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# IMPACT OF SALINITY ON SEED GERMINATION AND SEEDLING GROWTH OF WHEAT

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## ABSTRACT

Salinity is a widespread problem in arid and semiarid region, which severely limits plants growth and crop productivity. To evaluate the effect of salinity on germination and seedling growth a pot experiment was conducted during 2023 in the Department of Agronomy Lab. In this study, two varieties BWMRI Gom 1 and BWMRI Gom 2 were used to assess the effect of salinity levels (0, 3.5, 7 and 10.5 dS/m) on wheat seed germination efficiency. It was found that higher levels of salt stress significantly decreased germination percentage, coleoptile length, seedling shoot length, and seedling fresh, dry weight of shoot, root length, seedling fresh and dry weight of root. Moreover, at 10.5 dS/m NaCl seed germination percentage of the two varieties was remarkably reduced compared with non-stress conditions. The study showed that salinity influenced seed germination and seedling growth in both varieties of wheat, but BWMRI Gom 2 showed better results than BWMRI Gom 1.

**Keywords:** Salinity, wheat, seed germination, seedling growth, salt tolerance

## INTRODUCTION

Salinity is a widespread problem around the world. This is the most important abiotic stress which is responsible for limiting the productivity of agricultural crops, with adverse effects on germination, plant growth and crop yield ( Munns and Tester 2008 and Bakht *et al.* 2012). It is a very serious threat to agricultural productivity in arid and semi-arid areas (Babu *et al.* 2012). Like other crops, germination and seedling growth of wheat seed are negatively affected by salinity stress (Hampson and Simpson 1990). Higher salt causes toxic effects on embryo through induced plasmolysis and/or permeation of toxic salt ions into their embryos. Higher salinity delayed and reduced germination percentage (Ramaden 1986 and Tobe *et al.* 2000). Poor emergence and reduced crop stand establishment are the main constraints in getting good yield, under high osmotic stress conditions (Nawaz *et al.* 2013).

Wheat (*Triticum aestivum* L.) is a winter annual grain grass of the family Poaceae, the most widely grown leading cereal crop in the world (FAO and WFP 2015), and its demand is increasing due to a rise in the global population. Wheat is the second most important cereal after rice in Bangladesh (Timsina *et al.* 2016). In 2021-22 total estimated area under wheat crop is 3,14,865 hectares and the estimated yield is 3.449 metric tons per hectare (BBS 2022). Bangladesh's overall wheat consumption is expected to fall 10% to 69 lakh tonnes in the marketing year 2022-23 due to high market prices and a lack of wheat supply, although the country's current wheat demand is 77 lakh tons (USDA 2023). According to SRDI (2022) out of 2.86 million hectares of coastal and off-shore lands about 1.056 million hectares of arable lands are affected by varying degrees of salinity. Crop production in salt-affected areas in the coastal regions differs considerably from non-saline areas. So, rapid, uniform, and a high germination percentage for wheat seed is a pre-requisite for successful stand establishment and yield. The objective of the present research was therefore based on investigating the effect of salinity on germination and seedling growth of wheat varieties.

## MATERIALS AND METHODS

This study was carried out in Dinajpur from 01 September to 15 September 2023 at Hajee Mohammad Danesh Science and Technology University in the Agronomy Department Laboratory. The experiment consisted of four salinity levels with three replications. Wheat *(Triticum aestivum* L.) cultivars viz. $V_1$= BWMRI Gom 1 and $V_2$ = BWMRI Gom 2 were tested for germination and seedling growth with the salinity level of $S_1$ = 0 dS/m, $S_2$ = 3.5 dS/m, $S_3$ = 7 dS/m, and $S_4$ = 10.5 dS/m (equivalent NaCl concentrations established with NaCl in deionized water). Distilled water (0 dS/m) was used as a control. Fifteen seeds of each cultivar were placed on pre-moistened sand in petri dishes. Germination was scored during 14 days after seed placement. The experiment was a factorial completely randomized design (CRD) with three replications. Germination percentage, coleoptile length, seedling shoot and root length, seedling shoot and root fresh weight, and seedling shoot and root dry weight were investigated.

The final germination percentage (FGP**) is** calculated as follows:

$$GP = Ni/N \times 100$$

Ni = number of germinated seeds till $i^{th}$ day

N = total number of seeds

After the 14 days, seedling shoot and root fresh weights were recorded and finally oven dried at 80°C for 48 hour and the seedling shoot and root dry weight were measured using sensitive balance.

### Statistical Analysis

Data analysis was carried out under two factors completely randomized design by using computer package Statistix 10 and the treatment means were compared by Least Significant difference (LSD) test at 0.05 probability levels.

## RESULTS AND DISCUSSION

### Seed germination

### Effect of salinity on seed germination

The effect of varying concentrations of salts on germination has been presented in Figure 1. Germination (%) of wheat varieties was significantly decreased with the increases concentration of NaCl in two varieties of wheat used in the present investigation. However, the extent of reduction of germination (%) under high salinity concentration (10.5 dS/m) was more than that under low concentration. The germination (%) decreased with increasing salinity levels apparently in two varieties where BWMRI Gom 2 showed less reduction in germination (%) than BWMRI Gom 1. The highest germination (%) was recorded from BWMRI Gom 2 (93.33%) followed by BWMRI Gom 1 (86.67%) at the control condition. The lowest germination was observed in BWMRI Gom 1 (46.67%) at 10.5 dS/m salt concentration. The seed germination percentage of BWMRI Gom 1 and BWMRI Gom 2 were not affected by 0 dS/m of NaCl, whereas germination percentage was significantly decreased at all level of NaCl concentration used in this investigation. At 10.5 dS/m salt stress level, seed germination percentage of two varieties were highly reduced compared with non stress condition. With higher NaCl concentrations, it is simple to determine the decrease in germination rates (Akbarimoghaddam *et al.* 2011 and Sourour *et al.* 2014).

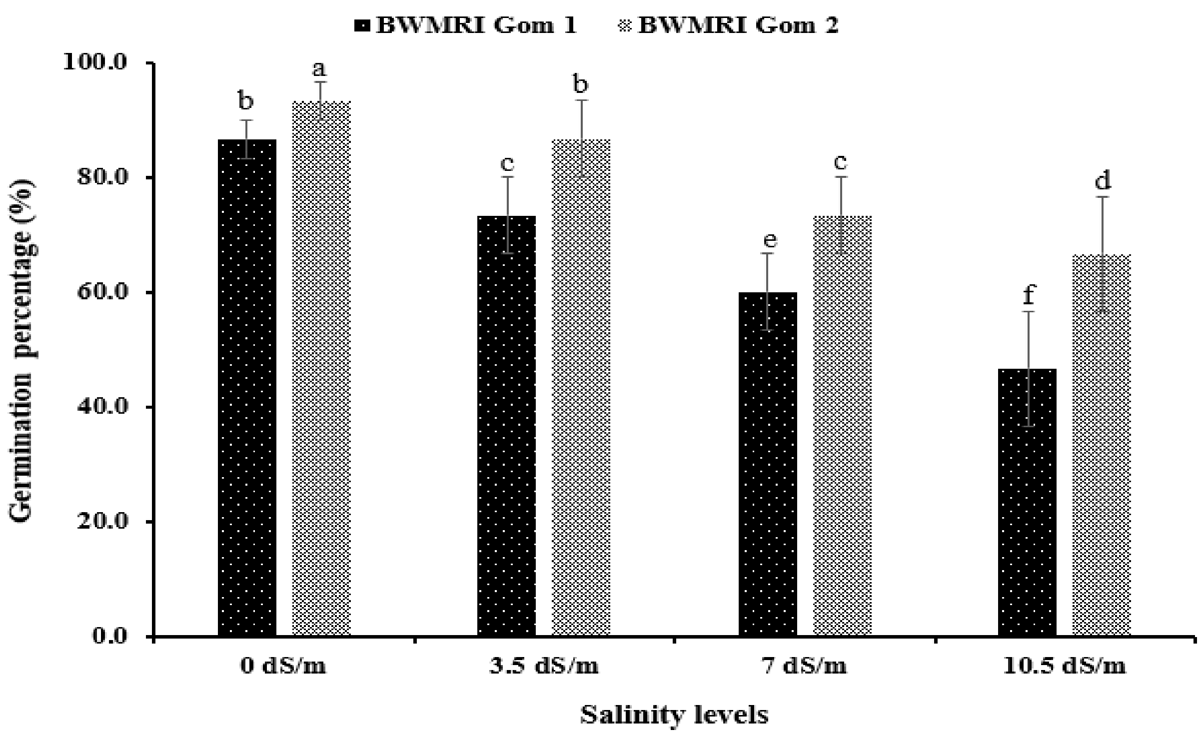


**Figure 1: Effect of salinity levels on germination percentage of wheat variety**

**Effects of salinity on seedling growth**

**Coleoptile length**

In this phase, experiment was carried out using four different concentration of salt stress (0, 3.5, 7 and 10.5 dS/m of NaCl). With the increase of salinity coleoptile length (cm) start to reduce (Figure 2). In 0 dS/m saline treatment coleoptile length was maximum (2.97 cm) for BWMRI Gom 2 and at 10.5 dS/m saline treatment it showed minimum coleoptile length (2.17 cm) for BWMRI Gom 1. From these experiments, it was observed that the coleoptile length under salt stress was significantly decreased at 10.5 dS/m. Decreased enzyme activities with increasing salt concentrations also reduced coleoptile and radicula lengths of the seeds. The harmful effects of salts might include the total amount of dry matter that is carried from the seeds through the radicula and coleoptile (Sourour *et al.* 2014).

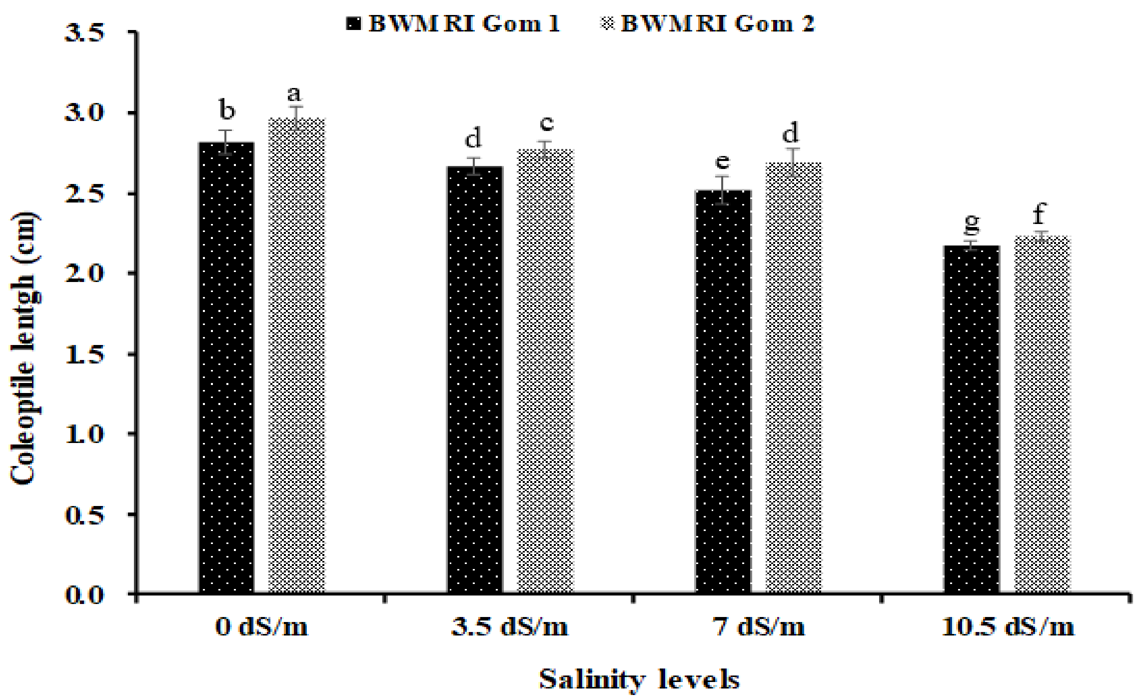


**Figure 2: Effect of salinity levels on coleoptile length of wheat variety**

**Shoot length**

Shoot length (cm) of wheat varieties has significantly affected by increasing level of salt concentration, compared with the plants of control experiments (Figure 3). In 0 dS/m saline treatment showed the largest shoot length (15.27 cm) for BWMRI Gom 2 followed by BWMRI Gom 1 (14.85 cm) and at 10.5 dS/m saline treatment it showed the shortest shoot length (11.29 cm) for BWMRI Gom 1 followed by shoot length (12.24 cm) of BWMRI Gom 2. From these experiments, it was observed that the shoot length under salt stress was significantly decreased at 10.5 dS/m. Reduced shoot length under saline conditions could be due to a decrease in new cell production rate, which could inhibit plant growth. Plant growth is also slowed by cell wall modification, which is caused by the rigidity of the cell wall caused by salinity stress as reported by Radi *et al.* 2013.

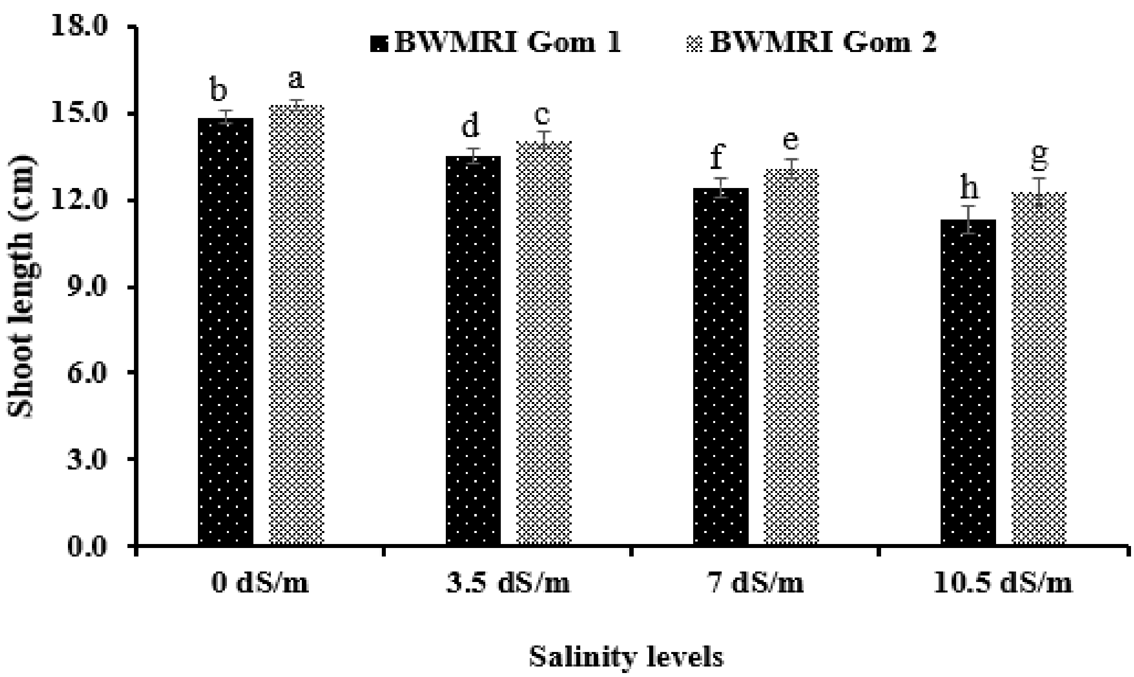


**Figure 3: Effect of salinity levels on shoot length of wheat variety**

**Root length**

It was also found that the general trend of the treatment reflects a gradual decrease in the root length (cm) with the increase of salt concentration, compared with the plants of control experiments (Figure 4). In 0 dS/m saline treatment root length was maximum (11.70 cm) for BWMRI Gom 2 which followed by BWMRI Gom 1 (11.27 cm) and at 10.5 dS/m saline treatment it showed minimum root length (7.20 cm) for BWMRI Gom 1. From these experiments, it was observed that the root length under salt stress was significantly decreased at 10.5 dS/m. Increased NaCl concentration reduced root and shoot length. Moreover, shoots were more sensitive than roots. The findings are consistent with those reported by other researchers (Gupta *et al.* 1989 and Saboora *et al.* 2006).

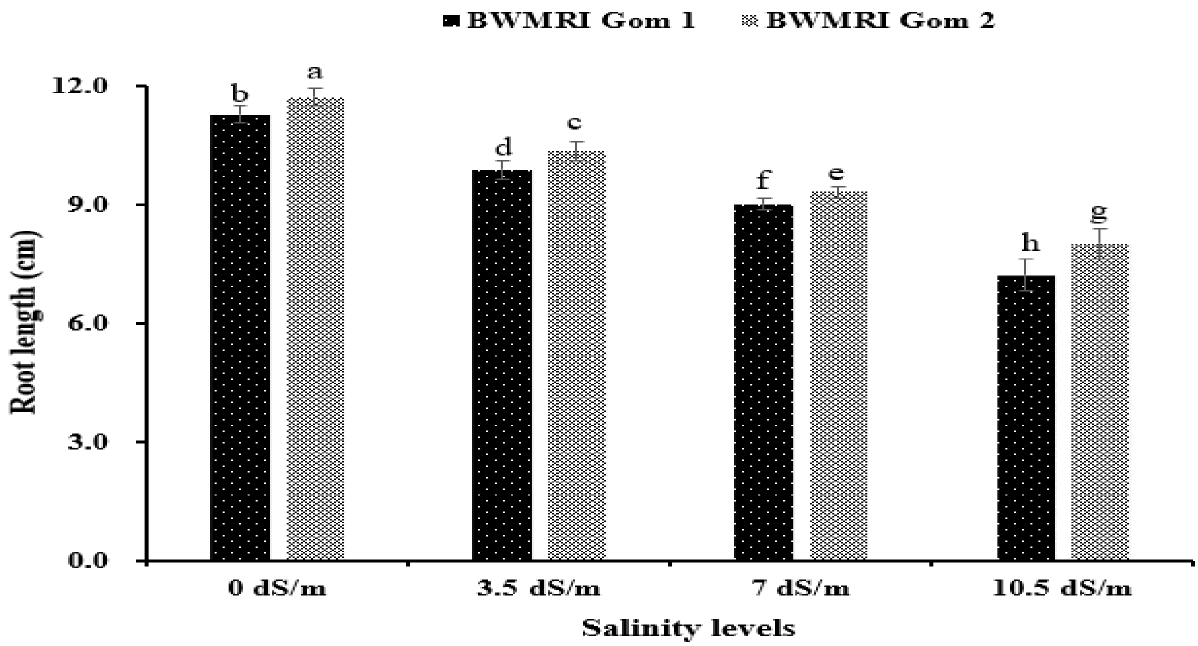


**Figure 4: Effect of salinity levels on root length of wheat variety**

**Shoot fresh and dry weight**

Shoot fresh and dry weight decreased as the salinity level increased (Table 1). The maximum average shoot fresh and dry weight (0.085 mg and 0.020 mg) respectively were obtained from BWMRI Gom 2 under 0 dS/m and the minimum average shoot fresh and dry weight (0.023 mg and 0.008 mg) from BWMRI Gom 1 under 10.5 dS/m. In this regard, highly significant differences between the two varieties were observed. Reduction of dry weights relatively depended on shoot lengths. The results are like those reported by researchers (Salim 1991 and Ghoulam *et al.* 2001).

**Table 1. Effect of salinity levels on fresh and dry weight of shoot of wheat variety**

| Variety | Fresh weight of shoot (mg) | | | | Dry weight of shoot (mg) | | | |
|---|---|---|---|---|---|---|---|---|
| | Salinity level | | | | Salinity level | | | |
| | 0 dS/m | 3.5 dS/m | 7 dS/m | 10.5 dS/m | 0 dS/m | 3.5 dS/m | 7 dS/m | 10.5 dS/m |
| **BWMRI Gom 1** | 0.066 c | 0.050 e | 0.033 f | 0.023 g | 0.016 b | 0.013 c | 0.010 d | 0.008 e |
| **BWMRI Gom 2** | 0.085 a | 0.073 b | 0.057 d | 0.035 f | 0.020 a | 0.017 b | 0.014 c | 0.009 e |
| **CV (%)** | 4.88 | | | | 4.87 | | | |
| **Level of significance** | ** | | | | ** | | | |

Here, * indicates 1% level of probability and ** indicates 5% level of probability

**Root fresh and dry weight**

On the other hand, root fresh and dry weight decreased as the salinity level increased (Table 2). The maximum root fresh and dry weight (0.025 mg and 0.013 mg) respectively were obtained from BWMRI Gom 2 under 0 dS/m and the minimum root fresh and dry weight (0.013 mg and 0.005 mg) from BWMRI Gom 1 under 10.5 dS/m. As NaCl concentration increased, it antagonistically affected shoot and root dry weight. Reduction of dry weights relatively depended on root lengths. The results are like those reported by researchers (Salim 1991 and Ghoulam *et al.* 2001).

**Table 2. Effect of salinity levels on fresh and dry weight of root of wheat variety**

| Variety | Fresh weight of root (mg) | | | | Dry weight of root (mg) | | | |
|---|---|---|---|---|---|---|---|---|
| | Salinity level | | | | Salinity level | | | |
| | 0 dS/m | 3.5 dS/m | 7 dS/m | 10.5 dS/m | 0 dS/m | 3.5 dS/m | 7 dS/m | 10.5 dS/m |
| **BWMRI Gom 1** | 0.019 cd | 0.017 d | 0.015 e | 0.013 f | 0.012 b | 0.009 c | 0.007 d | 0.005 f |
| **BWMRI Gom 2** | 0.025 a | 0.023 b | 0.020 c | 0.016 e | 0.013 a | 0.011 b | 0.009 c | 0.006 e |
| **CV (%)** | 4.28 | | | | 5.10 | | | |

| | | |
|---|---|---|
| **Level of significance** | ** | ** |

Here, * indicates 1% level of probability, ** indicates 5% level of probability

## CONCLUSION

The assessment of the effect of salinity on the germination, seedling growth in wheat cultivars lead to conclude that all the considered parameters were significantly affected by salt stress. The study proved that the variety BWMRI Gom 2 was the more salt tolerant than other variety BWMRI Gom 1. Thus, this variety could be cultivated on slightly saline soils for its rapid seedling emergence, higher germination percentage, facilitated growth, and higher biomass production. Therefore, to recommend the cultivation of this wheat variety in the field, it must be further profound field investigation at the whole plant growth stage.

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