CONTROLLING CALIFORNIAN THISTLE (*CIRSIMUM ARVENSE*) THROUGH PASTURE MANAGEMENT

J.P.J. EERENS¹, S.S. SEEFELDT², G. GARRY¹ and
M.L. ARMSTRONG³

¹AgResearch Ltd, Ruakura Research Centre, Private Bag 3123, Hamilton

²US Sheep Experiment Station, HC 62 Box 2101 Dubois, Idaho 83423, USA

³AgResearch Ltd, PO Box 60, Lincoln

Corresponding author: han.eerens@agresearch.co.nz

ABSTRACT

The impact of grazing pasture to different heights on the development of Californian thistle (*Cirsium arvense*) was simulated over two years in container trials. Californian thistle field densities were simulated by transplanting seedlings into perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*) that had been sown at 20 and 5 kg/ha respectively. In a high fertility situation adding fertiliser did not influence Californian thistle development in the pasture sward. Californian thistle grown without companion ryegrass and white clover grew the best, reaching the highest levels of biomass (shoot and root material) and number of shoots (supra and subterranean). Californian thistle grown with the highest level of pasture competition fared the worst with the lowest level of biomass and number of shoots. The results show that grazing to a higher residual severely reduces Californian thistle growth and is a useful tool to assist in the control of Californian thistle.

Keywords: Californian thistle, *Cirsium arvense*, grazing height, pasture management, ryegrass.

INTRODUCTION

Californian thistle (*Cirsium arvense* L.) is a weed of pastures and crops in most temperate regions of the world. It has been described as New Zealand's most pernicious weed (Roy et al. 1998). In pasture, it has been linked to the occurrence of animal health problems such as scabby mouth (Mitchell & Abernethy 1993). Control of Californian thistle is especially difficult in areas where the terrain is not easily accessible to machinery, restricting opportunities for an integrated approach using spraying, mowing and biological means to control the weed. Biological control options may offer the best potential for management of Californian thistle and several options have or are being investigated. These include the introduction of insects (Jessep 1989) and plant pathogens (Bourdôt et al. 1993), with grazing management also offering possibilities. Pasture competition work with Californian thistle was reviewed by Bourdôt (1996).

The work described in this paper expands the population model for Californian thistle that is currently based on the weed growing in monocultures (D. Leathwick & G. Bourdôt, unpubl. data). The impact of different grazing intensities on Californian thistle growth and development in mixed swards was investigated. To simulate the field situation Californian thistle plants were planted in boxes at discrete intervals amongst ryegrass and white clover.

METHODS

2000/01 experiment

Perennial ryegrass cv. Bronsyn at 20 kg/ha and white clover cv. Prestige at 5 kg/ha were sown in pasture derived soil on 21 September 2000 in wooden crates measuring

New Zealand Plant Protection 55:111-115 (2002)

0.83 m long x 0.55 m wide x 0.36 m deep. Californian thistle plants were grown from pre-germinated seed and after two months transplanted into the crates on 23 November 2000 at a density of 11 plants/m². The crates were situated in the nursery outside at the Ruakura Research Centre. There were three cutting heights: 20, 60 and 100 mm, with maximum regrowth to 60, 100 and 150 mm respectively. These cutting regimes simulate set stocking by sheep (20 to 60 mm), dairy heifer rotation (100 to 150 mm) and an intermediate grazing intensity. A further two treatments of 0 and 30 kg N/ha applied every 6 - 8 weeks were combined in a complete factorial design, giving a total of six treatments replicated four times. The ryegrass plants were cut when they reached the maximum regrowth height limit of the treatment. Ryegrass clippings were dried, weighed and returned to the crates.

2001/02 experiment

Perennial ryegrass cv. Bronsyn at 20 kg/ha and white clover cv. Prestige at 5 kg/ha were sown in similar soil as the previous year on 17 September 2001 in square plastic crates measuring 0.33 m square and 0.26 m deep. Californian thistle plants were transplanted into the crates on 23 October 2001 at a density of 46 plants/m². The higher thistle density was used to more closely simulate the field situation. The crates were located in the nursery outside at the Ruakura Research Centre. The four treatments were the three cutting heights used in the 2000/01 experiment with the addition of a thistle only treatment. There were four replicates with a complete set of 16 crates destructively harvested every month for five months after transplanting the Californian thistle. All crates present at the time a non-destructive measurement was made were included, which increased replication in the early stages of the trial to 20. Ryegrass clippings were dried and weighed but not returned to the crates. A soil test showed that soil fertility levels were good (Olsen-P 16) and clover's nitrogen fixing ability eliminated the need to add nitrogen fertilisers.

Measurements

Thistle plant height and diameter were recorded on a fortnightly basis on five plants per crate in both years. Shoot biomass in both years was estimated on the basis of a standard curve ($\text{weight} = 0.002 (\sqrt{(\text{diameter}^2 + \text{height}^2)})^{2.181}$, $r^2 = 0.9045$). In the second year, at each harvest the plants intended for that harvest were cut at ground level, shoot material was collected, dried and weighed. The area around the central plant of each crate (0.21 m x 0.21 m) was dug out, subterranean material was sorted into root and shoot material, dried and weighed. The number of ryegrass tillers in the dug out area was counted. From the third harvest the subterranean material was washed and placed in an 85% solution of lactic acid (food grade) for 7 days at 60°C, to clarify the orientation of vascular bundles to distinguish between root and shoot tissue. After a week the material was examined and shoot buds counted. The material was then rinsed, oven-dried and weighed. The soil moisture was determined on each crate at harvest, a sub-sample of soil was weighed (wet), dried and weighed to determine its moisture content.

Data analysis

The data in the first year were analysed as a complete random block with four replicates. In the second year the data were analysed as complete random replicated blocks for each harvest. The data were Log transformed for analysis using Genstat for Windows. Transformed data are presented.

RESULTS

2000/01 experiment

The estimated average dry weights of the Californian thistle plants over the duration of the experiment are given in Figure 1. The cutting regime had a highly significant ($P < 0.001$) impact while the fertiliser treatment had no significant effect at any time on thistle development. Thistles developed into bigger plants when the height of companion pasture was kept short. More pasture was produced at progressively higher cutting height

($P < 0.001$), but fertiliser did not significantly influence pasture production (data not shown).

FIGURE 1: Estimated (log transformed) shoot biomass of Californian thistle plants over time during the 2000-01 growing season. Bars indicate LSD ($P < 0.05$).

2001/02 experiment

The development of Californian thistle was suppressed by the presence of pasture (Fig. 2). The different cutting heights had no significant effect until after the third harvest, when pasture cut to 100 mm suppressed Californian thistle development ($P < 0.05$) more than pasture cut to 20 mm. The correlation between the measured and estimated weight of Californian thistle plants is somewhat variable, the difference being greatest early on and decreasing with increasing plant size.

FIGURE 2: Estimated (open symbol) and actual (closed symbol) shoot biomass (log transformed) of Californian thistle plants over time during the 2001-02 growing season. Bars indicate LSD ($P < 0.05$).

The number of shoots produced per plant was on average highest for the pasture-free treatment at each harvest time and reduced as the pasture was allowed to grow taller (Table 1). Similar trends were observed for subterranean shoot numbers and weight ($P < 0.05$) and root weight ($P < 0.001$) up to the third harvest after which differences were no longer significant. Soil moisture did not significantly differ between the treatments with the difference varying less than 2% (data not presented).

TABLE 1: Number of above and below ground shoots as well as, underground shoot and root weight (g/plant) for the four treatments during the five harvests of 2001/02.

Harvest	Treatment	Shoot number/plant		Underground weight	
		Above ground	Underground	Shoot	Root
1	No grass	2.50 a ¹	2.50 a	0.09 a	0.75 a
	20 mm	0.50 b	1.75 a	0.02 b	0.44 ab
	60 mm	0.25 b	1.25 a	0.02 ab	0.49 ab
	100 mm	0.25 b	2.00 a	0.01 b	0.24 b
2	No grass	1.45 a	4.75 a	0.59 a	6.33 a
	20 mm	0.35 b	3.50 a	0.21 a	2.78 b
	60 mm	0.30 b	2.25 a	0.16 a	1.76 b
	100 mm	0.15 b	2.25 a	0.07 a	1.24 b
3 ²	No grass	2.50 a	28.0 a	0.97 a	10.1 a
	20 mm	1.60 b	16.3 a	0.97 a	7.30 ab
	60 mm	1.15 bc	13.8 a	0.46 a	5.42 b
	100 mm	0.60 c	4.75 a	0.28 a	5.85 b
4 ²	No grass	3.05 a	16.3 a	0.34 a	12.2 a
	20 mm	2.80 ab	20.8 a	0.68 a	12.2 a
	60 mm	1.95 bc	21.3 a	0.81 a	15.4 a
	100 mm	1.47 c	22.5 a	0.50 a	10.0 a
5 ²	No grass	4.40 a	20.8 a	3.43 a	12.0 a
	20 mm	3.30 a	18.5 a	1.61 b	10.5 a
	60 mm	1.45 b	18.8 a	1.27 b	9.5 a
	100 mm	1.30 b	23.5 a	2.36 ab	14.2 a

¹Within each harvest, different letters indicate significant difference at $P < 0.05$.

²The lactic acid method was used at this harvest

DISCUSSION

Plants compete for scarce resources and in a multi-species environment this competition is both intra- and inter specific. The scarce resource in the experiments reported here is access to radiation. Competition from pasture significantly retarded thistle development in both years and the effects were greatest when ryegrass exerted the most competition. Similar results were obtained by Ang et al. (1994) and Hartley et al. (1984). In field situations stock will graze young Californian thistle shoots if the stocking rate is high enough (Hartley et al. 1984) but these experiments indicate that by leaving higher pasture residues fewer shoots will develop. These two contrasting grazing management strategies offer opportunities to control Californian thistle, but can not be applied simultaneously, since hard grazing implies high pasture utilisation and low residue levels after grazing. Additional advantages of leaving higher residues are that pasture production will be higher, fewer gaps in the sward will restrict the development of other weeds and soil moisture retention will be improved. Preventing Californian thistle shoots developing is potentially a better form of weed control than reliance on grazing animals to remove the shoots that have developed.

In the 2000/01 experiment the lack of a pasture or thistle response to fertiliser application indicates that soil fertility levels were more than adequate and not growth limiting. It is unlikely that this fertility level gradually declined over time with all clippings being returned. The nitrogen added to the crates at 6 - 8 weekly intervals only increased the nitrogen pool which was already more than adequate.

The large increase in the number of subterranean shoots from the third harvest on in the 2001/02 experiment was an artefact of the use of the lactic acid method on subterranean material. This indicates that Californian thistle buds can be identified at a growth stage far less developed than was previously possible.

ACKNOWLEDGEMENTS

This work was instigated by Drs Dave Leathwick and Graeme Bourdôt. The assistance of Geoff Hurrell in demonstrating the lactic acid method for identifying early development stage buds is acknowledged.

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