A preliminary investigation into the effects of night cultivation and tillage method on weed emergence

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Summary Recent research has suggested conducting tillage operations at night can reduce weed emergence. This has sparked a great deal of interest, particularly overseas, in determining the usefulness and accuracy of these claims. There have been quite mixed results, due to differences in species responses to light exposure. Interactions with environmental conditions also seem to have a large influence on the 'photo-control' of weed species.

In this research, we investigated the effects of night and day cultivation on the background weed flora in a weed-infested paddock. This was coupled with the use of two different methods of tillage, which were discing and scarifying. The results showed that there were early trends towards greater emergence of grass and broadleaf weeds in the day cultivations compared with the night. At the conclusion of the experiment there were lower numbers of grass weeds (P=0.05) with greater than four leaves in the night scarify treatment compared with the day scarify treatment. There were similar trends for the night disc treatments. After 57 days, the disc treatments had greater weed emergence (P=0.05) than the undisturbed control. The same trend was seen in the scarify treatments. These preliminary results suggest that photo-control of weeds may hold potential benefits for integrated weed management in Australian cropping systems.

Keywords Night cultivation, emergence, tillage, germination.

INTRODUCTION

The problem of herbicide resistance in weeds in Australian cropping systems is a major concern and requires new and integrated weed management approaches. Recent overseas data (Milberg *et al*. 1996, Botto *et al*. 1998, Gallagher and Cardina 1998) suggest that cultivation at night can reduce the emergence of some weed species due to their requirement for light to stimulate germination. In Australia, farmers already cultivate at night to cover more area whilst soil moisture conditions are adequate, and with new navigation technology, night cultivation may become more common. If it were shown that certain weeds respond differently to night in comparison with day cultivation, then farmers may be able to alter their practices for maximum weed suppression. However, there has been relatively little published work dealing with the comparative efficacy of day and night cultivation for control of Australian weed flora. The aim of this preliminary research was to investigate the effects of night cultivation on the background weed flora in a weed infested paddock, coupled with the use of two different methods of tillage (discing and scarifying).

MATERIALS AND METHODS

This experiment was conducted at Lauredale Research Station, the University of New England, Armidale, NSW on a basalt clay soil under fallow. The climate of Armidale is temperate with summer dominant rainfall.

The experiment consisted of five treatments with four replicates in a randomised complete block design. The treatments were uncultivated control, day-time scarifying, night-time scarifying, day-time discing and night-time discing. Each plot was 6 × 2 m. Six hours prior to the cultivation treatments, the entire area, apart from a 2 m strip on one end of each of the control plots (to allow existing weeds to mature for identification), was sprayed with 1.1 L ha^{-1} of Roundup CTXtra® (490 g L^{-1} glyphosate). Scarification was with 18 cm points and discing with off-set discs each to a depth of 10 cm. The day-time treatments were carried out on 5 April 2001 at 3 p.m. in full sunlight (538 W m^{-2}) and the night-time treatments at 8 p.m. on the same day with shields over the implements to block moonlight. Gravimetric soil water content was 28% at the time of cultivation.

Weed counts were taken using either three or four 0.25 m^2 quadrats per plot, 26, 39, 57 and 75 days after the treatments were carried out. Due to their small size, weed seedlings were classified only as either grasses or broadleaf weeds. A separate count on day 75 recorded the number of larger grass plants with greater than four leaves to see if earlier trends carried through to the end of the experiment. On 14 May (day 39), mature weeds in the unsprayed sections of the controls were identified. The results of the experiment were analysed using analysis of variance and contrasts with S-Plus 2000 (Release 3). Grass and broadleaf weed numbers were analysed separately.

RESULTS

The weed seedlings in this experiment were slow to emerge because of the onset of cooler winter temperatures and the weeds remained small for most of the experiment. The scarifier caused the least soil disturbance but left large furrows. The offset-discs, on the other hand, disturbed the soil more but the soil was more level.

On day 26, the emergence of weeds was relatively low and there were no significant differences between the treatments, although there appeared to be a trend suggesting that the day cultivations had greater numbers of weeds emerging than the night treatments (Figure 1). The probability values were 0.104 and 0.139 for the grass and broadleaf weeds respectively. The grasses in the control treatment appeared to be more advanced.

On day 39, greater numbers of weeds had emerged, but the trends between treatments were very similar to those at day 26 (data not shown). There was a tendency in the scarified treatments for more weeds to be growing in the furrows, than on the mounds left behind the scarifier.

At both times, there were more emerged grasses than broadleaf weeds. The grasses that were noted in the unsprayed sections of the control plots were primarily *Lolium* sp. (ryegrass), whereas the majority of the broadleaf plants were *Polygonum aviculare* L. (wireweed) and *Stachys arvensis* (L.) L. (stagger weed). Other species that were observed in lower frequencies were *Lamium amplexicaule* L. (deadnettle), *Hirschfeldia incana* (L.) Lagr.-Foss. (Buchan weed), *Sonchus oleraceus* L. (milk thistle), *Crepis capillaris* (L.) Wallr. (smooth hawksbeard), *Trifolium* sp. (clover) and *Lepidium* sp. (peppercress).

By days 57 and 75, there was a statistical difference in weed emergence between the types of implement used for cultivation, but not between day and night cultivations, for both grass and broadleaf weeds. The disc treatments generally had significantly higher levels of weed emergence than the scarify and control treatments. At day 57, the emergence of grass weeds was still greater than the emergence of broadleaf weeds, but by day 75 the number of broadleaf weeds had far surpassed that of the grass weeds for all treatments (Figure 2).

The control had more grass weeds with greater than four leaves than the average of the two disturbance treatments as well as being higher than the disc treatments. There were more large grasses in the day scarify treatment compared with the night, however while the trend was the same for the disc treatments, differences were not statistically significant (data not shown). The trend of the grass weeds greater than four leaves for all the treatments on day 75, closely resembled the trends of the grass weeds emerged on day 26.

DISCUSSION

The results of this experiment, whilst not showing strong statistical evidence, showed trends in the effects of night and day cultivation that are supported by other authors. The variability of weed emergence was high, which may have masked the treatment effects. Gallagher (1996) found that germination responses to the light environment in the field were far more variable than what would be predicted from laboratory

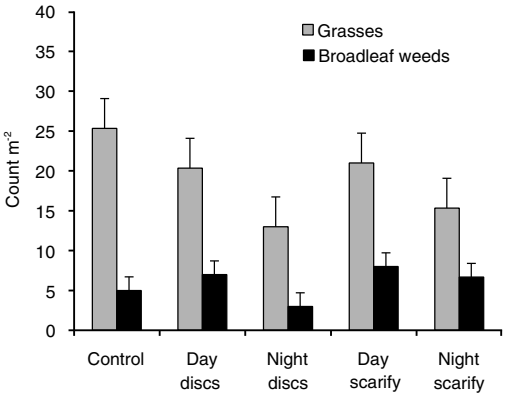

Figure 1. Weed counts on day 26. Vertical bars are standard errors but there were no significant differences between treatments.

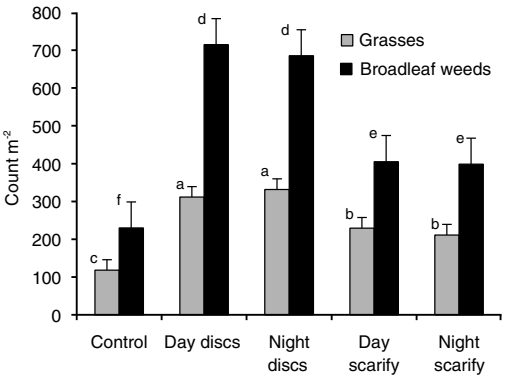

Figure 2. Weed count on day 75. Error bars show standard errors. Treatments topped with the same letter are not significantly different.

experiments investigating light induced germination. Experiments by other authors tend to also give mixed results, where there are trends for both light stimulation of some species and inhibition of others, yet the statistical analysis does not always support these trends at the P=0.05 level (Ascard 1994, Botto *et al*. 1998, Gallagher and Cardina 1998).

The trends noted in this experiment seemed to suggest that there was a general reduction in the number of broadleaf weeds and in particular grass weeds, emerging immediately after night cultivation compared with daylight cultivation. This trend diminished over time, and by 57 days after cultivation, the total number of weeds in the day treatments had caught up to those in the night treatments. However, on day 75 there were significantly more large grass weeds (with greater than four leaves) in the day scarify treatment than the night scarify treatment, which supports the inference that there were early differences between the night and day treatments, at least for the scarified plots.

The high emergence counts in the early stages of the experiment for the control compared with the cultivation treatments could be due to the fact that many weed seeds would have already germinated beneath the soil surface and would not have been affected by the application of glyphosate. The cultivation treatments on the other hand, may have killed pre-germinated plants through the disturbance of the soil, thus delaying the emergence of new weeds. Another reason for initially more weeds emerging in the control treatment could be due to better soil-seed surface contact than in the highly disturbed cultivated plots. Until the soil subsided, the germination of seeds in these plots may have been delayed to some extent. The trend of the scarified treatments initially having more weeds germinate than the disc treatments could be for the same reason, as the disced soil was a rougher seedbed than the scarified soil. A greater proportion of seeds could also have been buried at depth in the disc treatments, slowing the emergence of weeds in those plots. Vertical distribution of weed seeds in the soil is known to vary considerably depending on the type of tillage regime (Mulugeta and Stoltenberg 1997).

Although early weed emergence was higher in the control plots, this situation was reversed by Day 57 with the disturbed treatments having greater numbers of grasses and broadleaf weeds emerge. This change in dominance was particularly evident in the disc treatments. Aeration in the disturbed soil may have been more favourable for germination, since oxygen is crucial for germination to proceed following imbibition (Bradbeer 1988). The quality of the seedbed produced by differing soil disturbance intensities may influence the germination and establishment of weeds in night and day tillage experiments. Alternatively, the dominance of weeds in the disc treatments over the scarify treatments that appeared by day 57, could have been due to the inversion of soil in the disced plots bringing greater numbers of dormant weed seeds closer to the surface. This is particularly important for weed species that have a prolonged dormancy capability and could have been lying at depths for many years, too great for germination (Pratley 2000).

The results that were obtained suggest that there could be some benefits obtained for weed control, by altering the timing of soil disturbance operations to take advantage of weed seed responses to light stimuli. The difference in weed emergence between night and day tillage has been reported to be as high as 80% (Hartmann and Nezedal 1990). However, a response of this magnitude is seldom seen, and often disputed (Gallagher 1996). Many authors do agree that the response in germination of dormant seeds to light exposure varies with species and environmental conditions (Scopel *et al*. 1994, Botto *et al*. 1998, Gallagher and Cardina 1998). Results from this project suggest that a slight reduction in grass and broadleaf weeds may be possible by cultivating at night, though weed numbers would still necessitate post-emergence control measures.

It is also important to keep in mind that for this system to be used effectively, it would be necessary to know much more about the specific responses to light of various weed species, and particularly under field conditions. If a situation arose where a particular weed was the dominating species, then with knowledge about the light response of that species, the timing of tillage operations could be adjusted to take advantage of any potential reduction in emergence. Whilst the response may not be remarkable, any delay in the initial emergence and establishment may result in a reduced requirement for other weed control measures, particularly if a competitive crop was being sown at the time of the soil disturbance.

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