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SALINITY MEDIATED CHANGES IN YIELD AND NUTRITIVE VALUE OF CHICKPEA (*CICER ARIETINUM* L.) SEEDS

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SUMMARY

An experiment was conducted on eight genotypes of chickpea, varying in their salt tolerance level, to evaluate effect of salinity on yield related parameters and the quality of seeds produced. Lower salinity (4dSm^{-1}) did not affect the number of flowers and pods per plant except in the genotypes HC-1, CSG9505 and HC-5. Higher salinities reduced the number of flowers and pods; the reduction being maximum in CSG 9505 followed by Pusa 256, HC-5 and HC-1 while HC-3 and KC-1 showed minimum reduction. Salinity also affected number and weight of the seeds per plant adversely, irrespective of the tolerance status of the genotype; reduction being more in the sensitive genotypes than the tolerant ones. Salinity also decreased starch and protein content of the seeds; the genotype KC-1 and HC-3 (salt tolerant)evinced relatively less decrease over CSG 9505 and HC-5 (salt sensitive), thereby proving that salt tolerant genotypes are neither high yielder nor produce quality seeds when compared to the control.

Key words: **Chickpea, salinity, seed composition, protein, starch**

INTRODUCTION

With the development of irrigation facilities, agricultural areas in the arid and semi-arid regions have suffered changes in the composition of the soil. The steady built up of salts is one such modification, salinity being one of the constraint limiting crop growth and productivity. The problem is assuming serious proportions as India has invested more than Rs. 50,000 crores in irrigation sector and has largest net irrigated area in the world. Today, approximately 20% of the cultivated land and almost 50% of the irrigated land on the earth is salt affected (Zhu 2001). Salinity is known to reduce net photosynthesis (Soussi *et al.* 1999), the magnitude of nodulation and N-fixation (Bekki *et al.* 1987) and quantity and quality of sexual units (Dhingra and Varghese 1985, 1994). The magnitude of reduction depends upon plant species, type and level of salinity which in turn will affect quality of the agricultural produce. Little is however, known on the quality aspects of fruits and seeds (Mizrahi and Pasternak 1985). Sharma and Gupta (1986) reported salinity mediated deterioration in the quality of fruits in terms of their protein and carbohydrate contents while Shannon (1985) reported an increase in total soluble solids which is index of improved quality. Salinity mediated changes in protein and carbohydrate metabolism during seed development have been reported in mungbean (Dhingra and Sharma 1992), chickpea (Dhingra *et al.* 1994, 1996) and Brassica (Sureena *et al.* 2001). These studies employed a few (1-3) genotypes for the crop in question with no information on the tolerance status. Since the degree of metabolic shift during seed

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development is a function of relative stress tolerance, this communication intends to decipher if genetic salt tolerance is accompanied with little or no changes in the yield and quality of the produce by employing a sizeable number of genotypes with known degree of salt tolerance (Asha 2005).

MATERIALS AND METHODS

Uniform sized seeds of eight genotypes of chickpea (*Cicer arietinum* L.) namely CSG 8962 (KC-1), HC-3, C 235, Pusa 256, IPC 94-94, HC-1, CSG 9505 and HC-5 differing in their salinity tolerance were surface sterilized by treating with 95% ethanol for 10 seconds followed by treatment with 2.5% sodium hypochlorite for 10 minutes. These were thoroughly washed with sterile water and then inoculated with *Rhizobium leguminosarum* strain Ca 181. Six seeds were sown in each pot lined with a polythene bag filled with 8 kg of acid treated and thoroughly washed river sand in a screen house, under naturally lit conditions. Each bag was having a drainage hole at one of the corners of sealed end. The cut portion was plugged with a wad of glass wool from inner side to allow free drainage of solution from the bag without any outflow of sand and to avoid waterlogging. Plants were nourished by nitrogen free nutrient solution (Wilson and Reisenauer 1963) at 10 days interval except the starter dose of NO_3-N (45 mg/pot). Chloride predominant salinity (control, 4.0, 6.0 and 8.0 dS m^{-1}) was created by adding appropriate amount of different salts, viz. NaCl, $CaCl_2$, $MgCl_2$ and $MgSO_4$ to N-free nutrient solution in the proportion of 4:1:3 :: Na:Ca : Mg and Cl : SO_4 :: 7 : 3 on milliequivalent basis and maintained by the method as described earlier (Dhingra and Sharma 1992).

The quality of mature seeds as influenced by salinity was evaluated by estimating starch and total soluble protein content. For extraction, 100 mg mature seed was homogenized in 80 per cent ethanol (v/v) using acid washed sand as an abrasive. The homogenate was refluxed thrice with 80% ethanol. The pellet obtained was further hydrolyzed with 4 ml of chilled 0.2 N $HClO_4$ and allowed to stand for 24 h at 4^0C. It was then centrifuged and supernatant was used for starch estimation. The residue left after perchloric acid extraction of starch was treated with 1N NaOH for protein hydrolysis and kept over night and then centrifuged. The extraction was repeated with 1N NaOH and centrifuged again. The supernatant was pooled and volume was made to 5 ml with 1N NaOH and centrifuged again. Starch and protein contents were estimated by the methods described by McCready *et al*. (1958) and Bradford (1976), respectively.

RESULTS AND DISCUSSION

Data present in table 1 vivdly evince that the salinity affected the number of seeds per plant least by in KC-1 genotype followed by HC-3 and most adversely in CSG 9505 genotype at 8.0 dS m^{-1}. Seed weight also followed similar trend. In conformity, reduction in seed yield and its attributing characters have been reported in chickpea (Manchanda and Sharma 1990, Dhingra *et al.* 1995, Kiran 2004, Singla and Garg 2005), pea and broadbean (Manchanda *et*

Table 1: Effect of salinity on number of seeds plant^{-1} and seed weight g plant^{-1} (in parentheses) in different genotypes of chickpea.

Genotype	Salinity level (dS m^{-1})				Mean
	Control	4.0	6.0	8.0	
KC-1	15.83 (1.95)	15.16 (1.88)	13.33 (1.61)	12.66 (1.38)	14.24 (1.70)
HC-3	15.33 (3.81)	14.00 (3.47)	13.00 (3.00)	11.50 (2.41)	13.45 (3.17)
C 235	16.16 (1.97)	14.50 (1.52)	12.66 (1.32)	11.16 (0.97)	13.62 (1.44)
Pusa 256	15.83 (3.43)	13.83 (2.76)	11.83 (2.00)	8.66 (1.07)	12.53 (2.31)
IPC 94-94	15.50 (2.81)	14.83 (2.44)	11.66 (1.68)	9.00 (41.93)	12.74 (1.99)
HC-1	15.16 (2.10)	12.33 (1.43)	10.00 (0.92)	7.83 (0.64)	11.33 (1.27)
CSG 9505	16.33 (2.29)	9.33 (1.08)	7.16 (0.69)	6.00 (0.49)	9.70 (1.13)
HC-5	16.00 (2.60)	12.73 (1.90)	9.96 (1.20)	7.66 (0.75)	11.59 (1.61)
Mean	15.77	13.34	11.20	9.31	

CD at 5%: Genotype(G) = 0.483, Salinity(S) = 0.342, G x S=0.967

al. 1991) and mungbean (Singh 2003, Kanta 2004). Infact, reduction in seed set starts before the very beginning of fruit development due to failure of fertilization and abortion of the fertilized ovules. Reductions in seed set is increased remarkably by sibling rivalry for assimilate supply.

Salinity is known to exert depressive effects on physiological functions and energy generating biochemical processes in legumes (Ferri *et al.* 2000, Garg 2002). Chickpea seeds are known to contain starch ranging from 41.0 to 50.8% (Singh *et al.* 1997). Data present in Fig. 1 vividly evince that seeds of genotypes HC-3, C 235, IPC 94-94, HC-5 and CSG 9505 possessed comparable and significantly higher starch content over the rest of tested genotypes. Application of salinity significantly decreased the starch content of mature seeds, the decrease being maximum in genotypes CSG 9505 (42.04%) and HC-5 (39.14%) over their respective controls. The seed starch of KC-1, C 235 and HC-3 was relatively less affected by salinity). Kiran (2004) also noticed accumulation of total soluble sugars and decrease in starch content under salt stress in chickpea seeds. Reduction in the starch is possibly due to non-availability of soluble sugars as has been reported earlier (Dhingra *et al*. 1994). Possibly tolerant genotypes like KC-1 suffered less over the sensitive CSG 9505 and HC-5.

Another important component of chickpea seeds is protein, with content ranging from 12.6 to 30.5% (Singh *et al.* 1997). Seed protein of untreated plants was higher in Pusa 256 and CSG 9505 and lower in HC-3, IPC 94-94 and HC-5 when compared to other tested genotypes (Fig.2). Salinity decreased the protein content of seeds in all tested genotypes; the decrease being maximum in HC-1 (38.13%) followed by genotypes CSG 9505 (35.22%), Pusa 256 (33.97%) and HC-5 (33.43%).On the other hand, the genotypes KC-1, C 235 and HC-3 showed less decrease (28.29%) as compared to other genotypes. Earkier, Dhingra *et al.* (1996) reported an increase in protein content at low level of salinity whereas higher doses decreased it markedly in seeds of ICCV 88102, H82-2 and C235 genotypes. Also plants receiving salinity treatment at 65 days after sowing (prior to florogenesis) possessed enhanced level of seed proteins as compared to plants exposed to salinity treatment at sowing stage. Progressive decrease in protein content with increasing salinity has also been reported in faba bean leaves (Gabballah and Gomma 2004) and mungbean seeds (Kanta 2004). The decrease in protein content under salinity stress may be ascribed to decreased protein synthesis or increased hydrolysis of protein (Brady *et al.* 1984). Decreased protein synthesis in plants under salinization may be due to excessive increase of non-nutrient ionic strength in the cells. A progressive

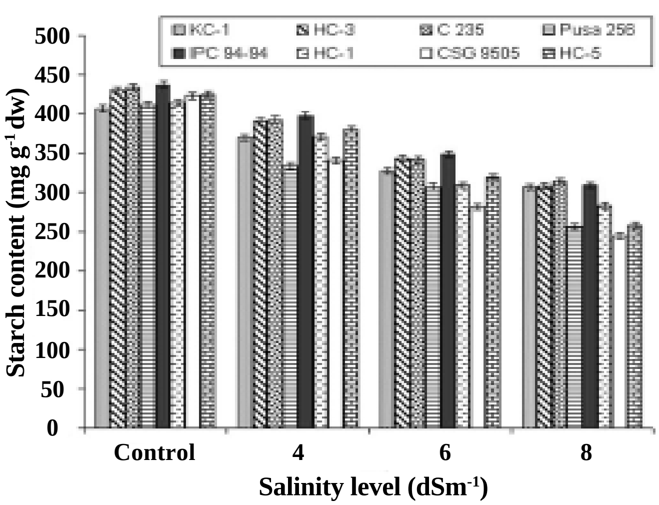

Fig. 1. Effect of salinity on starch content (mg g^{-1} dw) of seed in different genotypes of chickpea

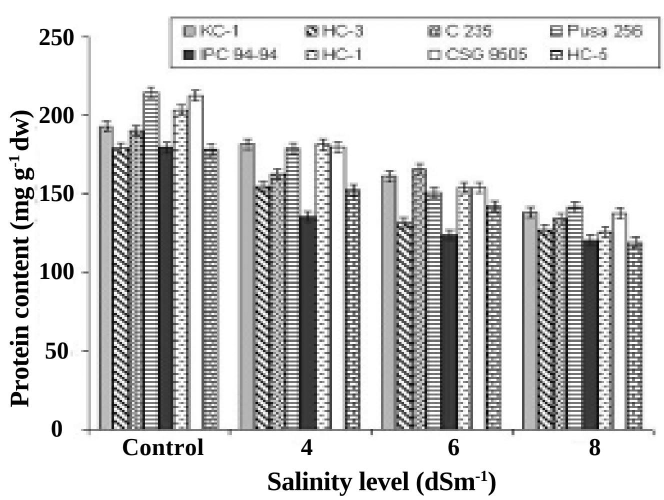

Fig. 2. Effect of salinity on protein content (mg g^{-1} dw) of seed in different genotypes of chickpea

decrease in soluble proteins due to enhanced protease activity corroborated with an accumulation of free amino acids including proline with increasing salinity has been reported in cumin at both vegetative and flowering stages (Garg *et al*. 2002) and other plants (Sheoran and Nainawatee 1990).

It may thus be concluded that although we have succeded in developing salinity tolerant genotypes of crop plants, such a genetic line is neither high yielding nor good in terms of seed quality when compared to the control.

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