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SHORT COMMUNICATION

SOIL pH DECLINES AND ORGANIC CARBON INCREASES UNDER HAWKWEED *(HIERACIUM PILOSELLA)*

Summary: Changes in soil chemistry in relation to hawkweed *(Hieracium pilosella)* presence were determined at a site receiving less than 600 mm rainfall where hawkweed was colonising Pallic Soils (yellow-grey earths). pH was significantly lower (by 0.5 units) and organic carbon values were significantly higher (0.7% absolute, 40% relative) within hawkweed patches than in adjacent soil, but there was no significant difference in total nitrogen. These differences are attributed to the change from sparse vegetation dominated by ephemeral annual plant species to continuous vegetation dominated by a perennial.

Keywords: hawkweed; plant-soil relationships; soil carbon; soil pH; soil nitrogen.

Introduction

There are few published accounts of the relationship of soil characteristics of a site to the presence of hawkweed *(Hieracium pilosella* L.) in New Zealand (e.g., Makepeace, 1985; Treskonova, 1991), but some studies have assessed the effects of fertiliser application on hawkweed growth and competitiveness (e.g., Pollock, 1989; Scott and Covacevich, 1987; Scott, Robertson and Archie, 1989; Scott, Robertson and Burgess, 1990). This short communication reports the results of an analysis of soil chemistry in relation to the presence or absence of hawkweed in an area where hawkweed cover is rapidly increasing.

Methods

A site with significant but patchy hawkweed cover on Glencaim Station (NZMS 260 H39 827490), near Twizel in the Mackenzie Basin, was chosen for study. It is located on soils developed in greywacke loess over fan alluvium, mapped by N.Z. Soil Bureau (1968) as yellow-grey earths, now defined as Pallic Soils (Hewitt, 1992). The site receives approximately 500-600 mm annual rainfall (B. Aubrey, Glencaim Station, *pers. comm.)*. These drier Pallic Soils appear particularly susceptible to hawkweed colonisation (Hunter, 1991). The site has never received fertiliser.

Twelve soil samples 0-7.5 cm deep were taken from the centre and beyond the perimeter of each of 10 hawkweed patches. Organic carbon (C), total nitrogen (N), and pH (in H_2O) in the 0-2 mm fractions were determined by standard methods used by Invermay Agricultural Centre, AgResearch, Mosgiel, New Zealand.

Differences in soil parameters within and outside hawkweed patches were statistically compared by paired value t-test.

Results

Mean values for pH, C and N within and outside hawkweed patches are given in Table 1. Soil pH was significantly $(P < 0.0001)$ lower, and C significantly $(P < 0.005)$ higher, within hawkweed patches than outside them, but there was no significant difference in N.

Discussion

In the absence of hawkweed, vegetation at this site comprises sparse cover of annual herbaceous species and perennial grasses. There is a high

Table 1: *Mean values for pH. organic* C *and total N from within and outside hawkweed patches. Glencairn. Significance levels* (P) *are given.*

	pH	C (%)	N (%)
Within patch	5.90*	2.42*	0.186
Outside patch	6.37*	1.73*	0.161
P	<0.0001	0.0013	0.0677

proportion of bare soil (R.B. Allen, *unpub. data)*.

The possibility that the distinctive soil properties (lower pH and higher C) under hawkweed patches are related to a previous vegetation pattern and therefore unrelated to hawkweed presence requires consideration. No independent data are available for the spatial variability of soil C, but in 1979,56 adjacent 2 x 4 m plots, within 50 m of the present site, were sampled at 0-7.5 cm depth and analysed for soil pH, prior to laying down of a fertiliser trial described by McIntosh, Sinclair and Enright (1985). Of these plots, only 2 pairs of adjacent plots had a pH difference exceeding 0.2 units. In addition the mean pH in 1979 was 6.43, with no plot having a pH lower than 6.1.

These pH data indicate that it is unlikely that discrete patches of naturally lower soil pH exist at the site, or that hawkweed has preferentially selected these areas. Rather, it appears that hawkweed establishment is random or governed by factors other than pH, and that hawkweed has lowered pH after establishment.

We suggest that soils under hawkweed patches have higher soil C than adjacent soils because hawkweed is a perennial plant and returns more organic carbon to the soil by leaf and root death than does the surrounding, sparse, and predominantly annual, flora. Soil acidification could have occurred through organic acid production under hawkweed and/or greater cation uptake by hawkweed than the adjacent vegetation. The relative importance of these mechanisms requires further investigation.

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