Effect of lime on the persistence and production of two chicory cultivars on an acid soil.

R.C. Hayes, B.S. Dear and G.D. Li
E.H. Graham Centre for Agricultural Innovation
E H Graham Centre for Agricultural Innovation (NSW Department of Primary Industries and Charles Sturt University), Wagga Wagga Agricultural Institute, Wagga Wagga, NSW 2650.
Cooperative Research Centre for Plant-based Management of Dryland Salinity, 35 Stirling Highway, Crawley, WA 6009.

Introduction

Chicory (*Cichorium intybus*) is a pasture herb identified as a possible alternative to lucerne (*Medicago sativa*) for southern farming systems. It establishes readily and provides forage of high quality without the animal health risks of bloat and redgut associated with lucerne. A limitation of chicory is its strong winter dormancy. This poses a problem when chicory is included in a pasture mix with winter active species. Heavy grazing of summer active chicory in winter months can lead to significant plant damage and mortality (Li and Kemp 2005). The production and persistence of more winter active varieties of chicory has not been evaluated under Australian conditions.

Chicory is considered to be more tolerant of acidic soil conditions than lucerne although the extent of this tolerance has not been quantified. Lime is commonly used to ameliorate soil acidity, but little work has been done on the response of chicory to the application of lime. The following study investigated the performance of two chicory cultivars that differ in their seasonal pattern of growth, on an acid soil with and without the addition of lime.

Materials and Methods

A field experiment was sown at Binalong, southern NSW (34°33.52'S, 148°42.08'E) on 28 May 2004. Two chicory cultivars, Grasslands Puna (Puna) and the more winter active Inia Le Lacerta (Lacerta) from Uraguay, were sown in alternate plots each 2 x 21 m, and replicated 10 times. The soil pH_{CaCl2} was 4.3 in the surface 10 cm with 16% exchangeable aluminium. Half of each plot had 2.8 t/ha lime incorporated into the soil surface which increased the pH to 5.3 and decreased the exchangeable aluminium to <2%. Sowing rates of Puna and Lacerta were 6 kg/ha and 12 kg/ha respectively, the latter sown at double the seeding rate based on a low germination percentage reported on the label.

Plant density was counted using a 0.1 m² quadrat in July of the establishment year, then on another three occasions during the next two years. Herbage yield and botanical composition were visually assessed with appropriate calibration on seven occasions during the experiment, the trial being mowed after each assessment. Following the appearance of boron (B) deficiency in leaves, four composite samples of above-ground herbage, two from limed plots and two from unlimed plots, were sent for mineral composition analysis using Inductively Coupled Plasma Atomic Emission Spectrometry (ICPAES) which indicated B was likely to be deficient. Borax was therefore applied to all treatments with a boom spray at a rate equivalent to 29 kg B/ha on 3 March 2005, three weeks prior to the third herbage yield assessment.

Results

Lacerta established at double the density of Puna, but by winter of the second year both cultivars had declined in density to a similar level (Figure 1). Herbage yield differed with significant interactions between lime treatment and time of measurement and between cultivar and time of measurement (Table 2), but there was no 3-way interaction between cultivar, lime treatment and time of measurement. Lecerta yielded more than Puna at five of the seven harvests

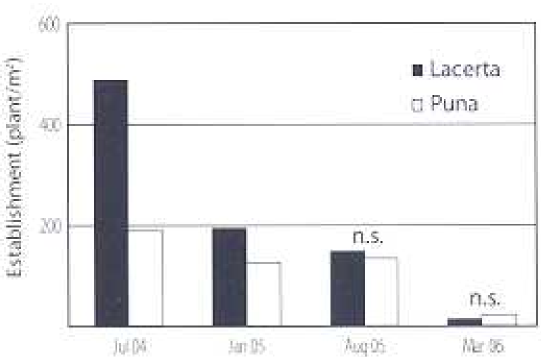

Figure 1 Change in density (plants/m²) of two chicory cultivars with time. n.s. – no significant difference in plant density between the two cultivars (P<0.001).

Table 1 Effect of lime and cultivar on total chicory herbage yield (kg/ha). Values with the same letter are not significantly different ($P<0.001$).

Treatment	Sampling time						
	Nov 04	Dec 04	March 05	Aug 05	Sept 05	Oct 05	Jan 06
Unlimed	2917^{e}	4696^{a}	1048^{i}	1069^{i}	2351^{f}	2934^{e}	3074^{e}
Limed	2555^{cd}	4802^{a}	1654^{f}	1318^{i}	2776^{de}	2791^{de}	4192^{f}
Lacerta	3459^{f}	5106^{a}	1327^{i}	1814^{i}	3316^{ef}	2668^{c}	4354^{b}
Puna	2014^{i}	4392^{a}	1374^{i}	574^{k}	1811^{i}	3056^{f}	2913^{de}

during the experimental period, with Puna yielding more on only one occasion, October 2005. ICPAES analysis of above ground herbage indicated that B content decreased with the addition of lime from 27–32 mg/kg in unlimed treatments to 12–17 mg/kg in limed treatments.

Discussion

Little is known of the B requirements of chicory. However, signs of B deficiency in the shoots of plants from the same Asteraceae family, celery (*Apium graveolens* L.) and lettuce (*Lactuca sativa* L.), can become evident when the concentration of B reduces to less than 20 mg/kg (Reuter and Robinson 1997). The low B values observed in the chicory shoots from the limed treatments suggest that lime induced B deficiency may be an explanation for the suppressed growth of chicory in the limed plots prior to the application of borax. B deficiency in soils is widespread across the high rainfall zone of eastern Australia (Jackson and Chapman 1975) and has been shown to inhibit the production of other pasture species such as subterranean clover (*Trifolium subterraneum* L.) (Dear and Lipsett 1987). Further work is warranted to quantify the B requirement of chicory.

Winter active chicory cultivars such as Lacerta are not readily available to Australian growers, but this experiment demonstrated the potential they have in local farming systems, particularly in terms of increased herbage production in the first two years after establishment. Yields, particularly in August and September 2005 show that with similar plant densities, the winter active variety can produce twice the biomass of Puna. It is also interesting to note that despite significant differences in plant density at establishment which are attributed to differences in sowing rate, both varieties declined to a similar density within the first year.

References

Dear, B.S. and Lipsett, J. (1987). The effect of boron supply on the growth and seed production of subterranean clover (*Trifolium subterraneum* L.). *Australian Journal of Agricultural Research* **38**, 537–46.

Jackson, J.F. and Chapman, K.S.R. (1975). The role of boron in plants. In Trace Elements in Soil-Plant-Animal Systems. Eds D.J. Nicholls and A.R. Egan pp. 213–25. Academic Press: New York.

Li, G.D. and Kemp, P.D. (2005). Forage chicory (*Cichorium intybus* L.): A review of its agronomy and animal production. *Advances in Agronomy* **88**, 187–222.

Reuter, D.J. and Robinson, J.B. (1997). 'Plant Analysis an Interpretation Manual' second edition. CSIRO Publishing; Collingwood.