ALLELOPATHY OF MOUSE-EAR HAWKWEED

W. MAKEPEACE

Botany Department, University of Canterbury

Summary

The vegetative expansion and allelopathic potential of mouse-ear hawkweed (*Hieracium pilosella*) are investigated. Mouse-ear hawkweed is expanding vegetatively into fescue tussock (*Festuca novae-zelandiae*). Leaf material of mouse-ear hawkweed is shown to be allelopathic to cocksfoot (*Dactylis glomerata*) and white clover (*Trifolium repens*) in the laboratory.

INTRODUCTION

Mouse-ear hawkweed (*Hieracium pilosella*) is a drought tolerant perennial which has become increasingly common in high country short tussock grassland during the past 25 years. Originally recorded near Ashburton ca 1919, this adventive is now found in both the North and South Islands, chiefly in grazed land and open sites on the poorer soils of the yellow-brown earth and grey-brown earth series. It is most common in Central Marlborough, Canterbury high country, and the Te Anau region, especially on the drier sites where it forms extensive mats of leaves and stolons virtually excluding all other vegetation (Anon 1976, Healy 1970). Although present in Otago, it is apparently absent from the most arid regions.

The means by which mouse-ear hawkweed was introduced to New Zealand is not known although impure seedlines are highly suspect. Early records indicate a coastal establishment followed by a gradual spread to inland areas. The apparently rapid population increase of this species in recent years may be a consequence of increased seed production following the reduction in rabbit numbers during the early 1950s. Watt (1962) noted marked increases in flowering, seed production, and establishment of mouse-ear hawkweed in Britain following the myxomatosis epidemics in the rabbit population.

In well-established mouse-ear hawkweed patches, virtually all improvement species are absent. Of the native flora, the mat-forming *Coprosma petriei* and fescue tussock (*Festuca novae-zelandiae*) are the only well-represented species although even the tussocks are being eliminated in some areas.

Allelopathy is the term coined by Molisch which refers to any direct or indirect harmful effect by one plant on another through the production of chemical compounds that escape into the environment (Rice 1975). Allelopathic effects of hawkweeds have been observed in a variety of communities outside New Zealand (Becker and Guyot 1951; Davies and Maravalo 1973; Duquenois *et al* 1956; Guyot 1957; Thomas and Dale 1974; Watt 1962).

This paper presents an investigation of the vegetative expansion of mouse-ear hawkweed into fescue tussock grasslands and the allelopathic potential of mouse-ear hawkweed leaf material on germination of two improvement species.

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MATERIALS AND METHODS

1. Heights of fescue tussocks in the study area at the Wolds Station, Mackenzie Country were measured in mouse-ear hawkweed-dominant and fescue tussock-dominant sites about 10 m apart to demonstrate the effect of mouse-ear hawkweed on tussocks. Annual stolon production (number and length) of reproducing mouse-ear hawkweed was recorded at the same sites to compare their respective population dynamics.

2. Preliminary investigations indicated that the potential allelochemicals in mouse-ear hawkweed are phenolics which escape from senescing leaves. Leaves were harvested from plants growing in the study area and on return to the laboratory, air dried for 6 weeks, ground, and 0.5 g placed in a petri dish beneath a germination paper on which test seed was germinated. Each dish received 15 ml of distilled water. Treatments were replicated 3 times with 100 seeds per dish. Cocksfoot (*Dactylis glomerata*) was germinated at 25°C and white clover (*Trifolium repens*) was maintained at 20°C. Germinated seeds were removed daily. Total germination was recorded after 7 days.

3. An additional experiment on the effect of mouse-ear hawkweed leaf material on white clover radicle extension was arranged. Ten germinated white clover seeds per replicate were placed on test paper in petri dishes containing 0.2 g of mouse-ear hawkweed beneath germination paper moistened with 15 ml of distilled water. Radicle extension was recorded after 12 days at 20°C.

RESULTS AND DISCUSSION

The results of field work (Section 1) are presented in Table 1. Fescue tussocks are significantly shorter in the mouse-ear hawkweed-dominant site. Remains of fescue tussocks were evident on hummocks occupied by mouse-ear hawkweed. These features indicate a decline in the vigour and population size of fescue tussock where mouse-ear hawkweed has surrounded the tussocks.

TABLE 1: SOME VEGETATION CHARACTERISTICS OF MOUSE-EAR HAWKWEED AND FESCUE TUSSOCK IN THE STUDY AREA (WOLDS STATION, MACKENZIE COUNTRY)

Stand type	Tussock height	Site of measurement	% of reproducing mouse-ear hawkweed		Stolon length
			With Stn.	Without Stn.	
Fescue dominant	39 ± 7 cm	Centre to edge of tussock	95	5	1.7 ± 1.6 cm
Mouse-ear hawkweed dominant	20 ± 6 cm	Centre of mouse-ear hawkweed colony	6	94	0.4 ± 0.1 cm
(mean ± s.d.)			(mean ± s.d.)		

Stolon production of mouse-ear hawkweed is greatest in the more vigorous rosettes. Such individuals occur most frequently in the outer 10-30 cm of the colony (i.e. the expanding zone). The figures in Table 1 indicate that vegetative expansion of mouse-ear hawkweed is occurring within the tussocks. This behaviour suggests that the tussocks are not able to offer as much shoot competition as might be expected. Once stolons have entered a tussock, rosettes develop which will give rise

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to new stolons consolidating the mouse-ear hawkweed cover. Adventitious roots produced by these rosettes can be traced among the fescue tussock tillers. Examination of soil profiles through tussocks shows mouse-ear hawkweed to be producing a root system that extends above and below that of the fescue tussocks. Only *Coprosma petriei*, which has a deeper root system than mouse-ear hawkweed, persists in these older colonies.

The results of the allelopathy experiments (Sections 2 and 3) are presented in Table 2. The germination of cocksfoot is strongly inhibited by mouse-ear hawkweed leaf material. White clover, a faster germinating species, was not significantly inhibited by this treatment. The experiment was repeated with the germination paper and leaf material being moistened 24 hours before the seed was placed in each dish. A similar result as before was obtained.

TABLE 2: ALLELOPATHIC INHIBITION OF COCKSFOOT AND WHITE CLOVER BY MOUSE-EAR HAWKSWEED LEAF MATERIAL

Species	% Germination	Radicle length (mm)
Cocksfoot, control	25	—
Cocksfoot, with leaf material	8 *	—
White clover, control	76	11.7
White clover, with leaf material	61 ns	5.2 *

Levels of significance

* = $p < 0.001$

ns = $p > 0.05$ (not significant)

Radicle extension of white clover was found to be severely checked and damage to the root apices occurred in over half of the seedlings.

The possibility of differing osmotic stress between the treatments and controls producing the effects described, was considered but ruled out on the basis of the degree of osmotic stress tolerance of the test species (W. Makepeace, unpublished data).

CONCLUSIONS

Mouse-ear hawkweed is expanding vegetatively by stolons into tussocks. Field evidence indicates that this invasion has resulted in a decline and local elimination of fescue tussock and that this process is still continuing. This change results in a reduction in the number of favourable microhabitats afforded by tussock cover, a factor of considerable importance in determining the survival of intertussock species. The allelopathic potential of senescent mouse-ear hawkweed leaves is an additional factor contributing to the success of this species in dominating large areas. It must also increase the difficulty in establishing preferred grasses and clovers.

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