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Direct control of *Hieracium* using fertiliser and trace element products

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Abstract

Various fertiliser and trace element products were applied to small plots (10 m^2) dominated by *Hieracium* species (predominantly *Hieracium pilosella)* in Central Otago. The object of this study was to assess whether any fertiliser product had any "direct control" effect on *Hieracium*. Originally, 30 treatments were applied to a series of replicated small plots. At the sites studied, the boron compound Fertiliser Borate FB48 was the only treatment to display directly control on *Hieracium*. Further research has since concentrated on using boron as a control method. Twenty-three sites in total have developed along this theme covering a large range of climate zones (mainly Otago) and soil types, Boron-containing compounds can selectively control *Hieracium* (especially *H. pilosella)* without adversely affecting other plant species present. The timing of treatments and evenness of application is critical. New pasture species can be introduced successfully by traditional methods such as direct drilling and oversowing.

Keywords: boron, direct control, fertilisers, *Hieracium,* seasonal variation, selective control

Introduction

Large areas of the South Island semi arid hill and high country are at threat from the invasion of *Hierucium.* There are numerous possible causes, including rabbits, droughts which are helping this invasive species.

Farmers in the Central Otago region have been particularly concerned with the rapid increase of *Hieracium* (especially *H. pilosella).* Most farmers, regardless of economic viability, are aware of the integral place that fertilisers and oversowing techniques must play in the sustainability of their farming systems. In the late 1980s many were asking if there was any potential to use a fertiliser product to directly control *Hieracium.*

Previous work has been carried out across the Central Otago region to assess the effect of generating greater competition by using improved pasture species (Cossens & Boswell 1993). However, in practice, with overriding factors such as prolonged drought and rabbits, competition is often retarded, leaving *Hieracium* to continue its invasion.

It was assessed that there is some place for a 'direct control' option. This report covers the potential of fertiliser and trace element products to directly control *Hieracium.*

Methods

Project aims

In mid 1990 a trial design was formulated based on two main objectives:

1. To ascertain if any simple (one fertilising element only, e.g. phosphorus) or complex (two or more fertilising elements had any *direct* effect on *Hieracium* by way of killing or retarding its growth.
2. The duplication of any successful treatment in conjunction with the re-introduction of 'improved' pasture species in order to return the treated area to a productive pastoral system.

Initial site selection

The first trial site was laid down at Little Valley Station near Alexandra (Central Otago) (soil group yellow-grey earth, MAF soil test levels - pH 5.6, P 48, S 9,350 mm rainfall per annum). A random small plot design (10 m^2 plots) was used.

In March 1991 the above design was duplicated at another site in the Nevis Valley (west of Cromwell) in order to ascertain climate variations (soil group yellow-grey earth, MAF soil test levels - pH 5.1, P 37, S 2,875 mm rainfall per annum).

Both sites were selected according to a visual assessment of *Hieracium* (estimated 80% plus of ground cover). All sites were almost entirely dominated by *H. pilosella.*

Initial treatments

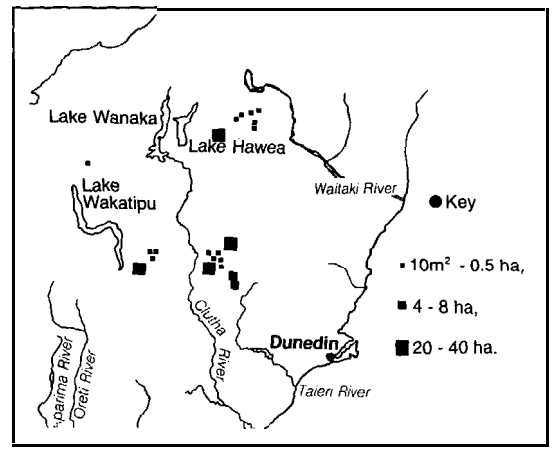
A total of 30 treatments were applied (2 replicates of each) at both of the sites. The treatments included superphosphate (0-9-0- 11) at 4 sowing rates: 11, 22, 44 and 66 kg P/ha (125, 250, 500 and 750 kg/ha). Triple super (0-20-O-l) and reactive phosphate rock (0- 14-0-1) were both sown at the same rates of phosphorus as that of the three higher rates of superphosphate, i.e. 22,

superphosphate, i.e. 22, 44 and 66 kg P/ha. DAP (18-20-0-1), sulphate of ammonia (21-O-O-24) and 50% sulphur super (0-5-O-50) were applied at 2 rates, 250 and 500 kg/ha. 22% sulphur super (0-8-O-22) was applied at 250, 375 and 500 kg/ha. Urea (46-O-O-O) was applied at 125 kg/ha, elemental sulphur at 125 and 250 kg/ha, sulphate of iron at 125 and 250 kg/ha, sodium molybdate at 150 and 250 g/ha, fertiliser borate at 125 kg/ha, zinc sulphate at 125 kg/ha, hydrated lime at 250 kg/ha and control.

Measurements

Because the project aimed to dramatically reduce the *occurrence* of *Hieracium* within the plots, a simple visual assessment of the percentage of ground cover by use of photographic techniques was used as the form of comparison. Extensive photographic records have been kept of all sites.

Figure 1 Trial sites.



Trial expansion

After spring (1991) assessment of the two sites described above, all future trials were focused around the use of boron compounds. Future trials used various sowing rates and timing of applications.

The next small plot trial was laid down in October 1991 and consisted of 20 treatments. Four rates of boron were used, applying 2, 4, 7.5 & 15 kg/ha of elemental boron (12.5, 25, 50 and 100 kg/ha of Fertiliser Borate FB48 (disodium tetraborate pentahydrate)) both alone and in combination with 3 different basal fertiliser treatments (superphosphate, 22% sulphur super, 50% sulphur super) and lime.

The trial programme was then expanded into a more commercial scale. The entire research project now consists of a total of 23 sites (Figure 1), 9 small plot sites, six 0.5 ha plot sites ground applied, one 4 ha and one 8 ha plot ground applied and six 20 ha & 40 ha plots aerial, spread over a wide range of soil types and climate zones (Tables 1 and 2).

Seeds of Grasslands Tahora white clover, alsike clover, Grasslands Maku lotus, Grasslands Wana

Table 1 Site information.

Site Number	Date Treated	Site Name	Plot Size	Estimated Rainfall (mm)	Altitude (ASL)
1	22.12.90	Little Valley 1	10 m²	350	670 m
2	25.03.91	Nevis 1	IO m²	a75	770 m
3	13.06.91	Little Valley 2	0.5 ha	350	670 m
4	07.08.91	Omarama (CI)	0.5 ha	600	540 m
5	16.08.91	Omarama (W1)	0.5 ha	550	460 m
6	10.09.91	Omarama (T1)	10 m²	600	530 m
7	26.09.91	Little Valley 3	10 m²	350	650 m
a	26.09.91	Little Valley 4	0.5 ha	350	700 m
9	07.10.91	Nevis 2	10 m²	a75	770 m
IO	26.03.92	Little Valley 5	20 ha	350	700 m
11	26.03.92	Little Valley 6	40 ha	325	460 m
12	30.03.92	Millers Flat	20 ha	800	610 m
13	30.03.92	Lammerlaw	40 ha	700	670 m
14	01.04.92	Lindls	20 ha	1125	950 m
15	07.04.92	Little Valley 7	10 m²	350	670 m
16	07.04.92	Omarama (T2)	IO m²	600	530 m
17	09.04.92	Nevis 3	10 m²	a75	770 m
18	11.04.92	Nokamai	40 ha	950	a50 m
19	18.05.92	Glenorchy	10 m²	1750	600 m
20	20.05.92	Omarama (C2)	0.5 ha	600	540 m
21	21.05.92	Omarama (W2)	0.5 ha	550	460 m
22	03.06.93	Little Valley 6	8 ha	625	a20 m
23	30.05.94	Little Valley 9	4 ha	625	620 m

Table 2 Grouped site soil data (pre-treatment).

Site Group	Soil Group	Ranges		
		pH	P	S
Little Valley	YGE	5.2-5.7	12-48	6-20
Nevis	YGE	5.1-5.5	30-37	2
Omarama	Upland YBE	5.2-5.8	24-31	3-8
Lindis	Upland YBE	5.5	20	3
Glenorchy	Upland YBE	5.1	10	2
Millers Flat	YGE	5.2	18	3
Lammerlaw	Upland YBE	5.1	8	9

cocksfoot and Massey Basyn Yorkshire fog have been applied to a number of sites by methods such as oversowing and direct drilling.

Results and discussion

Initial results

Out of the 30 original treatments (applied in late 1990) the application of boron in the form of Fertiliser Borate FB48 was the only one to retard the growth habit of *Hieracium*. By the spring of 1991 photographic evidence showed the above ground portion of *Hierucium* within the boron plots to be totally desiccated (Figure 2). No other treatment had this effect.

Some treatments, especially nitrogen, appeared to visually enhance the dry matter production from *Hierucium*. This would appear to be similar to the effects experienced in past fertiliser and oversowing trials (Cossens & Boswell 1993).

Application rates

The direct effect on the *Hieracium* in each plot was consistent with the application rate of boron (Table 3). There was no superior effect on the control of *Hieracium* by adding basal fertilisers.

Table 3 Effect of boron application rate as a percentage of *H. pilosella* ground cover on two sites in Central Otago – Little Valley (Site 15) and Nevis (Site 17).

	Application rate of Fertiliser Borate FB48 (kg/ha)				
	0	12.5	25	50	100
Site 15	80	70	60	40	20
Site 17	70	60	50	30	10

A wide variety of application rates have been used from 1-37 kg/ha of elemental boron. In the drier climates (during dry seasons) 4 kg/ha of elemental boron (25 kg/ha of Fertiliser Borate FB48) gave reasonable control (both initially and ongoing). As rainfall increases, so does the requirement for boron (Table 4). The trials show that in 600-1000 mm rainfall areas 7.5 kg/ha of elemental boron (50 kg/ha of Fertiliser Borate FB48) will give reasonable control. The commercial cost of this rate would be approximately $60/ha.

Figure 2

(a) *H. pilosella* control.

(b) *H. pilosella* treated with Fertiliser Borate FB48.

Table 4 Effect of boron application rate as a percentage of *H. pilosella* ground cover at a low rainfall site (375 mm/annum) and a high rainfall site (1750 mm/annum).

	Application rate of Fertiliser Borate FB48 (kg/ha)			
	0	25	50	100
Low rainfall	80	60	40	20
High rainfall	70	70	60	40

Timing

Duplication of the various applications rates have been carried out in all four seasons. The recommendation is that boron should be applied during the months of

February to May. Results from spring applications have generally been poor (Table 5). Further research is required in order to ascertain why treatment 'post flowering' is most effective.

Table 5 Effect of timing of application of 50 kg/ha of Fertiliser Borate FB48 as a percentage of *H. pilosella* ground cover

Time of application	% cover of *H. pilosella* Pre-treatment	6 months	12 months
Spring	80	60	70
Autumn	80	30	30

Application method

Precision application is required in order to achieve the appropriate application rate.

Control of *Hieracium* from boron applied by aircraft was not statistically significant (through no fault of the operator). This was confirmed by the statistical analysis used by Landcare Research New Zealand Ltd under contract to Southfert. Cover and frequency of plant species was measured by quadrat and point intercept methods on two of the 20 ha aerial applied sites. This response is likely for two reasons. Firstly 4 kg/ha elemental boron was applied. Owing to increased seasonal rainfall, this was insufficient to have a major effect on *Hieracium* cover (as in small plot trials of the same period). Secondly, varying contours within sites meant that there was a dilution effect due to contour, i.e. as the degree of slope increased, the true application rate decreased. Aerial application of fertiliser is based on a 'flat survey' to sloping ground. This can mean that there can be up to 20% more 'true' area than there may appear on a 'flat survey' basis. Experience from the small plots suggest that this is sufficient to markedly dilute the response. This is probably a greater factor than is the physical movement of boron down the slope. Further research is required, however, to substantiate this.

Consequently, groundspreading is the most desired method of application as the spreading can be more closely controlled.

Boron toxicity

It was assumed that the rate of boron required to control *Hieracium* would also cause toxicity problems for other plants, but *Hieracium* appears to show far less tolerance to boron than most if not all other plants (both resident and introduced) within the extensive pastoral systems that *Hieracium* is commonly found. The apparent flexibility of application rate is much greater than we would have expected. Even at excessive application rates (greater than 20 kg/ha elemental boron) no long term effect was evident on other plant species.

Caution must, however, be exercised especially with regards to the toxic effect that boron can have on germinating seeds (During 1984). Introduction of new species, whether by oversowing or direct drilling is best carried out in the spring following the autumn boron treatment.

Oversowing

Both oversowing and direct drilling techniques have been used to introduce new pasture species, e.g. Tahora white clover, Alsike clover, Maku lotus, Wana cocksfoot and Massey Basyn Yorkshire fog. The success of oversowing is affected by seasonal climatic patterns, more so than any other factor.

The introduction of new pasture species by direct drilling has been particularly successful to date even in very dry seasons. Half of the original small plot sites at Little Valley were direct drilled 9 months (September 1991) after initial treatment. Legumes in all plots except that of the boron treatment showed very slow establishment. Conversely the boron-treated plots showed a much greater rate of establishment. This was largely due to less competition (from *Hieracium)* for available moisture (Wills et *al.* 1993).

***Hieracium* regrowth**

In most cases where *Hieracium* was controlled physically, some regrowth occurred, generally coinciding within the October to December period. This regrowth, however, was never as active as that of the *Hieracium* within control areas. The most interesting observation with *Hieracium* regrowth is that it again dries off in the autumn/winter period in a very similar manner to the original response.

The boron treatment displays a residual effect on *Hieracium*. The original plots (now four seasons old) are still showing ongoing control.

Variation

Not all trial sites have been successful. A small number concentrated in the Omarama area have shown only small responses, and some none at all, to the boron treatments. All three sites are situated on upland yellow-brown earths with base MAF soil test levels of pH 5.2-5.8, P 25-31, S 2-6. Base fertility levels are within the ranges of all other sites. The soils within these sites do, however, contain higher levels of aluminium than do the soils on all other sites. Further research is required to ascertain whether this is a contributing factor to the success or failure of boron treatments on *Hieracium*.

Conclusions

- Out of 30 different fertiliser treatments, the application of boron was the only one to display a *direct* control effect on *Hieracium*. Boron can dramatically retard the growth of *Hieracium* (especially *H. pilosella*) and if applied at sufficient rates, can totally kill it.
- Boron can selectively control *Hieracium,* i.e. *Hieraciutn* shows less tolerance than do all other plant species observed within the extensive pastoral systems of Central Otago.
- The trials have shown that there is seasonal variation to treatments. Treatment must be carried out between February and May.
- New pasture species can be successfully introduced into a treated area even with high rates of boron application. Direct drilling techniques have been particularly successful.
- Boron as a control method for *Hieracium* displays a residual effect with the possibility of control for at least 4 years.
- The original successful small plot treatments can and have been duplicated on a commercial scale. The response obtained can vary with application method, groundspreading techniques being the most effective to date.

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