A LONG-TERM EFFECT OF SITONA WEEVIL DAMAGE IN CANTERBURY LUCERNE

S.L. GOLDSOON, J.R. PROFFITT and R.C. STEPHEN

MAFTech, P.O. Box 24, Lincoln

SUMMARY

A long term study on the damage effects of *Sitona discoideus* Gyllenhal has indicated that contrary to earlier findings, some 4-year-old lucerne is not immune to larval damage. Results showed that lucerne subjected to nutritional deficiencies may be susceptible to *S. discoideus* larval damage even at relatively low larval densities. This damage may be minimised by fertiliser application, particularly potassium. The reason for these effects are unresolved and probably complex.

INTRODUCTION

The seasonal damage potential of *Sitona discoideus* Gyllenhal in young (<4 years old) Canterbury lucerne is now quite well understood (e.g. Goldson *et al* 1985; Goldson *et al* 1987). In essence, the spring-time (November-December) denodulation of the plants' roots by weevil larvae (Goldson *et al* 1986) can impose severe nitrogen stress (Goldson unpublished data) that may result in early to mid-season production losses of up to 50% (Goldson *et al* 1985; unpublished data). However, the lucerne has shown remarkable resilience in its ability to recover from such damage. By the autumnal hay cut (if there is one) in March-April, production in young stands has been found to be completely restored (Goldson *et al* 1985; Goldson *et al* 1987). However, the question arises as to what may be the cumulative effects of repeated damage on the performance of the crop. This is prompted in particular, by complaints from many growers that in recent years lucerne has shown poor persistence (B.P. Stephenson pers. comm.).

On the basis of their long-term study, Proffitt and Goldson (1986) recently reported relatively minor permanent effects on lucerne growth after three consecutive seasons of larval damage. These effects involved reductions in yield and foliar nitrogen levels. This contribution describes more recent findings derived from the same study and discusses possible interactions between *S. discoideus* and soil fertility.

METHODS AND MATERIALS

The observations presented in this paper were derived from two adjacent experiments.

The initial and ongoing experiment was established on Chertsey silt loam near Darfield early in the 1983-84 season as part of a project to measure the acute (short-term) spring impact of a manipulated range of *S. discoideus* larval densities (Goldson 1983) on 1-year-old lucerne (cv. W L318) yields (Goldson *et al* 1985). This experiment has since been adapted to compare the performance of lucerne that has been exposed to repeated *S. discoideus* larval damage with that which has been fully protected. This was achieved by the annual elimination of post-aestivatory, immigrant, pre-reproductive weevils from 10 of the twenty 24 x 24 m original plots using chlorpyrifos (Lorsban 40 EC) at 0.6-1.0 kg ai/ha in late May each year (Goldson 1984). During this time the untreated plots were exposed to larval damage for four consecutive seasons. Throughout, management decisions regarding fertiliser regimes and mowing times were at the discretion of the property owner. Yield assessments in this study were made from cuts taken on 5 November and 17 December 1986.

The peak *S. discoideus* larval population was assessed by sampling untreated areas at approximately 10 day intervals from early November until mid-December 1986. Sampling consisted of taking fifteen 140 mm x 140 mm x 250 mm soil blocks dug from

Proc. 40th N.Z. Weed and Pest Control Conf.

the rows; the larvae were subsequently extracted using a saline flotation/wet-sieving technique (Goldson *et al* 1985).

On 24 December 1986 twelve 25 mm diameter soil cores were taken from each plot; these were separated into 0.7 cm, 7-15 cm and 15-30 cm depths, bulked for each plot and analysed using quick tests for pH, Ca K, P, Na, Mg and SO₄ levels.

In addition to the initial experiment, in the autumn of 1986, a fertiliser/insecticide trial based on a 2² factorial design was established. All treatments were applied in full factorial combination and the highest order interaction was confounded with blocks (R.C. Stephen, unpublished). The trial commenced with a basal application of a mix of fertilisers (P at 25 kg/ha, K at 125 kg/ha, S at 25 kg/ha and B at 15 kg/ha). In early April the experimental treatments of molybdenum (351 g/ha), hydrated lime (735 kg/ha), rhizobial inoculum granules (Rhizocote G at 22 kg/ha) and urea (50 kg/ha) were applied. The insecticidally treated plots were sprayed with chlorpyrifos at 1 kg ai/ha on 6 May, 4 July and 22 September 1986. The area used for this trial consisted of lucerne that had been annually exposed to *S. discoideus* attack since the stand was established. Larval damage was therefore very similar to that of the untreated plots in the initial experiment, as post-aestivatory ground distribution of weevils within lucerne stands tends to approach uniformity (Goldson 1983). The plot size was 7 x 7 m and yields were assessed by weighing the herbage cut from two 7 x 1 m swathes/plot. No first cut yield data were obtained but second cut yields were measured on 17 December 1986.

RESULTS AND DISCUSSION

In the 1986-87 season, the *S. discoideus* larvae in the 4-year-old stand under study peaked at 900 ± 80/m². This density compared to 4600 ± 1370/m² in a nearby 1-year-old stand (Goldson and Proffitt unpublished) and thus conformed well to the finding of Goldson and French (1983) who estimated a likely decline in larval densities of 40% for each year the stand aged. It was on this basis that they contended that stands of >3-years-old were probably not susceptible to *S. discoideus* larval damage (Goldson and French 1983).

TABLE 1: The effect of *S. discoideus* larval attack on yield in the initial experiment and the fertiliser trial as found at the time of the first and second cuts in the 1986-87 season.

	Initial experiment D.M. yield (kg/ha)		Fertiliser/insecticide trial D.M. yield (kg/ha)	
	+ sitona	– sitona	+ sitona	– sitona
Cut 1 (5/11/86)	2400 ± 120	2460 ± 150	—	—
Cut 2 (17/12/86)	870 ± 50	1400 ± 120	1600 ± 160	1850 ± 164

The effects of *S. discoideus* on total dry matter production in both experiments are summarised in Table 1. At the time of the first cut it seemed that four consecutive seasons of larval damage had not influenced yield in the initial experiment and inspection of the nearby fertiliser/insecticide trial indicated a similar result (Proffitt unpublished). By the time of the second cut, however, yield in the damaged (+ sitona) plots in the initial experiment was 38% less than that in the consistently protected (– sitona) plots (Table 1). Importantly, this was observed in lucerne that hitherto had not been regarded as susceptible on account of its age (4 years) (Goldson and French 1983). Equally as important was the observation that this yield loss was incurred by only 900 larvae/m². This density was well below that thought to have been necessary to cause damage in an initially moist growing season such as that in 1986-87. Goldson *et al* (1985) and Goldson and Proffitt (1985) have shown that in young stands (<3 years old), damage threshold densities of 1150-2000 larvae/m² were needed before yield loss occurred. They also noted that, in wet conditions, the upper end of the threshold density range was required before damage became apparent (Goldson and Proffitt,

1985). In general, the expression of damage in this study was different from that in young stands severely damaged by high larval densities. Invariably the latter at the time of mowing have shown significant increases in percent foliar dry matter (Goldson *et al* 1985); this did not apply in this study.

In the fertiliser/insecticide trial, unlike the initial experiment, four consecutive seasons of larval damage (+ sitona) had little apparent effect on yield (Table 1.). This was in spite of the fact that weevil damage in both + sitona treatments was similar. The major difference between these two treatments was the heavier application of fertilisers to the fertiliser/insecticide trial. Within the fertiliser/insecticide trial itself the only significant main treatment effect was a small (14%) response to the chlorpyrifos application. Since there were no significant treatment interactions in the fertiliser/insecticide trial, it was concluded that the basal fertiliser application was probably responsible for the higher yield in the + sitona treatment and for the reduced response to insecticide. This contention was supported by the single plot which, with only a basal mix applied, had still yielded 1425 kg/ha.

While it is not possible to separate out the effects of the individual components of the basal fertiliser treatment, analyses of soil samples taken from the untreated areas of the field indicated moderate deficiencies in phosphorus and sulphur and a marked deficiency in potassium (Table 2.) Potassium deficiency could therefore have been a major factor influencing herbage yields. Recent work by Collins *et al* (1986) has shown that potassium availability may greatly affect nodulation and nitrogen fixation in lucerne. Since nitrogen fixation is the process that *S. discoideus* larvae disrupt, the addition of potassium in the basal fertiliser mix to the insecticide/fertiliser trial may have been the factor that minimised the weevil damage. However, in spite of the potassium deficiency in the initial experiment, the – sitona plots still yielded 1400 kg/ha in the second cut (Table 1.). The marked reduction of yield in the + sitona treatment in this experiment suggests that the plants in these plots may have become sensitised to the potassium deficiency through the four consecutive seasons of *S. discoideus* larval attack.

TABLE 2: Quick test analyses of soil samples taken from the experimental area one week after 1986-87 season's second hay cut.

Soil horizon (cm)	pH	Ca	K	P	Na	Mg	SO ₄
0- 7	6.1	13.4	6.1	9.5	4.2	14.9	6.3
7-15	5.9	11.1	2.9	7.5	3.7	10.8	6.8
15-30	5.7	7.9	2.1	6.4	3.0	8.3	8.2

CONCLUSIONS

An important finding of this work is that 4-year-old is not necessarily immune to *S. discoideus* larval damage. Whether this is the case in lucerne that has been protected against the weevil up to its fourth year is uncertain and remains the subject of further research. It is also apparent that lucerne exposed to repeated larval damage may become less tolerant of nutrient deficiencies and/or relatively low levels of *S. discoideus* larval damage. It may be that such losses can be minimised by full use of fertiliser, particularly potassium.

The mechanisms associated with yield loss in older stands remain obscure. In young lucerne there is little doubt that production is lost simply through denodulation and ensuing nitrogen stress. In older stands there may be a combination of factors including loss of nodulation vigour (perhaps through soil-borne antibiotic factors). It seems probable that *S. discoideus* plays a significant role in such a process and as such, the whole area demands further collaborative research.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the co-operation of Mr W. Band on whose Darfield property this study is being conducted.

REFERENCES

- Collins, M., Lang, D.J. and Kelling, K.A., 1986. Effects of potassium, and sulfur on alfalfa nitrogen-fixation under field conditions. *Agron. J.* 78: 959-963.
- Goldson, S.L., 1983. Field technique to established a replicated range of sitona weevil densities. *Proc. 36th N.Z. Weed and Pest Control Conf.*: 30-32.
- Goldson, S.L. and French R.A., 1983. Age-related susceptibility of lucerne to sitona weevil, *Sitona discoideus* Gyllenhal (Coleoptera:Curculionidae) larvae and associated patterns of adult infestation. *N.Z. J. Agr. Res.* 26: 251:255.
- Goldson, S.L., Frampton, E.R., Barratt, B.I.P. and Ferguson, C.M., 1984. The seasonal biology of *Sitona discoideus* Gyllenhal (Coleoptera:Curculionidae), an introduced pest of New Zealand lucerne. *Bull. Ent. Res.* 74: 249-25.
- Goldson, S.L. and Proffitt, J.R., 1985. Measurement of the impact of different larval densities of *Sitona discoideus* Gyllenhal (Coleoptera: Curculionidae) on Canterbury lucerne. *Proc. 4th Australasian Conf. on Grassland Invert. Ecol.*: 26-34.
- 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. *Bull. Ent. Res.* 75: 429:442.
- Goldson, S.L., Frampton, E.R. and Jamieson, P.D., 1986. Relationship of *Sitona discoideus* (Coleoptera:Curculionidae) larval density to September-October potential soil moisture deficits. *N.Z. J. Agr. Res.* 29: 275-279.
- Goldson, S.L. Bourdot, G.W. and Proffitt, J.R. 1987. A study of the effects of *Sitona discoideus* (Coleoptera:Curculionidae) larval feeding on the growth and development of lucerne *Medicago sativa*. *J. Applied Ecol.* 24: (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 N.Z. Weed and Pest Control Conf.*: 38-40.