EFFECT OF DIFFERENT SALT STRESS CONDITIONS ON GROWTH AND YIELD OF BRINJAL (Solanum melongena)

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EFFECT OF DIFFERENT SALT STRESS CONDITIONS ON GROWTH AND YIELD OF BRINJAL (Solanum melongena)

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CERTIFICATE

This is to certify that the thesis entitle, "EFFECT OF DIFFERENT SALT STRESS CONDITIONS ON GROWTH AND YIELD OF BRINJAL (Solanum melongena)" *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE IN AGROFORESTRY AND ENVIRONMENTAL SCIENCE****, embodies the result of a piece of bona fide research work carried out by* ***SHAON MONDAL*** *Registration No.* 19-10303 *under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated: December, 2021
Dhaka, Bangladesh

Dr. Nazmun Naher
Professor
Supervisor

Dedicated to

My Beloved Parents

And Family

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ABSTRACT

Salt stress inducts substantial adverse effect on the performance and physiology of the crop plants. A pot experiment was conducted during November 2020 to March 2021 at Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 to evaluate the effect of different salt stress levels on growth and yield of brinjal namely BARI Begun 1, BARI Hybrid 2, EG 203. The three salinity levels (4 dS/m, 8dS/m, 12dS/m) along with a control where only water was applied which were inclined by irrigation of NaCl salt solution. The experiment was placed out following two factor Randomized Complete Block Design (RCBD) with three replications. Results showed that BARI Begun 1 gave the tallest (40.95cm) plant at control while it was 24.32 cm at 12 dS/m salinity level. Like plant height all the other parameters i.e. no of leaves (13.74), leaf length (15.6 cm), leaf breadth (6.7 cm), chlorophyll content (35.5) etc. were also decreased with increasing of salinity level. Maximum number of fruits per plant was obtained at control in BARI Hybrid 2 and decreased in higher salinity. Individual fruit weight of BARI Hybrid 2 (127.67gm) was highest among the varieties. Yield per plant was maximum in BARI Hybrid 2 (5.22 kg) obtained at control and minimum in EG 203 (2.16) under 12 dS/m salinity level. Yield contributing characters i.e. no of fruit/plant, fruit diameter (cm), individual fruit weight (gm), yield/plant etc. were also decreased with the increasing of salinity level. Therefore BARI Hybrid 2 performed best among the selected varieties and can be added in the saline area of Bangladesh.

ACRONYMS

% = Percent
^{0}C =Degree Celsius
AEZ =Agro Ecological Zone
AIS =Agriculture Information Service
ANOVA =Analysis of Variance
BARI =Bangladesh Agricultural Research Institute
BBS = Bangladesh Bureau of Statistics
cm =centimeter
cm^2 =Centimeter square
CV =Co-efficient of Variation
DAE =Department of Agricultural Extension
dS/m =deci Siemens per meter
DW =Dry weight
EC =Electrical conductivity
e.g. =For example
et al. =And others
FAO =Food and Agriculture Organization
FAOSTAT =Food and Agriculture Organization Statistics
FW =Fresh weight
g =Gram
K =Potassium
Kg =Kilogram
LSD =Least Significant Difference
m =Metre
mg =Miligram
Mg =Magnesium
mm =Milimeter
mM =Mili mole
m mhos/cm =Milimohos per centimeter
MoA =Ministry of Agriculture
N =North
Na =Sodium
no. =Number
S =South
SAU =Sher-e-Bangla Agricultural University
viz. =Namely

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CHAPTER I

INTRODUCTION

Salinity is the major abiotic stresses in the world especially in arid and semi-arid regions and can severely limits the plant growth and productivity of the economically important crop plants. Salinity affects nearly 20% of the world's cultivated area and about half of the world's total irrigated lands (Zhu 2001; FAO 2008). In Asia alone, 21.5 million ha of land area is thought to be salt- affected, with India having 8.6 million ha of such area (Sahi *et al*. 2006). Bangladesh is an agricultural based country. By the sea level rising, a huge amount of land in the southern coastal region will go under water and salinity will access the new areas of land. It will decrease the exiting crop area severely thereby decreasing agricultural productions. Moreover, the densely populated country might face food shortage to feed the people.

Salinity is a major issue to crop productivity in the southern and south-western part of Bangladesh, where it is increased due to frequent flood sea water of the Bay of Bengal and on the other hand introduction of irrigation with saline water. Agricultural land in the southern region of Bangladesh is uncultivated because of high soil salinity which covers almost 32,000 km^2 about 34% of the cultivated lands of the country (Haque, 2006). About one million ha of land of these coastal and offshore areas are affected by varying degrees of salinity (Asib, 2011).These coastal saline soils are distributed unevenly in 65 thanas of 14 coastal districts covering 8 agro-ecological zones (AEZ) of the country. The mainly salinity affected land exists in the districts of Khulna, Bagerhat, Barguna, Patuakhali, Pirojpur and Bhola, Satkhira on the western coast and a smaller portion in the district of Chittagong, Cox's Bazar, Noakhali, Lakshmipur, Chandpur and Feni. According to the report of Soil Resource Development Institute (SRDI, 2012) of Bangladesh, about 248337 ha of land is very slightly (2-4 dS/m), 218145 ha is slightly (4-8 dS/m), 198014 ha is moderately (8-12 dS/m) and 198486 ha is strongly (>12 dS/m) salt affected soils in southwestern side of the coastal belt region of Bangladesh.

The cropping patterns introduced in the coastal areas are mainly Fallow-Fallow-Transplanted Aman rice. Soil salinity is supposed to be mainly responsible for low land use as well as cropping intensity in the area (Rahman and Ahsan, 2001). During rabi season large area remain barren due to lack of irrigation water and higher concentration of salinity. Again the coastal belts remain inundated with range of 60 cm to 80 cm from May to September limiting the cultivation of crops except some local rice varieties, covering 60% of total cultivated land (Karim *et al*., 1998). Large interchange in salinity levels over time are also developed at almost all sites in these regions. The common trend is an increased in salinity with time, from November-December to March-April, ntil the beginning of the monsoon rains.

The salinity problems received very little attention in the past, such that the increasing demand for growing more food to feed the vast population of the country. Some recent past observation, it is observed that due to increasing degree of salinity and prolongation of affected areas normal agricultural land use practice become more problematic. The affected area of Bangladesh are still growing rapidly (SRDI, 2010). Salinity in soil or water is one of the major stresses that severely limit crop production (Haque, 2006). The effect of salinity on plant growth are associated with low osmotic potential, solution (water stress), nutritional imbalance, specific ion effect, or a combination of these factors (Ashraf, 1994; Sultana *et al*., 1999; Asch *et al*., 2000, Juan *et al.* 2005). Salinity of soil is a major problems for crop production not only to the southern region but also the most other parts of the country. The salinity affected area is increasing day by day and spreading all over the country through the intrusion of saline water. Due to soil salinity, large amount of the cultivable land become barren.

Eggplant (*Solanum melongena L.*) is the second most important vegetable crop next to potato in Bangladesh in respect of acreage and production (BBS, 2018). Different forms, colors, sizes and shapes of brinjal are introduced throughout the Southeast Asia inclined that this area is an important center of diversity and possibly of beginning. It is a favourible vegetable to the plains and is available more or less throughout the year. Brinjal is quite high in nutritive value and can compare with tomato (Choudhury, 1976). It is nutritious vegetable and has got multipurpose use as a dish item (Bos and Som, 1986 and Rashid, 1993). It has high calorie, iron, phosphorus and riboflavin contents than tomato (Shaha, 1989). It has potential as raw material in pickle making and in dehydration industries (Singh *et al*., 1963). Fried brinjal has some medicinal value to cure liver problem (Chauhan, 1981). Brinjal is a familiar vegetable crop for its easier cooking quality, better taste and lower market price. It is largely cultivated in almost all districts of Bangladesh. It can be grown at homestead area and kitchen garden because of its popularity especially for urban people. About 8 million farm families are involved in brinjal cultivation (Islam, 2005).

Eggplant is widely reported to be sensitive to salinity (Yasar *et al*., 2006; Abbas *et al*., 2010; Unlukara *et al*., 2010). Eggplant is very important vegetable as its nutritional value is almost equal to that of tomato as both are a rich source of minerals and vitamins (Kalloo 1993; Abbas *et al.* 2010). According to FAO (2012), eggplant is cultivated on an area of about 4 million acres (1.6 million ha) world-over. It is cultivated on about 15% of total vegetable cultivated land and contributes about 8% to total vegetable production (BBS, 2011). However, there is a dire need to enhance its yield and introduced more varieties which could thrive well under stressful habitats including saline stress (Chartzoulakis and Loupassaki 1997; Abbas *et al*. 2010). If the salt tolerant varieties of eggplant plants are explicitly elucidated, it may be possible to minimize salt-induced injury in this crop. So, this experiment was conducted to fulfil the following objectives:

1. To determine the effects of salinity on morphological parameters of brinjal;
2. To assess the salinity effect on yield and yield attributing characteristics of brinjal and
3. To identify the salt tolerant variety

CHAPTER II

REVIEW OF LITERATURE

The physiological aspects of growth and yield with growth analysis on various crops to know the reason of yield decreasing due to changing of soils has not yet been done at appropriate level. In this chapter a few attempts have been made to review some of available information about soil salinity and its effect on growth and yield components of brinjal.

2.1 Soil salinity

Soil salinity is the term used to designate a condition in which the soluble salt content of the soil reaches a level harmful to crops. Soil with an electrical conductivity of saturation extracts above 4 dS /m is called saline soil. It contains an excess of soluble salts, especially sodium chloride. Soil salinity is a major constraint of food production because it limits crop yield and restricts uses of uncultivated land (Flowers and Yeo, 1995).

Salinity causes unfavorable environment and hydrological situation that restrict normal crop production throughout the year. The freshly deposited alluviums from upstream in the coastal areas of Bangladesh become saline as it comes in contact with the sea water and continues to be inundated during high tides and ingress of sea water through creeks. The factors which contribute significantly to the development of saline soils are, tidal flooding during wet season (June-October), direct inundation by saline or brackish water and upward or lateral movement of saline ground water during dry season (November-May).

Saline soils have a high concentration of soluble salts. They are classed as saline when the EC> 4 dS/m. This definition of salinity derives from the EC that would reduce yield of most crops. However, many crops are affected by an EC< 4 dS/m. Osmotic and salt specific components inhibit root ans shoot growth EC is the electrical conductivity of the saturated paste extract, and reflects the concentration of salts in saturated soil. A conductivity of 4 dS/m is equivalent to 40 mM NaCl.

Tanji (1990) said that soil salinity is the concentration of dissolved mineral salts present in water and soils on a unit basis or weight.

Salinity reduces the ability of plants to take up water, and this quickly causes reductions in plant growth rate. When excessive amounts of salt enter the plant, salt will eventually rise to toxic levels in the older transpiring leaves, causing premature senescence, and reduce the photosynthetic leaf area of the plant to a level that cannot sustain growth. Higher amount of Na + and Cl - accumulation in plant was the cause of salt toxicity. Salt-tolerant plants differ from salt- sensitive ones in having a low rate of Na + and Cl - transport to leaves, and the ability to compartmentalize these ions in vacuoles to prevent their build-up in cytoplasm or cell walls and thus avoid salt toxicity (Munns, 2002).

Munns and Termat (1986) explained that even at low salinity levels, external salt concentration is much greater than that of nutrient ions, so that a considerable concentration of ions may reach the xylem. Being the actively transpiring parts of the plant, the leaves accumulated salt, which leads to their premature death.

2.2 Salinity around the world and Bangladesh

Asib (2011) reported that the ways of using the land use in coastal area are gradually changed and that is diverse, competitive and alarming. Out of 2.85 million hectares of the coastal and off-shore lands about 1.05 million hectares of arable lands are affected by varying degrees of salinity. Fifty percent of coastal lands are subject to inundation of varying degrees and frequency that limit their effective use. The land use of coastal area is used in different purposes such as shrimp culture, ship breaking yards, industry, salt production and settlements etc.

According to Bradbury and Ahmad (1990), one - third of the worlds land surface is arid or semi - arid, out of which one - half is estimated to be affected by salinity.

According to FAO (2010) the total world wide area of land affected by salinity is about 190 million ha.

Bangladesh is highly vulnerable to sea level rise (Brammer *et al*., 1993). The coastal area in Bangladesh constitutes 20% of the country of which about 53% are affected by different degree of salinity. The whole coast runs parallel to the Bay of Bengal, forming 710 km long coastline (CZP, 2005). The area lies at 0.9 to 2.1 meters above mean sea level (Iftekhar and Islam, 2004).

Soil resource development Institute (2000) showed that soil saline area in the country has increased to 1.02 million ha. Agricultural land used in these areas is very poor, which is roughly 50% of the country's average (Petersen and Shireen, 2001). In Bangladesh, coastal areas about 2.86 million ha covered by 30% of the total crop land of the country. Of this, nearly 1.056 million ha are affected by varying degrees of salinity (Karim *et al*., 1990).

Salinity problems might be severe in arid and semi-arid regions since rainfall is not sufficient and water supplies are also scarce as compared to water needs for crop production (Lamsal *et al.*, 1999).

The problems of salinization are increasing, either due to bad irrigation drainage or agriculture practices. Despite its relatively small area, irrigated land is estimated to produce one - third of the world food (Munns, 2002). Hasanuzzaman *et al.* (2013) reported that the arable land is continuously transforming into saline (1- 3% per year) either due to primary/natural salinity or secondary/irrigation-associated salinity, and is expected to increase up to 50% land loss by 2050.

According to SRDI (2010), in Bangladesh out of coastal cultivable saline area, about 328 (31%), 274 (26%) and 190 (18%) thousand hectares of land are affected by very slight (2.0-4.0 dS/ m), slight (4.1- 8.0 dS /m) and moderate salinity (8.1-12.0 dS/ m), respectively are scope to successfully crop production.

Table 1. Soil salinity class and area in coastal saline belt of Bangladesh

Mapping unit	Description	Total cultivated area (ha)	Total saline area (ha)	%	Salinity class and area (ha)									
					S1 2.0-4.0	%	**S2 4.1-8.0**	%	**S3 8.1-12.0**	%	**S4 12.1-16.0**	%	**S5 >16.0**	%
					dS/m									
1.	Non saline with some very slightly saline	650769	193278	30	133406	69	52375	27	7497	4	0	0	0	0
2.	Very slightly saline with some slightly saline	348090	248337	71	124726	50	82414	33	34532	14	6665	3	0	0
3.	Slightly saline with some moderately saline	271064	218145	80	55402	25	86872	40	43190	20	24635	11	8046	4
4.	Strongly saline with some moderately saline	219448	198014	90	14065	7	40777	21	47257	29	63755	32	22160	11
5.	Very strongly saline with some strongly saline	200460	198486	99	831	0	11782	6	47234	24	66925	34	71714	36
Total		1689831	1056260	63	328430	31	274220	26	189710	18	161980	15	101920	10

Source: SRDI, 2012

Islam (2005) reported that brinjal can be grown at homestead area and kitchen garden because of its popularity especially for urban people. About 8 million farm families are involved in brinjal cultivation. Jamil et al. (2005) observed the germination, germination rate, shoot and root length, shoot and root fresh weight, leaf area and number of leaves of canola (Brassicanapus), cabbage (Brassica oleracea capitata), and cauliflower (Brassica oleracea botrytis) were reduced significantly with increasing salinity.

According to the coastal zone policy (CZPo, 2005) of the Government of Bangladesh, 19 districts out of 64 are in the coastal zone covering a total of 147 upazilas of the country. Central coastal zone extends from Feni river estuary to the eastern corner of the Sundarbans, covering Noakhali, Barisal, Bhola and Patuakhali districts. The zone receives a large volume of discharge from the Ganges-Bhrahmputra- Meghna river system, forming high volume of silty deposition. More than 70% of the sediment load of the region is silt; with an additional 10% sand (Allison *et al*., 2003)

Naher *et al*. (2011) found that the lands of coastal area become saline as it comes in contact with sea water by continuous inundation during high tides and ingress of sea water through cracks and sometimes cyclone induced storm surge. The severity of salinity is increasing in the coastal area during winter with the drying of soil.

Salinity causes unfavorable environment and hydrological situation that restrict normal crop production throughout the year. 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. Soil reaction values (pH) in coastal regions range from 6.0–8.4 (Haque, 2006 and Naher *et al*., 2011). Observations in the recent past indicated that due to increasing degree of salinity of some areas and expansion of salt affected area as a cause of further intrusion of saline water, normal crop production becomes more restricted.

2.3 Fertility status of saline soils

Soil reaction values (pH) range from 6.0-8.4 with the exception of Chittagong and Patuakhali, where the pH values range from 5.0-7.8. The soils are in general poor in organic matter content with the excepton of Paikgachha upazila of Khulna district, where the top soils contain high organic matter (7%). The organic matter content of the top soils ranges from less than 1% to 1.5%. The low organic content in soils indicates poor physical condition of the coastal soils. The total N contents of the soils are generally low, mostly around 0.1%. The low N content may be attributed to low organic matter contents of most of the soils. Available P status of the soils ranges from 15-25 ppm. Some deficient P soils are also found in Chittagong, Barguna, Satkhira and Patuakhali districts. Widespread Zn and Cu deficiencies have been observed in the coastal regions (Karim *et al.,* 1990 and Naher *et al*., 2011).

2.4 Effects of salinity on growth and physiology

Salt stress inducts substantial adverse effects on the performance and physiology of the crop plants, which eventually leads to plant death as a consequence of growth arrest and metabolic damage (Hasanuzzaman *et al*., 2012).

Solanum melongena L., commonly so called as eggplant, aubergine, guinea squash or brinjal (Kantharajah and Golegaonkar 2004), is an economically significant vegetable crop of tropical and temperate parts of the world.

Eggplant is a native of the Indian sub-continent, with India as probable center of origin (Gleddie *et al.* and Keller, 1986). Eggplant has been cultivated in Asia for over 1500 years, used in traditional medicines (Khan,1979).

In Bangladesh total cultivated area of kharif and rabi brinjal reported to be 22,221 hectares and 42,836 hectares of land respectively (BBS, 2020) and total production was 5,58,000 metric tons (BBS, 2019-20). Wide range of variability was practiced in respect of morphological traits, but till date very few systematic assessment of genetic diversity on this crop has been done.

Asia has the largest eggplant production, which comprises more than 90% of the world production area and 87% of the world production (Choudhary and Gaur, 2009).

Recently, Sehrawat *et al.* (2013) reported that eggplant also encounters the cumulative adverse effects of other environmental factors as insects, pests, high temperature, pod-shattering along with salinity causing high yield loss.

Singleton and Bohlool (1984) reviewed that the salinity reduces the survival of rhizoidal inhibiting the infection process affecting fruit development and function or reducing plant growth.

The effect of salinity on decreasing growth of Brinjal plants has been reported sporadically (Raptan, 2001; Islam, 2001and Faruquei, 2002).

In eggplant seedlings, high salt concentration causes increased H_2O_2 content in both roots and leaves, hence salts should be removed to ensure proper growth and development (Saha *et al*., 2010).

Misra *et al*. (1996) reviewed that both root and shoot lengths were reduced with increased NaCl concentration, but roots were more damaged, with an increase in number of lateral roots and increase in its thickness, compared to shoots.

Nandini and Subhendu (2002) overviewed that high salinity results in a decrease in total leaf area and stomatal opening when three species of *Vigna (V. radiata, V.mungo, and*

V. unguiculata) subjected to varied doses of NaCl (50, 75, 100, 125, and 150 mM), and reduction in chlorophyll content, sugar, starchand peroxidase enzyme activity were observed in shoots and roots by Arulbalachandran *et al.*, (2009). Germination %, seedling growth rate, RWC and photosynthesis decreased with increasing NaCl levels in all species. The growth decrease was higher in mungbean than in black gram and cowpea.

Saito *et al.* (2008) was conducted an experiment to investigate the effects of 50mM NaCl in a hydroponic solution on the levels of various metabolites, including soluble sugars, amino acids, and organic acids and on the expression levels of salinity-responsive genes during fruit development. Results indicate that under salinity, brix (%), surface color density, and flesh firmness of the fruit were significantly enhanced, whereas fruit enlargement was suppressed. Salinity stress strongly promoted the accumulation of sucrose, citrate, malate, and glutamate, and slightly promoted glucose and γ-aminobutyric acid.t the transcriptional level, up-regulation ofethylene-synthetic1-aminocyclopropane-1-carboxylateoxidaseanddown-regulation under the level of chlorophyll a/b binding protein Cab-1Boccurred earlier in stressed fruit than in control fruit. Additionally, the carotenoid-biosynthesis regulatory gene, Phytoene synthase 1, and phosphoenol pyruvate carboxy kinase (PEPCK) were up-regulated under moderate salinity in the re dustage. The expression profiles of these genes in stress-treated fruit were consistent with the changes in fruit quality, including earlier ripening and a deeper red color. Furthermore, the up-regulation of PEPCK suggested that gluconeogenesis is involved in the accumulation of sugars in salinity-stressed fruit.

Rivera and Heras (1973) got that the adverse relationship between salinity and growth, that high salinity affected the protein bonds of green pigments and caused a cute decrease on the chlorophyll content. Photosynthetic activity of eggplant is reduced due to reduced function of electron transport and instability of pigment protein complex (Promila and Kumar, 2000).

Parida *et al*. (2005) and Hajier *et al.* (2006) was found that salinity stress results in a clear stunting of plant growth, which results in a considerable decrease in fresh and dry weights of leaves, stems and roots. Increasing salinity is also accompanied by significant reductions in shoot weight, plant height and root length.

Munns and Termat (1986) explained that even at low salinity levels, external salt concentration is much greater than that of nutrient ions, so that a considerable concentration of ions may reach the xylem. Being the actively transpiring parts of the plant, the leaves accumulated salt, which leads to their premature death.

Olympios *et al.* (2003) found that salinity negatively affects the size of the plant and total weight of fruits: the higher the concentration, the lower the growth and yield. Four levels of salinity in the irrigation water (I: 1.7dS/m (control), II: 3.7dS/m, III: 5.7dS/m and IV: 8.7dS/m) were applied to tomato plants at various stages of growth and for different time duration. The number of fruits and the average weight of fruit were reduced at the highest salinity especially when applied at an early stage of growth. When good quality water was applied at the beginning of growth, followed later by salinity, the negative effect on plant height, fresh and dry weight of shoots, leaf area, yield, average weight of fruits and the percentage of fruit with blossom-end-rot was less severe.

Wests and Francios (2004) reported that vegetative growth reduced 9.0% for each unit increase in electrical conductivity of in cowpea. Salinity Stress causes an imbalance in the uptake of mineral nutrients and their distribution within the plants (Grattan and Grieve, 1992 and Glenn *et al.*, 1999)

Singh *et al.*, (1993), found that the effect of varying levels of soil sodicity on plant height and found that increasing soil sodicity decreased the plant height in tomato.

Chakrabarti and Mukherji (2002) reviewed that application of NaCl salinity (EC value 4 dSm^{-1}) resulted decreasing in total leaf area in brinjal. Plants challenged with salinity display many visual signs of salt injury. Qualitative effects are symptomatic i.e. stunted growth (Srivastave and Jana, 1984), chlorosis of green parts (James, 1988; Pentalone *et al*., 1997 and Husain *et al*., 2003), leaf tip burning (Wahid *et al*., 1999b), scorch (Barroso and Alvarez, 1997) and necrosis of leaves (Volkumar *et al.*, 1998). Quantitative ones include reductions in dry mass, elongation and expansion growth of leaves (Neumann *et al*., 1988), tissue ionic and nutrient contents (Misra *et al.,* 2001) etc. Suppression in growth is usually ascribed to a reduced capacity of the green parts to photosynthesize under salinity (Morant-Manceau *et al.*, 2004), which, in addition to other factors, is more related to increased chlorophyll fluorescence (Murillo-Amamdor *et al*., 2002b) and changes in overall chlorophyll content (Zayed and Zeid 1997 and

Husain *et al*., 2003). Appraisal of morphological and physiological criteria of salinity tolerance has proven beneficial in increasing our understanding of salt tolerance in many plant species (Wahid *et al*., 1999b; Murillo-Amamdor *et al*., 2002a and Morant-Manceau *et al*., 2004)

Salt stress alters the membrane properties leading to reduced uptake of various essential nutrients by the roots and transport to the shoots (Promila and Kumar, 2000; Lauchli and Luttge, 2002).

2.5 Salinity effect on growth and yield

Selvaraj *et al.* (2009) found five genotypes namely IC112589, IC126784, IC203585, IC90774, IC112960 showed maximum tolerance for salinity stress at 0.25 % level among twenty five genotypes. The performance of the line IC 111589 alone was found to be better by recording higher germination percentage of 64,26, and 14 and seedling vigour index of 150.3; 40.6 and 6.2 at 0.25 %; 0.50% and 0.75% sodium chloride concentration respectively. Key words: seedling vigour, genotypes, salinity stress.

Sarker *et al*. (2008) got yield potent was significantly higher in BARI Begun-5 followed by BARI Begun-5. The lowest yield was performed by BARI Begun-6. Tarapuri might have best yield potential in the study area but it needs further extensive study using different plant growth regulators.

Hassen *et al*. (1999) was indicated that Threa brinjal variety was sensitive to salt stress than Barcelona variety. Phenotypic data of plant height, leaf number, branches number, leaf area, shoot dry weight, average of fruit number, average of fruit weight and total fruit harvest showed high decrease under 8 and 12 Ec (dS/m) under salt stress.

Musa *et al*. (2015) found that NC-2 (green variety) appears to respond more to higher N-application (up to 200kgN/ha) as compared to NC-1 (offwhite variety). Also, fertilizer had significant effect on vegetative characters, yield and some yield components. The yield were found to be statistically at par.

Amini, F. and Ehsnapour (2006) studied the effect of MS and agar medium containing NaCl and sucrose on germination percentage, seedling growth, chlorophyll content, acid phosphate activity and soluble proteins in different cultivars of Lycopersicon esculentum Mill. (Cv. Isfahani, Shirazy, Khozestaniand Khorasani). Seeds were germinated under various mediums, MS with sucrose, water agar with and without sucrose with different concentration of NaCl (0, 40, 80, 120 and 160 mM). Increasing salinity decrease the germination percentage and seedling dry weight. The highest germination percentage was found in Cv. Isfahani and lowest in Cv. Shirazy. Chlorophyll content (Chl a, Chl b, and total Chl) were decreased with increasing salinity in both Cv. Isfahani and Shirazy. Acid phosphates activity was decreased in stem leaf while it was increased in roots. Enzyme activity was decreased on stem leaf in Cv. Shirazy but increased in Cv. Isfahani. Soluble proteins in roots of both cv showed variation.

Adams and Ho (1992) conducted an experiment and find out that increased salinity to 10 dSm^{-1} does not affect fruit set significantly but fruit set was reduced particularly on the upper trusses at higher salinity ($15dsm^{-1}$). The tomato cultivars Counter, Calypso and Spectra were grown in NFT at a range of salinities 5, 10 and 15 mS cm^{-1}. The incidence of the blossom end rot (BER) was higher in high salinity and thus reduced the fruit number.

Bresler *et al*. (1982) were reported that eggplant is highly sensitive vegetable crop and it has great potentiality to grow in saline soil.

Ep heuvelink (2005) said in his book Tomatoes (Crop Production Science in Horticulture) salinity can reduce the fruit growth rate and final fruit size by an osmotic effect. High salinity lower water potential in the plant which was reduce the water flow in the fruit and that therefore the rate of fruit expansion. ECs of 4.6-8 ds/m reduced fruit yield because reduction of fruit size whereas ECs Of 12ds/m reduced number and size of fruit.

Hao *et al.* (2000) found higher salinity reduced total marketable yield and fruit size, but improved tomato fruit quality. Tomato cv. Trust plants were grown with Nutrient Film Technique (NFT). The EC of nutrient solution was increased to 40 or 80% above the standard, with either all major macronutrients, NaCl or NaCl/KCl following a seasonal EC schedule, in which target EC changed with plant age and ambient solar radiation.

Jamil *et al*. (2005) observed the germination, germination rate, shoot and root length, shoot and root fresh weight, leaf area and number of leaves of canola (*Brassica napus*), cabbage (*Brassica oleracea capitata*), and cauliflower(*Brassica oleracea botrytis*) were reduced significantly with increasing salinity. The treatment were 0.0 (control), 4.7, 9.4 and 14.1 dS m^{-1} NaCl. In case of germination percentage cabbage and canola showed more tolerant to salinity than cauliflower. Fresh shoot and root weight, leaf area and number of leaves were severely affected at all salinity treatments.

Jamil *et al.* (2007) found dry root and shoot weight, fresh leaf weight and leaf area of sugar beet (*Beta vulgaris L.*) and cabbage (*Brassica oleracea capitate L.*) decreased significantly with increasing salt concentration whereas there were no changes in dry leaf weight and leaf water content. Seedlings of sugar beet and were grown in sand culture at salinities of 0 (control), 50, 100 and 150 mM NaCl. Salinity induced no effects in both species on the maximal efficiency of PSII (Fv/Fm) photochemistry, efficiency of excitation energy capture by open PSII reaction canters, electron transport rate (ETR), photochemical quenching coefficient (qP), non-photochemical quenching coefficient (qN) and physiological state of the photosynthetic apparatus(Fo/Fm).

Karen *et al*. (2002) conducted an experiment to determine the effects of ozone and salinity, singly and in combination, on the growth and ion contents of two chickpea (*Cicer arietinum L.*) varieties. Salinity at a concentration of 30 mM NaCl caused a substantial reduction in plant height, number of leaves and the dry weights of the leaves, stems and roots. Ozone at a concentration of 85 nmol mol($^{-1}$) for 6 h per day for 25 days reduced plant height and dry weights but had no effect on leaf number. Salinity and ozone have substantial effects on chickpea growth and ion concentrations.

Melon (*Cucumis melo L. Cv Parnon*) plant grown in high salinity (50 mM NaCl) and higher concentrations of CO_2 (200 μmol mol^{-1}) reduces shoot fresh weight, plant height, leaf surface area, Chlorophyll content and fruit yield (Mavrogianopoulos, 1999). Plants were grown in rock wool culture in the greenhouse was CO_2 enriched, for 5h every morning, at 400, 800 and1200 μmol mol^{-1} and trickle-irrigated with nutrient solutions amended with 0,25 and 50 mM NaCl. At 25 mM NaCl, the decrease in yield resulted mainly from the smaller fruit size, but at 50 mM yield reduction was due both to smaller fruit size and to fewer fruits per plant. High CO_2 level increased fruit yield, the increase being greater in unsalinated plants than in salinated. With total shoot fresh weight, the increase was greater in salinized plants. Measurements of gas exchange showed that, for the above mentioned CO_2 and NaCl concentrations, net assimilation was affected by CO_2 to a greater degree than by salinity. Stomatal conductance was most affected by salinity at a concentration of 50 mM NaCl.

Magan *et al.* (2008) conducted an experiment to evaluate the effect of salinity on fruit yield, yield components and fruit quality of tomato grown in soil-less culture in plastic greenhouses in Mediterranean climate condition. Two spring growing periods and one long season, autumn to spring growing period of studies were conducted with two cultivars, 'Daniela' and 'Boludo'. Seven levels of electrical conductivity (EC) in the nutrient solution were compared (2.5–8.0 dS m^{-1}) and five levels (2.5–8.5 dS m^{-1}). Total and marketable yield decreased linearly with increasing salinity above a threshold EC value (ECt).Average threshold EC values for total and marketable fruit yield were, respectively, 3.2 and 3.3 dS m^{-1}.Increasingsalinity improved various aspects of fruit quality, such as: (i) proportion of 'Extra' fruits (high visual quality), (ii) soluble solids content, and (iii) titratable acidity content. However, salinity decreased fruit size, which is a major determinant of price.

A two-factor experiment was conducted by Rashid *et al.* (2010) at the Agricultural Research Station, Rumais, Oman to evaluate the performance of yield and quality of tomato (*Lycopersicon esculentum L.*) with three levels of saline water (3, 6 and 9 dS m^{-1}) and three types of fertilizers viz- inorganic, NPK, organic (cow dung), and a mixed fertilizer of both. Results indicated that growing tomatoes under 3 and 6 dS/m irrigation water produced the highest yield whereas irrigating with 9 dS/m significantly reduced the final fruit number and fruit weight. Tomatoes grown using cow manure produced the least amount of yield compared to those with inorganic and mixed fertilizers. Fruit quality attributes were not significantly affected by salinity or fertilizer treatments.

Siddiky *et al.* (2012) reported that different salinity level (2, 4, 8 and12ds/m) significantly effects on tomato plant height, leaf area, plant growth, yield, dry matter plant, Na^+ and Cl^- accumulation in tomato tissues. Under saline condition, all plant parameters of tomato varieties were reduced compared to the control. Plant growth and yield was decreased gradually with the increase of salinity levels.

Zhang *et al.* (2016) was found that total yield of tomato is significantly reduced at salinity equal and above 5 dS m^{-1}, and a 7.2% yield reduction per unit increase in salinity. Salinity can decrease root water uptake through its osmotic effect, and subsequently induce water stress.

CHAPTER III

MATERIALS AND METHODS

A brief description of experimental location, soil characteristics, climate, materials, layout and design of the experiment, land preparation, manuring and fertilizing, transplanting of seedlings, intercultural operations, data collecting procedure, economic and statistical analysis etc. are included in this chapter.

3.1 Experimental Site

A pot experiment was conducted at the Agroforestry Farm, Sher-e-Bangla Agricultural University, Sher-E-Bangla Nagar, Dhaka-1207. The experimental site was at 23^0 $74^/$ N latitude and 90^0 $35^/$ E longitudes with an elevation of 8.1 meter from sea level (UNDP, 1988) in Agro- Ecological Zone of Madhupur Tract (AEZ. 28).

3.2 Experimental Period

The experiment was conducted during the period from November 2020 to March 2021 (rabi season).

3.3 Climatic Condition

The experimental location was situated in the subtropical monsoon climatic zone, the mean lowest and mean highest temperatures in the 6 months are 18.2 °C and 31.6 °C respectively. The monthly total rainfall, temperature, average sunshine per hour during the study period was shown in Appendix I.

3.4 Materials

This experiment comprised of three brinjal varieties including:

- BARI Begun 1 (Uttora)
- BARI Hybrid 2 (Satkara)
- EG 203

The seeds were collected from Horticulture Research Center, BARI, Gazipur.

3.5 Design and Layout of the experiment

The two factor experiment was conducted in pots following the Randomized Complete Block Design (RCBD) with three replications.

3.6 Treatments of the experiment

Factor A: Brinjal **varieties**

V_1: BARI Begun 1

V_2: BARI Hybrid 2

V_3: EG 203

Factor B: Salinity **levels**

Four salinity levels dSm^{-1} (deci-simens per meter),

T_0= Control (Tap water),

T_1= 4 dSm^{-1},

T_2= 8 dSm^{-1} and

T_3= 12 dSm^{-1}

So, there were 12 treatment combinations such as T_0V_1, T_0V_2, T_0V_3, T_1V_1, T_1V_2, T_1V_3, T_2V_1, T_2V_2, T_2V_3, T_3V_1, T_3V_2 and T_3V_3.

3.7 Pot preparation

Top soil was collected from experimental field and then pulverized. The inert materials, visible insects, pests and plant propagates were removed from the soil. Then the soil was dried thoroughly. Compost (1/4th of the soil volume) and 0.3 g Urea, 0.4 g TSP and 0.12g of MP per pot were incorporated uniformly into the soil. Clean and dried plastic pots of 10 liter size were used for each variety. Each pot was then filled with 8 kg previously prepared growth media (soil and cow dung mixture). Treatments were replicated three times each. Salt solution was prepared to give the same concentration levels, and was added as irrigation water to plastic pots, in addition to distill water treatment was applied as a control. Seeds had chosen and sowed in each pot at a depth of 1 cm. Intercultural operation, weeding and other measures were taken when necessary.

3.8 Transplant of seedlings

Seeds of different varieties were first shown in an open plot. Care should be taken is necessary for healthy seedlings. After 20-22 days of showing the seeds, the seedlings were ready to transplant. The healthy seedlings were then transplanted in the 10 liter size pots which were ready previously.

3.9 Application of the treatments

Four salinity levels of 0 mM NaCl (Control), 40 mM NaCl (T_1), 80 mM NaCl (T_2), and 120 mM NaCl (T_3) were prepared artificially by dissolving calculated amount of commercially available sodium chloride in the water used for irrigation to impose salt stress. The control treatment (0 mM NaCl) was without sodium chloride. The EC of the respective salt solution was equivalent to 4 and 8 d S/m respectively and 0.3 d S/m for tap water (control). Pots were maintained at field capacity until seed sowing. Brinjal seedlings were subjected to salinity at vegetative stage after establishment (20 DAS) with sufficient quantities of salt solutions in the treated pot. Salt solutions were provided once in a week to impart salt stress. The plants provided with equal volume of water without NaCl were used as control (C).

3.10 Intercultural operations

Weeding was done for all pots when required, to keep the plant free from weeds, pests and diseases that can be a major factor for decreasing brinjal production. Brinjal plants were treated with Dithane M45 @ 0.5 ml/L and 2 gm/L to prevent unwanted disease problems. On the other hand, Brinjal shoot and fruit borer is one of the important pests during the growing stage. This was controlled by Tufgor @ 1.5 ml/L. Those fungicides and insecticide were sprayed two times, first at vegetatively growing stage and next to early flowering stage to manage diseases and pests. Precautionary measures against disease infection especially phomopsis fruit rot of brinjal was taken by spraying Bavistin fortnightly at the rate of 2 g/L.

3.11 Harvesting of fruits

Harvesting of fruits was done after the fruits reached at maturity level. Brinjal fruits were collected when they attained full maturity indicating deep violet in color and hard in consistency. Harvesting was started 82 DAT and was continued until 140 DAT as financial production.

3.12 Data Collection

i. Growth parameters

a) Plant height (cm)

b) Leaf number

c) Leaf length (cm)

d) Leaf breadth (cm)

ii. Yield parameters

e) No. of flowers / plant

f) No. of fruits / plant

g) Individual fruit weight (gm)

h) Average fruit length (cm)

i) Average diameter of fruit (cm)

j) Yield (kg/plant)

Plant Height (cm)

Height of plants were measured by meter scale. Plant height was measured from base to the tip of the plant. Height of three plants from each plot was recorded and the mean was calculated.

Number of leaves, flowers and fruits per plant

All the leaves were counted separately from the each plant. The average number of leaves of three plants gave the number of leaves per plant. Number of flower buds, flowers and fruits per plant was recorded by counting all the leaves, flower buds, flowers and fruits from each plant of pot and the mean was calculated.

Length and width of the leaves (cm)

Two plants from each pot were randomly selected at vegetative and reproductive stage for collecting data on length and width of leaves. Length and width of leaves were measured by scale and the mean was collected.

Fruit length and diameter (cm)

Fruit length was measured with a scale from the neck of the fruit to the bottom and average was calculated and expressed in cm. Diameter of fruit was measured at the middle portion of selected fruit from each plant by using a slide calipers and their average was calculated and expressed in cm.

Yield (kg/plant)

Electric balance was used to take the weight of fruits per plant. It was measured by the summation of all harvested fruit weight per plant and finally data were recorded in kilogram (kg). Data were recorded as the average of 5 plants selected from the each pot.

3.13 Statistical analysis

Data obtained for different parameters were statistically analyzed to observe the significant difference among the treatment. The mean value of all the parameters was calculated and analysis of variance was performed. The recorded data on different parameters were statistically analyzed by using Statistic 10 software to find out the significance of variation resulting from the experimental treatments. The significance of the difference among the treatment means was estimated by the Randomized Complete Block Design (RCBD) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The study was conducted to identify the productive brinjal accessions for commercial production in saline prone areas of Bangladesh under saline condition and in this chapter the results of the research work have been showed and discussed. Various data have been presented in table for ease of discussion and understanding. Summary of the analysis of variances in respect of all the parameters have been shown in appendices. Results of the experiment have been presented and discussed, and possible interpretations are given under the following heads.

4.1. Effect of salinity on growth and morphological characteristics

4.1.1. Effect of salinity on plant height

Plant height is the most important growth index of plant. The height of three brinjal plants was calculated at different stages. The effect of salinity on plant height was statistically significant ($P>0.05$) at vegetative and maturity stage (Figure 1). Plant height decreased with the gradual increase of salinity at different levels of harvest. At vegetative stage the tallest plant (32.74 cm) was obtained from control followed by 4 dSm^{-1} level of salinity.

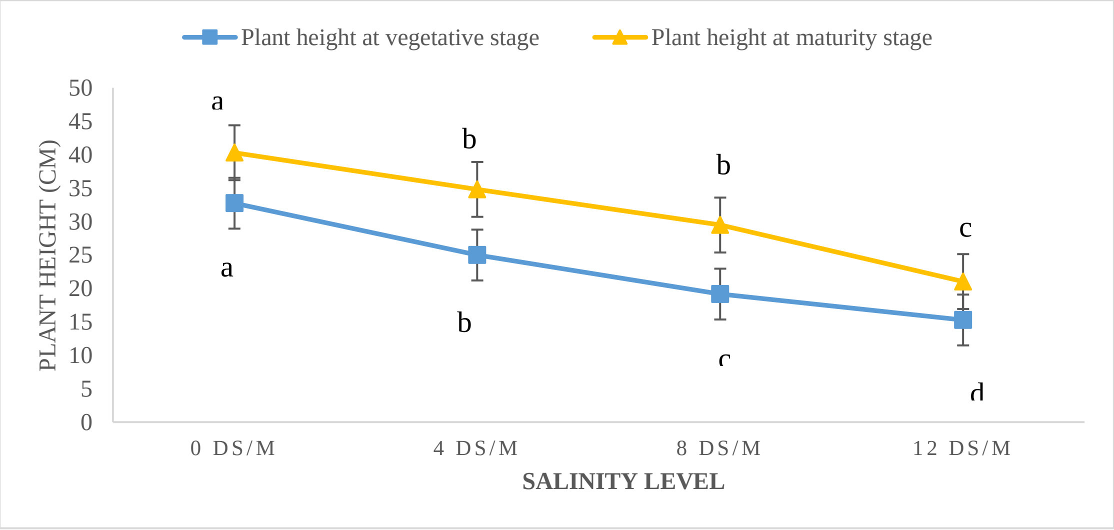

Figure 1. Effect of salinity level on plant height (cm) of brinjal varieties at CV (13.8) and LSD $_{(0.05)}$ (3.18)

The shortest plant (15.27 cm) was found from the salinity at 12 dSm^{-1}. In maturity stage the tallest plant (40.29 cm) was obtained from control followed by 4 dSm^{-1}. The shortest plant (21 cm) was found from the salinity of 12 dSm^{-1}. Decreasing of plant height might be due to decrease nutrients availability caused by increasing salinity level. Salinity had direct effect on plant height. Egeh and Zamora (1992) reported that plant height of brinjal genotypes were decreased by salinity.

Effect of salinity on plant height of brinjal varieties

Effect of salinity stress on different genotypes was statistically significant (Figure 6). In vegetative stage the highest plant height was found in Eg 203 (24.867 cm) and lowest was in BARI Hybrid 2 (19.6 cm). At maturity stage the highest plant height was found in BARI Begun 1 (32.74 cm) and lowest was in Eg 203 (30.408 cm). The variation of plant height among the varieties might be due to different genetic makeup of the plant varieties.

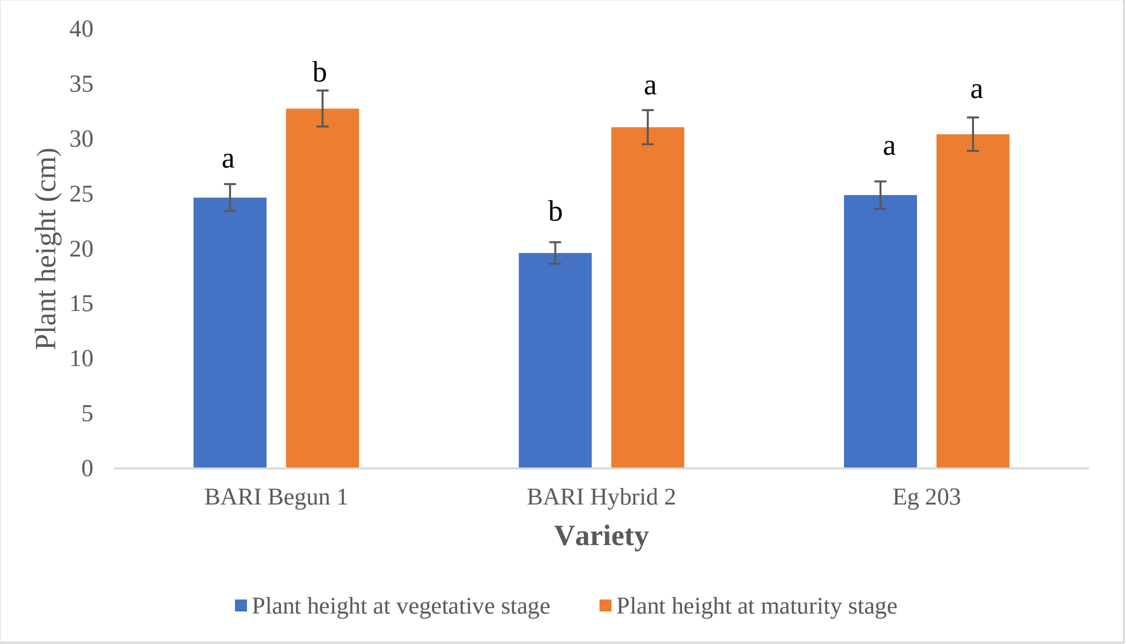

Figure 2. Varietal effect of salinity on plant height (cm) of brinjal varieties at LSD $_{(0.05)}$ (2.7)

Interaction effect of salinity level and brinjal varieties on plant height

The interaction effect on plant height between salinity levels and varieties was found significant. From the Table 2, it was observed that the tallest plant was found (13.03 cm) at 12 dS/m at vegetative stage and (24.32 cm) at 12 dS/m at maturity stage in BARI Begun 1 variety. The shortest plant (12.300 cm) was found in Eg 203 at 12 dS/m salinity level at vegetative stage.

In every varieties, there were decreasing characteristics in plant height with increasing salinity levels. Similar trends were also reported by Hossain *et al*. (2008), Qados (2011) and Velmani *et al*. (2012) in *Vigna spp* and Bakht *et al* (2011) in *Zea mays*. Wests and Francios (2004) showed that vegetative growth reduced 9.0% for each unit increase in electrical conductivity of in cowpea.

These results reported that vegetative growth of these species was the most sensitive to salinity compared to other growth stages in different brinjal variety. The reduction of the plant height due to increasing salinity may be a result of a combination of osmotic ion effects of Na and Cl (Zhu *et al.* 2001). Similar results were found by Singh *et al.* (1993). They reported that the effect of varying levels of soil salinity on the parameter plant height and found that increasing soil salinity decreased the plant height.

Table 2. Interaction effect of salinity level and brinjal variety on plant height (cm)

Interaction	Plant height at vegetative stage (cm)	Plant height at maturity stage(cm)
Treatment ×Variety		
Control ×BARI Begun 1	32.972 ab	40.947 ab
Control ×BARI Hybrid 2	27.167 b	38.267 abc
Control ×Eg 203	38.067 a	41.667 a
4 dS/m× BARI Begun 1	26.622 bc	35.547 a-d
4 dS/m× BARI Hybrid 2	20.167 d	34.200 a-d
4 dS/m× Eg 203	28.167 b	34.667 a-d
8 dS/m× BARI Begun 1	18.472 de	30.147 c-e
8 dS/m× BARI Hybrid 2	18.033 de	31.467 b-e
8 dS/m× Eg 203	20.933 cd	26.800 d-f
12 dS/m× BARI Begun 1	20.478 d	24.320 ef
12 dS × BARI Hybrid 2	13.033 ef	20.233 f
12 dS × Eg 203	12.300 f	18.500 f
SE(±)	**2.2974**	**3.7035**
CV	**13.88**	**16.41**

4.1.2. Effect of salinity level on leaf length

Effects of different salinity levels on leaf length

Leaf length was significantly affected by salinity stress during both vegetative and maturity stages given in Figure 3. In vegetative stage leaf length was significant and maturity stage the leaf length was insignificant. At maturity stage the highest leaf length (30.631 cm) was found from control and lowest (15.6 cm) was recorded from the salinity 12 dS/m.

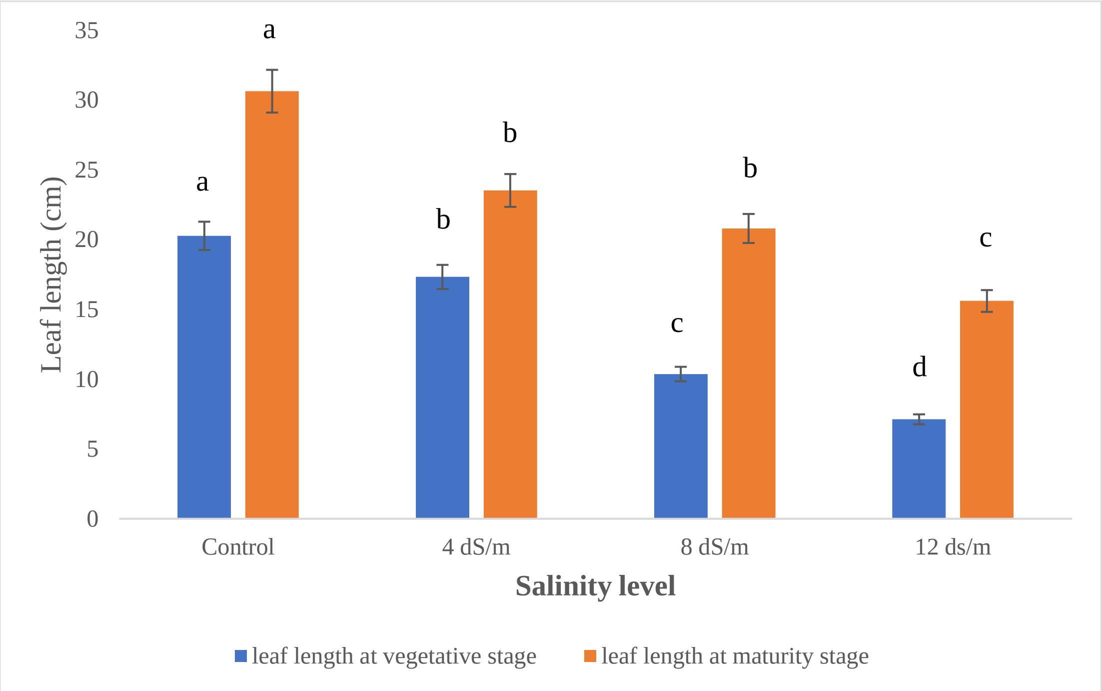

Figure 3. Effect of salinity level on leaf length (cm) of brinjal varieties at LSD $_{(0.05)}$ (2.28)

Effects of salinity on leaf length(cm) of brinjal varieties

Effect of salt stress on different genotypes was statistically significant (Figure 4). At vegetative stage the maximum leaf breadth was in BARI Hybrid 2 (17.64 cm) and minimum was in Bari Begun 1 (10.22cm). At maturity stage the maximum breadth was recorded in BARI Begun 1 (23.56 cm) and minimum was in BARI Hybrid 2 (21.45cm).

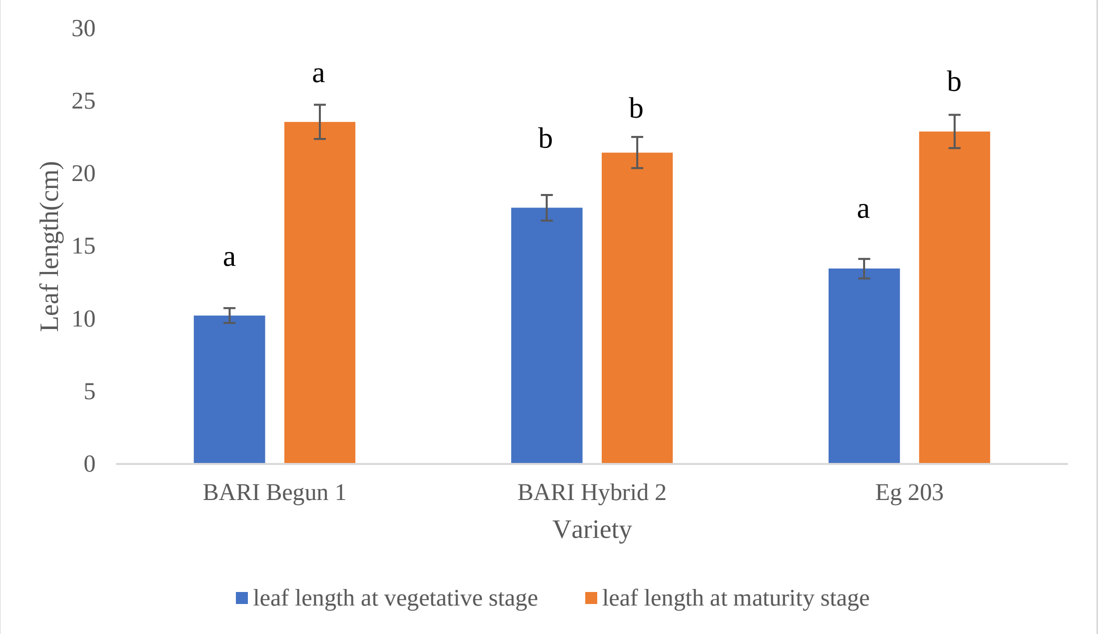

Figure 4. Varietal effect of salinity on leaf length (cm) of brinjal varieties at LSD $_{(0.05)}$ (1.94)

Interaction effect of salinity stress and variety on leaf length (cm)

The interaction effect on leaf length between varieties and salinity levels was found significant. From the Table 3, it was observed that the maximum leaf length was found BARI Hybrid 2 (24.43 cm) at control and (9.262 cm) at 12 dS/m and minimum leaf length was found in Eg 203 (5.23 cm) at 12 dSm^{-1} salinity level in vegetative stage. Again it was found that the maximum leaf length was found BARI Begun 1 (24.02 cm) at control in maturity stage.

Table 3. Interaction effect of salinity level and brinjal variety on leaf length (cm)

Interaction	Leaf length at vegetative stage (cm)	Leaf length at maturity stage (cm)
Treatment ×Variety		
Control ×BARI Begun 1	14.398 cd	24.018 a
Control ×BARI Hybrid 2	24.433 a	23.500 a
Control ×Eg 203	21.433 ab	21.400 a
4 dS/m× BARI Begun 1	12.638 de	21.018 ab
4 dS/m× BARI Hybrid 2	21.667 a	20.933 ab
4 dS/m× Eg 203	17.667 bc	17.800 a-c
8 dS/m× BARI Begun 1	6.438 fg	12.918 cd
8 dS/m× BARI Hybrid 2	15.200 cd	14.500 cd
8 dS/m× Eg 203	9.467 ef	9.500 de
12 dS/m× BARI Begun 1	6.878 fg	12.132 d
12 dS × BARI Hybrid 2	9.267 ef	9.033 de
12 dS × Eg 203	5.233 g	5.067 e
SE(±)	**1.6510**	**2.5487**
CV	**16.68**	**15.18**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

4.1.3. Effect of salinity level on leaf width (cm)

Leaf width was decreasing with increasing the levels of salinity. The leaf width was significantly changed by salt stress during both vegetative and maturity stage given in Figure 5. At vegetative stage the highest leaf width (18.06 cm) was obtained from control which was statistically similar to 4dS/m and lowest (6.74 cm) was recorded from the salinity of 12 dS/m. At maturity stage the highest leaf width (14.5 cm) was obtained from control and lowest (6.73 cm) was recorded from the salinity of 12 dS/m.

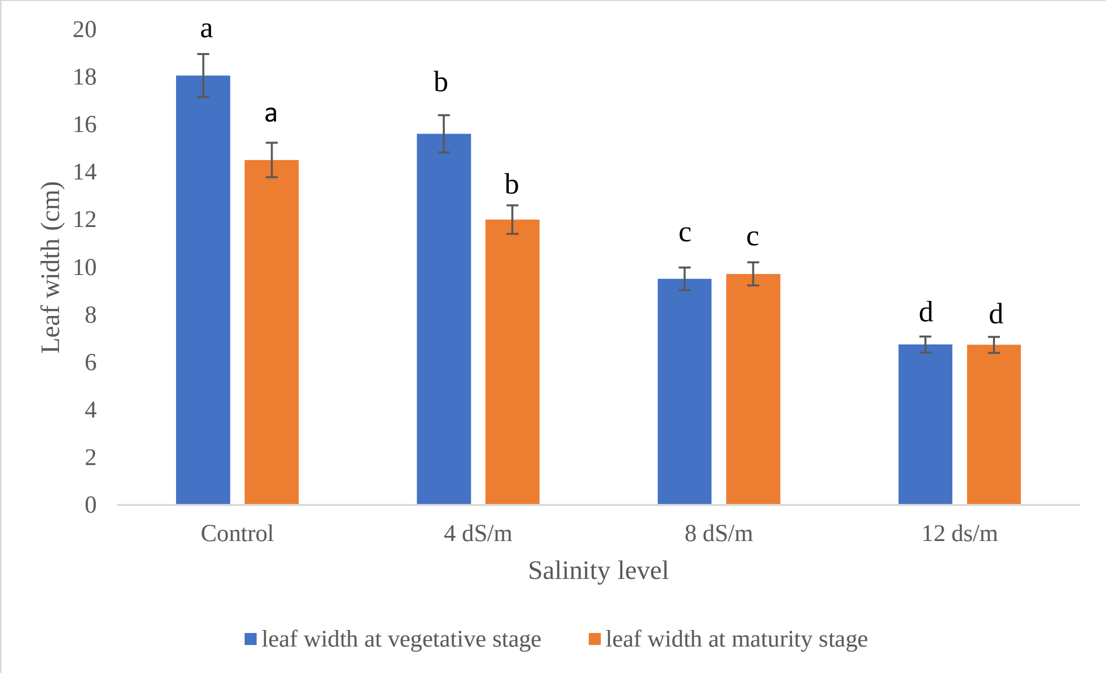

Figure 5. Effect of salinity level on leaf width (cm) of brinjal varieties at LSD $_{(0.05)}$ (2.20)

Effects of salinity on leaf width (cm) on brinjal varieties

Effect of salt stress on different varieties was statistically significant (Figure 6). At vegetative stage the maximum leaf width was in BARI Hybrid 2 (15.77 cm) and minimum was in Bari Begun 1 (9.38 cm). At maturity stage the maximum width was recorded in Eg 203 (11.3 cm) and minimum was in BARI Hybrid 2 (9.9 cm).

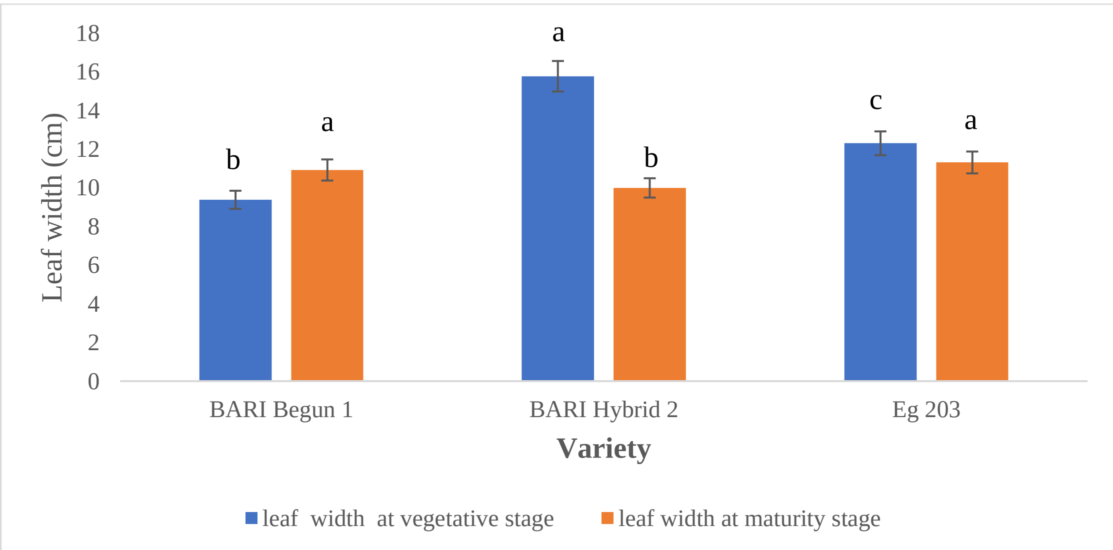

Figure 6. Varietal effect of salinity on leaf width (cm) of brinjal varieties at LSD $_{(0.05)}$ (1.89)

Interaction effect of salinity levels and variety

The interaction effect on leaf width among the varieties and salinity levels was found significant. From the Table 4, it was observed that the maximum leaf width was found in BARI Hybrid 2 (21.77 cm) at control in vegetative stage and minimum leaf width was found in Eg 203 (4.73 cm) at 12 dSm^{-1}salinity level at vegetative stage.

Table 4. Interaction effect of salinity level and brinjal variety on leaf width (cm)

Interaction	Leaf width at vegetative stage (cm)	Leaf width at maturity stage (cm)
Treatment ×Variety		
Control ×BARI Begun 1	11.541 cd	13.763 a
Control ×BARI Hybrid 2	21.767 a	12.833 a
Control ×Eg 203	19.500 a	16.500 a
4 dS/m× BARI Begun 1	10.041 de	10.638 ab
4 dS/m× BARI Hybrid 2	19.433 a	10.833 ab
4 dS/m× Eg 203	13.500 c	13.900 a-c
8 dS/m× BARI Begun 1	5.991 fg	9.213 cd
8 dS/m× BARI Hybrid 2	15.200 cd	9.867 cd
8 dS/m× Eg 203	8.667 d-f	9.733 de
12 dS/m× BARI Begun 1	5.740 g	7.963 d
12 dS × BARI Hybrid 2	8.367 ef	6.433 de
12 dS × Eg 203	4.733 g	5.100 e
SE(±)	**1.6510**	**1.0978**
CV	**13.32**	**14.22**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

4.2. Effect of salinity on yield and yield components

4.2.1. Effect of salinity level on individual fruit wt. (gm)

The effect of salinity on individual fruit weight was statistically significant ($P<0.05$) (Figure 7). The highest (88.62g) fruit weight was found from control treatment. The lowest (58.31g) fruit weight was found from 12 dS/m salinity level which indicated that with the increasing salinity levels the fruit weight gradually decreasing.

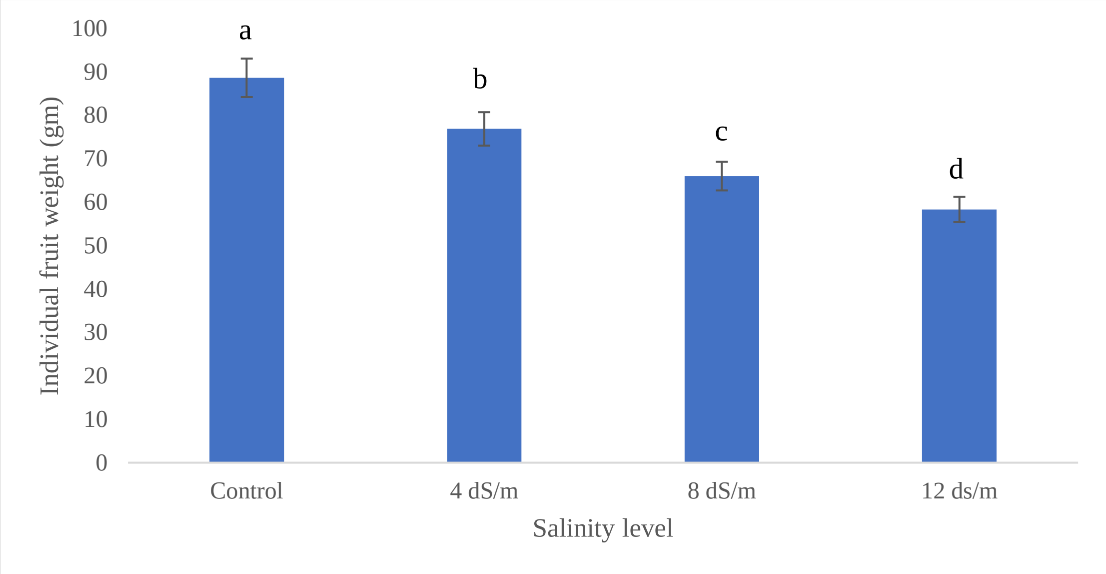

Figure 7. Effect of salinity level on individual fruit weight (gm) of brinjal varieties at CV (5.51) and LSD $_{(0.05)}$ (3.9)

Varietal effects of brinjal varieties on individual fruit wt. (gm)

Among the varieties the individual fruit weight was statistically significant ($p<0.05$). The maximum fruit weight (111.89g) was observed in BARI Hybrid 2 and the minimum (42.68g) in BARI Begun 1.

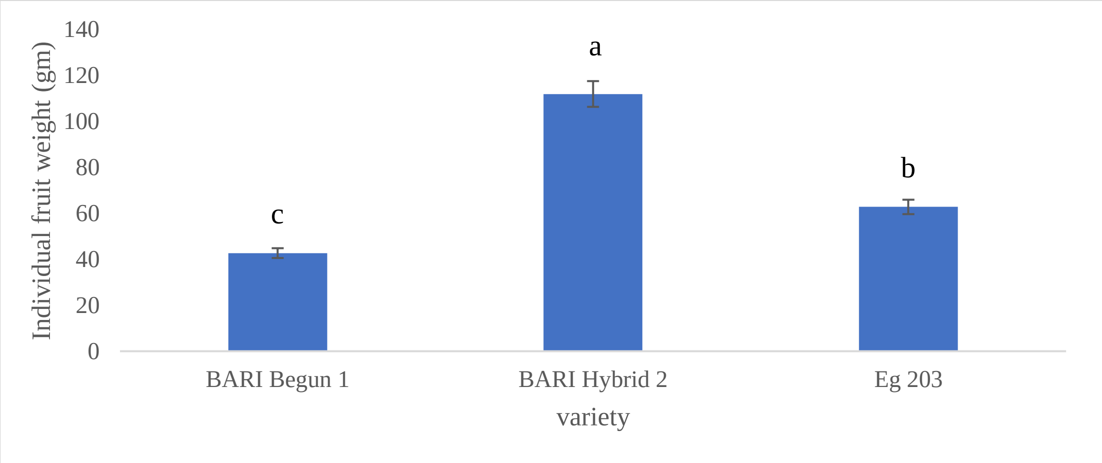

Figure 8. Varietal effect of salinity on individual fruit wt. (gm) of brinjal varieties at LSD $_{(0.05)}$ (3.38)

Interaction effect on salinity levels and varieties of brinjal

The interaction effect of salinity levels and variety in relation to individual fruit weight was found significant ($P<0.05$). From Table 5, the maximum weight (127.67g) was found in BARI Hybrid 2 at control and the minimum fruit weight (36.29g) was observed in Eg 203 at 12 dS/m salinity.

Table 5. Interaction effect of salinity level and brinjal variety on individual fruit wt. (gm)

Interaction	Individual fruit wt. (gm)
Treatment ×Variety	
Control ×BARI Begun 1	52.25 fg
Control ×BARI Hybrid 2	127.67 a
Control ×Eg 203	85.93 d
4 dS/m× BARI Begun 1	44.85 gh
4 dS/m× BARI Hybrid 2	114.07 b
4 dS/m× Eg 203	71.67 e
8 dS/m× BARI Begun 1	37.35 hi
8 dS/m× BARI Hybrid 2	105.30 c
8 dS/m× Eg 203	55.33 f
12 dS/m× BARI Begun 1	36.29 i
12 dS × BARI Hybrid 2	100.53 c
12 dS × Eg 203	38.10 hi
SE(±)	**2.8712**
CV	**5.51**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

4.2.2. Effect of salinity level on yield (kg/plant)

The effect of salinity on yield/plant was varied significantly. The highest production (4.1 kg) was obtained from control, followed by 4 dSm^{-1} salinity level (3.6 kg). The lowest yield (2.5 kg) was recorded from 12 dSm^{-1} salinity level (Figure 9). Salinity stress influenced the size of the fruits. Fruit size was reduced with increased salinity stress.

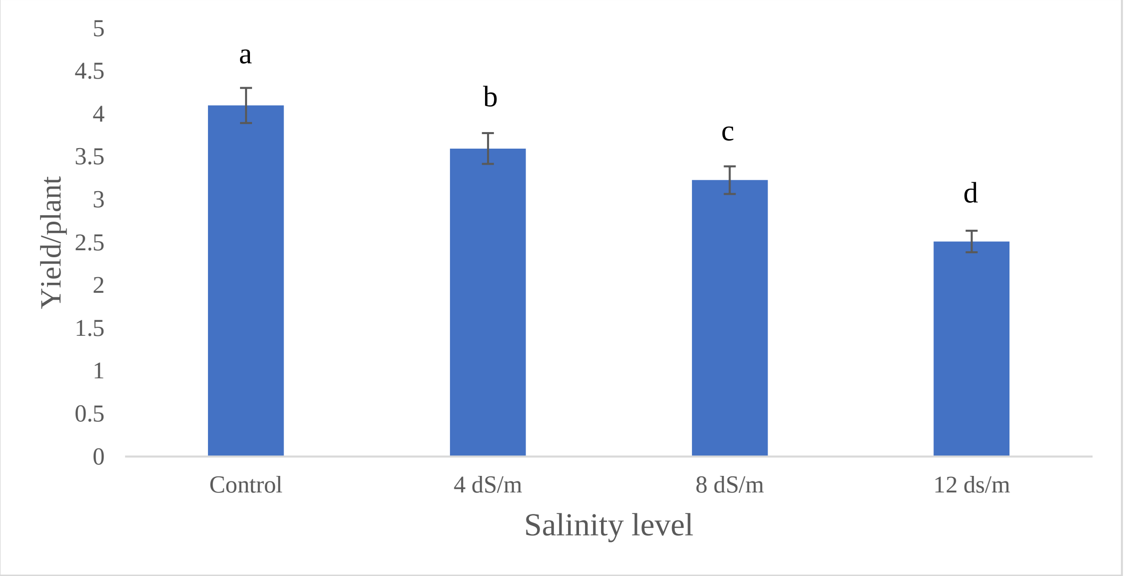

Figure 9. Effect of salinity level on yield per plant (kg) of brinjal varieties at LSD $_{(0.05)}$ (0.28)

Varietal effect of salinity on yield per plant (kg) of brinjal

Among the genotypes, yield/plant was significant (P<0.05). Among the varieties, BARI Hybrid 2 produced the maximum (4.28 kg) production and BARI Begun 1 produced the lowest (2.8 kg) production.

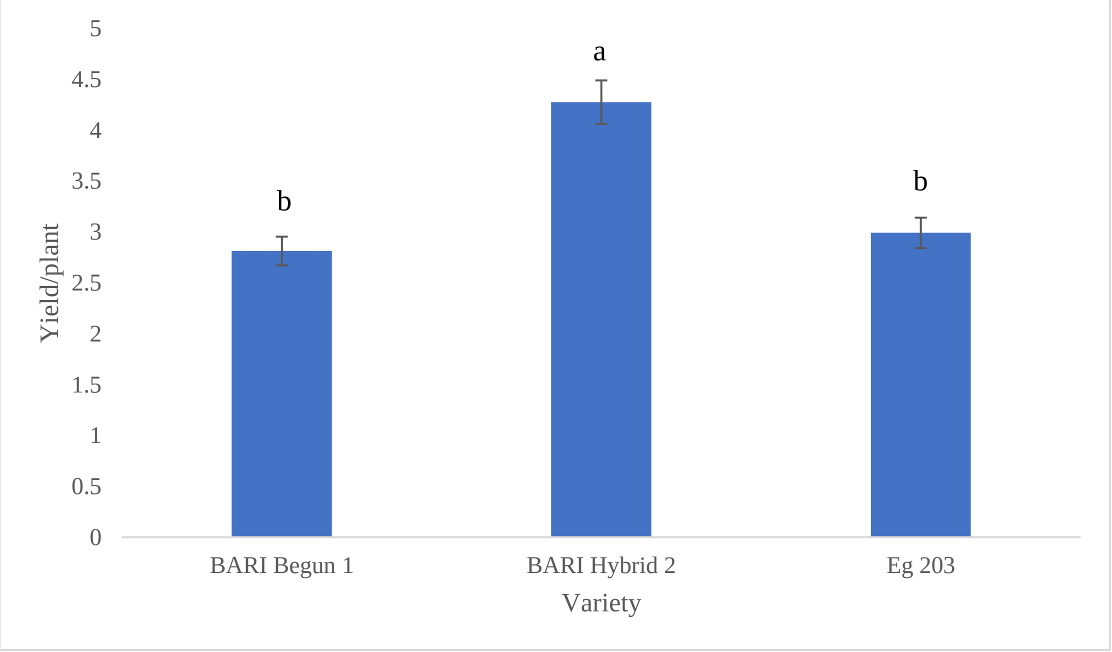

Figure 10. Varietal effect of salinity on yield per plant (kg) of brinjal varieties at LSD $_{(0.05)}$ (0.24)

Interaction effect on salinity levels and variety

The interaction effect of salinity levels and brinjal varieties on yield (kg/plant) was also varied significantly (Table 6). The highest yield/plant was found in BARI Hybrid 2 (5.22kg) at control condition which was followed by at 4 dS/m with same variety and its lowest value (2.16 kg) was recorded in Eg 203 at 12 dS/m.

Table 6. Interaction effect of salinity level and brinjal variety on yield (kg/plant)

Interaction	yield (kg/plant)
Treatment ×Variety	
Control ×BARI Begun 1	3.2495 d
Control ×BARI Hybrid 2	5.2167 a
Control ×Eg 203	3.8333 c
4 dS/m× BARI Begun 1	2.8995 d
4 dS/m× BARI Hybrid 2	4.6667 b
4 dS/m× Eg 203	3.2267 d
8 dS/m× BARI Begun 1	2.7495 de
8 dS/m× BARI Hybrid 2	4.2000 bc
8 dS/m× Eg 203	2.7333 de
12 dS/m× BARI Begun 1	2.3505 ef
12 dS × BARI Hybrid 2	3.0167 d
12 dS × Eg 203	2.1667 f
SE(±)	**0.2018**
CV	**8.36**

With the increased salinity levels, yield/plant gradually decreased. Similar result was reported by Ayoub (1976). He found that yield of brinjal was decreased to 50% at soil salinity level of 3.5 mhos/cm. The yield and yield components of black gram and brinjal (number of seed per plant, and yield per plant) reduced due the imposition of salt stress reconfirms by Ahmed (2009), Hossain *et al.* (2008). Dua (1992) reported that the 1000 seed weight was less affected by salinity level. Such decrease in the 1000-seed weight was expected because salinity as an environmental stress decreases the days to maturity and consequently decreases the period of seed development and affected seed filling that means the plants of the control treatment set their pods compared to those plants subjected to salinity stress. Das *et al.* (2018) found that 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 for better result.

CHAPTER V

SUMMARY AND CONCLUSION

SUMMARY

A pot experiment was conducted at the Agroforestry farm, Sher-e-Bangla Agricultural University, Dhaka-1207 during the month of November 2021- February 2022 to find salt tolerant brinjal variety. The experiment was conducted using three varieties -BARI Begun 1, BARI Hybrid 2, Eg 203 and three salinity levels viz. control, 4 dS/m, 8 dS/m and 12 dS/m were outlined in two factor Randomized complete block design (RCBD) with three replications. Data were taken on plant height, leaf number, chlorophyll content, leaf area, number of flowers per plant, number of fruit per plant, length of fruit, weight of fruit, diameter of fruit, yield per plant and calculated yield per plant. Collected data were statistically analyzed for the evaluation of treatments for the searching of suitable brinjal variety in high salinity level. Summary of the result have been describe in this chapter. In case of plant height the tallest plant was found from Bari Begun 1 (32.7 cm) while the shortest plant from Eg 203 (30.4 cm) at mature stage. In different salinity levels tallest plant was found from control (40.3 cm) whereas the shortest from 12 dS/m (21 cm) at mature stage. In interection of brinjal varieties and different salinity levels tallest plant was found Eg 203 (41.68 cm) whereas BARI Hybrid 2 (20.2 cm) at 12 dS/m in mature stage.

In terms of leaf length the maximum leaf length (23.56 cm) was recorded from BARI Begun 1, while the minimum (21.45 cm) from BARI Hybrid 2 at mature stage. In saline condition the highest leaf length (30.63 cm) was found from control level, while the lowest (15.6 cm) from 12 dS/m at mature stage. Interaction effect of brinjal accessions and saline condition the highest leaf length (24 cm) was recorded from BARI Begun 1 under control level while the lowest leaf length (5 cm) from Eg 203 under 12 dS/m at mature stage. In case of chlorophyll content the maximum chlorophyll content (52.3%) was recorded from BARI Hybrid 2, while the lowest (43.4%) from Eg 203. In saline condition the highest chlorophyll content (52.7%) was recorded from control, while the lowest chlorophyll content (41.0%) in 12 dS/m. Interaction effect of brinjal accessions and saline condition the highest chlorophyll content (59.2%) was recorded from BARI

Begun 1 under control level, while the lowest chlorophyll content (37.5%) from Eg 203 under 12 dS/m at mature stage.

Among the brinjal varieties Bari Hybrid 2 gave the maximum individual fruit weight (111.9 g) and minimum fruit weight (42.68 g) was obtained from BARI Begun 1.In different salinity levels, maximum individual fruit weight of brinjal (88.6 gm) was found in control level and lowest fruit weight (58.36 gm) was found in 12dS/m treatment . In combination of Varieties and different salinity levels, maximum individual fruit weight (127.7 gm) was obtained from BARI Hybrid 2 under control level and minimum fruit weight (36.3 gm) was found by BARI Begun 1 under 12 dS/m condition.In case of fruit yield of brinjal per plant BARI Hybrid 2 accessions gave the maximum yield (4.28kg/plant) and minimum fruit yield (2.8kg/plant) was obtained from BARI Begun 1. In different salinity level highest yield of brinjal (4 kg/plant) was found in control level and lowest fruit yield (2.5 kg/plant) was found in 12dS/m treatment. During interaction of varieties and different salinity levels, highest fruit yield (5.22kg/plant) was obtained from BARI Hybrid 2 under control level and lowest fruit yield (2.16 kg/plant) was given from Eg 203 under 12dS/m condition.

Finally maximum fruit weight was found from BARI Hybrid 2 (88.6 g) at control, (76.86g) at 4 dS/m, (65.9 g) at 8 dS/m and (58.3 g) at 12 dS/m as well as maximum yield/plant was also recorded from BARI Hybrid 2 (4 kg) at control, (3.6 kg) at 4 dS/m, (3.2 kg) at 8 dS/m and (2.5kg) at 12 dS/m.

CONCLUSION

Salinity stress is one of the most ghastly environmental factor restricting productivity of all kinds of plant as well as brinjal in arid and semiarid regions. Considering the findings of the present study following conclusions can be drawn-

- Tallest plant was found in BARI Begun 1 (24.32 cm) and shortest was in Eg 203 (18.5cm) at 12 dS/m salinity.
- The highest individual fruit weight was obtained in BARI Hybrid 2 (100.5gm) and minimum fruit weight in BARI Begun 1 (36.29gm) at the highest salinity condition 12 dS/m.
- The highest yield was found BARI Hybrid 2 (3kg/plant) than other varieties such as BARI Begun 1 (2.35kg/plant) and Eg 203 (2.17kg/plant) at high salinity condition 12 dS/m level.

BARI Begun 1 was best variety for the both the level of 8 dS/m and 12 dS/m for plant growth related characteristics and was closely followed to the BARI Hybrid 2 concerning yield and yield contributing characters. Therefore, BARI Begun 1 and BARI Hybrid 2 can be added in the existing cropping pattern in coastal region of Bangladesh.

CHAPTER VI

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APPENDICES

Appendix I. Characteristics of soil of experimental field

A. Morphological features of the experimental field

Morphological features	Characteristics
Location	Sher-e-Bangla Agricultural University Agroforestry Research Farm, Dhaka
AEZ	AEZ-28, Modhupur Tract
General Soil Type	Deep Red Brown Terrace Soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled

Appendix II. Records of air temperature, relative humidity and rainfall during the period from November 2020 to March 2021

Month	Air temperature (^{0}C)		Relative humidity (%)	Rainfall (mm)
	Maximum	Minimum		
October	37	26	81	22
November	26.1	16.4	75	05
December	23.0	13.8	71	00
January	20.4	11.2	67	00

Source: Bangladesh Meteorological Department (Climate and weather division), Agargoan, Dhaka- 1207

Appendix III. List of necessary tables for result and discussion.

Table 1. Effect of salinity level on plant height (cm) of brinjal

treatment	Plant height at vegetative stage	Plant height at maturity stage
Control	32.735 a	40.293 a
4 dS/m	24.985 b	34.804 b
8 dS/m	19.146 c	29.471 b
12 ds/m	15.271 d	21.018 c
SE(±)	**1.532**	**2.469**
LSD$_{(0.05)}$	**3.176**	**4.12**

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Table 2.Varietal effect of salinity on plant height (cm)

Variety	Plant height at vegetative stage	Plant height at maturity stage
BARI Begun 1	24.636 a	32.740 b
BARI Hybrid 2	19.600 b	31.042 a
Eg 203	24.867 a	30.408 a
SE(±)	1.305	2.1035
$LSD_{(0.05)}$	2.706	4.3623

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Table 3. Effect of salinity level on leaf length (cm) of brinjal

treatment	leaf length at vegetative stage	leaf length at maturity stage
Control	20.268 a	30.631 a
4 dS/m	17.324 b	23.519 b
8 dS/m	10.368 c	20.797 b
12 ds/m	7.126 d	15.603 c
SE(±)	1.1006	1.4715
$LSD_{(0.05)}$	2.2826	3.0517

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Table 4.Varietal effect of saline on leaf length (cm) of brinjal

Variety	leaf length at vegetative stage	leaf length at maturity stage
BARI Begun 1	10.223 c	23.562 a
BARI Hybrid 2	17.642 a	21.450 b
Eg 203	13.450 b	22.900 a
SE(±)	0.9377	1.2536
$LSD_{(0.05)}$	1.9446	2.5999

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Table 5. Effect of salinity level on leaf width (cm) of brinjal

	leaf width at vegetative stage	leaf width at maturity stage
Control	18.060 a	14.507 a
4 dS/m	15.610 b	12.001 b
8 dS/m	9.510 c	9.719 c
12 ds/m	6.746 d	6.732 d
SE(±)	1.0770	0.8734
$LSD_{(0.05)}$	2.2061	1.7891

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Table 6.Varietal effect of saline on leaf width (cm) of brinjal

Variety	leaf width at vegetative stage	leaf width at maturity stage
BARI Begun 1	9.378 c	10.919 a
BARI Hybrid 2	15.767 a	9.992 b
Eg 203	12.300 b	11.308 a
SE(±)	0.9245	0.7497
$LSD_{(0.05)}$	1.8937	1.5358

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Table 7. Varietal effect of saline on individual fruit weight (gm)

Variety	Individual fruit weight
BARI Begun 1	42.68 c
BARI Hybrid 2	111.89 a
Eg 203	62.76 b
SE(±)	1.6307
$LSD_{(0.05)}$	3.3891

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Table 8. Varietal effect of saline on yield per plant (kg)

Variety	Yield/plant
BARI Begun 1	2.8123 b
BARI Hybrid 2	4.2750 a
Eg 203	2.9900 b
SE(±)	0.1146
$LSD_{(0.05)}$	0.2377

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Table 9. Effect of salinity level on individual fruit weight (gm)

treatment	Individual fruit weight (gm)
Control	88.616 a
4 dS/m	76.861 b
8 dS/m	65.994 c
12 ds/m	58.306 d
SE(±)	1.9141
$LSD_{(0.05)}$	3.9697

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Table 10. Effect of salinity level on yield per plant (kg)

treatment	yield per plant (kg)
Control	4.0998 a
4 dS/m	3.5976 b
8 dS/m	3.2276 c
12 ds/m	2.5113 d
SE(±)	0.1345
$LSD_{(0.05)}$	0.2790

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Appendix IV: Analysis of variance tables

Table 1: Analysis of variance on plant height at vegetative stage

Source	DF	SS	MS	F	P
replication	2	13.37	6.687		
variety	2	204.91	102.453	10.03	0.0000
treat	3	1465.17	488.391	47.81	0.0000
variety*treat	6	213.96	35.659	3.49	0.0141
Error	22	224.74	10.216		
Total	35				
Grand Mean 23.034					
CV 13.88					

Table 2: Analysis of variance on leaf width

Source	DF	SS	MS	F	P
replication	2	4.139	2.0697		
variety	2	10.839	5.4197	2.40	0.0113
treat	3	292.855	97.6184	43.26	0.0000
variety*treat	6	44.786	7.4644	3.31	0.0179
Error	22	49.649	2.2568		
Total	35				
Grand Mean 10.565					
CV 14.22					

Table 3: Analysis of variance on number of fruit

Source	DF	SS	MS	F	P
replication	2	4.663	2.3325		
variety	2	32.494	16.2470	9.36	0.0113
treat	3	119.238	39.7460	22.91	0.0000
variety*treat	6	1.487	0.2478	0.14	0.0511
Error	22	38.169	1.7350		
Total	35				
Grand Mean	10.139				
CV	12.99				

Table 4: Analysis of variance on yield (kg/plant)

Source	DF	SS	MS	F	P
replication	2	0.1492	0.07461		
variety	2	14.3928	7.19638	91.30	0.0000
treat	3	11.8796	3.95987	50.24	0.0000
variety*treat	6	1.5784	0.26306	3.34	0.0172
Error	22	1.7340	0.07882		
Total	35				
Grand Mean	3.3591				
CV	8.36				

Table 5: Analysis of variance on fruit diameter (cm)

Source	DF	SS	MS	F	P
replication	2	36.3	18.1		
variety	2	21344.9	10672.5	561.66	0.0000
treat	3	5769.9	1923.3	101.22	0.0000
variety*treat	6	861.6	143.6	7.56	0.0002
Error	22	418.0	19.0		
Total	35				
Grand Mean	71.254				
CV	6.12				

Table 6: Analysis of variance on individual fruit wt.

Source	DF	SS	MS	F	P
replication	2	34.2	17.1		
variety	2	4456.3	1485.5	93.10	0.0000
treat	3	27770.9	13885.4	870.26	0.0000
variety*treat	6	902.9	150.5	9.43	0.0000
Error	22	351.0	16.0		
Total	35				
Grand Mean	72.444				
CV	5.51				

Table 7: Analysis of variance on leaf length at vegetative stage

Source	DF	SS	MS	F	P
replication	2	3.587	1.794		
variety	2	701.480	233.827	89.61	0.0000
treat	3	289.068	144.534	55.39	0.0000
variety*treat	6	86.170	14.362	5.50	0.0013
Error	22	57.408	2.609		
Total	35				
Grand Mean	12.132				
CV	13.32				

Plate 1: Transplant the seedlings from seedbed to prepared pot

Plate 2: Inspection the experimental site

Plate 3: Condition of seedlings 20 days after transplanting

Plate 4: Measuring the chlorophyll content of leaves at vegetative stage

Plate 5: BARI Hybrid 2

Plate 6: BARI Begun 1

Plate 7: Measurement of plant height at vegetative stage