield loss risk levels of any canola diseases in the HyTTec Trophy® paddock. There were no observed soil borne disease symptoms evident in the trial.

Harvest grain yields

The HyTTec Trophy® site was hail damaged between maturity cuts and machine harvesting. The whole paddock was assessed with an average 20% yield loss but the paddock section around the trial was assessed with higher loss. Only minor hail damage was reported for the InVigor R 4022P site.

InVigor R 4022P

A significant difference (P=0.019) was found between 100N and 280N for the average hand cut seed yield with the 280N having a greater average yield than 100N (Table 7). There were no significant yield differences between the N rates applied from the header yields (p<0.05).

HyTTec Trophy®

No significant yield differences between the N rates applied from the header yields (p<0.05). There were also no significant differences between N rates for the average of dry matter seed yield weight.

Table 7. Canola hand harvest and plot header seed yields per nitrogen rate

Variety	Nitrogen rate	Hand cut seed yields (kg/ha)	Harvested yield (kg/ha)
InVigor R 4022P	100	3445	2816
	180	3756	2890
	280	4011	2854
Lsd.		68.6	127
HyTTec Trophy®	100	3334	1953
	180	3267	2062
	280	3228	2107
Lsd.		65.2	2000

Seed oil%, protein and harvest index

InVigor R 4022P

There was a significant difference in seed oil per cent between 100N and 180N (P=0.007) but no other difference for other N rates. There were significant seed protein differences between 100N and 180N (P=0.047) as well as between 100N and 280N (P=0.008) (Table 8)

HyTTec Trophy®

The seed oil per cent was significantly different (P=0.025) between 100N and 280N. There was also a significant difference in seed protein (P=0.024) between 100N and 280N (Table 8).

Table 8. Average percent oil, protein in the canola seed and harvest index per nitrogen rate

Variety	Nitrogen rate	Oil %	Seed protein %	Harvest index
InVigor R 4022P	100	48.0	20.2	0.32
	180	46.9	21.2	0.31
	280	47.3	21.7	0.32
Lsd		0.753	1.184	
HyTTec Trophy®	100	46.5	20.2	0.29
	180	45.5	20.4	0.29
	280	45.0	21.3	0.29
Lsd		1.160	1.056	

N analysis (kgN/ha in seed, fine, coarse and whole tops)

InVigor R 4022P

Both the fine material (P= 0.007, 0.0002 respectively) and coarse material (P= 0.0020, 0.0004 respectively) had significant difference in N content for 100N and 180N as well as 100N and 280N (Table 9).

HyTTec Trophy®

The fine material had significant difference in N content between 100 (P=0.022) and 180 (P=0.007) as well as 100 and 280 but no difference between 180N and 280N. The coarse material had significant differences between all treatments (Table 9)

Table 9. Average kgN/ha in the seed, fine material, coarse material and the total N taken up by canola per hectare.

Variety	Nitrogen rate	Seed* kgN/ha	Fine material** kgN/ha	Coarse material*** kgN/ha	Total N in mature plants kgN/ha
InVigor R 4022P	100	108.29	37.11	13.78	156.88
	180	125.36	47.87	24.21	190.60
	280	154.16	54.71	33.60	242.47
Lsd		1.184	0.054	0.152	
HyTTec Trophy®	100	113.14	40.30	19.53	172.97
	180	99.65	42.68	21.03	154.26
	280	112.98	44.42	30.48	187.88
Lsd		1.056	0.149	0.142	

*The seed was thrashed out of the pods.
**The fine material refers to the pods and thinner stems in upper canopy.
***The coarse material is the whole stem from ground level including lower portion of branches.

Discussion

While there were no significant yield responses to N from the plot header yields and no disease present, the InVigor R 4022P trial achieved above the estimated yield potential, based on rainfall from the 2020 season. The rainfall-limited yield potential for this site using French and Schultz (1984) was 2.6t/ha for canola. The rainfall-limited yield potential was calculated using 25% of rainfall between January and March plus rainfall from April to October less 33% losses from April to October and a water use efficiency of 12kg/ha/mm. The InVigor R 4022P yielded higher than the calculated yield potential, with a site mean of 2.85t/ha (Table 7). The HyTTec Trophy® at machine harvest was damaged by hail and yielded less than the estimated yield potential, with a site mean of 2.04t/ha (Table 7).

The conditions required for sclerotinia yield loss are a history of disease in the paddock and a wet humid season. The 2020 season was not conducive to sclerotinia, therefore the fungicide treatments showed no effect. Further investigation in higher potential seasons usually suitable to sclerotinia are necessary to explore disease by nitrogen interactions.

Interestingly, plant counts for InVigor R 4022P were around 10 plants/m^2 less than for HyTTec Trophy®. This demonstrated InVigor R 4022P's ability to compensate and outyield the HyTTec Trophy® by approximately 800kg/ha. Such canola compensation is commonly observed by growers and advisors.

The dry matter cuts used to measure harvest index (HI), used as a measure of reproductive efficiency, were calculated at 0.31–0.32 for InVigor R 4022P and 0.29 for

HyTTec Trophy® (Table 8). The HI achieved at this site was greater than 0.23 which was achieved at Gibson in 2015 at a DPIRD N timing trial conducted by Mark Seymour and Raj Malik (highest N rate was 125 units). The 125kgN/ha treatment at Gibson yielded 2.8t/ha which is similar to the South Stirling InVigor R 4022P trial average.

From the maturity dry matter analysis the expectation of higher N fertiliser increasing the N uptake in seed, fine material and coarse material is confirmed. Therefore, the more N applied the more N that is removed. The InVigor R 4022P trial demonstrated an incremental increase of N uptake with higher N fertiliser rates evident in the N uptake for seed, fine and coarse material. The results from HyTTec Trophy® showed the 100N treatment removing more N than the 180N treatment but this site was more severely hail-damaged. The data from these two trials indicate that there is not always a yield increase when higher N is applied. However, subsequent crops may benefit from residual N in the following year.

Conclusion

These trials using two canola hybrid varieties with different herbicide technology confirmed the typical trends observed in canola whereby the seed protein increases with increased N fertiliser whilst the oil content decreases. However, higher N fertiliser does not always result in higher yields. A subsequent year of yield and protein measurements at these sites when sown to a cereal is needed to assess the value of any residual N. Further investigation in seasons suitable to sclerotinia infection is also required to explore how increased N, and subsequent increased biomass and canopy bulk, affects the occurrence of disease.

References

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Important disclaimer