2023 Hyola Innovation Winter Canola Graze n Grain by Nitrogen Rate Results – Wallendbeen NSW

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.

[1]*Justin Kudnig, Pacific Seeds Melbourne*

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.
- 200kg applied N/ha provided the best responses to both biomass dry matter feed production, grain yield production, and associated gross returns, higher than the 400kg/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 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 Wallendbeen, NSW 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_WAL		
Company Name	Pacific Seeds		
Individual contact	Justin Kudnig	Contact number	0408 408 616
Trial custodian	Rob Presser	Contact number	0429 002 205
Crop:	Canola CL	Variety	Hyola Feast CL
Site:	Wallendbeen	Previous crops:	Wheat: Canola: Barley
Date sown: Soil Type:	17-Mar-23 Silty Brown Loam	Date harvested: Bulk Density: pH	11-Dec-23 1.3: 5.09 (CaCl2)
Trial focus:	Hyola Innovation Winter CL Agronomy		

Treatment List

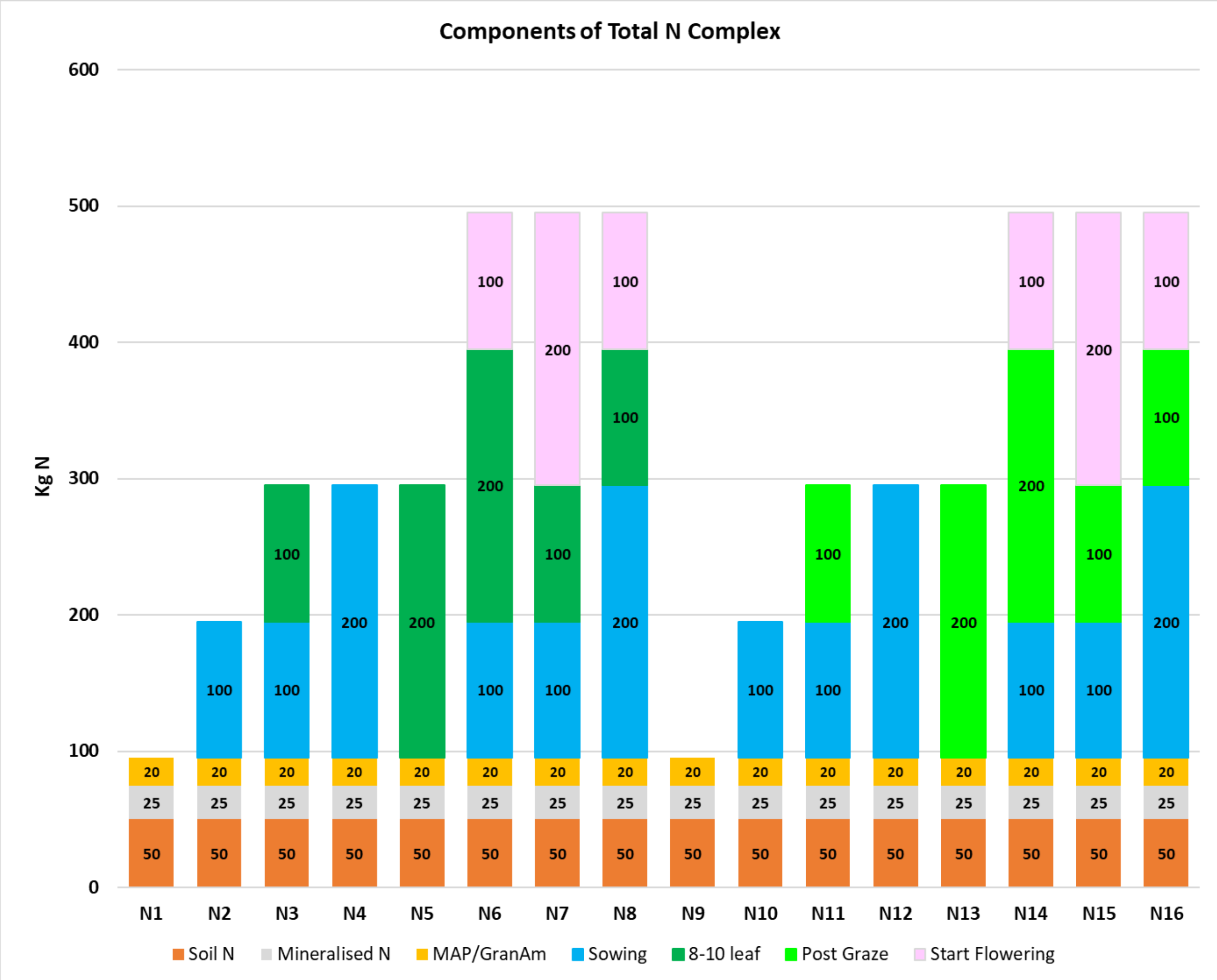
Grazing Treatment	Nitrogen Trt #	Applied sowing	Post Graze or 8-10 Leaf	Start Flowering	Total N Applied	Applied Urea $/ha
1 Grazing Event Simulated Treatment	1	0	0	0	0	$0
	2	100	0	0	100	$130
	3	100	100	0	200	$260
	4	200	0	0	200	$260
	5	0	200	0	200	$260
	6	100	200	100	400	$520
	7	100	100	200	400	$520
	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	0	10.2	0	3	0	0	0	0	0
2	0	0	0	0	2	0	3.4	0	0	0	0	0
3	0.2	0	0	0	0	0	0	0	0	0	0	1
4	0	0	0	0	4	0.6	3.2	0	0	1.8	0	0
5	0	0	0.8	0	0	2.6	11.4	2.8	0	37	0	0
6	0	0	20	10.6	0	0	1	0.4	0	0.8	0	0
7	0	0	0	0	9.2	0	6.4	0	0	0	0	0
8	0	0	0	7	4	6.1	0.4	0	3.2	0	0	0
9	0	0	0	0	0	6	3	0	1	0	0	7.8
10	0	0	0	0	0	0	2	0	0	0	5.4	0
11	0	0	0	0	0	0	0	0	0	0	0	8
12	0	0	0	0	0	0.4	0	0	0	0	0	0
13	0	0	35.8	7	0	0	0	1.8	0	3.4	0	0
14	0	0	3.6	0.6	0	3	0	7	0	0	0	17
15	0	0	1.8	0	0	0	0	4	0	0	0	0
16	2.2	0	0	8.8	0	0	0	0	0	0	0	0
17	0	0	0	1.4	0	0	0	17.4	0	2	0	0
18	0	0	0	0	0	0	0	3.2	0	0	0	0
19	3.6	2	0	0	0	0	0	3.4	0	0	0	0
20	0	0	0	0	0	8.2	0	0	0	0	0	4
21	0	0	0	0	1.6	0	0	0	0	0	0	0
22	0	0	31.6	0	0.2	0	0	0	0	0	0.4	0
23	0	0	8.8	0	0	12.6	0	5	0	0	0	0
24	0	0	14	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	6	0
26	0	0	0	0	1.6	0	0	0	0	0	2.6	0
27	0	0	0	0	0	0.2	0	0	0	0	0	0
28	0	0	0	0	0	2.4	0	0	0	0	0	9
29	0		1.3	10.2	8.4	6.6	6	0.6	0	0	47.6	3
30	9.8		6.8	17	2.4	0.8	0.2	0	0	0	10	11.8
31	6		0		0		0	2		0		0
Month Total	21.8	2	124.5	62.6	43.6	49.5	40	47.6	4.2	45	72	61.6
Year to date	21.8	23.8	148.3	210.9	254.5	304	344	391.6	395.8	440.8	512.8	574.4
Mar -Nov			124.5	187.1	230.7	280.2	320.2	367.8	372	417	489	
April - Nov				62.6	106.2	155.7	195.7	243.3	247.5	292.5	364.5	

Figure 1. 2023 Wallendbeen NSW – Growing Season Rainfall Data (Wallendbeen)



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. Grain-only section treatments - August 2023

Figure 2b. Grazing section treatments - August 2023

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

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

Figure 4a. Grazing section - 100Kg N vs 400Kg N applied.

Figure 4b. Grazing section - 0Kg N vs 400 Kg N applied.

Figure 5. Grain-only treatments N11 - 200kg/ha N total applied vs N14 - 400kg/ha N total applied.

Figure 6. Wallendbeen NSW Hyola Winter Innovation Trial in the foreground – August 2023

Figure 7. UAV overview image (Wallendbeen NSW Hyola Winter Innovation Trial) - September 2023

Figure 8. Wallendbeen NSW Hyola Winter Innovation Trial - August 2023

Results and Discussion

This trial was sown inside normal recommended sowing windows (February – March), on the 17th March 2023, however, there were some drier conditions experienced during September which led to limited Dry matter growth recovery potential and associated grain yield production.

Dry Matter yields from the total Leaf & Stem cut varied from 2.185 (t/ha) in the 0kg/ha N9 treatment to 3.944 (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	2.185	*c*
N10	3.167	*b*
N11	2.987	*b*
N12	3.843	*a*
N13	2.216	*c*
N14	2.964	*b*
N15	2.949	*b*
N16	3.944	*a*

Table 2. Total Dry Matter Production (t/ha) across N rate treatments N9 to N16 with CV = 8.623. LSD = 0.418, Mean Yield = 2.961

Treatment #	Leaf Nitrate mg/kg	Stem Nitrate mg/kg
N9	149.77	383.49
N10	1097.85	6607.62
N11	1371.95	6836.25
N12	2037.65	12309.27
N13	137.63	622.65
N14	1350.88	6996.39
N15	1515.37	6015.43
N16	2167.83	8639.04

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 of 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	8.476	8.497	141.55	2.543
N2	8.128	7.978	151.99	2.948
N3	8.475	8.000	170.44	3.212
N4	8.588	7.990	160.59	3.110
N5	8.374	7.951	168.34	3.103
N6	8.822	7.989	171.78	3.319
N7	8.986	7.990	166.76	3.819
N8	8.980	7.987	172.13	3.411
N9	8.395	8.491	137.33	2.102
N10	9.172	8.144	146.52	2.548
N11	8.445	8.112	159.57	3.165
N12	8.845	8.143	158.13	3.124
N13	8.505	8.485	159.57	3.030
N14	8.754	8.144	161.63	3.229
N15	8.883	8.272	161.44	3.547
N16	8.868	8.339	161.16	3.253
Grand Mean Entry	**8.593**	**8.577**	**156.87**	**3.323**
CV_Percentage	**3.385**	**2.003**	**3.065**	**8.611**
LSD	**0.469**	**0.277**	**7.751**	**0.461**

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. Despite the large differences in N rate treatments, there was a trend towards higher upfront N treatments applied at sowing to having higher plant vigor values.

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 earlier to mature in the grain-only section and some treatments slightly earlier to mature in the grazed section.

Plant height measurements in the grain-only treatment section generally responded to higher rates of N applied, with the 200kg/ha N and 400kg/ha N being taller than the 0kg/ha N and 100kg/ha N treatments. In the grazed treatment section, there was a general trend for higher plant heights with the 200kg/ha N and 400kg/ha N treatments compared to the 0 and 100 kg N treatments, with some treatments being significantly different.

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

When comparing grain yield results across grain-only (N1-N8) to 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	$1,703.81	$1,703.81
N2	0	0	0	$0.00	$1,845.16	$1,845.16
N3	0	0	0	$0.00	$1,892.04	$1,892.04
N4	0	0	0	$0.00	$1,823.70	$1,823.70
N5	0	0	0	$0.00	$1,819.01	$1,819.01
N6	0	0	0	$0.00	$1,703.73	$1,703.73
N7	0	0	0	$0.00	$2,038.73	$2,038.73
N8	0	0	0	$0.00	$1,765.37	$1,765.37
N9	2185	1311	36	$437.00	$1,408.34	$1,845.34
N10	3167	1900	53	$633.40	$1,577.16	$2,210.56
N11	2987	1792	50	$597.40	$1,860.55	$2,457.95
N12	3843	2306	64	$768.60	$1,833.08	$2,601.68
N13	2216	1330	37	$443.20	$1,770.10	$2,213.30
N14	2964	1778	49	$592.80	$1,643.43	$2,236.23
N15	2949	1769	49	$589.80	$1,856.49	$2,446.29
N16	3944	2366	66	$788.80	$1,659.51	$2,448.31

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 grain-only treatments except for the N9 treatment of 0 Kg/ha of N applied, ranging between $365 to $756 per ha differences.

Overall, the 4 highest gross returns came from the 1 grazing event treatments, N11, 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 provides solid returns without taking on the extra production risk associated with the cost of fertilizer for 400kg/ha N applied 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 200kg/ha N applied 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 400kg/ha and 100kg/ha N strategies.

These treatments were identified as probably the most aligned with previous research where 150-250kg/ha of N potentially available (applied plus soil N and mineralisation) which provides 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 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.

Acknowledgments

Thanks to Kalyx Australia personnel for trial management and operations. Thanks to Willow Liddle from Pacific Seeds for the trial designs and assistance with ASReml analysis. Special thanks to Dr John Kirkegaard, CSIRO Canberra for his ongoing technical guidance and review.

References

Block J, (2020) Nitrate Poisoning of. Livestock. V839 (Revised February 2020). NDSU EXTENSION. North Dakota State University. Fargo, North Dakota.

Bell LW, et al. (2015). Integrating canola and wheat into high-rainfall livestock systems in south-east Australia: 3. An extrapolation to whole-farm grazing potential and productivity. Crop and Pasture Science 66, 390-398

Dann PR, et al. (1977). The grain yield of winter grazed crops. Australian Journal Experimental Agriculture and Animal Husbandry 17, 452-461.

Dove H and Kirkegaard JA (2014). Using dual-purpose crops in sheep-grazing systems: a review. Journal of the Science of Food and Agriculture 94, 1276-1283

Harrison MT, et al. (2011). Dual-purpose cereals: can the relative influences of management and environment on crop recovery and grain yield be dissected. Crop and Pasture Science 62, 930-946.

Kirkegaard JA, et al. (2012). Refining crop and livestock management for dual-purpose spring canola (Brassica napus). Crop and Pasture Science 63, 429-443.

Kirkegaard JA, et al. (2020). Dual-purpose crops – direct and indirect contributions to profit. GRDC Updates Wagga Wagga February 2020.

Lilley JM, et al. (2015). An analysis of simulated grain yield and grazing potential of dual-purpose crops across Australia's high rainfall zone. 2. Canola. Crop and Pasture Science 66, 349-364

McGrath S, et al. (2021). Utilising dual-purpose crops effectively to increase profit and manage risk in meat production systems. Animal Production Science (in press).

Sprague SJ, et al. (2015). Forage and grain yield of diverse canola (Brassica napus) maturity types in the high-rainfall zone of Australia. Crop and Pasture Science 66, 260-274