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Effects of NaCl Salinity on Seed Germination, Growth and Yield of two Varieties of Chickpea (*Cicer arietinum* L.)

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Abstract: Salt tolerance level of chickpea varieties (Pb-91 and C-44) in artificially salinized rooting media with NaCl has been studied. The results revealed significant decrease in germination, seedling characters, yield and yield components, with the increase of salinity. The varieties showed tolerance level up to 12.1 dS m^{-1} for germination and other growth parameters. But Pb-91 appeared relatively more tolerant.

Key words: Chickpea, salinity and *Cicer arietinum*

Introduction

Salinity is one of the major stress factors which limit crop production in most of the arid and semiarid regions of the world. The limitation of crop production is caused by osmotic as well as specific ion effects (Bernstein, 1975). With the increase in population effective utilization of saline soils have become necessary either by reclamation or by growing salt resistant agricultural crops. The biological reclamation is also cheaper. The biotic approach to overcome the salinity problems has received a considerable attention from many workers (Mrumaker and Chavan, 1987). Chickpea (*Cicer arietinum*) has received prime importance due to its low cost of production and high protein content and it has gained- a greater importance for the mankind. Despite its importance very little attention has been given to the impact of salinity on it. Present work describes the salt tolerance level of two gram varieties i.e., Pb91 and C44

Materials and Methods

Seed Germination Studies: Six different salinity levels, S_0 (control), S_1 (4 dS m^{-1}), S_2 (8 dS m^{-1}), S_3 (12 dS m^{-1}), S_4 (16 dS m^{-1}) and S_5 (20 dS m^{-1}) were prepared with NaCl (Richards, 1954). Experiments were carried out at room temperature (25°C), 16-8 day - night photoperiod, using white fluorescent tubes and 70% relative humidity maintained at growth room of Botany Deptt., UAF. 36 sterilized petri dishes of 12 cm diameter and 2 cm depth lined with filter papers were soaked in equal amounts of respective solutions used for seed germination. Ten healthy seeds were sown in 3 replicates per treatment per variety on 12 October 1992 in a randomized complete block design. Observations on the germination of seed up to 10 days were made. Germination percentage, plumule and radicle lengths and fresh and dry weights of plumule and radicle were recorded.

Effect of Soil Salinity on Plant Growth and Yield: Soil obtained from Botanical Garden Research Area of the University was thoroughly mixed, sieved (2 mm) and air dried. 6 different salinity levels i.e., 1.25, 4.20, 8.10, 12.15, 16.10 and 20.25 dS m^{-1} were achieved by NaCl in pots containing 10.5 kg of t he soil. A total of 108 earthened pots (26 cm × 25 cm) lined with polythene bags were filled with artificially salinized soil for 6 treatments in 3 replicates per variety. The harvests started 63 days after sowing and with six week interval were made. 10 seeds of each Chickpea variety were sown in pots on 28/10/92. After 21 days seedlings were thinned out to 3 per pot. The pots were placed in wire house of Botanical Garden, University of Agriculture, Faisalabad under the climatic conditions prevailing at that time of the year. All pots were placed in randomized complete block design and watered after alternate days. 63 days after sowing shoot and root length, root and shoot dry weights were noted at the time of each harvest. Number of flowers per pot and yield were recorded with II and III harvest respectively. Data so collected were analyzed statistically by adapting analysis of variance techniques based on randomized complete block design (RCBD) and split plot layout in harvests. Effects of various treatment means and variety means were compared by applying New Duncan's Multiple Range Test (Le Clerg *et al.,* 1962; Steel and Torrie, 1980) at 0.01 and 0.05 levels of significance.

Results

Effects of Salinity on Seed Germination and seedling growth

Germination Percentage: The data presented in Table 1 indicate that there was non-significant difference among the S_0, S_1, S_2 and S_3 treatments. The results showed that germination was suppressed at high salinity levels of 16.1 and 20.1 dS m^{-1} . Rest of the salinity levels showed as good germination as in control. Variety means indicated high percentage germination in Pb-91 than C-44 gram variety.

Seedling Growth: Plumule length (Table 1) was significantly suppressed by all salinity levels compared with control. Successive increase in salinity levels decreased the plumule length up to 16.1 dS m^{-1}. Increasing salinity among more than this level had no effect on plumule length. Plumule lengths of both the varieties was statistically similar. Low salinity level (S_1) gave similar radicle length as recorded in control pots (Table 1). Increasing salinity levels upto 16.1 dS m^{-1} decreased the radicle length successively. However, increasing salinity further had non-significant effect on radicle length. Higher radicle length (0.60 cm) in variety Pb-91 was recorded as compared with C-44. Data indicated that lower salinity level (4.1 dS m^{-1}) produced same fresh weight of seedling as in control. Similarly increasing salinity levels beyond 8.0 dS m^{-1} had no effect on fresh weight of seedling. Dry weight of seedlings was not affected by salinity levels as compared with that of control. Both the varieties showed statistically similar

Table 1: Effects of different salinity treatments on seed germination and seedling growth

Treatments (dS m^{-1})	Germination (%)	Plumule length (cm)	Radicle length (cm)	Fresh weight (g)	Dry weight (g)
S_0 (control)	93.33a	8.392a	1.105a	0.653a	0.270a
S_1 (4.1)	93.33a	5.060b	1.053a	0.603ab	0.245a
S_2 (8.0)	91.67a	3.523c	0.590b	0.542bc	0.243a
S_3 (12.1)	90.00a	2.447d	0.367c	0.518c	0.243a
5_4 (16.1)	53.33b	1.127de	0.063d	0.515c	0.243a
S_5 (20.1)	46.667b	0.648e	0.007d	0.498c	0.235a
LSD (p = 0.05)	9.56	1.37	0.219	0.092	0.053

	Variety means		
Items	Pb-91	C-44	LSD (0.05)
Germination (%)	80.78a	68.330b	9.560
Plumule length	3.943a	3.123a	1.370
Radicle length	0.760a	0.302b	0.219
Fresh weight	0.574a	0.536a	0.092
Dry weight	0.257a	0.237a	0.053

Table 2: Effects of salinity treatments on plant growth at Harvest I

Treatments (dS m^{-1})	Shoot length (cm)	Root length (cm)	Shoot dry weight (g)*	Root dry weight (g)
S_0 (control)	18.967ab	8.000a	0.950a	0.175a
S_1 (4.20)	21.083a	8.650a	0.950a	0.175a
S_2 (8.10)	18.1·50ab	6.733b	0.488c	0.088bc
S_3 (12.15)	17.233b	6.200b	0.488c	0.473bcd
5_4 (16.10)	11.050c	4.450c	0.163d	0.052cd
S_5 (20.25)	6.117d	2.200d	0.112d	0.042d
LSD (p = 0.05)	4.217	1.570	1.416	0.286

	Variety means		
Items	Pb-91	C-44	LSD (0.05)
Shoot length	17.233a	13.294b	4.217
Root length	6.217a	5.861a	1.570
Shoot dry weight	0.517a	0.454a	1.416
Root dry weight	0.094a	0.083a	0.286

*Means followed by the same letter within a column are not significantly different at 5% level as determined by least significant difference

Table 3: Effects of salinity treatments on plant growth at Harvest II

Treatments (dS m^{-1})	Shoot length (cm)	Root length (cm)	Shoot dry weight (g)	Root dry weight (g)	Flower number
S_0 (control)	44.733a	15.050a	3.398a	0.288a	22.000a
S_1 (4.20)	40.833ab	14.00a	2.362b	0.233a	16.167b
S_2 (8.10)	44.167a	12.250b	2.110b	0.233a	10.833c
S_3 (12.15)	39.167b	10.417c	1.810b	0.220a	5.667d
S_4 (16.10)	31.500c	9.917c	1.063c	0.192a	0.500e
S_5 (20.25)	22.083d	7.500d	0.613c	0.067a	0.167e
LSD (p=0.05)	5.695	1.687	1.020	0.502	3.474

	Variety means		
Items	Pb-91	C-44	LSD (0.05)
Shoot length	40.400a	33.761b	5.695
Root length	11.999a	11.056b	1.667
Shoot dry weight	2.009a	1.777b	1.020
Root dry weight	0.248a	0.173a	0.502
Flower No./plant	8.944a	8.833a	3.474

Table 4: Effect of salinity treatments on plant growth and yield at Harvest

Treatments (dS m^{-1})	Shoot length (cm)	Root length (cm)	Shoot dry weight (g)	Root dry weight (g)	Yield (g)
S_0 (control)	45.533a	13.383a	5.047a	0.288a	22.288a
S_1 (4.20)	39.667b	13.417a	4.128a	0.233a	13.767b
S_2 (8.10)	39.000b	12.167ab	3.823a	0.223a	10.446c
S_3 (12.15)	37.333b	10.167bc	3.743ab	0.220a	8.524d
S_4 (1 6.10)	30.333c	9.333cd	2.043ab	0.192a	2.618e
S_5 (20.25)	25.417d	7.667d	1.240b	0.067a	0.045f
LSD (p= 0.05)	3.697	2.585	2.394	0.387	1.404

	Variety means		
Items	Pb-91	C-44	LSD (0.05)
Shoot length	38.667a	33.761b	3.697
Root length	11.211a	11.056a	2.585
Shoot dry weight	2.009a	1.777a	2.394
Root dry weight	0.248a	0.173a	0.387
Total yield	12.016a	7.127b	1.404

fresh and dry weight of seedlings.

Effects of Salinity on Plant Growth and Yield

Harvest I: In Table 2 is given the data for length and weight of shoots and roots of the two chickpea varieties. All levels of salinity except S_i showed highly significant ($p < 0.05$) decrease than that of control (S_0). There was maximum (21.08 cm) shoot length in S_1 treatment and minimum (6.11 cm) in S_5 treatment. The shoot length decreased as the salinity level increased. The shoot length was longer in variety Pb-91 than that of variety C44. The root length of both varieties indicated highly significant decrease than that of control except S_1. The overall treatment means indicate that there was highly significant difference among the treatments. The longest (8.00 cm) root was reported in control and shortest (2.20 cm) in highly saline treatment. The treatments, S_0 and S_1 did not differ significantly but differed significantly than those of S_2, S_3, S_4 and S_5. The treatments S_2 and S_3 also did not differ significantly but differed significantly than those of S_4 and S_5 treatments. The longer root length was reported in variety Pb91 than that of variety C-44. There was highly significant difference between overall treatments for dry weight of the shoot. The medium salinity levels did not differ significantly. Similarly the high salinity levels also did not differ significantly. It is clear that there was progressive decrease in dry weight of shoot with the increase of salinity. The difference caused by salinity on dry weight in both varieties of gram was non significant. There was gradual decrease in the dry weight of root from control to high salinity levels. Both varieties showed non-significant difference in this regard.

Harvest II: The data given in Table 3 indicate the shoot and root length, shoot and root dry weight and numbers of flowers at Harvest II. The shoot length of the two varieties of gram showed highly significant difference among the treatments but S_0 and S_2 did not differ significantly. The maximum (44.733 cm) shoot length was noted in control (S_0) and minimum (22.083) in S_5 (highly saline) treatment. The overall treatment means indicated that shoot length decreased from low salinity level to high salinity levels except S_2 treatment. The longer shoot length was observed in variety Pb-91 than C-44. There was significant decrease in medium and high salinity levels than that of control in both varieties. The maximum (15.05 cm) root length was noted under control (S_0) and minimum (7.5 cm) root length was observed under highly saline treatment (S_5). The root length progressively decreased as the salinity levels increased. The root length of the variety Pb-91 was significantly longer than that of variety C-44. The treatments S_1, S_2 and S_3 did not differ significantly for the dry weight of the shoot of the two Chickpea varieties. Similarly the treatments S_4 and S_5 also did not differ significantly. The shoot dry weight decreased as the salinity level increased. There was non-significant difference between the dry weight of shoot of the two gram varieties and the root length of Pb-91 was slightly longer than that of C-44. The varietal difference was non significant for dry weight of root. Similarly nonsignificant difference was also observed in all treatments in both the varieties. The number of flowers per plant was counted in all salinity treatments at the time of II harvest on 13th February 1992, which indicated that there was highly significant difference between overall treatments. But treatments S_4 and S_5 did not differ significantly. Maximum (22.00) number of flowers was noted under S_0 and minimum (0.167) number was noted in S_5 treatment. Varietal difference was non-significant in this regard.

Harvest III: The data given in Table 4 indicates the shoot and root lengths, dry weights of shoot and root and yield of the two gram varieties at different levels of salinity and comparison with that of control at the time of harvest III. The data of the shoot length indicated that there was significant difference between the overall treatments but there was non-significant difference among S_1, S_2 and S_3 treatments. The maximum (45.53 cm) shoot length was noted under control (S_0) and minimum 25.41 cm) under S_5 (highly saline). But in S_1, S_2, S_3 and S_4 treatments the shoot length was observed in between these two extremes. Shoot length decreased as the salinity levels increased. The longer shoot length was observed in gram variety Pb-91 than variety C-44. The effect of medium salinity levels (S_2 and S_3) and high salinity levels S_4 and S_5) on root length of two gram varieties showed statistically highly significant decrease than those of control (S_0) and low salinity level (S_1) plants. There was highly significant difference among overall treatments but S_0 and S_1 showed non-significant difference and these two treatments differed significantly than those of S_2, S_3, S_4 and S_5. The longest (13.417 cm) root length was found under S_1 and minimum (7.667 cm). There was statistically non-significant varietal difference for their shoot length. The dry weight of shoot showed non-significant difference between the overall treatments. There was non-significant difference between S_0, S_1 and S_2 treatments. Similarly S_4 and S_5 treatments showed non-significance difference between each other. There was progressive decrease in dry weight of shoot with the increase of salinity levels. There was more shoot dry weight in variety Pb-91 than that of variety C-44. The dry weight of the root indicated the significant difference between overall treatments but S_1, S_2, S_3 and S_4 treatments did not differ significantly. The maximum (0.307 g) root dry weight noted under control (S_0) and minimum (0.078 g) under S_5 treatment. Varietal difference was also significant and there was more dry root weight in Pb-91 gram variety than that of C-44. The total yield per 9 plants of the two gram varieties indicated highly significant difference between overall treatments. The maximum (22.288 g) yield was noted under control (S_o) and minimum (0.045 g) under S_5 treatment. The intermediate mean values were observed under S_1, S_2, S_3 and S_4 treatments The total yield in terms of seed dry weight gradually decreased with the increase of salinity levels. The Variety Pb-91 produced more total yield (12.016 g) and variety C-44 produced lesser total yield (7.127 g).

Discussion

In treatments S_0, S_1, S_2 and S_3 the seed germination was equal and higher than those in S_4 and S_5 treatments in variety C-44. But in variety Pb-91 maximum seed germination took place in control and minimum seed germination took place in highly saline (S_5) treatment. In variety C44 there was slight stimulation of seed germination under S_1, S_2 and S_3 treatments (Table 1). The more delay in seed germination was observed in Variety C-44 than that of Pb-91 in highly saline treatments (Yadav *et al.,* 1989).

In variety C-44 maximum reduction (60%) in seed germination was observed under S_4 and S_5 treatments but in Variety Pb-91 maximum reduction was 33.33% under S_5 treatment. The germination percentage decreased as the salinity level increased (Mrumaker and Chavan, 1987). The seedling growth in terms of plumule and radicle lengths and fresh and dry weight was best in S_0 and S_1 (control and low saline) treatments, whereas there was poorest growth under S_4 and S_5 (highly saline) treatments in both the varieties. The seedling growth of S_2 and S_3 (moderately saline) treatments was intermediate between these two extremes. On the whole in highly saline treatments, there was more reduction of seedling growth in C-44 than in Pb-91. The plumule and radicle length gradually decreased with the increase in salinity (Sung, 1981). The fresh weight of the seedlings also decreased in these varieties (Hanks *et al.,* 1977). The decrease in fresh weight of seedling in highly saline media was due to the reduction in physiological availability of water with increase in solute suction from saline media and accumulation of toxic ions in plumule and radicle of the seedlings (Gill and Dutt, 1983). There was progressive decrease in dry weight of seedlings from control to highly saline media (Dua and Sharma, 1995). The growth in terms of shoot and root length fresh and dry weight of root and shoot of these varieties at the time of all the three harvests was best in S_0 and S_1 (control and low salinity) treatments, whereas in those of S_4 and S_5 (highly saline) treatments showed the poorest growth. The plants of S_2 and S_3 (moderately saline) treatments were in between these two extremes in both the varieties at the time of three harvests. The shoot and root length of the two varieties decreased with the increase of salinity media as reported by Ansari and Alam (1978) and Masih *et al.* (1978) respectively. Similarly shoot and root dry weight decreased as the salinity levels increased (Pakroo and Kashirad, 1981).

The varietal difference between these two varieties was highly significant and there was poorer growth in C-44 than in Pb-91 especially under highly saline treatments. Relatively speaking, at higher salinity levels the growth was better in variety Pb-91 than C-44.

The delay in flowering increased and the number of flowers per plant decreased as the salinity levels increased in both the varieties. (Datta *et al.,* 1981; Dhingra and Varghese, 1993). But decrease in flowering was more marked in variety C-44 than Pb-91. The total yield decreased as the salinity levels increased. The total yield reduced significantly by 38.06, 53.00, 61.65, 88.22 and 99.795% under S_1, S_2, S_3, S_4 and S_5 salinity stress respectively. There were no seed grain produced in variety C-44 under S_4 and S_5 (highly) saline media. But in variety Pb-91 the reduction in total yield was 77.75% and 99.61% under S_4 and S_5 treatments (Table 4). There was statistically gradual decrease in total yield of these varieties as the salinity levels increased (Manchandra and Sharma, 1990). Both varieties were adversely affected but variety C-44 showed comparatively more reduction than Pb91 From these studies it can be concluded that both varieties of Chickpea, *Cicer arietinum* proved to be salt sensitive. On the basis of their growth parameter, C-44 variety was more salt sensitive than Pb-91.

References

Ansari, A.Q. and S.M. Alam, 1978. Effect of sodium on the electrochemical potential difference and growth of sunflower plants. Proceedings of the Seminar on Membrane Biophysics and Development of Salt Tolerance in Plants, March 11-21, 1978, Faisalabad, Pakistan, pp: 16-31.

Bernstein, L., 1975. Effects of salinity and sodicity on plant growth. Ann. Rev. Phytopathol., 13: 295-312.

Datta, K.S., J. Dayal and C.L. Goswami, 1981. Effect of salinity on growth and yield attributes of Chickpea (*Cicer arietinum* L.). Ann. Biol., 36: 47-53.

Dhingra, H.R. and T.M. Varghese, 1993. Flowering and male reproductive functions of chickpea (*Cicer arietinum* L.) genotypes as affected by salinity. Biol. Planta., 35: 447-452.

Dua, R.P. and P.C. Sharma, 1995. Salinity tolerance of Kabuli and Desi chickpea genotypes. Int. Chickpea Pigeonpea Newslett., 2: 19-22.

Gill, K.S. and S.K. Dutt, 1983. Nature of salt injury at germination stage in paddy. Curr. Sci., 52: 1020-1022.

Hanks, R.J., T.E. Sullivan and V.E. Hunsaker, 1977. Corn and Alfalfa production as influenced by irrigation and salinity. Soil Sci. Soc. Am. J., 41: 606-610.

Le Clerg, E.L., W.H. Leonard and A.G. Clark, 1962. Field Plot Technique. 2nd Edn., Burgess Publishing Co., South Minneapolis, USA., pp: 144-146.

Manchandra, H. and S. Sharma, 1990. Influence of different chloride: Sulphate ratio on yield of chickpea. (*Cicer arietinum* L.) at comparable salinity levels. Indian J. Agric. Sci., 60: 553-555.

Masih, S.H., A. Kumar and D. Kumar, 1978. Salt tolerance of okra (*Abekmoschus esculentus*) Cr. Pusa Sawani. East Afr. Agric. For. J., 44: 171-174.

Mrumaker, C.V. and P.D. Chavan, 1987. Salinity induced biochemical changes during germination of chickpea. Actica-Agronmic-Hungarica, 36: 39-43.

Pakroo, N. and A. Kashirad, 1981. The effect of salinity and ion appliaction on growth and mineral uptake of sunflower (*Helianthus annus* L.). J. Plant Nutr., 4: 45-56.

Richards, L.A., 1954. Diagnosis and Improvement of Saline and Alkali Soils. Agriculture Handbook No. 60, United State Government Printing Office, Washington, DC., USA., Pages: 160.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics: A Biometrical Approach. McGraw Hill Co., New York, USA pp: 25-27.

Sung, J.M., 1981. Effect of sodium chloride salinity on germination of barley cultivars. J. Agric. Assoc. China, 113: 41-47.

Yadav, H.D., O.P. Yadav, O.P. Dhankar and M.C. Oswal, 1989. Effect of chloride salinity and boron on germination, growth and mineral composition of chickpea (*Cicer arietinum* L.). Ann. Arid Zone, 28: 63-67