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Establishment and growth of legumes on uncultivable hill country in East coast New Zealand

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Introduction

Steep, non-arable hill country is a significant feature of New Zealand farming (Sheath 2011) and large tracts of it have been improved by over-sowing grass and assorted clover species, particularly white clover (*Trifolium repens* L.). Numerous other legume species are available in New Zealand from similar environments overseas that may be more productive on some steep hill country. Plant breeders in New Zealand have also produced inter-specific hybrids (Williams *et al.* 2010) with potentially useful attributes. As part of a large project to increase pasture production on non-arable hills, a range of legume species were established at 2 sites in New Zealand in 2012. This paper reports results from the first spring and early summer following establishment.

Methods

Sites and management

Trials were conducted on both north and south-facing aspects in 2 summer-dry environments: Poukawa, Hawke's Bay (39°45'57"S, 173°88'32"E), and Cheviot, North Canterbury (42°52'75"S, 173°88'32"E), with 113 mm and 127 mm, respectively, of average summer rainfall (December to February). Slope angle averaged >20° and soils had moderate fertility with pH 5.5. Seedlings were germinated in a glasshouse in March, and transplanted in groups of 10 spaced plants/plot (2 rows of 5 plants, spaced 40 cm apart), in a randomised block design with 4 replicates. The trial areas were sprayed with 5 l/ha of glyphosate (a.i. 360 g/l) prior to transplanting on April 14 at Cheviot and May 2 at Poukawa. Diazinon (2 kg a.i./ha) was topdressed onto the Cheviot south trial on August 29 to control a significant grass grub (*Costelytra zealandica*) infestation, which killed a number of plants. After the first measurement on the Cheviot north trial, it was mowed and sprayed with Haloxypop (30 g a.i./ha) to control grass infestation, while the Poukawa site was lightly grazed with sheep on October 3. No further herbage was removed to allow the annual legumes to set and drop seed.

Treatments and Measurements

Twenty five perennial legumes (cultivars within 13 species and 4 hybrid lines) and 8 annual legumes (7 species,

including 2 subterranean clover cultivars) were planted. All live plants were assessed (Cheviot on August 29 and November 23) and (Poukawa on August 23 and October 29) for percent survival and herbage mass, with scores ranging from 1 (low) to 5 (high). The 10 highest scoring perennial and the 5 highest scoring annual legumes are reported.

Results

Survival at the second assessment

Among the perennial legumes, *Lotus pedunculatus* mean survival (99%) was significantly higher ($P < 0.05$) across all sites than all other legumes. Percent survival of the other 9 perennial legumes reported, consisting of *L. corniculatus*, *T. fragiferum*, 3 *T. repens* and 2 *T. pratense* selections and a *T. repens* x *T. uniflorum* hybrid, did not differ significantly from each other. Of the 5 annual legumes, *T. resupinatum* had the highest mean survival of 85%, which exceeded ($P < 0.05$) *T. vesiculosum* (arrowleaf clover) and the *T. subterranean* cultivars Woogenellup and Denmark, while *T. michelianum* cv. Bolta survival was significantly lower.

Herbage production

Table 1 details the mean plant mass of the top 10 perennial legumes. The 2 red clovers (*T. pratense*), *L. pedunculatus* and the Manawatu white clover selection had significantly higher mean scores than the other legumes. Both North Island white clover ecotypes had higher scores than cv. Nomad. The lotus lines with high survival scores also produced well. Two of the inter-specific hybrids produced well but only one (*T. repens* x *T. uniflorum*) was in the 10 best survivors.

Table 2 shows the mean plant mass of the top 5 annual legumes. *T. resupinatum* had a significantly greater ($P < 0.05$) mean plant mass than the other annual species. *T. nigrescens* (ball clover) was the most site-specific, being highest ranked in both sites at Poukawa and among the two lowest at Cheviot.

Conclusions

In the first spring/summer of this project 2 perennial inter-specific hybrids scored well for plant mass, along with a number of red and white clovers. The *Lotus* species, which

Table 1. Plant mass rankings of the top 10 perennial legumes at Cheviot and Poukawa (north and south aspects) and their mean score across sites (1-5, where 1 = low, 5 = high). The lowest scoring perennial (*T. alpestre*) is included for comparison.

Legume	Site and ranking				Mean score at all sites
	Cheviot north	Cheviot south	Poukawa north	Poukawa south	
<i>T. pratense</i> cv. Relish	2	4	1	6	3.24 a
<i>T. pratense</i> (late creeping selection)	1	3	7	3	3.23 a
<i>L. pedunculatus</i> cv. Trojan	4	1	3	9	3.22 a
<i>T. repens</i> (Manawatu selection)	3	6	2	1	3.19 a
<i>T. repens</i> (Ballantrae selection)	6	7	5	2	2.85 b
<i>L. corniculatus</i> (creeping selection)	8	2	6	11	2.84 b
<i>T. repens</i> x <i>T. occidentale</i> hybrid	5	13	4	5	2.74 bc
<i>T. repens</i> x <i>T. uniflorum</i> hybrid	10	8	8	4	2.68 c
<i>L. corniculatus</i> cv. Goldie	13	5	9	7	2.65 c
<i>T. repens</i> cv. Nomad	7	15	12	15	2.30 d
<i>T. alpestre</i>	25	25	25	24	1.08

Legumes which do not have a letter in common differ at the 5% significance level

Table 2. Plant mass rankings of the top 5 annual legumes at Cheviot and Poukawa (north and south aspects) and their mean score across sites (1-5, where 1 = low, 5 = high). The lowest scoring annual (*T. glomeratum*) is included for comparison.

Legume	Site and ranking				Mean score at all sites
	Cheviot north	Cheviot south	Poukawa north	Poukawa south	
<i>T. resupinatum</i> (Persian clover)	2	1	3	4	3.41 a
<i>T. vesticulosum</i> cv. Cefalu	1	2	2	6	3.23 b
<i>T. michelianum</i> cv. Bolta	4	3	5	2	3.14 bc
<i>T. subterraneum</i> cv. Woogenellup	3	4	4	3	2.95 c
<i>T. nigrescens</i> ssp. <i>nigrescens</i> (ball clover)	7	8	1	1	2.73 d
<i>T. glomeratum</i> (cluster clover)	6	7	8	8	1.69

Legumes which do not have a letter in common differ at the 5% significance level

are not used to a large extent in New Zealand pastures, survived and produced well in this study. The annual Persian and arrowleaf clovers produced large plants, but as with all the annuals the re-establishment from seed will be critical. This paper reports the preliminary results but the evaluation will continue over several years.

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