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EFFECTS OF SALINITY ON GERMINATION AND SEEDLING GROWTH OF LENTIL (*LENS CULINARIS MEDIK*) VARIETIES IN BANGLADESH

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Abstract

To evaluate the effect of salinity on germination and seedling growth of BARI masur variety of lentil were conducted. Salinity is a wide spread problem in arid and semi arid region, which severely limits plants growth and crop productivity. In this study five different varieties of BARI masur (BM-1, BM-3, BM-4, BM-5 and BM-7) were used to assess the effect of salinity levels (25, 50, 75, 100 and 150 mMol) on lentil seed germination efficiency. It was found that higher level of salt stress significantly decreased germination percentage, number of leaves per plant, length and fresh weight of shoot and root. Moreover, at 150 mMol NaCl seed germination percentage of all genotypes was remarkably reduced compared with non stress condition. In this level of salinity no germination was occurred in BM-1 and BM-5 variety of lentil. Although all varieties of lentil were sensitive to high salinity level but BM-3 and BM-7 showed better salt tolerance than other varieties. So, BM-3 and BM-7 could be used for further analysis and for hybridization in the breeding program. This study could be strengthened by further work under field conditions and also at mature vegetative and reproductive stage of this crop.

Keywords: Salinity, lentil, seed germination, seedling growth, salt tolerance

Introduction

Salinity is one of the major agro-environmental problems that affect the growth and development of crop plants, resulting in a reduction of crop yield (Foolad, 2004). It is a serious threat to agriculture productivity in most of the coastal, arid and semi arid regions of the world (Ashraf and Khan, 1994). Salinity causes hyper osmotic stress and ion disequilibrium, increased respiration rate, membrane instability, thereby disabling the

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vital cellular function of a plant. The adaptive mechanism of plants to those stresses could result a tolerance and/or showing dormant conditions (Cuartero et al., 2006). Differences in salt tolerance exist not only among different genera and species, but also within the different organs of the same species (Flowers and Hajibagheri, 2001). Typically grain legumes, especially lentil are more sensitive during emergence and seedling growth compared to their other stages of growth and grain development.

In higher plants, seed germination is one of the most important events in the life cycle. It is the sum of all physiological process occurring inside the seed which starts with the imbibitions in water and ends with emergence of embryonic roots (Ouji et al., 2015). Tobe et al., (2000) reported that seed germination is adversely affected under salt stress through induced plasmolysis and/or permeation of toxic salt ions into their embryos. Salt stress affects germination percentage and seedling growth in different ways depending on plant species. Some researchers have indicated that the main reasons for germination failure was the inhibition of seed water uptakes due to a high salt concentration (Coon et al., 1990) where as others have suggested that germination was affected by salt toxicity (Leopold and Willing, 1984; Khajeh- Hosseini et al., 2003).

Rapid, uniform and a high germination percentage for legumes is a pre-requisite for successful stand establishment and yield (Demir and Ermis, 2003). Economically legumes represent the second most important family of crop plants after Poaceae, accounting for approximately 27% of the world production. Among legumes lentil (*Lens culinaris* Medik., Fam.: Leguminaceae) is the most popular protein rich pulse crop. Annual demand of lentil in Bangladesh is 1.8-2.0 million MT which will be 3.0 million MT in the year 2030, while the average production is only 0.92 million MT in the last ten years. However, in Bangladesh, the coastal region covers almost 29,000 km^2 or about 20% of the country. About 53% of the coastal areas are affected by different degree of salinity. It affects crops depending on degree of salinity at the critical stages of growth, which reduces yield and in severe cases total yield is lost. Therefore, a salt tolerant cultivar of lentil is very much in need to promote production of this important pulse crop in the coastal regions of Bangladesh. The objective of the present research is therefore based on to investigate the effect of salinity on germination and seedling growth of BARI masur varieties of lentil.

Materials and methods

The study was conducted from October 2017 to June 2018 in the laboratory at the Department of Botany, University of Barisal. Sterilized, hand selected seeds of BM-1, BM-3, BM-4, BM-5 and BM-7 was used for the study. Before beginning the experiment, solutions were prepared by dissolving sodium chloride (NaCl) in distilled water at four different concentrations (25, 50, 75, 100 and 150 mMol) and left 48 h to dissolve. The salt concentrations were prepared every week so that it is relatively fresh for the germinating seeds.

The experiment was conducted under field condition and based on morphological variation among lentil varieties in order to assess the salt tolerance in term of seed germination and seedling growth.

The experimental soil was taken from cultivated land near university campus. Fifteen surface sterilized uniform seeds of each lentil varieties were sown in the plastic pots at uniform depth and distance. Pots were arranged in CRBD, replicate three times and irrigated with equal 100 ml of salt solutions (25, 50, 75, 100 and 150 mMol) and tap water as control. Treatment application with the same amount of salt solutions continued every other day and the germination was recorded at 24 hours interval for 15 days. After 30 days of seed sowing, the length of root and shoot were measured with the help of scale.

Statistical analysis

All the germination parameters were calculated using the method used by Li (2008) with some modifications. A seed was considered to be germinated when plume and radical emerge from seeds. In all treatments continuous assessment in seedling growth were carried out during the subsequent days until the day 30. Germination percentage was calculated using the formula proposed by Kandi et al., (2012).

Shoot and root length of seedling were measured after 30 days of sowing. The perpendicular distance from the ground level to the tip of the longest branch had measured on five randomly selected seedlings for each treatment and the average value was recorded. Total number of leaves on five randomly selected seedlings from each treatment was counted and the average has been recorded. Seedling fresh weights were measured after 30 days of sowing by weighting the mass of shoot and roots using sensitive balance. Total number of flowers and seed bearing pods from each variety were counted and the average value was reported. Analysis of variance was performed and significant differences among mean values were compared by LSD test at 5% level of significance.

Results and Discussion

Seed germination

The effect of varying concentration of salts on germination has been presented in Fig. 1. It is evident that percentage of germination gradually decreased with the increases concentration of NaCl in all variety of lentil used in the present investigation. But the extent of reduction under high concentration stress (150 mMol) was much greater than that under low stress. Inhibition of germination due to salinity has been also reported by Buchade and Karadge, (2014) on five legume crops namely, *Dolichos biflorus* L., *Lens esculanta* Moench, *Phaseolus aureus* Roxb., *P. acnitifolius* L., and *Trigonella foenum-graceum* L.

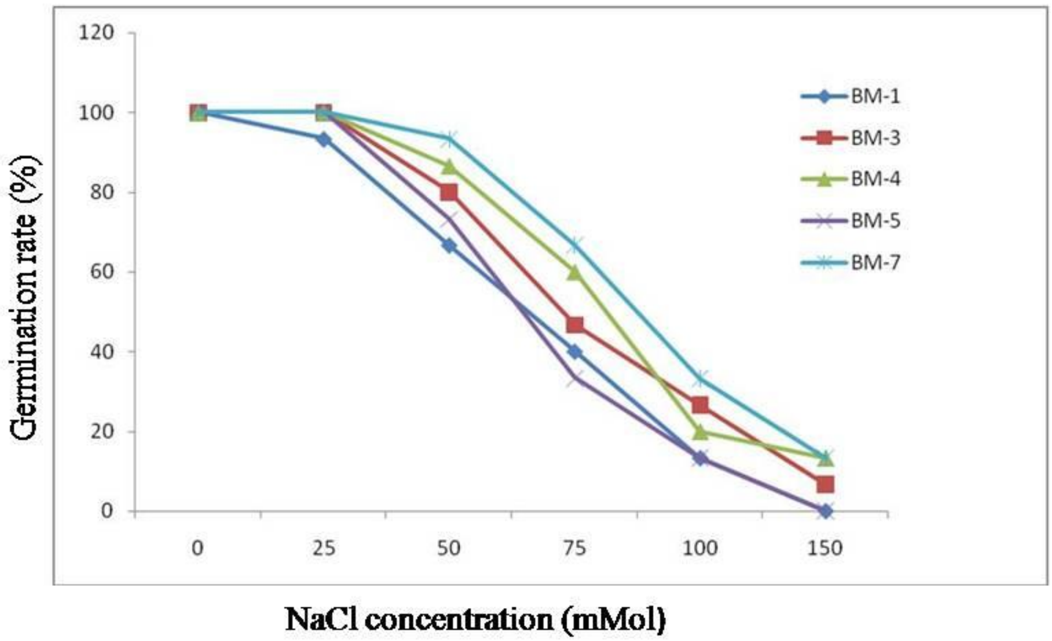

Fig. 1. Germination rate at control (0 mMol NaCl) and salt stress condition (25 - 150 mMol NaCl) of five BARI masur varieties of lentil.

No significant difference was observed among the varieties under the control condition, however the varietal differences were observed under the salt stress. The seed germination percentage of BM-3, BM-4, BM-5 and BM-7 were not affected by 25 mMol of NaCl, whereas germination percentage was significantly decreased at all level of NaCl concentration used in this investigation in case of BM-1 variety of lentil. At 150 mMol salt stress level, seed germination percentage of all variety were highly reduced compared with non stress condition. In this concentration no germination was observed in BM-1 and BM-5, very low germination occurred in BM-3, BM-4 and BM-7. Relevant results in legumes was reported by Gunjaca and Sarcevic, (2000); Almansouri et al., (2001). They reported that increasing osmotic pressure (OP) in saline condition decrease water uptake and finally collapse seed germination.

Effects of salinity on seedling growth

In this phase, experiment was carried out using four different concentration of salt stress (25, 50, 75 and 100 mMol of NaCl). The effect of the concentration of 150 mMol NaCl was not observed in this phase because most of the variety failed or show very low germination in this concentration.

From these experiments it was observed that the length of shoots under salt stress was slightly decreased at 25 mMol. It was also found that the general trend of the treatment reflect a gradual decrease in the shoot length with the increase of salt concentration, compared with the plants of control experiments, except for the 50 mMol treatment. In this concentration (50 mMol) increased length of shoot was recorded in all variety of lentils (Table 1). Seed length was significantly affected when subjected to 100 mMol of NaCl concentration. Here mean height of shoot was 0.98 whereas it was 13.68 in control in case of BM- 7 variety of lentil. These findings is supported by Hamada (1995) with his study on maize, Misra et al., (1997) on rice, Dantus et al., (2005) on cowpea, Memon et al. (2010) on mustard where they indicated that the use of low concentrations of sodium chloride led to increase in plant lengths, whereas higher concentrations caused shortage. Azene et al., 2014 reported that the reduction of shoot length was probably due to the excessive accumulation of salts in the cell wall elasticity, thus, secondary cell wall appears which block the cell wall enlargement that finally results in short shoot growth.

Table 1. Effects of salinity on plant height of different lentil variety.

Lentil variety	Salinity level (mMol NaCl)*				
	0	25	50	75	100
BM-1	12.93i	9.67fg	10.7gh	9.0f	2.53d
BM-3	13.99j	11.04gh	11.45h	11.09gh	1.88cd
BM-4	13.78j	11.15gh	11.54h	7.9f	1.6bc
BM-5	13.7j	10.65gh	9.32fg	8.93f	1.5bc
BM-7	13.68j	10.28gh	12.1h	4.88e	0.98a

*Values with the same letter are not significantly different using LSD tests at 5%.

In root length, the effect of salinity was found to be significant with the increase of salt concentration (Table 2). In this observation, highest reduction of root growth was found in BM-5 at 100 mMol NaCl treatment (10.94 cm at control, 4.98 at 100 mMol) whereas, lowest growth reduction was observed in BM-1 compared with the control. This result is similar to the findings of Ashraf and Waheed (1990) for lentil and Duzdemiro et al. (2009) for pea. The reduction of shoot and root length may be due to the toxic effect of the higher level of NaCl concentration as well as unbalanced nutrient uptake by the seedling as reported by Majid et al., (2013).

Table 2. Effects of salinity on root length of different lentil variety.

Lentil variety	Salinity level (mMol NaCl)*				
	0	25	50	75	100
BM-1	8.0c	5.53ab	6.06b	5.11a	3.83a
BM-3	9.98d	8.57cd	8.79cd	9.2cd	4.94ab
BM-4	8.88cd	8.8cd	7.73bcd	6.47b	4.27ab
BM-5	10.94d	6.88bc	4.84a	7.63bc	4.98ab
BM-7	10.49d	7.65bcd	7.55bcd	5.86b	4.93ab

*Values with the same letter are not significantly different using LSD tests at 5%.

Number of leaves

Results, presented in Table 3 indicated that a significant reduction of leaf number was observed when salinity stress was increased from 0 to 100 mMol. At the higher salt concentration the leaf number was extremely affected and made the seedlings less thrived for the stress.

These results have been confirmed by the results of Karen et al. (2002) in chickpea, Raul et al. (2003) on cowpea. They reported that the treatment of sodium chloride reduced the number of leaves compared with control plants.

Table 3. Effects of salinity on the number of leaves of lentil.

Lentil variety	Salinity level (mMol NaCl)*				
	0	25	50	75	100
BM-1	13.3e	11.0de	11.0de	4.20bc	2.66a
BM-3	12.2de	11.4de	11.22de	4.22bc	1.25a
BM-4	15.8f	14.7ef	10.11d	4.6bc	1.50a
BM-5	13.5e	13.6e	11.2de	4.44bc	1.0a
BM-7	16.9f	13.6e	9.57d	4.7c	1.75a

*Values with the same letter are not significantly different using LSD tests at 5%.

Fresh weight of shoot and root

Going through the data in Figs. 2 - 3, it is indicated that there is a negative effect for salt stress on fresh weight of shoot and root in lentil verities. Significant difference was observed in fresh weight of shoot in different variety under different salinity level. Maximum reduction of shoot fresh weight was observed in BM-4 variety of lentil in 100 mMol concentration of NaCl. In this variety, mean fresh weight of shoot was 0.09 g whereas it was 0.44 g in control. The results was in agreement with the previous research findings of Stoeva and Kaymakanova (2008) who reported a rapid decrease in seedling fresh shoot weight of leguminous plant under saline environment. This reduction may be due to limited supply of metabolites to young growing tissues or toxic effect of higher concentration of NaCl (Hussain et al., 2009; Munns, 2002; Taffouo et al., 2009).

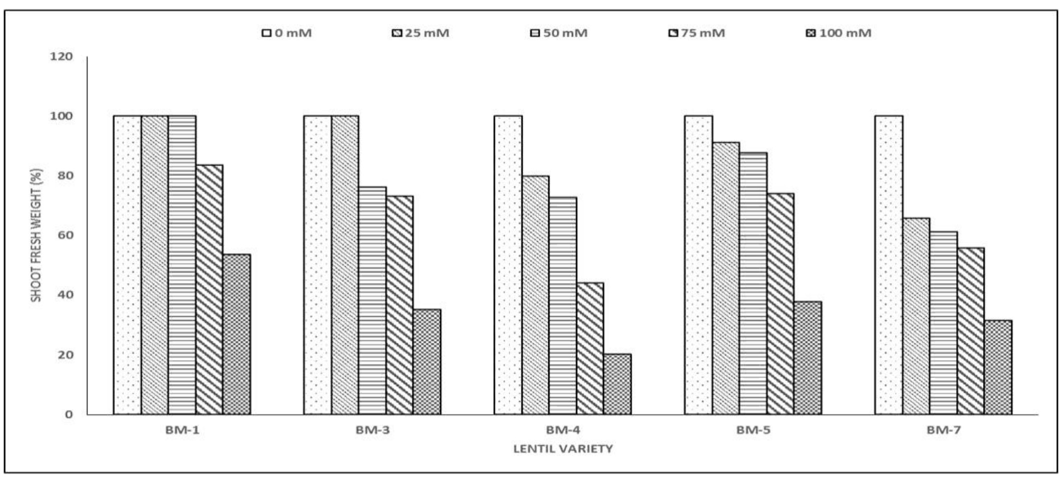

Fig. 2. Effect of different level of NaCl concentration on shoot fresh weight.

In case of root, salinity reduced the fresh weight remarkably in all varieties of lentil. Maximum weight loss was observed in BM-1 variety of lentil. This variety had minimum value of the seedlings root fresh weight in all concentration of NaCl (Fig. 3). On the other hand, the degree of reduction of root fresh weight was less for BM-3 variety of lentil. The findings of this study are similar to those of Jeannette et al. (2002) and Kagan et al. (2010) who reported increased salinity reduced root fresh weight in *Phaseolus* species and lentil, respectively.

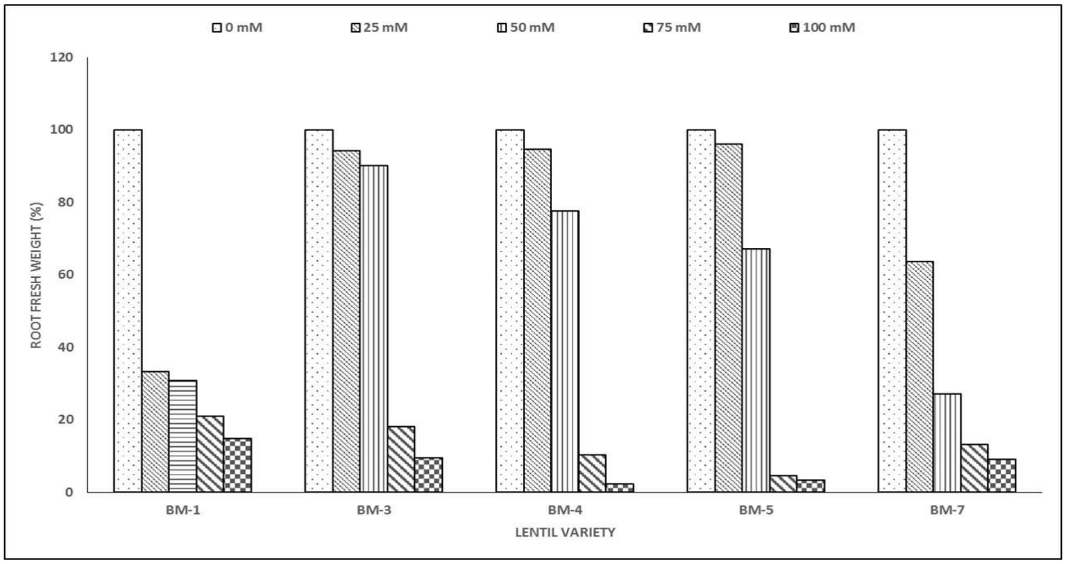

Fig. 3. Effect of different level of NaCl concentration on root fresh weight.

Conclusion

From this study, it can be concluded that, seed germination varied according to the change in NaCl level. In general, all the five variety of lentil showed healthy growth under control condition but they showed different response to higher level of salinity. These results indicate that genetic variation exists among lentil varieties in terms of germination percentage under salt stress. In the present investigation BM-3 and BM-7 showed most tolerance, this can be suggested for cultivation under salt stress condition.

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