EFFECT OF SALINITY ON SODIUM, POTASSIUM AND PROLINE CONTENT OF CHICKPEA SEEDLINGS

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ABSTRACT

Four chickpea seedlings belonging to the tolerant and susceptible groups were taken for the investigation of their response towards stimulated salt stress. On dry weight basis, it was observed that seedlings SG-11 and DHG-84-11 were tolerant to salt stress at early seedling growth as compared to Pusa-256 and Phule G-5. The tolerant seedlings have lower sodium, higher potassium and higher proline contents in shoots as compared to susceptible seedlings.

Keywords: Salinity, proline metabolism, sodium chloride, potassium, chickpea.

INTRODUCTION

Salinity is a major problem throughout the world and efforts are being made to find crop species able to tolerate increasing soil salinity levels. Plant adaption to saline conditions can depend on an increase in specific inorganic and organic solutes within the cell, which may contribute to osmoregulation or to the ability to prevent the accumulation of salts within the cytoplasm^{1,2} and the continuous accumulation of salt in cultivated soils as a result of irrigation and climate warming increases the importance of this stressful factor³. Saline impact on the osmotic potential of plants and soils subsequently affects water availability due to the limitation of water uptake of the plants. In addition, excessive uptake of Na and Cl may result in a limited assimilation, transport and distribution of mineral nutrients, as well as nutrient imbalances within the plants^{4,6} while the exclusion or maintenance of low concentrations of toxic Na and Cl ions especially in meristematic tissues and reproductive organs is regarded as an essential phyto-physiological mechanism for salinity tolerance⁷. However, analysis of plant tissue for Na and K contents under salt stress condition has been suggested as one of the useful parameters to measure the varietal salt tolerance^{8,9}. Hence,

the present investigation was undertaken to study the effect of salinity on Na, K and proline content during early seedling growth in the four genotypes (SG- 11, DHG-84-11, Pusa-256 and Phule G-5) of chickpea to assess the relative tolerance of these seedlings.

MATERIALS AND METHODS

The seeds were germinated at different salinity stress levels viz., 50 and 100 mM in sterilized germination boxes lined with blotting papers and kept at $25 \pm 2^\circ\text{C}$ in a BOD incubator under controlled conditions. On 8th day, seedling were transplanted in polythene sleeves (7" X 5") were filled with garden soil comprising red earth, sand and farmyard manure (1:2:1). Healthy seedlings were selected and planted in polythene sleeves. Control plants were irrigated with tap water. On 18th day, experiment was determined to study the sodium, potassium and proline content along with dry weight of shoot. Shoot dry weight was taken after drying the sample in an electric oven set at 100°C for ten minutes and later at 70°C to a constant weight. Quantitative estimation of sodium and potassium was carried out by using Flame photometer as described by¹⁰. The method developed by¹¹ was used for the quantification of proline.

Figure 1: Effect of salinity on dry weight (mg/plant) of four genotypes of chickpea

Figure 2: Effect of salinity on sodium content in shoot (mg/g dry weight) of four genotypes of chickpea

Figure 3: Effect of salinity on sodium content in root (mg/g dry weight) of four genotypes of chickpea

Figure 4: Effect of salinity on potassium content in shoot (mg/g dry weight) of four genotypes of chickpea

Figure 5: Effect of salinity on potassium content (mg/g dry weight) of four genotypes of chickpea

Figure 6: Effect of salinity on proline content (mg/g dry weight) of four genotypes of chickpea

RESULT AND DISCUSSION

Irrespective of the varietal tolerance to salinity, dry weight of all the four genotypes reduced in the saline treatment (Figure 1). A higher dry weight reduction in Pusa-256 and Phule G-5 (susceptible genotypes) showed its sensitivity to salinity over SG-11 and DHG-84-11 (tolerant genotypes). Both genotype of tolerant group were statistically significant over those of susceptible group in respect of dry weight of shoot. The sodium content in shoot (Figure 2) increased in all the chickpea genotypes with increasing salt stress. The Phule were significantly higher in susceptible genotypes viz., Pusa-256 and Phule G-5 than that of tolerant genotypes viz., SG-11 and DHG-84-11. As regards sodium content in root (Figure 3), the same trend of increase was found in all the genotypes. However, the value of sodium content was significantly higher in SG-11 and DHG-84-11 than that of Pusa-256 and Phule G-5. The bulk of sodium ions have been reported to be partitioned in the cell vacuole and thereby depleting the cytoplasmic sodium level and conferring the plants to function as normal¹². A positive relationship between soil salinity and uptake of Na has also been reported by¹³⁻¹⁵. Potassium content in shoot and root (Figure 4 and 5) decreased with rising salt stress. When both tolerant and

susceptible groups were compared for potassium content, it was found that the values of potassium content in shoot of tolerant genotypes were significantly higher than that of susceptible genotypes, whereas the values of potassium content in root of susceptible genotypes were significantly higher than that of tolerant genotypes. The decrease in potassium was attributed to the toxic effect of sodium on plant growth or competition by other salts which in turn exercised a regulatory control of potassium uptake. Sodium accumulation coinciding with loss or restriction of potassium uptake during salinity has been reported in several other plant species^{16,17}. Higher proline content was observed in tolerant genotypes. The per cent increase was more in tolerant than susceptible genotypes (Figure 6) enabling the former genotypes to cope with the salt stress condition comparatively in an efficient manner. Proline has been suggested to act as an intracellular osmoticum and salt tolerance has been associated with the capacity of a species to accumulate proline. Proline is also believed to function as compatible solute in balancing cytoplasm and vacuolar water potentials¹⁸. Similar increase in proline content has also been found in chickpea by^{19,20}. Thus, it may be concluded that genotypes under test showed tolerance because of better

osmoregulation due to higher accumulation of proline and lesser transport of sodium ions from root to shoot.

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