TRIAL LOCATIONS 2019: Miling and Kojonup, Western Australia

TITLE:

TRIAL 1A: The interaction between seeding rate and row spacing of hybrid and open pollinated canola (*Brassica napus*) varieties on annual ryegrass (*Lolium rigidum*) growth and seed production.

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ABSTRACT

The trials located at Miling and Kojonup in the grainbelt of Western Australia investigated combinations of canola variety (hybrid or open pollinated), crop row spacing (25 or 50cm) and canola seeding rate (20, 35 or 50 plants/m^2). The average seedbank at the Miling and Kojonup sites were 3,630 seeds/m^2 and 23,240 seeds/m^2 respectively. Annual ryegrass (ARG) establishment was reduced in hybrid canola treatments seeded at narrower 25 cm row spacing. Decreasing crop row spacing (from 50 to 25cm) and increasing canola seeding rate (from 20 to 50 plants/m^2) was found to reduce ARG establishment in the absence of herbicides. At the Kojonup site, ARG seed production was reduced by hybrid varieties (Trophy) and higher plant densities (50 plants/m^2). However due to the low rainfall at the Miling site, no interactions were identified. Canola yield in this study was increased in hybrid variety (Trophy) treatments especially at higher seeding rates (50 plants/m^2). Interestingly, however, canola seeded at the wider row spacing (50cm) consistently out yielded the corresponding variety and seeding rate combination at the narrower 25cm row spacing. This study conducted two trials in 2018 (Mingenew and Cunderdin) and 2019 (Miling and Kojonup). Multi- environment trial analysis for the combined 2018 and 2019 data to be completed.

INTRODUCTION

Canola (*Brassica napus*) is a major oilseed crop used to food products (de Oliveira et al., 2015). Rapid innovation of canola genetics incorporating herbicide-tolerant traits and F1 hybrid vigor has resulted in a rapid increase in canola plantings in Australia. Canola production has increased from approximately 100,000 ha in the early 1990's to an estimated 1.4 million ha in 2017 (ABARE 2018). Central to the increase in canola yields has been the rapid development of herbicide-tolerant canola varieties (HTC) (Harker, Blackshaw, Kirkland, Derksen, & Wall, 2000). However, despite the use of herbicide tolerance in canola varieties, weeds still commonly occur (Lemerle et al., 2001). With the widespread resistance of weeds to many herbicide modes of action, non- chemical weed control tactics, such as crop competition is essential (Blackshaw, Anderson, & Lemerle, 2007). Canola competitiveness can be increased by reducing row spacing, increasing seeding rates and the use of crop cultivars that emerge quickly and exhibit early vigorous growth (Beckie, Johnson, Blackshaw, & Gan, 2008; Harker, Clayton, Blackshaw, O'Donovan, & Stevenson, 2003). Therefore, the objective of this study is to determine the optimal combinations of canola cultivar, seeding rate and row spacing on annual ryegrass seed production and canola growth and yield.

METHODS

Trial design: Randomised complete block

Replicates: 3

Locations (2): Milling and Kojonup in the Western Australian grainbelt.

Row Spacing (2): 25 and 50 cm

Seed rate / plant establishment target (3): 20, 35 and 50 plants/m^2

Variety (2): Trophy (Hybrid) and Bonito (Open pollinated).

Herbicide treatment (2): Without (Knockdown treatment only) and with (1 L/ha Propyzamide IBS, 1.1 kg/ha Atrazine IBS, 1.1 kg/ha Atrazine 2-4 leaf and 500 mL/ha Select 4-6 leaf).

TRIAL MANAGEMENT

Table 1 Trial management details.

Date sown	03 May 2018	
Crop type	TT Canola	
Variety	Trophy (Hybrid) and Bonito (OP)	
Seeding rate (kg/ha)	Trophy 50 plants/m2 = 3 kg/ha Trophy 35 plants/m2 = 2.1 kg/ha Trophy 20 plants/m2 = 1.2 kg/ha Bonito 50 plants/m2 = 2.8 kg/ha Bonito 35 plants/m2 = 1.9 kg/ha Bonito 20 plants/m2 = 1.1 kg/ha	
Tillage type	Minimum tillage	
Soil moisture, depth (cm)	Poor	>5
Seed bed	Standing Stubble	
Clod size	5-10 cm	
Stubble loading	10-20%	
Sowing equipment	Knife points and press wheels	
Sowing speed (km/hr)	5	
Sowing depth	1 cm	
Row spacing (cm)	25 and 50	
Fertiliser applied	Pre-emergent	70 kg/ha Gusto Gold 100 kg/ha Urea
Post-emergent	150 L/ha UAN	
Herbicides applied	Pre-emergent	2 L/ha Roundup Ultra Max 150 mL/ha Lontrel Other pre-em herbicides as per treatment list
Post-emergent	As per treatment list 120 mL/ha Lontrel 3 L/ha Roundup Ultra Max (12 Oct 2018)	
Fungicides applied	Seed treatment	400 mL/100kg-seed Maxim XL
Fertiliser treatment	300 mL/ha Impact	
Post-emergent	300 mL/ha Prosaro	
Insecticides applied	Seed treatment	1 L/100kg-seed Cruiser Opti
Pre-emergent	1 L/ha chlorpyrifos 200 mL/ha bifenthrin	
Post-emergent	300 mL/ha Affirm	

The data was analysed using an analysis of variance in Genstat v15.

LOCATIONS

The soil characterization for Miling (-30.29S, 116.22E) and Kojonup (-33.84S, 117.15E) in the Western Australian grainbelt can be found in Table 2. The long-term (19 years) average growing season (April to October) rainfall at Miling and Kojonup was 242 mm and 383mm respectively. Prior to this study, all sites had been under continuous no-till crop production for 10 years.

Miling 2019

The Miling site had an estimated annual ryegrass seed bank of 3,630 seeds/m^2 in the top 10cm of soil. The site was seeded in dry with limited rainfall (<5mm) in March (3 weeks before seeding). As a result, the trial was seeded into dry soil. Canola germination and emergence at the Miling site did not occur until June when 87 mm fell in the month (Figure 1). Rainfall events occurred in July and August; however, conditions were cold limiting growth. The final rainfall occurred in October, providing sufficient moisture for a modest yield (Figure 6).

Kojonup 2019

The Kojonup site had an estimated annual ryegrass seed bank of 23,240 seeds/m^2 in the top 10cm of the soil. The site was seeded in good soil moisture due to good rainfall in late March so we had rapid crop emergence. Following seeding, there was no subsequent rainfall until June were excellent rainfall was recorded in late July and mid-August eliminating water stress from this trial (Figure 1).

Table 2 Soil description at all 2019 experimental sites.

		Milling	Kojonup
	Depth (cm)	0-10	0-10
Colour		LTGR	DKGR
Gravel	%	0	0
Texture		1.5	2.0
Conductivity	dS/m	0.127	0.122
pH Level (CaCl2)		6.0	5.9
pH Level (H2O)		6.8	6.6
Exc. Aluminium	meq/100g	0.073	0.097
Exc. Calcium	meq/100g	3.51	9.26
Exc. Magnesium	meq/100g	0.85	1.06
Exc. Potassium	meq/100g	0.30	0.24
Exc. Sodium	meq/100g	0.08	0.09
Total Carbon	%	1.69	4.33
ECEC	meq/100g	4.8	10.7
Organic Matter	%	3.23	6.62
Organic Moisture %	%	1.0	6.2
MIR% Clay	%	22.30	22.30
MIR% Sand	%	74.80	75.00
MIR% Silt	%	2.90	2.70

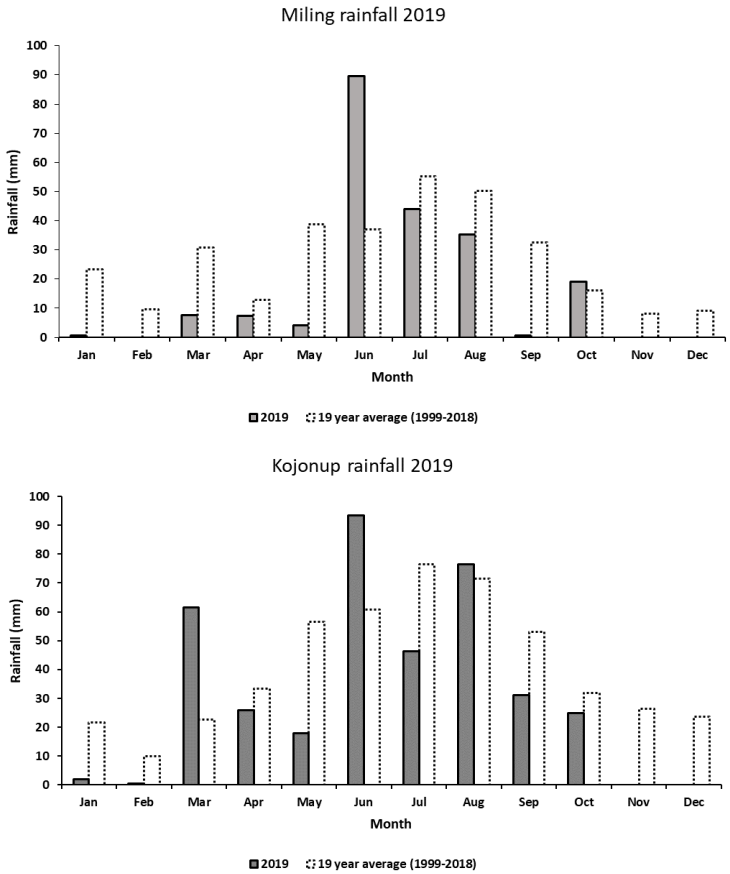
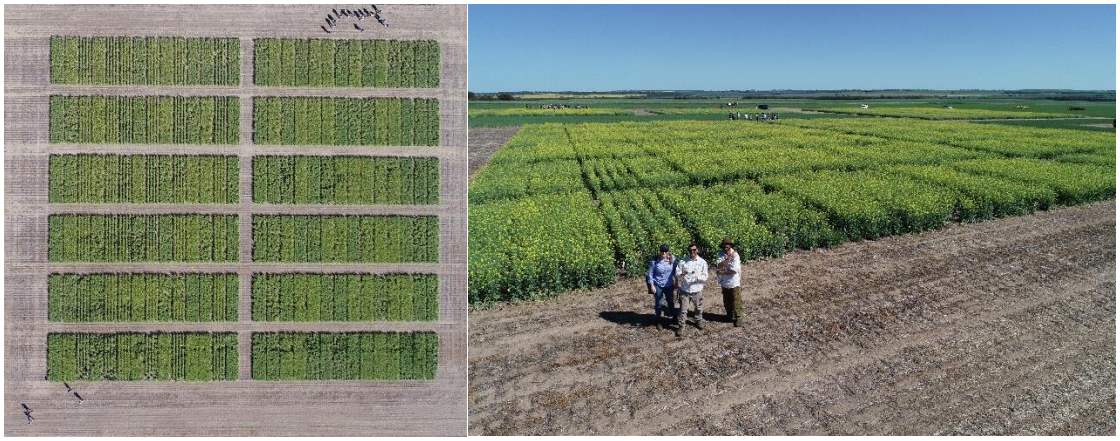


Figure 1 Average monthly rainfall at Miling and Kojonup trial sites in 2019.

A.



B.

Figure 2 Aerial trial photos of the (A.) Miling site during a grower presentation and (B.) Kojonup field sites in 2019.

RESULTS AND DISCUSSION.

Kojonup 2019

ARG emergence

At the Kojonup site in 2019, there was a significant interaction between pollination type (Hybrid or OP) and canola row spacing (25 or 50cm) (P=0.006) which demonstrated that the hybrid variety (Trophy) reduced ryegrass emergence when planted at the narrower 25cm row spacing. A similar interaction between crop row spacing (25 or 50cm) and seeding rate was identified (P=0.023) with a larger reduction in ARG emergence found in the narrower row spacings when seed rate was increased from 0.4RR (20 plants/m^2) to RR (50 plants /m^2). This study also found that the hybrid variety (Trophy) reduced ARG emergence compared to the OP variety (Bonito) (P=0.006). Increased plant establishment (50 plants/m^2) reduced ARG emergence more than lower seeding rates (20 plants/m^2) (P<0.007); and also, reduced row spacing (25cm) reduced ARG emergence over wider 50cm row spacing (P<0.001) (Figure 3).

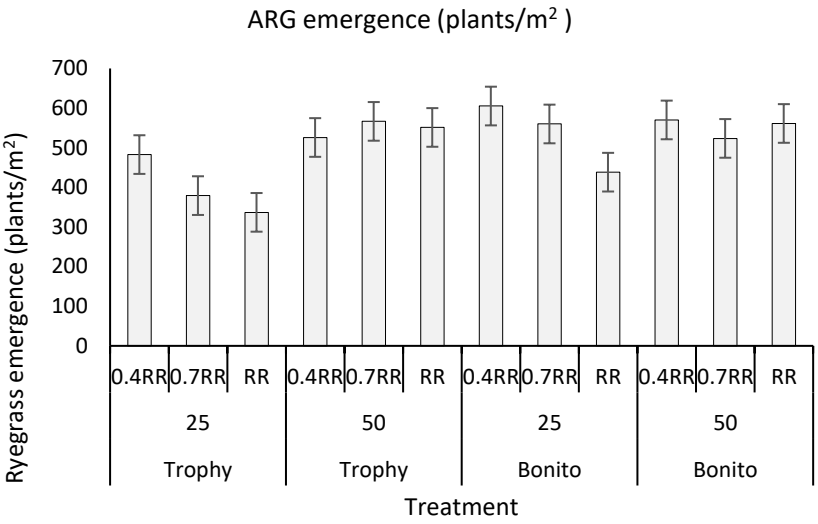


Figure 3: Annual ryegrass emergence at Kojonup in 2019.

Canopy cover

The early competitive ability of the canola treatments was demonstrated in the canopy cover (%) measured at 9WAE. Results indicate that there was an interation between pollination type (Hybrid or OP) and canola row spacing with the hybrid variety (Trophy) at the 25cm row spacing having the greatest percent canopy covers (P=0.052). This study also found that the hybrid variety (Trophy) increased canopy cover compared to the OP variety (Bonito) (P=<001), and it also found that higher plant establishment (50 plants/m^2) increased canopy cover compared to lower seeding rates (20 plants/m^2) (P=0.003) (Figure 4).

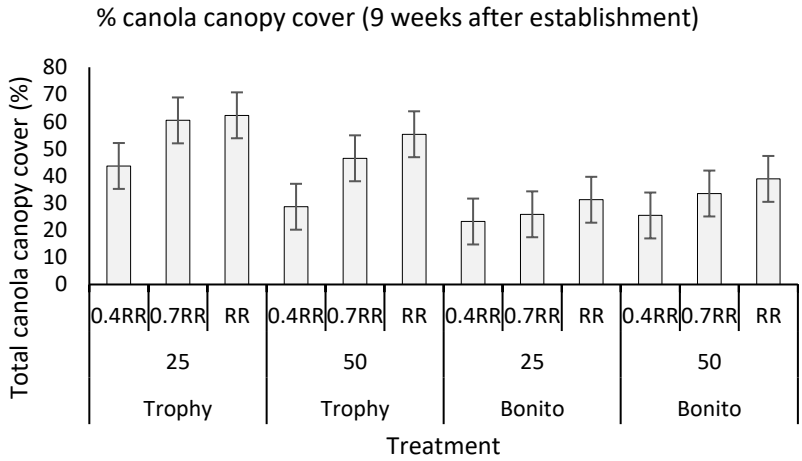


Figure 4 Canola percentage canopy cover 9 weeks after establishment at Kojonup in 2019.

ARG seed production

When assessing the ARG seed production it was found that no statistically significant interactions existed. This study however found that the hybrid variety (Trophy) decreased ARG seed production compared to the OP variety (Bonito) (P=0.009) and higher plant establishment (50 plants/m^2) decreased ARG seed production compared to lower seeding rates (20 plants/m^2) (P=0.018) (Figure 5).

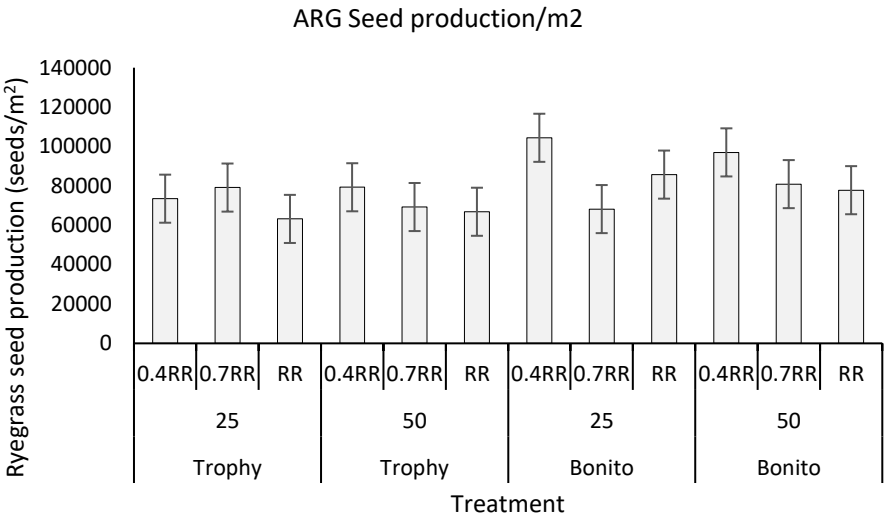


Figure 5 Annual ryegrass seed production in the plots where no herbicide was applied at Kojonup in 2019.

Canola yield

Canola yield in this study was assessed both infested with ARG (using crop competition factors only) and in the herbicide applied weed free situation. When herbicides were applied, yields were consistently higher (P<0.001), but no interactions between the trial treatments were identified; however, canola yield in the absence of ARG was significantly increased in hybrid variety (Trophy) treatments (P<0.001) and at higher seeding rates (50 plants/m^2) (P<0.001) (Figure 6). Interestingly, canola seeded at the wider row spacing (50cm) consistently had higher yields (P=0.034) than the corresponding variety and seeding rate combination at the narrower 25cm row spacing. When herbicides were not applied, it was found that there was an interaction between the pollination type and row spacing with the open pollinated (bonito) variety increasing its yield more when seeded at the 50cm row spacings (P=0.024). In the weedy situation, an interaction between row spacing and seeding rate was also identified (P=0.046) demonstrating that increasing canola seeding rates in the narrow row spacing (25cm) treatment was more responsive (Figure 6).

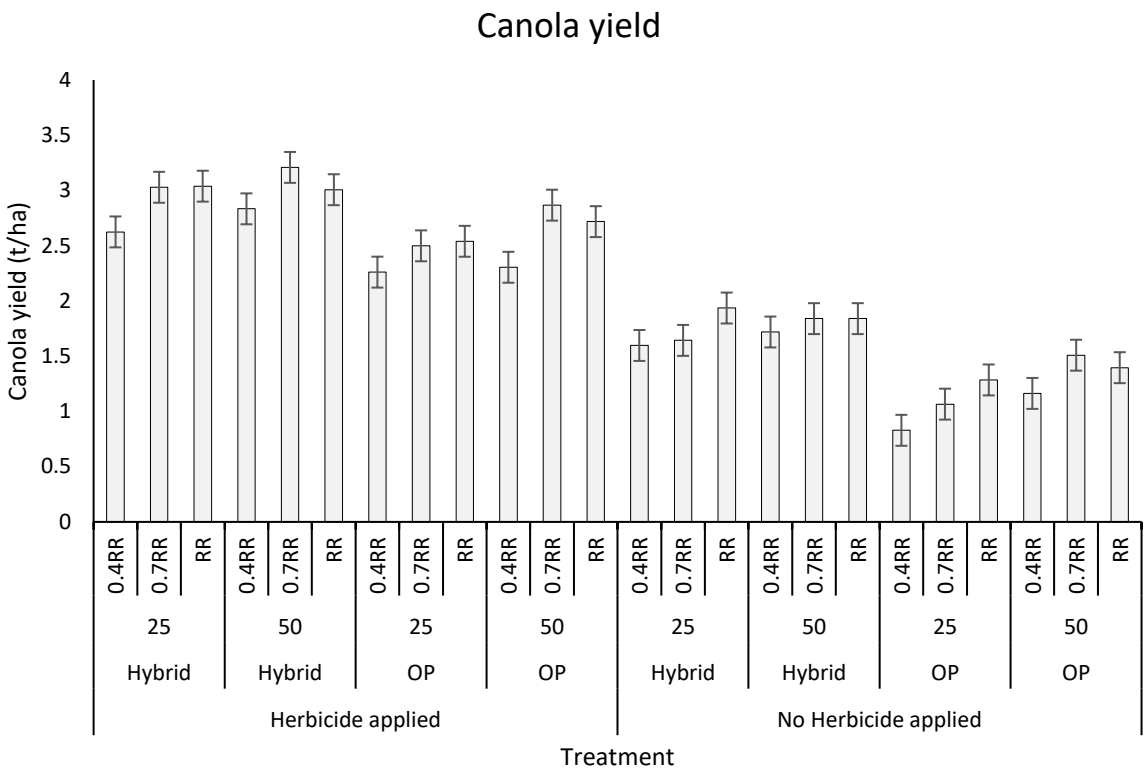


Figure 6: Canola yield for all treatments at Kojonup in 2019.

Miling 2019

ARG emergence

At the Miling site in 2019, no interactions or single factor significant differences in ARG emergence were identified (P>0.05) (Figure 7). However, whilst not statistically significant due to the variability in 2019, the trends in the data indicate that increasing canola seeding rate from 20plants/ m^2 to 50 plants/ m^2 and seeding the canola at 25cm instead of 50cm row spacing decreased ARG establishment. The lowest ARG establishment was in the treatment seeded to hybrid canola (trophy) seeded at narrow 25cm row spacing and at the highest seeding rate of 50 plants/ m^2. Conversely, the highest ARG emergence was on the OP treatment (Bonito), seeded at wide rows (50cm) and at the lowest seeding rate (20 plants/ m^2) (Figure 7).

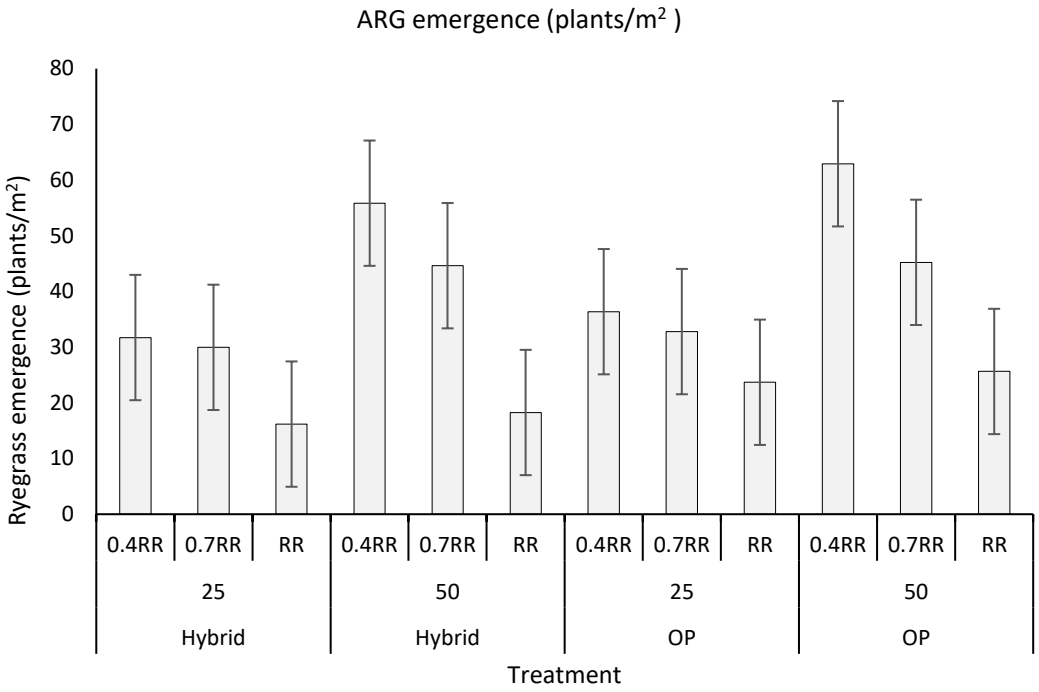


Figure 7 Annual ryegrass emergence at Miling in 2019.

Canopy cover

The early competitive ability of the canola treatments was demonstrated in the canopy cover (%) measured at 9WAE. Results indicate that there was an interation between pollination type (Hybrid or OP) and canola seeding rate (P=0.044) with hybrid variety (Trophy) at the 50cm row spacing having the greatest percent of canopy cover. This study also found that the hybrid variety (Trophy) increased canopy cover compared to the OP variety (Bonito) (P=0<001) and higher plant establishment (35 and 50 plants/m^2) increased canopy cover compared to lower seeding rates (20 plants/m^2) (P<0.001) (Figure 8).

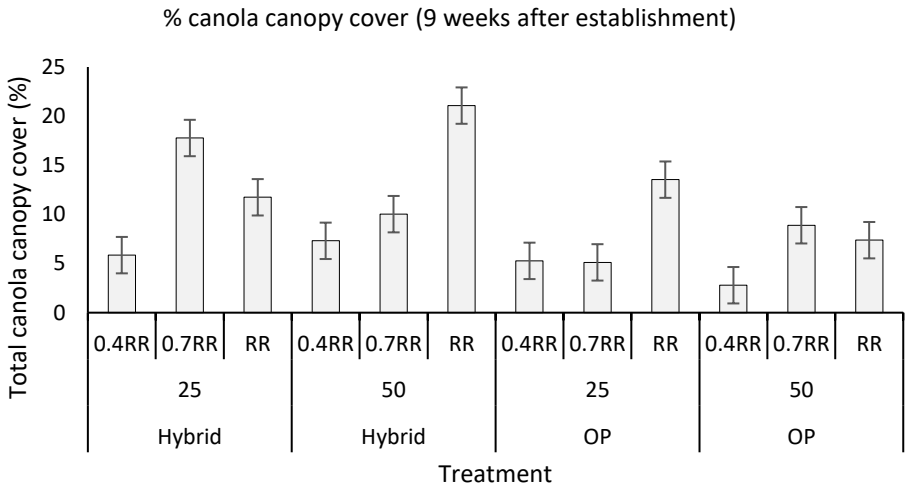


Figure 8: Canola percentage canopy cover 9 weeks after establishment at Miling in 2019.

ARG seed production

At the Miling site in 2019, no interactions or single factor significant differences were identified (P>0.05). Whilst not statistically significant due to the variability in 2019, trends in the data indicate that increasing canola seeding rate from 20 plants/m^2 to 50 plants/m^2 reduced ARG seed production (Figure 9).

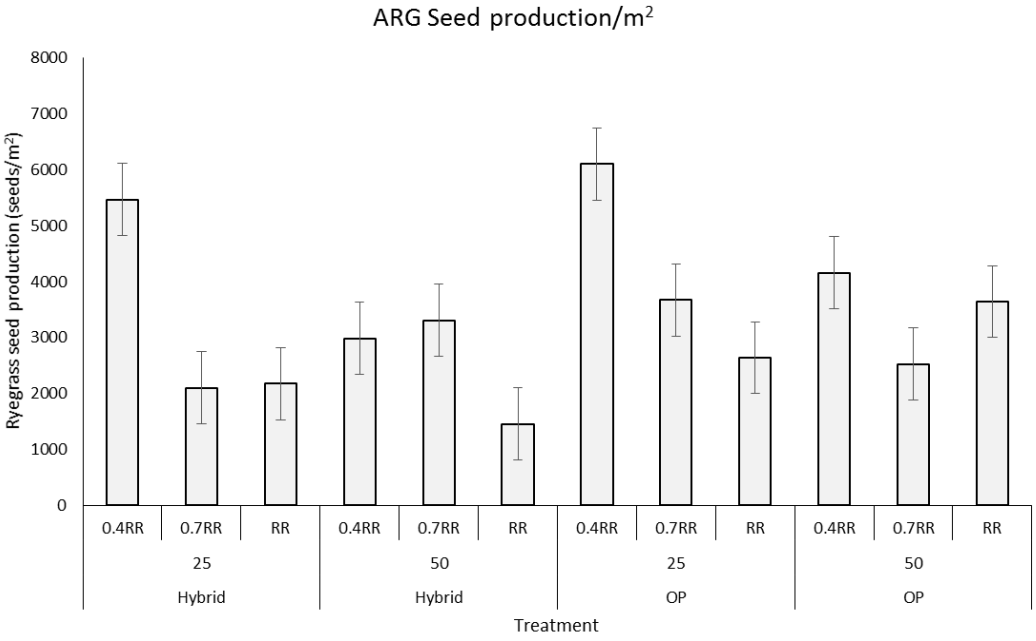


Figure 9 Annual ryegrass seed production in the plots where no herbicide was applied at Miling in 2019.

Canola yield

Canola yield in this study was assessed in both the infested with ARG (using crop competition factors only) and in the herbicide applied weed free treatments. Due to the low

rainfall resulting in low ryegrass establishment at the Miling site yields within the herbicide applied treatment was not statistically higher (P>0.05) (Figure 10). When herbicides were applied (Weed free), no interactions between the trial treatments were identified; however, canola yield in the absence of ARG was significantly increased in the hybrid variety (Trophy) treatments (P<0.001), at wider row spacing (50cm) (P<0.001) and at higher seeding rates (50 plants/m^2) (P=0.002). When herbicides were not applied it was found that the hybrid variety (Trophy) yielded more than the open pollinated variety bonito (P<0.001) (Figure 10).

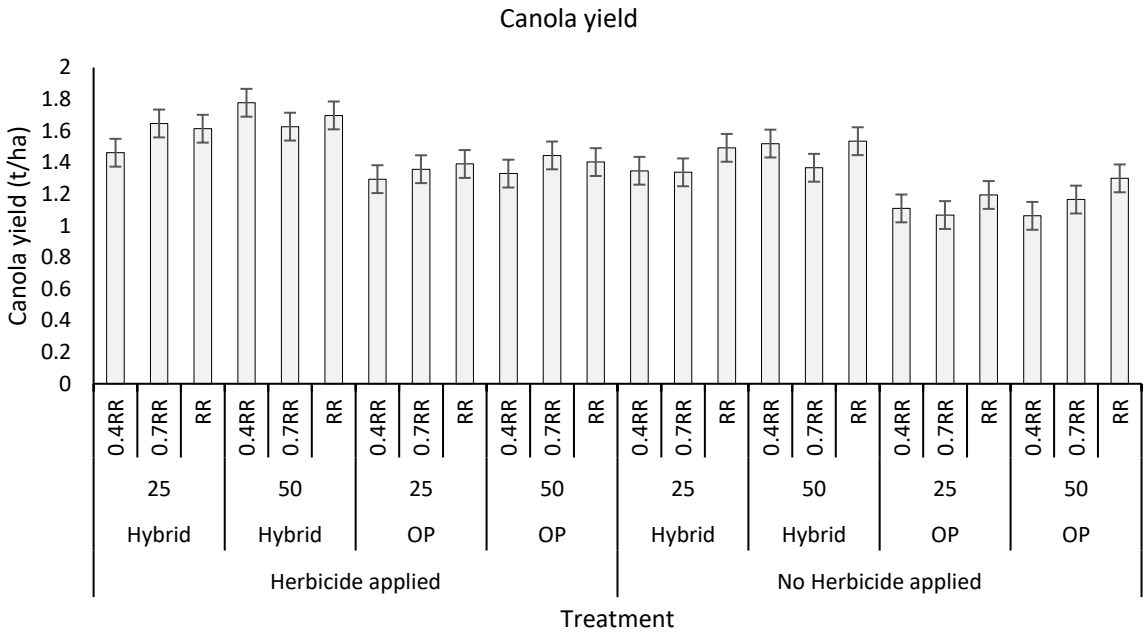


Figure 10 Canola yield for all treatments at Miling in 2019.

Acknowledgments

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References

Beckie, H. J., Johnson, E. N., Blackshaw, R. E., & Gan, Y. (2008). Weed suppression by canola and mustard cultivars. *Weed Technology, 22*(1), 182-185.

Blackshaw, R. E., Anderson, R. L., & Lemerle, D. (2007). Cultural weed management. *Non-chemical weed management. Principles, concepts and technology'.(Eds MK Upadhyaya, RE Blackshaw) pp*, 35-47.

de Oliveira, G. M., Stahl, M. A., Ribeiro, A. P. B., Grimaldi, R., Cardoso, L. P., & Kieckbusch, T. G. (2015). Development of zero trans/low sat fat systems structured with sorbitan monostearate and fully hydrogenated canola oil. *European journal of lipid science and technology, 117*(11), 1762-1771.

Harker, K. N., Blackshaw, R. E., Kirkland, K. J., Derksen, D. A., & Wall, D. (2000). Herbicide-tolerant canola: weed control and yield comparisons in western Canada. *Canadian Journal of Plant Science, 80*(3), 647-654.

Harker, K. N., Clayton, G. W., Blackshaw, R. E., O'Donovan, J. T., & Stevenson, F. C. (2003). Seeding rate, herbicide timing and competitive hybrids contribute to integrated weed management in canola (Brassica napus). *Canadian Journal of Plant Science, 83*(2), 433-440.

Lemerle, D., Gill, G. S., Murphy, C. E., Walker, S. R., Cousens, R. D., Mokhtari, S., . . . Luckett, D. J. (2001). Genetic improvement and agronomy for enhanced wheat competitiveness with weeds. *Australian Journal of Agricultural Research, 52*(5), 527-548.

Monteith, J. L. (1981). Climatic variation and the growth of crops. *Quarterly Journal of the Royal Meteorological Society, 107*(454), 749-774.

Patrignani, A., & Ochsner, T. E. (2015). Canopeo: A powerful new tool for measuring fractional green canopy cover. *Agronomy journal, 107*(6), 2312-2320.