WEED CONTROL IN ORGANIC ARABLE CROPS

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SUMMARY

Six experiments in two seasons investigated the effect of a post-emergence cultivation with a Lely tine weeder on density of weeds in arable crops. Wheat, barley, peas and oats were sown at different densities in 16 cm rows or broadcast with the Blackmore coulter. A single pass with the weeder reduced weed densities by 60 to 80% without affecting crop densities. A second pass further reduced weed densities without affecting crop densities. Crop yields were not increased by weeding.

INTRODUCTION

Herbicides are routinely used in conventional farming systems because weeds are thought to reduce crop yield and quality and to make harvesting more difficult and expensive. However, herbicides do not always increase crop yields, even when weed density is high (Davies *et al* 1989).

Conventional pesticides are prohibited in biological-organic cropping systems, because of perceived damage to beneficial organisms in the soil or elsewhere and because of the development of pesticide-resistant individuals or populations.

In an organic system, crop rotations maintain soil fertility, reduce carry-over of pests and diseases, and limit the increase of weed seeds in the soil. Even with crop rotations, weeds can become troublesome. The adverse effects of weeds on crop yields can be reduced by mechanical tillage or by increased crop competitiveness or both. Crop competitiveness towards weeds can be influenced by using appropriate crop species and cultivars, seed rates, spacing and sowing dates (Patriquin 1988; Richards 1989). Harrowing can be used to reduce weed densities before drilling, between drilling and crop emergence, or after the crop is well rooted (Patriquin 1988). Weed management is the aim, rather than complete control.

In these experiments post-emergent harrowing using a Lely tine weeder was tested on peas, barley, oats and wheat sown at different seed rates and with different drilling techniques.

METHODS

All trials were carried out on the organic mixed cropping farm at the Flock House Agricultural Centre. Crops were sown with an Aitchison Seedmatic drill and a 1.25 m strip from the centre of each sub or sub-plot was harvested with either a Hegi or a Wintersteiger small plot harvester.

The trials are listed in Table 1, along with relevant information. The basic experimental design for all cereal trials was four replicates of four main treatments, which were two sowing rates ('standard' or 'standard' + 10%) (Millner and Hampton 1986) by two drilling techniques (16 cm hoe coulters or Blackmore coulters, which gave a broadcast effect). Sub-plots were unweeded, or received one or two passes with a Lely tine weeder. The first pass was at growth stage 13-14 (Zadoks *et al* 1974) in the cereals and at the 3 node stage in peas. When a second pass was used, this was at growth stage 30-32. In all cereal trials sub-plot size was 15 m x 5 m.

The 1989 pea trial (Table 1) had four replicates of four main treatments, which were sowing rates ('standard' or 'standard' + 10%) by two weed treatments (untreated or a single tine weeder pass). Sub-plots were four pea cultivars. Each sub-plot was split, half being drilled with 16 cm row hoe coulters and half with Blackmore coulters. Sub-sub-plot size was 15 m x 2.4 m.

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TABLE 1: Experimental information.

		Cultivar	Sowing Date	1000 grain weight (g)	'Standard' sowing rate	Soil* type (silt loam)
Wheat	1988	Otane	12 Nov	39.5	139	Manawatu
	1989	Otane	10 Nov	41.7	147	Manawatu
Barley	1988	Fleet	11 Nov	41.5	157	Manawatu
	1989 (a)	Fleet	10 Oct	38.4	143	Parewanui
	1989 (b)	Fleet	31 Oct	38.5	143	Parewanui
Oats	1989	Awapuni	25 Sept	38.5	143	Manawatu
Peas	1989	Bolero	3 Nov	331.8	131	Parewanui
		Tere		238.5	238	
		Maro		317.1	317	
		Whero		261.6	307	

*Average Quicktest soil results: pH 6.5 (both wheat trials 5.5), Ca 11, P 15, K 13, S 12, Mg 30, total nitrogen .25%, organic carbon 2.4%, phosphate retention 22%.

Both crop plant and weed density were measured in ten 0.1 m^2 quadrats in each sub- or sub-sub-plot at growth stage 13-14 (3 node in peas), before any weeding treatment, and then immediately after each weeding. Cereal ear density at harvest was measured in two 0.5 m^2 quadrats in each sub-plot.

Percentage screenings were assessed with a Clipper seed dresser at DSIR, Palmerston North. Protein content of the wheat grain was measured with a Pacific Scientific Model 6200 near-infra red reflectance spectrophotometer (Stark *et al* undated).

RESULTS

The tine weeder significantly reduced weed density (Table 2). Despite this, none of the treatments had any significant effect on crop yields.

Target plant populations were achieved (Table 2). Sowing method, sowing rate and tine weeder had no significant effect on crop plant populations. In the cereal trials, however, the tine weeder tended to pull out more plants sown with the Blackmore coulter (8-12%) than with the 16 cm row hoe coulter (3-8%).

Ear density at harvest was not significantly affected by sowing method, sowing rate or tine weeding, and the overall mean values are shown in Table 2.

TABLE 2: Weed densities before and after cultivation (means across other treatments) and crop data (means over all treatments) from the cereal trials. Standard errors are in brackets.

	Wheat		Barley			Oats
	1988	1989	1988	1989a	1989b	1989
Weed density (plants/m^2)						
Pre-cultivation	24(4)	62(8)	23(4)	27(5)	27(5)	6(3)
Post-cultivation						
One pass	11(4)	37(4.5)	4(0.6)	6(1.5)	11(3.6)	4(1.5)
Two passes	7(2.1)	20(5.0)	2(1.3)	4(2.5)	3(2.1)	2(1.0
Untreated	30(1.2)	120(29.4)	20(3.3)	23(5.2)	35(6.3)	3(2.1)
Crop data (means over all treatments)						
Plant population /m^2	386(33)	298(40)	302(23)	268(28)	246(14)	287(19)
Ears/m^2 at harvest	607(30)	495(32)	800(231)	813(205)	762(270)	
Grain yield (kg/ha)*	5500(42)	6950(120)	7200(97)	6035(62)	5760(276)	4100(50)
% Screenings	18	4	13	9	9	

*At 14% moisture

In the two wheat experiments, the dominant weeds were scrambling fumitory (*Fumaria muralis*), twin cress (*Coronopus didymus*), black nightshade (*Solanum nigrum*), mouse-ear chickweed (*Cerastium fontanum*) and fathen (*Chenopodium album*). With all drilling methods and sowing densities the crop canopy was adequate, by 42 days after sowing, to shade out all weeds except scrambling fumitory, which was controlled with a second pass of the tine weeder. Protein content of the wheat grain was over 13% in both years.

In the three barley experiments, crop growth was very vigorous, with the canopy closing at 40 days from sowing and effectively shading out weeds. Twin cress and scarlet pimpernel (*Anagallis arvensis*) were the most common annual weeds and docks (*Rumex* spp.) the major perennial weed. In the two 1989 experiments some plots were waterlogged and this suppressed barley growth, enabling docks to grow more vigorously, and crop yields were reduced. Plots unaffected by waterlogging but with an equal number of dock plants had no grain yield reduction.

In all four pea cultivars where plant populations reached $95/m^2$, the crop effectively smothered weed growth during the early part of the season. A single pass of the tine weeder reduced weed population density by 66%. Again, crop yields were unaffected. After seed set, when the crop dried off, significant populations of large weeds developed in the cultivars Tere and Bolero. In these cultivars, there were about 48% more weeds in unweeded than in weeded plots.

DISCUSSION

Although the tine weeder significantly reduced weed population densities in these experiments, its use did not affect crop yields. Weed densities, even in unweeded plots, may not have been high enough to significantly affect crop yields. Relationships between weed density and crop yield loss depend on many factors (Wilson 1989). Davies *et al* (1989) pointed out that the method of weed control must be taken into account when describing weed and crop relationships. In the experiments described here, damage to the crop by the tine weeder may have balanced gains made by reducing weed density. Further work is needed to study both weed and crop interactions under New Zealand conditions, and to examine the effect of the tine weeder on yields of weed-free crops.

The experiments have certainly shown that weeds are not necessarily a major obstacle to growing organic crops. The yields and quality recorded here were equal to or greater than those of conventionally-grown crops in neighbouring paddocks. Weed populations were not especially high and it may be possible, under an organic system, to reduce weed effects on crop growth by management practices before mechanical control is even considered.

The tine harrow can reduce weed density without any apparent loss of crop yield. The first pass, at stage 13-14 (Zadoks *et al* 1974) when weed seedlings were small, was more effective in reducing weed density than the second. The second pass only removed later germinating weeds, but could reduce the effects of very competitive scrambling weeds like cleavers (*Galium aparine*) (Wilson 1979). The tine harrow could also be used to control very young weed seedlings after drilling but before the crop has emerged (Wookey 1985).

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