IWMA—INTEGRATED WEED MANAGEMENT ALTERNATIVES

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Summary Post emergent weed control in broadacre crops now relies primarily on selective herbicides. It is proposed that two alternative strategies may be used in some crops in some years. These involve the grazing of sheep in crops such as faba beans, coriander, narbon beans, chick peas and possibly mustard at low stocking densities early in the season. The other alternative involves the use of purpose built weeders for in-crop control, which are very effective if suitable conditions prevail.

INTRODUCTION

The need for farmers to practice integrated weed management, particularly as a means of prevention of herbicide resistant weed problems, has been widely espoused (Powles and Holtum 1990, Shaner *et al.* 1992). The concepts suggested by scientists, and put into practice by farmers, are now commonplace. They include the mixing of chemical groups, judicious burning or cultivation, stock grazing during a pasture phase and the harvest handling of weed seed such as collection or windrowing.

These practices are all designed to decrease the in-crop weed burden through pre-sowing paddock management. However, following crop emergence, few options to herbicides exist for in-crop reduction in weed competition and ultimately seed set.

As Combellack (1990) noted, greater emphasis needs to be placed on non-herbicide control methods to achieve the desired reductions in herbicide use suggested by Alexandra (1992). Two programs have been established to investigate the potential of non-conventional, non-chemical weed management practices which may have application on conventional and organic farms alike.

EXPLOITING THE PREFERENTIAL GRAZING HABITS OF SHEEP

Utilizing grazing animals does not conform to the description of classical biological weed control. However, the capacity of sheep to preferentially graze some plant species over others growing in the same environment has long been acknowledged. West and Dean (1990) found sheep to be useful weed control agents in New Zealand forests. Popay and Field (1992) recognise the use of grazing animals as biological control agents to be more sustainable than continuous chemical control. Sheep, cattle, goats and even geese all have roles in the control of different weed species in a range of environments. Carter (1990) notes the millions of dollars saved in herbicides annually where weed seed production and viability are reduced through the grazing of pastures prior to cropping.

Broadacre farmers have long recognized the unpalatable nature of chick peas to sheep, facilitating a reduction in weed competition and seed set through grazing the crop at light stocking rates. There was however, a dearth of empirical information regarding the palatability of other broadleaved crops to sheep, preventing the further exploitation of this virtue for in-crop grazing.

Materials and methods In a replicated field trial, the palatability to sheep of 13 crop species was compared: canola (*Brassica napus*), safflower (*Carthamus tinctorius*), fenugreek (*Trigonella foenumgraecum*), lupins (*Lupinus angustifolius* cv. *gungurru*), chickpea (*Cicer arietinum* cv. *semsen*), faba bean (*Vicia faba*, cv. *fiord*), field pea (*Pisium sativum* cv. *alma*), lathyrus (*Lathyrus sativa, L. cicera*), mustard (*Brassica juncea*), coriander (*Coriandrum sativum*), narbon bean (*Vicia narbonensis*) and lentil (*Lens culinaris* cv. *aldinga*). Wheat (cv. *trident*) was also grown to provide a common palatable crop species. Principal weeds present were Wimmera ryegrass (*Lolium rigidum*), wild oats (*Avena sativa*) and wireweed (*Polygonum aviculare*). The trial was grazed by Merino wether hoggets at 12 d.s.e. (dry sheep equivalents) per hectare on two separate occasions (nine weeks and thirteen weeks post-sowing) to determine whether crop palatability altered with its phenological development. A portion of the trial was also grazed at both of these periods.

Results and discussion Results from dry matter cuts and grain yields taken in 1995 showed significant variation in palatability between crop species which altered with time. Table 1 shows the relative palatability

Table 1. The relative palatability of thirteen crop species following grazing by sheep nine weeks post-sowing. Palatabilities are expressed as crop biomass remaining as a percentage of the ungrazed control; high >40%, moderate 15–40% and low <15%.

High	Field pea, *Lathyrus sativus*, fenugreek, lentils, canola, wheat, safflower, lupin
Moderate	Chick pea, mustard
Low	Coriander, faba bean, narbon bean

following the early grazing. These outcomes changed for the later grazing, with wheat, chick pea and fenugreek becoming less palatable. Relative grain yields were closely correlated with dry matter production.

While these results must be regarded as preliminary, they do suggest narbon beans, faba beans and coriander may be grazed by sheep to reduce weed competition with little damage to the growing crop. Chick peas, *Lathyrus cicera* and mustard may also have this potential. All other crops grown were shown to be as palatable as the weeds to the grazing sheep.

EXPLORING THE VALUE OF COMMERCIAL LIGHT TILLAGE TOOLS FOR CONTROLLING WEEDS PRE- AND POST-CROP EMERGENCE

The use of tertiary tillage (Wicks *et al.* 1995) was a common weed control practice prior to the advent of selective in-crop herbicides. Historically it involved using heavy leaf harrows over the paddocks a week post-sowing. When desperate, some farmers used the same machines for in crop control, but timing was critical in achieving the desired weed control while leaving the crop in situ. The poor capacity of harrows for handling crop residues, their requirement for tilled soil and the general trend to herbicides and reduced tillage has however seen the phasing out of this practice.

Farmers of the corn belt in the USA and western Europe are now revisiting post-sowing weed control with purpose built machinery. The value of these machines as weed control tools was unknown in Australia.

Materials and methods Rotary hoe weeders e.g. Yetter® (Buckingham 1976) as used in the corn belt are 3 P.L. mounted, available in sizes to 10 metres wide, and consist of spider wheels about 50 cm in diameter, with spoon teeth, which are ground driven and run parallel to the direction of travel.

In Europe, Lely® and Hatzenbichler® harrow comb weeders are commonly used. These are available in widths to 24 m, have 1.5 metre wide banks of 6 mm diameter finger tines spaced 25 mm apart over six rows. The rake of the tines is adjustable to accommodate different soil types, crop and weed species and their stages of development. Working speeds for both types of machine are 8–12 km h^{-1}.

Trials investigating the efficacy of these machines were conducted over the years 1993–95. The machines were assessed for their ability to control weeds including annual ryegrass (*Lolium rigidum*), barley grass (*Hordeum vulgare*), wild turnip (*Brassica tournefortii*) and wild oat (*Avena fatua*) in sown wheat (*Triticum aestivum*), faba bean (*Vicia faba*), field pea (*Pisum sativum*) and canola (*Brassica napus*) crops.

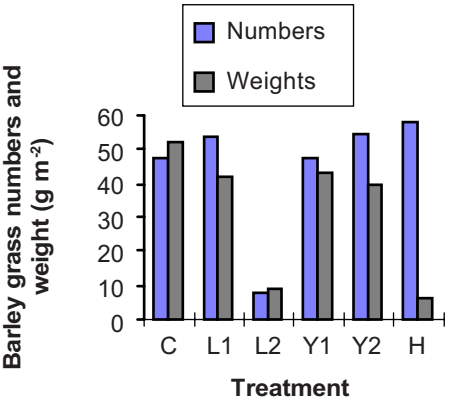

Figure 1. Barley grass numbers and weight were significantly reduced with two passes of the Lely weeder (L 2) compared with a no herbicide control (C), one pass with the Lely (L1), and one and two passes with the Yetter Y1 and Y2.

The trial design was completely randomized block with four replications and plots 40 metres long by the width of the machine. The treatments were implemented post-sowing pre- and post-crop emergence, using one or two passes of each machine. Actual timing of implementation depended on surface soil moisture (1–3 cm of dry soil existed at each working), weed and crop growth stage. Selective herbicides were used to control grass and broadleaved weeds on the controls.

The local environment consists of red brown earth duplex soils, receiving an average 440 mm winter dominant annual rainfall.

No attempt was made to weed interow; selectivity of the weeders is based on the plants morphology, its relative anchorage and the operator skill in setting the machine for particular situations.

Results and discussion The rotary hoe and harrow comb weeders work best when weeds are in the 'white stage', that is when they have germinated but not emerged (Wicks *et al.* 1995, Vangessel *et al.* 1995). The harrow comb weeder is more aggressive, and therefore works more effectively on emerged weeds. By contrast, the Yetter weeder, while being less damaging to the crop, was also less effective as a weed control implement in this environment. This outcome is in conflict with Vangessel *et al.* (1995) who found the weed control abilities of the two machines to be similar, but the rotary hoe being less damaging to the crop made this the preferred

option.

As shown in Figure 1, in a faba bean crop in the very dry year 1994, barley grass populations were reduced very effectively in pre-emergent applications of the harrow comb weeder, using two passes. Results post-emergent were very similar, as were the results in field peas. In the faba beans these translated to significant yield increases, but the drought prevented a harvestable yield being achieved in peas.

In the same year, wheat and canola crop plant numbers were significantly reduced with the Lely weeder, but yields were unaffected due to the drought conditions, allowing the remaining plants to utilize the available moisture.

Follow up work in 1995 was largely unsuccessful due to the persistent wet conditions following seeding, preventing any form of effective mechanical weed control. However, a trial in the sandy loam Mallee soils did provide a 12% yield increase over herbicide treatment where wild turnip was the principal weed. In this case, the weed did not emerge until the crop was established (1.5-leaf), providing the crop with adequate anchorage during weed removal.

Another trial at Roseworthy in 1995 was again opportunistic. Ryegrass had emerged from greater than 1 cm in the profile, while canola seed sown near the surface required a rain for germination. The ryegrass was effectively killed with the weeder prior to rain, and prevented the need for a grass herbicide in the growing crop.

While still preliminary, the results to date do show that post-sowing mechanical weed control using the harrow comb style machine has the potential to reduce weed competition and increase crop yields in some crops in some years. They are very much dependant on the timing of application, where the weeds must be very young and the crop better anchored in the soil than the weed. Soil conditions must also be sufficiently dry to enable rapid desiccation of the weed.

Further research will be conducted to validate the efficacy of the finger tine weeder in different environments and conditions, including its potential as a low draught secondary tillage machine for pre-sowing applications.

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