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## EFFECTS OF SALINITY AND VARIETY ON YIELD CONTRIBUTING CHARACTERS AND YIELD OF RED AMARANTH

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### ABSTRACT

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An experiment was conducted to evaluate the effects of salinity and variety on yield and yield contributing characters of Red amaranth at Horticulture Farm of Bangladesh Agricultural University, Mymensingh. The experiment consisted of three varieties viz; Altapety, RM, Deshi and four levels of salinity viz; 0mM, 25mM, 50mM and 75mM. The experiment was laid out following RCBD with three replications. Variety had significant effect on yield characters and yield. The highest average weight of plant (9.69 g/pot), highest average root weight (2.13 g/pot), highest average root length (10.28 g/pot) and highest yield per pot (237.08g) were found from the variety Altapety and the lowest average weight of plant (7.67 g/pot), lowest average root weight (2.03 g/pot), lowest average root length (8.83 g/pot) and yield per pot (198.58g) were found from the variety RM. Salinity had significant effect on yield characters and yield. The highest average weight of plant (10.22 g/pot) was recorded from the variety Altapety at the application of 25mM NaCl, highest average of root weight (2.27 g/pot) was recorded from the variety Altapety at the application of 25mM NaCl, highest average of root length (10.29 g/pot) was recorded from the variety Altapety at the application of 25mM NaCl and yield (259.56g/pot) were found from the application of 25mM NaCl. The lowest average weight of plant (6.93 g/pot) was recorded from the variety RM at the application of 75mM NaCl solution, lowest average of root weight (1.78 g/pot) was recorded from the variety RM at the application of 75mM NaCl solution, lowest average of root length (8.12g/pot) was recorded from the variety RM at the application of 75mM NaCl solution and yield per pot (154.44g) were found from the application of 75mM NaCl.

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## INTRODUCTION

Red amaranth (*Amaranthus tricolor* L.) plays an important role in nutrition among the leafy vegetables grown in Bangladesh. It belongs to the family Amaranthaceae. The leafy amaranth is said to be the native of India (Shanmugavelu, 1989; Nath, 1976). Among the leafy types, *Amaranthus tricolor* L. is the most commonly cultivated species in Bangladesh. It is cultivated all over the country in any season due to its adaptability to a wide range of soil and climate (Alam *et al.*, 2007). However, during winter its growth and development is slower than summer and rainy season. The total production of Red amaranth was 48810 metric tons in an area of 33118 acres in Bangladesh (BBS, 2016).

Red amaranth (*Amaranthus tricolor* L.) is the most widely grown commercial and dietary vegetables in Bangladesh and around the world because of their special nutritive value and widespread production. It is a very important vegetable crop from nutritional point of view, which contains an appreciable amount of iron, minerals, calcium and phosphorus. It is also an excellent source of vitamin C. Among the vegetables of tropics amaranths are very easy to grow. Amaranth is probably the most popular vegetable due to its short length, quick growing habit and riches in vitamins and minerals (Cole, 1979). More than 900 million hectares of land worldwide, 20% of the total agricultural land, are affected by salt, accounting for more than 6% of the world's total land area. NaCl is the predominant salt causing salinization and it is unsurprising that plants have evolved mechanisms to regulate its accumulation. An essential step in growing a successful crop is obtaining an adequate plant population, as yield is reduced by sub-optimal plant densities and uneven stands. Salinity of soil and irrigation water is a continuing threat to economic crop production especially in arid and semiarid regions of the world (Kayani *et al.* 1990). The ability of seed to germinate in saline environments, the cotyledons to break through a soil crust, emerging and seedlings to survive in saline conditions are crucial for crop production in saline soils (Maranon *et al.* 1989). Salt affected soils are distributed throughout the world and no continent is free from the problem (Brady and Weil, 2002). Salinization of soil is one of the major factors to limit crop production particularly in arid and semi-arid regions of the world. Globally, a total land area of 831 million hectares is salt affected. African countries like Kenya (8.2 Mha), Nigeria (5.6 Mha), Sudan (4.8 Mha), Tunisia (1.8 Mha), Tanzania (1.7Mha) and Ghana (0.79) are salt affected to various degrees (FAO, 2000). Salt stress is known to perturb a multitude of physiological processes (Ashraf, 2001). It exerts its undesirable effects through osmotic inhibition and ionic toxicity (Munns *et al.*, 2006). Increased salinity caused a reduction in plant height, leaf length, leaf breadth, and number of leaf and average weight of plant (Jacoby, 1994).

Salinity of the soil relates to accumulation of salts. Salinity is known to induce stress in plants; hence the ability of plants to tolerate and thrive in saline soils is of great importance in agriculture. Since it indicates that the affected plants had genetic potential of salt tolerance, which is highly desirable trait (Francois and Mass, 1994; Makus, 2003). Sudhakaret *et al.* (1993) attributes the lack of salinity cultivars to inadequate means of detecting and measuring plant response to salinity and ineffective selection methods. The salt-induced water deficit is one of the major constraints for plant growth in saline soil. Root zone salinity can rapidly inhibit root growth and in turn their capacity to uptake water and essential mineral nutrients from the soil (Ngigi, 2002), National Research Council (NRC). (1990) studied effect of sodium chloride on growth, photosynthesis and respiration and found growth decreased with increasing salt concentration. Salt induced oxidative stress is one of the most important factors that affect plants. Proline plays a major role in the anti-oxidative stress as a hydroxyl radical scavenger (Smirnov, 1993). Hydroxyl radical (OH<sup>·</sup>) are produced as a result of oxidative stress are harmful and can rapidly react with all types of biomolecules, such as DNA, proteins and lipids leading to radical chain processes, cross linking, peroxidation, membrane leakage, production of toxic compound and finally cell death (Hester *et al.* 2001). For instance, it was found that increasing of salinity stress decreased almost all the growth parameters in *Amaranthus tricolor* L. growth parameters and essential oil amount in chamomile. Also (Sohan *et al.* 1999) reported that enhancing salinity treatments lead to growth reduction. It also reduces germination amounts and seedling weight. (Ashraf and Sharif, 1997) reported that salinity treatment lead to reduction of growth and plant developments. The objective of the present study was to know the appropriate dose of salinity and to investigate the effects of salinity on yield characters and yield of different variety of red amaranth.

## MATERIALS AND METHODS

The present study was carried out at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during the period from February to April, 2018. The climate of the experimental area was sub-tropical in nature characterized by high temperature, heavy rainfall, high humidity and relatively long day during the month of March to August and scanty rainfall associated with moderately low temperature, low humidity and short day during the rest period of the year. The experimental pod was filled with a high land. It belongs to the Old Brahmaputra Flood Plain (FAO-UNDP, 1971) under AEZ (Agroecological zone) no-9 (Okigbo, 1990). It was fertile and well drained and slightly acidic with pH 4.7-7.2 (BARC, 2012).

Three varieties of red amaranth were used for the experiment, i.e.; Altapety, RM and Deshi. The all seeds of the Red amaranth varieties were procured from Natun Bazar, Mymensingh. Deshi is a local variety and Altapety is a variety of BADC.

The treatments of the present experiment were:

Factor A (Variety): Altapety, RM and Deshi.

Factor B (NaCl):

Levels:

- i)  $T_0 = 0\text{mM}$
- ii)  $T_1 = 25\text{mM}$  (1.4625g NaCl per litre of water)
- iii)  $T_2 = 50\text{mM}$  (2.9251g NaCl per litre of water)
- iv)  $T_3 = 75\text{mM}$  (4.3875g NaCl per litre of water)

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications and each replication containing 12 pots. Thus the total number of pot was 36. The size of unit pot was 25cm x 25cm. The pot to pot distance was 10cm and row to row distance was 20cm. The experimental pot was thoroughly prepared by high land soil. Weeds and stubbles were removed from the pot and clods were broken. The manure and fertilizers doses applied to per experimental pot were N 200g, P 150g, K 170g and Cowdung 3kg. Urea, TSP and MoP were the sources of nitrogen, phosphorus and potassium, respectively. All the doses of cow dung, P, K and N were applied during final soil preparation. All other agronomic practices were carried out uniformly for all the experimental units throughout the growing season.

Six plants from each unit pot were randomly selected and tagged as samples for collection of data. Fresh weight of 6 sample plants per pot was taken at harvest and then individual fresh weight per plant was calculated. Yield was calculated in gram per pot.

### Statistical Analysis

The collected data on various parameters were statistically analyzed using MSTAT-C package programme. The mean for all the treatments were calculated and analyzed and analyses of variance of all the characters were performed by F-variance test. The significance of differences between the pairs of treatment means was calculated by the least significant difference (LSD) test at 1% level of probability (Gomez and Gomez, 1984).

## RESULTS AND DISCUSSION

The present investigation was carried out to investigate the effect of salinity and variety on the yield and yield contributing characters of Red amaranth. The effects of variety on yield contributing characters of plant have been recorded. The highest average weight of plant (9.69 g/pot) was recorded from the variety Altapety and the lowest average weight of plant (7.67 g/pot) was recorded from the variety RM. The highest average root weight (2.13 g/pot) was recorded from the variety Altapety and the lowest average root weight (2.03 g/pot) was recorded from the variety RM. The highest average root length (10.28g/pot) was recorded from the variety Altapety and the lowest average root length (8.83 g/pot) was recorded from the variety RM (Table 1).

The effects of salinity on yield contributing characters of plant have been recorded. The highest average weight of plant (10.22 g/pot) was recorded from the variety Altapety at the application of 25mM NaCl and the lowest average weight of plant (6.93 g/pot) was recorded from the variety RM at the application of 75mM NaCl solution. The highest average of root weight (2.27 g/pot) was recorded from the variety Altapety at the application of 25mM NaCl and the lowest average of root weight (1.78 g/pot) was recorded from the variety RM at the application of 75mM NaCl solution. The highest average of root length (10.29 g/pot) was recorded from the variety Altapety at the application of 25mM NaCl and the lowest average of root length (8.12g/pot) was recorded from the variety RM at the application of 75mM NaCl solution (Table 2).

The combined effects of variety and different levels of salinity on yield contributing characters of plant have been recorded. The highest average weight of plant (10.72 g/pot) was recorded from the variety Altapety at the application of 25mM NaCl and the lowest average weight of plant (4.94 g/pot) was recorded from the variety RM at the application of 75mM NaCl solution. The highest average of root weight (2.29g/pot) was recorded from the variety Altapety at the application of 25mM NaCl and the lowest average of root weight (1.72g/pot) was recorded from the variety RM at the application of 75mM NaCl solution. The highest average of root length (10.84 g/pot) was recorded from the variety Altapety at the application of 25mM NaCl and the lowest average of root length (7.17g/pot) was recorded from the variety RM at the application of 75mM NaCl solution (Table 3).

**Table 1.** Effect of variety on yield and yield contributing characters of red amaranth

Variety	Plant weight (g)	Root weight (g)	Root length (cm)	Yield (g)
V <sub>1</sub>	9.69	2.13	10.28	237.08
V <sub>2</sub>	7.67	2.03	8.83	198.58
V <sub>3</sub>	9.03	2.11	9.24	224.17
LSD <sub>0.05</sub>	0.28	0.04	0.10	6.76
LSD <sub>0.01</sub>	0.38	0.05	0.14	9.19
Level of significance	**	**	**	**

\*\* = Significant at 1% level of probability

**Table 2.** Effect of salinity levels on yield and yield contributing characters of red amaranth

Salinity levels	Plant weight (g)	Root weight (g)	Root length (cm)	Yield (g)
T <sub>0</sub>	9.39	2.24	9.89	244.33
T <sub>1</sub>	10.22	2.27	10.29	259.56
T <sub>2</sub>	8.65	2.07	9.49	221.44
T <sub>3</sub>	6.93	1.78	8.12	154.44
LSD <sub>0.05</sub>	0.32	0.04	0.12	7.80
LSD <sub>0.01</sub>	0.44	0.06	0.16	10.61
Level of significance	**	**	**	**

\*\* = Significant at 1% level of probability

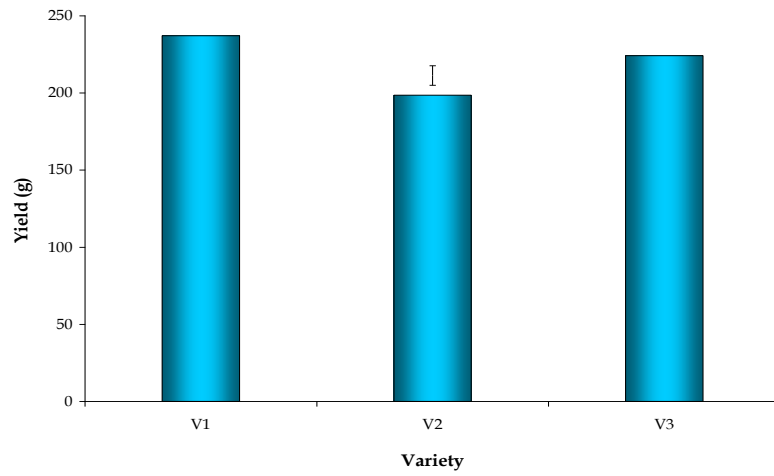
**Table 3.** Combined effects of variety and salinity levels on yield and yield contributing characters of red amaranth

Treatment combination	Plant weight (g)	Root weight (g)	Root length (cm)	Yield (g)
V <sub>1</sub> T <sub>0</sub>	10.22	2.25	10.71	257.67
V <sub>1</sub> T <sub>1</sub>	10.72	2.29	10.84	273.67
V <sub>1</sub> T <sub>2</sub>	9.39	2.16	10.11	229.33
V <sub>1</sub> T <sub>3</sub>	8.44	1.82	9.44	187.67
V <sub>2</sub> T <sub>0</sub>	8.50	2.21	9.21	225.67
V <sub>2</sub> T <sub>1</sub>	9.28	2.25	9.85	241.33
V <sub>2</sub> T <sub>2</sub>	7.94	1.96	9.08	213.67
V <sub>2</sub> T <sub>3</sub>	4.94	1.72	7.17	113.67
V <sub>3</sub> T <sub>0</sub>	9.44	2.25	9.74	249.67
V <sub>3</sub> T <sub>1</sub>	10.67	2.28	10.18	263.67
V <sub>3</sub> T <sub>2</sub>	8.61	2.08	9.27	221.33
V <sub>3</sub> T <sub>3</sub>	7.39	1.81	7.75	162.00
LSD <sub>0.05</sub>	0.56	0.08	0.20	13.52
LSD <sub>0.01</sub>	0.76	0.10	0.27	18.37
Level of significance	**	NS	**	**

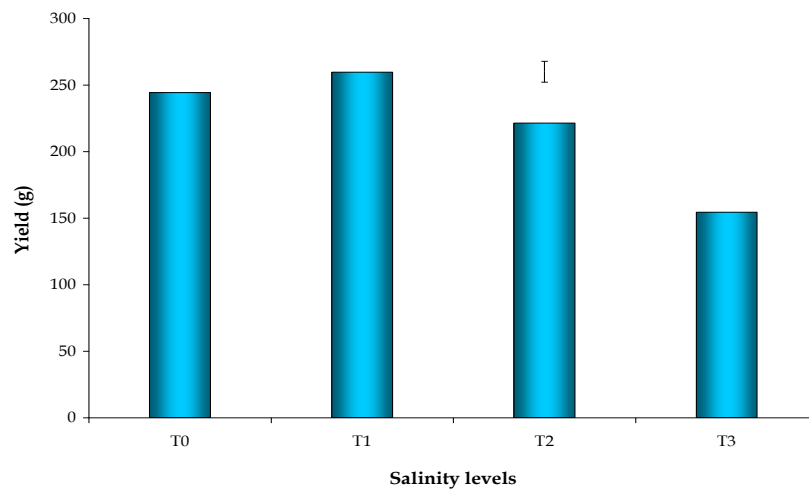
\*\* = Significant at 1% level of probability, NS = Not Significant

V<sub>1</sub> = Altapety, V<sub>2</sub> = RM, V<sub>3</sub> = Deshi, T<sub>0</sub> = 0mM, T<sub>1</sub> = 25mM, T<sub>2</sub> = 50mM, T<sub>3</sub> = 75mM

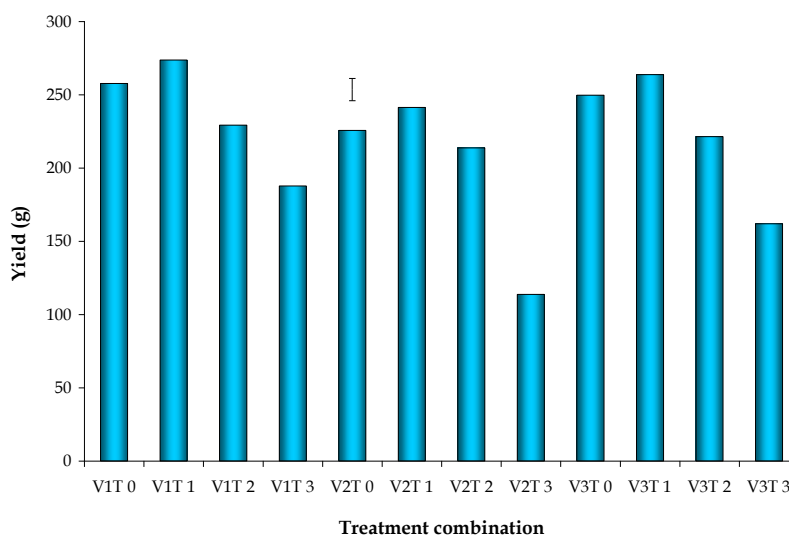
Significant variation on yield of Red amaranth per pot was found due to the different variety. The highest yield (237.08g/pot) was observed at Altapety variety and the lowest yield (198.58g/pot) was recorded from the variety RM (Figure 1). Different levels of salinity significantly influenced the yield per pot in Red amaranth. The highest yield (259.56g/pot) was found at the application of 25mM NaCl and the lowest yield (154.44g/pot) was found at the application of 75mM NaCl solution (Figure 2). The combined effect of variety and different levels of salinity on yield per pot have been presented in Table 3. The highest yield (273.67g/pot) was recorded from the treatment combination of variety Altapety with the application of 25mM NaCl and the lowest yield (113.67g/pot) was recorded from the treatment combination of variety RM with 75mM NaCl application (Fig. 3). Salinity progressively decreases the marketable yield (Yeo, 1998) but properly use of salinity is essential for vegetative growth, and desirable yield (Zhifang and Losecher, 2003).



**Figure 1.** Effects of variety on yield of red amaranth. The vertical bar represents LSD at 0.01 level of probability. V<sub>1</sub>= Altapety, V<sub>2</sub>= RM, V<sub>3</sub>= Deshi



**Figure 2.** Effects of salinity on yield of red amaranth. The vertical bar represents LSD at 0.01 level of probability. T<sub>0</sub> = 0mM, T<sub>1</sub> = 25mM, T<sub>2</sub> = 50mM, T<sub>3</sub> = 75mM.



**Figure 3.** Combined effects of variety and salinity on yield of redamaranth and the vertical bar represents LSD at 0.01 level of probability. V<sub>1</sub>= Altapety, V<sub>2</sub>= RM, V<sub>3</sub>= Deshi, T<sub>0</sub> = 0mM, T<sub>1</sub> = 25mM, T<sub>2</sub> = 50mM, T<sub>3</sub> = 75mM.

## CONCLUSION

The present study was conducted to investigate the effect of variety and salinity on the yield components. The maximum yield per pot (259.56g) was found from the application of 25mM respectively at 50 DAS and the minimum yield per pot (154.44g) was observed at 50 DAS from 75mM application. However, further study may be needed regarding salinity on yield and yield contributing character of Red amaranth in different Agro-Ecological Zones (AEZ) of Bangladesh with more varieties to recommend a package of technology for use at growers' level.

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## CONFLICT OF INTEREST

There is no conflict of interest.

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