New Herbaceous Perennial Legumes in Dryland Mediterranean Agroecosystems: Pasture Persistence and Productivity

Viviana Barahona
INIA, Chile

Carlos Ovalle
INIA, Chile

Alejandro del Pozo
Universidad de Talca, Chile

Soledad Espinoza
INIA, Chile

Fernando Squella
INIA, Chile

See next page for additional authors

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Viviana Barahona, Carlos Ovalle, Alejandro del Pozo, Soledad Espinoza, Fernando Squella, Fernando Fernandez, and Macarena Gerding

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Viviana Barahona [A]*, Carlos Ovalle* [A]*, Alejandro del Pozo*[B]*, Soledad Espinoza*[A]*, Fernando Squella* [A]*, Fernando Fernandez* [A] *and Macarena Gerding* [C]

[A] Instituto de Investigaciones Agropecuarias INIA-Chile, www.inia.cl
[B] Universidad de Talca. Facultad de Ciencias Agrarias, Chile, www.utalca.cl
[C] Universidad de Concepción. Facultad de Agronomía, Chile, www.udec.cl
Contact email: covalle@inia.cl

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Introduction

One of the strategies to improve pasture and crop productivity in the Mediterranean zone of Chile has been the introduction and use of annual legumes (del Pozo and Ovalle 2009; Ovalle *et al.* 2010). The growth rate of annual legumes is low during autumn and winter, and the distribution of the biomass production is mainly concentrated in spring when temperatures are moderate and soil water is available. It is hypothesized that perennial deep-rooted legumes can play a key role in improving soil physicochemical characteristics as well as water-use efficiency (Cocks 2001; Dear *et al.* 2003; Ward 2006). In addition, plants with deep roots can uptake nutrients from deeper soil layers in nutrient-deficient soils (McCallum *et al.* 2004) and could improve soil water infiltration.

The objective was to introduce and evaluate the persistence of new germplasm of perennial forage legumes to summer drought in the Mediterranean zone of central Chile.

Methods

Twenty two genotypes of six perennial legume species (*Medicago sativa*, *Hedysarum coronarium*, *Lotus corniculatus*, *L. tenuis*, *Bituminaria bituminosa*, *Cullen australasicum* and *Adesmia* spp.) were evaluated at four Mediterranean environments in central Chile: Litueche (sub–humid coastal dryland, 800 mm annual rainfall, inceptisol); Cauquenes (sub- humid interior dryland, 650 mm, granitic alfisol); Los Guindos (humid interior dryland, 900 mm, granitic alfisol) and Yungay (per-humid Andean foothill, 1000 mm, volcanic andisol). Two-month old seedlings of each genotype were planted in two 3 m-long rows separated by 40 cm and four replicate plots. Plant density was 30 plants/m2. Seedlings were developed in a glasshouse from seeds inoculated and lime pelleted with the appropriate strain of root nodule bacteria. Fertilization free of nitrogen (N) was applied at seedling establishment, using 90 kg/ha of P_2O_5, 2000 kg/ha of $CaCO_3$, 100 kg/ha of K_2SO_4 and 20 kg/ha of boron calcite. Evaluations included: (1) plant persistence measured in autumn of each growing season, by counting plants in the 3-m row; and (2) dry matter production evaluated at the end of each growing season by harvesting the 3-m row.

Results

Plant survival in the first summer period

M. sativa exhibited high survival rates in all genotypes and Mediterranean environments, ranging from 79 - 100% of the plants established at the beginning of the season. *H. coronarium* had a lower survival rate in Litueche, probably due to the higher acidic and clay texture of the soil. Among the *Lotus* species, the two genotypes of *L. corniculatus* presented high survival of plants everywhere, but only one genotype of *L. tenuis* (Maitén) had a high survival rate. The performance of shrub legumes (*B. bituminosa* and *C. australasicum*) was similar, showing high survival rates (76

Table 1. Plant survival (%) (± se) in four Mediterranean environments of Chile during the 2012-2013 growing season.

Species	N	Litueche		Cauquenes		Los Guindos		Yungay		Average
Medicago sativa	9	88	(±11)	96	(±4)	93	(±7)	85	(±14)	91
Hedysarum coronarium	2	69	(±10)	88	(±6)	92	(±3)	89	(±6)	84
Bituminaria bituminosa	2	87	(±8)	98	(±4)	93	(±4)	90	(±11)	92
Cullen australasicum	1	76	(±28)	93	(±11)	96	(±5)	84	(±21)	87
Lotus tenuis	3	61	(±19)	41	(±22)	73	(±16)	58	(±20)	58
Lotus courniculatus	2	82	(±9)	90	(±6)	86	(±13)	80	(±13)	84
Adesmia sp.	1	36	(±4)	44	(±9)	31	(±3)	43	(±5)	39
LSD%		12.7		9.0		9.4		12.2		
Significance		<0.0001		<0.0001		<0.0001		<0.0001		

Table 2. Biomass production (kg/ha) (± se) of perennial legume pastures in four Mediterranean environments of Chile during the 2012-2013 growing season.

Species	N	Litueche		Cauquenes		Los Guindos		Yungay		Average
Medicago sativa	9	1,540	(±330)	1,610	(±269)	748	(±212)	2,334	(±750)	1,558
Hedysarum coronarium	2	745	(±286)	1,195	(±289)	489	(±213)	134	(±54)	641
Lotus tenuis	3	1,968	(±928)	549	(±491)	1,000	(±449)	371	(±269)	972
Lotus curniculatus	2	2,076	(±908)	1,250	(±310)	1,200	(±494)	1,327	(±267)	1,463
LSD%		475		272		231		444		
Significance		<0.0001		<0.0001		<0.0001		<0.0001		

and 100%). *Adesmia* sp. had the lowest survival rate at all Mediterranean sites evaluated (Table 1).

Biomass production in the first growing season

Biomass production was significantly different in the four Chilean Mediterranean environments (Table 2). In the coast (Litueche) and interior (Los Guindos) dryland areas, the production of *L. tenuis* cv. Maitén and *L. corniculatus* cv. Quimey was significantly higher than that of the other *Lotus* accessions. At the Andean foothill site (Yungay), *M. sativa* accessions were the most productive. *H. coronarium* had the highest production in the interior dryland area of Cauquenes but low growth in volcanic soils of the Andean foothill, which can be attributed to the higher soil acidity and low winter temperatures in the latter environment. Shrub legumes (*B. bituminosa* and *C. australasicum*) and *Adesmia* sp. were not evaluated for biomass in the first year due to their poor growth. All the species and genotypes with high adaptation to the conditions of the Mediterranean zone of Chile will be evaluated in two additional growing seasons.

Conclusions

In the first growing season, genotypes of *M. sativa* showed high survival rates and biomass production in the four environments. The performance of *Hedysarum* and *Lotus* genotypes differed according to the environment. Except in the interior dryland of Cauquenes, *H. coronarium* showed low persistence particularly on acidic soils of volcanic origin (Andean foothill). *L. corniculatus* genotypes exhibited high survival at all sites, but for *L. tenuis* only cv. Maitén was highly persistent.

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