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Large variation in salinity tolerance in chickpea is explained by differences in sensitivity at the reproductive stage

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Abstract

Salinity is an ever-increasing problem in agriculture worldwide, especially in South Asia (India, Pakistan) and Australia. Improved genotypes that are well adapted to saline conditions are needed to enhance and sustain production in these areas. A screening of 263 accessions of chickpea, including 211 accessions from ICRISAT's mini-core collection (10% of the core collection and 1% of the entire collection), showed a 6-fold range of variation for seed yield under salinity (1.9 L of 80 mM NaCl per 7.5 kg Vertisol), with several genotypes yielding 20% more than a previously released salinity tolerant cultivar. The range of variation in yields under salinity was similar in both kabuli and desi chickpeas, indicating that breeding for salinity tolerance can be undertaken in both groups. A strong relationship ($r^2 = 0.50$) was found between the seed yield under salinity and the seed yield under a non-saline control treatment, indicating that the seed yield under salinity was explained in part by a yield potential component and in part by salinity tolerance *per se*. Seed yields under salinity were therefore computed to separate the yield potential component from the residuals that accounted for salinity tolerance *per se*. Among the genotypes evaluated, desi genotypes had higher salinity tolerance than kabuli genotypes. The residuals were highly correlated to the ratio of seed yield under salinity to that of the control, indicating that both parameters can be used to assess salinity tolerance. A similar ratio was calculated for shoot dry weight at 50 days after sowing. However, no significant correlation was found between the shoot dry weight ratio and the yield ratio, indicating that differences in salinity tolerance among genotypes could not be inferred from measurements in the vegetative stage. The major trait related to salinity tolerance was the ability to maintain a large number of filled pods, whereas seed size was similar in tolerant and sensitive genotypes. Salinity tolerance was not related to the shoot Na^+ or K^+ concentrations.

Keywords: Chickpea; *Cicer arietinum*; Salinity tolerance; Seed yield; Large screening; Mini-core collection

1. Introduction

Salinity affects about 100 million ha of arable lands worldwide and this area is expanding dramatically (Ghassemi et al., 1995). In Australia and India, salinity has already become a major deterrent to crop production, including legumes. In Australia, salinity is likely to affect 17 million ha by 2050 according to a recent report (ANRA, 2001). In India alone, about 13 million ha are currently affected by salinity (Consortium for Unfavorable Rice Environment, IRRI, 2003). Although agricultural management options are available and policies could be implemented, for example, in relation to the use of irrigation water, such options often contrast with the immediate economic choices of farmers. Therefore, a more practical and immediate option is the breeding of salinity tolerant cultivars.

Chickpea (*Cicer arietinum* L.) is very sensitive to salinity (Lauter and Munns, 1986). Previous results by Dua (1992) showed that no chickpea variety could grow at EC levels higher than 6 dS/m, although this work was done in soils that were also high in pH (8.8). To improve the adaptation of chickpeas to saline soils, it is critical to identify tolerant sources and understand the genetic basis of salinity tolerance. It has been previously stated that there is too little variability for salinity tolerance in chickpea to undertake a successful breeding program for salinity tolerance (Saxena, 1984; Johansen et al.,

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