NODULE DAMAGE BY CLOVER ROOT WEEVIL LARVAE IN WHITE CLOVER SWARDS

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ABSTRACT

The impact of clover root weevil larval populations was assessed in pure swards of Grasslands Prestige and Grasslands Kopu white clover in a small plot trial. Nodule damage was very evident, and both cultivars showed significant increases in nodule damage and decreases in percent foliar nitrogen in November in response to increasing winter larval numbers. Dry matter production of Kopu in November was related to foliar nitrogen levels.

Keywords: *Sitona lepidus*, white clover, nodules, foliar N, clover production.

INTRODUCTION

Clover root weevil (CRW) (*Sitona lepidus* Gyllenhal (Coleoptera: Curculionidae)) was first identified in New Zealand in 1996 (Barratt et al. 1996). Currently it is found throughout farmland north of Taumarunui and across to Gisborne, and will eventually colonise all pastures in New Zealand (Gerard et al. 1999). CRW is now one of New Zealand's most serious pasture pests. Adult CRW feed on the foliage of *Trifolium* species, showing a preference for white clover (*Trifolium repens*), and in particular for seedlings (Hardwick & Harens 2000). The larvae feed predominantly on the root nodules and fine roots in the early instars, shift onto coarser roots in later instars, and may attack stolons in the final instar (Gerard 2001a).

A few studies have been undertaken on the impact of CRW larvae on white clover. Glasshouse (Mowat & Shakeel 1988b) and laboratory (e.g. Murray et al. 1996) experiments have been carried out on seedlings or newly established plants. Field studies in Northern Ireland demonstrated pasture clover content was more than trebled by insecticidal control of CRW (Mowat & Shakeel 1988a), and that CRW may contribute to the inconsistent long-term performance of white clover often observed in mixed swards in the British Isles (Mowat & Shakeel 1989). A farmer survey in infested regions in New Zealand indicated that white clover plants under higher stress levels appeared to be affected most (Eerens et al. 1998).

This paper summarises vegetative plant data from a Foundation for Arable Research small plot trial aimed at quantifying the impact of CRW larvae on second crop, clover seed production.

METHOD

Plot trial

The small plot trial method has been described by Gerard (2001b). Briefly, 30 1×1 m plots of both Grasslands Prestige (a small-leaved, prostrate clover) and Grasslands Kopu (a large-leaved, upright clover) were established in cold-frame beds in autumn 1999. CRW adult numbers were manipulated in late summer/early autumn 2000 to obtain winter larval densities ranging from 0 to over 1000/m². Winter larval numbers were assessed on 2 August 2000 by taking four 76 mm diameter soil cores/plot to a depth of 10 cm. Each core was sorted by hand and the number of larvae recorded.

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Four 5 cm diameter cores to a depth of 10 cm were taken from each plot in September 2000, and stolon length, stolon and root dry matter (DM), and the numbers of whole and eaten nodules assessed. Foliage DM assessments were carried out on 27 September and 1 November, and sub-samples analysed for percent foliar nitrogen (foliar N). No further foliar DM samples could be taken as this would have compromised flowering and seed production assessments. A foliage DM cut carried out after seed harvest was destroyed in a fire.

Statistical analysis

Regression analysis was used to investigate relationships between larval density and plant measurements, and the differences between means were analysed using t-tests.

RESULTS

A wide range of larval densities was achieved across the trial site with at least six control plots containing no larvae and at least three plots exceeding 1000 larvae/m² for each cultivar.

No difference was found between Prestige and Kopu in the total number of root nodules, either in the controls or over all plots. There were significant linear relationships between winter CRW larval density and percent of total damaged nodules in September for both Prestige ($P < 0.01$, Fig. 1a) and Kopu ($P < 0.001$, Fig. 1b).

FIGURE 1: Relationships between clover root weevil larval numbers in winter and nodules found eaten on (a) Prestige and (b) Kopu white clover roots in September 2000.

In September, Prestige showed a significant decline in foliar N with increasing larval numbers ($P < 0.01$, $y = -0.0004x + 5.6$, $r^2 = 0.29$). However, much of the variability in nitrogen levels was not explained by this relationship. In November, both cultivars showed significant linear relationships between foliar N and winter larval numbers (Figs 2a & 2b). Mean foliar N for Prestige was significantly higher than Kopu, both on 27 September (5.35 vs 4.94%, $P < 0.001$), and on 1 November (5.09% vs 4.69, $P < 0.001$). Larval density appeared to have no impact on total nodule numbers, root or stolon DM, or stolon length. There was an indication that decreases in foliage DM production between September and November may have been influenced by increasing larval density ($P < 0.10$ for both cultivars).

FIGURE 2: Relationships between winter clover root weevil larval numbers and foliar N in (a) Prestige and (b) Kopu white clover foliage in November 2000.

November DM production was related to November foliar N for Kopu ($P < 0.01$, Fig. 3b), while this relationship for Prestige was only just outside statistical significance ($P = 0.051$, Fig. 3a). Kopu had higher DM than Prestige at both the September ($P < 0.001$) and November ($P < 0.01$) cuts.

DISCUSSION

The results from this small plot trial demonstrated that root nodule losses caused by winter populations of CRW larvae affected the amount of N in clover foliage in the spring, and this in turn impacted on DM production.

FIGURE 3: Relationships between DM and foliar N in (a) Prestige and (b) Kopu white clover in November 2000.

Goldson et al. (1988) showed a strong linear relationship between peak *Sitona discoideus* larval densities and November herbage N in a year old lucerne stand. The results from this trial mirror their findings, even to the extent that the regression equation for CRW and foliar N in Prestige was identical to that obtained for *S. discoideus* and nitrogen in lucerne.

The results from this trial on mature plants also support previous CRW laboratory and glasshouse studies on white clover seedlings. Murray et al. (1996) found that larval infestation of seedlings had no effect on nodule or root DM, but plant foliar N and foliar DM were greatly reduced. Most nodules were newly formed and non-functional. Mowat & Shakel (1988b) found a negative linear relationship between CRW larval numbers and foliar DM yield.

Cool temperatures in September and low rainfall in October 2000 (1.3°C and 30 mm less than the 25 year average, Ruakura Meteorological Station data) greatly retarded clover foliar growth. Therefore, expression of the impact of CRW larvae was severely compromised. Nevertheless, a significant interaction between Kopu foliar N and DM in November was found. Goldson et al. (1985) observed that whenever *S. discoideus* larval damage in lucerne reduced foliar N below a threshold of 4.7%, DM production decreased, whereas above this, the plants could compensate for the losses and yields were consistently

higher. Goldson et al. (1988) speculated that this threshold was reached when the production of new nodules began to consume more N than was fixed. In turn this would lead to an abrupt decline in photosynthetic efficiency. The pattern of foliar N and DM in this trial did not show the precipitous delineation at a threshold, as observed by Goldson et al. (1985), possibly because the combination of low foliage DM yield and interplot variation. However, it is of note that a polynomial curve was the best fit for the data (Fig. 3b).

The difference between cultivars in foliar N is likely to be related to plant growth habit and the amount of material removed when taking dry matter cuts. Kopu is upright and large-leaved whereas Prestige is a small-leaved prostrate clover. Therefore, a higher proportion of Kopu foliage was removed at each cut. This was particularly noticeable in winter when Prestige formed a tight mat, barely 2 cm above soil level. The fertiliser regime for the trial aimed at maximising seed production, not foliar growth, and no compensation was made for nutrients lost by foliage removal.

It is important to consider that the clover in this trial was in pure swards. Addison et al. (1998) recorded peak larval densities from 300 – 400/m² in Waikato pastures and Eerens et al. (1998) reported that Waikato pastures averaged around 18% clover in non-irrigated pastures less than eight years old, and 26% in irrigated pastures of similar age. Therefore individual clover plants in heavily infested pastures would be under much greater pressure from larval feeding than plants in this trial.

It is possible that white clover may have a similar threshold to lucerne below which the plant cannot compensate for loss in nodule function, and foliage production is impaired. Clover is the vulnerable partner in the ryegrass/white clover partnership and significant impairment of clover foliage production will lead to clover loss in spring as it is out-competed by ryegrass. Identification of this threshold would assist in the development of recommendations for remedial application of N, which in conjunction with appropriate management regimes, would allow farmers to retain clovers in pasture during times of peak pressure from CRW larval damage.

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