INFLUENCE OF SALINITY ON YIELD AND SEED QUALITY OF CHILLI (*Capsicum frutescens* L.)

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INFLUENCE OF SALINITY ON YIELD AND SEED QUALITY OF CHILLI (*Capsicum frutescens* L.)

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CERTIFICATE

*This is to certify that thesis entitled, "**INFLUENCE OF SALINITY ON YIELD AND SEED QUALITY OF CHILLI**" submitted to the Institute of Seed Technology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in SEED TECHNOLOGY**, embodies the result of a piece of bona fide research work carried out by **MD. EAFTAKHER ROSUL SIDDIK**, Registration No. : 11-04278 under my supervision and 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 been duly been acknowledged.

Dated: June, 2017
Place: Dhaka, Bangladesh

(Prof. Dr. A. K. M. Ruhul Amin)
Supervisor

Dedicated To

My Beloved Parents

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SAU, Dhaka ***The Author***

INFLUENCE OF SALINITY ON YIELD AND SEED QUALITY OF CHILLI

ABSTRACT

The study was carried out at the Agronomy Net-house Sher-e-Bangla Agricultural University, (SAU), Dhaka-1207, during the period November 2016 to April 2017 to study the influence of salinity levels on yield attributes, yield and seed quality of three selected chilli varieties. For this purpose three varieties of chilli viz. Local, BARI Morich 1, BARI Morich 2 and 4 levels of salinity viz. 0 dS/m, 3 dS/m, 6 dS/m and 9 dS/m NaCl concentration were used. The experiment was conducted by following Completely Randomized Design (CRD) with three replications. Results showed that in terms variety BARI Morich 1 is the best variety than other two. BARI Morich 1 ($V_{2)}$ showed the best result in plant height (27.16 cm), leaf number (28.75), pod length (6.63 cm), dry weight of plant (83.62 g), number of marketable fruit per plant (94 pieces on an average), weight of per green fruit (4.08 g), weight of per dry fruit (0.21 g), harvest index (18.46%), germination (54.50%), root length (4.44 cm), shoot length (5.38 cm), seedling length (10.32 cm) and dry weight of seedlings (0.30 g). In case of salt concentration application the best result was recorded in control (0 dS/m salt concentration). Results showed that in terms of salt concentration application of 0 dS/m salt concentration showed the highest plant height (29.11 cm), leaf number (29.88), pod length (6.44 cm), dry weight of plant (83.99 g), number of marketable fruit per plant (93.33 piece on an average), weight of per green fruit (4.54 g), weight of per dry fruit (0.24 g), harvest index (15.69%), seed germination (50.44%), root length (4.75cm), shoot length (5.69 cm), seedling length (10.40 cm) and dry weight of seedlings (0.29 g). The lowest result was found in case of S_3 (9 dS/m salt concentration). Considering interaction effect of variety and salinity V_2S_0 was recorded for the best result in plant height (30.66 cm), leaf number (32.33), pod length (6.90 cm), number of marketable fruit per plant (101.33 piece on an average), dry weight of plant (87.35 g), weight of per green fruit (4.86 g), weight of per dry fruit (0.26g), harvest index (21.34%), seed germination (59%), root length (5.02 cm), shoot length (5.90 cm), seedling length (10.94 cm) and dry weight of seedlings (0.32 g). From the above result concludes that no chilli variety can perform better in saline condition.

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ABBREVIATIONS AND ACRONYMS

%	=	Percentage
AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
Ca	=	Calcium
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
e.g.	=	exempli gratia (L), for example
et al.,	=	And others
etc.	=	Etcetera
FAO	=	Food and Agricultural Organization
g	=	Gram (s)
GM	=	Geometric mean
i.e.	=	id est (L), that is
K	=	Potassium
Kg	=	Kilogram (s)
L	=	Litre
LSD	=	Least Significant Difference
M.S.	=	Master of Science
m^2	=	Meter squares
mg	=	Miligram
ml	=	MiliLitre
NaOH	=	Sodium hydroxide
No.	=	Number
^oC	=	Degree Celsius
P	=	Phosphorus
SAU	=	Sher-e-Bangla Agricultural University
USA	=	United States of America
var.	=	Variety
WHO	=	World Health Organization
µg	=	Microgram

CHAPTER I
INTRODUCTION

Chilli is one of the important spices in many parts of the world. Chilli (*Capsicum frutescens* L.) belongs to the genus *Capsicum* of the family of *Solanaceae*. In Bangladesh, chilli is the most essential and important spices crops. It is cultivated both summer and winter season. The production of chilli is largely depends on the use of fertilizers, irrigation, pesticide etc. It grows well in warm and humid climate. Deep, loamy, fertile soils rich in organic matter are preferred by the crop for satisfactory growth. It also needed well drained soils with adequate soil moisture for the growth of the crop. Chilli grows well in the dry and the intermediate part of the country. The yield of green chilli in our country on an average 5 to 6 t ha^{-1}.

Chilli plants should be in a position that receives a good amount of light. Chillies should not be in a position where the nightly temperature falls below 12°C. Growth will be inhibited if temperatures fall below 15°C. Chilli plants is a type of seasonal crops (annual plant) which only live for one season then died. If cultivated this plant can grow and produce for several months after planting after which it will die.

Pepper fruits can be consumed at different ripening stages (green, red or not fully-ripe). In the field, they are harvested commercially at the mature green stage (Lin *et al*., 1993), while greenhouse-grown peppers are harvested at either the green or fully-red ripe stage (Bakker, 1989). From the point of view of the grower, a loss of harvest yield could result when immature fruits are harvested, since fruit growth continues until harvest and their size will be smaller than more mature fruits. Besides that, harvesting fruits in the red state could be more expensive because greater amounts of water and fertilizers are needed for cultivation. On the other hand, physical and chemical attributes change during maturation and ripening and the resultant effects on fruit quality have important dietary considerations that may affect the consumption of different pepper types (Nielsen *et al.*, 1991; Wall and Biles, 1993; Navarro *et al*., 2006). So, if fruits are picked when immature, they may not develop an acceptable flavour upon ripening (Boonyakiat *et al.*, 1987) and this may lead to loss of consumer confidence. So, determining the optimum maturity will benefit both consumer and grower.

Poverty cannot be reduced to a desired level excepting increasing productivity of agriculture sector and at the same time it is to be assured that farmers get fair price of the crops. Natural calamities like draught, flood, cyclone, tornado and salinity etc. are a very regular phenomenon which hinders the production of agriculture to a great extent. Cultivable land is being decreased due to the pressure of massive population. As a result, food security is being threatened and the risk of poor people is being increased.

Salinity is becoming one of the major barriers against successful production of crops in Bangladesh. It is one of the critical stresses to which crop plants are exposed (Kaymakanova, 2009) and is a serious limiting factor against crop production (Ashraf 1999). Salinity causes stunted growth of plants that ultimately leads to reduced yield (Munns, 2002). Many horticultural crops are more or less susceptible to salinity as a result production of these crops is hugely affected by this. Chilli is reported as a crop which is sensitive (Haman, 2000) to moderately sensitive (Kanber *et al.*, 1992) to salinity. According to Carter (1994), a salinity level of less than 1920 ppm is suitable for chilli. Under stressed condition such as low temperature and salinity, delayed and non-uniform germination of chilli is observed (Demir and Okcu, 2004).

High salt stress is an ever-existing and worsening problem, progressively degrading lands and resulting in low productivity in over 20 million ha in coastal and island Asia. Salinity delays the onset, reduces the rate and increases the dispersion of germination events, resulting in reduced plant growth and final crop yield (Ashraf, 2009). Seeds are particularly vulnerable to stress encountered between sowing and seedling establishment while plant salt tolerance usually increases with plant ontogeny. Soil salinity may affect the germination of seeds either by creating osmotic potential external to the seeds preventing water uptake or through the toxic effects of Na+ and Cl^- ions on germinating seed (Khaje-hosseini *et al.*, 2003). In many crop plants, seed germination and early seedling growth are the most sensitive stages to environmental stresses such as salinity (Sivritepe *et al.*, 2003).

There is a linear relationship between NaCl concentration and reduction of the total yield of chilli. Salinity may cause significant reduction in the rate and final percentage of germination, which in turn may lead to uneven stand establishment and reduced crop yields (Foolad *et al.*, 1999). The salinity caused the decrease in both the germination rate and germination percentage of chilli seeds that is hamper to the seed quality and ultimately decrease the crop yield. The salt tolerance of chilli plant is cultivar-dependent (Chartzoulakis and Klapaki, 2000).

Salinity decreases pepper yield (Chartzoulakis and Klapaki, 2000; Navarro *et al.*, 2002), affecting primarily the total fruit yield (above 10 mM NaCl), then the average fresh fruit weight (>25 mM NaCl) and, finally, the number of fruits per plant (>50 mM NaCl) (Chartzoulakis and Klapaki, 2000). The salt tolerance of pepper plants is cultivar-dependent (Chartzoulakis and Klapaki, 2000) and new commercial varieties are more sensitive to salinity than older ones (Post and Klein-Buitendijk, 1996; Navarro *et al*., 2002).

One of the most effective ways to overcome salinity problems is the introduction of salt tolerant crops. It has been reported that differences in salt tolerance exist not only among different species, but also within certain species. Furthermore, the sensitivity or tolerance may differ according to the culture medium, the type of salinity and the plant growth stage. Exposure to NaCl salinity affects water and ion transport processes in plant, which may change the nutritional status and ion balance as well as many physiological processes (Munns and Termaat, 2000).

Salinity is one of the basic abiotic stresses particularly effective in arid and semi-arid regions (Maas, 1986). There are large number of studies that deal with the effects of salinity on germination, seedling growth, plant growth and fruit yield in various crops (Maas, 1986; Cayuela *et al.*, 2001; Shannon and Grieve, 1999). Pepper was considered to be moderately sensitive crop and, regarding fruit yield, threshold electrical conductivity level was reported to be 2.0 dSm^{-1} (Maas, 1986). However, this may not necessarily be applicable for seed yield and quality because, seed maturation is a reproductive stage of the pepper plant and requires longer time than that of fruit on the mother plant. Demir and Ellis (1992) reported that pepper fruits reached full marketable size after 30 to 35 days, while maximum seed quality was obtained from fruits harvested 70 days after flowering. Although numerous studies were conducted on the effect of salinity on plant growth and fruit yield, very little is known about the effect of saline environments on seed quality (Maas, 1986; Shannon and Grieve, 1999).

On the basis of above discussion the present study has been undertaken with the following objectives.

Objectives of the Research work:

- To study the effect of different salinity levels on different growth stages of three chilli varieties,
- To evaluate the effect of the different levels of salinity on yield of three chilli varieties and
- To find out the effective salinity level on seed quality of three chilli varieties.

CHAPTER II

REVIEW OF LITERATURE

Review of literature is an attempt to search the research works related to the proposed research for reviewing the findings which give proper instruction in designing the future research problem and validating the new findings. It also helps to conduct the research work successfully by providing various knowledge and information related to the proposed study. The review of literature of the past studies and opinions of the researchers related to the present experiment collected through reviewing of journals, thesis, reports, newspaper, periodicals and other form of publications are presented below:

2.1. Production of chilli

Ahmed (1981) found that all the cultivars suggest that chilli cultivars, like Baromarich, Patni and Bogra are very promising under the agro-ecological conditions of Mymensingh as the produced satisfactory yield.

Padda *et al*. (1989) studied about eleven cultivars of chilli under the environmental conditions of Panjab Agricultural University, India during the year 1987. They found that the yield of red fruits per plant was varied from 113.7 to 399389g. The yield of red fruits per hectare varied from 4544 to 16004.2 kg.

Rahman (1990) conducted a study on production and marketing of chilli in some selected areas of Bogra district. He found that chilli produced per hectare by small, medium and large farmers were 41.89, 33.64 and 34.43 quintal, respectively in the study area. It is also found that the farmers combinedly consumed 1.97 percent of the total chilli produced and sold the rest 65.02 percent in green and 33.31percent in ripe form. About 65.02% of green chilli was sold within a day after harvest and dried chilli was sold within 3 to 8 months after harvest.

Sabur and Molla(1993) conducted a study on constraint to the production and marketing of species in Bangladesh. On the basis of area and production, five important spices growing regions *viz*,Faridpur, Rangpur, Dinajpur, Comilla and Jessore were selected covering 250 households in their study. Their study revealed that since independence there has been an upward trend in termaric and chilli production in Bangladesh. These trends were caused by area expansion and increased application of fertilizer and irrigation water.

Sarkhel (1995) conducted a study on chilli and other competitive crops. He found that per hectare cost and net return of chilli production were Tk.29662 and Tk.13821 respectively. He suggested to expand chilli cultivation.

Mahmood (1995) studied on selected spices in Comilla district of Bangladesh. He showed the relative profitability of selected spices, compared with their competing crops. Onion was the most profitable crop among all competing crops like potato, lentil, chilli and garlic. The net return per hectare of onion was found to be Tk. 26673.7 which was followed by potato Tk.25875.30, lentil Tk. 20652.10, chilli Tk. 14500 and garlic Tk. 16755.49.

Rahman (2000) conducted a study in an economic analysis of chilli production in some selected areas of Bogra district. He found that the small farmers are more devoted to chilli production with respect to their cultivable land and it is 17.41% of total land. On an average per hectare net return from chilli production was calculated at Tk. 13,332 in the study area.

Yeasmin, S. (2009) conducted a study namely an economic analysis of green chilli marketing in Punjab. They collected a data from a sample of 80 chilli growers, 5 wholesalers and 10 retailers from two district of Punjab. It was found that the farmers were forced to sell their product during the postharvest season itself inspite of well anticipated decline in prices consequent upon increased market arrivals. They also indicated that large number of intermediaries leads to lower producer share in the consumer’s rupee.

2.2. Effects of salinity on chilli and crops under solanaceae (production and quality)

Hopper *et al.* (1979) observed that it causes harmful damages to seeds germination and seedling growth either by preventing water uptake or by the toxicity of sodium and chloride ions.

Harvell and Bosland (1997) evaluated that in regard to pungency, increased salinity levels did not have a significant effect on capsaicinoid accumulation in pericarp (capsaicin and dihydrocapsaicin). Although pungency is related to environmental conditions and increases in response to stressful conditions.

Baskin and Baskin (1998) reported that seeds of *S.alba*, *B. oleracea*, *S. lycopersicum* and *C. annum* germinated at low concentrations of NaCl (200 mM), while at higher concentrations seeds these species were inhibited.

Demir and Van De Venter (1999) reported that salinity may influence germination by decreasing the water uptake.

Cabañero*et al.* (2004) recommended that for chilli plants, the addition of calcium could ameliorate the effects of high salinity on fruit yield.

Sudhir and Murthy (2004) evaluated that suboptimal substrate conditions had an inhibitory effect on the light-saturated photosynthetic rate. High salinity levels have been documented as reducing photosynthetic response.

Munns and Tester (2008) reported a 14% reduction in chilli yield with each increasing unit of salinity.

Shahbaz*et al.* (2008) found that under salinity stress, reduction in plant growth is usually interlinked with a variety of biochemical, physiological, and molecular characteristics.

Saito *et al.*(2008) reported that salinity in soil can be responsible for changes in fruit metabolism and physiology.

Petreikov*et al.*(2009) studied on *Solanaceae* and found that tomato plants that were exposed to moderate salinity levels presented an increase in starch biosynthesis in developing fruits, which is believed to increase sink strength. During maturation, subsequent starch hydrolysis could increase soluble sugar levels.

Dat*et al.* (2000) evaluated and found that on exposure to salt stress, active oxygen species (AOS) are generated in plants in response to stress conditions as one of the key secondary effects of salinity stress on plants These AOS cause damage to cellular ultrastructure and organic compounds as well as impair a variety of metabolic reactions.

Azuma *et al.* (2010) who grew chilliancho peppers with 50 and 100 mM of salt (≈7 and 11 dS·m−1, respectively) and observed reductions in the light-saturated photosynthetic rate of Capsicum plants of 18% and 32%, respectively. Reduction of the photosynthetic response caused by salinity treatments was more evident in habanero pepper plants.

Niu*et al.* (2010) reported that comparable salinity levels (2.5 and 4.1 $dS \cdot m^{-1}$) severely damaged chilli plants grown in the field, whereas all plants in this group of greenhouse grown chilli plants survived throughout this study. The contrasting responses could have been caused by differences in experimental conditions. Plants grown in the field were probably exposed to higher salinity levels than the applied treatments as a result of intrinsic soil salinity, interaction with soil particles, and variations in soil–water availability.

Azuma *et al.* (2010) evaluated that high salinity treatments (7 $dS \cdot m^{-1}$) also caused a significant increase in fruit glucose levels. Accordingly, in 'Caballero' peppers, a 20% increase in soluble sugars was observed in fruit grown at high salinity levels.

Akram*et al.* (2012) reported that the most common physio-biochemical attributes affected by salinity stress in different plants include protein synthesis, phytohormone regulation, respiration, photosynthetic capacity, efficiency of photosystems, stomatal regulation, water relations, activities of enzymatic antioxidants, and levels of non-enzymatic compound as well as inorganic nutrition.

Arrowsmith*et al*. (2012) found that for habanero 'Orange', high salinity conditions (7 $dS \cdot m^{-1}$) marginally increased pericarp capsaicin content (not statistically significant at $P \leq 0.05$). Similar trends in capsaicin concentration were found in 'Jalapeño' peppers under salt treatments.

Abbaspour(2012) has reported a significant reduction in lipid peroxidation, and glutathione reductase activity while an increase in superoxide dismutase (SOD), catalase (CAT), and APX activities as well as proline contents in pistachio seedlings under varying saline regimes, suggesting that pistachio plants could tolerate salt stress using protective mechanism against oxidative damage by maintaining activities of antioxidant enzymes and high levels of free proline in the cells.

2.3. Effects of salinity on chilli for seed quality

Saini and Aspinall (1981) reported that reduction in seed yield and quality preceded that of fruit yield under salt stress. This may be due to limitation in assimilate allocation to seeds by salinity. The reduction of the individual mass of seeds under high salinity levels has also been observed in wheat.

George (1985) evaluated that the level of salt tolerance based on vegetative plant growth stages or fruit yield may not necessarily be a good indicator of reproductive criteria of seed yield and quality in pepper.

Rahman (1990) conducted an experiment and found that priming enhances seed performance under normal as well as under saline conditions and this technique is considered as feasible and very cheap.

Wahid *et al.* (1999) conducted an experiment and found that salt injury symptoms, such as chlorosis, burning leaves, and necrotic areas were found severely in plants grown at 6 dSm^{-1} EC and no seeds were obtained from that concentration. Salinity stress during plant development might cause scorching, firing of leaves, shorter stature which cause slow seed maturation rate.

Parida and Das (2005) reported that salt stress affects some major processes such as germination, speed of germination, root/shoot dry weight and $Na^{(+)}/K^{(+)}$ ratio in root and shoot which in turn may lead to uneven establishment, uneven crop stand and reduced yield as well as bad quality seed production.

Munns and Tester (2008) evaluated that Salinity affects almost all the aspect of physiology and biochemistry of plants and significantly reduces yield. Salinity tolerance is critical during the life cycle of any crop species.

Dkhil and Denden (2010) reported that reduced seed yield and quality at higher salinity levels in this work might originate from physiological occurrences that reduce dry matter accumulation and partitioning.

2.4 Effects of salinity on seeding growth

Khurram*et al.* (2009) conducted an experiment and found that plant growth and development is hampered by various environmental stresses including salinity. Root and shoot length, dry matter contents, relative growth rate, leaf area, specific leaf area and leaf area ratio were significantly reduced by higher salinity levels (6 and 8 dS m-1).

Zhani*et al.* (2013) investigated the impact of NaCl on growth, mineral analysis and solutes synthesis in five Tunisian chili pepper (*Capsicum frutescens* L.) and the results showed that increasing salinity stress, for all cultivars, decreases the height and biomass (dry and fresh weight) of plant in addition to the relative water content. Na + content in roots and the biosynthesis of soluble sugars and soluble proteins in leaves increased.

Khan *et al.* (2016) conducted an experiment and found that to improve the hot pepper seed performance under salinity stress conditions, the effects of priming with an optimized dose (1 mM) of sodium chloride (NaCl) were assessed for improving seedling vigour and salt stress tolerance in seedlings of the hot pepper. Seeds primed with NaCl solution (1 mM) were examined at different salinity levels [0, 3, 6 and 9 dS m-1] in relation to early growth stage. Priming with NaCl was effective in alleviating the adverse effects of salinity. Significant increase in germination percentage, germination index and germination speed, vigour index, plumule and radicle length, and dry weight of the seedlings as compared to control was recorded. On the other hand, mean germination time, time to reach 50% germination and fresh weight of seedlings were non-significant against control. In this experiment, it was concluded that seed priming with NaCl has been found to be better treatment as compared to non-primed seeds in case of hot pepper for improving the seedling vigour and seedling establishment under salt-stressed conditions.

Yafizham*et al.* (2017) studied and found that to determine the effects of sodium chloride on the performance of chili pepper. The seedling height, plant height and number of leaves were recorded 30 days and 60 days after treatment, respectively. Seeds which radicle emerged were considered germinated, the seedling and plant height were measured from the tip of primary root to the base of the first leaf pair, and the number of leaves were counted for only fully expanded leaves. It was concluded that different doses of sodium chloride influenced the performances of chili pepper cv. Landung. Very low doses of sodium chloride (0-1.60 mM) might be used to study the improvement of chili pepper diversity.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during the period from November 2016 to April 2017 to study the influence salinity levels on yield attributes, yield and seed quality of three selected chilli varieties. This chapter includes a brief description of the methods and materials that were used for conducting the experiment.

3.1 Experimental site

The experiment was conducted at the Sher-e-Bangla Agricultural University, Dhaka ($90^0$33´ E longitude and $23^0$77´ N latitude) under AEZ 28 (Madhapur Tract) shown in Appendix I.

3.2 Experimental period

The experiments were conducted in the winter season started from November 2016 to April 2017.

3.3 Field experiment

3.3.1 Soil

Soil samples for the experimental pots were collected from Central farm, Sher-e-Bangla Agricultural University (SAU) at a depth of 0 to 15 cm. The soil of the experimental area belongs to the Modhupur Tract under AEZ No. 28. The experimental site was medium high land and the soil series was Tejgaon. The characteristics of the soil under the experimental 36 pot were analyzed in the Soil Testing Laboratory, SRDI Farmgate, Dhaka and details soil characteristics are presented in Appendix III.

3.3.2 Climatic condition

The experimental site was under the subtropical climate, characterized by three distinct seasons, winter season from November to February and the premonsoon or hot season from March to April and the monsoon period from May to October. Details of the meteorological data during the period of the experiment was collected from the Bangladesh Meteorological Department, Agargaon, Dhaka and presented in Appendix II.

3.4 Plant material

Seeds of three varieties of chilli were used in this experiment. The varieties were BARI Morich 1, BARI Morich 2 and Local. The seeds were healthy, vigorous, well matured and free from other crop seeds and inert materials. The source of varieties from where these were produced are given below:

Name of varieties	Source of varieties
Local	Spice Research Centre, Mohasthangarh, Bogra.
BARI Morich 1	Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur
BARI Morich 2	Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur

3.5 Design and layout of the experiment

The two factor experiment was laid out in Completely Randomized Design (CRD) with three replications. The number of pots needed for this experiment were 36(Appendix IV).

3.6 Treatments of the experiment

The experiment had two factors and designed to study the effects of different levels of salinity on growth and yield of three chilli varieties. The following treatments were included in the experiment:

3.6.1 Factor (A): Variety

V_1 – Local,

V_2 – BARI Morich 1 and

V_3 – BARI Morich 2

3.6.2 Factor (B): Salt concentration

S_0 – 0 dS/m,

S_1 – 3 dS/m,

S_2 – 6 dS/m and

S_3 – 9 dS/m.

3.6.3 Preparation and application of salt solution

The levels of the treatment of this experiment were 0 dS/m, 3 dS/m, 6 dS/m, 9 dS/m NaCl in concentration. S_0 the sodium chloride was weighed by an electric balance in 0, 15, 30, 45, and 60 g/1000ml, respectively. The weighed salt was mixed properly with soil in each pot.

3.7 Cultivation of chilli

3.7.1 Collection of experimental pot

Earthen pots were purchased from market. Before filling the pots four small holes were made at the bottom of the dishes. The holes were done to drain out excess water.

3.7.2 Preparation of pot soil

The soil was collected from the experimental field near the agronomy net house, Sher-e-Bangla Agricultural University (SAU), Dhaka. Plant parts, inert materials, visible insects pests were eliminated from soil by sieving and cattle manure was dried in open sun to reduce moisture. Then soil was properly mixed with manure and fertilizer before filling the pots. Each pot contained 10 kg of prepared soil.

3.7.3 Fertilization

The recommended chemical fertilizer doses were 10 ton of cow dung, 250 kg urea, 330 kg TSP and 250 kg MP per hectare (Source: BARI, Fertilizer recommendation guide)

3.7.4 Transplanting and crop management

Healthy and uniform 30 days old chilli seedlings were transplanted in the experimental pots on 11 December, 2016. The seedlings were uprooted carefully from the seed bed to avoid damage to the root system. To minimize the damage to the roots of seedlings, the seed beds were watered one hour before uprooting the seedlings. This allowed an accommodation of one plants per pot. Immediately after planting, the seedlings were watered.

3.7.5 Intercultural operations

After planting of seedlings, various intercultural operations, such as gap filling, weeding, irrigation, pest and disease control etc. were accomplished for better growth and development of the chilli seedlings.

3.7.6 Weeding

Weeding and mulching were executed as and whenever necessary to keep the crop free from weeds, for better soil aeration and to break the crust. It also preserved the soil moisture.

3.7.7 Gap filling

When the chilli seedlings were well established, the soil around the base of each seedling was pulverized. Gap filling was done by healthy seedlings of the same stock material grown in nearby plot where initial planted seedlings failed to survive.

3.7.8 Irrigation

Light watering was provided with water cane immediately after transplanting the seedlings and this technique of irrigation was used as every day at early morning and sometimes also in evening throughout the growing period. But the frequency of irrigation became less in harvesting stage. The amount of irrigation water was limited up to that quantity which does not leached out through the bottom. As such the salinity status was maintained in the desired level.

3.7.9 Plant protection measures

Insect infestation was a serious problem during the period of establishment of seeding in the seedbed. In spite of Cirocarb 3G applications during final land preparation few young plants were damaged due to attack of mole cricket and cut worm. Cut worms were controlled both mechanically and spraying Darsban 29 EC @ 3%. Some of plants were infected by *Alternaria* leaf spot diseases caused by *Alternaria brassicae*. To prevent the spread of the disease Rovral @ 2 gm per liter of water was sprayed in the pots. The diseased leaves were also collected from the infested plant and removed from the pots.

3.7.10 Harvesting of fruits

Harvesting of fruits was started at 80 DAT and continued up to final harvest based on the marketable sized of fruits. Harvesting was done by hand picking.

3.8 Laboratory experiment

After harvesting, the seeds of chilli were dried pot wise and tested for their quality standard in the Agronomy Laboratory of SAU.

3.8.1 Preparation of petri-dishes

Glass petri-dishes (9 cm in diameter) were used in conducting the laboratory experiment. The petri-dishes were firstly washed by washing powder and followed by rinsing with distilled water. Then these were dried. After drying the petri-dishes were ready for experiment. Filter paper was used as a matrix for seed germination. The diameter of filter paper was 9.0 cm. Then the whatman No.1 filter papers were placed into the petri-dishes. For the experiment 36 petri-dishes were prepared by the above method and 900 seeds were used for the whole laboratory experiment where 25 seeds were used in each petri-dishes.

3.9 Procedure of data collection

Data on the following parameters were collected during the course of experiment:

3.9.1 For Pot experiment:

1. Plant height (cm)
2. Leaf number (no.)
3. Pod length (cm)
4. Dry weight of plant (g)
5. Number of marketable fruit per plant
6. Harvest index (%)
7. Weight of per green fruit (g)
8. Weight of dry fruit (g)

3.9.2 For Laboratory experiment:

1. Seed germination (%)
2. Root length (cm)
3. Shoot length (cm)
4. Seedling length (cm)
5. Dry weight of seedlings (g)

3.10 Statistical analysis of data:

The data on different parameters was statistically analyzed with the computer based software Statistix-10 and mean separation will be done by LSD at 5% level of significance.

CHAPTER IV

RESULTS AND DISCUSSION

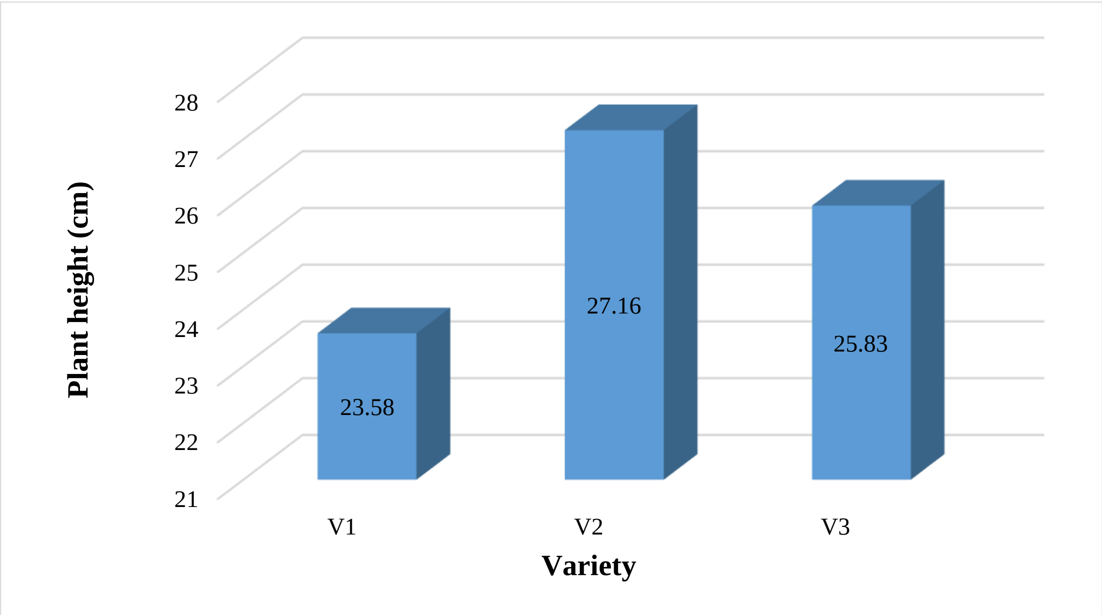
The experiment was conducted to determine the influence of salt concentration on 3 varieties on yield attributes, yield and seed quality of chilli. Data on yield contributing characters, yields, seed germination and growth of roots and shoots were recorded. The results have been discussed with the help of tables and graphs and possible interpretations.

4.1 Pot experiment

4.1.1 Plant height

Effect of variety

Plant height had a significant impact among three chilli varieties. Among three varieties BARI Morich-1(V_2) showed the highest length (27.16 cm) where Local Varity (V_1) produced the lowest length (23.58 cm) and BARI Morich-2 (V_3) produced 25.83 cm. statistically they all are different (Figure 1).

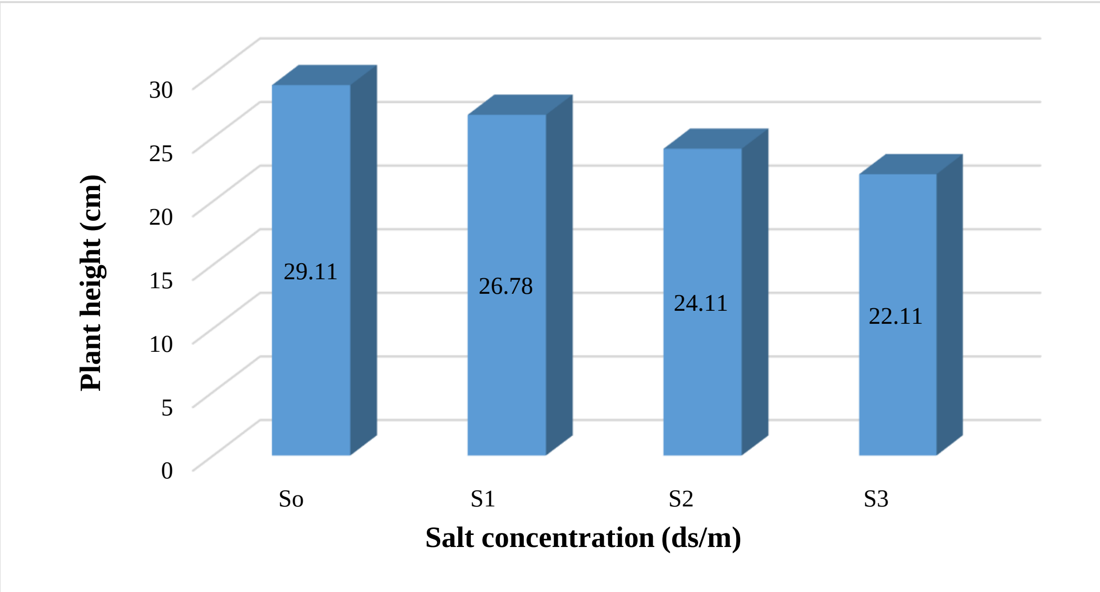


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

Figure 1. Effect of variety on plants height of chilli ($LSD_{0.05}$ = 1.16)

Effect of salinity

Under the treatment of salt concentration S_0 showed the highest length (29.11 cm) of plant which indicates that the minimum reduction of seedling length is at control (0 ds/m) and the highest reduction showed by S_3 (22.11 cm) (Figure 2). At present study it showed that S_3 caused the maximum reduction on plant height and S_0 caused minimum reduction.



S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 2. Effect of salinity on plants height of chilli varities ($LSD_{0.05}$ = 1.34)

Interaction effect of variety and salinity

Interaction effect of variety and salinity showed significant result. V_2S_0 showed the highest plant height (30.66 cm) among all other treatment combinations and V_1S_3 showed the least height (20.00 cm) (Table 1). V_2S_0 (30.66 cm) and V_3S_0 (29.00 cm) were statistically similar. Our results indicate that under salt stress, plant height was decreased compared to control. This reduction with increasing salinity may be due to limited supply of metabolites to young growing tissues because metabolic production is significantly perturbed at high salt stress, probably due to the toxic effects of salt (Yousofinia *et al.,* 2012). The present findings indicate that plant height significantly reduced at higher salinity levels.

Table 1. Interaction effect of variety and salinity on plant height of chilli

Treatment combinations	Plant height
V_1S_0	27.66 bc
V_1S_1	24.33 de
V_1S_2	22.33 e
V_1S_3	20.00 f
V_2S_0	30.66 a
V_2S_1	28.33 bc
V_2S_2	26.33 cd
V_2S_3	23.33 e
V_3S_0	29.00 ab
V_3S_1	27.66 bc
V_3S_2	23.66 e
V_3S_3	23.00 e
LSD (0.05)	**2.32**
CV (%)	**5.37**

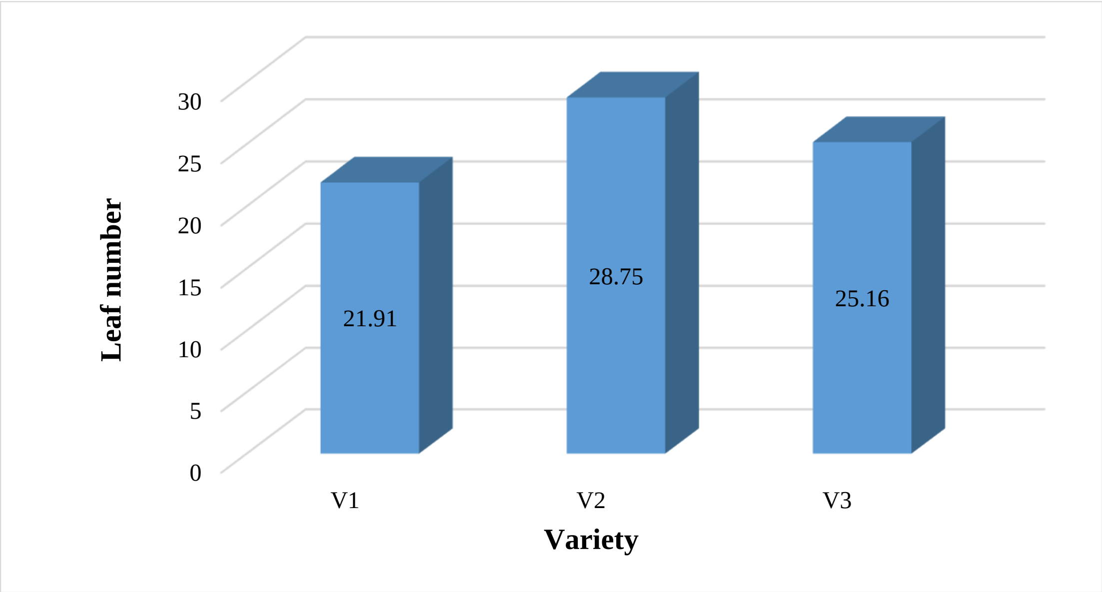
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.1.2 Leaf number

Effect of variety

Number of leaves plant^{-1} of chilli had a significant impact among three chilli varieties. BARI Morich-1(V_2) showed highest number of leaves (28.75) where BARI Morich-2 (V_3) produced 25.16 and Local (V_1) produced 21.91 respectively (Figure 3). Number of leaves plant^{-1} of chilli showed statistically significant differences due to application of different salt concentration. The maximum leaves plant^{-1} was noted in the V_2 and minimum in V_1.

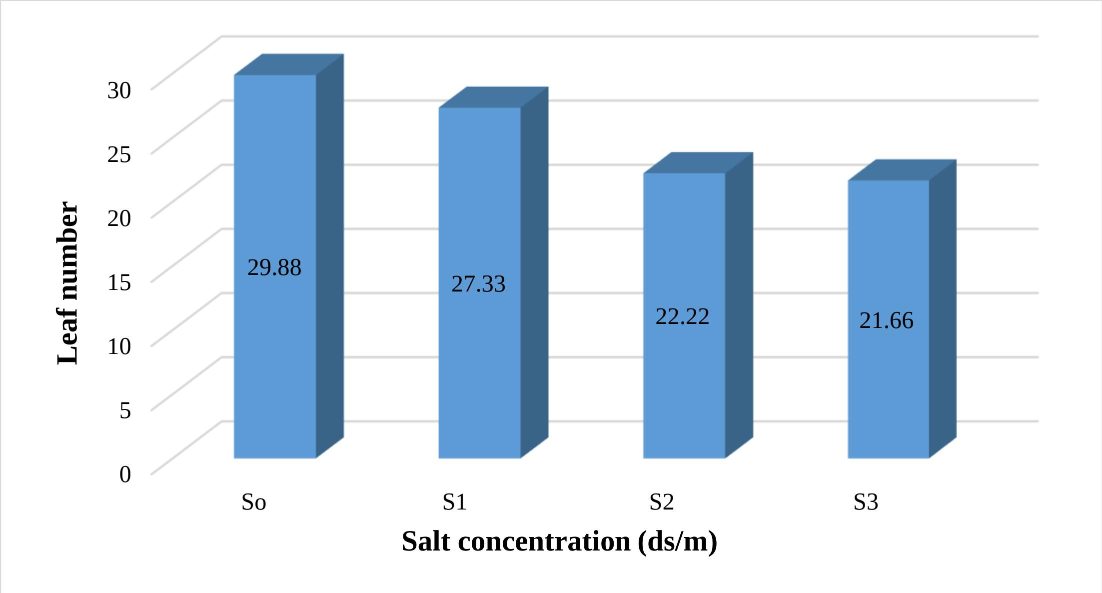


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

Figure 3. Effect of variety on number of leaves per plant of chilli ($LSD_{0.05}$ = 1.39)

Effect of salinity

Values of leaf plant $^{-1}$ data presented in figure 4. The figure indicated that the number of leaves plant $^{-1}$ decreased gradually with the increases of salinity and the lowest value number (21.66) was found with the highest salinity level (9 dS/m). The highest leaves plant $^{-1}$ (29.88) was recorded with the control treatment (S_0) (Figure 4).



S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 4. Effect of salinity on number of leaves per plant of chilli varieties ($LSD_{0.05}$ = 1.61)

Interaction effect of variety and salinity

Interaction effect of variety and salinity showed significant result. V_2S_0 showed the highest number of leaves (32.33) among all other treatment combinations and V_1S_3 showed the least number of leaves (15.66) (Table 2). V_2S_0 (32.33), V_2S_1 (30.33) and V_1S_0 (30.00) were statistically similar and V_1S_3 (15.66) and V_1S_2 (17.33) were statistically similar. It is evident that V_1 proved most sensitive and while V_2 proved highly tolerant and V_3 proved moderately tolerant to salinity in the terms of total number of leaves plant^{-1}. Similar observations have been reported by (Rastegar and Kandi, 2011) in soybean and (Hoque *et al.*, 2014) in maize. (Ashraf *et al.*, 2002) reported that the reduction in number of leaves plant^{-1} is due to decreasing water uptake by seedling in salt stress presence along with minimal uptake of nutrient from the soil because of salinity. (Mohamedin *et al.*, 2006) have also been reported that salinity induced water deficit hence the reduced plant growth as well as number of leaves plant^{-1}. Cha-Um and Kirdmane (2009) reported that a decrease in number of leaves plant^{-1} in maize seedling under NaCl salinity. According to them, salinity leads to water and nutrient deficit in plants thereby causing a decrease in fresh and dry weight (Ratanakar and Rai, 2013; Dadkhah and Grrifiths, 2006). Dadkhah and Grrifiths (2006) attributed such a decrease in number of leaves plant^{-1} to greater reduction in uptake and utilization of mineral nutrients by plants under salt stress. In general, there is a decrease in number of leaves plant^{-1} under saline conditions which can be attributed saline conditions, which can be attributed to reduced rate of photosynthesis, as suggested by (Jafari *et al.*, 2009). El-Tohamy *et al.* (2006) observed that for salinity the rate of photosynthesis reduced which caused the reduction of number leaves per plant drastically.

Table 2. Interaction effect of variety and salinity on number of leaves per chilli plant

Treatment combinations	**Number of leaf**
V_1S_0	30.00 ab
V_1S_1	24.66 c-e
V_1S_2	17.33 f
V_1S_3	15.66 f
V_2S_0	32.33 a
V_2S_1	30.33 a
V_2S_2	26.33 c
V_2S_3	26.00 cd
V_3S_0	27.33 bc
V_3S_1	27.00 c
V_3S_2	23.00 e
V_3S_3	23.33 de
LSD $_{(0.05)}$	**2.79**
CV (%)	**6.53**

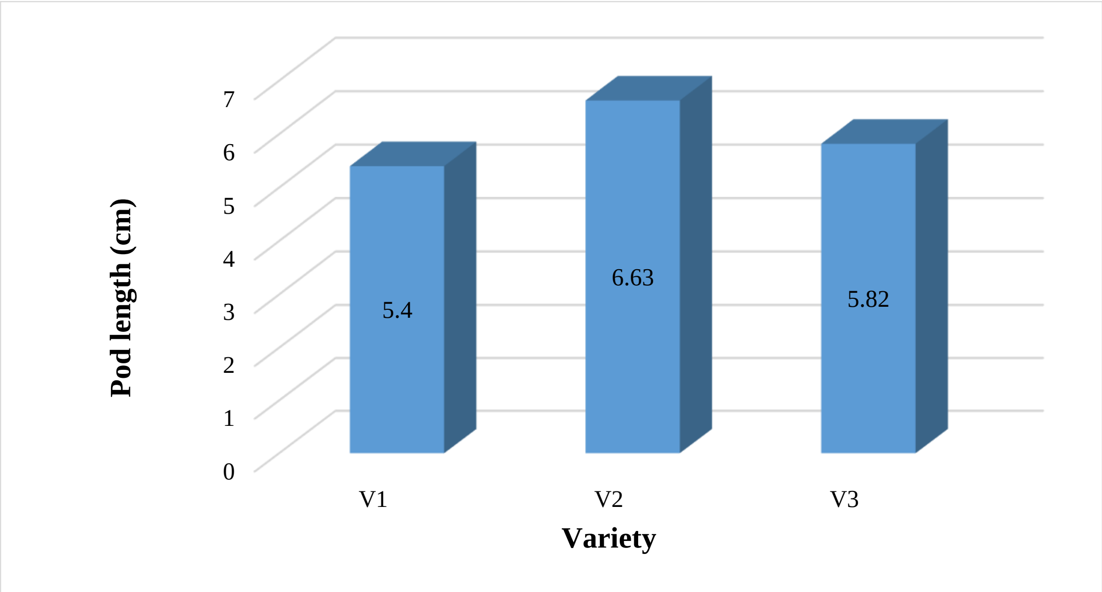
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.1.3 Pod length

Effect of variety

Pod length had a significant impact among three chili varieties. BARI Morich-1 (V_2) showed it's superity by producing 22.77% and 13.1% higher pod length over V_1 and V_3 varities. However BARI Morich-1(V_2) showed highest length (6.63 cm) where BARI Morich-2 (V_3) produced 5.82 cm and Local (V_1) produced 5.40 cm respectively (Figure 5).

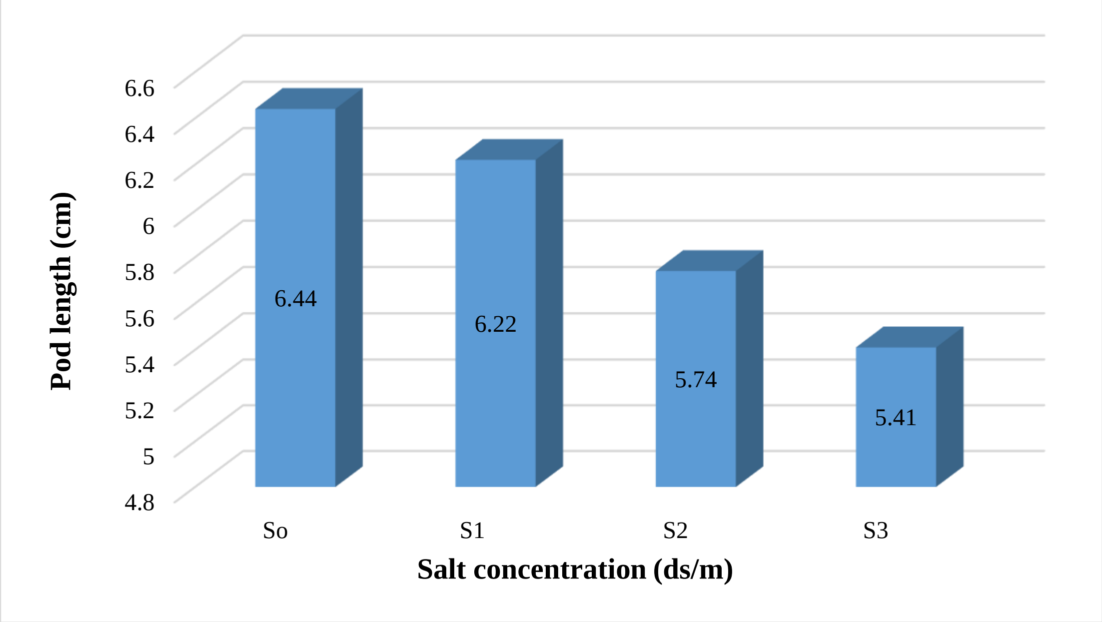


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

Figure 5. Effect of variety on Pod length of chilli ($LSD_{0.05}$ = 0.13)

Effect of salinity

Pod length showed different response on different salinity levels. All salinity treatments are statistically different where S_0 (6.44 cm) were best. S_3 and S_2 showed less increased pod length (5.41 cm and 5.74 cm), respectively (Figure 6).



S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 6. Effect of salinity on pod length of chilli varieties ($LSD_{0.05}$ = 0.15)

Interaction effect of variety and salinity

Interaction effect of variety and salinity showed significant result. V_2S_0 (6.90 cm) and V_2S_1 (6.76 cm) showed the highest length among all other treatment combinations and V_1S_3 showed the least pod length (4.56 cm) (Table 3). V_2S_0 (6.90 cm) and V_2S_1 (6.76 cm) were statistically similar and most significant. Different levels of salt concentration application in chilli plants had significant effect on pod length. Result revealed that the highest pod length was found from V_2S_0. Where the lowest pod length was obtained by V_1S_3. Similar result was found by Rubio *et al*. (2010). They found that pod length of chilli was decreased by salt concentration application. Similar result was also found by Shivaprasad *et al*. (2009) and El-Tohamy *et al*. (2006).

Table 3. Interaction effect of variety and salinity on pod length of chilli

Treatment combinations	Pod length(cm)
V_1S_0	6.10 c
V_1S_1	5.80 d
V_1S_2	5.16 f
V_1S_3	4.56 g
V_2S_0	6.90 a
V_2S_1	6.76 ab
V_2S_2	6.60 b
V_2S_3	6.26 c
V_3S_0	6.33 c
V_3S_1	6.10 c
V_3S_2	5.46 e
V_3S_3	5.40 ef
LSD $_{(0.05)}$	**0.26**
CV (%)	**2.63**

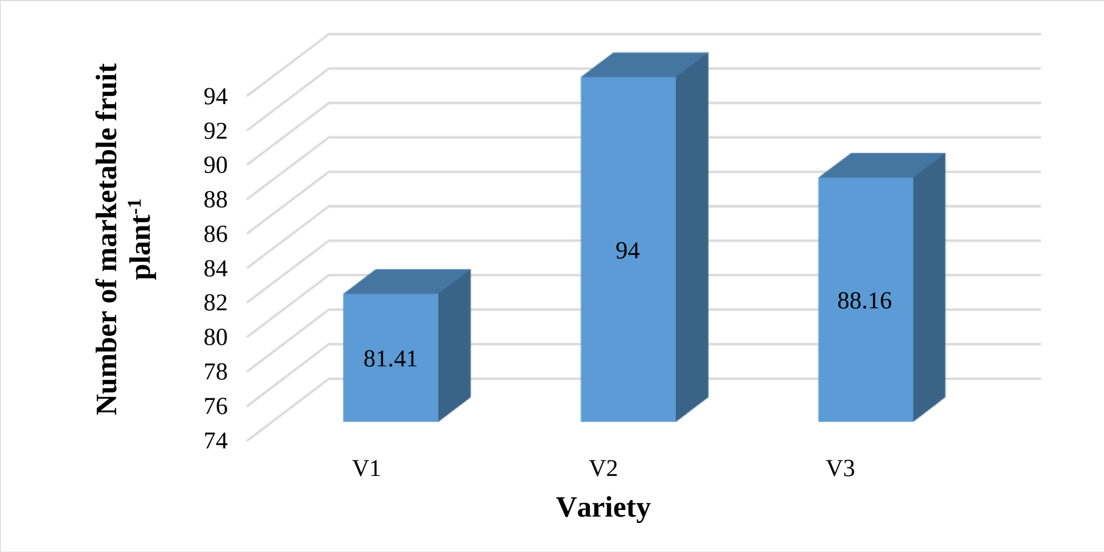
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.1.4 Number of marketable fruit per plant

Effect of variety

Number of marketable fruit per plant had a significant impact among three chili varieties. BARI Morich-1(V_2) shown highest length (94.00) where BARI Morich-2 (V_3) produced 88.16 and Local (V_1) produced 81.41, respectively (Figure 7).

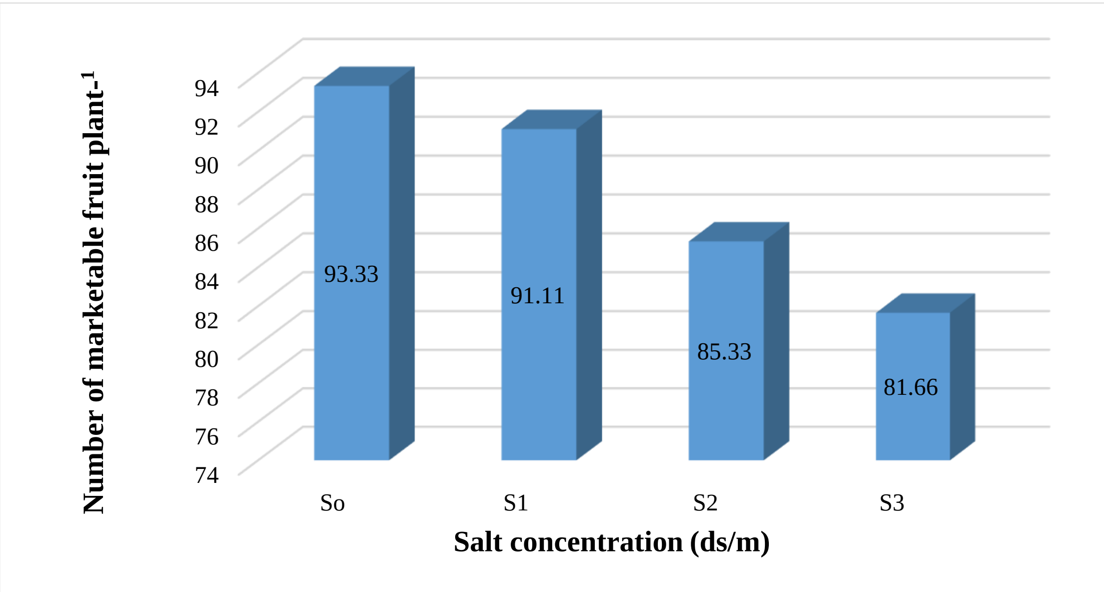


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

Figure 7. Effect of variety on total number of marketable fruit per plant of chilli ($LSD_{0.05}$ = 1.25)

Effect of salinity

Number of marketable fruit per plant showed different response on different salinity levels. S_0 showed highest number of fruits 93.33. S_3 showed lowest number of fruits 81.66 (Figure 8). All varieties are statistically different.



S_0 = control, S_1 = 3dS/m saline solution (NaCl); S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 8. Effect of salinity on marketable fruit per plant of chilli verities ($LSD_{0.05}$ = 1.44)

Interaction effect of variety and salinity

Interaction effect of variety and salinity showed significant result (Table 4). V_2S_0 showed the highest number of fruits (101.33). V_1S_1 (86), V_2S_3 (86.33), V_3S_3 (85.33), V_3S_2 (86.67) has showed statistically same result. Among all other treatment combinations and V_1S_3 showed the least number of fruits (73.33) (Table 4). Better performance of V_2 genotypes for these attributes might be because of decrease in water potential at lower level resulting in less loss of turgor, the balanced nutrient uptake and moisture content would have facilitated the enzymatic and protein activities necessary for fruit development under salinity. The maintenance of turgor even under salinity might have facilitated efficient cell division and elongation in these genotypes and consequently they had increased yield (Nocito *et al.*, 2007).

Table 4. Interaction effect of variety and salinity on marketable fruit per Plant

Treatment combinations	No. of marketable fruit per plant
V_1S_0	87.67 de
V_1S_1	86.00 e
V_1S_2	78.67 f
V_1S_3	73.33 g
V_2S_0	101.33 a
V_2S_1	97.67 b
V_2S_2	90.67 c
V_2S_3	86.33 e
V_3S_0	91.00 c
V_3S_1	89.67 cd
V_3S_2	86.67 e
V_3S_3	85.33 e
LSD $_{(0.05)}$	**2.49**
CV (%)	**1.68**

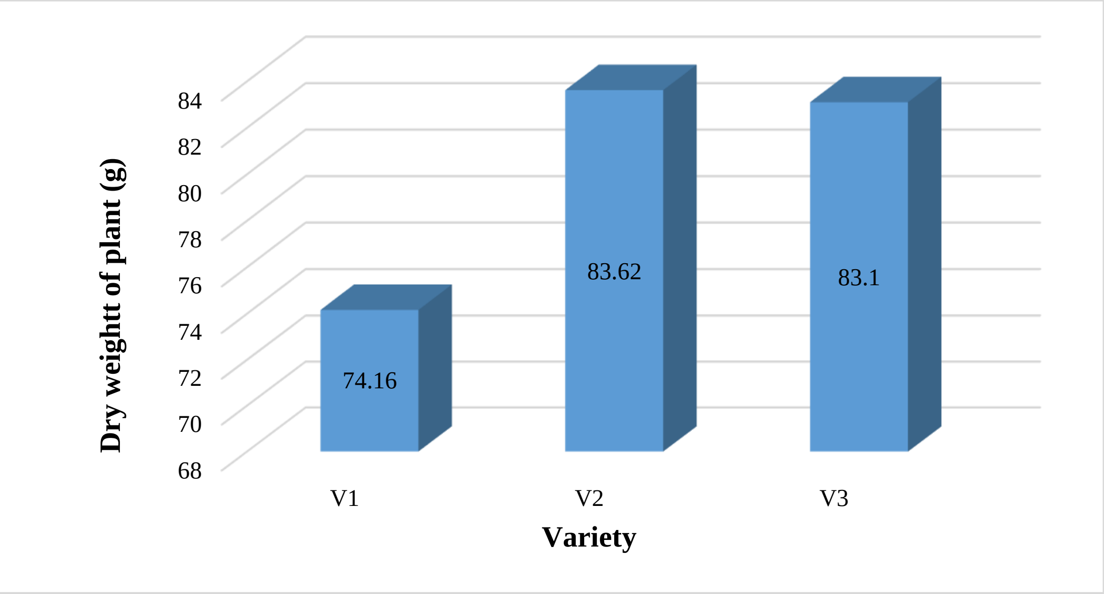
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.1.5 Dry weight of plant (g)

Effect of variety

Dry weight of plant had a significant impact among three chili varieties. BARI Morich-1(V_2) showed highest weight (83.62 g) statistically identical to BARI Morich-2 (V_3) produced (83.10 g) and Local (V_1) produced 74.16 g (Figure 9). The figure indicates that V_2 produced 12.75% and 0.06% higher dry weight plant^{-1} over V_1 and V_3 variety.

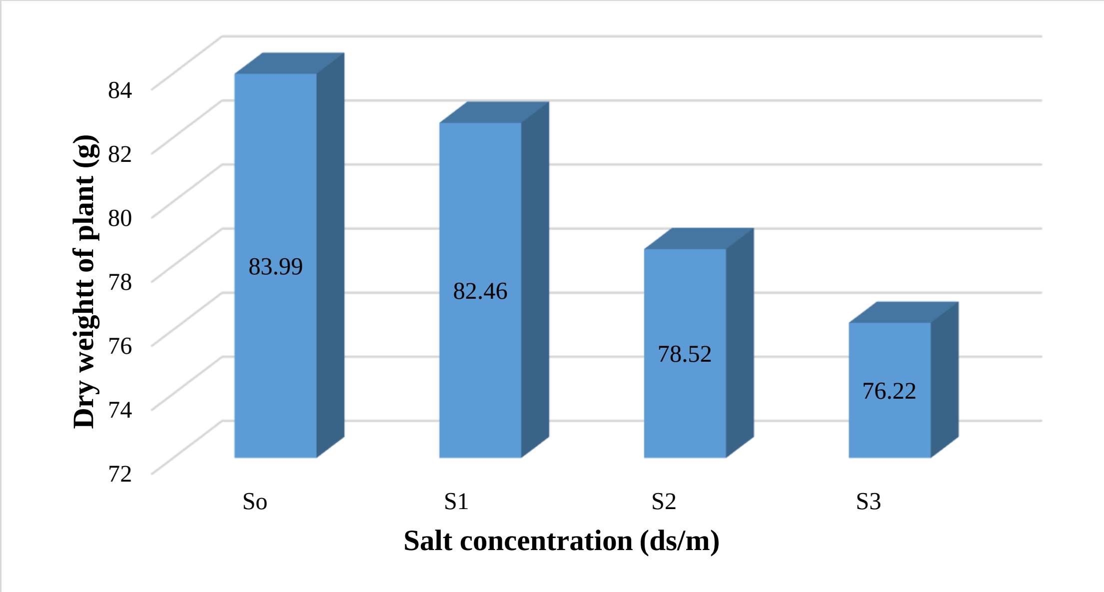


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

Figure 9. Effect of variety on dry weight of plants of chilli ($LSD_{0.05}$ = 1.20)

Effect of salinity

Dry weight of plant showed different response on different salinity levels. All salinity treatments showed significant result where S_0 showed highest weight 83.99g. S_3 and S_2 showed 76.22 g and 78.52 g, respectively (Figure 10). Statistically S_2 showed the most significant result.



S_0 = control, S_1 = 3dS/m saline solution (NaCl); S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 10. Effect of salinity on Dry weight of plants of chilli varieties ($LSD_{0.05}$ = 1.38)

Interaction effect of variety and salinity

Interaction effect of variety and salinity showed significant result.V_2S_0 showed the highest weight (87.35 g) followed by statistically identical V_3S_0 (86.85g), V_3S_1 (85.37 g) and V_2S_1 (85.12 g). Among all other treatment combinations V_1S_3 showed the least weight (69.22 g) (Table 5).The different varieties showed a declining trend in dry weight of shoot and root as concentration under varying salt stress. Dry weights of shoot and root were strongly inhibited at all level of salinity treatment. These results are similar to those reported by researchers (Shannon and Grieve, 1999; Akbarimoghaddam *et al*., 2011; Zhani *et al*., 2012) have also reported that the increasing salt concentration declined the dry matter yield at high NaCl concentration. Present study indicates that dry weight of root and shoot were significantly reduced at higher salinity levels (9 ds/m). Present results are also similar to the findings of Jamil and Rha, (2007) who had reported that the dry weight of shoot and root were decreased with increasing salt stress. The decrease of shoot and root dry weight probably may be due to some reasons such as (i) salt stress reduced photosynthesis per unit leaf area which turned into limited supply of carbohydrate needed for shoot length, (ii) reduced turgor resulting in lower water potential. In addition, salinity affected final cell size as well as rate of cell production and thereby resulting in reduced shoot and root dry weight. The results are in agreement with the findings of (Alam *et al*., 2004; Mahmood *et al*., 2009).

Table 5. Interaction effect of variety and salinity on dry weight of plants

Treatment combinations	Dry weight of plant (g)
V_1S_0	77.77 de
V_1S_1	76.90 e
V_1S_2	72.77 f
V_1S_3	69.22 g
V_2S_0	87.35 a
V_2S_1	85.12 a
V_2S_2	81.96 b
V_2S_3	80.07 b-d
V_3S_0	86.85 a
V_3S_1	85.37 a
V_3S_2	80.83 bc
V_3S_3	79.38 cd
LSD $_{(0.05)}$	**2.40**
CV (%)	**1.77**

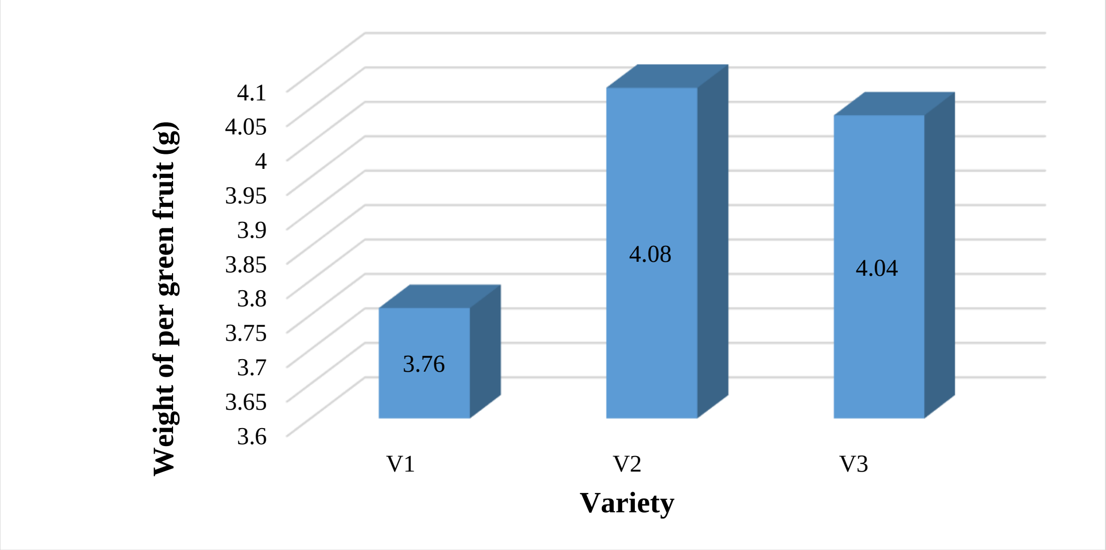
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.1.6 Weight of per green fruit (g)

Effect of variety

Weight of per green fruit had a significant impact among three chili varieties. BARI Morich-1(V_2) showed highest weight (4.08 g) which was statistically identical to BARI Morich-2 (V_3) (4.04 g) and Local (V_1) produced 3.76 g (Figure 11).

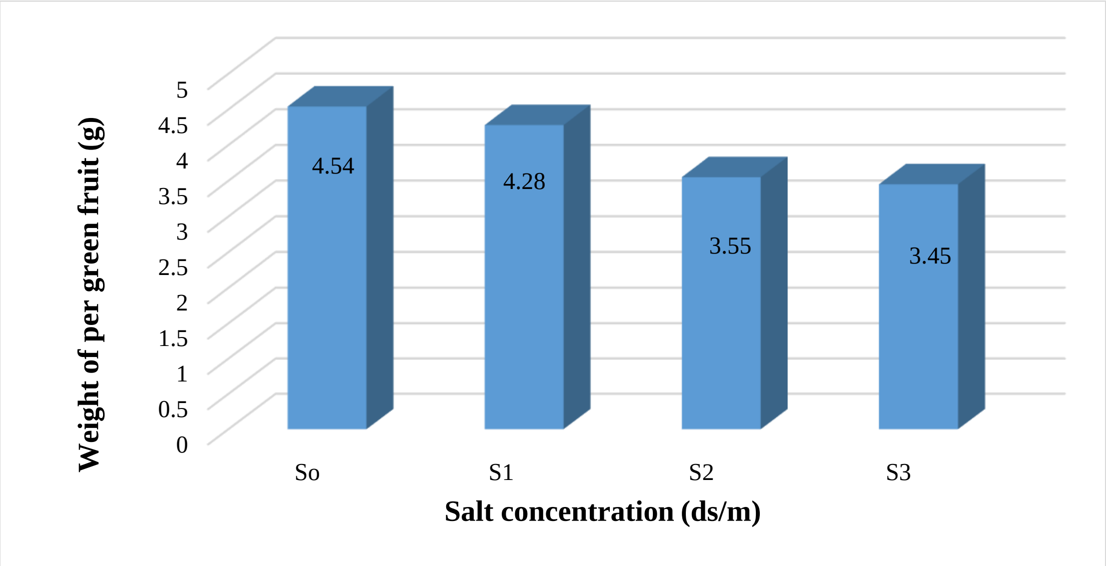


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

Figure 11. Effect of variety on weight of per green fruit of chilli ($LSD_{0.05}$ = 0.16)

Effect of salinity

Weight of per green fruit showed different response on different salinity levels. All salinity treatments are significant where S_0 showed highest weight 4.54 g. Statistically identical S_3 and S_2 showed lowest weight (3.45 g and 3.55 g), respectively (Figure 12).



S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 12. Effect of salinity on weight of per green fruit of chilli ($LSD_{0.05}$ = 0.18)

Interaction effect of variety and salinity

Interaction effect of variety and salinity showed significant result. V_2S_0 showed the highest weight (4.86 g) followed by statistically identical V_1S_0 (4.38 g), V_2S_1 (4.43 g), V_3S_0 (4.40 g) and V_3S_1 (4.40 g). Among all other treatment combinations V_1S_3 showed the least weight (3.26 g) followed by statistically same V_1S_2 (3.36 g), V_2S_3 (3.47 g) and V_2S_2 (3.56 g) (Table 6). With regard to green fruit weight, significant differences were observed for fresh weight and dry weight of pods in all the treatments. Similar result was found by Swati Barche *et al*. (2011).They found that pod length of chilli was decreased by salt concentration application. Similar result was also found by Halina *et al*., (2016).

Table 6. Interaction effect of variety and salinity on weight of per green fruit

Treatment combinations	Weight of per green fruit (g)
V_1S_0	4.38 b
V_1S_1	4.02 c
V_1S_2	3.36 ef
V_1S_3	3.26 f
V_2S_0	4.86 a
V_2S_1	4.43 b
V_2S_2	3.56 d-f
V_2S_3	3.47 d-f
V_3S_0	4.40 b
V_3S_1	4.40 b
V_3S_2	3.73 cd
V_3S_3	3.63 de
LSD $_{(0.05)}$	**0.32**
CV (%)	**4.88**

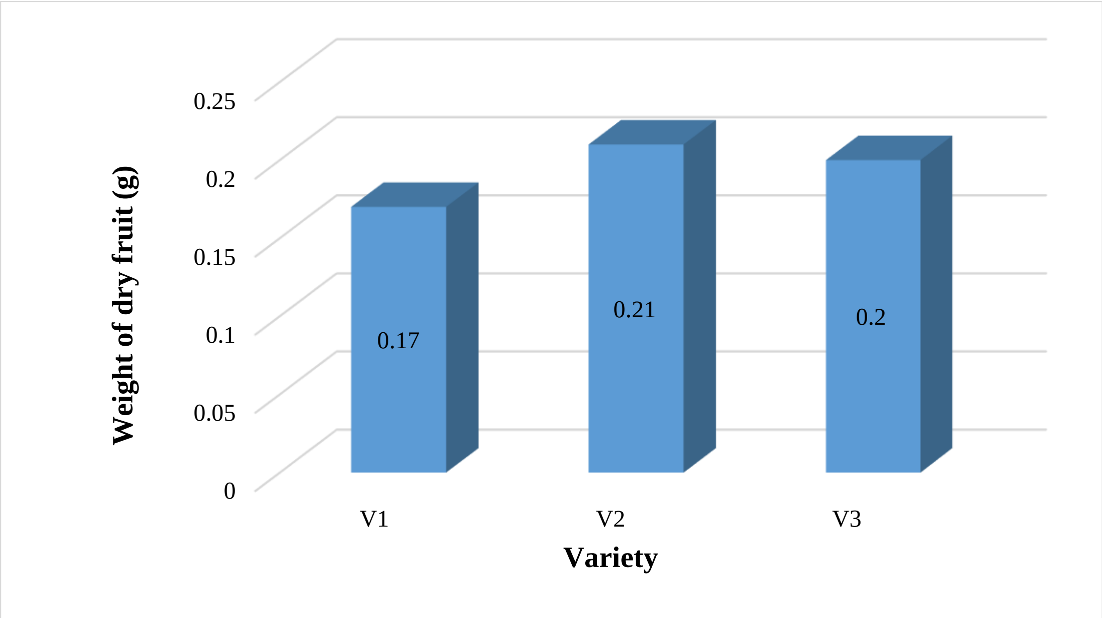
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.1.7 Weight of dry fruit (g)

Effect of variety

Weight of dry fruit had a significant variation among three chilli varieties. BARI Morich-1(V_2) showed highest weight (0.21g) where BARI Morich-2 (V_3) was 0.20g and they were statistically same. Local (V_1) weighted 0.17g (Figure 13).

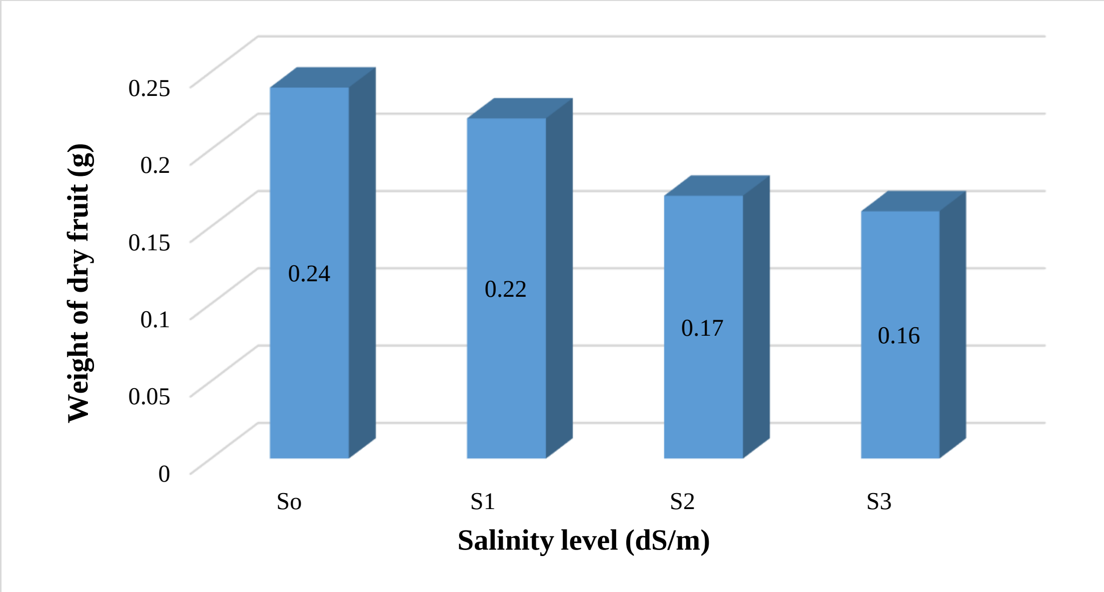


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2;

Figure 13. Effect of variety on weight of dry fruit of chilli ($LSD_{0.05}$ = 0.01)

Effect of salinity

Weight of dry fruit showed different response on different salinity levels and the values of dry weight of fruit presented in Figure 14. The figure indicated that the values dry weight of fruit showed a gradual decrease in trend with increase of salinity level. All four combinations of salinity levels are significant where S_0 showed highest weight 0.24 g. Statistically same S_3 and S_2 showed lowest weight (0.16 g and 0.17g), respectively (Figure 14).



S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 14. Effect of salinity on weight of dry fruit of chilli varieties ($LSD_{0.05}$ = 0.01)

Interaction effect of variety and salinity

Interaction effect of variety and salinity showed significant result. V_2S_0 (0.26 g) and V_3S_0 (0.25 g) showed the highest weight. Where V_2S_0 (0.26 g), V_3S_0 (0.25 g) and V_3S_1 (0.24 g) showed statistically same result. Among all other treatment combinations V_1S_3 showed the least weight (0.14 g) followed by statistically same V_1S_2 (0.16 g), V_3S_3 (0.16 g) (Table 7).With regard to green fruit weight, significant differences were observed for fresh weight and dry weight of pods in all the treatments. Similar result was found by Swati Barche *et al.*, (2011).They found that pod length of chilli was decreased by salt concentration application. Similar result was also found by Halina *et al.*, (2016).

Table 7. Interaction effect of variety and salinity on weight of dry fruit

Treatment combinations	Weight of dry fruit (g)
V_1S_0	0.22 bc
V_1S_1	0.19 de
V_1S_2	0.16 gh
V_1S_3	0.14 h
V_2S_0	0.26 a
V_2S_1	0.22 b
V_2S_2	0.20 cd
V_2S_3	0.18 d-f
V_3S_0	0.25 a
V_3S_1	0.24 ab
V_3S_2	0.17 e-g
V_3S_3	0.16 f-h
LSD $_{(0.05)}$	**0.02**
CV (%)	**7.36**

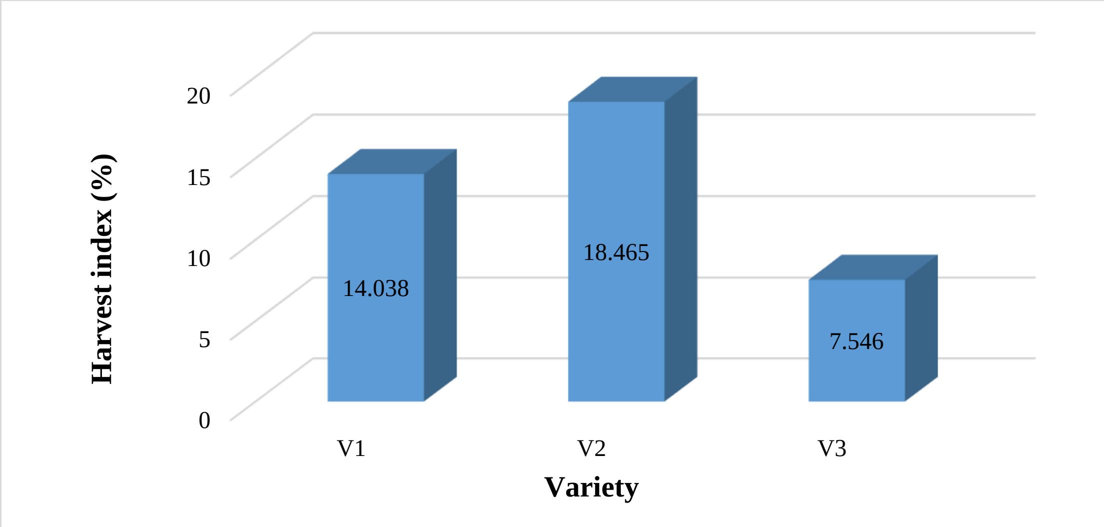
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.1.8 Harvest index

Effect of variety

Harvest index had a significant impact among three chilli varieties. BARI Morich-1(V_2) showed the highest percentage (18.46%) where BARI Morich-2 (V_3) produced 7.564% and Local (V_1) produced 14.038%, respectively (Figure 15). The figure indicated that variety V_2 produced 4.42% and 10.89% higher harvest index over V_1 and V_3 variety.

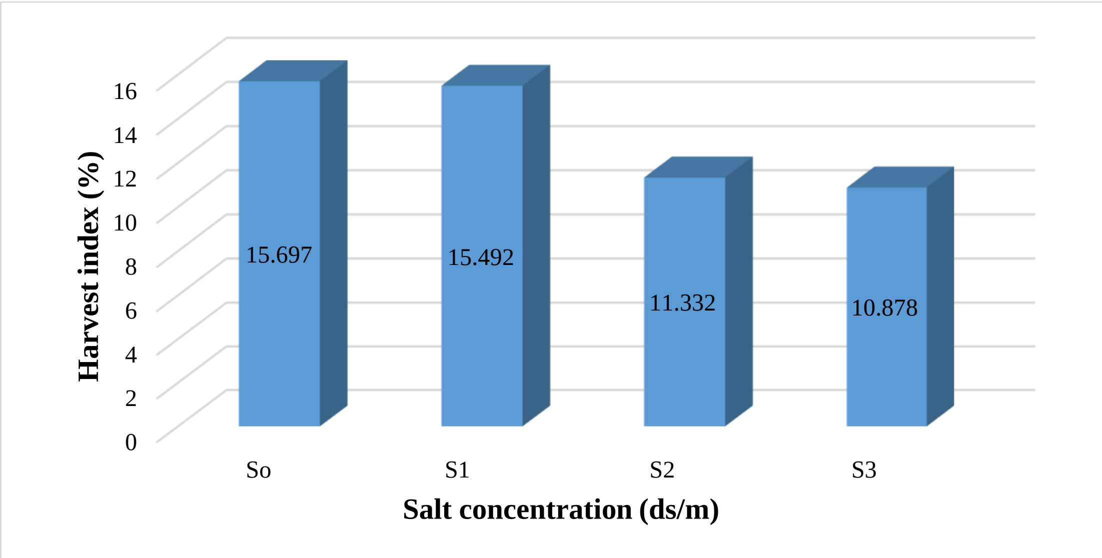


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

Figure 15. Effect of variety on harvest index of chilli ($LSD_{0.05}$ = 3.72)

Effect of salinity

Harvest index showed different response on different salinity levels. All salinity treatments are significant where S_0 showed highest percentage 15.69%. S_0 (15.69%) and S_1 (15.49%) showed statistically same result. S_2 and S_3 showed lowest percentage with statistically same result (11.33% and 10.87%), respectively (Figure 16).



S_0 = control, S_1 = 3dS/m saline solution (NaCl); S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 16. Effect of salinity on harvest index of chilli ($LSD_{0.05}$ = 4.29)

Interaction effect of variety and salinity

Interaction effect of variety and salinity showed significant result.V_2S_0 showed the highest percentage (21.34%) followed by statistically same V_1S_1 (20.23 %), V_1S_0 (20.027%) and V_2S_1 (18.983%). Among all other treatment combinations V_3S_3 showed the least percentage (4.90%) followed by statistically similar V_3S_2 (5.50%), V_1S_3 (7.747%) and V_1S_2 (8.15%) (Table 8). Our results indicate that under salt stress, harvest index was decreased in general compared to control. This reduction with increasing salinity may be due to limited supply of metabolites to young growing tissues because metabolic production is significantly perturbed at high salt stress, probably due to the toxic effects of salt (Yousofinia *et al.,* 2012). The present findings indicate that harvest index significantly reduced at higher salinity levels. Similar result was also found by Shivaprasad *et al*. (2009) and El-Tohamy *et al*. (2006).

Table 8. Interaction effect of variety and salinity on harvest index

Treatment combinations	**Harvest index (%)**
V_1S_0	20.027 a
V_1S_1	20.230 a
V_1S_2	8.150 d
V_1S_3	7.747 d
V_2S_0	21.343 a
V_2S_1	18.983 a
V_2S_2	17.552 ab
V_2S_3	15.980 a-c
V_3S_0	10.469 b-d
V_3S_1	9.310 cd
V_3S_2	5.500 d
V_3S_3	4.907 d
LSD $_{(0.05)}$	**7.4442**
CV (%)	**32.93**

V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2, S_0 =control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

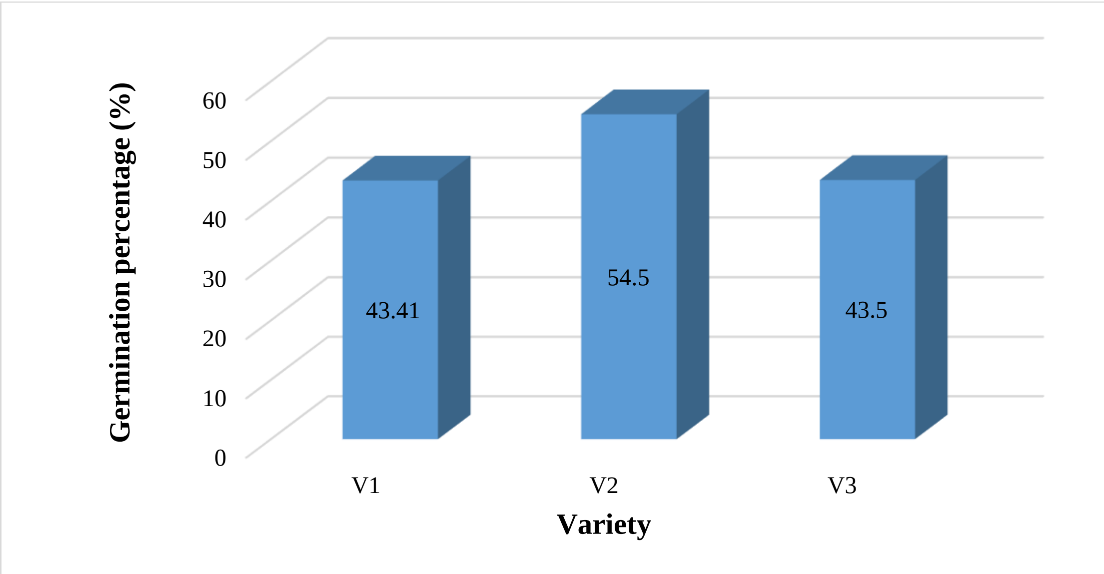
In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.2 Laboratory experiment for seed quality

4.2.1 Seed germination

Effect of variety

Germination percentage had a significant impact among three chilli varieties. BARI Morich-1(V_2) showed the highest germination percentage (54.50%) where BARI Morich-2 (V_3) produced 43.50 % and Local (V_1) produced 43.41%, respectively (Figure 17) and V_3 and V_1 were statistically similar. It is evident from the figure that germination percentage is the optimum for the V_2 which is BARI Morich 1 and the least germination percentage has been shown under V_1 or in the local variety.



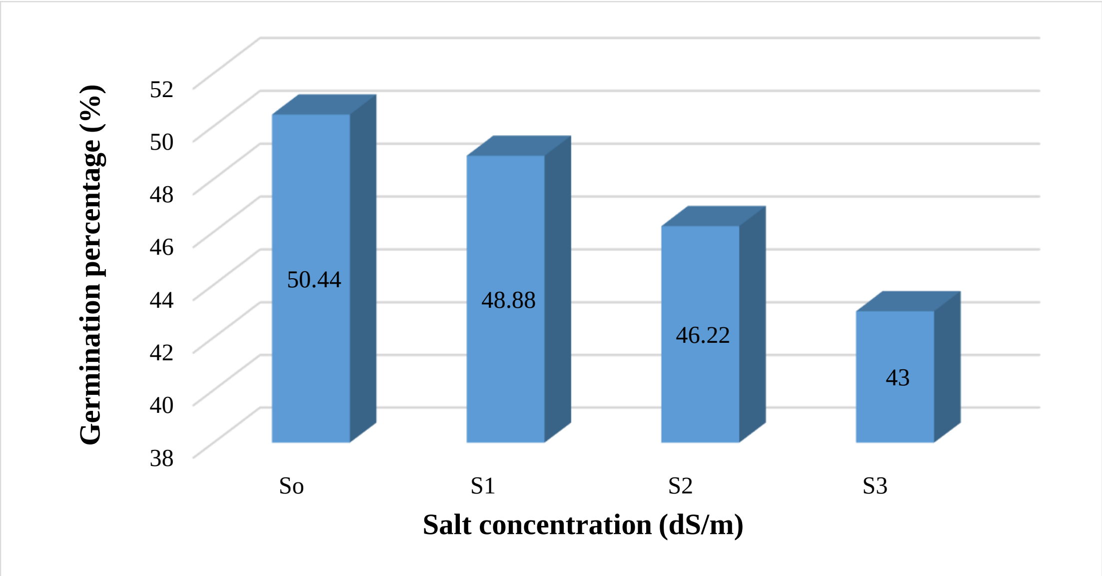
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2;

Figure 17. Effect of variety on germination percentage of chilli (LSD $_{(0.05)}$ = 0.78)

Effect of salinity

Germination percentage showed different response on different salinity levels. S_0 and S_1 showed the highest germination percentage 50.44% and 48.88%, respectively and but S_0 and S_1 were not statistically similar. S_3 and S_2 showed the lowest germination 43% and 46.22%, respectively (Figure 18) and but S_0

and S_1 were statistically different. This might be due to the different level of salinity effect on germination percentage. Germination is one of the most important phases in the life cycle of plant and is highly responsive to existing environment. The soluble salt in the root, beyond a critical limit, adversely influenced germination. Salinity causes osmotic stress (Nandawal *et al.*, 2000; Daniela *et al.*, 2004) or specific ion effects, which delay, reduces or completely inhibit seed germination (Munns, 2002; Hanselin *et al.*, 2005). Present results indicate that germination percentage in different chilli cultivars reduced significantly with increasing the salinity levels from 0 dS/m to 9 dS/m.



S_0 = control, S_1 = 3dS/m saline solution (NaCl); S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 18. Effect of salinity on germination percentage of chilli varieties (LSD $_{(.05)}$ = 0.89)

Interaction effect of variety and salinity

Interaction effect of variety and salinity showed significant result. Where V_2S_0 showed the highest result (59%) followed by V_2S_1 (57%), V_2S_2 (53.33%). V_1S_1 (45%) and V_3S_0 (46%) which were statistically dissimilar. V_1S_3 and V_3S_3 showed the lowest result 39.66% and 40.66%, respectively and there was no significant difference between them (Table 9). Tejovathi *et al*. (1988) reported that the ability of seed germination and emergence under salt stress indicates its genetic potential for salt tolerance. Verma *et al*., (1986) also reported the inhibition of germination in some cultivars of chilli. Similar results with different crops were recorded by many workers (Dantas *et al*., 2007; Zhang *et al*., 2010; Akbarimoghaddam *et al*., 2011). Studies on salt stress in germinating seeds showed that during this stage, the seeds are particularly sensitive to the saline environment (Bewley and Black, 1994). Salt induced inhibition in seed germination could be attributed to osmotic stress or ion toxicity (Huang and Redmann, 1995). According to Huang and Redmann(1995), the salt induced inhibition of seed germination could be attributed to osmotic stress or specific ion toxicity. Seed germination is an essential development event in plant (Kim and Park, 2008). It is an important growth stage often subjected to high mortality rates (Jamil *et al*., 2007; Asaadi, 2009; Begum *et al*., 2010) stated that the germination of seed depends on the utilization of reserved food material of the seed. Salinity interfere as with the process of water absorption by the seeds. This subsequently inhibits the hydrolysis of seed reserves which ultimately delays and decreases seed germination. Many scientists had reported the inhibitory effect of salinity on seed germination of various crops like *Glycinemax* (Essa, 2002), *Vigna* spp., *Brassica* spp. (Ulfat *et al*., 2007), *Zea mays* (Khodarahmpour *et al*., 2012), *Pisumsativum* (Tsegay and Gebreslassie, 2014).

Table 9. Interaction effect of variety and salinity on germination percentage of chilli

Treatment combinations	Germination percentage
V_1S_0	46.33 e
V_1S_1	45.00 ef
V_1S_2	42.66 g
V_1S_3	39.66 h
V_2S_0	59.00 a
V_2S_1	57.00 b
V_2S_2	53.33 c
V_2S_3	48.66 d
V_3S_0	46.00 ef
V_3S_1	44.66 f
V_3S_2	42.66 g
V_3S_3	40.66 h
LSD $_{(0.05)}$	**1.56**
CV (%)	**1.95**

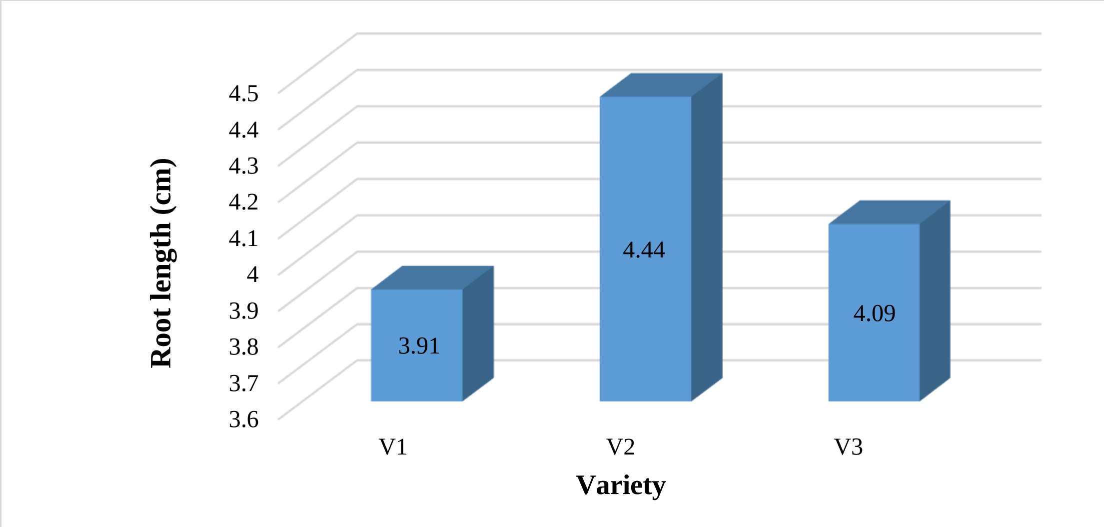
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.2.2 Root length (cm)

Effect of variety

Root length had a significant impact among three chilli varieties. BARI Morich-1(V_2) showed the highest root length (4.44cm) where BARI Morich-2 (V_3) produced 4.09cm and Local (V_1) produced 3.91cm, respectively (Figure 19).

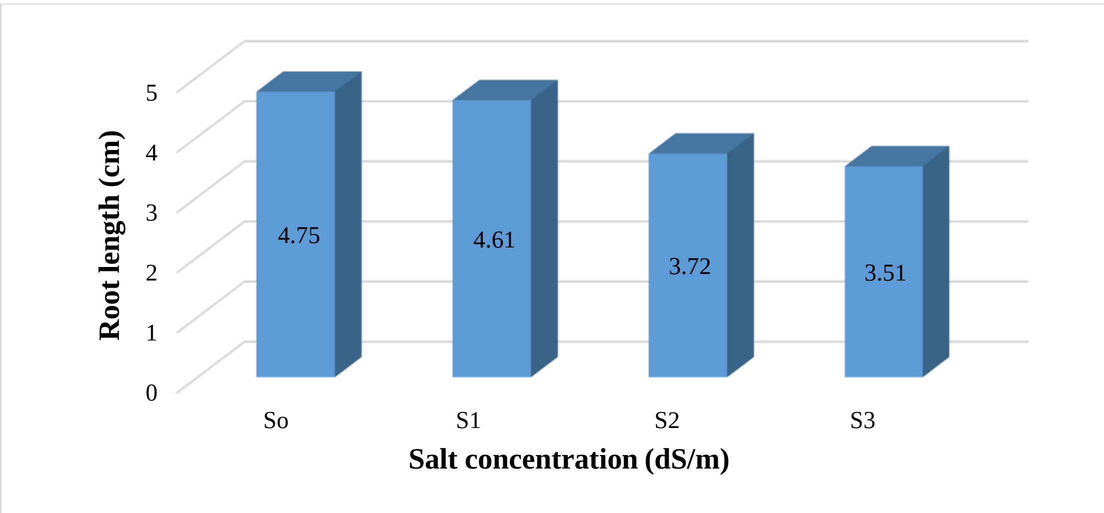


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

Figure 19. Effect of variety on root length of chilli verities ($LSD_{0.05}$ = 0.07)

Effect of salinity

Root length showed different response on different salinity levels and the values of root length data were presented in figure 20. From the figure, there observed a gradual decreasing trend with increasing salinity level and it continued up to highest salinity treatment (V_3). S_0 and S_1 showed the highest root length 4.75 cm and 4.61 cm, respectively. S_3 and S_2 showed the lowest root length 3.51 cm and 3.72 cm, respectively. (Figure 20).



S_0 = control, S_1 = 3dS/m saline solution (NaCl); S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 20. Effect of salinity on root length of chilli varities ($LSD_{0.05}$ = 0.08)

Interaction effect of variety and salinity

Interaction effect of variety and salinity exerted significant variation on root length of chilli (Table 10). Where V_2S_0 showed the highest result (5.02 cm) and V_1S_3 showed the lowest result (3.30 cm). At higher levels of salinity (9 ds/m) the length of root in all cultivars was more affected as compared to lower levels of salinity. Statistical data revealed that root length of V_1, V_2 and V_3 were significantly affected at all level of salinity at 5% level of significant. V_2S_0 (5.02) and V_2S_1 (4.93) showed statistically similar result. V_3S_0 (4.66) showed moderate result. Statistical data revealed that salinity level of S_0 is the most suitable for the root length. It increases the root length. Our results indicate that under salt stress, root lengths were decreased in general compared to control. This reduction with increasing salinity may be due to limited supply of metabolites to young growing tissues because metabolic production is significantly perturbed at high salt stress, probably due to the toxic effects of salt (Yousofinia *et al.,* 2012).

Table 10. Interaction effect of variety and salinity on root length of chilli

Treatment combinations	Root length (cm)
V_1S_0	4.56 bc
V_1S_1	4.36 d
V_1S_2	3.43 g
V_1S_3	3.30 h
V_2S_0	5.02 a
V_2S_1	4.93 a
V_2S_2	4.04 e
V_2S_3	3.76 f
V_3S_0	4.66 b
V_3S_1	4.53 c
V_3S_2	3.70 f
V_3S_3	3.46 g
LSD $_{(0.05)}$	**0.13**
CV (%)	**1.86**

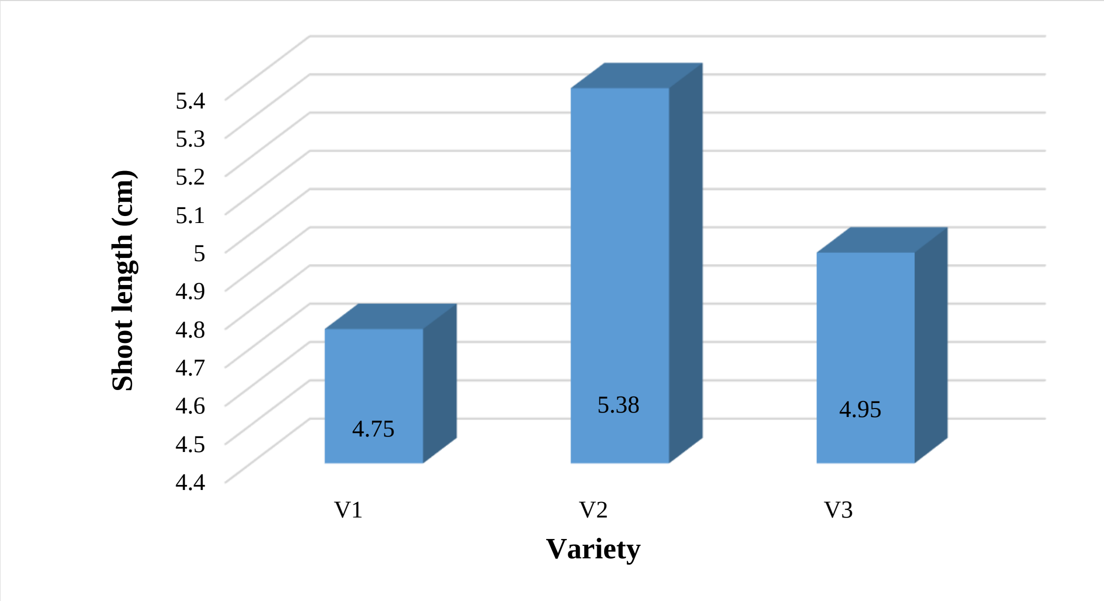
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.2.3 Shoot length

Effect of variety

Shoot length had a significant impact among three chili varieties. BARI Morich-1 (V_2) showed the highest shoot length (5.38 cm) where BARI Morich-2 (V_3) produced 4.95 cm and Local (V_1) produced 4.75 cm, respectively (Figure 21). Statistical data revealed that V_2 (5.38 cm) is statistically different than other two tested varieties.

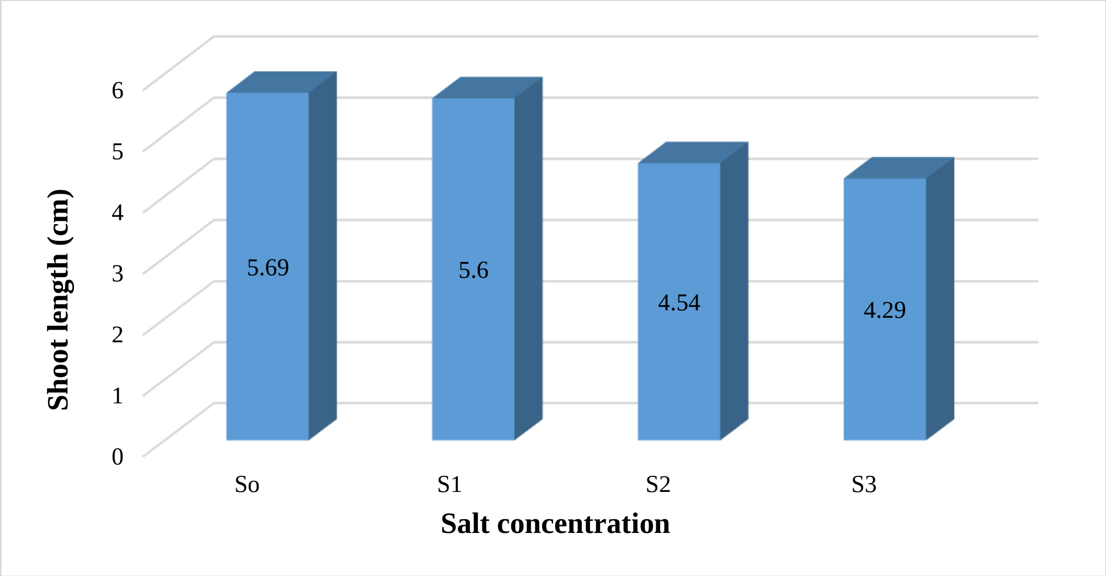


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

Figure 21. Effect of variety on shoot length of chilli ($LSD_{0.05} = 0.16$)

Effect of salinity

The present findings indicate that length of shoot significantly reduced at higher salinity level. S_2 and S_3 showed the lowest shoot length (4.54 cm 4.2 and 4.29 cm) among three verities (Figure 22). S_0 (5.69) and S_1 (5.60) showed the similar statistical result and S_0 (5.69) showed the highest result among all four treatments.



S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 22. Effect of salinity on shoot length of chilli varities ($LSD_{0.05} = 0.19$)

Interaction effect of variety and salinity

Interaction effect of variety and salinity showed significant variation on shoot length of chilli (Table 11). Where V_2S_0 (5.90 cm) showed the best result among all the combinations. V_2S_0 (5.90 cm) was statistically different and most significant. V_1S_3 given the least significant result (3.90 cm). It was observed by (Gupta and Srivastava, 1989) that roots were less affected than shoots in wheat as salinity of the medium increased. Similar observation have been reported by (Mauromicale and Licandro, 2002), in barley (Turan *et al*., 2010), in maize (Ratanakar and Rai, 2013) in *Trigonella foenum-graecum*. Radicle length was more suppressed than plumule by salinity at all salt concentration levels. The gradual decrease in root length with increase in salinity might be due to more inhibitory effect of salt to root growth compared with shoot growth (Anbumalarmathi and Mehta, 2013), in rice. Salinity leads to disturbances in plant metabolism, which consequently led to reduction of plant growth and productivity (Shafi *et al*., 2009; Jaleel *et al*., 2008) also reported a decrease in root length in *Catharanthus roseus* under salinity. Such a decrease in root length and shoot length may be due to salt toxicity and disproportion in nutrient absorption by the seedling as suggested by (Bybordi and Tabatabaei, 2009).

Table 11. Interaction effect of variety and salinity on shoot length of chilli

Treatment combinations	Shoot length (cm)
V_1S_0	5.50 bc
V_1S_1	5.43 c
V_1S_2	4.20 ef
V_1S_3	3.90 f
V_2S_0	5.90 a
V_2S_1	5.82 ab
V_2S_2	5.00 d
V_2S_3	4.80 d
V_3S_0	5.68 a-c
V_3S_1	5.55 bc
V_3S_2	4.42 e
V_3S_3	4.17 ef
LSD (0.05)	**0.33**
CV (%)	**3.86**

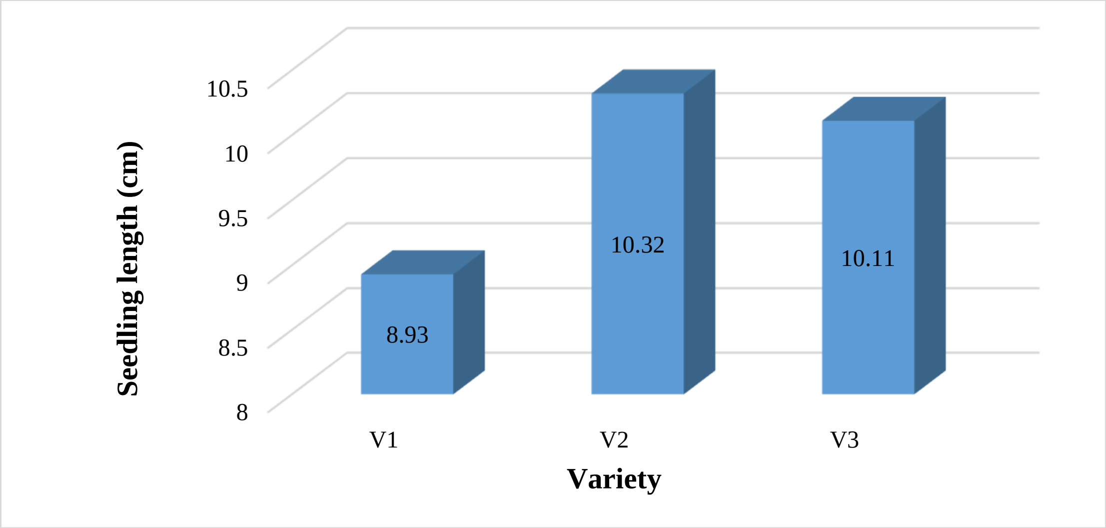
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 =control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.2.4 Seedling length

Effect of variety

Seedling length of all the three varieties decreased with the increase of salinity level. Among the three varieties the seedling length of V_2 is the highest and V_1 is the least under control. BARI Morich-1(V_2) showed the highest seedling length (10.32 cm) where BARI Morich-2 (V_3) produced 10.11 cm and Local (V_1) produced 8.93 cm respectively (Figure 23).

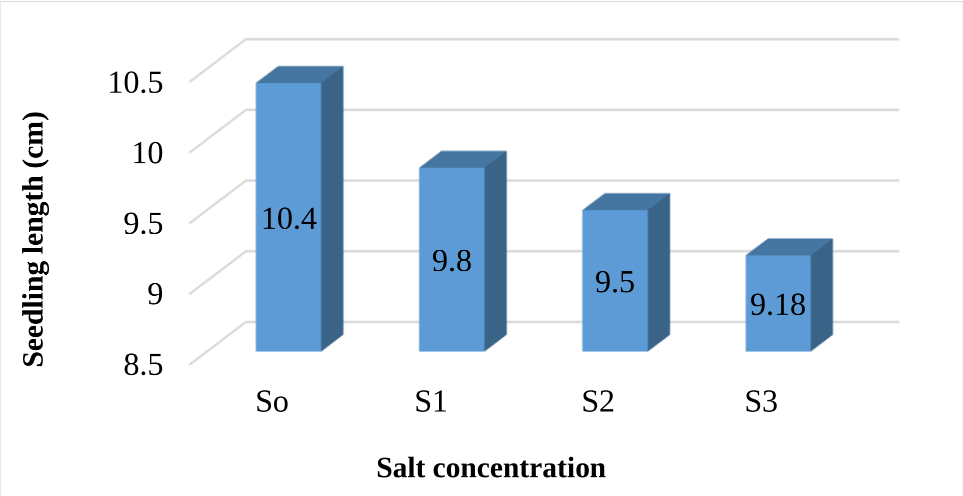


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

Figure 23. Effect of variety on Seedlings length of chilli varities ($LSD_{0.05}$ = 0.16)

Effect of salinity

Under the treatment of salt concentration S_0 showed the highest length (10.40 cm) of seedling growth which indicates that the minimum reduction of seedling length is at control (0 dS/m) and the highest reduction showed by S_3 (9.18 cm) (Figure 24).



S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 24. Effect of salinity on Seedling length of chilli varities ($LSD_{0.05}$ = 0.19)

Interaction effect of variety and salinity

Interaction effect of variety and salinity varied significantly on shoot length of chilli (Table 12). Interaction of V_2S_0 showed the highest seedling length (10.94 cm) among all other treatment combinations and V_1S_3 showed the least seedling growth (8.46 cm). V_2S_0 (10.94 cm), V_2S_1 (10.72 cm) and V_3S_0 (10.76 cm) were statistically similar. Palta (1990) confirmed that the application of NaCl at 6 ds/m followed by Ca at 35 mgL^{-1} can significantly ($P \leq 0.05$) increase the salinity tolerance and seedling length in chili plants. Role of Na^+ and Cl^- in conferring tolerance against abiotic stresses has been linked to ATPase activation which pumps back the nutrients that were lost during cell damage. The Ca also plays a role as calmodulin which controls the plant metabolic activities and enhances the plant growth under stressed condition.

Table 12. Interaction effect of variety and salinity on seedling length of chilli

Treatment combinations	**Seedling length (cm)**
V_1S_0	9.49 d
V_1S_1	8.96 e
V_1S_2	8.80 ef
V_1S_3	8.46 f
V_2S_0	10.94 a
V_2S_1	10.72 ab
V_2S_2	10.10 c
V_2S_3	9.53 d
V_3S_0	10.76 ab
V_3S_1	10.46 b
V_3S_2	9.67 d
V_3S_3	9.55 d
LSD $_{(0.05)}$	**0.33**
CV (%)	**2.04**

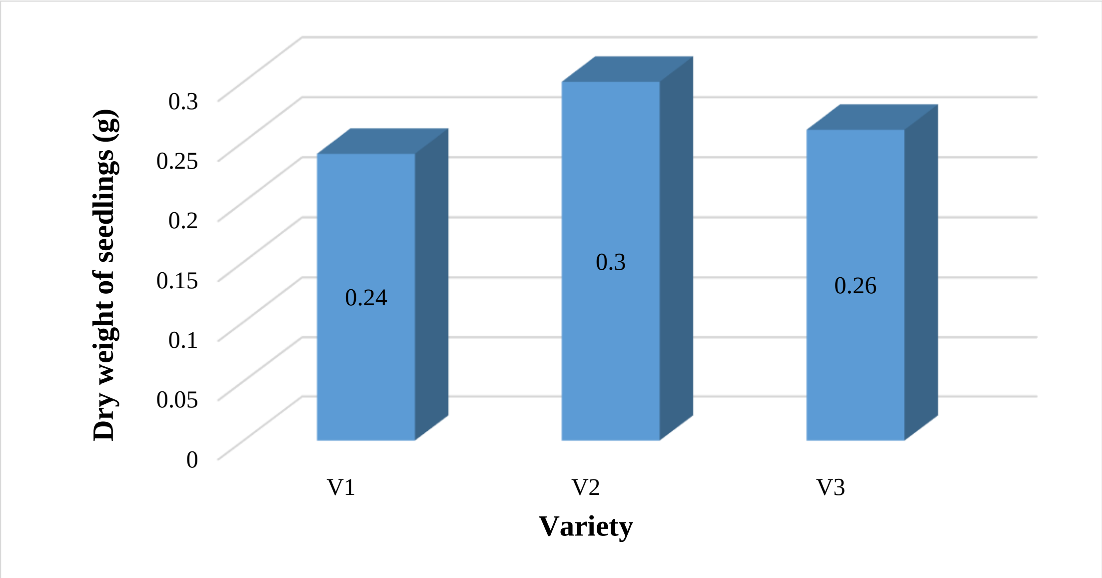
V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

4.2.5 Dry weight (g) of seedlings

Effect of variety

Among the tested three varieties BARI Morich-1 (V_2) showed it's superiority in producing the highest (0.30 g) dry weight of seedling and the lowest (0.24 g) dry weight of seedlings was found in Local variety (V_1). But the Local variety (V_1) and BARI Morich-2 (V_3) showed statistically similar result (Figure 25).

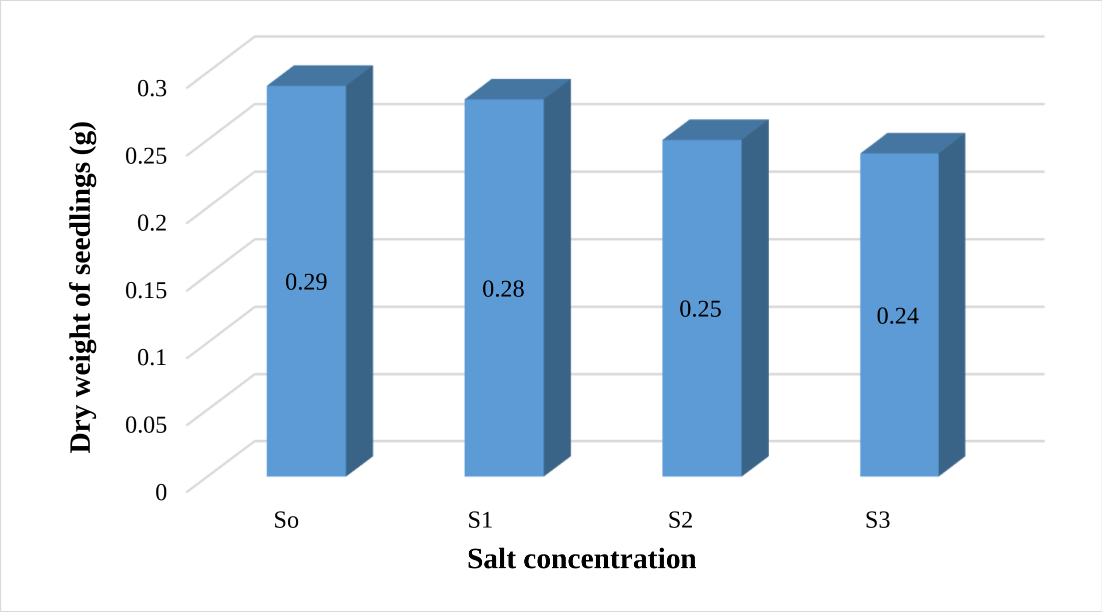


V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

Figure 25. Effect of variety on dry weight of seedlings of chilli ($LSD_{0.05}$ = 0.03)

Effect of salinity

Under the treatment of salt concentration S_0 showed the highest weight (0.29 g) of seedling and S_3 showed the minimum seedling weight (0.24 g). S_1 and S_2 had no statistical difference (Figure 26). The figure clearly represent a gradual decreasing trend with increase of salinity.



S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

Figure 26. Effect of salinity on dry weight of seedlings of chilli varieties ($LSD_{0.05}$ = 0.03)

Interaction effect of variety and salinity

Interaction effect of variety and salinity varied significantly. Where V_2S_0 and V_2S_1 both showed the highest result (0.32 g) and V_1S_3 showed lowest result (0.22 g) (Table 13). V_2S_0 (0.32 g), V_2S_1 (0.32 g), V_2S_2 (0.30 g), V_3S_0 (0.29 g) and V_3S_1 (0.27 g) were statistically similar. Similar observation have been reported by (Rastegar and Kandi, 2011) in soybean and (Hoque *et al*., 2014) in maize. Ashraf *et al.*,(2002) reported that the reduction in seedling fresh and dry weight is due to decreasing water uptake by seedling in salt stress presence have also been reported that salinity induced water deficit hence the reduced plant growth. Cha-Um and Kirdmane (2009) reported that a decrease in fresh weight as well as dry weight in maize seedling under NaCl salinity. According to them, salinity leads to water deficit in plants thereby causing a decrease in fresh and dry weight (Dadkhah and Grrifiths, 2006). Dadkhah and Grrifiths (2006) attributed such a decrease in dry weight to greater reduction in uptake and utilization of mineral nutrients by plants under salt stress. In general, there is a decrease in dry weight of plants under saline conditions which can be attributed to reduced rate of photosynthesis, as suggested by (Jafari *et al.,* 2009).

Table 13. Interaction effect of variety and salinity on dry weight of seedlings

Treatment combinations	Dry Weight of seedling (g)
V_1S_0	0.25 b-d
V_1S_1	0.25 cd
V_1S_2	0.23 d
V_1S_3	0.22 d
V_2S_0	0.32 a
V_2S_1	0.32 a
V_2S_2	0.30 ab
V_2S_3	0.26 b-d
V_3S_0	0.29 a-c
V_3S_1	0.27 a-d
V_3S_2	0.24 cd
V_3S_3	0.24 cd
LSD $_{(0.05)}$	**0.05**
CV (%)	**11.03**

V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2; S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Agronomy Net-house of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from November 2016 to April 2017 to study the influence of salinity levels on yield attributes, yield and seed quality of three selected chilli varieties. (Local variety, BARI Morich 1, BARI Morich 2). The experiment consisted of two factors: Factor A (Chilli varities): Local variety, BARI Morich 1, BARI Morich 2 and Factor B (Salinity concentration): S_0= 0 dS/m, S_1= 3 dS/m, S_2= 6 dS/m, S_3= 9 dS/m. The two factors experiment was laid out in a Completely Randomized Design (CRD) with three replications. Data on plant height (cm), number of leaf, pod length (cm), number of marketable fruit plant, dry weight of plant (root and shoot), weight of per green fruit (g), weight of per dry fruit (g), harvest index (%), seed germination (%), root length and shoot length (cm), seedling length (cm), dry weight of seedlings (g) were recorded and statistically significant variation was observed for different treatment. Different levels of salt concentration application had significant variation on yield contributing parameters, yield and seed quality of chilli.

In terms of variety, BARI Morich 1 is the best variety than other two. BARI Morich 1 was recorded for the best result in plant height (27.16 cm), leaf number (28.75), pod length (6.63 cm), dry weight of plant (83.62 g), number of marketable fruit per plant (94 pieces on an average), weight of per green fruit (4.08 g), weight of per dry fruit (0.21 g), harvest index (18.46%), germination (54.50%), root length (4.44 cm), shoot length (5.38 cm), seedling length (10.32 cm) and dry weight of seedlings (0.30 g). The lowest result was found in case of Local variety.

In case of salt concentration application the best result was recorder in control (0 dS/m salt concentration). Results showed that in terms of salt concentration application, highest seed germination (50.44%) was recorded in control (0 dS/m salt concentration). 0 dS/m salt concentration was also recorded for the best result in plant height (29.11 cm), leaf number (29.88), pod length (6.44 cm), dry weight of plant (83.99 g), number of marketable fruit per plant (93.33 piece on an average), weight of per green fruit (4.54 g), weight of per dry fruit (0.24 g), harvest index (15.69%), root length (4.75cm), shoot length (5.69 cm), seedling length (10.40 cm), dry weight of seedlings (0.29 g).

Considering interaction effect of variety and salinity V_2S_0 was recorded for the best result in plant height (30.66 cm), leaf number (32.33), pod length (6.90 cm), number of marketable fruit per plant (101.33 piece on an average), dry weight of plant (87.35 g), weight of per green fruit (4.86 g), weight of per dry fruit (0.26g), harvest index (21.34%), seed germination (59%), root length (5.02 cm), shoot length (5.90 cm), seedling length (10.94 cm) and dry weight of seedlings (0.32 g).

From the above discussion, it can be concluded that the best result was found in BARI Morich 1. Where's other two varieties showed moderate to poor result. In case of different levels of salt concentration application 0 dS/m level of salt concentration gave the best result and in terms of interaction effect of variety and salinity V_2S_0 was recorded for the best result. But in 3 dS/m level of salinity BARI Morich 2 gives the best result. So, between BARI Morich 1 and BARI Morich 2 comparing with salinity level BARI Morich 2 is suggested and V_3S_1 is the best variety. Further works to be conducted again to find out better variety which gives better performance under salinity condition.

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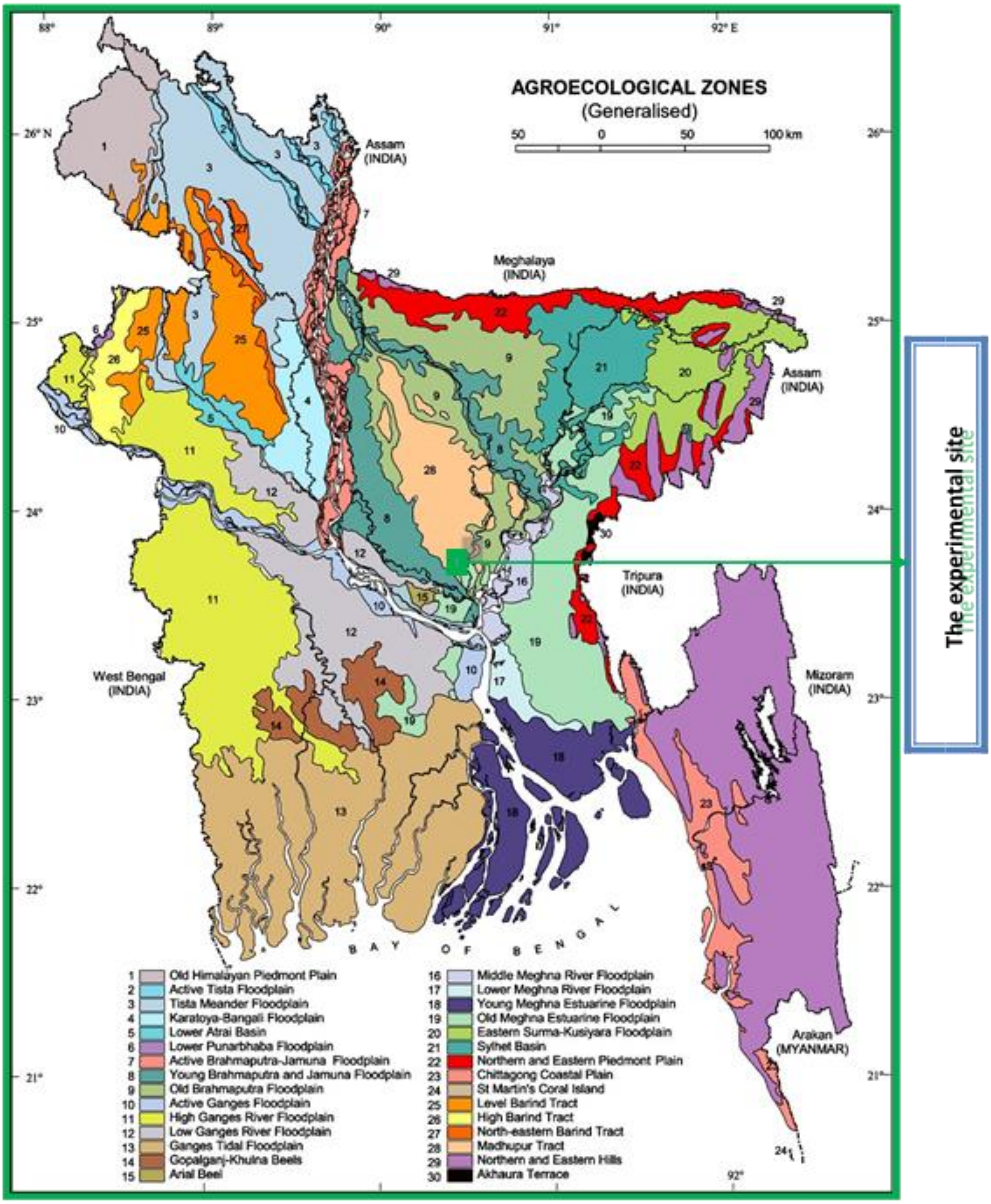
APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location



Appendix II. Monthly records of air temperature, relative humidity, rainfall and sunshine hours during the period from November 2016 to April 2017

Month	RH (%)	Air temperature (°C)			Rainfall (mm)
		Max.	*Min.*	*Mean*	
November, 2016	77	29.6	19.2	24.4	34.4
December,2016	69	35.20	21.00	28.10	20.4
January, 2017	68	34.70	24.60	29.65	165.0
February, 2017	68	32.64	23.85	28.25	182.2
March, 2017	64	27.40	23.44	25.42	190.0
April, 2017	69	33.20	25.74	29.47	304.0

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212

Appendix III. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Horticulture Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Not Applicable

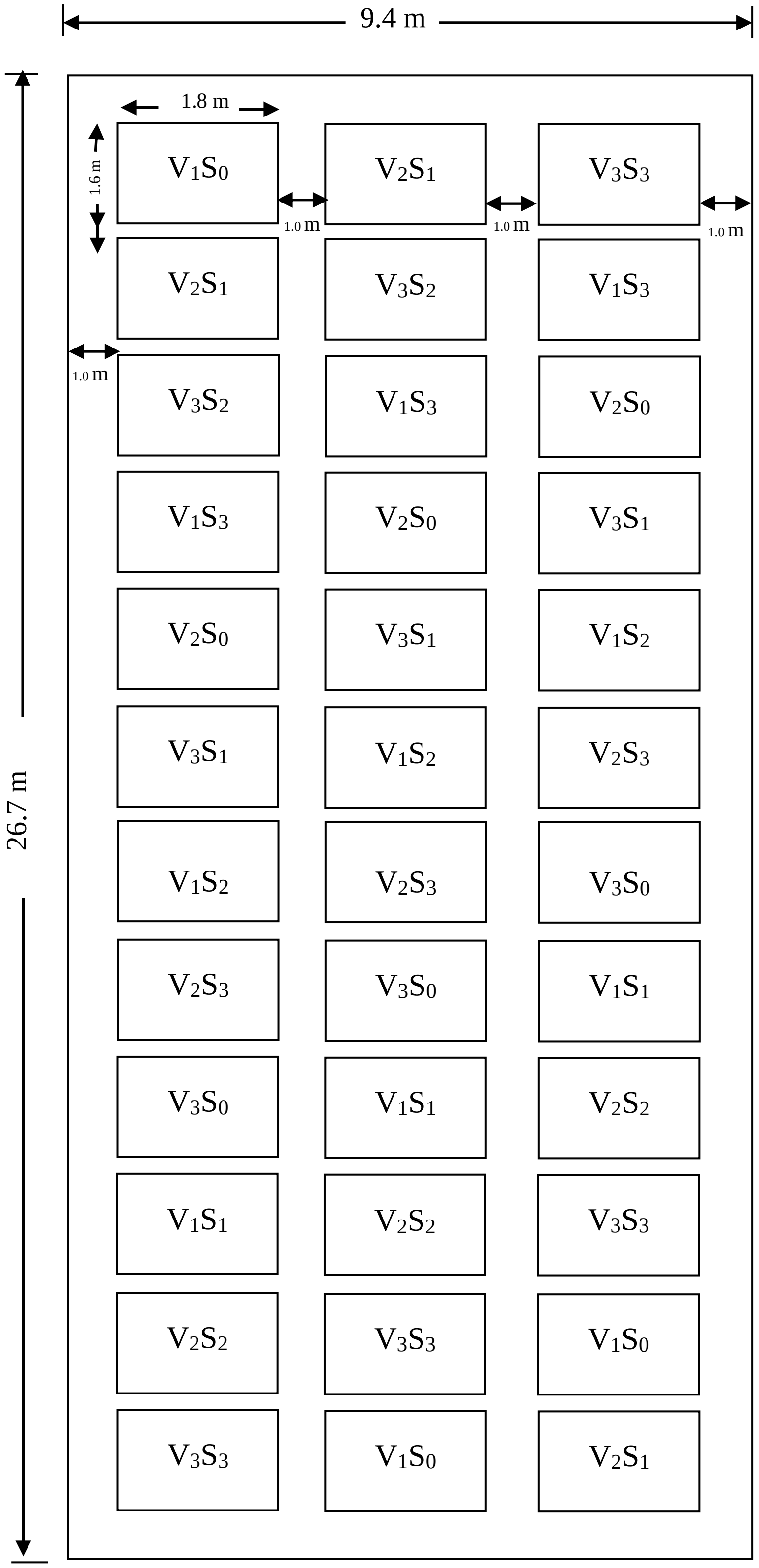
Source: Soil Resource Development Institute (SRDI)

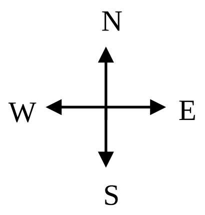
B. Physical and chemical properties of the initial soil

Characteristics	**Value**
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix IV. Layout of the experimental plot





Plot size: 1.8 m × 1.6 m

Plot spacing: 0.50 m

Between block: 1.00 m

Factor A: Variety

V_1 = Local,

V_2 = BARI Morich 1

V_3 = BARI Morich 2

Factor B: Salt concentration

S_0: 0 dS/m (control)

S_1: 3 dS/m

S_2: 6 dS/m

S_3: 9 dS/m

Appendix V. Effect of different varieties on chilli yield attributes, yield and seed quality

Variety	Plant height (cm)	Number of leaves (no.)	Pod length (cm)	No. of marketable fruit per plant	Dry weight of plant (g)	Green weight of per fruit (g)	Weight of dry fruit (g)	Harvest index (%)	Germination percentage (%)	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Dry Weight of seedling (g)
V_1	23.58 c	21.91 c	5.40 c	81.41 c	74.16 b	3.76 b	0.17 b	14.038 b	43.41 b	3.91 c	4.75 c	8.93 c	0.24 b
V_2	27.16 a	28.75 a	6.63 a	94.00 a	83.62 a	4.08 a	0.21 a	18.465 a	54.50 a	4.44 a	5.38 a	10.32 a	0.30 a
V_3	25.83 b	25.16 b	5.82 b	88.16 b	83.10a	4.04 a	0.20 a	7.546 c	43.50 b	4.09 b	4.95 b	10.11 b	0.26 b
LSD (0.05)	1.16	1.39	0.13	1.25	1.20	0.16	0.01	3.7221	0.78	0.07	0.16	0.16	0.03
CV (%)	5.37	6.53	2.63	1.68	1.77	4.88	7.36	32.93	1.95	1.86	3.86	2.04	11.03
Level of significance	**	**	**	**	**	**	*	*	**	**	**	**	*

V_1 = Local, V_2 = BARI Morich 1, V_3 = BARI Morich 2

** Significant at 1% level   * Significant at 5% level

Appendix VI. Effect of different salt concentration on chilli yield attributes, yield and seed quality

Salt concentration	Plant height (cm)	Number of leaves (no.)	Pod length (cm)	No. of marketable fruit per plant	Dry weight of plant (g)	Green weight of per fruit (g)	Weight of dry fruit (g)	Harvest index (%)	Germination percentage (%)	Root length (cm)	Shoot length (cm)	Seedli-ng length (cm)	Dry Weight of seedlin-g (g)
S_0	29.11 a	29.88 a	6.44 a	93.33 a	83.99 a	4.54 a	0.24 a	15.69 a	50.44 a	4.75 a	5.69 a	10.40 a	0.29 a
S_1	26.78 b	27.33 b	6.22 b	91.11 b	82.46 b	4.28 b	0.22 b	15.49 ab	48.88 b	4.61 b	5.60 a	10.05 b	0.28 ab
S_2	24.11 c	22.22 c	5.74 c	85.33 c	78.52 c	3.55 c	0.17 c	11.33 bc	46.22 c	3.72 c	4.54 b	9.52 c	0.25 bc
S_3	22.11 d	21.66 c	5.41 d	81.66 d	76.22 d	3.45 c	0.16 c	10.87 c	43.00 d	3.51 d	4.29 c	9.18 d	0.24 c
LSD (0.05)	1.34	1.61	0.15	1.44	1.38	0.18	0.01	4.29	0.89	0.08	0.19	0.19	0.03
CV (%)	5.37	6.53	2.63	1.68	1.77	4.88	7.36	32.93	1.95	1.86	3.86	2.04	11.03
Level of significance	**	**	**	**	**	*	**	*	**	**	**	**	*

S_0 = control, S_1 = 3dS/m saline solution (NaCl), S_2 = 6dS/m saline solution (NaCl), S_3 = 9dS/m saline solution (NaCl)

** Significant at 1% level * Significant at 5% level

Plate 1: A. Germinating stage, B. Seedling stage, C. flowering stage, D. Fruiting stage

Plate 2: Tagging of each genotype of entire pots

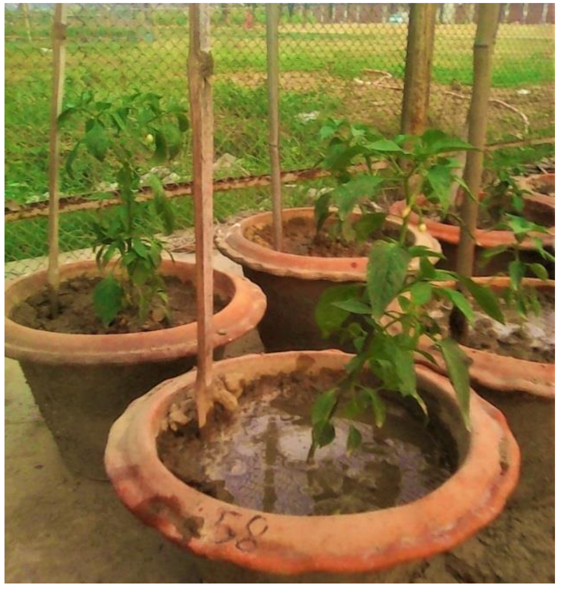


Plate 3: Leaning of the plants for salinity effects