2023 Hyola Innovation Winter Canola Graze n Grain by Nitrogen Rate Results – Tatyoon Vic

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 has a significant influence on early biomass development, DM production, grazing recovery times and potential grain yield of the winter graze n grain types.
- 150-250kg/ha of N potentially available (applied plus soil N and mineralisation) treatments provided the best responses to both biomass dry matter feed production, grain yield production and associated gross returns for growers.
- These treatments were identified as probably the most aligned with previous research where 100-200kg/ha of N applied, which provides solid returns without taking on the extra production risk associated with the cost of fertilizer for 400 kg/ha 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.

Key words: 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 Inverleigh, Victoria 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, Yield and Oil% 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_LKB**		
Company Name	Pacific Seeds		
Individual contact	Justin Kudnig	**Contact number**	0408 408 616
Trial custodian:	Alex Prince	**Contact number**	0436 331 535
Crop:	Canola CL	**Variety**	Hyola Feast CL
Site:	Tatyoon	**Previous crops:**	Wheat: Barley: Canola
Date sown:	24-Mar-23	**Date harvested:**	13-Dec-23
Soil Type:	Brown Clay	**Bulk Density: pH**	1.3: 6.20 (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

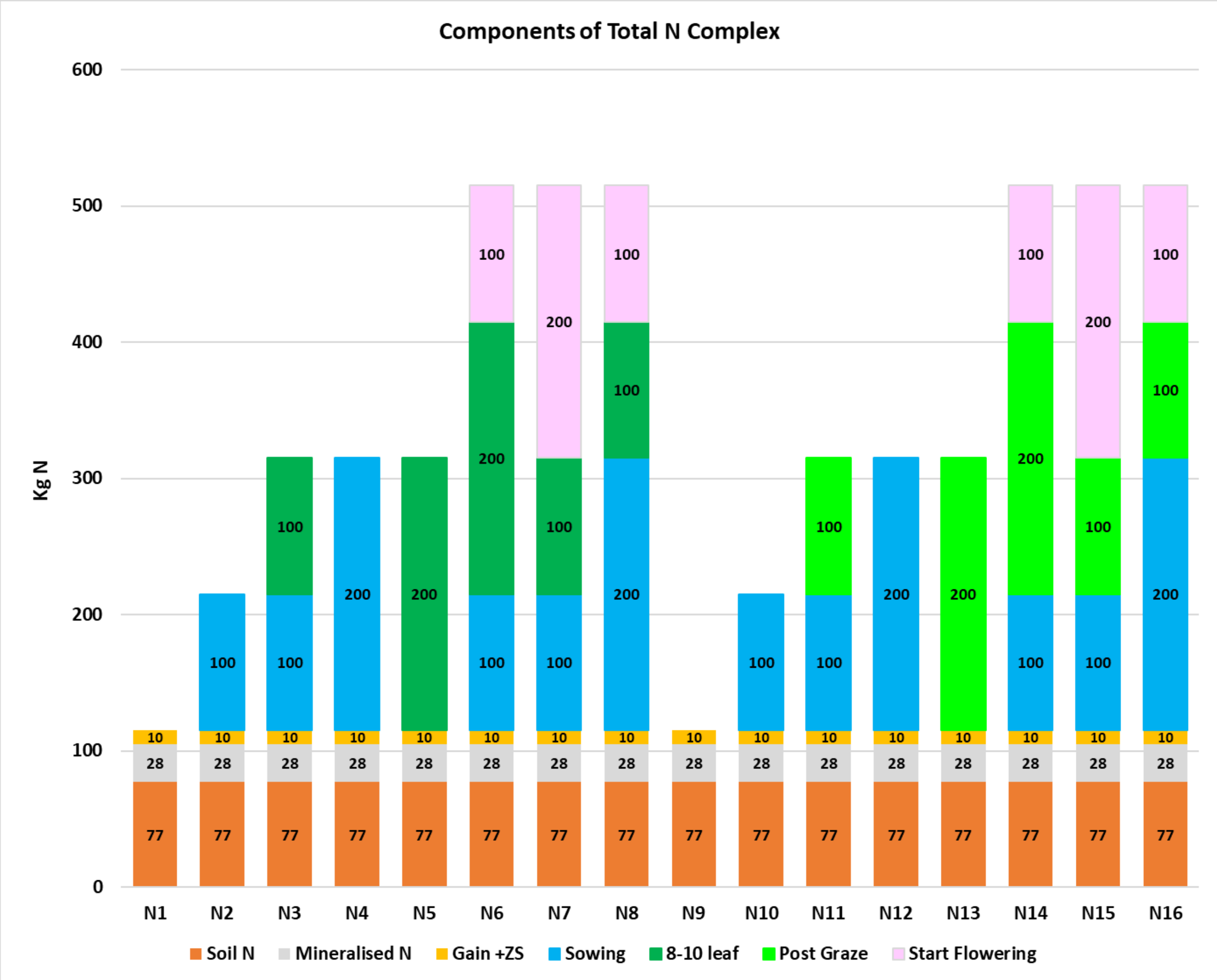
Table 1. Applied Nitrogen rates across different growth stages in total N kg/ha within the matrix of the number of grazing events.

Rainfall Data

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

1	0	0	0	1.8	0	1.8	0.8	0.6	0.8	0	0	0
2	0	0.2	0.2	0	0.2	0	0.6	0			0	5.8
3	0	12	0	0	5	3.6	0	0		3	0	0
4		10.6	0	0.2	1.2	2.8	0.8	0.6	0	2.2	0	0
5		0	0	0	0	0.2	3	0.4	1.4	0.2	0	0
6	0	0	3.2	0	4	0	0	0.2	0	2.2	0	0
7	0	0	0	15.8	1	3.2	0.4	0.4	0	0	0	0
8	0	0	2.4	25	0.2	14.4	2	0.2	8	0	0	0
9	0	0	0	2	2.4	5.4	2.6	0	3	0	0	6.4
10	0	0	0.4	3	0.8	0.4	0.8	2.4	1.4	0		13.2
11	0	0	0	0.8	0	0.2	0	0.6	0	0	0	11
12	0	0.8	0	7.2	0	0		0.2	0.2	2.8	0	9.8
13	0	0	0	5.4	0	3.2		1.2	0	6.6	0	0
14	0	0	0	0	0.2	2.4	0	0.2	0	1.8	0	
15	0	0	0	0.2	0	0.8	0.2	0	0	0.8	0	0
16	0	0	0	12.8	0.8	0	0.4	0.2	0	3.4	0.4	
17	0	0	1	0.4	0.4	0	0	0	0	0.4	0	
18	4	0	0.2	0	0	4.8	0	4.6	0	0	0	
19	0.6	0	0	0.2	0.6	17.8	1.2	0.8	0	0	0	4.2
20	0	0	0	0	2.2	0.8	0	0	0.6	0	0	
21	0	0	0	0	3	0	2	0	1.6	0	0	0
22	0	0	0	0	0	1.2	0	2.8		0	0	
23	0	0	3.2	0	0	0.6	1.2	1.4	0	2	0	
24	0	0	6.2	0	0	0	0.2	0.2	0	0	0.8	0
25	0	0.2	0	0	0	2	0.2	0	0	0	10.8	26.8
26	0	14.2	0	0	2.8	2	0.2	0	0		16.8	22.2
27	0	0.4	2	7.4	0.2	0.2	0.2	0		0	1.2	1.8
28	0	0	4.8	0.4	2.2	1.6	6.2	0	0	0	0.2	
29	2		0	0.2	2.4	0.4	0.2	0	0	0	0.6	0.2
30	0.6		0.2	0	0	0.2	0	4.4	0	0	2.8	0
31	0		0.2		0		1.8	2		2		0.2
Month Total	7.2	38.4	24	82.8	29.6	70	25	23.4	17	27.4	33.6	101.6
Year to date	7.2	45.6	69.6	152.4	182	252	277	300.4	317.4	344.8	378.4	480.0
Mar -Nov			24	106.8	136.4	206.4	231.4	254.8	271.8	299.2	332.8	
April - Nov				82.8	112.4	182.4	207.4	230.8	247.8	275.2	308.8	

Figure 1. 2023 Tatyoon Vic – Growing Season Rainfall Data (Westmere)



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

05-July-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. N3 - 100Kg/ha N PSPE + 100k/hag N at 8-10 leaf stage

Figure 2b. N8 - 200Kg/ha N PSPE + 100kg/ha N at 8-10 leaf stage

Figure 3a. N11 - 100Kg/ha N PSPE + 100kg/ha N post grazing

Figure 3b. N15 - 100Kg/ha N PSPE + 100kg/ha N post grazing

Figure 4a. N12 - 200Kg/ha N PSPE then grazed, no more N applied

Figure 4.b N12 - 200Kg/ha N PSPE then 100Kg/ha N post grazing.

Figure 5a. N1 – Nil Control 0Kg/ha applied with no grazing

Figure 5b. N9 – Nil Control 0Kg/ha applied with 1 grazing event.

Figure 6. Gorst Rural agronomists with Dan Rolls (Pacific Seeds) with grain-only treatment plots of 200Kg N and 400Kg

Figure 7. Gorst Rural with Pacific Seeds Field Day (Tatyoon Vic Hyola Winter Innovation Trial) - July 2023

Figure 8. Gorst rural agronomists (Tatyoon, Vic Hyola Winter Innovation Trial) - July 2023

Results and Discussion

This trial was sown inside normal recommended sowing windows (February – March), on the 24th March 2023. There were some waterlogging conditions, extremely high resistant ryegrass pressure, and 2 spray strategy clethodim herbicide damage which led to higher competition that significantly limited Dry matter growth potential for total Dry matter yield and grain yield production.

Dry Matter yields from the total Leaf & Stem cut varied from 0.870 (t/ha) in the 0kg N13 treatment to 2.622 (t/ha) in the N12 applied N treatment regime. The higher N rate treatments trended towards higher Dry matter production than the lower N rate treatments and the 0kg/ha N applied treatments, depending on the N timing strategy applied.

Winter Entry by Treatment	Total DM (t/Ha) Leaf & Stem	LSD Sig
N9	0.870	*e*
N10	1.795	*cd*
N11	1.925	*bc*
N12	2.622	*a*
N13	0.910	*e*
N14	1.634	*d*
N15	2.080	*b*
N16	2.524	*a*

Table 2. Total Dry Matter Production (t/ha) across N rate treatments N9 to N16 with CV = 4.014. LSD = 0.275, Mean Yield = 1.795

Treatment #	Leaf Nitrate mg/kg	Stem Nitrate mg/kg
N9	40.00	40.00
N10	397.66	1640.45
N11	111.79	1758.12
N12	718.46	6546.2
N13	40.00	51.56
N14	267.43	3178.78
N15	451.32	4399.41
N16	1113.58	8472.87

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 cuts were all below 1500 mg/kg, which is well within the acceptable levels of being safe to graze.

However, Stem Nitrates from the DM cut, across treatments N9 to N16, showed that the treatments with upfront N applied at sowing were all above 1500 mg/kg, which is the published danger level and has some important limitations for grazing by cattle and sheep.

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 measured levels > 4000 are 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, which was evident in these trial plots.

This helps explain the results between Leaf and Stem tested nitrate values, including the increasing Nitrate trend relationship with the timing of N applications.

Treatment #	VIGR	MATR	HGT	GYH
N1	7.847	7.958	147.39	2.793
N2	8.508	7.804	154.14	4.007
N3	8.683	7.926	154.75	3.897
N4	8.673	8.022	148.54	3.343
N5	8.847	8.015	159.89	3.706
N6	9.346	8.052	148.48	3.706
N7	8.507	8.056	149.93	3.605
N8	9.175	8.269	151.99	3.681
N9	8.534	7.587	140.89	2.239
N10	9.197	7.885	137.65	3.149
N11	9.033	7.782	134.04	2.409
N12	8.868	8.273	141.27	2.718
N13	8.199	7.435	145.80	2.700
N14	9.201	7.843	135.27	2.572
N15	9.531	8.004	142.69	2.508
N16	9.864	8.161	132.06	2.574
Grand Mean Entry	**8.587**	**7.937**	**145.22**	**3.102**
CV_Percentage	**3.385**	**2.894**	**4.184**	**10.266**
LSD	**0.471**	**0.382**	**10.00**	**0.377**

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

Analysed results for a range of measured traits are shown above in Table 7. Despite the large differences in N rate treatments, there was often no significant responses within total N treatments, however, there were between total N kg/ha applied treatments 0 to 100 to 200 to 400 with an increasing trend.

The flowering maturity scores did show some significant responses between lower N rate to higher rate treatments, with the overall trend of higher N rate treatments being slightly later to mature in the grazing section and relatively similar to mature in the grain-only treatment section.

Plant height measurements in the grain-only treatment section generally responded to higher rates of N applied, however with the 3 treatments with a total of 400kg N applied, the plant height decreased when compared to the 3 treatments with 200kg N applied. In the grazed treatment section, there was no clear pattern other than the potential influence of the N timing of applications.

Grain yield results within grain-only (N1-N8) showed there were significant responses with the 100, 200, and 400kg/ha N treatments compared to the 0 kg/ha N control treatments. Yield results within grazed treatments (N9-N16) showed that the N10 treatment of 100Kg/ha N at sowing with no further N applications gave a significantly higher yield than all other treatments.

When comparing grain yield results across grain-only (N1-N8) directly to grazed treatments (N9-N16) there were significant responses for all treatments with N applied treatments, meaning that the grazing event adversely affected the harvested yield values.

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	$1,871.31	$1,871.31
N2	0	0	0	$0.00	$2,554.69	$2,554.69
N3	0	0	0	$0.00	$2,350.99	$2,350.99
N4	0	0	0	$0.00	$1,979.81	$1,979.81
N5	0	0	0	$0.00	$2,223.02	$2,223.02
N6	0	0	0	$0.00	$1,963.02	$1,963.02
N7	0	0	0	$0.00	$1,895.35	$1,895.35
N8	0	0	0	$0.00	$1,946.27	$1,946.27
N9	870	522	15	$174.00	$1,500.13	$1,674.13
N10	1795	1077	30	$359.00	$1,979.83	$2,338.83
N11	1925	1155	32	$385.00	$1,354.03	$1,739.03
N12	2622	1573	44	$524.40	$1,561.06	$2,085.46
N13	910	546	15	$182.00	$1,549.00	$1,731.00
N14	1634	980	27	$326.80	$1,203.24	$1,530.04
N15	2080	1248	35	$416.00	$1,160.36	$1,576.36
N16	2524	1514	42	$504.80	$1,204.58	$1,709.38

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 showed varied responses depending on the N rate and timing strategy applied, where treatments N10 and N12 showed higher returns than other grazing treatments, especially against N9 with no N applied, whilst the N6, N7, and N8 showed the strong financial impact of the cost associated with a total of 400kg/ha N being applied.

In the grain-only treatments, N2 - nil N upfront, N3 - 200kg/ha N upfront with no further N applications, and N5 – 200Kg/ha N applied post-grazing demonstrated the highest returns for growers.

Treatments N2, N3, N5, and N12 were identified as probably the most aligned with previous research where 150-250kg/ha of N potentially available (including soil N and mineralisation) provides solid returns 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.

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 150-250kg/ha of N potentially available (applied plus soil N and mineralisation) provided the best responses to both biomass dry matter feed production, grain yield production and associated gross returns for growers.

These treatments that were identified as probably the most aligned with previous research where 150-250kg of N applied which provide solid returns without taking 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.

Industry research by CSIRO, Departments of Ag, GRDC-funded groups, and by Pacific Seeds has 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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