TRIAL LOCATIONS 2020: Mingenew, Dandaragan and Avondale, Western Australia

TITLE:

Trial 2: The interaction between seeding rate and seed size of hybrid and open pollinated canola (*Brassica napus*) varieties on wild radish (*Raphanus raphanistrum*) growth and competition.

Mike Ashworth*[A], Roberto Lujan Rocha[A], Richard Devlin[B], Orna Tippett[B], Andrew Grose[C]

[A] Australian Herbicide Resistance Initiative, School of Agriculture and Environment, The University of Western Australia, Crawley, WA 6009, Australia.

[B] Living Farm 2 Maxwell Street, York, Western Australia

[C] Statistics for the Australian grains industry (SAGI WEST), Curtin University of Western Australia, Curtin University of Technology, WA, 6102.

KEY MESSAGE

- This study demonstrates that increasing canola seeding rate and using large canola seed size are important factors in achieving the highest yields whilst reducing wild radish seed production when sown to both open pollinated or hybrid canola varieties (Bonito and Trophy respectively).

INTRODUCTION

Canola is the most widely grown broadleaf crop in Australia since its introduction in 1969 (Angus et al., 2015; Colton and Potter, 1999) due to its profitability and rotational benefits to the successive crops (Seymour et al., 2012). Past research has demonstrated the link between developing sufficient vegetative biomass before anthesis and canola yield potential (McCormick et al., 2012; Robertson et al., 2004). Biomass produced at anthesis has been shown to be affected by sowing date, cultivar choice (Robertson et al., 2004), N rate (Hocking and Stapper, 2001) and plant population (Brandt et al., 2007). In Australia however, Brill et al (2016) demonstrated that seed characteristics such as seed size were major determinants of anthesis biomass due to its effect on improving canola establishment and early biomass accumulation in both hybrid and open-pollinated cultivars. It is expected that any improvement in canola establishment and early biomass accumulation leading to increased biomass at anthesis will improve the crops competitiveness against weeds and reduce weed seed production. The objective of this study is to determine the optimal combinations of canola cultivar, seeding rate and seed size on wild radish seed production and canola growth and yield.

Methods

Trial design: Randomised complete block

Replicates: 3

Locations (2): Avondale, Dandaragan and Mingenew in the Western Australian grainbelt.

Seed size (2): <1.8mm and >2.0mm in diameter

Canola seed rate / plant establishment target (3): 20 (0.4RR), 35 (0.7RR) and 50 plants/m^2 (RR)

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

Herbicide treatment (2): Nil (Knockdown treatment only) and herbicide applied (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.

Crop type	TT Canola
Variety	Trophy (Hybrid) and Bonito (OP)

Seeding rate (kg/ha)	Trophy<1.8 mm Recommended 1.8 kg/ha Trophy<1.8 mm 70% 1.3 kg/ha Trophy<1.8 mm 40% 0.7 kg/ha Trophy>2 mm Recommended 4.3 kg/ha Trophy>2 mm 70% 3.0 kg/ha Trophy>2 mm 40% 1.7 kg/ha Bonito <1.8 mm Recommended 1.9 kg/ha Bonito <1.8 mm 70% 1.3 kg/ha Bonito <1.8 mm 40% 0.8 kg/ha Bonito >2 mm Recommended 3.3 Bonito >2 mm 70% 2.3 kg/ha Bonito >2 mm 40% 1.3 kg/ha	
Tillage type	Minimum tillage	
Soil moisture, depth (cm)	Poor	>5
Seed bed	Standing Stubble	
Clod size	None	
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	100 kg/ha Gusto Gold 50 kg/ha Urea
	Post-emergent	40 L/ha UAN 100 L/ha UAN
Herbicides applied	Pre-emergent	1.2 L/ha Roundup Ultra Max 150 mL/ha Lontrel Other pre-em herbicides as per treatment list
Post-emergent	As per treatment list 3 L/ha Roundup Ultra Max	
Fungicides applied	Seed treatment	400 mL/100kg-seed Maxim XL
Fertiliser treatment	300 mL/ha Impact	
	Post-emergent	150 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	50 g/ha Transform 300 mL/ha Affirm	

The data collected during the 2020 growing season was statistically analysed by the statistics for the Australian Grains Industry (SAGI; Curtin University).

LOCATIONS

The soil characterisation per site can be found in table in Table 2.

Table 2 Soil description at the trial sites in 2020.

	Depth (cm)	Mingenew 0-10	Beverley 0-10	Dandaragan 0-10
Colour		GRYW	GRBR	YWGR
Gravel	%	0	5	0
Texture		1.0	1.0	1.0
Ammonium Nitrogen	mg/kg	< 1	11	5
Nitrate Nitrogen	mg/kg	13	26	13
Phosphorus Colwell	mg/kg	18	36	25
Potassium Colwell	mg/kg	28	50	46
Sulfur	mg/kg	1.5	9.6	3.3
Organic Carbon	%	0.52	1.04	0.71
Conductivity	dS/m	0.036	0.083	0.047
pH Level (CaCl2)		5.4	4.4	6.5
pH Level (H2O)		6.5	5.3	7.2

AVONDALE

The average annual rainfall at Avondale was lower than the 19-year average at 305 mm of rainfall in 2020 compared to 380.8 mm for the long-term average. March and April were very dry, however

above average rainfall fell soon after seeding in early May and June. The rest of the season's rainfall was lower than average (Figure 1).

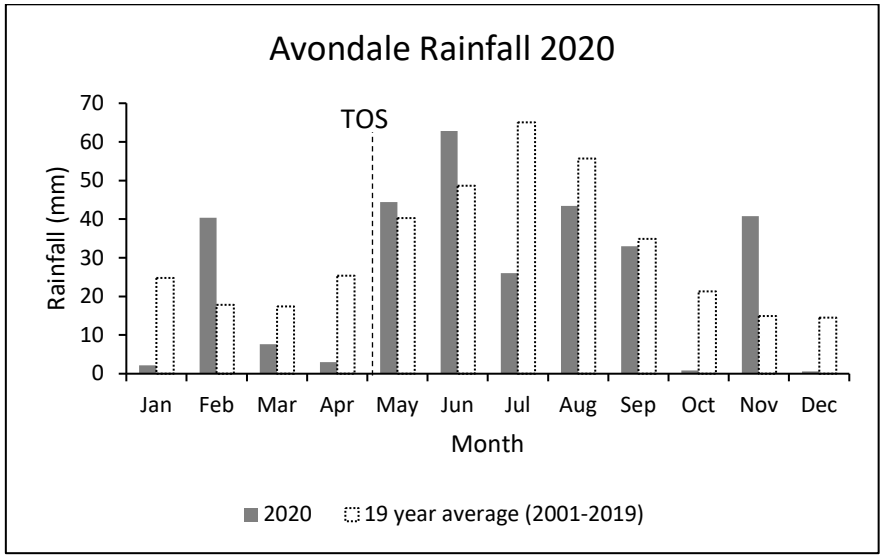

Figure 1 Monthly rainfall at Avondale trial site.

Figure 2 Aerial photo of the Avondale trial site highlited in blue.

Results and Discussion.

WR establishment

No significant interactions were found in WR establishment between variety, seed size and seed rate ($p>0.05$); however, a weak non-significant interaction was observed between variety and seed rate ($p=0.06$) and when these factors were analysed individually (main effects), significant differences were found for seed rate ($p<0.01$) and variety ($p<0.01$) (Table 3). As observed in Figure 3, these results

indicate that canola seed size had no effect on wild radish establishment. Hybrid variety treatments consistently had a lower wild radish establishment ($p<0.01$); with increased canola seeding rate found to reduce wild radish establishment in both varieties (Figure 3). Wild radish establishment was lowest at the full seeding rate for large and small seed of the OP variety whereas wild radish establishment was lowest at the 35 (0.7RR) and 50 plants/m2 (RR) seeding rate for both seed sizes in the hybrid variety.

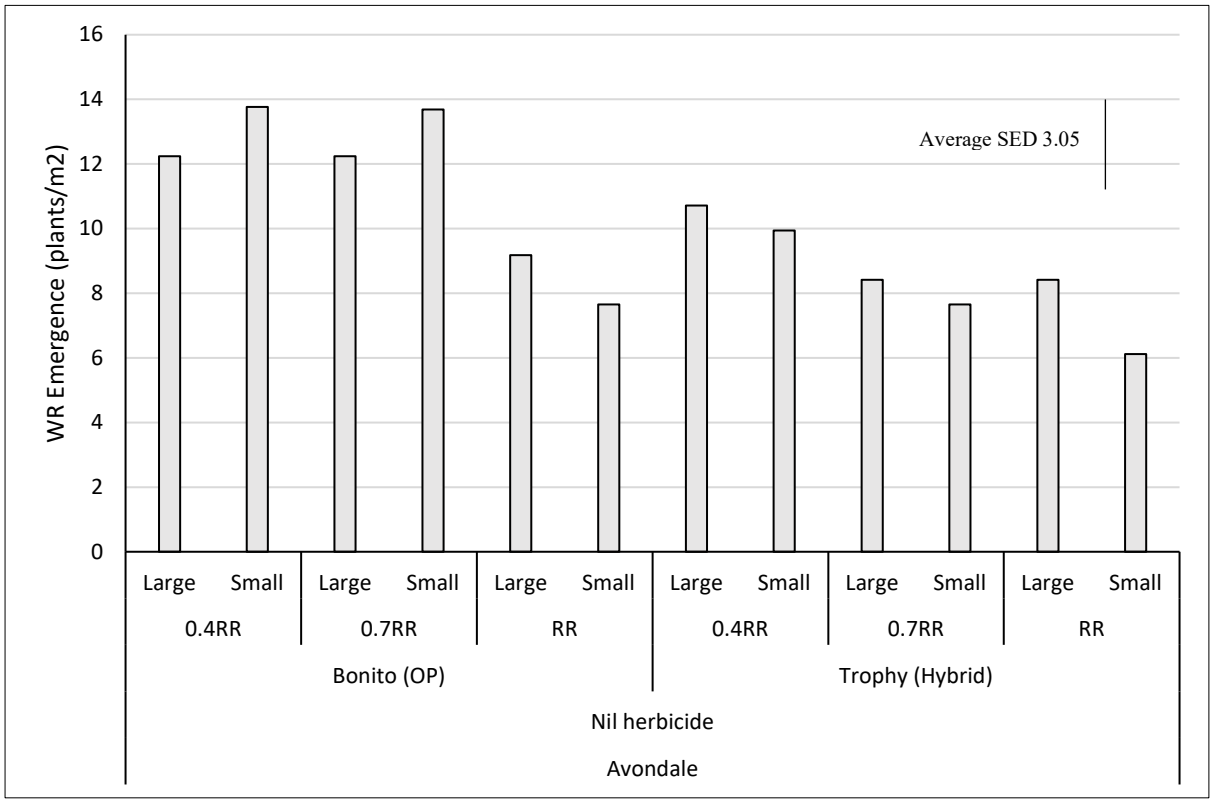

Figure 3 Wild radish emergence where no herbicide was applied in 2020; seeding rates were 0.4RR, 0.7RR and RR which equate to 40%, 70% and 100% of the recommended seeding rate.

Crop canopy cover NDVI 10WAS

As estimated by the spectroradiometric NDVI index, a significant interaction was observed between variety and seeding rate ($p<0.01$) with the open polinated variety (Bonito) having a larger estimated biomass at 10WAS when seeding rate was increased to 50 plants/m^2 (RR). Seed size however was found to have no effect on early biomass (NDVI) ($p>0.05$) (Table 4). As expected, the hybrid variety had a significantly greater percent canopy cover compared to the open pollinated variety ($p<0.001$). Increased canola seeding rate also significantly increased % canopy cover, especially within the OP variety treatments ($p<0.001$). As shown in Figure 4, NDVI increased with increasing seeding rate. The rate of early biomass change, as seeding rate was increased, was greater for the OP variety compared to the

hybrid. Consequently, this study found that seeding rate was more responsive in the OP variety for increassing early canola biomass.

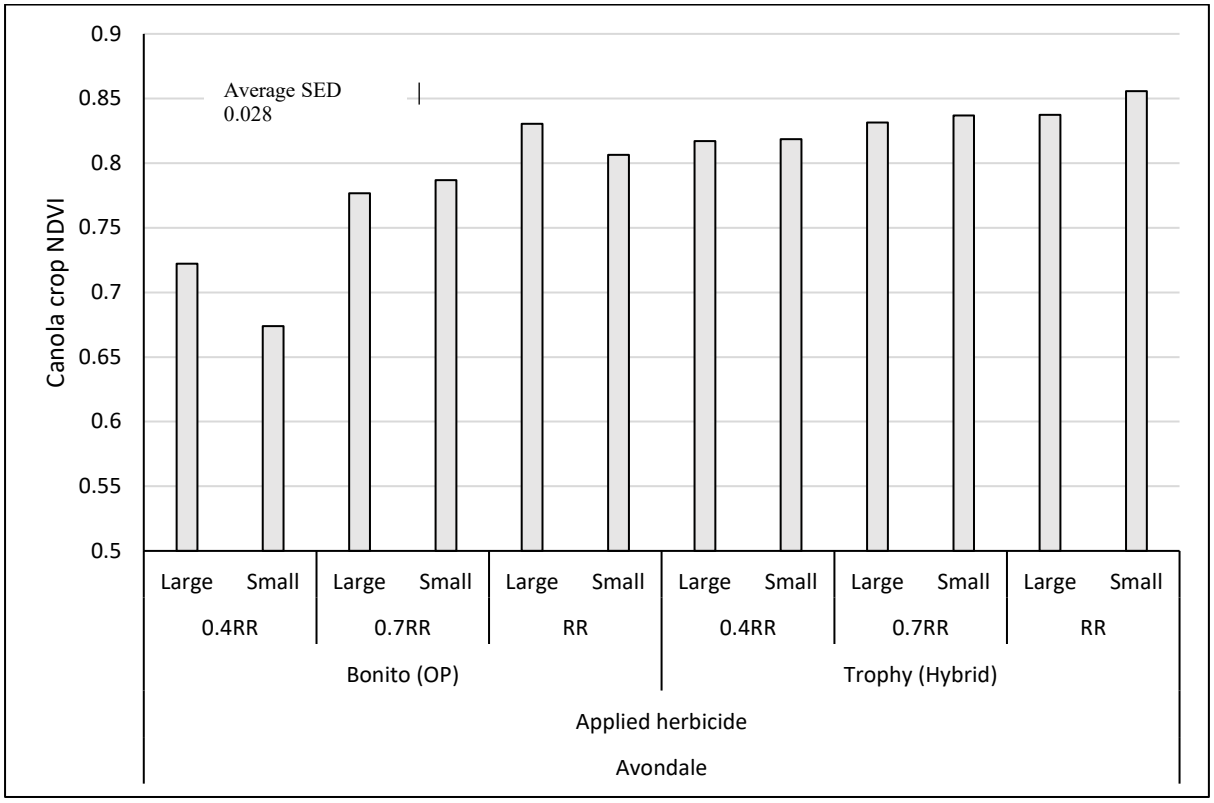

Figure 4 Crop NDVI demonstrating crop canopy cover at 10 WAS.

Wild radish biomass

Whilst statistical analysis showed that there were no significant interactions between all the factors (seeding rate, seed size and cultivar) in this study ($p<0.05$), it was found that the hybrid variety (trophy) significantly reduced wild radish biomass ($p<0.05$) (Table 3). The average biomass for wild radish in the open pollinated variety was 99.6 g plant^{-1} compared to 71.7 g plant^{-1} for the hybrid variety. Also, there is a trend indicating that when the hybrid variety was seeded using the larger canola seed size, wild radish biomass was reduced regardless of the seeding rate, although not statistically significant ($p>0.05$). A similar trend can be observed for the OP variety; however, the full seeding rate was required to achieve similar WR biomass reductions. Further trials are scheduled in 2021 to complete this study.

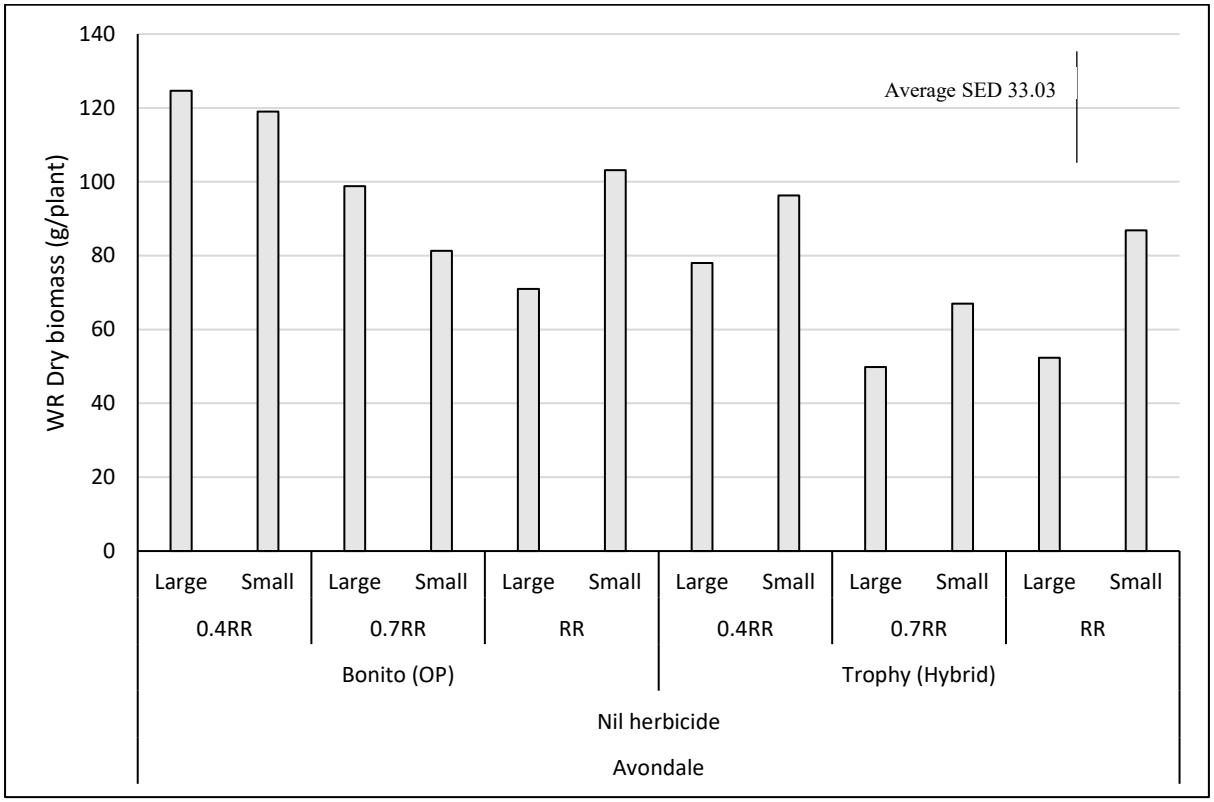

Figure 5 Wild radish total dry biomass in 2020 where 0.4RR, 0.7RR and RR equate to 40%, 70% and 100% of the recommended seeding rate.

WR seed production

Increasing canola seeding rate was found to reduce WR seed production (p=0.06) (Table 3) (Figure 6). Variety also significantly affected WR seed production with the OP variety Bonito averaging 12,841 seeds plant^{-1} and the hybrid variety (Trophy) treatment having 9,429 seeds plant^{-1}. Importantly there was a trend indicating that larger canola seed reduced wild radish seed production, however this was not statistically significant. Figure 6 shows that in the hybrid variety treatment, using larger canola seed reduced the average wild radish seed production. This trend also occurred in the OP treatments; however, similar control was only achieved at the full canola seeding rate of 50 plants/m^2.

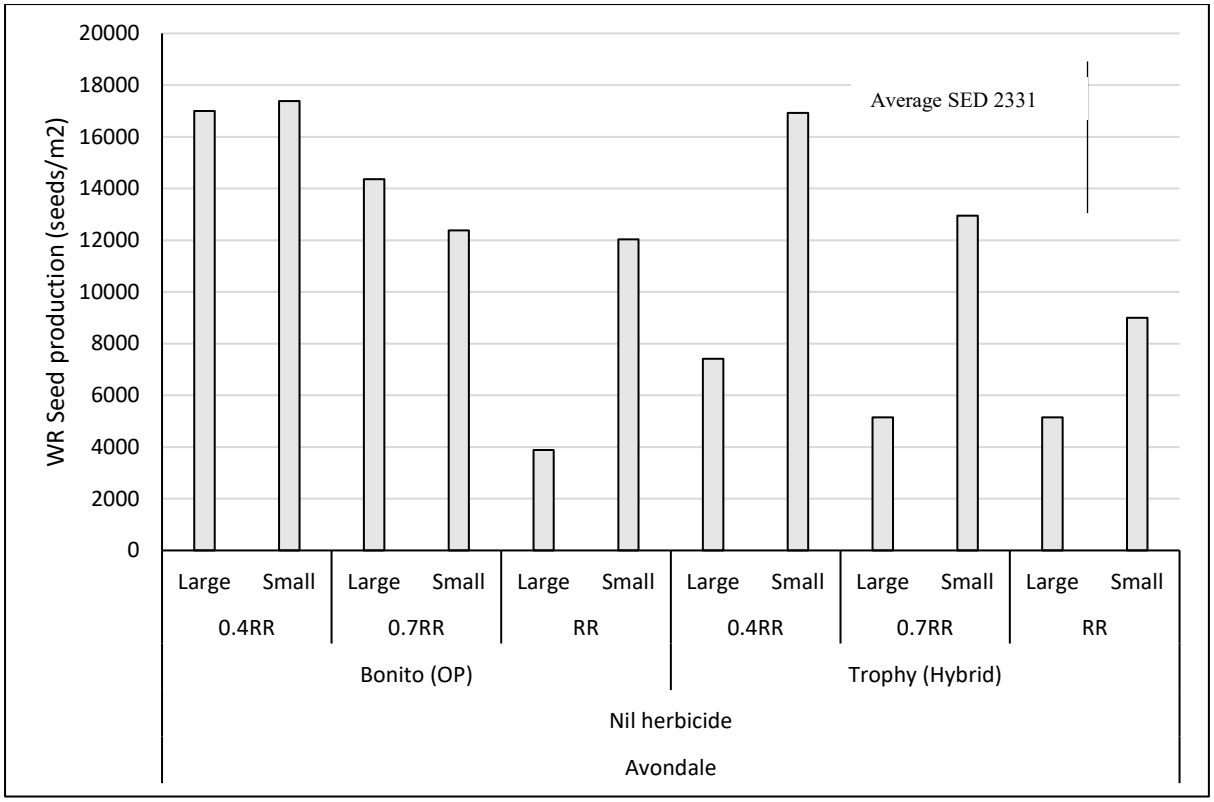

Figure 6 Wild radish seed production in 2020 where 0.4RR, 0.7RR and RR equate to 40%, 70% and 100% of the recommended seeding rate. For the statistical analysis seed production was log transformed.

Canola yield

This study clearly demonstrates that across all variety, seeding rate and seed size treatments, wild radish competition significantly reduced canola yield; however, canola yields were improved where the hybrid variety was seeded ($p<0.001$). Yield in competition with WR were increased by increasing canola seeding rate ($p<0.001$), however using larger seed size did not significantly increase yield ($p>0.05$) (Figure 7) (Table 3). An interaction was identified between seed size and seeding rate, where at the full seeding rate (50 plants/m^2), canola yield was significantly increased ($p=0.05$) likely owing to the improved competitiveness against WR. In the absence of WR competition (herbicide applied) and for plots seeded to the OP variety Bonito, increased seeding rate appears to reduce crop yield when large canola seed was used ($p= 0.011$). In contrast, when small canola seed was used, the yield of canola increases with increasing seeding rate ($p=0.011$). It is considered likely that these yield penalties may be the result of intra-specific competition as the larger seed produces more vigorous seedlings resulting in an increased need for space as demonstrated in the canopy cover results (Figure 4). Thus, in the absence of wild radish competition, no yield penalties were demonstrated when canola seeding rate was reduced.

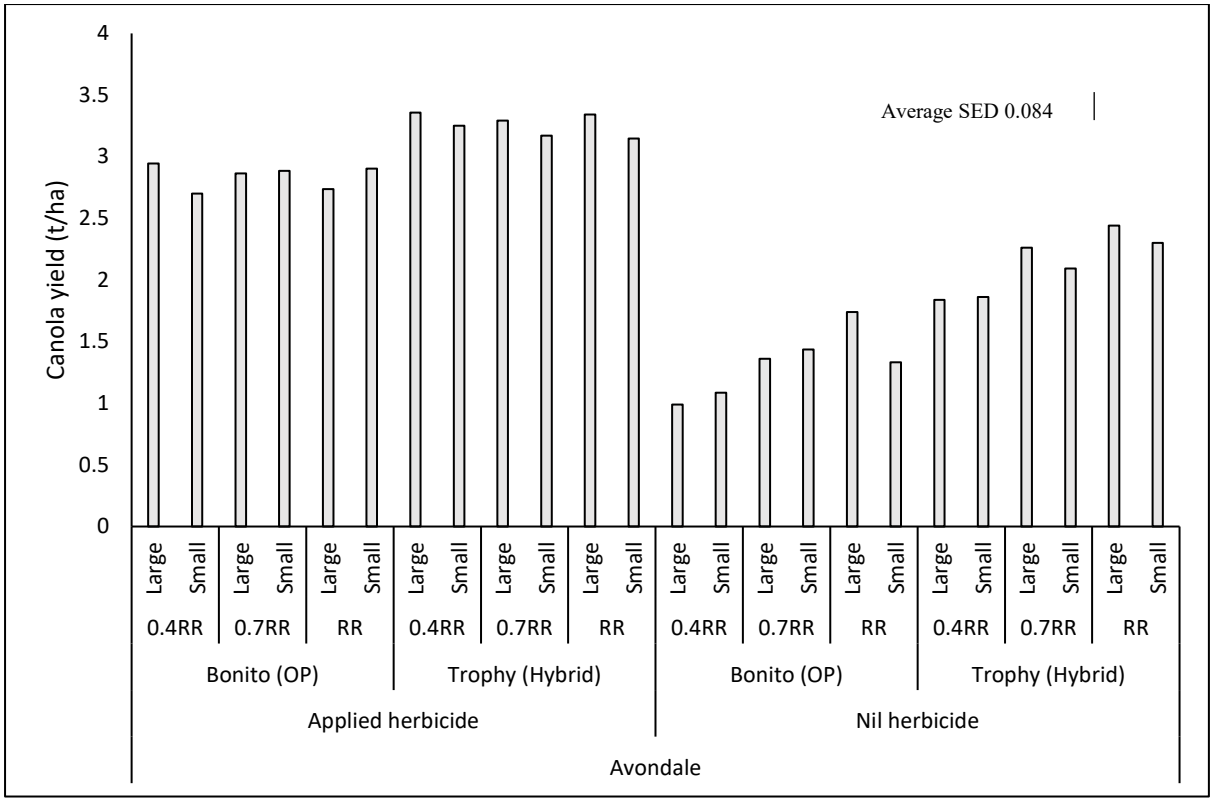

Figure 7 Canola yield for all treatments in 2020 where 0.4RR, 0.7RR and RR equate to 40%, 70% and 100% of the recommended seeding rate.

MINGENEW

The trial at Mingenew was sown on 3 May 2020, due to a strong wind (once in a decade weather event) after seeding (24th to the 26th of May 2020), the trial was eroded due to wind gusts of over 100 km/h. As a result of erosion, seeded treatments were disturbed destroying the trial. This trial was then re-sown in another location on the 12 June; however, due to dry conditions, the crop did not grow well, confounding the competitive ability of the crop. Figure 8 and 9 show the re-sown site in September 2020 with a wilted crop due to late sowing plus poor rainfall and hot August weather conditions. The trial was harvested and measured, however no meaningful conclusions could be made of this trial.

Figure 8 Trial site at Mingenew in September 2020. Site was re-sown on 12 June 2020.

Figure 9 The crop wilted and did not recover after extreme weather events in 2020.

DANDARAGAN

The Dandaragan site was sown on the 15th of May 2020 (Figure 10) into excellent moisture. Unfortunately, in July the contractor mistakenly sprayed the incorrect range resulting in damage to the weed plots and double spraying on some of the herbicide applied ranges, affecting the growth of the

canola and WR treatments. The data collected from this trial is not reliable for presentation and the trial will be repeated in 2021 at the contractor's expense.

Figure 10 Dandaragan trial site.

CONCLUSION

This study aimed to determine the optimal combinations of canola cultivar, seeding rate and seed size on wild radish seed production and canola growth and yield. It found that in the absence of herbicides, seeding rates and seed size are important factors in achieving the greatest canola yields whilst reducing wild radish seed production. For the OP variety (Bonito), a combination of the full recommended seeding rate and large seed size produced 37% greater yield compared to using 40% of the recommended seeding rate and small seed size. These treatments also resulted in a 77% reduction in WR seed production. For the hybrid variety (Trophy), using the recommended seeding rate and large seed size produced 23% greater yield compared to using 40% of the recommended seeding rate and small seed size. Wild radish seed production was also reduced by 69%.

Interestingly in the absence of WR, the OP variety had a negative response to seeding rates and seed size. When using small seed size, canola yields increase with increasing seeding rates; contrastingly when large seed is used, canola yield decreases with increasing seeding rates. These interactions are likely to be the effect of intra-specific competition; however, further studies are required to confirm this. With the hybrid variety, using large seed consistently resulted in greater yields at all seeding rates; however, no yield differences were observed between seeding rates.

Importantly, note that these results are from the Avondale site only. The Mingenew site was destroyed by a wind event and the Dandaragan site was compromised by herbicide application errors. The Dandaragan trial will be repeated in 2021.

Summary tables

Table 3: Predicted Values, P-values and Average SED for Canola variety, seeding rate and seed size when grown in WR competitive (Nil herbicide applied) plots at Avondale in 2020.

Variety	Seedsize	Seedrate	Crop Emergence (plants/m^2)	WR emergence (plants/m^2)	Rad. Int. (μmol m^{-2} s^{-1})	PAR Int. (%)	WR Biomass (g/plant)	WR Seeds (Seeds/plant)	Yield (t/ha)
Bonito (OP)	Small	0.4RR	16.702	13.77	716.966	83.291	119	29158.39	1.086
		0.7RR	25.872	19.89	764.361	91.277	81.333	11899.11	1.436
		RR	34.715	7.65	772.729	89.884	103.167	5344.72	1.332
	Large	0.4RR	16.375	12.24	705.336	84.662	124.667	18493.26	0.989
		0.7RR	22.27	12.24	759.808	90.779	98.833	20210.63	1.361
		RR	34.06	9.18	690.056	83.827	71	4103.21	1.74
Trophy (Hybrid)	Small	0.4RR	20.632	9.945	731.462	85.071	96.25	16677.25	1.862
		0.7RR	28.165	7.65	711.194	86.672	67	6632.43	2.093
		RR	39.3	6.12	741.008	90.078	86.833	7138.09	2.302
	Large	0.4RR	20.632	10.71	720.86	83.758	78	8291.91	1.838
		0.7RR	26.2	8.415	679.931	84.149	49.833	3325.96	2.261
		RR	38.317	8.415	752.435	90.224	52.333	5032.21	2.441
Average SED			2.623	3.05	31.45	3.518	33.03	-	0.139
Source of Variation			P-Value						
Variety			0	0.002	0.621	0.662	0.038	0.035	0
Seedsize			0.241	0.609	0.103	0.303	0.329	0.423	0.127
Seedrate			0	0.01	0.636	0.023	0.139	0.067	0
Variety:Seedsize			0.799	0.125	0	0.862	0.451	0.52	0.892
Variety:Seedrate			0.874	0.06	0.605	0.035	0.857	0.33	0.918
Seedsize:Seedrate			0.582	0.212	0.006	0.698	0.56	0.879	0.05
Variety:Seedsize:Seedrate			0.93	0.415	0.574	0.371	0.883	0.822	0.172

Note: 0.4RR = 20 plants/m^2; 0.7RR = 35 plants/m^2 and RR = 50 plants/m^2

Table 4: Predicted Values, P-values and Average SED for Canola variety, seeding rate and seed size when grown in WR free (Herbicide applied) plots at Avondale in 2020.

Variety	Seedsize	Seedrate	Crop Emergence ($plants\ /\ m^2$)	NDVI	Rad. Int. ($\mu mol\ m^{-2}\ s^{-1}$)	PAR Int. (%)	Yield (t/ha)
Bonito (OP)	Small	0.4RR	15.72	0.674	626.712	81.415	2.701
		0.7RR	25.5	0.787	681.789	88.08	2.884
		RR	40.938	0.806	633.963	86.51	2.903
	Large	0.4RR	22.598	0.722	638.871	83.12	2.944
		0.7RR	28.82	0.777	653.499	88.358	2.863
		RR	36.352	0.83	705.214	88.361	2.736
Trophy (Hybrid)	Small	0.4RR	26.855	0.819	674.81	85.429	3.252
		0.7RR	35.698	0.837	561.054	83.299	3.171
		RR	48.143	0.856	648.783	86.88	3.148
	Large	0.4RR	28.493	0.817	554.257	82.765	3.356
		0.7RR	29.148	0.831	669.212	86.387	3.292
		RR	48.47	0.837	639.663	83.181	3.343
AvSED			5.449	0.028	31.421	2.233	0.084
Source of Variation			P-Value				
Variety			0.001	0	0.001	0.149	0
Seedsize			0.998	0.589	0.016	0.919	0.021
Seedrate			0	0	0.667	0.004	0.751
Variety:Seedsize			0.434	0.203	0.007	0.194	0.076
Variety:Seedrate			0.692	0.003	0.325	0.046	0.334
Seedsize:Seedrate			0.4	0.527	0.041	0.458	0.135
Variety:Seedsize:Seedrate			0.383	0.573	0.018	0.128	0.011

Note: 0.4RR = 20 plants/m^2; 0.7RR = 35 plants/m^2 and RR = 50 plants/m^2

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