White clover (*Trifolium repens* L.) germplasm evaluation under two levels of soil phosphorus: growth and phosphorus absorption

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INTRODUCTION

White clover is the most important forage legume species in grazing pastures in the central irrigated and southern humid regions of Chile. Naturalized germplasm was collected in 1994 from the central and southern regions of the country, where the soils, derived from volcanic ash, are phosphorus fixers because they contain amorphous clays that precipitate phosphate compounds through adsorption mechanisms. To extend the use of the species in marginal areas of the aforementioned regions, genotypes are required that combine phosphorus deficiency tolerance with high nutritive value, forage productivity, persistence and grazing resistance.

OBJECTIVES

The objective of this work was to identify phosphorous deficiency tolerant populations for breeding programs from nine white clover naturalized populations.

MATERIALS AND METHODS

The experiments was carried out, during three years, from autumn 2007, in the experimental field of the Quilamapu Research Centre, INIA, at Chillán, Chile (36°36'S; 72°02'W).

TREATMENTS AND DESIGN

A randomized block experimental design was used with three replicates. All factorial combinations of two levels (low and high) of soil phosphorus and nine white clover naturalized populations, plus two contrasting cultivars (Will and Huia, large- and small-leaved, respectively), were tested in mixture with perennial ryegrass (cultivar Nui). Plots were 1.5 m x 3.0 m, with a separation of 0.5 m.

DRY MATTER EVALUATIONS

DM production was evaluated at approximately 21-day intervals in spring and 27- to 30- day intervals in summer and autumn, by cutting a strip of 0.5 m x 3 m, at a height of 5 cm (rotary grasscutter), alternatively on the left and right side of each plot.

GRAZING

After DM evaluation, the plots were grazed at a high stocking rate by 300 kg heifers for a short period (1 to 2 h) to avoid nutrient transference within plots.

PHOSPHORUS TREATMENTS

Before sowing, soil phosphorus (0-10 cm depth) was determined (7 mg kg-1). A high phosphorus level (20 mg kg-1) was generated by incorporating triple superphosphate (according to the phosphorus fixing capacity of the soil) to a depth of 0-10 cm. In autumn 2008 and 2009, 200 kg ha-1of triple superphosphate was applied to high phosphorus plots.

RESULTS

The DM yield of six populations and the cultivar Huia did not differ (P>0.05) at different levels of soil phosphorus (Figure 1A). The populations 9-2-X and 8-1-X and 'Huia' showed higher yields than the rest at a low level of phosphorus. These two populations did not vary in stolon length and dry weight when the soil phosphorus level was changed (Table 1). They showed the highest (P<0.05) values of phosphorus uptake at the low soil phosphorus level in the three first cuts of the third growing season (2009-2010), 0.87 and 1.11 kg ha-1, respectively. Therefore, these two populations are of great interest for future work in breeding white clover cultivars adapted to phosphorus deficient soils.

The ryegrass grown with the accession 8-1-X reached one of the highest DM yields, indicating that this mixture was the most productive (12.4 t ha-1) at low levels of phosphorus, being superior to the mixture with 'Will', a highly productive cultivar (Figure 1B).

Table 1. Density of white clover growing points and clover stolon length and dry weight at two contrasting levels (low and high) of soil phosphorus.

Clover accessions	Growing points (N° 0.1m^{-2})				Stolon length (m 0.1m^{-2})				Stolon dry weight (g 0.1m^{-2})			
	2008		2009		2008		2009		2008		2009	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
2-3-X	23	37	12	30	8.4	7.7	2.6	0.7	8.8	7.2	1.56	0.23
7-1-X	50	28	60	63	11.3	9.4	3.1	6.6	9.7	7.7	1.36	3.98
9-1-X	37	27	19	61	9.5	9.6	2.1	4.8	7.5	8.2	0.35	2.63
5-2-X	36	41	41	38	6.3	8.0	1.8	2.9	5.0	7.6	0.58	1.70
8-2-X	67	29	66	100	10.6	6.7	5.3	9.2	7.9	5.8	2.40	3.90
12-2-X	34	36	50	50	10.4	7.6	3.8	5.5	7.2	6.8	1.41	3.55
8-1-X	33	45	68	82	7.8	7.4	3.9	9.3	5.8	5.3	1.39	3.87
9-2-X	33	26	37	103	10.0	7.5	5.1	5.5	7.8	6.1	2.14	2.22
6-1-X	27	49	57	81	10.7	7.6	4.4	5.2	10.6	7.2	1.73	2.11
Huia	40	19	32	17	10.7	4.5	9.4	3.8	9.5	4.1	2,30	1.96
Will	33	58	20	77	5.3	7.1	9.1	2.6	8.4	11.0	1.07	2.19
Mean	38	36	42	64	9.2	7.6	4.6	5.1	8.0	7.0	1.48	2.58
s.e.m.	10.9		17.7		1.57		1.81		1.52		0.450	

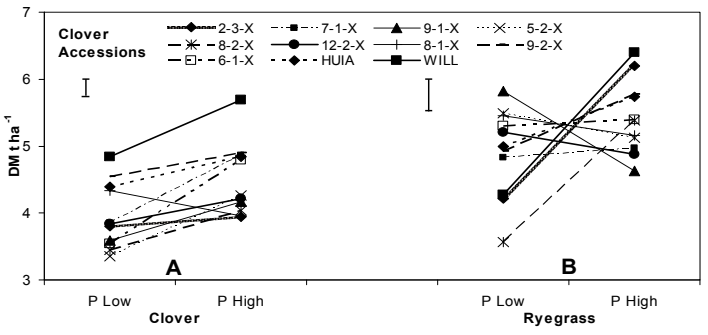

Figure 1. Effect of soil phosphorus levels on DM yields of pure white clover (A) and pure perennial ryegrass (B) in the mixture during the 2008-2009 growing season. Vertical bars indicate standard error of mean for comparing phosphorus x accession means.

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CONCLUSIONS

Two populations of white clover were found with equivalent DM yields to that of 'Huia' at a low level of soil phosphorus. One of them showed high compatibility with the companion grass at the aforementioned level of soil phosphorus. They presented high phosphorus uptake at a low soil phosphorus concentration and the same level of stolon development at the different levels of phosphorus in the soil.