TRIAL LOCATION 2019: Cunderdin, Western Australia

TITLE:

TRIAL 1B: The interaction between seeding rate and row spacing of hybrid and open pollinated canola (*Brassica napus*) varieties on wild radish (*Raphanus raphanistrum*) growth and seed production.

Mike Ashworth*[A], Roberto Lujan Rocha[A], Richard Devlin[B], Rebecca Smith[B], Zhanglong Cao[C]

[A] Australian Herbicide Resistance Initiative, School of Plant Biology, 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.

ABSTRACT

This trial was located at Cunderdin in the grainbelt of Western Australia and 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) on wild radish (WR) competitiveness and seed production. Prior to seeding, after ripened herbicide susceptible wild radish seed (WARR 7) was spread to produce an even seedbank of approximately 20 seeds/m^2. This trial found that WR establishment from this seed 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 reduced WR establishment in the absence of herbicides. At the Cunderdin site, WR seed production was reduced within hybrid variety treatments (Trophy) and when seeded at higher plant densities (50 plants/m^2). However due to the low rainfall at the Miling site, no interactions were identified. ($P>0.05$). Canola yield in this study was increased in the open pollinated variety treatments (Bonito) especially when seeded 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 at Cunderdin in 2018 and 2019. Multi-environment trial analysis for the combined data to be completed.

Introduction

Wild radish is a prevalent annual weed species infesting all cropping regions of southern Australia on neutral to acidic soils. The economic impact of wild radish is attributed to its ability to greatly reduce crop yield and quality. In addition, immature wild radish plants pose harvest and grain storage problems. Although herbicides are available to control wild radish, the protracted germination and long seed dormancy of wild radish make it difficult to control (Reeves, Code, & Piggin, 1981). When growing in a crop, wild radish is a vigorous competitor capable of causing large reductions in crop yield. Modest wild radish densities of 7 and 200 plants m^{-2} have been found to reduce wheat (*Triticum aestivum* L.) yield by 10 and 50%, respectively (Code & Reeves, 1981; Pathan, Hashem, & Koetz), with wild radish that emerges with or shortly after the crop causing the largest reduction in yield (Cheam & Code, 1995). However, wild radish often emerges throughout the crops growing season with late-emerging plants capable of producing sufficient seed to replenish the soil seed bank (Cheam, 1986; Code & Donaldson, 1996; Reeves et al., 1981). Despite a diverse range of herbicide tolerance in F1 hybrid and open pollinated canola varieties, Australian weed surveys have found that wild radish is still present in 13% of the canola fields after all weed management practices are completed (Lemerle et al., 2001). Despite being recognized as a troublesome weed in canola; the effect that canola competitiveness has on wild radish, and the effect of wild radish on canola yield is not well documented. Therefore, this study was conducted to determine the effect of factorial combinations of seeding rate, row spacing and pollination type on canola yield and wild radish fecundity.

Methods

Trial design: Randomised complete block

Replicates: 3

Locations (1): Cunderdin in the Western Australian grainbelt.

Row Spacing (2): 25 and 50 cm

Seed rate / plant establishment target (3): 20, 35 and 50 plants/m2

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	11 May 2019	
Crop type	TT Canola	
Variety	HyTTec Trophy (Hybrid) and Bonito (OP)	
Seeding rate (kg/ha)	HyTTec Trophy 50 plants/m$_2$ = 3.7 kg/ha HyTTec Trophy 35 plants/m$_2$ = 2.6 kg/ha HyTTec Trophy 20 plants/m$_2$ = 1.5 kg/ha Bonito 50 plants/m$_2$ = 2.8 kg/ha Bonito 35 plants/m$_2$ = 1.9 kg/ha Bonito 20 plants/m$_2$ = 1.1 kg/ha	
Tillage type	Minimum tillage	
Soil moisture, depth (cm)	Poor	>5
Seed bed	Standing stubble	
Clod size	None	
Stubble loading	20-30%	
Sowing equipment	Knife points and press wheels	
Sowing speed (km/hr)	5	
Sowing depth	1 cm	
Row spacing (cm)	25.4	
Fertiliser applied	Pre-emergent	70 kg/ha Gusto Gold 100 kg/ha Urea
Post-emergent	100 L/ha UAN	
Herbicides applied	Pre-emergent	2 L/ha Roundup Ultra Max 1 L/ha propyzamide 150 g/ha Lontrel (PSPE) Other pre-em herbicides as per treatment list
Post-emergent	As per treatment list 100 mL/ha Verdict (volunteer cereal management) 2 L/ha Reglone (23 Oct 2019)	
Fungicides applied	Seed treatment	400 mL/100 kg-seed Maxim XL
Fertiliser treatment	300 mL/ha Impact	
Post-emergent	500 mL/ha Aviator Xpro	
Insecticides applied	Seed treatment	1 L/100 kg-seed Cruiser Opti
Pre-emergent	1 L/ha chlorpyrifos 200 mL/ha bifenthrin	
Post-emergent	1 L/ha chlorpyrifos 50 g/ha Transform 300 mL/ha Affirm	

LOCATIONS

The soil characterization for the Cunderdin (-31.65S, 117.24E) site in the Western Australian grainbelt can be found in Table 2. The long-term (19 years) average growing season (April to October) rainfall at Cunderdin was 316 mm. Prior to this study, all sites had been under continuous no-till crop production for more than 10 years.

Cunderdin2019

The Cunderdin site had an established wild radish seed bank of 20 seeds/m^2 in the top 10cm of soil. The site was seeded dry with limited rainfall (<10mm) in May. Canola germination and emergence at the Cunderdin site did not occur until June when 67 mm fell in the month (Figure 1). Rainfall events occurred in July and August however the trial was moisture stressed for a number of weeks. The final rainfall occurred in October, providing sufficient moisture for yield (Figure 7).

Table 2 Soil description at the Cunderdin experimental site in 2019.

		Cunderdin
	Depth (cm)	**0-10**
Colour		LTGR
Gravel	%	0
Texture		1.5
Conductivity	dS/m	0.161
pH Level (CaCl2)		6.1
pH Level (H2O)		6.6
Ammonium Nitrogen	meq/kg	2
Nitrate Nitrogen	meq/kg	50
Phosphorous	meq/kg	38
Colwell Potassium	meq/kg	55
Colwell Sulphur	meq/kg	18.1
Total Carbon	%	1.08

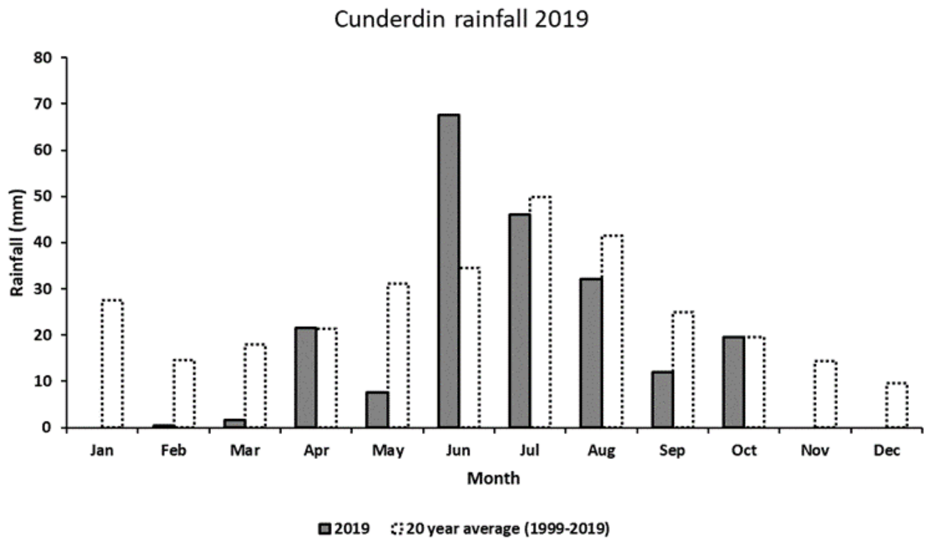

Figure 1: Monthly rainfall at Cunderdin trial site.

Figure 2 Aerial photo of the Cunderdin trial site.

Results and Discussion.

WR establishment

At the Cunderdin site in 2019, there was a significant interaction between pollination type (Hybrid or OP) and canola row spacing (25 or 50cm) (P=0.036) with the Hybrid variety (Trophy) reducing WR establishment when planted at the wider 50cm row spacing. A significant interaction between pollination type and canola seeding rate was also identified (P=0.024), highlighting that increasing canola seeding rates in the hybrid variety (Trophy) reduced WR establishment. An interaction between crop row spacing (25 or 50cm) and seeding rate was found (P=0.054), with increasing seeding rates from 20 to 50 plants/m^2 resulting in larger reductions in WR establishment at the narrower row spacing of 25cm. A single factor significant difference was also found with wider row spacing (50cm) reducing WR establishment over more conventional narrower 25cm row spacing (P=0.036) (Figure 3).

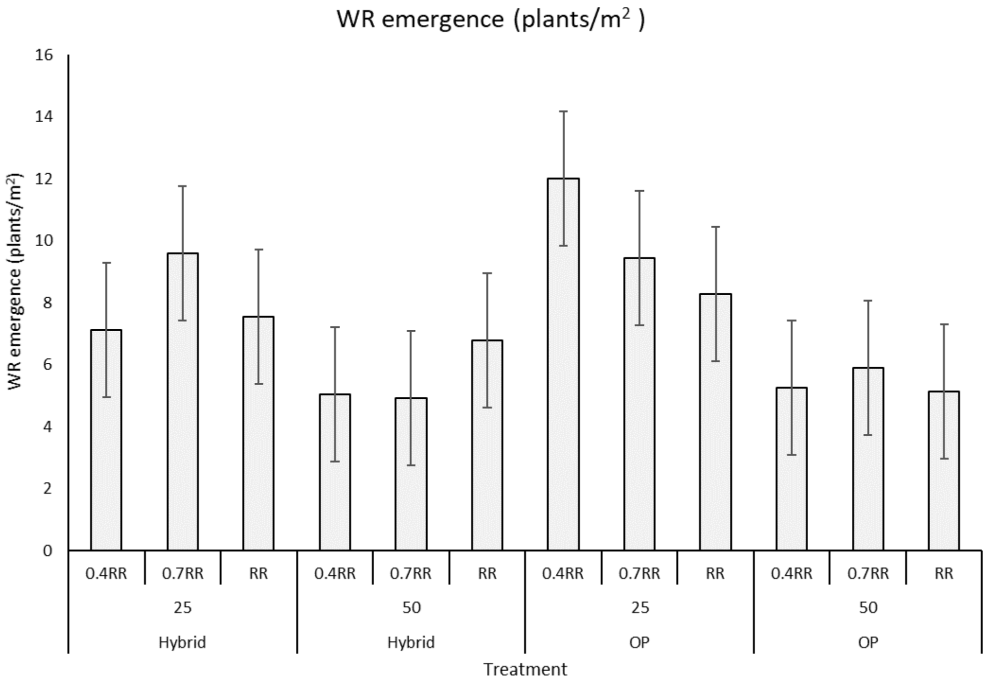

Figure 3 Wild radish emergence where no herbicide was applied in 2019. Error bars denote 1SE of the mean.

Canopy cover

When assessing the canola canopy cover (as a percentage of the total area) it was found that no statistically significant interactions existed between canola pollination type, seeding rate and row spacing (P>0.05). There was however a trend in the narrow row spacing treatment (25cm) for increased % canopy cover when seeding rates were increased from 20 to 50 plants/m^2 (Figure 4).

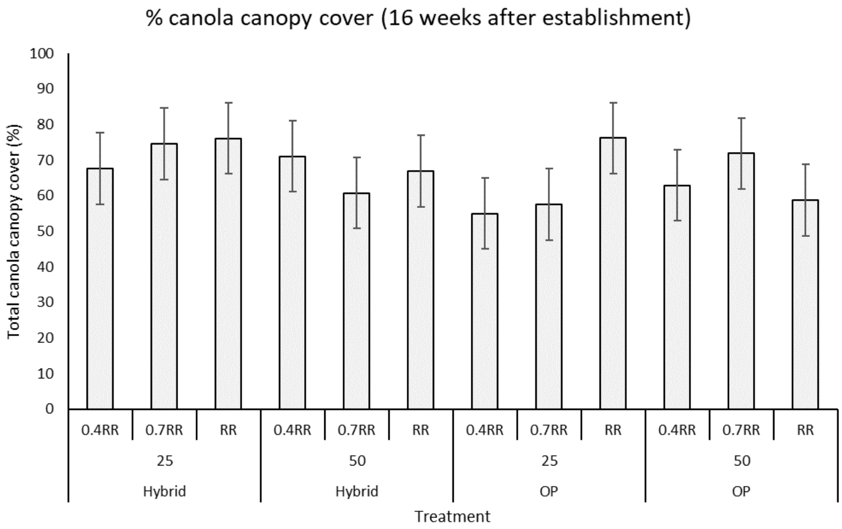

Figure 4: Percentage of Canola canopy cover measured at nine weeds after establishment in 2019. Error bars denote 1SE of the mean.

Wild radish biomass

When assessing the effect of canola competition factors on wild radish biomass, it was found that a statistically significant interaction existed between pollination type and seeding rate, with the hybrid variety (Trophy) decreasing WR biomass when seeded at rates above 35 plants/m^2 (P= 0.05). A single factor significance was also found with the hybrid variety (Trophy) effectively reducing wild radish seed production when compared to the open pollinated variety (Bonito) (P<0.001) (Figure 5 and 6).

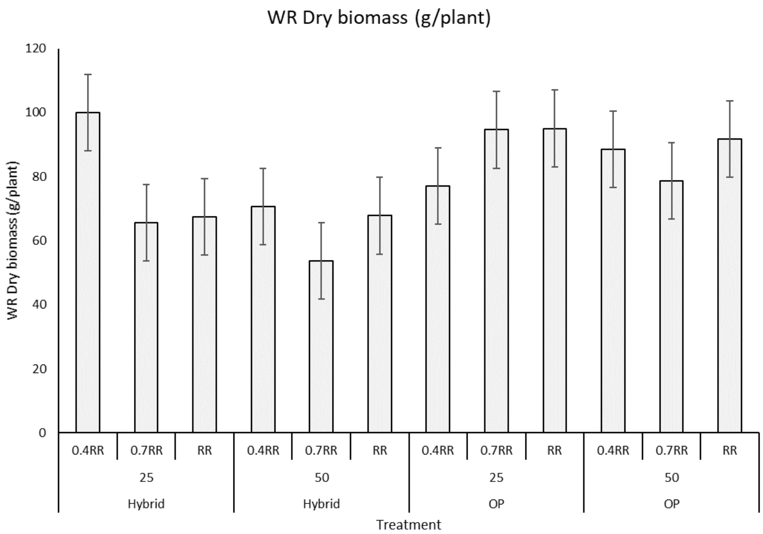

Figure 5 Wild radish total dry biomass in 2019. Error bars denote 1SE of the mean.

WR seed production

Despite limited differences in wild radish establishment and biomass, it was found that multiple interactions between canola crop competition contributed to reducing WR seed production. A pollination type and canola seed rate interaction was identified demonstrating that greater reduction in WR seed production occurred when increased seeding rates (50 plants/m^2) of the hybrid variety (Trophy) were used (P=0.006). A Canola row spacing and canola seeding rate interaction was found where high seeding rates (50 plants/m^2) at 50cm row spacing reduced WR seed production (P<0.001). This was demonstrated with the smallest WR seed production found where the hybrid variety (Trophy) was seeded at 50 plants /m^2 and at the 50cm row spacing (P<0.001). This study also found multiple single factor significant differences with the hybrid variety (Trophy) reducing WR seed production (P<0.001), wider row spacing (50cm) (P<0.001) and increased seeding rates (50 plants/m^2) (P<0.001) found to reduce WR seed production (Figure 6).

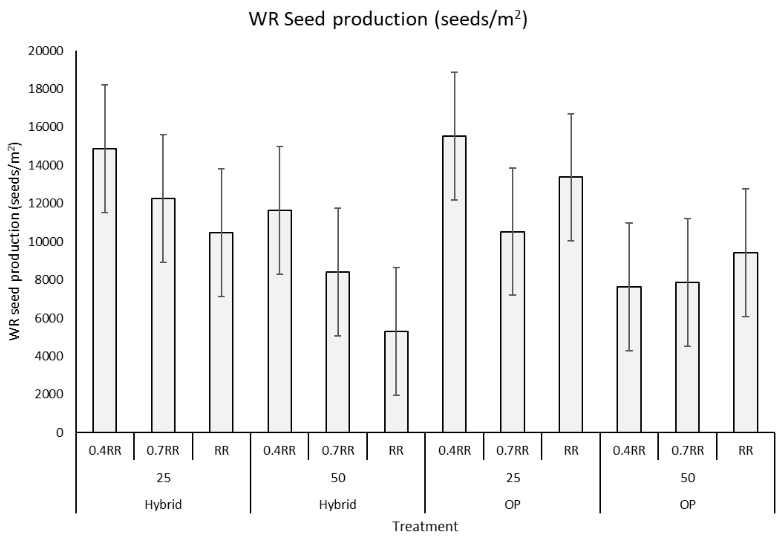

Figure 6: Wild radish seed production in 2019. Error bars denote 1SE of the mean.

Canola yield

When assessing the canola canopy cover it was found that no statistically significant interactions existed between canola pollination type, seeding rate and row spacing (P>0.05). However, multiple single factor significant differences were identified, with the hybrid variety (Trophy) out yielding the open pollinated (Bonito) (P<0.001) and the wider row spacing treatment (50cm) out yielding the narrower 25cm row spacing (P<0.001). The highest canola seeding rate (50 plants/m^2) consistently out yielded lower seeding rates (P=0.007) (Figure 7).

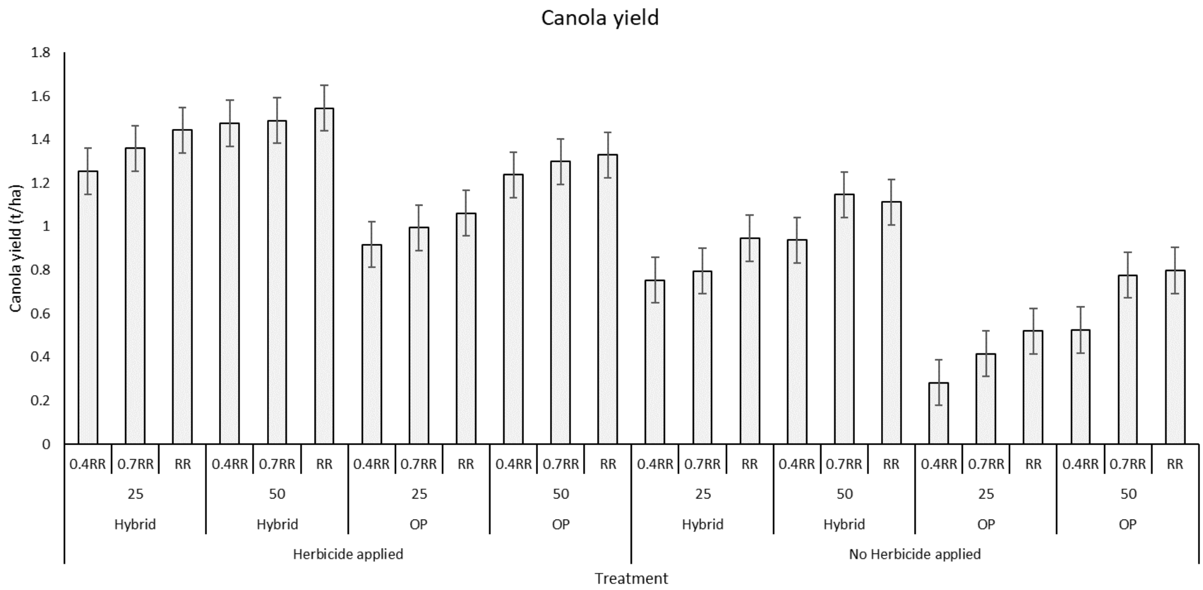

Figure 7 Canola yield for all treatments in 2019. Error bars denote 1SE of the mean.

Acknowledgments

This research was funded by the Grains Research Development Corporation of Australia (GRDC).

References

Cheam, A. H. (1986). Seed production and seed dormancy in wild radish (Raphanus raphanistrum L.) and some possibilities for improving control. *Weed Research, 26*(6), 405-414.

Cheam, A. H., & Code, G. R. (1995). The biology of Australian weeds. 24. Raphanus raphanistrum L. *Plant Protection Quarterly, 10*(1), 2-13.

Code, G. R., & Donaldson, T. W. (1996). Effect of cultivation, sowing methods and herbicides on wild radish populations in wheat crops. *Australian Journal of Experimental Agriculture, 36*(4), 437-442.

Code, G. R., & Reeves, T. G. (1981). *Chemical control of wild radish in wheat.* Paper presented at the Proceedings of the Sixth Australian Weeds Conference, 1981.

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.

Pathan, S., Hashem, A., & Koetz, E. Competitive effects and fecundity of wild radish. *Wild Radish*, 103.

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

Reeves, T. G., Code, G. R., & Piggin, C. M. (1981). Seed production and longevity, seasonal emergence and phenology of wild radish (Raphanus raphanistrum L.). *Australian Journal of Experimental Agriculture, 21*(112), 524-530.