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# Morpho-Physiological Response of Groundnut Genotypes to Salinity Stress at Early Seedling Stage

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**Abstract:** An experiment was conducted at the Department of Crop Botany, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh during the period from January, 2020 to June, 2020 to evaluate the morpho-physiological response of groundnut genotypes under salinity stress at early seedling stage. The four groundnut genotypes were, namely, $V_1$= BARI Chinabadam-8, $V_2$= Maijchar badam (Dhaka-1), $V_3$= Binachinabadam-6 and $V_4$= Binachinabadam-8. Two salinity levels were, namely, $S_1$= 0 dS/m NaCl and $S_2$= 12 dS/m NaCl used for hydroponic experiment. The treatments were designed in a Completely Randomized Design (CRD) with four replications in a factorial arrangement. The parameters of the experiment measured were root length, shoot length, number of leaves, number of leaflets, leaf area, Soil Plant Analysis Development (SPAD) value, root fresh weight, leaf fresh weight, shoot fresh weight, root dry weight, leaf dry weight, and shoot dry weight. The result indicated that there were significant differences between the genotypes and salinity stress in all of the studied parameters. Maximum root length (33.20 cm), number of leaves (7.25), number of leaflet (24.50), leaf area (128.07 $cm^2$), SPAD value (41.67), leaf fresh weight (3.43 g) and shoot dry weight (0.11 g) were recorded in the genotype Binachinabadam-6 in a combination of control condition. On the contrary the minimum shoot length (12.17 cm), root length (16.72 cm), number of leaves (2.75), number of leaflet (15.50), leaf area (21.90 $cm^2$), SPAD value (31.42), leaf fresh weight (0.72 g), shoot fresh weight (0.92 g), leaf dry weight (0.11 g) and shoot dry weight (0.09 g) were recorded from the genotype Binachinabadam-8 in stress condition. So, the higher susceptible genotype Binachinabadam-8 to saline conditions and the lower was Binachinabadam-6. Therefore, it may be concluded that the variety Binachinabadam-6 will be more suitable for the saline prone areas of Bangladesh.

**Keywords:** Groundnut; Genotypes; Hydroponics; Physiology; Salinity; Photosynthesis.

## INTRODUCTION

Groundnut (*Arachis hypogaea* L.), the king of oil seeds originates from South America, is one of the major legume crops of tropical and semiarid tropical countries including Bangladesh, where it provides a major source of oil, carbohydrates and proteins. Salinity is one of the leading environmental factors that affects the groundnut yield and food safety worldwide. Severity of salinity relies on the stage of crop development, the length of stress period and the enormity of salt. Membrane lipids and photosynthetic responses in plants are hampered by salinity (Lauriano *et al.* 2000). Ungar *et al.* (1979) have earlier reported that saline soil had significant negative effects on plant growth. Salinity is also considered as an incite stress in plants; hence the ability of plants to tolerate and accrete in saline soils has a significant agricultural importance, since it evidences that oppressed plants have genetic potential against salinity is a very covetable trait (Francois and Maas 1994). High soil salinity causes yield reduction, which is considered as a severe abiotic constraint for groundnut cultivation. In Bangladesh, around 1.02 million ha of cultivable land in coastal belt, is affected by various levels of soil salinity, 2.0 to >16 dS/m (Karim *et al.* 2001 and SRDI 2003). Soil salinity in those areas remains lower from June to November but increases and accentuates from May onwards (Islam *et al.* 1997). Water consuming crop cultivation is hardly possible during the dry period (November to May) in saline prone areas of Bangladesh due to lack of adequate irrigation water. Groundnut (*Arachis hypogaea* L.) needs only 350 mm water to complete its entire life cycle (Field 1995) and is mostly cultivated under rainfed conditions during November to April/May. The edaphic and climatic conditions of saline prone areas of Bangladesh are good for growing groundnut, but this is restricted by soil salinity and high pH (SRDI 2003 and Reddi *et al.* 1996). For growing in this condition, a groundnut cultivar must have the potentiality to tolerate salinity up to 8 dS/m. If it was possible, the area of groundnut cultivation could be extended to saline-affected soils.

In agricultural cultivation, concentrated fertilizer solutions are used containing abundant nutrients. In 1976, Moody introduced fertilizer-driven forward osmosis desalination concept (Moody *et al.* 1976), and the feasibility of drawing water from brackish water was justified through ammonium sulfate. After several years, single and blended inorganic salts like $NH4^+$, $K^+$ and $PO_4^{3-}$ were used as the draw solutes (Phuntsho *et al.* 2012 and Phuntsho *et al.* 2011) and it was recorded that those draw solutes can create an osmotic pressure higher than the seawater. Moreover, commercial solid and liquid fertilizers (Zou and He 2016, Xie *et al.* 2015) were also inquired as draw solutes. All these researches approved that application of concentrated fertilizers are appropriate as the draw solutions for FO processes. In view of the above facts, this experiment was commenced to investigate the morpho-physiological response against salt tolerance variability among the groundnut genotypes.

## MATERIALS AND METHODS

### Study location

The experiment was conducted at crop physiology laboratory of Crop Botany Department in Bangladesh Agricultural University, Mymensingh located at 24.75° North latitudes and 90.50° East longitudes during the period from January, 2020 to June, 2020 to evaluate the morpho-physiological response of groundnut genotypes under salinity stress at early seedling stage.

### Experimental design and data collection

Seeds of BARI Chinabadam-8, Maijchar badam (Dhaka-1) were collected from BARI (Bangladesh Agricultural Research Institute) and Binachinabadam-6, Binachinabadam-8 from BINA (Bangladesh Institute of Nuclear Agriculture). The experiment was comprised of two factors. The factors were: A. 4 Varieties: $V_1$= BARI Chinabadam-8, $V_2$= Maijchar badam (Dhaka-1), $V_3$= Binachinabadam-6 and $V_4$= Binachinabadam-8.; B. Two levels of salinity in hydroponics: $S_1$= 0 dS/m NaCl and $S_2$= 12 dS/m NaCl (5.48 g NaCl per liter, distilled water). The experiment was set in Completely Randomized Design (CRD) with four replications. Total four pots and two water tanks were used in this experiment. The individual tank was 8 L in capacity. The treatments were assigned randomly to the water tank. The experiments were established in a growth chamber at 25°C under a 12 h light and 12 h dark regime, 70% relative humidity. Germination of seed and growth of seedlings were frequently monitored and pH (5.5) of the culture solutions was accurately maintained in all the experiments. The solution was refreshed with new nutrient solutions containing, $NH_4NO_3$: 500 µM, $Ca(NO_3)_2$: 500 µM, $MgSO_4$: 200 µM, $KH_2PO_4$: 100 µM, $FeCl_3$: 2 µM, $H_3BO_3$: 11 µM, $MnCl_2$: 2 µM, $ZnCl_2$: 0.35 µM, $CuCl_2$: 0.2 µM, $(NH_4)_6Mo_7O_4$: 0.1 µM at 5 days interval. Germination of groundnut seeds were executed in nets connected with distilled water having 100 µM $CaCl_2$ in glass house controlled condition. Seven days old seedlings were shifted to incessantly aerated nutrient solutions. Sodium chloride solution of 12dS/m concentration was employed in water tank containing both macro and micro nutrients at 5 days interval. Parameters of the experiment measured were root length, shoot length, number of leaves, number of leaflets, leaf area, SPAD value, root fresh weight, leaf fresh weight, shoot fresh weight, root dry weight, leaf dry weight, and shoot dry weight. The data in respect of growth were analyzed statistically to determine the significance of the experimental results. Mean values for all the treatments were computed and the ANOVA for all the characters were performed by F test (Gomez and Gomez 1984). The significance of difference between the pairs of means was distinguished by LSD test at 5% levels of probability by using MSTAT package program.

## RESULTS AND DISCUSSIONS

### Root length (cm)

In case of root length, the effects of salt differ significantly (Fig. 1). In control condition, the longest root length (33.20 cm) was measured from the genotype Binachinabadam-6 and the shortest root length (16.72 cm) was achieved from Binachinabadam-8 in stress condition. These results are similar with Doley and jite (2012) who confirmed that root length of groundnut curtailed with increasing salinity level, where salinity reduced root length of groundnut.

### Shoot length (cm)

The effects of salinity on shoot length of groundnut genotypes differ significantly (Fig. 2). In control condition, the longest shoot length (34.35 cm) was measured from the genotype BARI Chinabadam-8, was statistically identical with Binahinabadam-6 and the shortest shoot length (12.17 cm) was achieved from Binachinabadam-8 in stress condition. The graph showed that, shoot length was decreased in each genotype in stress condition. These results are similar with Doley and Jite (2012) who figured that shoot length of groundnut abated with increasing

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salinity level, where salinity reduced shoot length of groundnut.

**Number of leaves per plant**

Significant variation was observed among the genotypes and treatment (Fig. 3). In control condition, the maximum number of leaves (7.25) was counted from the genotype Binachinabadam-6, was statistically identical with all other combination except Binachinabadam-8 in stress condition (2.75) which mean minimum the number of leaves. Villa-castorena *et al*. (2003) reported that higher salinity restricts leaf quantity in plant.

**Number of leaflet per plant**

Four groundnut genotypes showed different magnitude of reductions in the number of leaflet due to salt. Significant variation was observed among the genotypes and treatment (Fig. 4). In control condition, the maximum number of leaflet (28.50) was recorded from the genotype Binachinabadam-6 followed by BARI Chinabadam-8 and the minimum (15.50) was found in Binachinabadam-8 in stress condition.

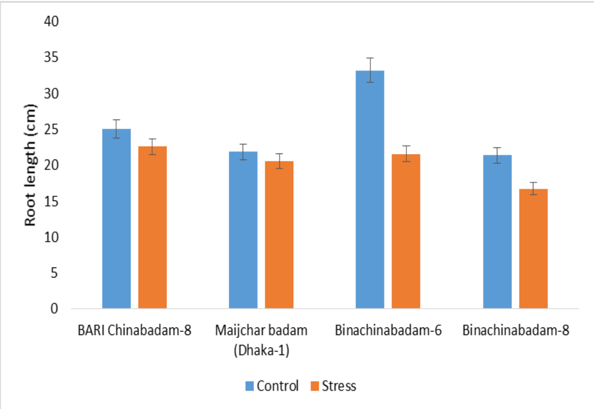


Fig. 1. Effects of salt stress on root length of four groundnut genotypes

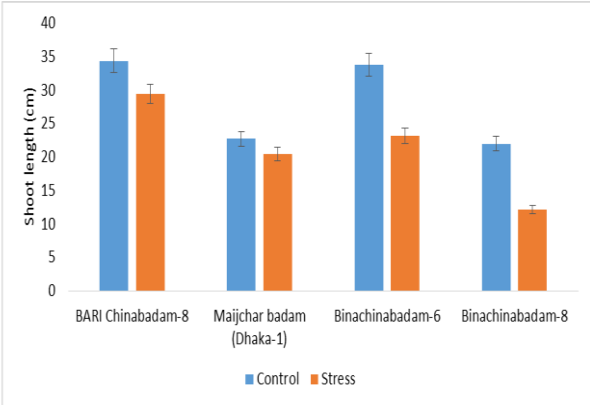


Fig.2. Effects of salt stress on shoot length of four groundnut genotypes

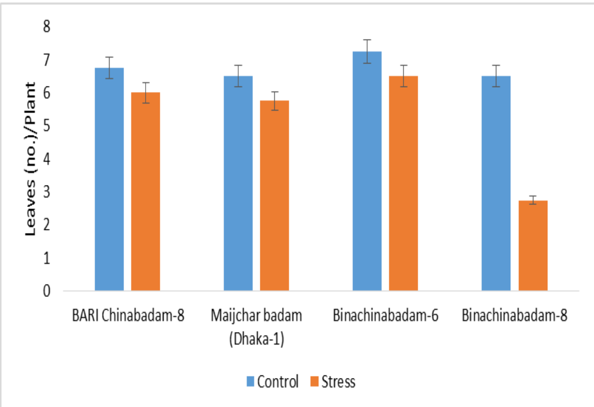


Fig. 3. Effects of salt stress on number of leaves per plant of four groundnut genotypes

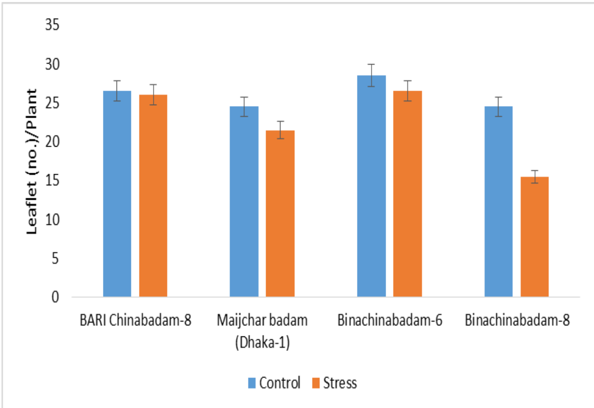


Fig. 4. Effects of salt stress on number of leaflet per plant of four groundnut genotypes

**Root fresh weight (g)**

Four groundnut genotypes showed different magnitude of reductions in the root fresh weight due to salt. Significant variation was observed among the genotypes and treatment (Table 1). In control condition, the maximum root fresh weight (1.26 g/plant) was achieved from the genotype Binachinabadam-8 and the lowest root fresh weight (0.57 g/plant) was achieved from Binachinabadam-6 in stress condition. Similar trend was observed in case of root fresh weight and dry weight. Higher salinity may restrict root growth and plant elongation due to poor uptake of water by the plant which might be another cause for this decrease (Werner and Finkelstein 1995). These results also consist with Satu and Ahmad (2019) who reported that root fresh weight of groundnut decreased with increasing salinity level, where salinity reduced root fresh weight of groundnut.

**Root dry weight (g)**

Four groundnut genotypes showed different magnitude of reductions in the root dry weight due to salt. Significant variation was observed among the genotypes and treatment (Table 1). In control condition, the highest root dry weight (0.31 g) was achieved from the genotype Binachinabadam-

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8 and the lowest root dry weight (0.12 g) was achieved from BARI Chinabadam-8 in stress condition. Mwai (2001) reported that root dry weight was decreased with the increment of salinity levels.

**Table 1.** Combined effects of salinity and genotypes on root, shoot and leaf of groundnut genotypes

| Salinity level(s) | Genotype(s) | Root fresh wt. (g) | Root dry wt. (g) | Shoot fresh wt. (g) | Shoot dry wt. (g) | Leaf fresh wt. (g) | Leaf dry wt. (g) |
|---|---|---|---|---|---|---|---|
| Control ($S_1$) (0 dS/m) | BARI Chinabadam-8 ($V_1$) | 0.74d | 0.19c | 4.00a | 0.33a | 3.13b | 1.02a |
| | Maijchar badam (Dhaka-1) ($V_2$) | 1.13b | 0.17c | 2.28c | 0.25c | 1.80c | 0.21c |
| | Binachinabadam-6 ($V_3$) | 1.10b | 0.25b | 3.66b | 0.36a | 3.43a | 0.20c |
| | Binachinabadam-8 ($V_4$) | 1.26a | 0.31a | 2.50c | 0.29b | 1.75c | 0.23b |
| Stress ($S_2$) (12 dS/m) | BARI Chinabadam-8 ($V_1$) | 0.61e | 0.12d | 3.44b | 0.18d | 3.00b | 0.12e |
| | Maijchar badam (Dhaka-1) ($V_2$) | 0.88c | 0.21bc | 1.27d | 0.21c | 1.50d | 0.17de |
| | Binachinabadam-6 ($V_3$) | 0.57e | 0.15d | 1.04de | 0.29b | 0.86e | 0.19d |
| | Binachinabadam-8 ($V_4$) | 0.86c | 0.13e | 0.92e | 0.09e | 0.72e | 0.11f |

In a column, values with same letter(s) do not differ significantly at 5% level by LSD

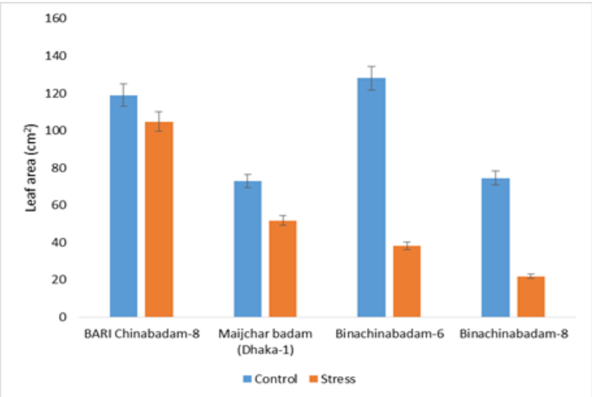


Fig. 5. Effects of salt stress on leaf area of four groundnut genotypes

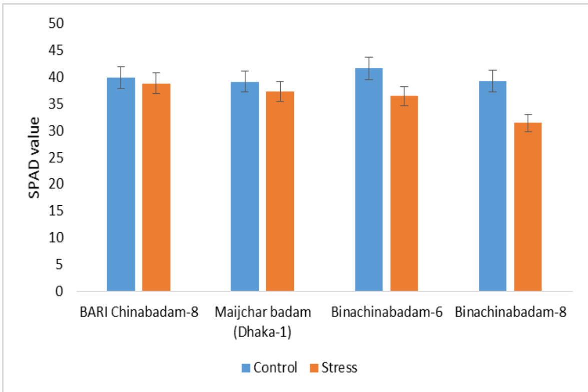


Fig. 6. Effects of salt stress on SPAD value of four groundnuts genotypes

**Shoot fresh weight (g)**

Salinity has effects on shoot fresh weight of groundnut genotypes differ significantly (Table 1). In control condition, the maximum shoot fresh weight (4.00 g) was recorded from the genotype BARI Chinabadam-8 and the lowest shoot fresh weight (0.92 g) was achieved from Binachinabadam-8 in stress condition. Severe salinity may inhibit shoot and plant growth due to slow uptake of water by the plant which might be another cause for this decrease (Werner and Finkelstein 1995). These results also consist with Satu and Ahmad (2019) who reported that shoot fresh weight of groundnut abated with increasing salinity level, where salinity reduced shoot fresh weight of groundnut.

**Shoot dry weight (g)**

The effects of salinity on shoot dry weight of groundnut genotypes differ significantly (Table 1). In control condition, the maximum shoot dry weight (0.36 g) was gained from the genotype Binachinabadam-6 and the minimum shoot dry weight (0.09 g) was achieved from Binachinabadam-8 in stress condition. The table showed that, shoot dry weight was decreased in each genotype in salt. Similar result was found in white seed coat bambara (Tafouo *et al*. 2008).

**Leaf fresh weight (g)**

Four groundnut genotypes showed different magnitude of reductions in the leaf fresh weight due to salt. Significant variation was observed among the genotypes and treatment (Table 1). In control condition, the utmost leaf fresh weight (3.43 g/plant) was achieved from the genotype Binachinabadam-6 and the least leaf fresh weight (0.72 g/plant) was achieved from Binachinabadam-8 in stress condition.

**Leaf dry weight (g)**

Four groundnut genotypes showed different magnitude of reductions in the leaf dry weight due to salt. Significant variation was observed among the genotypes and treatment (Table 1). In control condition, the highest leaf dry weight (1.02 g) was recorded from the genotype BARI Chinabadam-8 and lowest the root dry weight (0.11 g) was

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achieved from Binachinabadam-8 in stress condition. Tafouo *et al*. (2008) also reported that leaf dry weight had significant negative correlation with higher salinity levels.

**Leaf area ($cm^2$)**

In case of leaf area, the effects of salt differ significantly. In control condition, the highest leaf area (128.07 $cm^2$) was recorded from the genotype Binachinabadam-6 and the lowest leaf area (21.90 $cm^2$) was achieved from Binachinabadam-8 in stress condition. Confirming the obtained results Sanchez-Blanco *et al*. (2002) reported that the effects of salinity on leaf area were significant. The graph showed that, leaf area was decreased in each genotype in stress (Fig. 5).

**SPAD value**

The effects of salt on SPAD value of groundnut genotypes differ significantly (Fig. 6). In control condition, the highest SPAD value (41.67) was obtained from the genotype Binachinabadam-6 and the minimum SPAD value (31.42) was achieved from Binachinabadam-8 in stress condition. The graph showed that, SPAD value was decreased in each genotype at salinity. Nozulaidi *et al*. (2015) reported that salinity negatively affects relative chlorophyll content of leaves in plants.

## CONCLUSION

The experiment was driven to assess the variation caused by salt at early seedling stage in groundnut genotypes. The results revealed that salt tolerant genotypes exhibited minimum relative reduction of morpho-physiological attributes at early seedling stage under salt stress. Binachinabadam-6 genotype was found salt tolerant while Binachinabadam-8 appeared as salt sensitive from overall performance based on morphological and physiological response. So, it may be concluded that the variety Binachinabadam-6 will be suitable for cultivation in saline prone areas of Bangladesh and further study is needed to develop new salt tolerant groundnut genotypes.

**Conflict of Interest**

There are no conflicts of interest declared by the authors.

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