

BIOLOGICAL CONTROL OF RAGWORT: DOES SHEEP GRAZING AFFECT RAGWORT FLEA BEETLE?

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ABSTRACT

Ragwort flea beetle (*Longitarsus jacobaeae*) (RFB) is present in many parts of New Zealand. Its impact on ragwort mortality, both alone and on ragwort trimmed to simulate sheep grazing, was investigated. Trimming reduced ragwort size and biomass throughout the trial. More plants died in spring and summer, but fewer plants died over the 12 month period, in trimmed than untrimmed treatments. Trimmed ragwort had fewer RFB larvae/g DM than untrimmed ragwort on only 1 of 3 occasions. RFB, at 12.3 RFB larvae/g DM in August did not affect ragwort mortality. Low larval numbers were probably a result of high ragwort densities (up to 36/m²).

Keywords: biocontrol, ragwort, integrated weed management, ragwort flea beetle (*Longitarsus jacobaeae*).

INTRODUCTION

Ragwort (*Senecio jacobaea*) is widespread throughout New Zealand (Syrett 1989). It poisons and may kill stock, particularly cattle and deer. Control is achieved by sheep grazing (Betteridge *et al.* 1994), chemical and cultural methods (Wardle 1987) and, since the early 1990s, increasingly by larvae of ragwort flea beetle (*Longitarsus jacobaeae*) (Coleoptera: Chrysomelidae), often within 3–4 years of adult beetle release (McEvoy *et al.* 1991; Hayes 1996). Ragwort flea beetle (RFB) distribution throughout New Zealand is incomplete (L. Hayes, pers. comm.), possibly because farm practices conflict with its establishment. Sheep grazing on dairy and beef farms is one possible means of controlling ragwort during the transition from herbicide to biological control. This paper reports results from a field trial that investigated the impact of RFB on ragwort, where ragwort was trimmed to simulate sheep grazing in a sheep-cattle grazing situation, or sprayed with insecticide to provide plants free of RFB larvae.

METHODS AND MATERIALS

This trial was established in March 1998 on a dairy farm with a severe ragwort problem near Dannevirke. In 1996 more than 5000 RFB had been released within 100 m of the trial site and suction sampling in April 1998 revealed an existing population of about 3 RFB adults/plant. As this population was considered to be small, 600 adults collected by suction from another farm were released near the centre of the trial site in April 1998. In May and again in June a further 10 adults were released onto each tagged ragwort plant. Within each of three adjacent 10 × 20 m blocks, 120 randomly located rosette ragwort plants were tagged. All blocks were grazed simultaneously by the dairy herd on a 3–6 week rotation. Within blocks one of four treatments was assigned to individual tagged plants using a completely randomised 2 × 2 factorial design. There were 30 plants/treatment/block. The treatments were:

Factor 1: with (RFB₊) or without (RFB₀) RFB;

Factor 2: ragwort trimmed to 50 mm with electric shears at 4-week intervals or untrimmed.

The RFB₀ plants were spot-sprayed with Orthene (acephate) at 0.78 g ai/litre at 4-week intervals from April, then at 3-week intervals from July to keep plants free of RFB larvae.

The height and basal diameter of ragwort plants were measured six times from March 1998 until May 1999. Plant mortality was determined by counts at the same time as the size data were collected. In June, August and November 1998, RFB larvae were counted in each of five washed whole plants/treatment within blocks, after extracting for 48 h under 40 W light bulbs. Plants, split vertically through the crown, were dried at 80°C for 8 h, then weighed. Adult RFB density was assessed in February 1999 by randomly selecting six points within the trial area, and suction sampling six un-tagged plants closest to these points. Ragwort density was assessed in 10 randomly placed 0.25 m² quadrats within the trial area.

Plant mortality was analysed by logistic regression using a Generalised Linear Model (Genstat 5.0) assuming binomial error distribution with a logit link function ($\log_e(D/(1-L))$) where D = proportion dead and L= proportion live ragwort plants. Dimensions of surviving plants were analysed by GLM (SAS) within each cutting date.

RESULTS

Trimmed ragwort was consistently smaller than untrimmed ragwort, being 4-6 times narrower ($P<0.001$) (Fig. 1a) and always shorter ($P<0.001$) (Fig. 1b). Between June and November 1998 trimmed ragwort plants grew from 1.8 to 2.3 g DM/plant while untrimmed plants grew from 6.6 to 15.5 g DM/plant ($P<0.001$; Fig. 1c). RFB treatment effects on ragwort height and basal area, while sometimes statistically significant, were always too small to be important, except in November when RFB₊-untrimmed plants (10.8 g) were half the weight of RFB₀-untrimmed plants (20.2 g) ($P<0.05$).

RFB larvae were not completely removed by the insecticide treatment. In June 1998, larval numbers were similar for all treatments at 0.8/plant ($P>0.05$). By August, these had increased to 12.3/plant on RFB₊-untrimmed plants, compared to no more than 2.3/plant in remaining treatments ($P<0.05$). By November, numbers had halved but were still greater in the RFB₊ treatments ($P<0.05$).

On a per unit dry weight of plant material basis the number of larvae in June and November was similar ($P>0.05$) between treatments (Fig. 1d). There were more larvae in RFB₊ than RFB₀ treatments in August ($P<0.01$) and in untrimmed compared with trimmed plants ($P<0.01$). The greatest density of larvae was 1.8/g ragwort DM in August.

Few plants died before August (Table 1) and throughout the trial, RFB had no effect on mortality ($P>0.05$). A higher percentage of trimmed than untrimmed plants had died by both November and March, but by the following May this pattern was reversed.

In February 1999 mean density of adult RFB was 0.5 ± 0.4 /plant. Ragwort density was 36 ± 25 plants/m² of which 33 were small rosettes and 3 were either large rosettes or small multi-crown plants.

TABLE 1: Effect of RFB and trimming on the cumulative percentage of dead ragwort plants from March 1998 to May 1999.

Treatment	Mar 98	Jun 98	Aug 98	Nov 98	Mar 99	May 99
6RFB ₊ untrimmed	0	0	0	0	33	86
6RFB ₀ untrimmed	0	0	0	0	27	82
6RFB ₊ trimmed	0	2	4	20	57	69
6RFB ₀ trimmed	0	1	3	16	50	63
Trim effect SED	0	0.8	1.5	4.6	10.0	8.6
Trim effect P-value				$P<0.001$	$P<0.001$	$P<0.001$

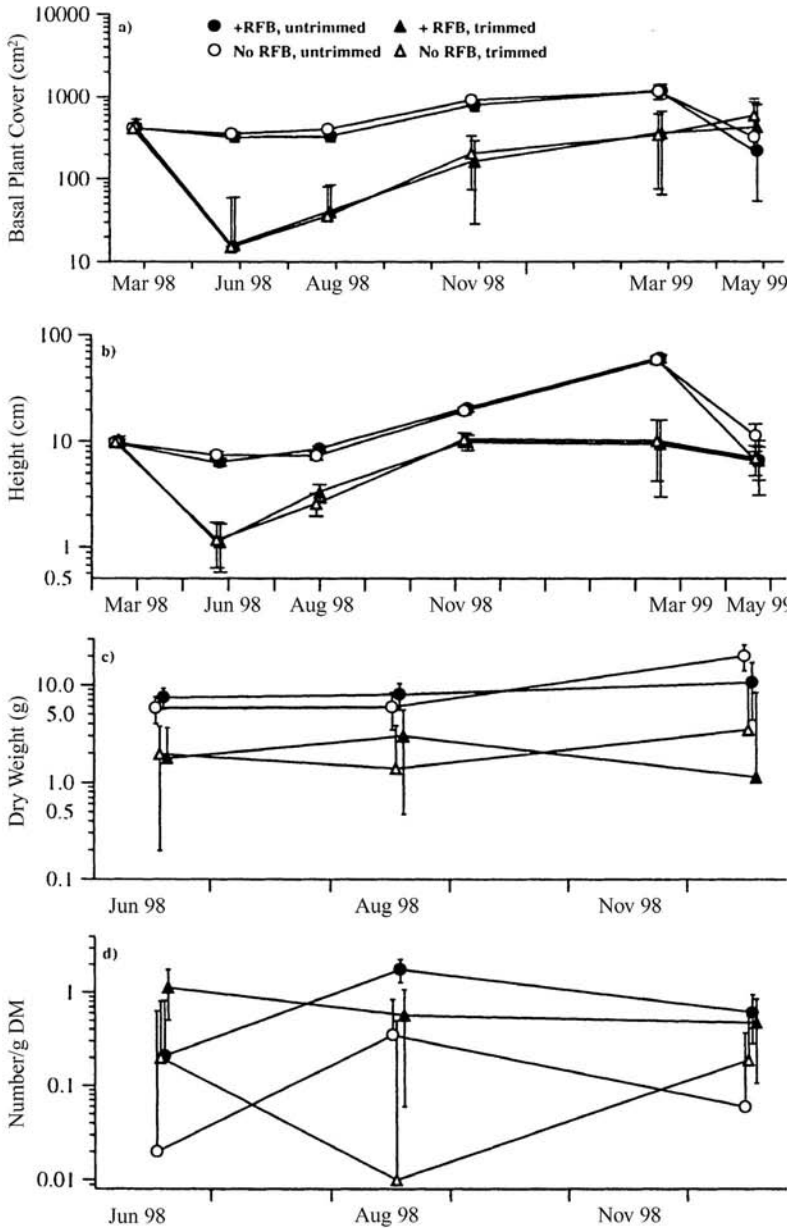


FIGURE 1: Effect of ragwort flea beetle and trimming on mean a) ragwort basal area, b) plant height, c) dry weight and d) larvae density. Bars are upper and lower 95% confidence limits. Lower limits less than zero are not shown. Y-axis data have been log-transformed.

DISCUSSION

Although RFB were always present, they had no detectable effect on the dense ragwort population in this trial. The apparent decrease from 3 RFB adults/plant in April 1998 to 0.5 in February 1999 was probably because assessments were not in the same month and because beetles released on tagged plants could disperse from the trial site. In a nearby trial, peak egg laying occurred in April-May (Page 2000) and continued through September (B. Page, unpubl. data). Therefore, the augmentation of the RFB population during autumn and winter should have increased larval numbers and consequent damage to plants. The changes in larval density in the RFB₊ untrimmed treatment (lowest larval density in June, peaking in August and declining by November), probably indicate normal dynamics, including the exodus of larvae to pupate in the soil (Ireson *et al.* 1991). Feeding damage done by the maximum of 12 larvae/plant was insufficient to kill plants directly or as a consequence of additional climatic, nutritional or disease stresses (D. Isaacson, pers. comm.). RFB larvae did, however, reduce plant growth. While no data are available to show the number of larvae required to kill a ragwort plant, McEvoy *et al.* (1993) reported that cohorts of plants with 19.3 larvae/g ragwort DM all died subsequently. This contrasts with the maximum infection rate of only 1.8 larvae/g DM in this trial. Nevertheless, in November RFB₋ untrimmed plants were half the weight of RFB₀-untrimmed plants.

Two other factors have accentuated the difficulty in detecting the impact of RFB on ragwort at these low RFB densities. Firstly, Orthene did not kill all RFB larvae. Secondly, with ragwort density exceeding 30/m², plant density was never a limiting factor, but instead may have resulted in fewer eggs being laid on/under each plant.

Trimming kept ragwort at a size similar to that found under sheep grazing (Betteridge *et al.* 1994). Eggs of RFB are laid predominantly on, or under rosette ragwort plants (Ireson *et al.* 1991; Page 2000) which provide a more humid environment than that of elongated flowering plants. On an eggs/g DM basis, small rosettes were found to be equally as attractive for oviposition as large rosettes, except that small isolated plants had fewer eggs than a cluster of similarly small ragwort plants (Page 2000). Whereas untrimmed plants in the present trial generally contained 5 to 6 times more RFB larvae than the smaller trimmed plants, when expressed as numbers of larvae/g DM, only in August were there more larvae in untrimmed than trimmed plants. These findings present no clear evidence that RFB will establish more quickly and be more efficient at reducing ragwort vigour where ragwort is able to grow larger in the absence of sheep grazing. Unless sheep grazing kills large numbers of rosette plants, it seems that the impact of sheep on the efficacy of RFB against ragwort will be at most small.

Plant mortality was enhanced by simulated sheep grazing (trimming) until March 1999. This was consistent with previously published work showing that pastures set-stocked with sheep have higher and earlier ragwort mortality rates than pastures mob-stocked or not grazed by sheep (Betteridge *et al.* 1994). The rapid increase in mortality of untrimmed ragwort from March to May 1999 is probably due to a higher rate of natural mortality of untrimmed ragwort after flowering (Wardle 1987), as most of these plants were flowering by 31 March.

Ragwort biological control was not achieved within the third year after first release of RFB. The density of RFB was too low due to high numbers of ragwort plants. We conclude that sheep grazing at a moderate intensity is unlikely to jeopardise establishment of RFB populations.

ACKNOWLEDGEMENTS

Mr and Mrs V. Payne, Dannevirke, for access to their land, interest in and co-operation during the trial. Dr F. Potter, AgResearch for statistical analyses.

REFERENCES

- Betteridge, K., Costall, D.A., Hitching, S.M., Devantier, B.P. and Liu, Y., 1994. Ragwort (*Senecio jacobaea*) control by sheep in a hill country bull beef system. *Proc. 47th N.Z. Plant Prot. Conf.* 53-57.

- Hayes, L., 1996. The Biological Control of Weeds Book – A New Zealand Guide. Landcare Research, Lincoln.
- Ireson, J.E., Friend, D.A., Holloway, R.J. and Paterson, S.C., 1991. Biology of *Longitarsus flavicornis* (Stephens) (Coleoptera:chrysomelidae) and its effectiveness in controlling ragwort (*Senecio jacobaea* L.) in Tasmania. *J. Aust. Ent. Soc.* 30: 129-141
- McEvoy, P.B., Cox, C. and Combs, E., 1991. Successful biological control of ragwort, *Senecio jacobaea*, by introduced insects in Oregon. *Ecol. Applic.* 1: 430-442.
- McEvoy, P.B. and Rudd, N.T., 1993. Effects of vegetation disturbances on insect biological control of tansy ragwort, *Senecio jacobaea*. *Ecol. Applic.* 3: 682-698.
- Page, B., 2000. Oviposition preference of ragwort flea beetle (*Longitarsus jacobaea* (Waterhouse)); as influenced by condition of host, *Senecio jacobaea* L. M.Sc. Thesis, Massey University, Palmerston North, New Zealand.
- Syrett, P., 1989. *Senecio jacobaea* L., ragwort (Asteraceae). Pp 361-366 *In: A review of biological control of invertebrate pests and weeds in New Zealand 1874 to 1987*, Tech. Comm. No. 10, P.J. Cameron, R.L. Hill, J. Bain and W.P. Williams (Eds); CAB International Institute of Biological Control Oxon.
- Wardle, D.A., 1987. The ecology of ragwort (*Senecio jacobaea* L.) - A review. *N.Z. J. Ecol.* 10: 67-76.