Yield gains from wide-adaptation and specific-adaptation strategies for alfalfa in northern Italy

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Breeding for specific adaptation may adopt distinct genetic bases (each including material with the desired adaptation), distinct selection environments (each representative of the target environments), or both. Earlier work showed that genotype × location interaction for dry matter (DM) yield of alfalfa cultivars across northern Italy is wide and repeatable in time, is associated with soil type and level of summer drought stress, and can be reproduced by 4 artificial environments created by the factorial combination of soil type (sandy-loam or silty-clay) and drought stress level (almost nil or high). Two contrasting subregions, named as A (with sandy-loam to loam soil and limited drought stress due to irrigation) and C (tending to clay soil and severe stress due to rainfed cropping), and an intermediate subregion B, emerged from test site classification. This study aimed at comparing wide- vs specific-adaptation strategies on the basis of DM yield gains over 11 harvests from phenotypic selection of individual plants, assessing the value of specific genetic bases and selection environments for the contrasting subregions A and C. The following selected populations were evaluated along with 5 reference cultivars: GW-SW, GA-SA, GA-SC, GC-SC and GC-SA (where: GW, GA and GC = genetic bases for wide adaptation, subregion A and subregion C, respectively; SW, SA and SC = selection environments for wide adaptation, subregion A and subregion C, respectively). The above-mentioned artificial environments acted as selection and test environments (where 'no stress/sandy-loam soil' and 'stress/silty-clay soil' reproduce the entry responses in subregions A and C, respectively, and the other environments jointly reproduce the responses in subregion B). Entry × environment interaction ($P \leq 0.01$) implying sizeable cross-over interaction (Figure 1) occurred due to both environmental factors. Specific genetic bases (GA and GC) implied selection gains in their target subregions of 6.7% (with 3-fold greater selection efficiency) for subregion A and 2.0% (with 28% greater efficiency) for subregion C compared with the widely-adapted one (GW) (assessing gains over the top-yielding variety in each environment). The advantage of SA ('no stress/sandy-loam soil') over SC ('stress/silty-clay soil') decreased from subregion A (10.4%) through C (2.2%) but exhibited a superiority per se across environments of 5.3% associated with higher broad-sense heritability.

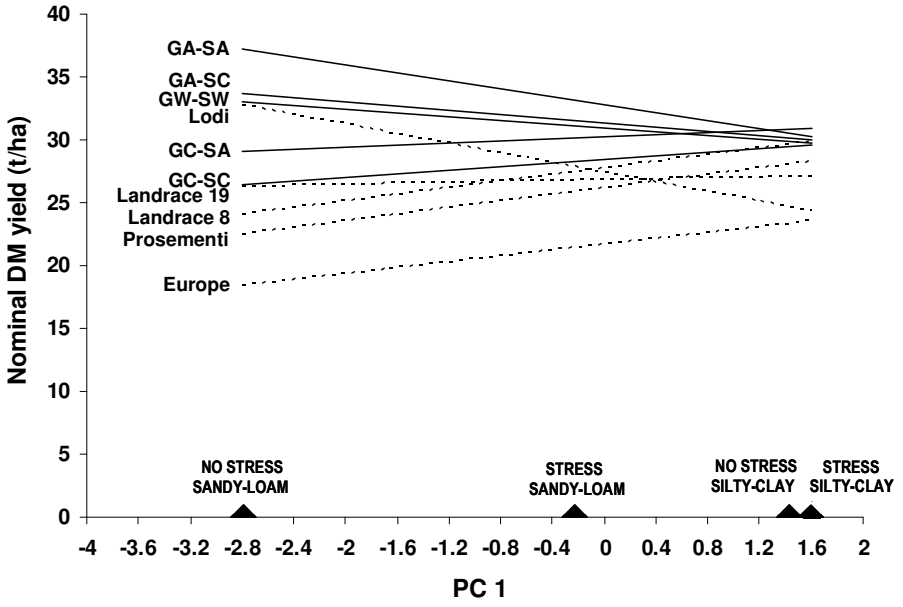

Figure 1. Nominal DM yield of alfalfa populations as a function of the first genotype × environment interaction principal component score of artificial environments in an Additive Main effects and Multiplicative Interaction analysis (continuous line = selections, dotted line = reference cultivars; see text for codes of selections)