Phenotypic traits expressed in white clover cold tolerant genotypes selected from populations naturalized in the Patagonia region of South America

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In Mediterranean environments, an important aspect of the compatibility in a grass/White Clover (WC) mixture is the lower WC growth rate at low temperatures (5-15° C). This affects the WC competitiveness during early spring and late autumn, resulting in a low contribution of WC to total yield. A white clover association mapping population (WCAMP) comprised of 192 WC genotypes was developed for identifying phenotypic traits and genomic regions (QTLs) that are controlling the WC cold tolerance. The objective of this work was to identify phenotypic traits associated to cold tolerant WC genotypes. The WC genotypes were selected from 28 naturalized accessions collected from seeds in the Argentinean and Chilean Patagonia Region, during 1994-1996 (Acuña et al., 2014). The WCAMP was established in three environments that represent a winter cold gradient associated with the altitude: Santa Rosa (SR_{140}), Atacalco (AT_{660}) and Puente Marchant (PM_{1050}), located at 140, 660 and1050 m.a.s.l., respectively. In each location, a spaced plant experiment was arranged in an alpha lattice experimental design with two replicates and 24 incomplete blocks (IB). Each genotype was planted in rows of 1x1 m. The experiment was established during October-November 2013 and evaluated during three growing seasons (2013, 2014/15 and 2015/16). The dry matter (DM) production was evaluated through two cm cuts above ground level with an electric shearing machine. During the spring, stolon length and diameter were measured periodically in two stolons per plant. Also, one time per season (spring) leaf area, petiole length, and specific leaf area (SLA=cm^2 g^{-1}) were measured. During the first winter, stolon total water soluble carbohydrates (WSC) were measured three times (early, middle, and late of winter). On the same dates, stolon DM and stolon total length were measured in a 15 cm diameter core-sample collected for each plant. A phenotypic linear mixed model was implemented in asreml-R to estimate the variance components, the best linear unbiased prediction (BLUP), genetic correlation between traits, and the broad sense heritability (H^2) on a clone mean basis. All phenotypic traits showed significant genotype effect and most of them showed a significant genotype × environment interaction ($P<0.05$). Spring DM production was describing early vigor and cold tolerance in this population. The degradation rate of WSC and stolon DM measured during winter were genetically correlated with spring DM production ($P<0.05$). On the other hand, petiole length, leaf area, stolon diameter, and stolon elongation rate were highly genetically correlated with total and spring DM production ($P<0.05$). With different levels of contribution, all these phenotypic traits are modulating the early vigor and cold tolerance in WC.

Reference: Acuña, H., L. Inostroza, and M.T. Pino. 2014. Selection of contrasting cold-tolerant white clover genotypes from twenty-eight populations naturalized in southern Chile and Argentina. Grassland Science in Europe 19:858-860.