SEASONAL DAMAGE BY ARGENTINE STEM WEEVIL TO PERENNIAL RYEGRASS PASTURES WITH DIFFERENT LEVELS OF *ACREMONIUM LOLII*

A.J. POPAY and R.A. MAINLAND

DSIR Plant Protection, Private Bag, Palmerston North.

SUMMARY

For two years between August and March, Argentine stem weevil adult feeding and oviposition, and larval damage, were monitored fortnightly on tillers taken from a low endophyte (*Acremonuim lolii*) pasture (1989/90), a mixed high and low endophyte pasture (1990/91) and a high endophyte pasture (both years). In all pastures substantial egg laying occurred in the spring and was followed by an increase in larval damage in November and December. During summer, oviposition and larval damage were high in the low and mixed endophyte pastures, but negligible in the high endophyte pasture. Oviposition and larval damage were highly dependent on infection by *A. lolii*.
Keywords: Argentine stem weevil, endophyte, phenology, damage

INTRODUCTION

Argentine stem weevil (ASW) (*Listronotus bonariensis* (Kuschel)) is a major pest of perennial ryegrass (*Lolium perenne* L.) in the Manawatu, but there is little information on the seasonality of oviposition and damage in this area. In the Waikato, damage attributed to the spring generation is much less important than damage from the summer generation (Prestidge *et al* 1984). This has been partly attributed to a high mortality of overwintering adults in this region resulting in fewer eggs and subsequent larval damage in the spring (Barker *et al* 1989). This is in contrast to the situation in Canterbury, where spring populations can cause substantially more damage than the summer generation (Pottinger 1961). In the Manawatu, Gaynor and Hunt (1982) have presented information which suggests that summer populations are the most damaging but there is no indication as to the cause of this.

Infection with the endophyte *Acremonium lolii* Latch, Christensen & Samuels protects perennial ryegrass from ASW attack (Prestidge *et al* 1982). Nevertheless populations of ASW can be found in predominantly endophyte-infected pastures. Adults from such pastures can exhibit a decreased sensitivity to the endophyte-produced feeding deterrent, peramine, compared with adult weevils in endophyte-free pastures (A.J. Popay, unpublished). Such populations may cause some damage to endophyte-infected pastures. Furthermore, the known seasonality of *A. lolii* mycelia in ryegrass (di Menna and Waller 1986) may allow spring damage to plants with a low endophyte content.

These aspects were investigated in a study that compared ASW oviposition and larval damage in an endophyte-infected pasture ("high endophyte"), an endophyte-free pasture ("low endophyte") and a pasture with an intermediate level of endophyte infection. The results of these studies are reported in this paper.

METHOD

In autumn 1986 four paddocks on Massey University No. 3 Dairy Farm were sown with either high or low endophyte perennial ryegrass cv. Grasslands Nui. We studied two of these paddocks; a 0.9 ha low endophyte pasture and a 0.72 ha high endophyte pasture adjacent to each other but separated by a race. Both pastures were grazed regularly with dairy cows and received annual applications of fertiliser.

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Beginning in August, 1989, at fortnightly intervals, 100 perennial ryegrass tillers were taken at random from each paddock by cutting them at ground level. Adult feeding on each tiller was scored on a scale of 0-5 (0 = no feeding and 5 = extensive feeding over the entire leaf area). Each tiller was then dissected and the number of eggs, larval damage and presence of larvae were recorded. Larval damage was considered to be light if only an entrance/exit hole was visible and little or no mining of the tiller had taken place, moderate if there was some mining of the tiller and severe if the tiller had been extensively damaged.

In the 1989/90 season sampling ceased at the end of February. In May, 1990, the low endophyte pasture was direct drilled with "Super Nui" (high endophyte) perennial ryegrass at 18 kg/ha, without prior use of herbicide. Sampling of the two pastures recommenced at the end of August and continued until March, 1991.

To determine if tillers were infected by *A. lolii*, we examined each tiller from one sample taken in the 1989/90 season (in January), and from each fortnightly sample taken from December to March in the 1990/91 season. After recording the ASW data, strips of epidermal sheath tissue were removed and stained with aniline blue in lactophenol. The presence or absence of mycelium was determined by examination of these tissues under the light microscope (250x).

RESULTS

Low Endophyte Pasture

In January, 1990, 91% of tillers were endophyte-free.

Egg laying increased during August and September to reach a spring peak in early October (Fig. 1A), when eggs were found on 45% of tillers examined. Adults emerging from this spring generation deposited large numbers of eggs in early January and continued to lay eggs until monitoring ceased at the end of February. Substantial larval damage was not recorded until late November when 52% of tillers had been attacked (Fig. 1A), of which approximately 30% had suffered severe damage. High levels of damage were sustained through the summer. In early January 89% of that damage was classed as light but as the season progressed more tillers became moderately or severely damaged.

High Endophyte Pasture

In January 1990, 86% of tillers were infected with *A. lolii.* During the 1990/91 season the mean percent infection level was 91% (range 82-96%).

In both seasons egg laying was high in spring although numbers were lower than in the low endophyte pasture (Figs. 1A; 1B). At peak oviposition 25% and 32% of tillers had eggs on them in 1989 and 1990, respectively. Spring larval damage reached a maximum of 32% of tillers damaged in late November, 1989. Of these, 87% suffered only light damage. In the following year damage levels reached only 9%.

Both egg laying and larval damage declined rapidly in late spring or early summer and remained low for the rest of the season in both years (Figs. 1A; 1B). Similarly, there was little difference in the intensity of adult feeding on the low and high endophyte pastures until mid November (mean total scores 65.2 and 55.7 respectively for low and high endophyte for 1989, and 90 and 79.8 for 1990) but then feeding in the high endophyte pasture either remained the same or declined whilst that in the low endophyte pasture increased.

Endophyte-free tillers in the high endophyte pasture suffered more larval damage than infected tillers (Table 1).

Mixed Endophyte Pasture

The mean level of *A. lolii* infection was 34% (range 23-41%).

Spring egg laying peaked in late October (Fig. 1B), 3 weeks later than in the previous year. The increase in larval damage showed a similar delay. Fewer eggs were produced by the summer generation than by the spring generation but most larval damage occurred in February when 32% of tillers sustained some damage. Severity of damage tended to increase as the season progressed.

Both egg laying and larval damage were greatly affected by tiller infection with *A. lolii.* Fewer infected tillers supported eggs and sustained larval attack than did endophyte-free tillers (Table 1). In February, 44% of endophyte-free tillers were damaged compared with only 9% of endophtye-infected tillers. Endophyte infection also affected severity of damage (Table 1).

Fig. 1: The number of eggs laid and tillers damaged by Argentine stem weevil per 100 tillers sampled in a high and a low endophyte pasture in 1989/90 (A) and in a high and a mixed endophyte pasture in 1990/91 (B).

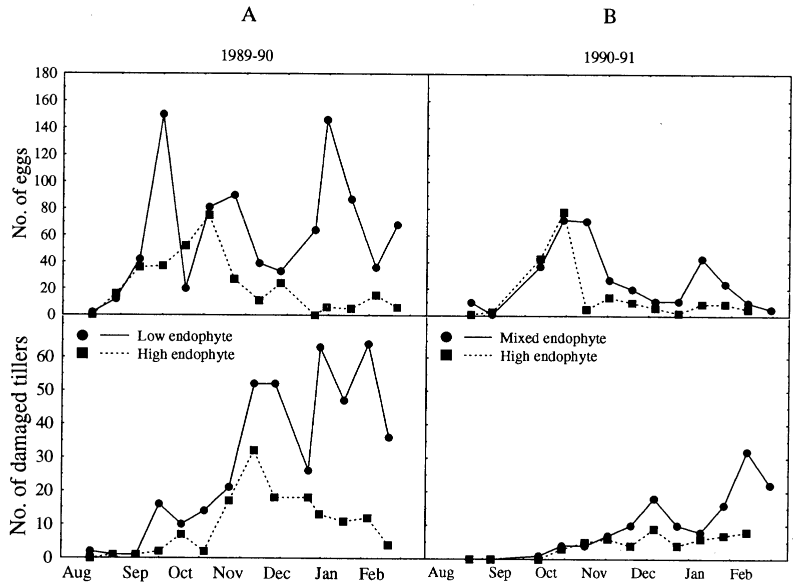

TABLE 1: The mean percentage of *A. lolii*-infected (E+) and uninfected (E−) ryegrass tillers with eggs and damaged by ASW larvae in a high and a mixed endophyte pasture between December 1990 and March 1991.

Pasture		% Tillers with eggs	% Tillers damaged	Damage severity (%) Light	Moderate	Severe
Mixed	E−	10.9	22.2	32.4	47.0	27.6
	E+	3.8	4.1	71.4	14.3	14.3
High	E−	11.5	20.7	54.5	27.3	18.2
	E+	3.1	5.1	50.0	50.0	0

DISCUSSION

The phenology of ASW damage in pastures is as important as determining population densities when considering management and control of this pest. Our study has shown that, in low endophyte pastures in the Manawatu, spring damage by ASW larvae is of relatively little consequence compared with summer damage. This confirms the results of Gaynor and Hunt (1982) and is similar to the situation in the Waikato (Prestidge *et al* 1984). In the Waikato, the lack of spring damage is partly attributed to a small egg population from the relatively few adults surviving the winter (Barker *et al* 1989), whereas in our study the amount of oviposition was similar in spring and summer. The increase in larval damage did not closely follow the increase in oviposition in spring, probably due to a masking of damage by rapid plant growth and a high tillering rate. There may also be some ASW mortality at this time due to desiccation of eggs and neonatal larvae (Barker *et al* 1984) but this is unlikely to be greater in October than in January. Further work on these aspects is required but it does appear that, unlike the Waikato, spring populations in the Manawatu are potentially as damaging as summer populations.

In high endophyte pasture, larvae resulting from the substantial egg deposition in spring also have the potential to cause considerable damage. However, most of the damage we observed was very minor and was unlikely to have affected pasture production. The decline in egg laying and adult feeding in the high endophyte pasture, in both years from November, may be associated with changes in endophyte content of plants and metabolite production. Peramine levels in endophyte-infected plants in the Manawatu increase during November and December (B.A. Tapper and D.D. Rowan, pers. comm.). However such increases were less apparent in trials in the Waikato which also showed that peramine levels for most of the year were higher than those required to deter adult feeding (Ball *et al* 1991). Other factors may therefore be responsible for the decline in feeding and oviposition observed in the summer in high endophyte pastures.

The marked differences in egg numbers and larval damage between endophyte-infected and endophyte-free tillers in the same pasture demonstrate the acute selectivity of ASW. The ability of the adult to discriminate between infected and non-infected plants is well known, but it has been suspected that larvae did not possess that same ability. Dymock *et al* (1989a) found that larvae were less sensitive than adults to peramine in choice tests, although only low concentrations of this chemical were required to decrease feeding. It has also been reported that larvae will transfer readily into endophyte-infected tillers (Prestidge and Gallagher 1988) and cause substantial death of infected tillers where they are planted in association with endophyte-free grasses (Prestidge *et al* 1986; Thom and Prestidge 1988). Contrary to these studies, our results indicate that larvae can discriminate between endophyte-infected and endophyte-free tillers prior to mining them, and cause only minor damage to the infected component of a mixed endophyte-infected and endophyte-free pasture. Low egg deposition is unlikely to account for the low tiller damage to endophyte-infected plants because larvae utilise several tillers in their development. Furthermore, even where there is equivalent adult feeding and egg laying between infected and non-infected plants, larvae will seldom penetrate the infected plants (A.J. Popay, unpublished). A similar finding was made by Barker *et al* (1984) in a pot experiment. Lolitrem B, produced in *A. lolii*-infected ryegrass, will deter larval feeding (Dymock *et al* 1989b) and may be at least partially responsible for the low larval damage to endophyte-infected tillers.

Direct drilling of high endophyte grass into an existing low endophyte pasture in autumn thus appears to have been at least partially successful in reducing ASW damage, with success or otherwise of this technique dependent on the rate of establishment of *A lolii*-infected plants. However, the reduction in damage in the mixed pasture in the 1990/91 season compared to the damage in the same pasture the previous season can only be partly attributed to the higher proportion of infected plants. Seasonal differences may also have had an effect with the cool wet summer of 1990/91 being detrimental to an insect known to prefer dry conditions.

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