Using sowing direction and row spacing for brome grass (*Bromus diandrus* Roth.) management in the Mallee

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Abstract

Weeds are responsible for large yield losses and increasingly there is a need for sustainable alternatives for weed management since herbicide-resistant weeds appeared. This experiment aimed to determine if sowing direction and row spacing can be used to influence grass weed populations and growth, and to measure their impact on crop performance in the Mallee. Wheat was sown in a paddock containing brome grass (*Bromus diandrus* Roth.). Crop and weed populations and growth were monitored, and data on ground cover and light interception was gathered. After harvest, samples were processed for standard yield and grain quality assessments. Results showed that east-west rows intercepted more light than north-south rows and narrow rows intercepted more light than wide rows. A grain yield penalty was found for wide row spacing, but grain protein content was higher. Sowing direction had no influence on grain yield. The presence of weeds reduced yield, lowered grain protein content and test weight. In narrow rows, a possible reduction in weed biomass was found, which can be linked to the measured increase in light interception by the crop in narrow rows. There was no effect of row spacing or sowing direction on weed seed set after one year. However, farmers should reduce row spacing as far as practical due to demonstrated benefits on crop yields. Weed populations should be monitored over a longer timeframe to examine whether cumulative effects are significant.

Keywords

Weed control, sowing direction, row spacing, low rainfall.

Introduction

The reliance on agrochemicals, particularly herbicides, has increased over time in Wimmera and Mallee farming systems. As a result, the number of weed populations with some level of resistance to herbicides has continued to rise, motivating growers to seek alternatives for weed management.
Previous experiments have shown that crop sowing direction and row spacing have an impact on weed growth and seed production. However, these experiments have only been conducted in environments that differ in soil type, rainfall and sun angle through winter compared to the Victorian Mallee (Borger et al. 2010; Gardner 2013; Reithmuller 2005). The reported findings suggest narrow rows and sowing in an east-west direction suppresses weeds better. The aim of this experiment was to determine if this was also true in the Mallee, and if there are any benefits from combining the two practices.
In 2016 a trial was established, looking at natural grass weed populations comprising primarily of brome grass (*Bromus diandrus*), but that also included some barley grass and low levels of ryegrass and wild oats. It was anticipated that by using a real weed population the results could be more relatable to what a grower would encounter and will more accurately indicate whether practice change could benefit their system.

Methods

A replicated split plot trial with sowing direction as the main plot and row spacing*weeds as the sub plot was established at Jil Jil in north west Victoria. The paddock had a grass weed population of predominantly brome grass (*Bromus diandrus*), but also barley grass (*Hordeum leporinum* Link) and low levels of annual ryegrass (*Lolium rigidum* L.) and wild oats (*Avena sativa* L.). The soil type was sandy clay loam and mineral soil nitrogen was 108 kg N/ha to one metre depth. Recorded annual rainfall was 446 millimetres and growing season rainfall was 373 millimetres. Wheat (*Triticum aestivum* L.), variety Grenade CL Plus, was sown on the 5th of May 2016 using a plot-seeder with knife points and press wheels, at a target density of 130 plants/m^2. The different treatments are presented in Table 1. Presence or absence of weeds was obtained by herbicide use at pre-sowing and in-crop to keep grass weeds to a minimum in the weed free plots.

Table 1. Treatments used in the trial at Jil Jil Victoria, 2016.

Sowing direction	Row spacing	Weeds
North-South	22.5cm	presence
East-West	30.5cm	absence
	38.0cm	

Assessments carried out in-crop included: emergence counts of crop and weeds 40 days after sowing; biomass cuts and further weed counts at Zadoks 30 (end of tillering) and Zadoks 65 (flowering); and crop head and weed panicle numbers at early grain fill. Light interception was measured at full flag leaf emergence (Zadoks 39) using a ceptometer to determine if the treatments had an impact on the amount of light reaching the weeds lower in the canopy. Plots were harvested and processed for standard yield and grain quality assessments.
Seed set in brome was assessed by randomly selecting 20 panicles per weedy plot and counting seed number. This was then calculated to seeds/m^2 based on the number of brome panicles present in plots.

Results

Growing season rainfall in 2016 was exceptional resulting in an average trial yield of 3.7 t/ha. Rainfall around sowing time allowed uniform crop establishment with no significant differences in crop counts at Zadoks 12 noted between treatments. Average plant density over the trial was 135.9 plants/m^2, regardless of treatment. Weed populations were variable across the site, ranging from 14.3 plants/m^2 to 76.3 plants/m^2 in weedy plots at Zadoks 30.

The influence of sowing direction and row spacing on light interception, crop growth and yield

Light interception

At noon, EW rows intercepted significantly more light than NS rows (P = 0.001) (Figure 1). The effect of row spacing on midday light interception was also significant (P = 0.001), narrower rows intercepting more light than wider rows (Figure 1). As seen in Figure 1, the impact of row spacing on crop light interception at noon magnifies as row spacing gets wider: the wider the row spacing, the greater the difference between EW and NS (P = 0.021).

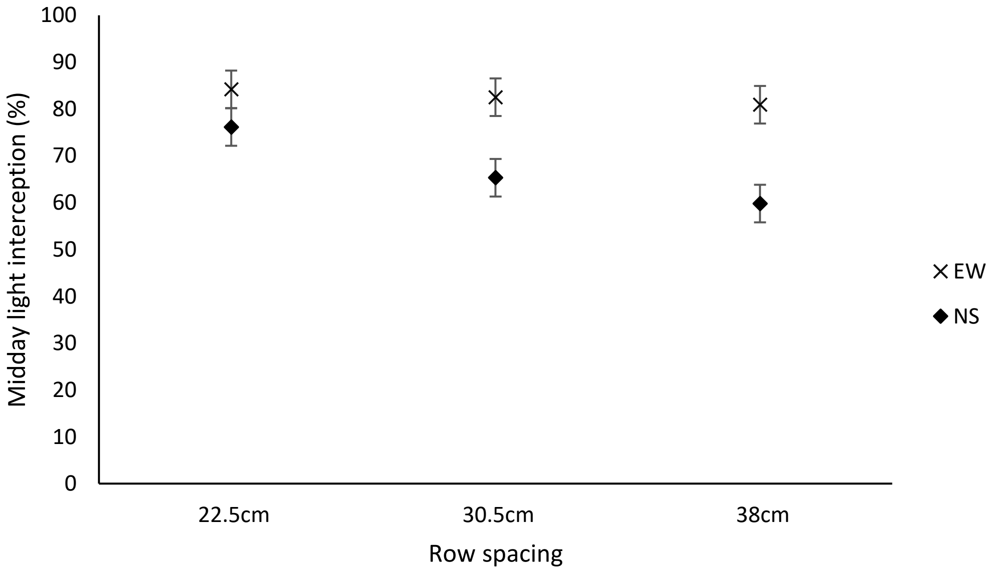

Figure 1. Crop light interception (%) at midday as measured with ceptometer, Jil Jil, 2016.

Crop growth, yield and quality
Sowing direction and row spacing had no influence on crop biomass at Zadoks 30 and Zadoks 65. At Zadoks 30, average crop biomass for the trial was 0.53 t/ha and at Zadoks 65 it was 6.24 t/ha.

Row spacing influenced head production and yield, with 38 cm row spacing having lower head numbers (P=0.002) and yield (P=0.011) suggesting the competition between plants within the row for inputs was greater (Table 2).

Table 2. The influence of row spacing on head number, grain yield and protein in wheat.

Row spacing	Heads/m^2	Grain yield (t/ha)	Protein (%)
22.5cm	260	3.8	9.1
30.5cm	248	3.6	9.3
38.0cm	226	3.5	9.7
LSD (P<0.05)	16.23	0.16	0.4

Sowing direction had no influence on yield (P = 0.516). Grain protein content was inversely proportional to yield and increased with row spacing (P = 0.034). This clearly shows a dilution effect for the 22.5 cm spacing (yield is higher but protein content is lower compared to wider treatments). No differences were found for row spacing and sowing direction on any other grain quality parameters (screenings, 1000 grain weight and test weight), and no interactions were detected, hence why only main effects and presented.

The influence of weeds on yield and grain quality
The presence of weeds reduced yield by 0.25t/ha (P<0.001) even under relatively low weed pressures and in a decile 9 season. Weeds also significantly lowered grain protein content (9.47 % weed free, 9.23 % weeds, P = 0.009), and test weight (79.64 kg/hL weed free, 78.39 kg/hL weeds, P < 0.001).

The influence of sowing direction and row spacing on weed development
Weed growth
At Zadoks 30, neither row spacing (P = 0.602) nor sowing direction (P = 0.616) had influenced the number of weeds present in weedy plots. Weed biomass assessments at both Zadoks 30 and Zadoks 65 did not indicate an influence of sowing direction on weed dry matter accumulation (P=0.458 and P=0.407 respectively). Row spacing showed more influence on weed biomass production, however was still not detected at the 95% confidence level (P = 0.135 and P = 0.120 respectively)

Weed seed production
There was no significant (P = 0.102) effect of sowing direction on weed seed set with 974 weed seeds.m^{-2} being produced in the EW treatment compared to 1482 weed seeds.m^{-2} in the NS treatment. There was no effect of row spacing on weed seed set (P = 0.925).

The variability of the natural weed population meant that differences in many cases could not be detected at the 95% confidence level, but given the measured differences in crop light interception (Figure 1), it is plausible that the effect of narrow row spacing on weed biomass, and sowing direction on weed seed set could be real. Further investigation on more uniform brome populations over multiple seasons would determine if this could occur.

Conclusion
In the Mallee and around the world, weeds are an ongoing challenge for growers as they are responsible for large yield losses. Dependence on agrochemicals and development of herbicide resistant weeds is forcing farmers and researchers to develop new alternatives for weed management. In this study, sowing direction and row spacing in wheat were tested as cultural methods to suppress grass weed populations in the low rainfall environment.

Results showed that EW rows and/or narrow rows intercepted more light than NS rows and that a yield penalty was found for wide row spacing, but sowing direction had no influence on grain yield.
As found in previous studies, presence of weeds in the plots had negative effects on crop development and the presence of weeds reduced yield and lowered grain protein content and test weight.

Based on the measured effect of row spacing on light interception, a comparable and possible effect of row spacing on weed biomass was found. Narrow rows tended to reduce weed biomass at Zadoks 30 and at Zadoks 65, however this was not statistically significant.

Growers would be well advised to adopt as narrow a row spacing as practical due to the clear, demonstrated benefits to crop yield. However, these results do not show significant suppression of brome weed populations after one year. Future research should monitor effects over a longer period to establish whether cumulative effects would result in statistical differences over time.

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