Non-chemical weed control in an organic wheat crop

Thomas R. Sweeney¹ and Steven R. McCoy²
¹ PO Box 483, Northam, Western Australia 6401, Australia
² Department of Agriculture, Locked Bag 4, Bentley DC, Western Australia 6983, Australia

Summary With growing evidence of herbicide resistance and increasing interest in health issues being pursued by an aging population, farmers are looking for alternative methods of both growing crops and controlling weeds. The use of finger tyne harrows and a higher seeding rate in an organic wheat crop, provides one such method and this was tested in a replicated trial on two soil types.

The finger tyne harrows reduced the numbers of all plant groups measured. For a high seeding rate (79 kg ha⁻¹) and two passes, the effects were greatest. Broadleaf weeds were reduced from 11 to <1 plants m⁻² on a heavy soil site and from 91 to 34 plants m⁻² on a light soil site (P <0.05). Grass weeds were also reduced from 47 to 7 plants m⁻² on the heavy site (P <0.05) and from 54 to 39 plants m⁻² on the light site (just not significant). Wheat plant numbers also declined, from 65 to 30 plants m⁻² on the heavy site and from 86 to 66 plants m⁻² at the light site (P <0.05). This drop in wheat plant density did not result in a reduction in wheat grain yield. Wheat yields however, were significantly increased at the higher seeding rate on both soil types, without affecting weed numbers.

Keywords Organic, grass weeds, broadleaf weeds, finger tyne harrow (FTH).

INTRODUCTION

In Western Australia (WA) there are approximately 25 grain growers located from Morawa in the north to Esperance on the South Coast, who undertake organic crop production on a broadacre basis. Their total capacity is estimated at 10,000 tonnes per annum. The main market is noodle wheat, milled in WA and exported to Japan as Udon noodle premix. Demand has decreased in recent years for this product, due to the economy of Japan and also regulatory issues. However, new opportunities are occurring on both the domestic and export markets (S. McCoy unpublished data).

Without herbicides, organic farmers have limited means of controlling weeds in the cropping year. For a multiple-pasture crop rotation, these include mowing or fodder conservation and/or grazing in the pasture year, followed by pre- and post-seeding cultivations in the crop year. Collecting as much weed seed as possible at harvest and using very clean seed further reduces the weed burden. The results from this paper were from trials that were conducted at Moora (174 km north of Perth), on the property of a farmer who is a member of a group called the 'Broadacre Organic Farmers of WA'. There are eight members of the group and they produce a range of grains including approximately 500 tonnes of hard wheat for the domestic market. They are certified organic by the National Association for Sustainable Agriculture Ltd. (NASAA) under the Australian Quarantine and Inspection Service (AQIS) accreditation system. The farm has been producing organically for 11 years.

This paper reports the findings of two trials where a finger tyned harrow implement was used to control weeds in organically grown wheat crops.

MATERIALS AND METHODS

Two paddocks where chosen on the same farm for the trials (latitude 30°34´11.3´ S, longitude 183°56´0.3´ E). The soil type in one paddock was hard cracking clay (heavy site) and in the other, a shallow sandy duplex containing some gravel (light site). Both paddocks were mown in the first week of October 2002, to further reduce seed set. No fertiliser was applied during this grazing period. The heavy site had more phosphorus than the light site, 30 versus 17 ppm.

In 2003, both sites were cultivated twice with a finger tyne harrow (FTH). Three point linkage (Hatsenbichler brand) 8 m wide:
1. harrow with the FTH four days (light site) and five days (heavy site) after sowing (pre-emergent);
2. two passes with the FTH at the three to five leaf stage (wheat) and again at the mid-tillering stage (double pass);
3. one pass with the FTH at the three to five leaf stage (wheat) stage (single pass); and
4. an untreated control.

Each plot was divided into two, with half sown to wheat at a high rate (79 kg ha⁻¹) and half at a low rate (53 kg ha⁻¹)
There were four replications. The timings listed above were later than preferred (two and four leaf stage wheat), but came about because of the likelihood of rain at the earlier preferred stages. For best results, a dry period of 5–7 days after treatment is recommended (M. Collins pers. comm.).

Lime at 1 t ha⁻¹ was applied on 1 April. Fertiliser was applied using a pelleted mixture of Multigrow (4% nitrogen, N) and rock phosphate (12.5% P) at 45 kg ha⁻¹ in a ratio of 3:1, on two occasions. The first was during the second cultivation and the second at seeding. The second cultivation, seeding and passes with the FTH were all in parallel, while the first cultivation was at 90°.

Seed was sown at a depth of 2.5–4 cm (full disturbance) and the weeder cultivated at a depth of 2–3 cm. The weeder was pulled by a Ford tractor (87 hp) at a speed of 8 km h⁻¹ (7th gear). Weed and wheat plant numbers were counted prior to any weed treatment (except the pre-emergent) and then again afterwards. There were five pegged sites in each plot where plant counts occurred and the quadrat size was 0.1 m².

Weeds found at the sites were, wild radish, Wimmera ryegrass, Emex australis L. (doublegee/three cornered jack), Vulpia bromoides L. (silver grass), Arctotheca calendula L. (capeweed), Trifolium subterraneum L. (subterranean clover) and Cotula spp. (water weed).

Wheat yields were calculated using a plot harvester and wheat seeding rates using 1 m row counts and a row spacing of 17.5 cm (Anderson and Garlinge 2000). Results were subjected to an analysis of variance.

The farm recorded an annual rainfall of 368 mm for 2003 compared with the average at Moora, 10 km SW, of 461 mm.

**RESULTS**

**Wheat plant densities** Wheat density was significantly reduced with both the single and double pass on the heavy site compared with the control. The single pass pre-emergent treatment also reduced wheat density (high seed rate). On the light site, wheat numbers were significantly reduced for both seeding rates on the double pass. For the single pass, reductions occurred but just failed to be significant. It is important to note, that while wheat plant densities did fall as a result of the weeding, this did not carry through to differences in grain yields between weeded treatments. Yields averaged 2.3 t ha⁻¹ for the heavy site and 1.4 t ha⁻¹ for the light and were significantly different (P <0.05). It is also important to note that there were significant differences in wheat yields between seeding rates at both sites.

<table>
<thead>
<tr>
<th>Seeding rate (kg ha⁻¹)</th>
<th>Heavy site</th>
<th>Light site</th>
</tr>
</thead>
<tbody>
<tr>
<td>53</td>
<td>2208</td>
<td>1234</td>
</tr>
<tr>
<td>79</td>
<td>2465</td>
<td>1513</td>
</tr>
<tr>
<td>LSD (P = 0.05)</td>
<td>204.6</td>
<td>69.7</td>
</tr>
</tbody>
</table>

**Table 1.** Effect of seeding rate of wheat on wheat yields (kg ha⁻¹) on heavy and light soil types at Moora in 2003.

**Figure 1.** Wheat density (plants m⁻²) at Moora 2003; LSD (P = 0.05) H (heavy site) = 12; L (light site) = 18; SR = seeding rate.

**Figure 2.** Broadleaf weeds (plants m⁻²) at Moora 2003; LSD (P = 0.05) H (heavy site) = 9; L (light site) = 23; SR = seeding rate.

**Figure 3.** Grass weeds (plants m⁻²) at Moora 2003; LSD (P = 0.05) H (heavy site) = 16; L (light site) = 15; SR = seeding rate.
**Broadleaf weeds** These were reduced at the heavy site, in particular for the high seeding rate and the double pass. Numbers dropped from 11 m\(^{-2}\) to <1 m\(^{-2}\) when comparing the double pass with the nil treatment at the high seeding rate. The single pass also had an effect. On the light site, significant differences did result from both the double and single pass at both seeding rates.

**Grasses** There were differences due to the weeder (both single and double pass) on the two soil types. On the heavy site, variable starting grass numbers compounded some of the effect, yet when an allowance was made for this variation, there was still significant reduction in grass levels for the double pass at the high seeding rate. On the light site, significant reductions occurred at the low seeding rate, for both the single and double pass.

**Other results** Tests were also carried out on the harvested seed for: hectolitre weight; % screenings; % grass seed; % broadleaf weed seed; % wheat; % protein; and % blackpoint. There were no issues of significance to raise from these investigations.

On the heavy site, a large density of water weed (*Cotula*) compounded the counting of other weeds at the pre-treatment counts. In a 0.1 m\(^{2}\) quadrat, counts approaching 100 plants m\(^{-2}\) were experienced. This weed had largely disappeared by the time of the post-treatment counts. Hence pre- and post-comparisons here were not useful. Because of waterlogging and patchiness of the wheat crop, plot length was reduced to 30 m (from 50 m) at harvest on the heavy site. Loose smut and webworm were observed at both sites. The effects of these two factors were not considered to be significant.

**DISCUSSION**

Data obtained in the two trials supports the hypothesis that finger tyne harrows used at the post-emergent stage in a wheat crop, will assist with weed control. These results endorse findings from another source (M. Collins unpublished data), that finger tyne harrows reduce both broadleaf and grass weed densities.

Of the three treatments, the pre-emergent harrowing did not control weeds well. This can be partly explained by the dry conditions that prevailed at seeding and that continued for another 18 days. The cultivation four or five days after sowing would not have been expected to intercept many emerging seedlings, because the dry dusty conditions had not yet triggered weed germination. However, wheat density was reduced significantly (P <0.05) for the high seed rate on the heavy site. It is possible that with greater water retention on the heavy site, germination of wheat had commenced and this accounted for the damage by the weeder (FTH).

For the post-emergent treatments, two passes with the weeder appeared to bring about greater reductions in weed density levels when compared with one pass. Comparison between the double and the single pass shows that there was a consistent difference, with two passes resulting in lower weed numbers and lower wheat plant numbers too. More work is needed to confirm the result for a range of seasons.

Increasing wheat seeding rate appears to be one way of increasing wheat yield. There were significant increases on the two soil types. However, there was no evidence to suggest that increasing seeding rate, improved weed control with respect to either broadleaf or grass weeds on either soil type.

While the finger tyne harrow technique of controlling weeds appears promising, farmers are strongly encouraged to control weeds in the years leading up to a cropping year. By doing this they will reduce the weed challenge to a more manageable level in the cropping years. It is also of interest to note, that the differences caused by the weeder (FTH) were difficult to observe in the field. It was only when the counts were analysed, that the significance of the work was realised. There are plans to continue the work this year.

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**REFERENCE**