LOCATION: Avondale 2020

TRIAL 4: The contribution of nitrogen fertilizer timing and placement in reducing the growth and seed production of wild radish (*Raphanus raphanistrum*) in competition with wheat (*Triticum aestivum* L.).

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KEY MESSAGE

- Nitrogen fertilizer timing (early or late) and placement (banded or broadcast) did not have any significant effect in reducing the growth and seed production of wild radish.

INTRODUCTION

Managing fertilizer inputs in a dryland cropping system is an important yet underutilized component of integrated weed management (Gill & Holmes, 1997; Liebman & Janke, 1990). Of all nutrients, the greatest competition between plants and weeds is for nitrogen (N) which is routinely applied by growers to optimize crop yield and grain quality (Patterson, 1995; Raun & Johnson, 1999). However, the application of additional N can greatly alter the competitive balance between crops and weeds. In many situations, this is because increased available N in the form of applied fertiliser can greatly increase the weeds growth rate relative to the surrounding crop species, resulting in an increased capacity for weeds to compete with the crop (Ampong-Nyarko & De Datta, 1993; Robert E. Blackshaw et al., 2003; Carlson & Hill, 1985; Dhima & Eleftherohorinos, 2001; Morales-Payan, Santos, Stall, & Bewick, 1998; Peterson & Nalewaja, 1992a, 1992b; Supasilapa, Steer, & Milroy, 1992). Past research has demonstrated that the placement of the N fertilizer influences the competitiveness of crops and weeds. Fertilizer placed in narrow bands below the soil surface, favoring crop growth compared to being surface broad-cast evenly across the site increasing weed growth and reducing the ability of crops to compete against wild oat (*Avena fatua* L.) (Kirkland & Beckie, 1998; Reinertsen, Elliott, Cochran, & Campbell, 1984), foxtail barley (*Hordeum jubatum* L.) (R. E. Blackshaw, Semach, Li, O'Donovan, & Harker, 2000) and downy brome (*Bromus tectorum* L.) (Rasmussen, 1995). Therefore, this study determines the effect of N fertilizer placement, N fertiliser rate and N application timing on the competitive ability of wheat *(Triticum aestivum* L.*)* in reducing the growth and seed production of wild radish (*Raphanus raphanistrum*) in dryland no-tillage cropping system in the Western Australian grainbelt.

TRIAL MANAGEMENT

Table 1 Trial management details.

Crop type	Wheat	
Variety	Magenta (Intergrain Australia)	
Seeding rate (kg/ha)	75	
Tillage type	Minimum tillage	
Soil moisture, depth (cm)	Marginal	4-5
Seed bed	Burnt stubble	
Clod size	Small (<5cm)	
Stubble loading	Nil	
Sowing equipment	Knife points and press wheels	
Sowing speed (km/hr)	5	
Sowing depth	1.5 cm	
Row spacing (cm)	25.4	

Fertiliser applied	Pre-emergent	100 kg/ha Gusto Gold
	Post-emergent As per treatment list	
Herbicides applied	Pre-emergent	1.5 L/ha Roundup Ultra Max 2.5 L/ha Boxer Gold
	Post-emergent 1 L/ha Velocity	
Fungicides applied	Seed treatment	N/A
Fertiliser treatment	300 mL/ha Uniform	
	Post-emergent N/A	
Insecticides applied	Seed treatment	N/A
	Pre-emergent 1 L/ha chlorpyrifos 200 mL/ha bifenthrin	
Post-emergent	50 g/ha Transform 150 mL/ha Affirm	

TRIAL TREATMENTS

Table 2 Treatment list

Treatment Number	Topdressing N method description	Comments
1	Broadcast post N	Basal plus UAN broadcast across the site
2	Banded post N	Basal plus UAN banded only on the crop row
Treatment Number	**Fertiliser timing description**	**Comments**
1	Early top-dress timing	UAN application early tillering (see below)
2	Delayed top-dress timing	UAN application at stem elongation (see below)
Treatment Number	**Fertiliser rate Description**	**Comments**
1	Low N input	See Below
2	Yield optimising N input	See Below
Control	**Control**	**Comment**
1	No topdressing	No topdressing, basal only

Table 3 Factorial combinations of Urea and ammonium Nitrate (UAN) fertiliser placement (streaming over the crop row vs broadcast spray), UAN rate, and UAN application timing applied to wheat in 2020.

Treatment	Basal treatment	Treatment description	Total N applied
1	-10 kg N ha-1 with establishment fertilizer	Nil N applied post emergent	10 kg N ha-1
2	-10 kg N ha-1 with establishment fertilizer -10 kg N ha-1 UAN sprayed evenly post sowing	10 kg N ha-1 UAN sprayed evenly at GS21,	30 kg N ha-1
3	-10 kg N ha-1 with establishment fertilizer	10 kg N ha-1 UAN banded to the crop row at GS21	30 kg N ha-1

	-10 kg N ha-1 UAN banded to the crop row post sowing		
4	-10 kg N ha-1 with establishment fertilizer -10 kg N ha-1 UAN sprayed evenly post sowing	10 kg N ha-1 UAN sprayed evenly at GS31	30 kg N ha-1
5	-10 kg N ha-1 with establishment fertilizer -10 kg N ha-1 UAN banded to the crop row post sowing	10 kg N ha-1 UAN banded to the crop row at GS31	30 kg N ha-1
6	-10 kg N ha-1 with establishment fertilizer -10 kg N ha-1 UAN sprayed evenly post sowing	40 kg N ha-1 UAN sprayed evenly at GS21,	60 kg N ha-1
7	-10 kg N ha-1 with establishment fertilizer -10 kg N ha-1 UAN banded to the crop row post sowing	40 kg N ha-1 UAN banded to the crop row at GS21	60 kg N ha-1
8	-10 kg N ha-1 with establishment fertilizer -10 kg N ha-1 UAN sprayed evenly post sowing	40 kg N ha-1 UAN sprayed evenly at GS31	60 kg N ha-1
9	-10 kg N ha-1 with establishment fertilizer -10 kg N ha-1 UAN banded to the crop row post sowing	40 kg N ha-1 UAN banded to the crop row at GS31	60 kg N ha-1

As there was no wild radish seed bank on site, seed was evenly spread acrros the trial site at a rate of 20 plants/m^2.

Statistical analysis carried out by SAGI (Curtin University).

LOCATION

The soil characterization for the Avondale (-32.119493 S, 116.865662 E) site in the Western Australian grainbelt can be found in Table 4. The average annual rainfall 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, though we had above average rainfall soon after seeding in early May followed by above average rainfall in June, the rest of the season's rainfall was lower than average (Figure 1). The site had been under long term no till cereal cropping and as a result was highly nitrogen responsive.

Table 4 Soil description at the Avondale experimental site in 2020.

		Avondale
	Depth (cm)	**0-10**
Colour		BRGR
Gravel	%	5
Texture		1
Conductivity	dS/m	0.108
pH Level (CaCl2)		4.8
pH Level (H2O)		5.7
Ammonium Nitrogen	meq/kg	11
Nitrate Nitrogen	meq/kg	33
Phosphorous	meq/kg	38
Colwell Potassium	meq/kg	94
Colwell Sulphur	meq/kg	15.7
Total Carbon	%	1.42

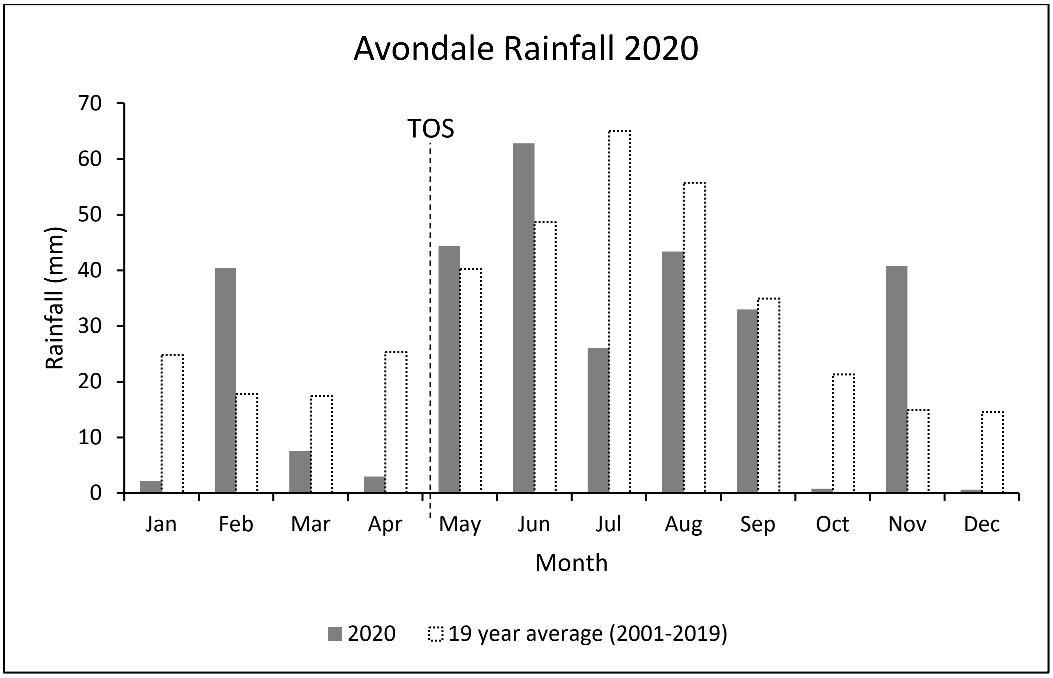

Figure 1 Monthly rainfall at Avondale trial site in 2020.

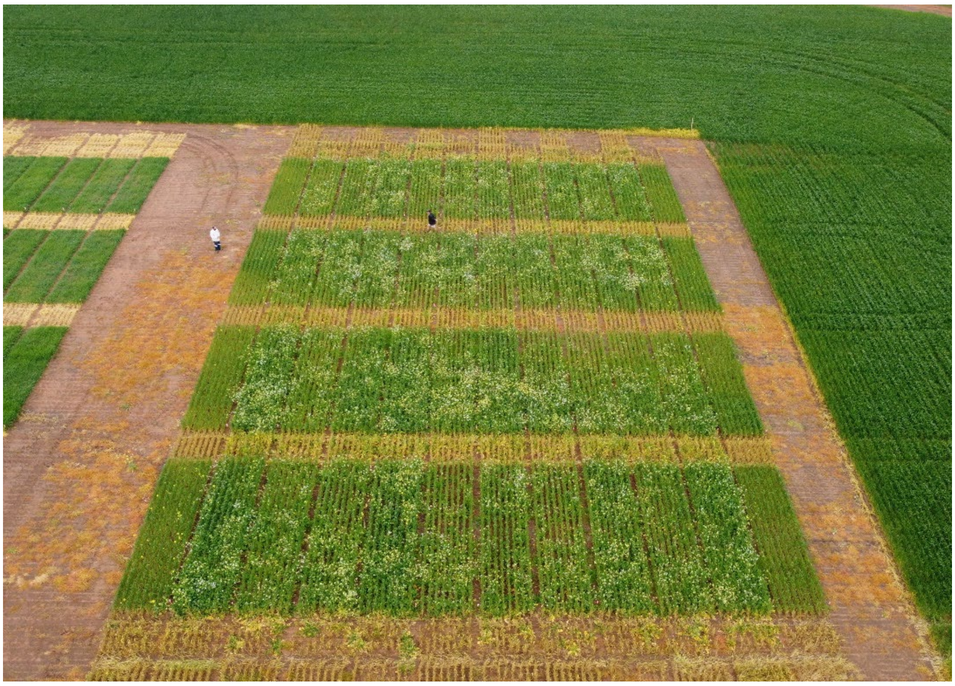
Figure 2 Trial site at the Avondale site in 2020.

Results and Discussion.

This study aimed to determine the effect of N fertilizer placement (Banded or broadcast), N fertiliser rate (Low input or label rate input), and N application timing (Early or late application) on the competitive ability of wheat *(Triticum aestivum* L.*)* against wild radish (*Raphanus raphanistrum*). The results found no statistically significant effects of N fertiliser placement, timing or rate on WR biomass or seed production ($p>0.05$). This lack of change in WR seed production occurred despite statistically significant increases in early competitiveness as measured by radiation interception (%) when N was applied at the optimum rate ($p=0.003$) (Table 5). Whilst the N application at the optimum rate increased light interception ($p=0.007$) it is evident that this was not enough to outcompete or suppress wild radish seed production.

Whilst statistically significant differences were not widely identified, there was a trend towards increased WR biomass where N application was increased (optimum) treatment. This trend however was not evident for seed production. This trial also demonstrated a trend towards increased wheat yields where N application were applied at the early timing. Whilst this site was N responsive, this trial site had enough residual N to support a yield of 1.7t/ha (nil control). In 2021, an alternate site that has a lower nutritional value will be selected.

These preliminary results of this single study demonstrate that wild radish establishment, biomass and seed production are unlikely to be affected by N placement, timing or rate. Wild radish is a rapidly growing, highly fecund weed species that thrives on disturbed sites that can either be fertile and infertile. The results of this trial will be replicated and confirmed in 2021 on a nutritionally deficient site.

Table 5 Predicted values, P-values and average SED for the Avondale trial in 2020.

Topdressing	Timing	Rate	Crop Emergence (m^2)	Weed counts (plants/m^2)	Rad. Int. (μmol m^{-2} s^{-1})	Rad. Int. (%)	WR Biomass (g/plant)	WR Seeds/plant	Yield (t/ha)
Nil	Nil	Nil	174.858	21.352	768.129	69.596	53.312	53930.7	1.7632
Band	Early	Optimum	173.903	21.222	900.007	86.058	84.875	67780.2	2.0584
		Low	172.429	20.622	841.567	76.624	62.562	57261.5	1.8003
	Late	Optimum	171.201	21.442	994.342	86.789	53.5	47652.2	1.8650
		Low	174.639	18.848	821.628	74.106	65.375	58621.6	1.8105
Broad	Early	Optimum	167.762	23.114	934.023	86.189	57.125	62538.2	1.9361
		Low	168.008	22.04	866.485	79.101	58.625	43532.4	1.8948
	Late	Optimum	181.517	19.406	916.695	83.058	59.875	56536.0	1.7569
		Low	172.429	21.315	819.7	78.605	75.375	53649.5	1.9051
Average SED			8.777	2.585	71.323	5.558	19.434	-	0.1174
Source of Variation			P-Value						
Control			0.675	0.581	0.004	0.000	0.311	0.703	0.089
Control:Topdressing			0.892	0.550	0.888	0.768	0.702	0.361	0.864
Control:Timing			0.328	0.213	0.944	0.637	0.821	0.396	0.146
Control:Rate			0.704	0.482	0.007	0.003	0.870	0.298	0.396
Control:Topdressing:Timing			0.302	0.520	0.346	0.872	0.230	0.264	0.953
Control:Topdressing:Rate			0.550	0.483	0.650	0.356	0.493	0.989	0.083
Control:Timing:Rate			0.807	0.881	0.328	0.957	0.229	0.154	0.104
Control:Topdressing:Timing:Rate			0.431	0.344	0.564	0.608	0.614	0.511	0.954