Abstract

Bean (*Phaseolus vulgaris* L.) originated in the American continent, specifically in the Mesoamerican zone, and its domestication occurred independently in the Mesoamerican area and the Andean zone, giving rise to two well-differentiated gene pools. It was also observed that the wild Andean populations originated from only a few thousand individuals of the wild Mesoamerican populations, which produced a large bottleneck in the formation of the Andean population. During centuries of cultivation in the Iberian Peninsula after their introduction in the 16th century, beans adapted to new environments, evolving numerous landraces.

In this study was also evaluated the resistance to salinity of several local Spanish cultivars of *Phaseolus lunatus* L. (lima bean). Plants were subjected to various salt treatments and growth and biochemical parameters were determined. It was observed that salt stress reduced the fresh weight of aerial organs, which allowed us to classify the four genotypes according to their tolerance to salinity. The concentration of photosynthetic pigments remained unchanged, except for carotenoids which were reduced in the least salt tolerant cv. (cultivar) VPH-79. Leaf Na^+ and Cl^- concentrations increased with increasing salt concentration of irrigation water, but K^+ remained constant, as in the most tolerant 'BGV-15410', or increased in the other cultivars, resulting in an unchanged K^+/Na^+ ratio under stress in two of the selected cultivars. In addition, proline increased in all cultivars, most notably in cv. VPH-79, with the highest absolute concentrations recorded in the most salt tolerant cultivars. Interestingly, these cultivars already had relatively higher proline concentration in unstressed plants. These findings indicate that *P. lunatus* is moderately salt tolerant and that its main mechanisms for adapting to salt stress are the maintenance of high K^+ concentrations and proline accumulation in leaves.

In studies conducted in this research project, 24 landraces of *P. vulgaris* from Spain were analyzed in greenhouses during two consecutive seasons. From each genotype, five plants were grown and characterized for 17 quantitative and 15 qualitative traits using IBPGR descriptors. Data were statistically analyzed by analysis of variance (ANOVA), principal component analysis (PCA) and cluster analysis. The results obtained indicate high variability for most of the traits, especially those related to yield and its components. PCA and cluster analysis separated landraces according to seed color, yield, and yield-related pod and seed traits. Numerous traits exhibited genotype-environment interactions. Most accessions achieved higher yields in spring when solar radiation favors photosynthesis and, consequently, photoassimilation. The different response to the changing environment of the set of accessions studied in the present work is of great interest and can be exploited in breeding cultivars adapted to a wider range of environmental conditions.

On the other hand, this study analyzed the responses to water deficit and salt stress treatments, in terms of growth inhibition and leaf proline (Pro) content, in 47 *Phaseolus vulgaris* genotypes of different origins. Two-way analysis of variance (ANOVA), Pearson's moment correlations and principal component analysis (PCA) were performed on all measured traits to assess the overall stress responses of the genotypes investigated. For most of the growth variables analyzed and Pro, the effects of cultivar, treatment and their interactions were highly significant ($p < 0.001$); root morphological traits, stem diameter and number of leaves were mainly due to uncontrolled variation, whereas variation in fresh weight and water content of stems and leaves was clearly induced by stress. Under our experimental conditions, the average effects of salt stress on plant growth were relatively weaker than those of water deficit. In both cases, however, growth inhibition was mainly reflected in the stress-induced reduction of fresh weight and water content of stems and leaves. Pro, in turn, was the only variable that showed a negative correlation with all growth parameters, but particularly with those of stems and leaves mentioned above, as indicated by Pearson's correlation coefficients and PCAs. Thus, in common beans, higher stress-induced Pro accumulation is unequivocally associated with greater growth inhibition; i.e., greater stress sensitivity of the corresponding cultivar. We propose the use of Pro as a biochemical marker suitable for simple, rapid, large-scale screening of bean genotypes to exclude the most sensitive, those that accumulate higher concentrations of Pro in response to water or salt stress treatments.

In addition, responses to salinity were analyzed in six common bean cultivars: four local varieties from Spain and two experimental lines from Cuba. Proline was used to rank the relative tolerance of the cultivars, confirming a previous study that reported two of the Spanish landraces as more stress tolerant. Concentrations of total soluble sugars varied with treatments and among genotypes, but it was difficult to assess their role in stress tolerance of the plants tested. Leaf sodium concentration was lowest in one of the two salt-resistant cultivars, and potassium did not vary or increase under salt stress in all of them, except in the most susceptible one, where a drop of this cation below 150 NaCl mM was recorded. Changes in malondialdehyde (MDA) content did not indicate salt-induced membrane peroxidation as a result of secondary oxidative stress; consequently, accumulation of total phenolic compounds and flavonoids, as an antioxidant defense mechanism, was not detected. These results highlight the reliability of the use of proline as a biochemical marker of salt stress in common beans and the importance of the mechanism related to potassium transport to leaves in conferring stress tolerance to some common bean cultivars.