Variability in tolerance to water stress by *Holcus lanatus* L., *Bromus valdivianus* Phil. and *Agrostis capillaris* L. accessions

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Introduction *Holcus lanatus* L. (Hl), *Bromus valdivianus* Phil. (Bv) and *Agrostis capillaris* L. (Ac) are frequently present in the naturalised pasture of the Chilean humid region, which has a summer drought with two distinguishable areas according to average summer rainfall: a Northern area (Long summer drought, LSuD: 136-186 mm;) and a Southern area (Short summer drought, SSuD: 186-338 mm). It was hypothesised that plant species have colonised areas with different water deficits during summer through differentiated drought tolerance, which would imply ecotype generation.

Materials and methods Three accessions of *H. lanatus* (Hl), *B. valdivianus* (Bv) and *A. capillaris* (Ac) were collected from the LSuD area and three from the SSuD area. From each of these, three individual tillers were established in pots in a glasshouse. The water stress levels applied were: 100% field capacity (FC), 50% FC, and 25% FC. The water stress period was equivalent to that of Valdivia (1,196 accumulated growing degree days). Leaf appearance rate (LAR), leaf extension rate, leaf length (LL), number of leaves (LN), tiller number (TN), extended height (DH), tiller weight (TW), and sheath (SW) and laminae (LW) weights were evaluated. Following this period, the plants were trimmed to a height of 3 cm and accumulated herbage mass (HM1) was measured. All pots were irrigated to 100% FC for 30 d (resilience period), DH was measured, and accumulated herbage mass (HM2) evaluated to ground level. Total accumulated herbage mass (TAHM) was calculated. The design was a complete block with factorial arrangement of the treatments, with four blocks. Results were analysed using ANOVA and Canonical Variate Analysis (CVA).

Results The results from ANOVA and CVA were in agreement. For Hl, the first two canonical variates of the CVA explained 75% of the differences between accessions, such that TW, LW, LL, DH, TN significantly diminished due to water stress (CAN1: 53%). The differences due to accession features were explained by CAN2 (22%), with LSuD2 behaving differently ($P<0.001$) from the other accessions, with higher LW, TW, HM1 during the water stress period, but with lower TN. The differences between LSuD2 and the other accessions were enhanced with increasing water stress. The results showed that only LSuD2 had a high water stress tolerance. The variability in behaviour due to water stress amongst the other Hl accessions was most likely due to phenotypic plasticity. The differences amongst accessions measured at the end of the resilience period were due to the differences shown during the stress period. The other variables that were measured did not explain differences amongst accessions.

The Bv accessions performed differently under all water treatments ($P<0.001$), but these differences were enhanced by water stress. The first three canonical variates explained 79.4% of the accession variation: CAN1 (40%) explained differences between the accessions in TN and DH in contrasting directions; CAN2 (23%) accounted for differences between the accessions in TW and HM1. The effects of the water stress period on the performance of accessions were shown by a regular pattern along CAN2. The differences amongst accessions were expressed as the combination between CAN1 and CAN2. Since all of the Bv accessions performed differently from each other, no groups were formed. The results indicated that the drought survival strategy of Bv would be through the presence of ecotypes. The other variables that were measured did not explain differences amongst Bv accessions.

The Ac accessions did not show differences and their performance was not affected by water stress.

These results show that plant species have different survival strategies for water stress, which are based on a combination of the presence of ecotypes and phenotypic plasticity. The extent that both strategies are present would be expected to affect the stability of grasslands.

Conclusions In the Chilean humid region, *B. valdivianus* showed a high intra-species diversity, through the presence of ecotypes, which allow it to survive through the summer drought. *Agrostis capillaris* survived this environmental constraint through its high phenotypic plasticity. *Holcus lanatus* showed a mixed survival strategy with both phenotypic plasticity and ecotype presence.