2023 Hyola Innovation Winter Canola Graze n Grain by Nitrogen Rate Results – Naracoorte SA

Comparing Dry Matter Production, Grain Yields, and Gross Returns of Winter Clearfield® canola under a Matrix of 8 different Nitrogen rate strategies with grazed vs un-grazed.

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Key messages

- TOS-related phenology responses and nitrogen management have a significant influence on early biomass development, DM production, grazing recovery times, and potential grain yield of the winter graze n grain types.
- 400kg applied N/ha provided the best responses to both biomass dry matter feed production, grain yield production, and associated gross returns, higher than the 200kg/ha and 100kg/ha N strategies.
- Treatments that were identified as the most aligned with previous research where 150-250kg/ha of N potentially available (applied plus soil N and mineralisation) provides solid returns due to increased concerns over animal health associated with very high nitrate levels and without taking on the extra production risk associated with the cost of fertilizer for 400kg/ha N and the varying growing conditions within or across seasons and environments.
- Nitrogen rate effects on plant growth and subsequent accumulation relationships of Nitrate levels in canola plants' Stem and leaf components have important ramifications for decisions on animal health considerations.

Keywords: Winter type, Winter canola, dual-purpose, hybrid, CL, nitrogen rates, grazing, canola, Hyola, grain yield, gross returns, nitrogen management, nitrogen by grazing, dry matter production.

Background

As the cropping area of Graze n Grain Winter type canola increases significantly across Australia, (now estimated at 200,000ha) coupled with extraordinary dual-purpose gross returns from the combined grazing and grain components, growers and advisors are seeking more scientific-based information around some Nitrogen rate strategic comparisons across one and two grazing events.

Growers and advisors have been trying to find a balance across different paddocks and seasons between Nitrogen rate applications and timings, biomass dry matter production, and plant height and how these factors are affected by grazing events on final grain yield, and gross returns. Outside of using growth regulators, this research investigated how different nitrogen rate strategies interacted with grazed vs un-grazed canola across multiple growing environments.

Method

This research trial conducted near Naracoorte SA forms part of a 4 trial MET group across Australia. This trial represents 1 of 4 trials in higher rainfall environments with a good range of differences for seasonal rainfall, cropping histories, soil types, and soil pH, whilst applying a combination of Best Management Practice (BMP) and District Standard Practice (DSP) treatments per each location, thus enabling a diverse set of data collection for accurate comparison.

1 Winter hybrid Clearfield® canola variety, Hyola Feast CL was sown with 8 Nitrogen rates applied graduating from 0 to 400 kg N per ha with one grazing event compared to 6 Nitrogen rates applied graduating from 0 to

400 kg N per ha with no grazing, grain only harvest. The target population for all treatments was 35 plants per m2, based on 90% germination and an estimated 75% establishment survival factorial by adjusting all seed packet weights.

Measurements across all replicates and environments conducted were visual subjective vigour ratings at 4-6 leaf stage, visual maturity ratings at flowering and maturity, plant height (cm), grain yield (t/ha) using plot harvesters, and Gross return calculations using base assumptions included in tables provided.

Population, and Yield analysis for Single Sites were performed fitting Entry, Vigor, Leaf and Stem Dry matter, Flowering maturity (MATR), plant height (HGT) and yield (GYH) as fixed linear factors and spatial adjustments performed using the auto-regressive model hence giving a BLUE output for each site. Statistical Reference: Using ASReml (Gilmour *et al.,* 2023).

In addition, this site will be included in a Single Step Factor Analytic MET (Multiple Environment Trial) analysis with ASReml in a model with Nitrogen rates and grazing events as a linear fixed factor with Composite Entry as a random factor hence giving a BLUP for each site. Spatial adjustments were determined using the auto-regressive model. Significant G*E*M effects were identified by the MET analysis. Statistical Reference: Using ASReml (Gilmour *et al*., 2023).

Trial Name	**23STWL56_NAR**		
Company Name	Pacific Seeds		
Individual contact	Justin Kudnig	**Contact number**	0408 408 616
Trial custodian	Nic Amos	**Contact number**	0427 826 733
Crop:	Canola CL	**Variety**	Hyola Feast CL
Site:	Naracoorte	**Previous crops:**	Faba Beans: Clover: Wheat
Date sown: **Soil Type:**	29-Mar-23 Grey Clay Loam	**Date harvested:** **Bulk Density: pH**	18-Dec-23 1.3: 6.90 (CaCl2)

Treatment List

Grazing Treatment	Nitrogen Trt #	Applied sowing	Post Graze or 8-10 Leaf	Start Flowering	Total N Applied	Applied Urea $/ha
1 Grazing Event Simulated Treatment	1	0	0	0	0	$0
	2	100	0	0	100	$130
	3	100	100	0	200	$260
	4	200	0	0	200	$260
	5	0	200	0	200	$260
	6	100	200	100	400	$520
	7	100	100	200	400	$520
	8	200	100	100	400	$520
Nil Grazing Grain Only Treatment	9	0	0	0	0	$0
	10	100	0	0	100	$130
	11	100	100	0	200	$260
	12	200	0	0	200	$260
	13	0	200	0	200	$260
	14	100	200	100	400	$520
	15	100	100	200	400	$520
	16	200	100	100	400	$520

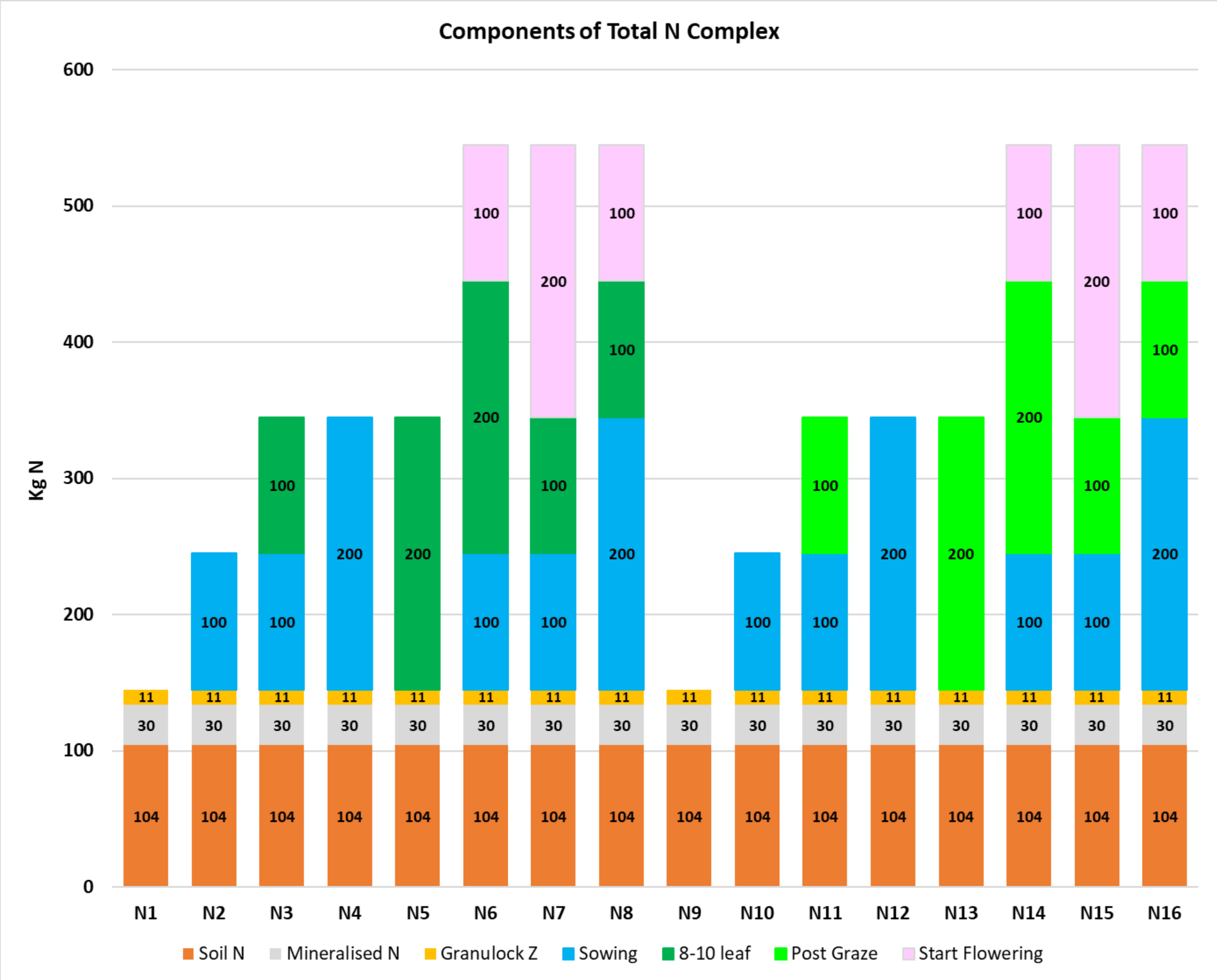
Table 1. Applied Nitrogen rates across different growth stages in total N kg/ha within the matrix of the grazing vs grain-only treatments.

Rainfall Data

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

1	0	0.2	0	0	1.4	2	1.4	0.4	0.2	0	0	0
2	0	0	0	0	3	0	0.4	0	0	0	0	0.6
3	0	14.2	0	0	11.4	0.4	0	0	0	2	0	0
4	0	4.4	0	0	0.4	0	5	2.8	1.2	1	0	0
5	0	0	0	0	0	0	0.6	0.4	0.4	0	0	0
6	0	0	3.6	0	7	0.4	0.8	0	0	2	0	0
7	0	0	2		0	11.6	3.6	0.2	0.8	0	0	0
8	0	0	6.2	24	0.2	10.8	20	0	11.2	0	0	0
9	0	0	1	0	0.2	8.4	8	0	1.2	0	0	5.8
10	0	0	0.4	0.4	0		3.6	5.4	8.2	0	0	3.8
11	0	0	0	0.2	0	3.6	1	1	0.4	0	0	6.8
12	0	1.2	2.4	9.8	0.2	0	0.2	2	0	0.8	0	1.8
13	0	0	0	3.4	0	17	0	1.2	0	0.6	0	7
14	0	0	0	0.2	0	4.6	0	0	0	0.6	0.8	0.8
15	0	0	0	7.4	0	9.2	1.6	0.2	0	2.6	0	0
16	0	0	0	2.6	0.4	2.4	0.2	0	0.2	6.8	0	0
17	0	0	2.2	0.4	0	0	0	0	0	0	0	0
18	10	0	0	0.2	0	10.4	2.4	10.2	0	0	0	0.6
19	0	0	0	1	1.2	29.8	0.2	1.8	0	0	0	7.2
20	0	0	0	0.2	1.2	0.2	1.8	0.6	2	0	0	0
21	0	0	1.6	1	2	0	2	0	5.6	0	0	0
22	0	0	0	0.2	0	2.6	0.4	1.2	0	3.8	0	0
23	0	0	0	0	0	2.8	2.2	0	0	0.4	0	0
24	0	0	0	0	0	0.6	0.6	0	0	0	35.6	0
25	0	14	0	0	2.8	6.2	0.2	0	0	1.6	56.4	10
26	0	2	0	0	1.8	22.5	0.2	0	0.2	0	0.4	2.8
27	0	0.2		10.6	0.6	2.9	0	0	0	0	0	0
28	0	0	5.4	1.8	16.2	1.2	10.6	0	0	0	0	0
29	2.8		0	0.8	0.6	0.8	0.4	0	0	0	0	0
30	0		0	0	0.6	1.8	0.2	1	0	0	0	0
31	0		1		0.2		3	0.4		6.8		0
Month Total	12.8	36.2	25.8	64.2	51.4	152.2	70.6	28.8	31.6	29	93.2	47.2
Year to date	12.8	49	74.8	139	190.4	342.6	413.2	442	473.6	502.6	595.8	643
Mar -Nov			25.8	90	141.4	293.6	364.2	393	424.6	453.6	546.8	
April - Nov				64.2	115.6	267.8	338.4	367.2	398.8	427.8	521	

Figure 1. 2023 Naracoorte SA – Growing Season Rainfall Data (Bool Lagoon – Locksley Farm SA)



Graph .1. Total N availability showing Nitrogen rates across different growth stages encompassing Residual Soil N, Mineralised N, and Applied Nitrogen.

Trial Management

Simulated grazing event cuts for Leaf and or Stem Dry Matter

26-June-23: WOSR grazing cuts for leaf and stem

Grazing Treatments were dry matter cuts taken in 1m2 quadrants and then whole plots were all mechanically mown down to 10cm stem height to simulate a moderate to high grazing event.

Stem dry matter cuts were also taken from 1m2 for dry matter to assist in determining potential grain yield after any treatments final leaf dry matter cut operation.

Representative Leaf and Stem samples were also tested for Nitrate levels in mg/kg.

Figure 2a. Grazing section - 0Kg N vs 200Kg N applied.

Figure 2b. Grazing section - 0Kg N vs 400Kg N applied.

Figure 3a. Grazing section - 100Kg N vs 200Kg N applied.

Figure 3b. Grazing section - 100Kg N vs 0 Kg N applied.

Figure 4a. 0Kg/ha N applied.

Figure 4b. 100Kg/ha N applied.

Figure 4c. 200Kg/ha N applied.

Figure 4d. 400Kg/ha N applied.

Figure 5. Naracoorte SA Hyola Winter Innovation Trial – June 2023

Figure 6. UAV Image – Naracoorte SA Hyola Winter Innovation Trial – July 2023

Figure 7. UAV overview image (Naracoorte SA Hyola Winter Innovation Trial) - September 2023

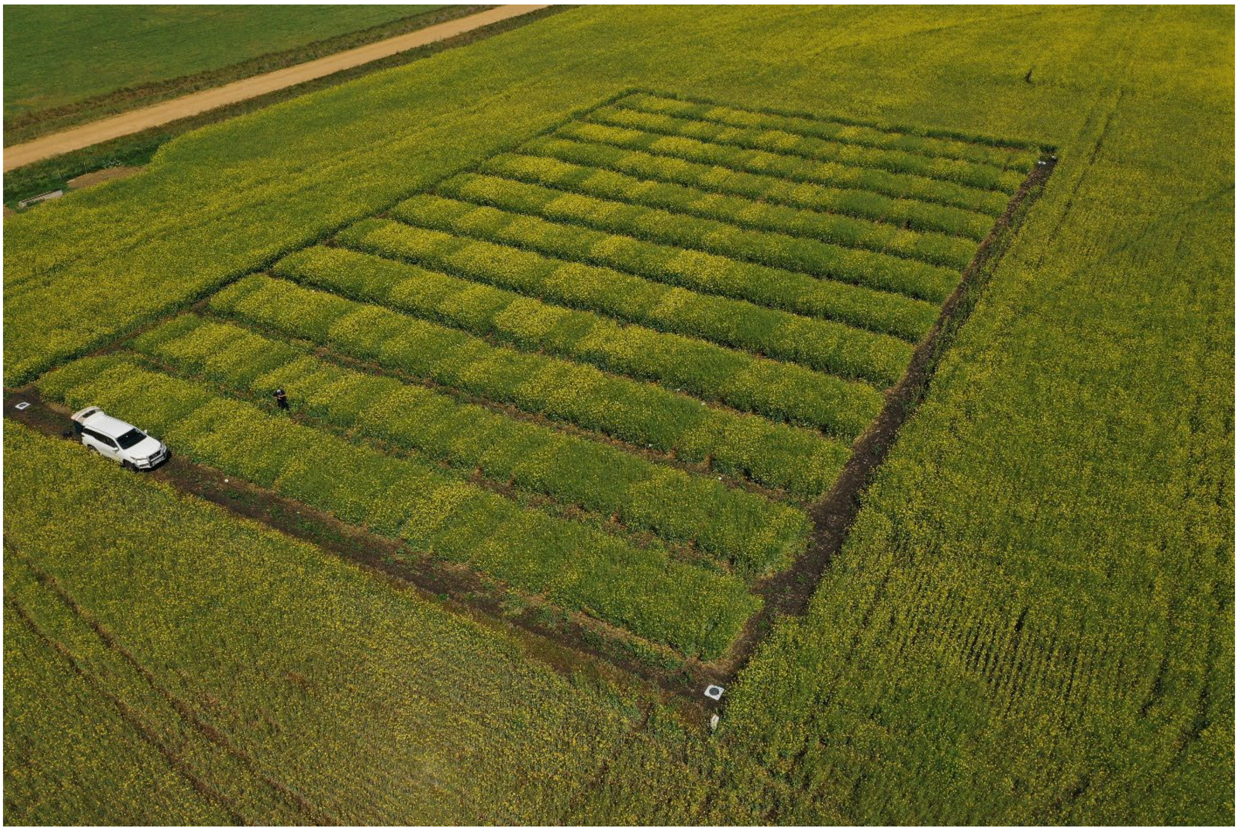


Figure 8. UAV overview image (Naracoorte SA Hyola Winter Innovation Trial) - September 2023

Results and Discussion

This trial was sown inside normal recommended sowing windows (February – March), on the 29th March 2023, however, there were wetter conditions experienced during June which may have led to limited Dry matter growth recovery potential and associated grain yield production.

Dry Matter yields from the total Leaf & Stem cut varied from 1.810 (t/ha) in the 0kg N9 treatment to 9.101 (t/ha) in the N16 applied N treatment regime. The higher N rate treatments showed significantly higher Dry matter production than the lower N rate treatments.

Winter Entry by Treatment	Total DM (t/Ha) Leaf & Stem	LSD Sig
N9	1.810	*e*
N10	4.593	*d*
N11	4.522	*d*
N12	8.955	*a*
N13	2.153	*e*
N14	7.426	*b*
N15	6.683	*c*
N16	9.101	*a*

Table 2. Total Dry Matter Production (t/ha) across N rate treatments N9 to N16 with CV = 8.247. LSD = 0.613, Mean Yield = 3.911

Treatment #	Leaf Nitrate mg/kg	Stem Nitrate mg/kg
N9	40.00	40.00
N10	397.66	1640.45
N11	503.51	1932.96
N12	718.46	6546.20
N13	40.00	51.46
N14	402.40	1806.56
N15	451.73	1939.82
N16	989.78	8531.22

Table 3. 1st Leaf and Stem Nitrate results (mg/kg) across N rate treatments N9 to N16

Leaf nitrate test levels across all N treatments from the DM leaf cut showed values increasing with the amount of N applied at sowing time. Levels under 1500 mg/kg are within the acceptable levels of being safe to graze.

Stem Nitrates from the DM cut, across treatments N9 to N16, showed that any treatment with upfront N applied at sowing had levels above 1500 kg/kg and could cause some animal health issues.

Block J, (2020) recommends for nitrate levels between 1500 to 4000 pro-rata limitation of the ration should apply including not feeding to pregnant animals, whereas levels > 4000 is dangerous and do not feed to animals.

General principles associated with nitrate accumulation are that the smaller the plant size, the more concentrated the nitrate levels are, especially in the Stem component of the plant.

This helps explain the results between Leaf and Stem tested nitrate values, including the increasing Nitrate trend relationship with the total N rates applied at sowing.

Treatment #	VIGR	MATR	HGT	GYH
N1	9.129	8.148	150.62	4.370
N2	10.729	7.803	150.62	4.573
N3	10.887	7.812	157.11	4.881
N4	11.926	7.796	154.52	4.717
N5	8.702	7.993	164.74	4.848
N6	11.002	7.973	154.07	4.957
N7	11.018	8.011	156.92	5.113
N8	10.810	7.673	159.67	4.809
N9	7.372	8.375	146.78	4.416
N10	10.084	7.892	148.11	4.594
N11	11.266	7.738	157.76	4.725
N12	10.841	7.862	146.04	4.704
N13	7.020	8.075	164.29	4.887
N14	10.328	7.890	163.71	5.162
N15	10.334	7.931	164.55	5.274
N16	10.438	7.929	165.41	5.378
Grand Mean Entry	**8.443**	**8.608**	**153.19**	**4.533**
CV_Percentage	**7.309**	**3.480**	**3.360**	**7.824**
LSD (0.05)	**0.995**	**0.483**	**8.344**	**0.571**

Table 7. Analysed results for Plant vigor, flowering maturity, plant height, and harvested grain yield across N rate treatments N1 to N16.

Analysed results for a range of measured traits are shown above in Table 7. Plant vigor values for the grain-only and grazed sections showed significant differences between the 0Kg/ha N and all the applied N treatments.

The flowering maturity scores did show a trend towards earlier maturity for grain-only and grazing treatments with N-applied treatments compared to the 0Kg/ha N control.

Plant height measurements for the grain-only and grazed sections showed significant differences between the 0Kg/ha N and all the applied N treatments. In the grazing section, there were also some significant increases in plant height between the N rates applied.

Grain yield results within grain-only (N1-N8) or grazed treatments (N9-N16) showed there were significant responses with the 200 and 400kg/ha N treatments compared to the 0kg/ha N treatments and sometimes between the 100kg or 200kg/ha N treatment strategies compared to the 400kg/ha N applied treatments.

When comparing grain yield results across grain-only (N1-N8) to all grazed treatments (N9-N16) there were no significant responses between each of the comparable N treatments, meaning that the grazing event did not adversely affect the harvested yield values.

Whether grazed or grain-only, the 400kg/ha N treatments provided the highest harvested grain yields.

Nitrogen Rate by Grazing Event Trt	Mean Total DM Yield Kg/ha	Grazing yield (60% less 40% residual loss)	30kg Lambs/ha @ 1.2kg/DM/hd/day for 30 days	Total Value = Mean Lamb Yield $/ha @ 100g/day Meat @ $4/kg	Grain Yield Gross Return $/ha minus Nitrogen Costs	Total Gross Return Value $/ha
N1	0	0	0	$0.00	$2,927.90	$2,927.90
N2	0	0	0	$0.00	$2,933.91	$2,933.91
N3	0	0	0	$0.00	$3,010.27	$3,010.27
N4	0	0	0	$0.00	$2,900.39	$2,900.39
N5	0	0	0	$0.00	$2,988.16	$2,988.16
N6	0	0	0	$0.00	$2,801.19	$2,801.19
N7	0	0	0	$0.00	$2,905.71	$2,905.71
N8	0	0	0	$0.00	$2,702.03	$2,702.03
N9	870	522	15	$174.00	$2,958.72	$3,132.72
N10	1795	1077	30	$359.00	$2,947.98	$3,306.98
N11	1925	1155	32	$385.00	$2,905.75	$3,290.75
N12	2622	1573	44	$524.40	$2,891.68	$3,416.08
N13	910	546	15	$182.00	$3,014.29	$3,196.29
N14	1634	980	27	$326.80	$2,938.54	$3,265.34
N15	2080	1248	35	$416.00	$3,013.58	$3,429.58
N16	2524	1514	42	$504.80	$3,083.26	$3,588.06

Table 8. – Total Gross Return Comparisons ($/ha) combining Mean Lamb Yield $/ha + Grain Yield gross returns across N rate treatments N1 to N16. (Assumptions: non-GM Grain Price = $670/MT, Urea @ $600/MT)

Mean Total Dry Matter yield refers to the N9 to N16 treatments, whereas for treatments N1 to N8 was the grain-only N applied treatments. Grazing Yield in kg/ha is expressed as a 60% value less the 40% residual value.

Mean Lamb yield expressed as $/ha is based on the assumptions of the number of lambs for 30 days yielding 100g/day meat at $4.00 per kg. The Total Gross Return value provided as heatmap $/ha values are the combination of both the Mean Lamb Yield (Grazing Value) plus the Gross Grain Yield Returns (Nitrogen costs removed).

After one grazing event, gross $/ha returns were higher than all grain-only treatments including the N9 treatment of 0Kg/ha of N applied, ranging between $122 to $787 per ha differences.

Overall, the 3 highest gross returns came from the 1 grazing event treatments, N12, N15, and N16 which were 200kg/ha N and 400 Kg/ha N applied treatments, irrespective of N application timing.

Treatments N11 and N12 were identified as probably the most aligned with previous research where 150-250kg of N applied providing solid returns. However, in this trial, the 400kg/ha N treatments of N15 and N16 provided the highest returns due to the very high dry matter production and grain yields.

Conclusion

Kirkegaard et al 2012, stated that factors affecting vegetative growth, flowering, seed-filling, and grain yield in canola included vapour pressure deficits, daylength, total solar radiation, maximum temperatures, minimum temperatures, and total monthly evaporation, rainfall and irrigation.

Overall, the results from this trial highlighted the need for growers to align with previous research which recommends earlier sowing into February and March for Winter canola types to complete yield recovery in crops defoliated in the vegetative stage and provide sufficient time and reasonable conditions allow sufficient biomass recovery to fulfil the water-limited yield potential.

Kirkegaard et al, also concluded that later defoliations than optimal timings prior to bud formation or after bud elongation, combined with accelerated development prevented the recovery of leaf area and biomass and reduced assimilation during pod-fill in defoliated plants.

It is important to note that TOS-related phenology responses and nitrogen management have a significant influence on early biomass development, DM production, grazing recovery times and potential grain yield of the winter graze n grain Winter types.

This research showed that 400kg applied N/ha for either upfront or split application provided the best responses to biomass dry matter feed production, grain yield production, and associated gross returns, higher than the 200kg and 100kg N strategies.

However, the overall recommendation is to focus on the 200kg/ha applied N due to increased concerns over animal health associated with very high nitrate levels and without taking on the extra production risk associated with the cost of fertilizer for 400 kg/ha under variable growing conditions within or across seasons and environments.

Nitrogen rate effects on plant growth and subsequent accumulation relationships of Nitrate levels in canola plants, Stem, and leaf components have important ramifications for decisions on animal health considerations.

Industry research by CSIRO, Departments of Ag, GRDC-funded groups, and Pacific Seeds have demonstrated that TOS-related phenology responses and nitrogen management have a significant influence on early biomass development, DM production, grazing recovery times, and potential grain yield of the winter graze n grain types.

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