



EFFECTS OF SALINITY ON THE GROWTH AND DEVELOPMENT OF GROUNDNUT PLANT (*Arachis hypogaea L.*)

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ABSTRACT

The present study investigated the effects of salinity on the growth of groundnut (*Arachis hypogaea L.*), variety BARI Badam-8. The plants were grown in a series of plastic pots under controlled light and temperature conditions in the growth room. Salt (NaCl) solutions of different concentrations (0 mM, 50 mM, 100 mM, 150 mM, 200 mM, and 250 mM) were added to the pots, with three replicates. Results showed that shoot height, number of plants, main root length and lateral root length significantly decreased with the increase of salt concentrations. Fresh weight as well as dry weight of shoots and roots also decreased with the increase of salt concentrations while leaf proline and protein concentrations increased. Overall results indicate that high salinity condition is not suitable for growing groundnut.

Keywords: Groundnut, salinity, salt tolerance

INTRODUCTION

Salinity can limit the growth and development of plants (Shanon, 1986). It is reported that 20% of the agricultural land and 50% of the world's crop land are salt affected and the area under salinity is increasing throughout the world (Yokoi *et al.*, 2002; Ponnampuruma, 1984).

Groundnut is a tropical legume which can feed human and poultry. Lipid content of groundnut is 42-52 percent, and protein is 25-32 percent. There are many vitamin and minerals in groundnut including vitamin A, vitamin B, Riboflavin, Folate, Mg, P, Mn, and some of the antioxidant compounds such as vitamin E and vitamin D (Sharif, 1997 and Karra *et al.*, 2013).

The climatic and edaphic conditions of coastal areas of Bangladesh are suitable for growing groundnut, but this is limited by high soil salinity and high pH (Reddy and Kaul, 1996). A groundnut cultivar needs to tolerate up to 8 dS/m salinity. Salinity decreases the growth indices of

the seedlings as well as the seed size (Smart, 1994). However, cultivation of groundnut has been challenged in Bangladesh due to increased salinity over the years (Sikder and Elias, 1985).

The main objective of the present study was to identify whether the variety, BARI Badam 8, is salt tolerant by examining the effects of salinity on seed germination rate and growth parameters (shoot height, root length, fresh and dry biomass of shoot and root) under different known concentrations of salt (NaCl) solution.

MATERIALS AND METHODS

Seeds of groundnut (*A. hypogaea L.*), BARI Badam-8, was collected from Bangladesh Agricultural Research Institute (BARI), Joydevpur, Gazipur. Germination rate and weight of 100 seeds were recorded. Before germination, seeds were surface-sterilized with 5% sodium hypochlorite. Then, the seeds were

left for three days for germination in a Petri-dish with autoclaved distilled water.

Three-day old seedlings were transferred to plastic pots previously filled with soil collected from the Botanical Garden of Jagannath University, Dhaka. Plants were supplied with salt solutions (NaCl) of six concentrations (0 mM, 50 mM, 100 mM, 150 mM, 200 mM, and 250 mM). Salt solution was applied to the pots once a week and water was applied once in every two days. Each treatment had three replicates. Thus, a total of 18 pots were used to grow plants in the growth room at the Department of Botany, Jagannath University. Ten plants were grown in each pot and the plants were allowed to grow for 6 weeks in the growth room.

Soil pH was determined from suspension of soil: water (2:1, v:w) using pH meter (Hanna pH meter, pHpP). Soil conductivity was determined in suspension with distilled water (5:1, v:w) using conductivity meter (Hanna conductivity meter). Soil moisture content (%) was determined from 10 g fresh soil after oven-drying at 80°C for 24 h. Organic Carbon content was analyzed by Walkley and Black method (Black, 1965). Total N content was determined by Kjeldahl method (Black, 1965). Soil P content was determined by Vanadomolybdophosphoric yellow color method (Jackson, 1958).

Shoots and roots were separated from the plants. Shoot height, number of live plants, fresh

weight, dry weight and main root length, lateral root length, fresh weight and dry weight were noted. Dry weight was measured after drying in oven at 60°C for 24 h. The 1g fresh leaf was used for the extraction of proline; optical density was recorded at 520nm wavelength by spectrophotometer. Proline content being expressed per gram leaf. Fresh leaf 1 g was used for the extraction of protein.

Mean values were compared for statistical significance by Analysis of Variance (ANOVA). For data analysis, JMP 4.0 software (SAS Institute, Carry, NC, USA) and for LSD test, STAR software (Statistical Tool for Agricultural Research) was used.

RESULTS

Soil pH was 6.95, conductivity 44.67 μ S, moisture content 8.25%. Organic carbon, N and P values were 0.41, 0.076 and 0.063%, respectively. Germination rate of groundnut (BARI Badam-8) seeds is presented in Table 1. Germination rate and seedling length decreased with the increase of salt concentration. The highest germination rate and seedling length (100% and 1.5 cm, respectively) were obtained from control (0mM), and was followed by 50mM, 100 mM, 150 mM, 200 mM and 250 mM. The ability of a seed to germinate and emerge under salt stress indicates that it has genetic potential for salt tolerance (Tejovathi *et al.*, 1988). Increases in NaCl concentration progressively inhibited seed germination and seedling growth.

Table 1. Germination test of groundnut seeds at different concentrations of salt solution

Salt concentrations (mM)	Total seed	Germination rate (%)			Mean seedling length (cm)
		1st day	2nd day	3rd day	
0	6	67	100	100	1.5
50	6	50	84	100	1.1
100	6	34	67	84	0.8
150	6	17	34	67	0.7
200	6	17	34	50	0.5
250	6	0	17	34	0.3

Shoot height and live plants

Effects of salt content on the shoot height and live plant of groundnut presented in Table 2 showed that shoot height and the number of plants differed significantly ($P < 0.001$) with different concentrations of salt. Shoot height and the number of survived plants decreased with

are presented in Table 3. It showed significant difference ($P < 0.001$ and $P = 0.004$, respectively). Root length decreased with increasing salinity levels and ranged between (1.16 ± 0.60) cm in 250 mM and (5.70 ± 0.10) cm in control treatment. In case of lateral root length, it also decreased with the increase of salinity and

Table 2. Effects of salt solutions on the shoot height and number of live plants of groundnut

Salt conc. (mM)	12 days		22 days		32 days		42 days	
	Live plants (%)	Height (cm)	Live plants (%)	Height (cm)	Live plants (%)	Height (cm)	Live plants (%)	Height (cm)
0	80.0±0.00a	17.3±0.42abc	80.0±0.00a	23.8±0.19a	76.3±1.85a	23.1±0.36ab	74.00±3.05a	26.1±0.29a
50	76.7±1.66a	19.5±0.96a	73.0±1.00ab	22.5±0.37ab	69.0±1.00ab	23.9±0.31a	59.33±0.66ab	25.3±0.29ab
100	78.3±1.66a	18.0±0.36ab	74.0±1.00ab	21.5±0.31bc	64.3±2.33b	22.3±0.42b	53.33±1.66bc	23.5±0.29ab
150	78.3±1.66a	17.0±0.29bc	74.0±1.00ab	20.1±0.29c	65.3±2.66b	20.8±0.15c	53.33±1.66bc	21.8±0.16ab
200	70.0±0.00b	15.9±0.29bc	66.0±1.00b	17.8±0.37d	52.3±1.45c	19.2±0.18d	38.66±1.66c	19.8±0.33ab
250	66.7±1.66b	15.4±0.26c	55.7±4.70c	16.4±0.32d	43.3±3.33d	18.0±0.28d	16.66±8.81d	12.6±6.28b
F-ratio	15.6	8.79	16.6	80.16	28.29	56.89	24.64	3.68
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.03

Means followed by the same letter does not differ significantly.

the increase of salt concentrations. Decreased growth under salt stress has been reported on arocado plant species (Bernstein *et al.*, 2004). At 12 days, the highest shoot height (19.51 ± 0.96) was found at 50 mM salt concentration while at 22, 32 and 42 days it was highest in control.

Main root length and lateral root length

The effect of different salinity levels on main root length and lateral root length of groundnut

ranged between (1.33 ± 0.66) cm in 250 mM and (4.63 ± 0.63) cm in control treatment. Root length decreased with increasing salinity levels, as reported by Aydinsakir *et al.* (2015). Plant height and root length are the most important parameters for salinity because roots are in direct contact with soil and absorb water from soil and the shoots supply it to the aerial parts of the plant (Jamil and Rha, 2004).

Table 3. Effects of salt solutions on the root length of groundnut

Salt conc. (mM)	Root length (cm)	Lateral root length (cm)
0	5.70 ± 0.10a	4.63 ± 0.63a
50	4.40 ± 0.05b	4.06 ± 0.47a
100	3.93 ± 0.06bc	3.40 ± 0.30ab
150	3.23 ± 0.14cd	2.83 ± 0.16ab
200	2.23 ± 0.14de	2.46 ± 0.26ab
250	1.16 ± 0.60e	1.33 ± 0.66b
F-ratio	36.84	6.64
P-value	<.001	0.004

Means followed by the same letter does not differ significantly.

Shoot fresh and dry weight

The effects of different salinity levels on plant fresh and dry weight are displayed in Table 4. It showed significant difference (P = 0.004 and P = 0.001, respectively). The highest plant fresh weight was found in control (1.36 ± 0.15 g) and the lowest fresh weight was in 250 mM (0.33 ± 0.16 g). The highest plant dry weight was noted in control (0.15 ± 0.01 g), and the lowest plant fresh weight in 250 mM (0.04 ± 0.02 g). It was observed that fresh and dry weights decreased gradually from control to 250 mM salt treatment.

Root fresh and dry weight

The effects of different salinity levels on root fresh and dry weight are presented in Table 4.

Root fresh and dry weight showed significant difference (P = 0.003 and <.001). Root fresh weight ranged from 0.019 ± 0.009 g to 0.060 ± 0.006 g and dry weight from 0.002 ± 0.001 g to 0.015 ± 0.001 g. The highest root fresh weight was obtained in control (0.060 ± 0.006 g) and the lowest root fresh weight in 250 mM (0.019 ± 0.009 g). Similar trend was found in case of root fresh and dry weights. High salinity may inhibit root and plant elongation due to slowing down the water uptake by the plant which might be another reason for this decrease (Werner and Finkelstein, 1995). Salinity can rapidly inhibit root growth and hence capacity of water uptake and essential mineral nutrition from soil (Neumann, 1995).

Table 4. Effects of salt solutions on fresh and dry biomass (shoot and root) of groundnut

Salt conc. (mM)	Shoot fresh weight (g/plant)	Shoot dry weight (g/plant)	Root fresh weight (g/plant)	Root dry weight (g/plant)
0	1.36 ± 0.15 a	0.15 ± 0.01 a	0.060 ± 0.006 a	0.015 ± 0.001 a
50	1.06 ± 0.13 a	0.12 ± 0.009 ab	0.052 ± 0.001 a	0.015 ± 0.001 a
100	1.01 ± 0.13 ab	0.10 ± 0.01 abc	0.048 ± 0.003 a	0.011 ± 0.0008 ab
150	1.00 ± 0.12 ab	0.09 ± 0.01 abc	0.036 ± 0.003 ab	0.007 ± 0.0003 bc
200	0.90 ± 0.02 ab	0.08 ± 0.002 bc	0.034 ± 0.002 ab	0.005 ± 0.0004 cd
250	0.33 ± 0.16 b	0.04 ± 0.02 c	0.019 ± 0.009 b	0.002 ± 0.001 d
F-ratio	6.64	8.83	7.20	30.71
P-value	0.004	0.001	0.003	<.001

Means followed by the same letter does not differ significantly.

Proline and Protein content

Effects of salinity on the proline and protein contents of groundnut plants are shown in Table 5. In the leaf tissues the proline and protein contents differed significantly ($P < 0.001$) among different concentrations of salt. Proline accumulation in root tissue increased with the increase of salt concentrations. The lowest proline content was ($0.503 \pm 0.012 \mu\text{g/g}$) recorded

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Table 5. Proline and protein concentrations of groundnut plant under different salt concentrations

Salt conc. (Mm)	Proline concentrations ($\mu\text{g/g}$)	Protein concentrations (mg/g)
0	$0.5 \pm 0.012\text{f}$	$0.21 \pm 0.008\text{d}$
50	$0.81 \pm 0.017\text{e}$	$0.22 \pm 0.012\text{cd}$
100	$1.02 \pm 0.017\text{d}$	$0.328 \pm 0.01\text{bc}$
150	$1.75 \pm 0.015\text{c}$	$0.303 \pm 0.01\text{b}$
200	$2.0 \pm 0.014\text{b}$	$0.372 \pm 0.01\text{b}$
250	$2.15 \pm 0.008\text{a}$	$0.475 \pm 0.02\text{a}$
F-ratio	2226.77	55.98
P-value	<0.001	<0.001

Means followed by the same letter does not differ significantly.

in control and the highest proline content was ($2.15 \pm 0.008 \mu\text{g/g}$) obtained in 250 mM salt treatment. Cha-Um and Kirdmanee (2009) have reported higher proline concentration in lentil plants under salt stress condition.

The lowest protein content ($0.210 \pm 0.008 \text{mg/g}$) was found in control and the highest protein content ($0.475 \pm 0.024 \text{mg/g}$) in 250 mM salt concentrations.

Overall, results indicate that the growth parameters of groundnut (BARI Badam-8) plants were markedly affected by 250 mM salt treatments indicating that high salinity is not suitable for cultivation of groundnut.

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