THE EFFECT OF PASTURE DEFOLIATION IN SPRING ON ADULT EMERGENCE OF SOLDIER FLY

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Summary

The maintenance of long pasture is shown to enable adult emergence of soldier fly (*Inopus rubriceps*) to continue from spring throughout the summer. The cutting of long pastures prior to and during spring emergence drastically reduced the number of adults that emerged, almost prevented emergence during the summer months and reduced number of larvae in the subsequent generation.

INTRODUCTION

In New Zealand, soldier fly (*Inopus rubriceps*) adults emerge in two main flight periods, one in spring (mid-November to mid-December) and the other in autumn (March and April), although adults may be observed throughout the summer (Wilcocks 1973). Adults live for a few days and eggs are laid at shallow depths in the soil. The eggs hatch in about 2 weeks and the larvae begin sucking nutrients from roots. The duration of the larval stage is uncertain, perhaps between 1 and 3 years (Wilcocks 1973). Pupae remain within the old larval skin for about 1 month, and are usually found in a vertical position just below the soil surface although some have been observed, by the authors, lying on the soil surface under rank pasture.

Soldier fly larvae pupate close to the soil surface where they may be susceptible to desiccation. Osborn and Forteach (1974) found more pupae in areas shaded by plants than in areas exposed to sun and hypothesized that larvae actively seek shade in which to pupate. Defoliation by mowing or grazing whilst the pupal stage is present exposes the soil surface and may play a significant role in population reduction.

Kain and Burton (1975) established that populations of soldier fly are extremely sensitive to changes in ground cover during both spring and autumn flight periods. Severe defoliation in spring of long and medium length pastures at the beginning, peak and end of adult emergence reduced the subsequent number of small larvae by more than 80% in comparison with long pasture. Reductions in number and size of egg clusters and reduced viability of eggs were factors thought to be involved.

This paper reports on studies conducted at Matangi, Hamilton, between November 1975 and March 1976 to assess the effect on soldier fly populations of defoliating the pasture during the pupation, adult flight and egg stages of the life cycle.

METHOD

The trial consisted of 35 plots, 2 × 4 m, arranged in five single replicate blocks. A 1 m wide buffer strip was maintained as short pasture between all plots. The 7 treatments investigated were all applied in the spring and are listed in Table 1.

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The times of defoliation were determined by monitoring adult emergence in surrounding areas with the use of adult emergence cages of the type developed by Oliver (pers comm). Peak spring emergence occurred in the first week of December. The treatments were imposed by mowing long pasture with a rotary mower to a height between 1.5 and 2.5 cm and maintaining this height for the duration of the trial. All clippings were removed.

Adult emergence from treatments 1, 2, 3 and 7 was monitored with two adult emergence cages on each plot. The cages were inspected weekly and then moved.

Larval sampling was carried out prior to pupation (early October) and 3 months after peak emergence (March) when newly hatched larvae were of sufficient size to be accurately extracted. Fifty-four, 2.5 cm diameter soil cores 15 cm in depth were taken randomly from each plot and bulked into six lots of nine. The larvae were extracted using a wet sieving-flotation method developed by Wilcocks and Oliver (1971). The larvae were divided into three classes, large (close to size of pupae), medium, and small (those that were assumed to have originated from eggs laid by adults in the most recent flight season).

Samples to collect pupal exuviae were taken in mid-March at the conclusion of the trial. Six 12.5 cm diameter cores were taken from each plot and the pupal exuviae extracted by hand.

RESULTS

The weekly adult emergence totals for treatments 1, 2, 3 and 7 are presented in Figure 1.

Pasture in treatment 7 was maintained long for the duration of the trial and produced approximately 90%, 85%, and 77% more adults respectively than treatments 1 (cut at the start of pupation), 2 (cut at the start of emergence), and 3 (cut just before emergence peak). Also adult emergence from the plots with long pasture was prolonged, continuing throughout January and February, when adult emergence had virtually ceased in the other treatments and in the grazed areas surrounding the trial site.

The number of adults trapped per plot was proportionally related to the number of pupal exuviae recovered in that plot, as represented in Figure 2. The numbers increased exponentially with the dates of cutting indicating that the effect of defoliation was greatest in the spring and decreased as the time of defoliation progressed towards the summer, i.e. later in the emergence period. Almost all pupal exuviae were found embedded in the soil. Subsequent mowing tests indicated they were not picked up by the mower.

TABLE 1: EFFECT OF TIME OF DEFOLIATION IN SPRING ON THE SUBSEQUENT POPULATION OF SMALL SOLDIER FLY LARVAE

Time of defoliation	Within-group	
	No. small larvae/m ²	standard deviation
1 Start of pupation (9/10/75)	219	15
2 Start of adult emergence (6/11/75)	204	20
3 Just prior to peak emergence (27/11/75)	387	26
4 End of emergence (24/12/75)	1314	83
5 Three weeks after end of emergence (15/1/76)	1431	157
6 Six weeks after end of emergence (5/2/76)	1183	82
7 Not defoliated	1570	161

Pasture Pests

The effect of time of defoliation on subsequent small larvae is given in Table 1. Plots that have been defoliated prior to peak emergence contained less larvae than those maintained as long pasture over this period. A highly significant relationship was found between numbers of small larvae and numbers of adults ($P < .01$), indicating that the number of small larvae present was dependent upon the number of adults emerging and that these increased in number as did the population of small larvae. The larval populations of the later treatments, particularly of treatment 7, are probably underestimates as larvae hatching during January and February would be too small to be extracted efficiently with the techniques used.

Fig. 1. Weekly adult emergence from treatments 1, 2, 3 and 7.

Fig. 2. Relationships between pupal exuviae, adults and time of defoliation.

DISCUSSION

Defoliation of long pasture brings about an abrupt change of the microclimate, exposing much of the soil surface, which may severely limit favourable pupation sites. As few dead pupae were recovered, mortality probably occurs during the prepupal stage. Long pasture may not only protect pupae but may also allow further larvae to develop into pupae and emerge during summer. This perhaps explains why as the time of cutting became later in the flight period, more adults emerged and particularly why treatment 7 (maintained long for the duration of the trial) produced 7 times more adults after the emergence peak than treatment 3 (cut just before the emergence peak). It should be noted that this work was carried out in an unusually wet summer.

Peak emergence occurred during the first week of December and at this time plots in treatments 1, 2, and 3 were all defoliated. It seems likely that more eggs were laid in the long pasture on treatments 4, 5, 6, and 7 and this difference is reflected in larval numbers (Table 1). Treatments maintained in long pasture at the peak of the flight season harboured 5 times as many small larvae as the defoliated treatments. These results are generally similar to those of Kain and Burton (1975). They suggested that the large reductions they achieved in the numbers of small larvae by the defoliation of long pasture were the results of reductions in number and size of egg clusters and reduced viability of eggs. While these factors may play an important role in population regulation,

Pasture Pests

the results of this trial indicate that limitation of adult emergence may be the primary effect of defoliation in spring. This introduces a mortality factor which has added significance in that it prevents the multiplication process from adults to eggs.

The results of this trial suggest that if pasture is left completely untouched from spring, then soldier fly adults may possibly have only one prolonged emergence from November to May and that the two flight periods experienced in New Zealand may result from farm practices. Further research is needed to determine the relative importance of the different regulatory factors that influence soldier fly populations after defoliation, taking into account the effects of seasonal weather. The influence of grazing frequency and intensity and the timing of harvesting hay and silage crops needs to be investigated so that soldier fly populations may be successfully manipulated in farm systems.

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