EFFECT OF POTASSIUM FERTILISER, STAND AGE AND DAMAGE HISTORY ON THE RESPONSE OF LUCERNE TO *SITONA DISCOIDEUS* LARVAL DAMAGE

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SUMMARY

In a factorially designed field experiment the effect of 4 consecutive years of damage to lucerne by *Sitona discoideus* was studied. The 5 year old stand was highly susceptible to larval damage at a threshold density of < 670 larvae/m^2. The crop was probably potassium deficient and the consequent response was additive to that of insecticide. There was no insecticide/potassium interaction, contrary to earlier suggestions that poor potassium status may increase lucerne sensitivity to *S. discoideus* damage. Where neither potassium nor insecticide were applied, plots that had been consecutively damaged for four seasons showed a greater yield loss than those attacked for the first time in their fifth year.

INTRODUCTION

The nature and extent of seasonal losses of lucerne production that result from *Sitona discoideus* larval feeding are now fairly well understood and documented (e.g. Goldson *et al*, 1985; Goldson and Muscroft-Taylor 1988). However, the interaction of the pest with soil fertility, stand age and damage history has been less thoroughly explored. This is particularly so with reference to numerous reports of unsatisfactory stand persistence in Canterbury.

Proffitt and Goldson (1986) have demonstrated that after three consecutive seasons of weevil attack there were minor but apparently permanent effects on lucerne nitrogen status and yield. More recently it has been suspected that the application of potassium can alleviate larval damage (Goldson *et al* 1987). In addition there has been growing evidence that as crops age, they show increasing susceptibility to larval attack through progressive nodulation failure (Goldson and Muscroft-Taylor 1988). Such nodulation failure is probably responsible for the obvious nitrogen stress and eventual runout of older stands (Proffitt and Goldson 1986). Related to this, in what may be a particularly important recent development, Stephens *et al* (1988) have preliminarily identified the soil-borne pathogenic fungus *Mortierella* sp. as possibly inhibitory to the renodulation of *S. discoideus*-damaged plants. Since nodules also slough off naturally (Burton 1972) the fungus may be implicated in the premature runout of lucerne whether it is severely attacked by *S. discoideus* or not.

The aim of this contribution is to add to the overall understanding of the interactions described above, particularly with reference to Goldson *et al*'s (1987) preliminary observations on the interrelationship between stand age, soil potassium status and sensitivity to larval damage.

METHODS AND MATERIALS

The lucerne stand (cv. WL318) employed in this study was located 3 km west of Darfield and was the same as that used in other recent work on *S. discoideus* (e.g. Goldson *et al* 1985; Goldson *et al* 1987; Goldson and Muscroft-Taylor 1988). The stand was drilled into Chertsey shallow silt loam on 10 November 1982 and was thereafter maintained under standard management for hay production. A maintenance top-dressing of about 250 kg/ha of superphosphate was applied annually. The experiment, as laid down in the 1983-84 season assessed the effect of various larval densities on yield. It comprised a randomised block design of four manipulated larval densities replicated five times. Plot size was 24 m × 24 m. From the 1984-85 season, the emphasis of the experiment changed in order to evaluate long-term effects of *S. discoideus* damage on production. Manipulation of population size was abandoned. The two plots in each block that had had the higher larval densities in preceding seasons remained unsprayed while the weevil was effectively eliminated from the two lower densities by applying chlorpyrifos (Lorsban 40EC) at 1 kg/ha in late May prior to the onset of the bulk of the weevil's egg-laying (Goldson 1984).

In 1987 the main plots were divided into paired 12 m × 24 m subplots, in a 2 × 2 factorial design. The main treatments (damage history) consisted of those plots which had either been subjected to four consecutive seasons of *S. discoideus* larval damage or had been completely protected. The four subplot treatments were control, insecticide only, potassium only and insecticide and potassium combined. The insecticidal treatment comprised chlorpyrifos applied at 1 kg/ha on 8 May 1987, while the fertiliser treated plots were topdressed with 444 kg/ha of potassium as potassium sulphate. Gypsum was applied at 470 kg/ha to the non-treated plots in equivalent amounts to the sulphur added to the potassium subplots.

The lucerne was mown on 3 November 1987 and 12 January 1988 using a Vicon 1.65 m disc mower. At the time of both cuts, the entire production of each subplot was raked up and weighed. One kilogram subsamples were taken for dry matter analysis and herbage dissection.

Peak larval density was estimated by taking five groups of five 140 mm × 140 mm × 250 mm soil samples at regularly spaced intervals in the buffer area at approximately 2 weekly intervals from 6 October 1987 until 5 January 1988. The larvae were extracted using a saline flotation/wet-sieving technique (Goldson *et al* 1985).

RESULTS AND DISCUSSIONS

The effect of damage history on yield

When taken across the insecticidal and fertiliser subtreatments, the two damage histories of the lucerne produced no significant difference in yield response.

Yield responses to insecticide and potassium application

(a) First cut:

A peak larval population of 670±280/m^2 was measured on 17 November 1987. While this was well below the damage threshold of 1150-2000 larvae/m^2 determined for younger stands (Goldson *et al* 1985), Table 1 shows that there was a 27.6% increase in production at the time of the first cut where the weevil was excluded. Such increased damage sensitivity in a 5 year old stand supports the idea that lucerne becomes more susceptible to *S. discoideus* damage as it gets older, probably through nodulation failure (Goldson and Muscroft-Taylor 1988). In addition, there was a 14.5% increase in yield in response to potassium application (Table 1). Both of these results are consistent with responses measured by Goldson *et at* (1987). There was no significant interaction between the insecticide and potassium applications (Table 2); their effects were essentially additive.

TABLE 1: The effect of potassium fertiliser and insecticide on first cut (3.11.87) dry matter yields (kg DM/ha).

	Treatment		% yield increase
	−I	+I	
Mean from fertilised and unfertilised plots:	1014	1294	27.6**
	−K	+K	
Mean from sprayed and unsprayed plots:	1076	1232	14.5*

* denotes significance level $P < 0.05$
** denotes significance level $P < 0.01$

TABLE 2: The interaction table taken from the lucerne response at the first cut to insecticide and fertiliser application (kg DM/ha). Interaction was not significant.

	– insecticide	+ insecticide
– potassium fertiliser	929	1222
+ potassium fertiliser	1098	1366
	LSD = 188 p = 0.05	

(b) Second cut:

Table 3 demonstrates that by the time of the second cut, the crop had recovered from the damaging effects of *S. discoideus* larvae while the beneficial effects of the potassium application remained largely unchanged producing an 18.8% increase in yield. The interaction (Table 4) was again insignificant.

It seems that at the time of the experiment the stand had become generally deficient in potassim and the measured yield increases were part of a relatively simple agronomic response to its replenishment. The significantly improved production that arose from the insecticidal application and its lack of significant interaction with the potassium (Tables 2 and 4), indicates that, irrespective of the potassium status, a relatively low density of *S. discoideus* larve was able to disrupt yield. The lack of a significant interaction in yield responses between the insecticide and potassium application also indicates that the potassium does not significantly offset damage as initially contended by Goldson *et al* (1987).

TABLE 3: The effect of potassium fertiliser and insecticide on second cut (12.1.88) yields (kg DM/ha).

	Treatment		% yield increase
	–I	+I	
Mean from fertilised and unfertilised plots:	663	711	7.2ns
	–K	+K	
Mean from sprayed and unsprayed plots:	628	746	18.8*

* denotes significance level $P<0.05$
ns denotes no significance

TABLE 4: The interaction table taken from the lucerne response at the second cut to insecticide and fertiliser application (kg DM/ha). Interaction was not significant.

	– insecticide	+ insecticide
– potassium fertiliser	608	648
+ potassium fertiliser	717	775
	LSD = 107 p = 0.05	

Long-term effects of repeated damage on the sensitivity of lucerne to damage by *S. discoideus*.

Figure 1 is a plot of the total yields (cuts 1 and 2 combined) from the two damage histories as affected by insecticide and/or fertiliser. The results show that the difference in damage history of the crop in no way affected the yield obtained following the addition of insecticide and/or fertiliser. However, differences were apparent where neither fertiliser nor insecticide were applied (i.e. both populations of plants were therefore exposed to *S. discoideus* damage in their fifth year). Under these circumstances, the yield was 27.4% higher ($p<0.10$) in those plots that had been protected for their first 4 years of growth compared to those that had been damaged each season for the preceding 4 years.

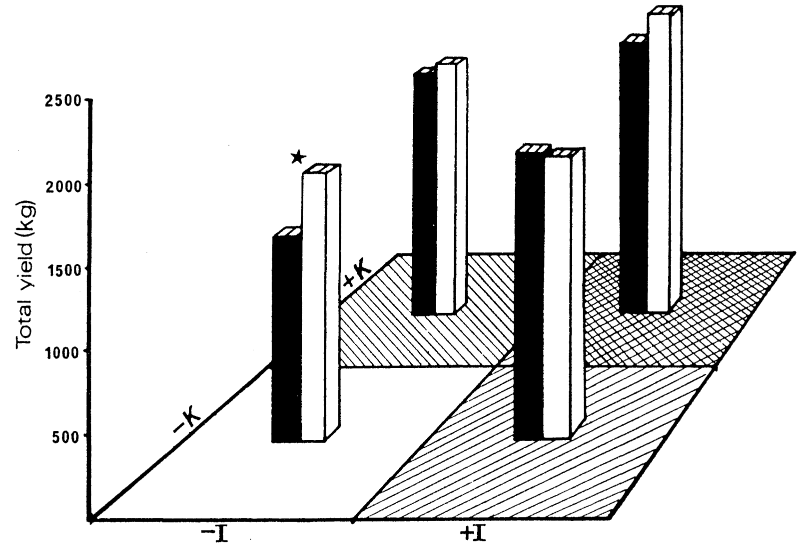

Fig. 1: **Plot of the total yields (cuts 1 and 2 combined) that arose from the two damage histories as affected by insecticide (±I) and/or fertiliser (±K). Solid column = 4 years damage prior to the experiment; open column = no damage prior to the experiment. * = significantly different ($p<0.10$).**

CONCLUSIONS

The 5 year old lucerne stand studied in the 1987-88 season showed a high degree of susceptibility to *S. discoideus* larval damage. The crop was probably potassium dificient and the response to the addition of potassium sulphate was additive to that of the insecticide. Potassium application did not significantly offset the larval damage. Where neither potassium nor insecticide were applied, plots that had been consecutively damaged for the preceding four seasons showed a greater yield loss than those that were attacked for the first time in their fifth year.

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REFERENCES

Burton, J.C., 1972. Nodulation and symbiotic nitrogen fixation. p. 234. *In:* Hanson, C.H. (ed.) *Alfalfa Science and Technology*. American Society of Agronomy.

Goldson, S.L., 1984. Sitona Weevil in Lucerne — Biology and Control. AgLink FPP 548, Information services, MAF, Private Bag, Wellington, New Zealand.

Goldson, S.L., Dyson, C.B., Proffitt, J.R., Frampton, E.R. and Logan, J.A., 1985. The effect of *Sitona discoideus* Gyllenhal (Coleoptera:Curculionidae) on lucerne yields in New Zealand. *Bulletin of Entomological Research 75:* 429-442.

Goldson, S.L., Proffitt, J.R. and Stephen, R.C., 1987. A long-term effect of sitona weevil damage in Canterbury lucerne. *40th NZ Weed and Pest Control Conf:* 212-215.

Goldson, S.L. and Muscroft-Taylor, K.E., 1988. Interseasonal variation in *Sitona discoideus* Gyllenhal (Coleoptera:Curculionidae) larval damage to Canterbury lucerne and the associated economics of insecticidal control. *NZ J. Agric. Res. 31* (in press).

Proffitt, J.R. and Goldson, S.L., 1986. The cumulative effect of sitona weevil larval damage on a Canterbury lucerne stand after three seasons. *Proc 39th NZ Weed and Pest Control Conf.:* 38-40.

Stephens, P.M., Goldson, S.L. and Noonan, M.J., 1988. Effects and interactions of *Sitona discoideus* Gyllenhal (Coleoptera:Curculionidae) and soil-borne fungi on the nitrogen/nodulation status of different aged alfalfa stands in Canterbury, New Zealand. *Applied Environmental Microbiology* (submitted).