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EFFECT OF SALINITY ON GROWTH, SEED YIELD AND NODULATION OF *CICER ARIETINUM*

JAVED I. MIRZA AND ROBINA TARIQ

Institute of Biology,
Bahauddin Zakariya, University, Multan, Pakistan.

Abstract

Growth, seed yield and nodulation of *Cicer arietinum* were compared at 0, 0.1, 0.2, 0.4, 0.8, 1.2, 1.6 and 2.0% levels of NaCl salinity in sandy clay loam. Fresh weight of shoots and roots after 8, 12 and 15 weeks salinity treatment, generally decreased with increasing salinity levels. Compared to vegetative growth, reproductive growth was more affected since pods were formed upto 0.4% NaCl levels, whereas, seeds were formed at NaCl level of upto 0.1% only. Number of nodule per plant, nodule weight and nodule size decreased with increasing salinity levels.

Introduction

Nitrogen fixation is of great practical importance since the use of nitrogenous fertilizers has resulted in unacceptable levels of water pollution and also the fertilizers are becoming steadily less economic (Sprent & Sprent, 1990).

Saline soils are common in the regions of arid and semi-arid climate where transport of soluble salts to the ocean does not occur because of low rainfall (Eaglesham & Ayanaba, 1984). The inhibitory effect of salinity on plant growth is well documented (Ng, 1987; Salim & Pitman, 1988) compared to that on nitrogen fixation (Sprent, 1984). Generally nodulated crop plants do not like saline conditions. Balasubramanian & Sinha (1976) found that NaCl severely reduced nodule initiation in cowpea and mungbean. *Vicia faba* grown under salt stress showed reduced number of nodules per plant which was partially compensated by producing larger nodules (Yousef & Sprent, 1983). The effects of NaCl on growth, seed yield and nodulation of *Cicer arietinum* are reported in this paper.

Material and Methods

Seeds of *Cicer arietinum*, obtained locally, were germinated on filter paper soaked in water. One week old seedlings of uniform size were transplanted into pots containing sandy clay loam soil (EC_e = 1.0 dS m^{-1}) with 0, 0.1, 0.2, 0.4, 0.8, 1.2, 1.6 and 2.0% NaCl. The salt was first dissolved in 900 ml water sufficient to wet 3kg air dried soil in each pot. There were 24 replicates for each NaCl treatment and the experimental design was completely randomized. The pots were watered to field capacity a day before each harvest.

For each NaCl treatment, 6 plants were harvested at 8, 12 and 15 weeks (first, second and third harvest, respectively) after transplantation. At the first harvest, electrical conductivity (EC) of soil samples from the root zone was also measured by a conductivity meter (CM-30EF). The electrical conductivities in dS m^{-1} at 25°C were 1.0(0), 1.1(0.1), 2.4(0.2), 4.3(0.4), 8.1(0.8), 14.4(1.2), 19.2(1.6) and 21.0 (2.0), the figures in parentheses being the equivalent percent values of NaCl added to the soil. At each harvest, fresh weight of shoots and roots were determined. At the third harvest, number of nodules

Table 1. Effect of NaCl concentration on shoot and root fresh weight of *Cicer arietinum* after 8,12 and 15 weeks of salinity treatment. Each value represents mean + SEM of 6 plants.

NaCl Conc. (%)	8 weeks Shoot fresh weight (g plant^{-1})	8 weeks Root fresh weight (g plant^{-1})	12 weeks Shoot fresh weight (g plant^{-1})	12 weeks Root fresh weight (g plant^{-1})	15 weeks Shoot fresh weight (g plant^{-1})	15 weeks Root fresh weight (g plant^{-1})
0	2.26±0.30	3.84±0.31	6.44±0.79	9.79±1.46	9.57±1.28	9.59±1.11
0.1	2.19±0.18	4.10±0.38	5.09±1.35*	7.33±1.71*	3.65±1.28	6.35±0.91*
0.2	1.85±0.21	3.62±0.54	2.49±0.19**	4.51±0.26**	1.38±0.13**	2.28±0.25**
0.4	1.15±0.03**	2.36±0.04*	2.34±0.40**	4.01±0.84**	1.53±0.18**	2.25±0.31**
0.8	1.30±0.13**	2.05±0.14**	1.51±0.08**	2.00±0.11**	0.81±0.18**	0.99±0.21**
1.2	1.42±0.08*	2.03±0.06**	1.47±0.04**	1.92±0.07**	0.55±0.08**	0.92±0.08**
1.6	1.30±0.09**	0.65±0.01**	1.24±0.20**	1.21±0.30**	0.84±0.12**	0.80±0.14**
2.0	1.19±0.03**	0.50±0.01**	1.05±0.05**	1.19±0.18**	0.38±0.01**	0.39±0.05**

*Significantly different to the control (0% NaCl) at $P < 0.05$,
**Significantly different to the control (0% NaCl) at $P < 0.01$.

per plant were counted and the nodules separated from the roots. Fresh weight and size of nodules (maximum diameter) were measured.

Results and Discussion

Plant growth and seed production: The growth of *C. arietinum*, at first, second and third harvest (Table 1) showed a general decrease in fresh weight of shoot and root with increasing salinity levels. The growth inhibition of shoot and root by NaCl levels increased with the age of plants. NaCl level of 0.4% reduced the total fresh weight of the

Table 2. Effect of NaCl concentration on pod number, pod weight and seed yield of *Cicer arietinum* after 21 weeks of growth. Each value represents mean + SEM of 6 plants.

NaCl Conc. (%)	Pod number per plant	Pod weight (g plant^{-1})	Seed yield (g plant^{-1})
0	16.33±3.51	2.76±0.28	1.51±0.25
0.1	09.83±1.73**	1.93±0.54*	1.22±0.40*
0.2	05.00±1.38**	0.16±0.01**	0
0.4	02.50±1.06**	0.06±0.01**	0
0.8	0	0	0

*Significantly different from the control (0% NaCl) at $P < 0.05$,
**Significantly different from the control (0% NaCl) at $P < 0.01$.

Table 3. Effect of NaCl concentration on nodule number, nodule weight and nodule size of *Cicer arietinum* after 15 weeks of growth. Each value represents mean + SEM of nodules from 6 plants.

NaCl Conc. (%)	Nodule number per plant	Nodule fresh weight (g plant^{-1})	Average diameter of nodule (mm)
0	9.28±2.73	2.26±0.82	21.00±1.43
0.1	4.10±0.90**	0.96±0.12**	14.00±0.50**
0.2	1.66±0.27**	0.13±0.05**	07.60±0.70**
0.4	1.00±0.01**	0.01±0.00**	01.90±0.61**
0.8	0	0	0

*Significantly different to the control (0% NaCl) at $P<0.05$,
**Significantly different to the control (0% NaCl) at $P<0.01$.

plants to 42, 61 and 80% oí the control at the successive harvests. Such retarding effects of salinity with the age of plants has also been reported by Salim (1988).

Reproductive growth of *C. arietinum* at maturity was also markedly affected by salinity treatment (Table 2). Number of pods significantly reduced with increasing salinity levels of up to 0.4% NaCl, after which no pods were formed. With increasing salinity levels, the pods that were formed were weaker and contained aborted or no seeds. Of all the growth characteristics, seed yield was most adversely affected by salinity treatment. Seeds were not formed at salinity levels higher than 0.1% NaCl.

Root nodulation: Root nodulation was adversely affected by the NaCl levels (Table 3).

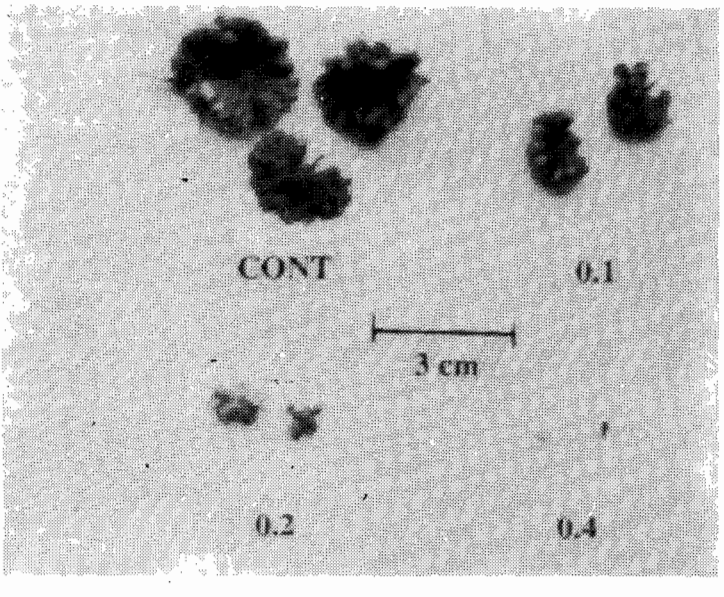

Fig.1. Effect of NaCl concentration (0 - 0.4%) on nodule size of *Cicer arietinum* after 15 weeks of growth.

At the third harvest, the number of nodules per plant decreased with increasing NaCl levels and as a result no nodules were formed at salinity levels higher than 0.4%. At 0.1% NaCl level, the number of nodules per plant reduced to 56% of the control, whereas, nodule fresh weight was reduced to 58% of the control. Average nodule size was also significantly reduced with increasing NaCl concentrations. These results are similar to the reports of Balasubramanian & Sinha (1976) and Ng (1987) which indicate an adverse effect of salinity on nodulation. However, Yousef & Sprent (1983) observed an increase in the nodule size of *Vicia faba* with increasing salinity. Zahran & Sprent (1986) investigated effects of salinity on infection processes in *V. faba* and found that bacterial colonization and root hair curling were both reduced by NaCl which presumably affected the nodule numbers. The reduced nodule numbers observed in *C. arietinum* might also involve an adverse effect of NaCl on the infection process.

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