Osmotic adjustment and water use efficiency of seven cultivars of *Lotus corniculatus* L.

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INTRODUCTION

The birdsfoot trefoil (*Lotus corniculatus* L.) is a perennial forage legume of high yield potential in marginal environments, where common forage species like alfalfa and white clover do not thrive. Good performance under drought conditions has been attributed principally to its deep root system. The contribution of physiological mechanisms is unknown. The objective of this work was to evaluate osmotic adjustment and water use efficiency (WUE) of seven cultivars of L. corniculatus introduced in Chile, and to determine their relevance in drought tolerance.

MATERIALS AND METHODS

The experiment was carried out under greenhouse conditions during the spring of 2008 at the Instituto de Investigaciones Agropecuarias INIA, Chillán, Chile (36º03'S W72º07').

GROWING CONDITIONS

Seeds were germinated in seedbeds with 27 cm^3 of capacity (3×3×3 cm) that contained peat moss as a substrate (Biolan, Finland). A week after their emergence, the seedlings were inoculated with a solution of *Mesorhizobium loti*. The plants were transplanted to pots with 3 L capacity (25 cm diameter) that contained a substrate of soil derived from volcanic ash with a silty loam texture (Andisol). The substrate was not fertilized and five plants per pot were established.

WATER TREATMENTS AND MEASUREMENTS

Two soil water treatments were designed, one non water stress (NWS), where the soil was maintained at 54% water content and -0.01 MPa of water potential, and the other with water stress (WWS), with soil maintained at 25% water content and -0.5 MPa of water potential. Fully developed plants were submitted to soil water treatments for 26 days. During this period, xylematic water potential (Ψx) was measured in one shoot per pot with a Scholander pump. Osmotic potential (Ψπ) was determined in an aliquot of 20 µl of leaf sap with an osmometer (Advanced Instruments, Inc., UK) and the pressure potential was estimated (Ψp = Ψx - Ψπ). Transpirated water (T) was recorded daily by weighing the pots. Dry matter growth (DM=leaf+shoot) was measured and WUE was calculated (DM/T). During the experimental period, the greenhouse was maintained at an average temperature of 28/20ºC (day/night), with a relative humidity of 43/63% (day/night). The experiment was arranged in a factorial RCB design (7 cultivars x 2 water treatments x 4 replications). The data were analyzed using ANOVA and the LSD test for comparison of means.

RESULTS

WATER POTENTIALS

There was no variation in Ψx, Ψp and Ψπ among cultivars and the cultivar × water treatment interaction was not significant (P>0.05). There was only a highly significant effect (P≤0.001) of the water treatments (Fig. 1). Osmotic adjustment involves the net accumulation of solutes at the cellular level in response to a fall in the plant water potential. As a consequence of this net accumulation, the osmotic potential of the cell is lowered, which in turn attracts water into the cell and tends to maintain turgor pressure. In this work, L. corniculatus showed a strong capacity for osmotic adjustment, given that plant water potential (Ψx) decreased by 86% under the WWS treatment compared to the NWS treatment. This provokes a 44% reduction in Ψπ and a 35% increase in Ψp (Fig. 1).

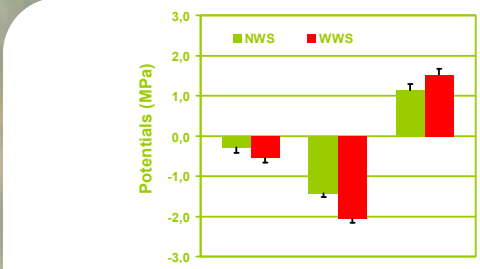

Figure 1. Xylematic (Ψx), osmotic (Ψπ) and pressure (Ψp) water potentials of *Lotus corniculatus* subjected to two soil water availability treatments: with water stress (WWS) and non-water-stressed (NWS). Average of seven cultivars; vertical bars indicate LSD value (*P*=0.05).

WATER USE EFFICIENCY (WUE)

WUE decreased by 30% under water stress. The South American cultivars (San Gabriel, Quimey and Ganador) obtained higher WUE, while the North America cultivar, Empire, obtained the lowest WUE (Fig. 2). A highly significant correlation was found under drought conditions between WUE and DM growth (r=0.90; P≤0.01).

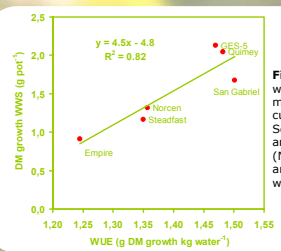

Figure 2. Relationship between water use efficiency (WUE) and dry matter (DM) growth of seven cultivars of *Lotus corniculatus* from South America (Ganador, Quimey and San Gabriel), United State (Norcen, Steadfast and Empire) and Australia (GES-5), subjected to water stress treatment (WWS).

ACKNOWLEDGEMENT
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CONCLUSIONS

Lotus corniculatus displays a pronounced capacity for osmotic adjustment. However, the physiological mechanism did not contribute to increasing DM production under drought conditions and is only associated with plant survival. On the other hand, water use efficiency is a physiological mechanism that increases DM production under water stress conditions. WUE also showed broad genetic variation among cultivars.