Successful establishment of oversown chicory and plantain on uncultivatable hill country

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Introduction

All-year grazing of livestock on steep, non-arable hill country (>20° slope angle, <1,000 m elevation) is a significant feature of New Zealand agriculture. Hill country pastures are in various states of improvement depending on factors such as extent of subdivision, fertiliser inputs, plant species introduction, and grazing management. Numerous introduced grass, legume and herb species are available to match the many micro-sites in steep hill country (Kemp *et al.* 1999).

There has been increasing use of the perennial herbs chicory (*Chicorium intybus* L.) and plantain (*Plantago lanceolata* L.) in seed mixtures used on a range of topographies, mostly flat to undulating terrain. Advantages of these species include tolerance of drought and high summer temperatures, highly palatable foliage, enhanced mineral content, and high animal growth rates (Stewart 1996; Li and Kemp 2005). Farmers have sown these species on hill country but there is negligible information on their establishment in such landscapes. As part of a large, New Zealand-wide programme to increase pasture productivity on non-arable hill country through new germplasm introduction, chicory and plantain were included in a seed mixture broadcast-sown at a range of sites. This paper reports on the seedling establishment of these two species.

Methods

Sites

Trials were conducted in four geographically and climatically distinct environments comprising summer wet (Ngaroma, South Waikato; 236 mm average rainfall in summer (December to February)), summer dry (Poukawa, Hawke's Bay; 113 mm), and summer moist (Woodville, southern Hawke's Bay; 177 mm) in the North Island and summer dry (Cheviot, North Canterbury; 127 mm) in the South Island. Average soil water deficits in summer range from 28 mm (Ngaroma) to 45 mm (Cheviot). Sites were selected that had slope angles averaging >20° and moderate to high soil nutrient status, *e.g.* pH >5.7, Olsen P > 15 ug/g.

Treatments and seed mixture

At each site, there was a "time of sowing" treatment (other treatments not presented) comprising spring 2011 or autumn 2012, which was evaluated on north (N) and south (S) aspects. Chicory cv. Choice (0.5 kg/ha, 92% germination) and plantain cv. Tonic (0.5 kg/ha, 90%) were the only herbs in a grass/legume/herb seed mixture which was broadcast by hand at 28 kg/ha. On each aspect, treatments were arranged in four randomised complete blocks and plots (experimental units) were 10 m x 10 m. Plots were sprayed with glyphosate (3 litres a.i./ha) 7-10 days before sowing to kill resident swards, and livestock (500 sheep/ha for 3 hrs) were used to trample seed after sowing to increase seed-soil contact.

Measurements and analysis

Soil temperature (2 cm depth; daily) and volumetric soil water content (VSWC up to 12 cm depth; sowing and every 1-3 weeks) were measured. Seedlings were counted 6 weeks after sowing in 10 x 0.2 m^2 quadrats per plot. Data were expressed as seedlings/m^2 and the percent establishment of each herb species was calculated as percentage of viable seed/m^2. Data were subject to analysis of variance.

Results

Across all sites, soil temperature within the first 6-8 weeks after sowing was generally within the range of 15-20°C in both spring and autumn. For example, in March 2012 on the N aspect, daily temperature averaged 17.8° at Ngaroma, 19.1° at Poukawa, 16.4° at Woodville, and 17.3° at Cheviot. Temperature was 1-3° higher on N than S aspects. VSWC exceeded 25% at both sowing times at all of the four sites and at each site, average content across plots on the S aspect was up to 10 percentage units higher than on the N aspect.

Seedling density, averaged over all sites, did not vary significantly between spring and autumn for chicory (5 vs. 3/m^2) and plantain (6 vs. 4/m^2), but there were considerable differences between sites. At Ngaroma and Woodville, seedling density of both species was 4-8-fold higher after

the spring than autumn sowing (P<0.001), whereas at Poukawa, there was an almost 12-fold greater seedling density of plantain sown in autumn than spring (P<0.001) and no significant difference in density of chicory from either sowing time. Cheviot was the only site where no significant differences in density were found between sowing times. Interactions occurred between aspect and sowing time for densities of plantain at Poukawa (P=0.011) and Woodville (P=0.003), and chicory at Cheviot (P<0.001). For example, at Cheviot, chicory seedling density was higher from autumn than spring sowing on the N aspect (5 vs. 2/m^2; P=0.011), whereas on the S aspect, spring sowing resulted in a higher seedling density than in the autumn (4 vs. 1/m^2; P=0.029).

Percent establishment of plantain across all sites was twice that of chicory sown in spring (26 vs. 13%) and autumn (18 vs. 7%). For each species, there was no significant difference in establishment at each sowing time. At Ngaroma, establishment was higher in spring than autumn (P<0.001) for chicory (18 vs. 4%) and plantain (31 vs. 5%), and this was the only site where no season x aspect interactions were detected for either species. An example of this interaction was for plantain at Poukawa, where establishment on the S aspect was greater from autumn than spring sowing (77 vs. 21%; P<0.001), whereas on the N aspect, the difference in establishment between sowing times was marginal (24 vs. 6%; P=0.059).

Discussion

This is the first quantification of establishment of chicory and the second for plantain, on steep hill country. Our results showed that both species established across the geo-climatic range tested, whether oversown in spring or autumn. Seedling density of plantain was 1.1/m^2 after 6 months when oversown in spring at 2 kg/ha in a seed mixture on a steep S aspect without salt addition (Gillespie *et al.* 2006). In this study, densities were only determined within 6 weeks of sowing, and were higher. Percent establishment values were within the range reported for other oversown species (Milne *et al.* 1993). The variable effects of sowing time and aspect at sites indicate the difficulty of developing general sowing guidelines for these two herbs in hill country.

Conclusion

Oversown chicory and plantain established successfully, but the extent of this depended on site-specific factors.

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