HARDSEEDEDNESS UNDER FIELD CONDITIONS OF *MEDICAGO POLYMORPHA* DURING FIVE SOFTENING SEASONS IN THE MEDITERRANEAN ZONE OF CHILE.

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ABSTRACT
The long term seed softening of burr medic (*Medicago polymorpha* L.) was studied in the field in a mediterranean environment in Chile. Burrs were collected in March of 1988, 1989, 1990 and 1991 (collecting years), and placed in the field either on the surface or buried at 1 cm depth. Field germination was recorded regularly and the remaining non-germinated seeds were tested for germination in the laboratory during 4 years.

The percentage of soft seeds on soil surface burrs was on average 3.2% (mean of 4 collecting years) after the first summer in the field, and reached 83% after 5 summers. Seed softening was significantly greater on burrs buried at 1 cm depth than those placed on soil surface. The split-split-plot ANOVA for cumulative soft seeds, showed that collecting year (CY), softening season (SS) and environment treatment (ET) were highly significant, but also the CY*SS*ET interaction was significant.

KEYWORDS
Burr medic, *Medicago polymorpha*, soft seeds, buried seeds, ley farming, mediterranean environment, Chile.

INTRODUCTION
Burr medic (*Medicago polymorpha* L.) is a self-regenerating specie that has a great potential in ley farming systems on large areas (0.5 million ha) in the "secano interior" (interior drylands) of Chile (Del Pozo *et al*., 1989). The persistence of the pasture on ley farming systems depend largely on the size of the seed bank and the rate of seed softening (Fortune *et al*., 1995).

Seed softening under field conditions is influenced both genetically and by environmental conditions, particularly soil temperature (Taylor and Ewing, 1988; 1992). In a previous paper (Avendaño, Del Pozo and Ovalle, 1993) we presented preliminary data of a long-term field study of seed softening in *M. polymorpha*. This paper reports the rate of softening of seeds contained in burrs placed on surface and buried at 1 cm depth, over 5 softening seasons from burrs collected on 4 consecutive years.

METHODS
The experiment was conducted at the Cauquenes Research Center (35°57'S; 72°19'W) using burrs of a local population of *M. polymorpha*. Annual rainfall is 662 mm (average of 33 years, 1959-1991) and mean temperature of the coldest and warmest month is 9.0°C (July) and 20.9°C (January), respectively (Novoa *et al*., 1989).

Burrs were collected in March of 1988, 1989, 1990 and 1991 (collecting years), and placed in the field either on the surface or buried at 1 cm depth, in the same month, i.e. after the first summer following seed set. On each collecting year, lots of 100 pods each surrounded by a wood frame of 20x20 cm, were placed on the soil surface (72 lots) and buried at 1 cm (12 lots), in a randomised block design with 3 replications. *In situ* or field germination was recorded regularly and the germinated seeds destroyed. Seeds were removed by hand from 3 lots of burrs from each environment treatment (surface and buried at 1 cm) and collecting year, every 2 months (March, May, July, September; November and January) on soil surface lots, and each March on buried lots, over a period of 4 years. Seeds were placed on Petri dishes with a moistened towel in a stove at 20 °C for 20 days to test germination of the *in situ* non-germinated seeds, and the remaining non-germinated were counted. Data were calculated as percentage of germinated seeds (in situ plus forced conditions) of the total seeds in each sample. In order to compare the two environment treatments, cumulative percentage of germination (cumulative soft seed) at the end of each summer (March) were calculated for each collecting year over five softening seasons.

Differences between treatments were analysed by using a split-split-plot ANOVA, previous transformation of the data to arcsin$\sqrt{x}$; collecting years were the "main plots", softening seasons the sub-plots and the environment treatments the sub-subplots.

RESULTS AND DISCUSSION
In all the collecting years burrs were obtained from the field after the first summer following seed set, therefore the percentages of soft seeds were similar (3.2%) on both lots of burrs, soil surface and buried at 1 cm. After the second summer the rate of seed softening was greater on burrs buried at 1 cm depth than those placed on soil surface, and increased more after the third and fourth summer, but at the end of the fifth summer the percentage of soft seeds was only slightly higher on buried burrs (Figure 1). Taylor and Ewing (1988) found no difference on the rate seed softening, between burrs buried at 2 cm and on surface, on both *M. polymorpha* (cv. Serena) and *M. truncatula* (cv. Cyprus).

The ANOVA for cumulative soft seeds during the last four softening seasons, showed that collecting year (CY), softening season (SS) and environment treatment (ET) were highly significant, but also the CY*SS*ET interaction was significant (Table 1). This means the pattern of seed softening in the field varies between years and depends apparently on soil temperature (Taylor and Ewing, 1992).

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Table 1
Split-split-plot ANDEVA of cumulative soft seeds. Data were transformed to arcsinšx.

Source	df	MS	F	P	
Replicate (R)	2	0.005	1.71	0.1971	
Collecting year (CY)	3	0.149	50.28	0.0001	**
R * CY	6	0.009	3.15	0.0153	*
Softening season (SS)	3	1.263	425.8	0.0001	**
CY * SS	9	0.010	3.39	0.0050	**
CY * SS * R	24	0.001	0.57	0.9234	
Environment treatment (ET)	1	0.561	189.2	0.0001	**
CY * ET	3	0.0009	0.31	0.8188	
SS * ET	3	0.027	8.96	0.002	**
CY * SS * ET	9	0.007	2.43	0.0313	*

Figure 1
Seed softening of burrs placed on soil surface (circles) and buried at 1cm depth (squares) over 5 softening seasons (5 summers in field). Data are mean (± s.e) of 4 collecting years.