THE EFFECT OF SIMULATED SPRAY-GRAZING ON THE PATERSON'S CURSE CROWN WEEVIL, *MOGULONES LARVATUS* SCHULTZE

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Summary This spray-graze study measured the effect of two herbicides, MCPA and 2,4-D and simulated grazing on the survival of the Paterson's curse crown weevil, *Mogulones larvatus*. The herbicides had no direct effect on *M. larvatus* larval mortality. Severe clipping to simulate intense sheep grazing used in the spray-graze technique significantly reduced *M. larvatus* numbers by 85%. The compatibility of spray-grazing and *M. larvatus* in the integrated management of Paterson's curse is discussed.

INTRODUCTION

Echium plantagineum L. (Paterson's curse) is a winter annual native to Mediterranean Europe and North Africa which was brought into Australia in the 19th century as an ornamental plant. It has become a weed in pastures of southern Australia by forming large rosettes that crowd out more beneficial pasture plants (Piggin 1978). *E. plantagineum* is also high in toxic alkaloids and if grazed in sufficient quantity can reduce animal productivity and in severe cases cause death (Seaman *et al*. 1989).

Spray-grazing is one of the many methods recommended for controlling pasture weeds, and if managed properly is an efficient method of controlling *E. plantagineum.* Spray-grazing involves applying a low dose of herbicide on young plants, causing the rosette leaves to curl upwards without killing the plant. The sprayed plants are then heavily grazed and the combination of the two treatments can remove up to 100% of *E. plantagineum* from the pasture (Pearce 1972, Piggin 1979). This technique is cheaper for farmers, through reduced herbicide costs, and is better for livestock which have a pasture free of *E. plantagineum* for the rest of the season. There are disadvantages with spray-grazing, as *E. plantagineum* is eaten more readily by grazing animals, it increases their risk to poisoning and the pasture may be damaged if grazed for too long after application of the herbicide (Parsons and Cuthbertson 1992). Management of livestock into densities sufficient to remove *E. plantagineum* also poses difficulties for farmers on broad acre farms. Potential problems associated with current control measures have prompted research into other methods of control.

The biological control of *E. plantagineum* was first considered in 1972. The importation of insects for the biological control of *E. plantagineum* resumed in the late 1980s after the lifting of a court injunction. The second insect released in Australia was the weevil, *Mogulones larvatus* Schultze. *M. larvatus* is found on *E. plantagineum* in North Africa and western Europe (Vayssieres and Wapshere 1983). The adult weevils feed on the foliage of *E. plantagineum,* but cause little damage to the plant. The weevil is univoltine and oviposition begins in late summer and continues until the end of winter (Vayssieres and Wapshere 1983). Females tend to lay eggs on the underside of the petiole and larvae mine their way through to the crown (Forrester 1993). When feeding is complete, in as little as six after oviposition depending on temperature, the larvae leave the crown and pupate in the soil (unpublished data). Adults usually emerge in spring and feed on the foliage and flowers of *E. plantagineum* and then aestivate over summer in the soil and leaf litter (Vayssieres and Wapshere 1983). Larvae are the most damaging life stage of the weevil, feeding as first instar larvae in the petiole with the majority of larvae moving into the crown as late instars, where their feeding forms a black mass of decaying tissue. If sufficient larvae feed on an *E. plantagineum* rosette, plant size is reduced or they can even cause death (Vayssieres and Wapshere 1983 unpublished data).

Spray-grazing to control *E. plantagineum* is most effectively used in autumn and early winter (Piggin 1979) when *M. larvatus* is very active in the field. The effect of herbicides and heavy grazing on the survivorship of *M. larvatus* are unknown. The aim of this preliminary experiment was to test the effect components of spray-grazing have on *M. larvatus* larval survival.

MATERIALS AND METHODS

The experiment was carried out at the CSIRO Black Mountain site, Canberra (latitude 35° 19'S, longitude 149° 12'W, altitude 570 metres). *E. plantagineum* was grown from seed in 15 cm pots in potting mix to a mature rosette, about 30 cm in diameter with 10–15 leaves. Early in April 1995, 80 *E. plantagineum* were planted two metres apart in a ploughed field using a randomized block design of eight blocks, ten plants per block.

Due to constraints in weevil numbers, oviposition could not begin until late in the season. In early to mid-May one male and female of *M. larvatus* were caged on each of the planted *E. plantagineum* for one week and then removed. As only forty pairs of *M. larvatus* were available, half the blocks were treated in the first week followed by the remaining blocks in the second week. At the completion of the second caged oviposition, the cages where removed and adult weevils were allowed to continue ovipositing on the experimental plants. The plants with different oviposition times were divided equally among subsequent treatments.

In the first week of July (to allow sufficient time for larval development to final instar), two herbicides, 2,4-D and MCPA, were each applied to thirty-two randomly selected plants (four plants per insecticide per block). The manufacturer's maximum recommended dose for the spray-graze technique was used (0.7 and 0.8 kilograms of active ingredient per hectare for MCPA and 2,4-D respectively). The herbicide was sprayed onto the plants using knapsack sprayers. Two plants per block were left unsprayed and served as the controls.

Two weeks after the application of the herbicides, when the rosettes had started to yellow and curl upwards, two plants were randomly selected from each of the herbicide treatments per block. A simulated grazing treatment was imposed on the selected plants by removing all above ground foliage at the top of the crown with scissors. All eggs and larvae in this foliage were counted. Two weeks later all plants were removed and dissected and all eggs and larvae counted.

Differences between treatment means were tested using analysis of variance and the students t-test.

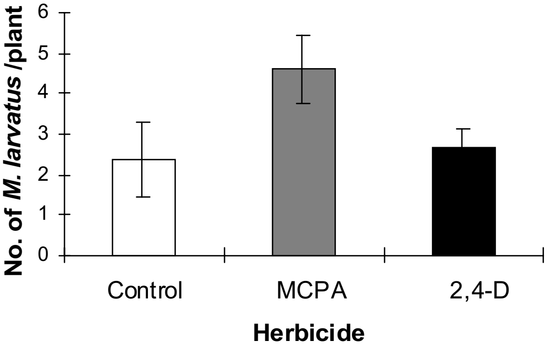

Figure 1. Mean number of *M. larvatus* eggs and larvae per plant (± SE) four weeks after the application of herbicides.

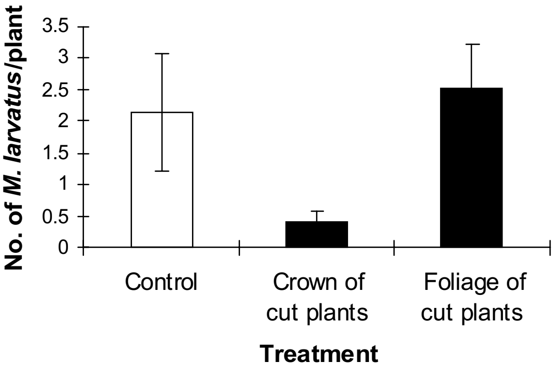

Figure 2. Mean number of *M. larvatus* eggs and larvae per plant (±SE), from control (white) and the crowns and foliage of cut plants (black).

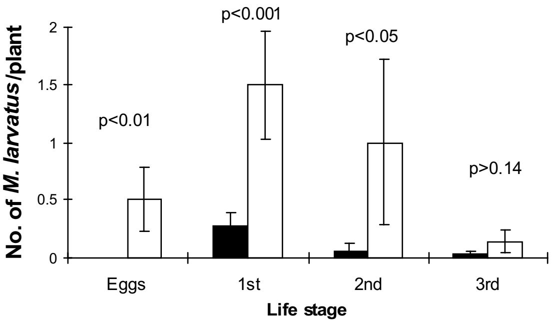

Figure 3. The effect of simulated grazing on the mean number of *M larvatus* eggs and larval instars on control (white) and cut plants (black) (±SE).

RESULTS

The two herbicides, minus simulated grazing, had no effect on the number of *M. larvatus* eggs and larvae per plant, P>0.07 (Figure 1). The two herbicide treatments are therefore combined when comparing the effect of the simulated grazing treatment.

The simulated grazing significantly reduced the number of *M larvatus* eggs and larvae per plant by 85%, P<0.01 (Figure 2). The number of *M. larvatus* eggs and larvae in the removed foliage is not significantly different from the control.

Figure 3 shows the effect of the simulated grazing treatment on the individual life stages of *M. larvatus.* The 'grazing' treatment significantly reduced the number of eggs, first and second instar larvae. There was no significant difference in the number of third instar larvae between control and simulated grazing treatments.

DISCUSSION

The results clearly show that the two herbicides had no direct effect on the number of *M. larvatus* counted on *E. plantagineum*. This experiment did not continue to monitor whether the herbicides have an effect on successful pupation of larvae, though this would seem unlikely. Previous work has shown that MCPA and 2,4-D have minimal or no direct effect on the mortality from egg to adult of other weevil species (Messersmith and Adkins 1995). Three *M. geographicus* larvae (another agent for

E. plantagineum) were also found feeding in the sprayed plants, oviposited by adults migrating in from a release site close by. This species may therefore be unaffected by the herbicides as well. Similar studies using this agent are currently under way.

In contrast, the simulated grazing treatment dramatically reduced weevil numbers, particularly for the youngest life stages (Figure 3). This was not surprising for eggs as the ovipostion site had been removed, and maturing larvae tend to move progressively deeper into the crown and root. The number of eggs and larvae counted in the cut foliage was not different to that found in the control plants. Therefore, the large reduction observed in the cut plants is due to removal of foliage which contained eggs and larvae. Based on this trial, *Dialectica scalariella* (Zell.), a leaf mining moth, the first agent introduced to Australia on *E. plantagineum,* would be incompatible with spray-grazing because of the location of larval feeding.

To integrate spray-grazing and *M. larvatus* to control *E. plantagineum*, the timing of grazing will be important for the survival of the weevil. Spray-grazing of *E. plantagineum* is most effective in terms of weed mortality and pasture productivity while the weed is still a young rosette in May and June (Pearce 1972, Piggin 1979). After this time, temperature limits germination of *E. plantagineum* but not its major pasture competitor, *Trifolium subterraneum* L. (Piggin 1976). Spray-grazing in August and September, although effective in removing 100% of *E. plantagineum* from a pasture is detrimental to pasture productivity (Piggin 1979). In field situations, the later spray-grazing is imposed the longer *M. larvatus* will have to complete its development. By the end of June, eggs laid in the first months of oviposition (which normally starts in February), will have completed development to pupa and the majority of late instar larvae will have reached the crown, thus limiting the effects of intensive grazing. Therefore, grazing at the end of June should not affect the majority of these *M. larvatus* larvae that had been oviposited early in the season while still promoting beneficial pasture species (Piggin 1979).

Due to the short time between the start of oviposition and simulated grazing in our trial (only ten weeks), the level of mortality observed was higher than should normally occur following a late June spray-graze in the field, since oviposition begins in February. Our study did show, however, that once *M. larvatus* larvae had reached the crown they are protected to some degree from the simulated spray-graze treatment. Clearly extension of this work to the on farm situation would refine these outcomes. To maximize the beneficial effects of spray-grazing with biological control of pasture weeds, consideration must be given to the effect on beneficial pasture species in relation to agent survival.

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