

# **Annual Research Report 2022-23**

**Salinity Management and Research Center  
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# **Effect of Different types of organic matter on Soil Salinity and Yield of Sweet gourd in Coastal Saline Soil**

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## **Abstract**

Salinity causes serious cellular damage and limits crop productivity. Accumulation of organic matter is one of the best adaptive mechanisms to reduce salinity affect in plants. By reducing soil salinity and for obtaining a better sustainable yield, a low-cost and farmer-ecofriendly method is required for sweet gourd, a well known vegetable. Accordingly, a field experiment was carried out in Salinity Management and Research Center, Soil Resource Development Institute, Batiaghata, Khulna during Kharif-1 season in 2023 to investigate the effect of different types of organic matter on soil salinity and yield of sweet gourd. The experiment includes five treatments viz. no organic matter (control), cow dung, saw dust, poultry manure and vermi-compost. The experiment was carried out in Randomized Complete Block Design (RCBD) with three replications. Field Soil salinity was recorded at 30 days intervals. Organic matter has showed that this causes effectively reduction the salt accumulation in the plant body and some modification accelerated. After three months of seed sowing, the highest soil salinity (15.7 dS/m) and lowest soil salinity (9.3 dS/m) were found at no organic matter (control) and poultry manure treatment respectively in the month of May. Organic matter treatments obviously have increased the growth and yield attributes of sweet gourd. The highest value of four growth parameters i.e., fruit length (23.40 cm), fruit diameter (80.40 cm), fruit weight (3.78 kg) and total yield (31.32 t/h) was found on poultry manure as compared to control. Again, the lowest value of four growth parameters i.e., fruit length (15.40 cm), fruit diameter (43.40 cm) , fruit weight (2.12 kg) and total yield (12.34 t/h) were found on saw dust treatment. The results revealed that the use of organic matter decrease soil salinity strength and also increases the yield of sweet gourd in saline soil. These findings suggest that the application of organic matter not only reduces soil salinity but also increases the structure of soil, regulate microbes and yield of sweet gourd.

Keywords: Salinity; cow dung; saw dust; poultry manure; yield; sweet gourd.

## **Introduction**

Salinity as a whole is very dangerous problem at present situation of crop production of southern part of Bangladesh. Soil salinity stress increases the accumulation of toxic ions such as Na<sup>+</sup> and Cl<sup>-</sup> in different plant parts, tissues, cells and cell organelles (Gadallah, 1999). Soil salinization is a major process of land degradation that decreases soil fertility and crop productivity. There is a report that coastal regions of Bangladesh are quite lower in soil fertility (Haque, 2006; Kibria et al., 2015). All soils contain a few water-soluble salts, but when these

salts happen in sums that are harmful for the germination of seeds and plant development, they are called saline (Conway, 2001). Salt affected soils generally exhibit poor structural stability due to low organic matter content. Many researchers have suggested that the structural stability of soil can be improved by the addition of organic materials (e.g. saw dust, vermin compost, cow dung and poultry manures). Soil salinity is a major barrier to crop production all over the world that affects probably all plant activities. Million hectares of land throughout the world are too saline to produce economic crops, and more land is becoming nonproductive each year due to salinity build up. Approximately 7% of the world's land area, 20% of the world's cultivated land and nearly half of the irrigated land are affected by soil salinity (Zhu, 2001; FAO, 2008; Mali et al., 2012). In view of another projection, 2.1% of the global dry land agriculture is affected by salinity (FAO, 2008). Besides this, increasing soil salinity of arable land is expected to have devastating global effects, resulting in up to 50% land losses by the middle of the twenty-first century (Mahajan and Tuteja, 2005). Out of total agricultural land about 2.86 million hectares of coastal and offshore lands of Bangladesh, about 10.56 lakh hectares are affected by varying degrees of soil salinity (SRDI, 2010). Among the environmental stresses, soil salinity is the most devastating (Shahbaz and Ashraf, 2013) which not only affect the plant growth and metabolism but also poses a foremost limitation to sustainable agricultural production (Tayyab et al., 2016). Important practice is the application of organic manure which can both ameliorate and increase the fertility of saline soil (Melero et al., 2007). Organic mulches can reduce the effect of salt toxicity on plant growth (Ansari et al. 2001; Landis 1988; Yobterik and Timmer, 1994) or actively accelerate soil desalinization (Dong et al. 1996). Considering the above fact, applying organic matter is one of the suitable technologies for reducing soil salinity, it reduces evapotranspiration and helps soil salinity remains lower in the soil. There are evidences that soil amendments with organic matter reduce the toxic effects of soil salinity in various plant species (Idrees et al., 2004; Abou El-Magd et al., 2008; Leithy et al., 2010; Raafat and Thawrat, 2011). Yield characteristics like diameter of fruit, weight of fruit and fruits per vine showed significant results with black polyethylene mulch in case of different high value vegetables in Bangladesh (Islam F, et al., 2010). Organic matter amendments improve physical, chemical and biological properties of soils under saline conditions. This experiment is designed to find out the effect of different organic matter on soil salinity management and to observe the yield performance of sweet gourd.

## **Materials and Methods**

### *Study location*

This experiment was conducted at the Salinity Management and Research Centre (SMRC), Soil Resource Development Institute, Batiaghata, Khulna, Bangladesh during the Kharif-1 season of 2023. Geographically, the study site was at 22°46'01.8" N latitude and 89°24'15.2" E longitude and under AEZ-13. With an average yearly temperature of 79.3 °F and monthly mean temperatures ranging from 54.3 °F in January to 93.7°F in May, the area is among the warmest

in Bangladesh. The land type of experimental plot was medium high land, land form was basin, land use was Fallow-kharif vegetable-transplanted aman, depth of flooding was 11/2-2 feet & duration of flooding was 3-4 months, soil series was barisal.

#### *Layout of Experiment and Management of crop*

The following expecting experiment was carried out in Randomized Complete Block Design (RCBD) with three replications. Sweet gourd (variety: Bengal sweet gourd-2) was taken as an experimental crop. Five experimental treatments were considered: (T<sub>1</sub>) control (no organic matter), (T<sub>1</sub>) cow dung, (T<sub>2</sub>) vermi-compost, (T<sub>3</sub>) saw dust and (T<sub>4</sub>) poultry manure with 3 replication. For gaining good tilt of soil condition, the experiment plot was prepared by several ploughing and cross ploughing followed by laddering and harrowing with tractor and power tiller. Weeds and other stables were removed carefully from the experimental plot and leveled properly. Basal doses of fertilizer were applied during land preparation.

#### *Pit preparation*

Total land was designed according to achieving the expected yield. The measurement of pit was One foot length x one foot breadth according to experimental demand. Then five experimental treatments were considered (T<sub>1</sub>) control (no organic matter), (T<sub>1</sub>) cow dung, (T<sub>2</sub>) vermi-compost, (T<sub>3</sub>) saw dust and (T<sub>4</sub>) poultry manure. Then pit soil and treatments materials were mixed with soil very properly, leveling and marked for data collection. After processing the pit area, sweet gourd seeds were sown in the pit with experimental need. Proper care and management were taken when pit was prepared. Necessary care and other intercultural operations were done when necessary. Data were recorded in accordance with the requirements. Soil salinity was measured by using an EC Meter at 30 days intervals. All the intercultural operations like watering, gap filling, staking, weeding, and plant protection measures were executed carefully.

#### *Measurement of Growth and Yield attributes*

Four growth and yield parameters such as fruit length (cm), fruit diameter (cm), fruit weight (kg) and total yield (ton/ hectare) were taken into consideration to analyze the effect of organic matter on yield of sweet gourd. Total yield (t/ha) was calculated by measuring the total fruit weight of the plot.

#### *Initial Chemical properties of soil of pot*

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				µg/g			
7.6	2.98	0.37	0.17	10.72	14.98	2.96	0.52
Slightly Alkaline	M	H	L	L	L	VH	O

### *Statistical Analysis*

The collected data were tabulated and statistically analyzed using Statistix10 software. The treatment means were separated statistically at a 5 % level of significance using Duncan's Multiple Range Test (DMRT).

## **Results and Discussion**

### *Effects of Different organic matter on Soil Salinity reduction*

Salinity controlling in root zone area in saline soil fields is highly considered beneficial to seed emergence and stand establishment" (Dong et al., 2010). In modern studies has shown that organic matter is a promising technique for salinity control in present agriculture. An upward trend of soil salinity at all treatments was observed from February to May (Table 1). In the month of February, the lowest soil salinity was found at poultry manure (4.10 dS/m) while the highest soil salinity was observed at control (4.3 dS/m) where no organic matter was used and saw dust (4.3 dS/m). Since soil salinity increases gradually from the month of February to May, the lowest salinity was found in the month of February (4.10 dS/m) as compared to the highest in the month of May (15.7 dS/m). In the month of May, the lowest soil salinity was found at poultry manure (9.3 dS/m) in comparison with the highest soil salinity found in control condition (15.7 dS/m) (Table 1). This data revealed that soil salinity can be reduced by using different organic matter in which poultry manure has a great significant effect on reducing soil salinity. some authors emphasized These results and reported that all organic matter effectively reduced salt accumulation in the root zone (Taia A, et al., 2016 ).

**Table 1: Month wise soil salinity of the experimental plot**

Treatment	Month wise Soil salinity (EC: dS/m)			
	Feb	Mar	April	May
T <sub>0</sub> (Control)	4.3	7.4	11.2	15.7
T <sub>1</sub> (Cow dung)	4.2	6.4	9.2	12.4
T <sub>2</sub> (Vermi-compost)	4.2	5.1	8.9	10.2
T <sub>3</sub> (Saw dust)	4.3	7.3	11.1	15.4
T <sub>4</sub> (Poultry manure)	4.1	4.3	7.5	9.3

### *Effects of different organic matter on Yield Attributes of sweet gourd*

#### *Fruit length of sweet gourd*

This experiment shows that, fruit length and other fruit length related parameters varies a lot that were statistically analyzed as shown in Table 2. They showed a significant variation in relation to different organic matter. The fruit length at control condition was 16.23 cm, at the

saw dust treatment it was about 15.40 cm and at treatment with cow dung it was 17.33 cm but at vermi compost treatment it was 22.50 cm of fruit length. The highest fruit length (23.40 cm) was found at poultry manure, while the lowest (15.40 cm) was found where saw dust was applied. The highest fruit length (23.40 cm) was observed at poultry manure in comparison with the saw dust treatment where the lowest fruit length (15.40 cm) was found (Table 2).

**Table 2: Yield and Yield attributes of sweet gourd in saline soil**

Treatment	Fruit Length (cm)	Fruit Diameter (cm)	Fruit weight (kg)	Yield (t/ha)
T <sub>0</sub> (Control)	16.23b	61.20c	2.45b	16.78c
T <sub>1</sub> (Cow dung)	17.33b	67.20b	2.79b	22.34b
T <sub>2</sub> (Vermi-compost)	<b>22.50a</b>	<b>78.30a</b>	<b>3.62a</b>	<b>30.43a</b>
T <sub>3</sub> (Saw dust)	15.40b	43.40d	2.12b	12.34d
T <sub>4</sub> (Poultry manure)	<b>23.40a</b>	<b>80.40a</b>	<b>3.78a</b>	<b>31.32a</b>
CV (%)	5.67	3.79	12.35	5.07
LSD	2.02	4.71	0.68	2.16

#### *Fruit Diameter of sweet gourd*

Fruit diameter manipulated in accordance with the organic matter treatment at the plot. So that continuing experiment showed that, fruit diameter and other components of creating fruit diameter quality enhance related parameters varies to a wide that were statistically analyzed as shown in Table 2. Those attributes showed a significant variation in relation to different organic matter. The fruit diameter at control condition was 61.20 cm, at the saw dust treatment the diameter was about 43.40 cm and at treatment with cow dung it was 67.20 cm but at vermi compost treatment, the fruit diameter was 78.30 cm. The highest fruit diameter (80.40 cm) was found at poultry manure, while the lowest fruit diameter (43.40 cm) was found where saw dust was applied. The highest fruit diameter (80.40 cm) was observed at poultry manure in comparison with the saw dust treatment where the lowest fruit diameter (43.40 cm) was found (Table 2). It had been observed that fruit diameter (cm) and other fruit diameter contributing characteristics to plant of sweet gourd were significantly superior to poultry manure organic matter while plants without organic matter (control situation) resulted in poor growth and fruit diameter.

#### *Fruit weight of sweet gourd*

Different growth stages and developmental indicators of sweet gourd varied at the different plot. It was happened due to application of different organic matter to plants. The fruit weight of different plants of various plot of sweet gourd grown under different organic

matter treatments are presented in Table 2. Statistical analysis was carried out on yield and yield attributes which revealed that these were significantly varied due to different organic matter. The fruit weight at control condition was 2.45 kg, at the saw dust treatment the weight was about 2.12 kg and at treatment with cow dung it was 2.79 kg but at vermi compost treatment, the fruit weight was 3.62 kg. The highest fruit weight (3.78 kg) was found at poultry manure, while the lowest fruit weight (2.12 kg) was found where saw dust was applied. The highest fruit weight (3.78 kg) was recorded in poultry manure whereas the lowest fruit weight (2.12 kg) was found in saw dust treatment (Table 2). That experiment indicated that plants under different organic matter treatment, produce larger fruit and have higher fruit weight per plant because of the better plant growth that is due to a favorable hydrothermal regime of soil and a completely weed free environment. Organic matter changes the micro environment of the plant and thus it enhances plant growth and vigor as well as production and yield. This result may be due to the improvement of soil physical properties as well as increasing soil water holding capacity which gave rise to good aeration and drainage that encourage better root growth and nutrient absorption.

#### *Total yield of sweet gourd*

Properly completion of sweet gourd growth stages and developmental process varied at the different plot. It was occurred due to application of different organic matter to plants. The total yield of different plants of various plot of sweet gourd grown under different organic matter treatments are presented in Table 2. Statistical analysis was carried out on yield and yield attributes which revealed that these were significantly varied due to different organic matter. The total yield of sweet gourd at control condition was 16.78 t/ha, at the saw dust treatment the total yield was about 12.34 t/ha and at the treatment with cow dung it was 22.34 t/ha but at vermi compost treatment, the fruit yield was 30.43 t/ha. The highest fruit yield (31.32 t/ha) was found at poultry manure, while the lowest fruit weight (12.34 t/ha) was found where saw dust was applied (Table 2). The doing experiment showed that plants under different organic matter promotes larger fruit and have higher fruit yield per plant because of the better plant growth that is due to a favorable nutrient channel through the soil and a completely symbiosis environment. This result may be due to the improvement of soil physical properties as well as increasing soil water holding capacity which gave rise to good aeration and drainage that encourage better root growth and nutrient absorption. Organic matter changes the micro environment of the plant and thus it enhances plant growth and vigor as well as production of total yield of sweet gourd.

#### **Conclusion**

Sustainable soil management practices and the maintenance of soil salinity are central issues to agricultural sustainability. It may be concluded from that experiment's findings that using organic matter prompt to a noticeable decrease in the accumulation of soil salinity.

Maximum soil salinity was reduced by using poultry manure in comparison with the control treatment where no organic matter was applied. This experiments point out that, soil salinity reduce by the following order of treatment: poultry manure > vermi-compost > cow dung > saw dust > control. Different growth and yield attributes were significantly impacted due to different organic matter treatments. This results showed that, poultry manure treatments gave the highest yield (31.32 t/ha) whereas, the lowest yield (12.34 t/ha) was recorded in saw dust treatment. Among five of organic treatment, poultry manure can be used at the farmer's level to reduce soil salinity strength and increase the yield of sweet gourd. However, further research is still needed to work out a cost effective technology to reduce soil salinity and increase the yield of sweet gourds.

## **Avoiding soil salinity through different sowing method of sweet gourd in coastal saline soil**

A Biswas, Md. Z Islam

### **Abstract**

A field experiment was conducted at Salinity Management and Research Center, Soil Resource Development Institute, Batiaghata, Khulna during 2023 in kharif-1 season to study the impact of saline water in the saline soil on the economics of sweet gourd (*Cucurbita pepo*) yield and soil salinity after the end of the crop. There were three treatments having early pit method, tray seedling transplanting method and conventional method. The design of the experiment was Randomized Complete Block Design (RCBD) with three replications. Every plot received recommended rate of nitrogen, phosphorus and potash fertilizer. The promising text crop was sweet gourd. Field Soil salinity was recorded at 15 days intervals. The treatments were early pit method, tray seedling transplanting and seed sowing directly conventional method. After three months of seed sowing into early pit method, tray seedling transplanting and conventional method the highest soil salinity (13.6 dS/m) and the lowest soil salinity (2.8 dS/m) were found at conventional method plot and early pit method plot respectively in the month of May. Early pit method treatment obviously has increased the growth and yield attributes of sweet gourd. The highest value of four growth parameters viz., fruit length (20.30 cm), fruit diameter (82.06 cm) , single fruit weight (3.98 kg) and total yield (34.56 t/h) were found on early pit method as compared to other method. Again, the lowest value of four growth parameters i.e., fruit length (15.20 cm), fruit diameter (69.56 cm) , single fruit weight (2.72 kg) and total yield (25.22 t/h) were found on conventional method respectively. The changing of crop production time and method has a positive effect on fruit yield. Application of different time of cultivation and method increase soil moisture content and reduce electrical conductivity therefore it is recommended for sustainable yield of sweet gourd in saline soil and reduces soil salinity related land degradation and have a great potential under saline prone areas.

**Keywords:** salinity; pit method; tray; conventional; potential

### **Introduction**

Limitation in crop productions in south and south western area due to salinity problem in soil and water is a very serious problem. In the coastal saline belt with short winter season timely sowing/planting of Rabi (winter season) crops is essential but this is restricted by late harvest of aman rice. Rainy water storing in land causes late water recession from the cropping land. This water inundation condition makes the 'Joe' stage occurring in late in soil. And when Joe comes in cropping soil, at the same time salinity starts to increase in soil and water. Evaporation, evapotranspiration, hydrolysis, and leakage are the causes of salt accumulation when mineralized ground water near the ground surface continually evaporates and causes

minerals to precipitate and by evapotranspiration where infiltrating recharge water is continually taken up by plants and salt is concentrated in the unsaturated root zone. It is very difficult to control of salinity existing in soil and water. 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. If planting date or seedling transplantation may change in early or time may convert in different sowing time, it will cause the crop production in early without any damage of yield. It will prohibit salt storing and upward in top soil by breaking down the capillary action that increases starts from last of February. Ground water depth and salinity are affected by the sea and river water level and river water salinity. Since groundwater is the lower boundary condition of surface soil salinity, and also groundwater is closed related to river water, it is the important link between soil and river water. As the river water level and salinity changes, groundwater environment and soil salinity would be affected. Salinity level increases starts from February to May and decrease starts from the starting of rainy season in every year. It has a great effect on crop yield in dry season due to increased salinity level. If fresh water supply may increase in dry season, it reduces the salinity effect in crop production in Khulna. Rainfall also reduces the surfaces soil salinity. Soil salinity adversely influences seed germination, agricultural productivity, and soil and water quality, particularly in semiarid and arid regions, bringing about loss of arable areas and land degradation (Balkanlou et al., 2020; Bennett et al., 2019; Buthelezi--Dube et al., 2020). Soil salinization is the main reason for land degradation and crop yield reduction (Ivushkin et al., 2019; Makinde & Oyelade, 2019). In dry irrigated regions, the combination of elevated evapotranspiration (ET), little precipitation and soil factors hamper infiltration. Agricultural land use in these areas is very poor, which is much lower than a country's average cropping intensity that cause hydrological situation that restrict the normal crop production throughout the year. The factors which contribute significantly to the development of saline soil are tidal flooding during wet season (June to October), direct inundation by saline water, and upward or lateral movement of saline ground water during dry season (February to May). The severity of salinity problem in Bangladesh increases with the desiccation of the soil. In general, soil salinity is believed to be mainly responsible for low land use as well as low cropping intensity in the area (Rahman & Ahsan, 2001). Salt accumulation in the root zone or soil surface results in loss of soil fertility and alters the soil properties and therefore harmfully impacts soil's environmental functions (Fu et al., 2020). For instance, it restricts water intake and soil water capacity limit to plant uptake, which prompts surface runoff and erosion (Gorji et al., 2020). The occurrence of parent materials and physical or chemical weathering of minerals and seawater intrusion is the leading natural cause of soil salinization (Ramos et al., 2020). Saltwater intrusion is a natural process where seawater mix with coastal groundwater aquifers due to the density difference between saline and fresh waters, creating a barrier that evolves landward (Barlow and Reichard, 2010). Since, soil "joe" condition comes late in coastal area, thus farmer starts cultivation in late and that is why that

crop faced high salinity. But if we start cultivation early, then we can avoid salinity. Thus, the study was carried out to find out the yield of sweet gourd by avoiding the soil salinity.

## **Materials and Methods**

### *Study location*

This experiment was conducted at the Salinity Management and Research Centre (SMRC), Soil Resource Development Institute, Batiaghata, Khulna, Bangladesh during the Kharif-1 season of 2023. Geographically, the study site was at 22°46'01.8" N latitude and 89°24'15.2" E longitude and under AEZ-13. With an average yearly temperature of 79.3 °F and monthly mean temperatures ranging from 52.4 °F in January to 99.8°F in May, the area is among the warmest in Bangladesh (AEZ-13). The land type of experimental plot was medium high land, land form was basin, land use was Fallow-kharif vegetable-transplanted aman, depth of flooding was 11/2-2 feet & duration of flooding was 3-4 months, soil series was barisal.

### *Experimental design*

The following experiment was carried out in Randomized Complete Block Design (RCBD) with three replications. Sweet gourd (variety: Bengal sweet gourd-2) was taken as an experimental crop. Three experimental treatments were considered: (a) early pit method, (b) Tray seedling transplanting method, (c) Conventional pit preparation method with five replications.

### *Preparation of early pit*

Water recession condition of south west part of Bangladesh is late. Thus “joe” condition comes at first week of March. Before that soil keep moist. In early pit method, pit was prepared in 01-02-2023 in moist soil without ploughing the land. Then pit was kept fallow in sunshine. The “joe” condition of pit came in 10-02-2023. Then sweet gourd seed was sown in 10-02-2023.

### *Tray seedling preparation*

The second method was transplanting of tray seedling. Seedlings were grown early in tray. Seed was sown in tray in 25-02-2023. 15 days old seedlings were transplanted in main field in 13-03-2023.

### *Conventional pit preparation*

In conventional method land was plough and made pit. Then pit soil and other fertilizer treatments were mixed with soil very properly. After processing the pit area, seeds were sown in the pit in 13-03-2023. Soil salinity was measured by using an EC Meter at 15 days intervals. All the intercultural operations like watering, gap filling, staking, weeding, and plant protection measures were executed very carefully.

### Measurement of Growth and Yield attributes

Experiment was carried out for four growth and yield parameters such as fruit length (cm), fruit diameter (cm), single fruit weight (kg) and total yield (t/ha) were taken into consideration to analyze the effect of different pit method on yield of sweet gourd. Total yield (t/ha) was calculated by measuring the total fruit weight of the plot.

Initial Chemical properties of soil of pot

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				µg/g			
7.6	2.98	0.37	0.17	10.72	14.98	2.96	0.52
Slightly Alkaline	M	H	L	L	L	VH	O

### Statistical Analysis

The collected data were tabulated and statistically analyzed using Statistix10 software. The treatment means were separated statistically at a 5 % level of significance using Duncan's Multiple Range Test (DMRT).

## Results and Discussion

### Soil salinity condition of different types of pit

When seed was sown (10-02-2023) in pit that made early method, then soil salinity was 2.8 dS/m. At the time of tray seedling transplanting and normal seed sowing (13-03-2023), then soil salinity was 4.2 dS/m (Table 1). Soil salinity of early pit method at harvesting time (28-04-2023) was 8.1 dS/m, whereas other two method pit crops were in growing condition. In 13-05-2023 tray seedling crops were harvested and that time salinity was increasing at that time. Crops grown in conventional method harvested in 28-05-2023, faced long period high salinity. At harvesting time of conventional method the salinity was 13.6 dS/m.

Table 1: EC (dS/m) at different sowing/transplanting date in the field

Treatment	EC (dS/m)					
	10-02-2023	13-03-2023	13-04-2023	28-04-2023	13-05-2023	28-05-2023
T <sub>1</sub> (Early pit method)	2.8	4.2	6.3	8.1	-	-
T <sub>2</sub> (Tray seedling method)	-	4.2	6.3	8.1	11.3	-
T <sub>3</sub> (Conventional method)	-	4.2	6.3	8.1	11.3	13.6

EC: Electrical Conductivity

EC determined by 1: 1 extraction Method

## *Effects of different sowing method on Yield Attributes of sweet gourd*

### *Fruit length of sweet gourd*

The research showed that, the fruit length varies to a great extent that was statistically analyzed as shown in Table 2. Fruit length showed a significant variation in relation to different pit method treatment. After production with different pit method, the fruit length at early pit method (seed sown in 10-02-2023) was 20.30 cm, the fruit length at tray seedling method (transplanted in 13-03-2023) was 17.60 cm and the fruit length at conventional method (seed sown in 13-03-2023) was 15.20 cm. The highest fruit length (20.30 cm) was found at early pit method while the lowest fruit length (15.20 cm) was found where conventional method was followed. It was also found that fruit length (cm), numbers of fruit per plant of sweet gourd were significantly superior in early pit method to other treatments plot. Other planting treatments resulted in poor growth and yield of sweet gourd.

Table 2: Yield and Yield attributes of sweet gourd at different sowing method

Treatment	Fruit length (cm)	Fruit diameter (cm)	Single fruit weight (kg)	Total yield (t/ha)
T <sub>1</sub> (Early pit method)	20.30a	82.06a	3.98a	34.56a
T <sub>2</sub> (Tray seedling method)	17.60b	78.50b	3.11b	30.18b
T <sub>3</sub> (Conventional method)	15.20c	69.56c	2.72c	25.22c
CV (%)	5.96	1.41	4.95	1.10
LSD	2.39	2.44	0.36	0.74

### *Fruit Diameter of sweet gourd*

Salts affect plant growth due to increasing soil osmotic pressure and to interference with plant nutrition. A high salt concentration in soil solution reduces the ability of plants to acquire water, which is referred to as the osmotic or water deficit effect of salinity. The highest fruit diameter (82.06 cm) was found at early pit method. In case of tray seedling method, the fruit diameter was 78.50 cm and in case of conventional method, the fruit diameter was 69.56 cm. The highest fruit diameter (82.06 cm) was observed at early pit method in comparison with the conventional planting method where the lowest fruit diameter (69.56 cm) was found (Table 2). It is a great sign that shows different pit method cultivation positively affect the soil salinity and manipulates the soil structure, texture, biochemical reaction and soil fertility. It is also found that fruit diameter, numbers of fruits per plant and other growth of sweet gourd were significantly superior in early pit method to other method of another plot. Salinity lowers the total photosynthetic capacity of the plant through decreased leaf growth and inhibited photosynthesis limiting its ability to grow.

### *Single fruit weight of sweet gourd*

Sweet gourd yield parameters and single fruit weight grown under different methods are presented in Table 2. Statistical analysis was carried out on yield and yield attributes which revealed that these are significantly varied due to different planting method. The single fruit weight 3.98 kg was found in early pit method. In case of tray seedling method, the single fruit weight was 3.11 kg and in case of conventional method, the single fruit weight was 2.72 kg. The highest single fruit weight 3.98 kg was observed in early pit method in comparison with the conventional method where the lowest single fruit weight 2.72 kg was found (Table 2). That experiment indicated that plants under different planting method produce larger fruit and have higher single fruit weight per plant because of the better plant growth that is due to a favorable agro climate environment of soil and a completely moderate environment. Different planting method changes the micro environment of the plant and thus it enhances plant growth and vigor as well as production.

### *Total yield of sweet gourd*

Soil salinity works against the growth of plants and developmental structure that varies of sweet gourd due to different planting method at different plot. The total yield and yield attributes grown under different pit method are presented in Table 2. Statistical analysis was carried out on yield and yield attributes which revealed that these are significantly varied due to different pit method. The total yield of fruit (34.56 t/ha) was found in early pit method. In case of tray seedling method, the total yield of fruit was 30.18 t/ha but in case of conventional method, the total yield of fruit was 25.22 t/ha. The highest total fruit yield (34.56 t/ha) was observed in early pit method in comparison with the conventional method where the lowest total fruit yield (25.22 t/ha) was found (Table 2).

### **Conclusion**

Soil salinity is becoming a major constraint to vegetable crop production. This experiments point out that, soil salinity remain by the following order of planting method: early pit method > tray seedling method > conventional method. Different growth and yield attributes were significantly impacted due to different pit method. This results showed that, early pit method gave the highest total yield (34.56 t/ha) whereas, the lowest total yield (25.22 t/ha) was recorded in conventional method. It may be conclude that early pit method may be helpful for avoiding soil salinity.

## Effect of different strength of soil salinity on growth and yield of cauliflower

A Biswas, Md. Z Islam

### Abstract

Salt concentration in saline soil is a serious agricultural problem in south and south-western part of Bangladesh. This salt intensity creates a vital obstruction for cauliflower (*Brassica oleracea* Lin.) and other crops production. The experiment was conducted in the Salinity Management and Research Center under Soil Resource Development Institute at Batiaghata, khulna to observe the effect of soil salinity strength management on growth and yield of cauliflower hybrids. The research work was conducted in a completely randomized design (CRD) with three replication of salt concentration (2,4,6,8,10,12 dS/m EC). Result of the experiment showed that the different combinations of soil salinity significantly influenced all the indicators that studied. Yield performance per plant was investigated for Plant height (cm), numbers of leaves/ plant, leaves length (cm), spreading diameter (cm), Curd diameter (cm), Curd yield/plant (gm) and gross yield/plant (gm). The yield data were recorded at harvest time. The parameters were significantly varied due to soil salinity management. Higher curd yield/plant (636 gm) was found in T<sub>1</sub> treatment (2 dS/m EC). It was demonstrated that salinity strength affect to decrease all the indicators that impact directly to the cauliflower yield with the increasing salt intensity.

### Introduction

Cauliflower (*Brassica oleracea* Lin.) is one of the popular cole crops (botrytis Group) belonging Brassicaceae family (or Cruciferae) in the world. In the cultivation time excess salt level in saline soil causes serious physiological functional disorders, limiting vegetative and reproductive growth of vegetables and causes fertilization disorders decreases in marketing values, and also causes plant death (Dolarslan and Gul, 2012). Soil Salinity tolerance levels that affect yield are between 1.0-2.5 dS/m EC (Machado and Serralheiro, 2017). Cauliflower is a moderate salt sensitive vegetable, and the soil salinity uptaking level of irrigation water yield of cauliflower starts to decline between 1.9 and 2.7 dS/m EC (Snapp et al., 1991; Kotuby et al., 1997). The optimum temperature for cauliflower with stands is 10° to 15°C. Soil salinity strength effects the extensive number of observations on the physiology of plant salt tolerance to a genetic basis and particular modification (Zhu, 2000; Pardo, 2010). Soil salinity is a serious problem in arid and semi-arid region of the world where poor quality water is available for irrigation (Tanji, 1990; Maas and Grattan, 1999). The yield of cauliflower is low due to lack of proper management practices and nutrients deficiency in the saline soil. National production of cauliflower was 268.48 thousand MT from 19.42 thousand ha (BBS, 2016). It was estimated that about 20% (45 million ha) of irrigated land, producing one-third of the world's food, is salt-affected (Shrivastava, P.; Kumar, R; 2015). The amount of world agricultural land destroyed by

salt accumulation each year is estimated to be 10 million ha (Pimentel, D et al., 2004). It is estimated that, by 2050, 50% of the world's arable land will be affected by salinity (Bartels, D.; Sunkar, R, 2005) . In saline region it is almost impossible to cultivate more than one crop for salt concentration in soil and water. Farmer can not supply fresh and salt free irrigation in their field at crops demand time due to salinity problem in soil and water. The proper management of adequate soil physical, chemical and biological properties in saline environments may be gain by using irrigation water and soil amendments and proper cultural practices (Grattan and Oster, 2003). Short duration vegetables can be introduced in that region of medium high land. There is a huge scope in saline areas for vegetable cultivation through intensification and diversification of technology in the medium high land during winter. The shortage of fresh water and soil salt level, negatively effects on plant growth (Asik et al., 2009). Cauliflower would be a promising crop for that region. After recession of saline water and minimum salt concentration in soil and water, cauliflower and other winter vegetables could be grown easily in south saline area. Soil salinity generally stresses plant growth responses from specific salt tolerance properties (Dalton et al., 2000). Salinity inhibits photosynthesis by decreasing CO<sub>2</sub> availability as a result of diffusion limitation (Flexas, J, et al., 2007) and a reduction of the contents of photosynthetic pigments. Salt accumulation in cauliflower inhibits photosynthesis, primarily by decreasing stomatal and mesophyll conductance to CO<sub>2</sub> ( Di Martino, C.; Delfine, S.; Alvino, A.; Loret, 1999) and reducing chlorophyll content, which can affect light absorbance (Thompson et al., 2007). Appropriate saline water and soil management would play an important role in plant growth and curd formation especially in saline soil in winter crops production. In saline soil condition, Saline water should be used optimally and carefully to get the desire results from the irrigated crops (Alsaadawi and Mohamed ,2000). Research showed that saline soil and water management enhanced curd yield/plant, gross yield/plant and yield attributes substantially. Utilization of saline water has been well documented to improve physical, chemical and biological properties of soil. But the farmers of saline area are not habituated of cauliflower cultivation with proper soil salinity management of the crop. The goal of this study was to test the salt tolerance of cauliflower at different soil salinity level. As a result, the current study was designed to evaluate the impacts of saline soil on cabbage growth and yield.

### **Materials and methods**

The experiment was carried out at the salinity management and research center, under soil resource development institute, Batiaghata, Khulna to test the effect of different strength of saline soil on emergence, growth and yield of cabbage plant. Plastic pots were used in conducting the experiment. The plastic pots were firstly washed and followed by rinsing with distilled water. Then those pots were dried in air. After drying the plastic pots were ready for the experiment. Finely prepared soil was filled up to 4.5 cm of the pot by saline soil. Necessary

amount of salt treatment was given to create saline environment by saturating the soil before placing the cabbage seedling. The trial included the following treatments:  $T_1 = 2 \pm 0.2$  dS/m EC,  $T_2 = 4 \pm 0.2$  dS/m EC,  $T_3 = 6 \pm 0.2$  dS/m EC,  $T_4 = 8 \pm 0.2$  dS/m EC,  $T_5 = 10 \pm 0.2$  dS/m EC and  $T_6 = 12 \pm 0.2$  dS/m EC. The single factor experiment used completely Randomized design (CRD) with three replications. The experiment was divided into three equal replication blocks, each with six plots. As a result, the total number of unit plots was 18. The experiment's treatment combinations were randomized at random to 18 plots, each with three replications. Proper management about salinity control over the pot and growth of plants were observed. Time to time weeding, fertilizer application, irrigation, pot checking and special care to plant proper growth were following upto yield harvesting. Every three days later water application, pest controlling chemical and abiotic affect was observed. The data was collected at 60 days after cauliflower was fully matured. Intercultural operations were carried out when needed. The following yield related indicators were measured: plant height (cm), numbers of leaves/plant, leaves length (cm), spreading diameter (cm), curd diameter (cm), days required for head formation /plant, curd yield/plant (gm) and gross yield/ plant (gm).

#### *Preparation of saline soil*

For developing the expected soil salinity of 2 to 12 dS/m EC, salt affected soil was collected from different place of saline affected area. Different concentrations of soil salinity (2, 4, 6, 8, 10 and 12 ds/m) was applied to the transplanted seeding on plastic pot. The salinity level was maintained by assessing the salt level from laboratory test.

Initial Chemical properties of soil of pot

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				µg/g			
7.4	1.95	0.22	0.11	17.52	57.25	1.03	1.22
Slightly Acidic	M	M	L	M	VH	M	VH

#### *Statistical analysis*

The data obtained for different characters were statistically analyzed. The mean values of all the characters were evaluated and analysis of variance was performed by the 'F' test by using statistix software, version 10.

## **Results and discussions**

### *Plant height*

Cauliflower showed significant variation in plant height at 20, 40 and 60 days after transplanting (DAT) (Table 1). Significant variation of plant height was found due to management at different soil salinity strength to plants growth stages. At 20 DAT, 40 DAT and 60 DAT, the highest plant height of 14.60 cm, 24.60 cm and 32.83 cm respectively which was

statistically similar (32.23) to T<sub>2</sub> (4dS/m EC) respectively was observed when the plants received recommended saline water (T<sub>1</sub>) of 2 dS/m EC, and the lowest plant height at 20 DAT, 40 DAT and 60 DAT was 10.23 cm, 12.60 am and 21.33 cm respectively at T<sub>5</sub> (10 dS/m EC). At 60 DAT, the longest plant (32.83 cm) was found in T<sub>1</sub> treatment of 2 dS/m EC. The main causes of above result are the presence of available salinity strength of soil in sole application to pot for plant growth.

Table 1: Different plants parameter of different growth stages at different Soil salinity strength.

Treatment	PH			NL			LL
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT	
T <sub>1</sub> (2±0.2 dS/m)	14.60a	24.60a	32.83a	11.66a	21.00a	30.33a	37.70a
T <sub>2</sub> (4±0.2 dS/m)	12.10b	20.80b	32.23a	10.33b	15.66b	27.00b	36.63a
T <sub>3</sub> (6±0.2 dS/m)	11.30bc	18.16c	29.66b	9.33c	13.33c	21.33c	30.06b
T <sub>4</sub> (8±0.2 dS/m)	10.50c	15.53d	26.76c	6.33d	10.66d	16.00d	25.83c
T <sub>5</sub> (10±0.2 dS/m)	10.23c	12.60e	21.33d	3.66e	8.33e	14.66d	16.70d
T <sub>6</sub> (12±0.2 dS/m)	0.00d	0.00f	0.00e	0.00f	0.00f	0.00e	0.00e
LSD	1.55	1.78	2.24	0.93	1.10	2.05	2.53
CV (%)	8.94	6.58	5.30	7.65	5.42	6.34	5.83

\*EC determined by 1: 1 extraction Method

Plant height (cm)=PH, Numbers of leaves/plant=NL, leaves length (cm)=LL

#### *Number of leaves per plant*

Number of leaves per plant for every cauliflower plants at different DAT has been shown in Table 1, because of the influence of different salinity strength of soil, a significant difference in number of leaves per plant was observed that was statistically significant at different DAT. At 20 DAT, the plants treated with T<sub>1</sub> (2dS/m EC) had the highest number of leaves per plant (11.66), at 40 DAT the plants treated with T<sub>1</sub> had number of leaves per plant (21), at 60 DAT the plants treated with T<sub>1</sub> had the highest number of leaves per plant (30.33). But the lowest number of leaves per plant (3.66) treated with T<sub>5</sub> (10 dS/m EC) at 20 DAT, and at 60 DAT, the lowest number of leaves per plant (14.66) treated with T<sub>5</sub> (10 dS/m EC). Effect of saline soil showed significant variations in leaf number to every plant.

#### *Leaf length*

Cauliflower showed significant variations in leaf length at 20, 40 and 60 DAT (Table 1). Significant variation on leaf length was found due to application of different saline water strength. The maximum length of leaves (37.70) was found in T<sub>1</sub> treatment which was statistically similar to T<sub>2</sub>. But the lowest number of leaves length (16.70) treated with T<sub>5</sub>. Due to different soil salinity preparation, the increase salt concentration hit to cell elongation and cell division probably influenced the leaf growth of cauliflower.

Table 2: Different plants parameter of different growth stages at different Soil salinity strength.

Treatment	SD			CD	CY	GY
	20 DAT	40 DAT	60 DAT			
T <sub>1</sub> (2±0.2 dS/m)	13.80a	21.40a	43.03a	17.13a	636.00a	974.00a
T <sub>2</sub> (4±0.2 dS/m)	11.96b	17.20b	37.23b	15.63b	545.67b	876.67b
T <sub>3</sub> (6±0.2 dS/m)	10.10c	15.00c	22.46c	9.06c	422.00c	742.00c
T <sub>4</sub> (8±0.2 dS/m)	9.13cd	13.40c	18.86cd	4.90d	81.33d	269.00d
T <sub>5</sub> (10±0.2 dS/m)	8.43d	9.76d	15.50d	0.00e	0.00e	42.00e
T <sub>6</sub> (12±0.2 dS/m)	0.00e	0.00e	0.00e	0.00e	0.00e	0.00e
LSD	1.15	1.63	3.60	0.81	36.25	62.62
CV	7.32	7.17	8.86	5.88	7.26	7.27

\*EC determined by 1: 1 extraction Method,

Spreading Diameter (cm)=SD, Curd Diameter (cm)=CD, Gross yield (gm)=GY, Curd yield (gm)=CY

#### *Spreading diameter*

The higher spreading diameter of cauliflower was observed at 20 DAT, 40 DAT is 13.80 cm, 21.40 cm respectively shown (Table 2) and the maximum spreading diameter at 60 DAT was 43.03 cm at T<sub>1</sub> (2 dS/m EC). The lowest spreading diameter was 8.43 cm at T<sub>5</sub> (10 dS/m EC) at 20 DAT, at 40 DAT it was 9.76 cm with T<sub>5</sub> (10 dS/m EC) and the spreading diameter was 15.50 cm at T<sub>5</sub> (10 dS/m EC) in 60 DAT. The interaction effects of cauliflower and saline soil showed significant variation in spreading diameter.

#### ***Yield contributing characters of cauliflower***

##### *Curd diameter*

The maximum curd diameter was recorded at T<sub>1</sub> and it was 17.13cm shown (Table 2) while the lowest curd diameter (4.9 cm) was recorded with the T<sub>4</sub> with recommended saline soil management, Curd size has a positive response towards the proper irrigation and salt management. It is a mass message that, at 10, 12 dS/m EC facing cauliflower has not given any curd formation due to high soil salinity.

##### *Curd yield*

Curd yield of cauliflower drastically affected by soil salinity. When the soil and water becomes saline then curd production get seriously low. The highest curd yield was recorded shown (Table 2) at T<sub>1</sub> was 636.00 gm and the lowest curd yield was recorded at T<sub>4</sub> of 81.33 gm.

Combination of different saline soil gives result to curd yield goes down due to higher strength of saline soil.

#### *Gross yield per/plant*

Saline soil hardly perform for plant growth. The gross yield per plant was significantly influenced by different soil salinity strength (Table 2). The maximum gross yield/plant (974 gm) was observed in T<sub>1</sub> treatment, while the lowest gross yield/plant (42gm) was observed in the plants treated with T<sub>5</sub> (10 dS/m EC). At T<sub>6</sub> ( 12 dS/m EC) of saline soil does not give any gross yield.

#### **Conclusion**

This research results revealed that the cauliflower plants grow better with 2 dS/m EC soil salinity strength condition. The objective of the experiment was to determine the influence of different levels of soil salinity strength performance on cauliflower growth and production. From the results, it can be concluded that applying different levels of saline soil have a significant effects on cauliflower growth and yields. The highest gross obtained yield from lower level of soil salinity and gives the maximum gross yield (974 gm) per plant is helpful for increasing the growth and yield of cauliflower. The findings of the research may be applicable to other region of the southern area of the country. However, further research work at different doses of salinity strength of saline soil on the growth and yield of cauliflower will need to be performed in different saline area of Bangladesh to suggest specific conclusions and recommendations.

## Effect of different strength of soil salinity on growth and yield of cabbage

A Biswas, Md. Z Islam

### Abstract

Salinity of soil is a major problem in south and south-western part of Bangladesh. An investigation was made on growth and yield performance of cabbage (*Brassica oleracea* var. *capitata*) under different soil salinity strength to plants by saline soil at salinity management and research center. The experiment was laid out in a completely randomized design (CRD) with three replications of salt concentration (2, 4, 6, 8, 10, 12 dS/m EC). Result of the experiment revealed that the different combinations of saline soil significantly influenced all the parameters that studied. Yield performance per plant was investigated for plant height (cm), numbers of leaves/plant, fresh weight of loose leaves/plant (gm), diameter of head (cm), thickness of head (cm), fresh weight of head/plant (gm), days required for head formation/plant, numbers of folded leaves/plant and gross yield/ plant. It was proved that soil having salinity 2 dS/m gives best result for all parameter of cabbage.

### Introduction

Continuous rising of global temperature and associated climate changes are creating severe abiotic stresses that are seriously hampering crop yields and quality in many salt affected areas. Among those sufferings, major is soil salinity. Yield and quality traits of vegetable crops are adversely affected by environmental factors such as drought and/or high salinity of the root zone (Goyal et al., 2003). It is recognized that water and ions are the main physiological catalogue of processing plants physiology that need to optimize to resume growth in saline environments (Lauchli and Lutttge, 2002). Over 9% of the world's total land and approximately 20% of irrigated land is affected by high salinity barrier. The problem is particularly severe in the Mediterranean, semi-arid and arid areas (Zhang et al., 2014; Munns and Gilliam, 2015). Cabbage (*Brassica oleracea* var. *capitata* L.) is a popular green leafy vegetable of the family Brassicaceae. It is an herbaceous, biennial, dicotyledonous flowering plant distinguished by a short stem crowned with a mass of leaves, typically green but in some varieties red or purple, which while immature form a characteristic compact, globular cluster (cabbage head). Photosystem II (PSII) is the most sensitive part of the apparatus to salt stress (Kalaji et al., 2011; Jajoo, 2014; Oukarroum et al., 2015). Cabbage is a great source of vitamin C, with a moisture content of 60.6%. It also contains vitamin B complex, potassium, and calcium (Haque KMF, 2006). Soil contributes to the maintenance of cells' redox systems and the regulation of stomatal aperture in drought and salinity responses (Sharma et al., 2017). Saline soil play crucial roles in plants' physiological responses and adaptation to salinity stress (Fahad et al., 2015). Cabbage ranks second in terms of production and area among all vegetables grown in Bangladesh. It is grown on an 18 thousand hectares area with a total production of

312 thousand tons (BBS, 2017), but the yield is poor. In south and south-western part of Bangladesh is facing a huge constraint of salt problem. Every year farmers are losing their hope for cabbage cultivation for soil salinity. The main reason is NaCl toxicity in soil (Almeida et al., 2017). The reason for such low cabbage production are due to a lack of fresh water for cultivation. This low cabbage yield could be increased by adopting improved saline soil management research. It is very important to determine the limit of soil salinity that crops can tolerate and determine if they can uptake and accumulate salts to use them for soil desalination. This may encourage and motivate farmers to introduce cabbage plants into their cropping system. The goal of this study was to test the salt tolerance of Cabbage (*Brassica oleracea* var. *capitata* L.) at different soil salinity level. As a result, the current study was designed to evaluate the impacts of saline soil on cabbage growth and yield.

### **Materials and methods**

The experiment was carried out at the salinity management and research center, under soil resource development institute, Batiaghata, Khulna to test the effect of different strength of saline soil on emergence, growth and yield of cabbage plant. Plastic pots were used in conducting the experiment. The plastic pots were firstly washed and followed by rinsing with distilled water. Then those pots were dried in air. After drying the plastic pots were ready for the experiment. Finely prepared soil was filled up to 4.5 cm of the pot by saline soil. Necessary amount of salt treatment was given to create saline environment by saturating the soil before placing the cabbage seedling. The trial included the following treatments:  $T_1 = 2 \pm 0.2$  dS/m EC,  $T_2 = 4 \pm 0.2$  dS/m EC,  $T_3 = 6 \pm 0.2$  dS/m EC,  $T_4 = 8 \pm 0.2$  dS/m EC,  $T_5 = 10 \pm 0.2$  dS/m EC and  $T_6 = 12 \pm 0.2$  dS/m EC. The single factor experiment used completely Randomized design (CRD) with three replications. The experiment was divided into three equal replication blocks, each with six plots. As a result, the total number of unit plots was 18. 30 days cabbage seedlings were transplanted. The experiment's treatment combinations were randomized at random to 18 plots, each with three replications. Proper management about salinity control over the pot and growth of plants were observed. Time to time weeding, fertilizer application, irrigation, pot checking and special care to plant proper growth were following upto yield harvesting. Every three days later water application, pest controlling chemical and abiotic affect was observed. The data was collected at 60 days after cabbage transplanting. Intercultural operations were carried out when needed. The following parameters were measured: plant height (cm), numbers of leaves/plant, fresh weight of loose leaves/plant (gm), diameter of head (cm), thickness of head (cm), fresh weight of head/plant (gm), days required for head formation /plant, numbers of folded leaves/plant and gross yield/ plant.

### *Preparation of saline soil*

For developing the expected soil salinity of 2 to 12 dS/m EC, salt affected soil was collected from different place of saline affected area. Different concentrations of soil salinity (2, 4, 6, 8, 10 and 12 ds/m) was applied to the transplanted seeding on plastic pot. The salinity level was maintained by assessing the salt level from laboratory test.

### Initial Chemical properties of soil of pot

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				µg/g			
7.4	1.95	0.22	0.11	17.52	57.25	1.03	1.22
Slightly Acidic	M	M	L	M	VH	M	VH

### *Statistical analysis*

The data obtained for different characters were statistically analyzed. The mean values of all the characters were evaluated and analysis of variance was performed by the 'F' test by using statistix software, version 10.

## **Results and Discussions**

All the contributing parameters at different DAT have been shown. The influence of different saline soil of different strength caused a considerable variation in plant height and numbers of leaves per plants which was statistically significant at 20 DAT, 40 DAT, 60 DAT. Initial Salinity of pot soil was 1.54 dS/m EC. After applying different strength of soil salinity to different pot, the evaluating indicator was different.

### *Plant height*

The highest plant height was found from T<sub>1</sub> (2 dS/m EC). The highest plant height at 20, 40 and 60 DAT was 12.40 cm, 19.53 cm and 27.66 cm respectively (Table 1). The lowest plant height at 20, 40 and 60 DAT was 9.86 cm, 11.60 cm and 11.71 cm respectively.

### *Number of leaves per plant*

Number of leaves per plant at different DAT has been shown in Table 1. Due to the influence of different soil saline strength, a significant difference in Number of leaves per plant was observed that was statistically significant at different DAT. At 20 DAT the plants treated with T<sub>1</sub> had the highest number of leaves per plant (11.33), at 40 DAT the plants treated with T<sub>1</sub> had number of leaves per plant (26.00), at 60 DAT the plants treated with T<sub>1</sub> had the highest

number of leaves per plant (50.33). But the lowest number of leaves per plant (6.66 ) treated with T<sub>4</sub> at 20 DAT, and at 60 DAT, the lowest number of leaves per plant (30.00) treated with T<sub>4</sub>.

Table 1: Different growth stages of different plants after applying different strength of saline soil.

Treatment	PH			NL			FLL	DH	TH
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT			
T <sub>1</sub> (2±0.2 dS/m)	12.40a	19.53a	27.66a	11.33a	26.00a	50.33a	245.33a	20.33a	17.90a
T <sub>2</sub> (4±0.2 dS/m)	11.50a	17.43b	27.33a	10.33b	22.33b	41.33b	232.33a	16.33b	14.86b
T <sub>3</sub> (6±0.2 dS/m)	10.53b	15.10c	21.10b	9.33c	20.00c	35.33c	150.00b	10.63c	10.10c
T <sub>4</sub> (8±0.2 dS/m)	9.86b	11.60d	11.716c	6.66d	19.33c	30.00d	122.67c	0.00d	0.00d
T <sub>5</sub> (10±0.2 dS/m)	0.00c	0.00e	0.00d	0.00e	0.00d	0.00e	0.00d	0.00d	0.00d
T <sub>6</sub> (12±0.2 dS/m)	0.00c	0.00e	0.00d	0.00e	0.00d	0.00e	0.00d	0.00d	0.00d
LSD	0.95	1.16	1.53	0.83	1.87	2.81	15.23	0.94	0.76
CV (%)	7.24	6.15	5.87	7.51	7.21	6.04	6.85	6.71	6.00

\*EC determined by 1: 1 extraction Method

Plant height (cm) =PH,

DAT- Days After Transplanting

Numbers of leaves/plant=NL,

Fresh weight of loose leaves (gm) =FLL,

Diameter of head (cm) =DH,

Thickness of head (cm) =TH,

#### *Fresh wt. of loose leaves (gm)*

The effects of different saline strength of soil on fresh weight of loose leaves were significant (Table 1). The plants grown under the soil saline treatment of T<sub>1</sub> (2 dS/m EC) had the highest fresh wt. of loose leaves (245.33 gm), however the plants grown under the treatment of T<sub>4</sub> (8 dS/m EC) had the lowest fresh wt. of loose leaves (122.67 gm).

#### *Diameter of head (cm)*

Different saline strength of soil of pot culture and management had a significant effect on head diameter (Table 1). The plants with the largest diameter of head (20.33 cm) were grown with T<sub>1</sub> treatment (2 dS/m EC) while the plants with the smallest diameter of head (10.63

cm) were grown with the treatment of T<sub>3</sub> (6 dS/m EC). It is noticed that at 8, 10, 12 dS/m EC of soil, Cabbage crop has not given any head formation due to soil salinity.

*Thickness of head*

It would appear that the various soil saline conditions had a significant effect on the thickness of the head (Table 1). The T<sub>1</sub> treatment showed the highest thickness of head (17.90 cm), whereas the T<sub>3</sub> gave the lowest thickness of head (10.10 cm). It is noticed that at 8,10,12 dS/m EC of soil tolerant cabbage has not given any head formation due to soil salinity.

*Fresh weight of head/plant (gm)*

The highest fresh weight of head (680 gm) was found in plants grown with T<sub>1</sub> treatment (2 dS/m EC) (Table 2), while the lowest fresh weight of head (282.33 gm) was found in plants grown with T<sub>3</sub> (6 dS/m EC), and this difference was statistically significant. At different soil saline strength of 8, 10, 12 dS/m EC, any cabbage plants has not given any head.

*Number of folded leaf/plant*

The highest number of folded leaves/plant (51.66) was found in plants grown under treatment T<sub>1</sub> (2 dS/m EC) (Table 2), while the lowest number of folded leaves/plant (20) was found in plants grown under treatment T<sub>3</sub> (6 dS/m EC), and the difference was found. At different soil salinity strength of 8, 10, 12 dS/m EC, any cabbage plants has not given any folded leaves per plant.

Table 2: Different plants of different growth stages after applying different strength of soil salinity.

Treatment	FWH	NFL	GY
T <sub>1</sub> (2±0.2 dS/m)	680.00a	51.66a	945.33a
T <sub>2</sub> (4±0.2 dS/m)	538.33b	43.00b	768.67b
T <sub>3</sub> (6±0.2 dS/m)	282.33c	20.00c	429.00c
T <sub>4</sub> (8±0.2 dS/m)	0.00d	0.00d	117.33d
T <sub>5</sub> (10±0.2 dS/m)	0.00d	0.00d	0.00e
T <sub>6</sub> (12±0.2 dS/m)	0.00d	0.00d	0.00e
LSD	35.16	1.82	38.73
CV (%)	7.90	5.38	5.78

\*EC determined by 1: 1 extraction Method

Fresh weight of head/plant (gm) =FWH, Number of folded leaves/plant=NFL, Gross yield (gm)/Plant=GY

### *Gross yield per/plant*

The gross yield per plant was significantly affected by different saline soil intensity (Table 2). The maximum gross yield (945.33 gm) per plant was observed in T<sub>1</sub> treatment (2 dS/m EC), while the lowest gross yield/plant (117.33 gm) was observed in the plants treated with T<sub>4</sub> (8 dS/m EC). At 10 and 12 dS/m EC of soil saline condition has not formed any gross yield.

### **Conclusion**

The purpose of the experiment was to determine the influence of different levels of soil saline strength effect on cabbage growth and production. From the results, it can be concluded that management of different levels of saline soil have a significant effects on cabbage growth and yields. The highest gross and marketable yield were obtained at the combination from the application of T<sub>1</sub> treatment (2 dS/m EC) of soil and gives the maximum fresh weight of head (680.00 gm) per plant and gross yield (945.33 gm) per plant is helpful for increasing the growth and yield of cabbage. The findings of the study may be applicable to other locations of the southern region of the country as well. However, further research work at different cultivated land of different soil salinity strength on the growth and yield of cabbage will need to be performed in different saline area of Bangladesh to reach a specific conclusions and recommendations.

## Effect of different strength of soil salinity on growth and yield of knol khol

A Biswas, Md. Z Islam

### Abstract

Salinity is a crucial agricultural constraint for crops production in saline area. In south and south-western area of Bangladesh is overcoming a huge barrier of salt accumulation to soil and problematic condition for different agricultural activities. So for solving such a curse a field experiment was carried out to investigate the effect of different soil salinity strength on the growth and yield of knol khol (*Brassica oleracea* var. *caulorapa* L.) during Rabi season. The experiment was laid out in Completely Randomized Design (CRD) comprising of 18 treatments viz., T<sub>1</sub>- 2±0.2 dS/m EC, T<sub>2</sub>-4 ±0.2 dS/m EC, T<sub>3</sub>-6 ±0.2 dS/m EC, T<sub>4</sub>-8±0.2 dS/m EC, T<sub>5</sub>-10 ±0.2 dS/m EC, T<sub>6</sub>- 12±0.2 dS/m EC. Each replication was three times repeated. Treatments were randomly arranged in each replications, that divided into 18 pots. The results revealed that the application of T<sub>1</sub>- 2 dS/m EC gave maximum plant height, highest number of leaves per plant, Diameter of stem/plant, diameter of knob, Fresh weight of the knob/plant, Gross yield per/plant. So, we can consider 2 dS/m EC for our soil health, environmental benefits and ecological safety.

Keywords: Knol khol, Growth, saline water, diameter of knob, knob yield.

### Introduction

Soil salinity problem is the most abiotic barrier for crop production for arid and semi arid region in the world now a days. Soil salinity has great detrimental effects on crop production, especially in arid and semi-arid regions (Moud and Maghsoudi 2008; Keshavarzi 2011). High soil salinity is deleterious to most Knol khol (*Brassica oleracea* var. *caulorapa* L.), as it is a cole crops that produced worldwide, but very popular in Bangladesh also. The soil salinity of coastal saline soil is sometimes high, and with the same ion composition compared to sea water (Khan et al., 1996). In the other hand, the groundwater table of that saline region is quite shallow and the soil salinity changes seasonally (Shi et al., 2005). Different soil salinization process causes soil erosion on a global scale and reduces crop productivity (Acosta JA, Boris J, Karsten K, Martínez SM, 2011). Salt accumulation in soil is one of the most destructive environmental pressures in the uncultivated area, crop production and quality cause deficit (Yamaguchi, T., Blumwald, E., 2005, Lugtenberg, at all., 2002). There are long light green colored round shape structures, which come out as its shoots. Knol khol (*Brassica oleracea* var. *caulorapa* L.) also is known as kohlrabi belongs to the family cruciferae. It is a cold, hardy crop and can tolerate well in extremely cold weather and saline condition also. The fleshy portion of the stem develops entirely above the ground, called knob and is used as a vegetable (Raj et al., 2014). It is an excellent vegetable if it is used before it becomes tough and fibrous. It is high in

minerals and vitamins A and C. It contains adequate amount of water (85.9 g), calories (28.5.0 g), protein (2.10 g), carbohydrate (7.6 g), fibre (1.0 g) ) per 100 g of edible stem (Kamal et al., 2013). It also contains satisfactory amount of calcium, phosphorus , iron, sodium, potassium and vitamin A and C ( Dadhich et al., 2015). Basically edible part of knol khol is knob, which is form swelling of the stem tissue above the plants. The crop has miracle medicinal value like, acidosis, asthma, cancer, cholesterol level, heart problems, indigestion, muscle and nerve functions, prostate and colon cancer, skin problems, weight loss etc. The fleshy turnip like portion of the stem develops entirely above the ground. The modern nutrient management policy has changed its focus towards the concept of sustainability and eco-friendliness and productivity (N and P Mehta et al.,2015). The increasing use of chemical fertilizers and soil saline condition in Bangladesh has a great impact to increase vegetable production. Plant growth decreases significantly under the influence of salt stress however, the plants differ considerably in their sensitivity and ability to tolerate salinity stress (Amzallag et al., 1993). For irrigation purposes, saline water should be used optimally and carefully to get the desire results from the irrigated crops (Alsaadawi and Mohamed (2000). It has been widely recognized but its long run impact on soil health, ecology and other natural resources are detrimental which affect living organisms including beneficial soil microorganism for crop production. However, at high level of crop production, these saline environment are not congenial to plant growth and yield. Ground soil salinity is known to inhibit plant growth (Paul, D., 2012). Soil salinity strength has a negative effect on the yield and quality of beet crops like sugar beet,turnip, knol khol etc especially from the excessive absorption of sodium (Mekki and El Gazaar 1999; Cheggour and Fares 2002).This saline movement can also hamper soil physical and biological fertility, making it non ideal for land application as a working microclimate. Soil salinity is also a major problem in areas where high ground salt water is used for irrigation (Rausch, T., at all, 1996). The agricultural practices in saline soil is considered as a bad management practice in any agricultural production system because of its negatively stimulation of soil microbial growth and activity, subsequent conversion of plant nutrients, and promote to loss soil fertility and quality for any types of crops production. Bangladesh is a developing country. Most of the people living here are suffering from nutrient deficit i.e., malnutrition. Fresh knol khol can be a cheap and safe vegetables for health and that is our ultimate destination to produce crop. So, cultivation of knol khol in saline soil deserve great importance. In fine, the studied was undertaken to observe the evaluation of comparative effects of different soil salinity strength on growth and yield of Knol khol and to find out best intensity of soil salinity strength for obtaining higher economic yield.

### **Materials and Methods**

The experiment was carried out at the salinity management and research center, under soil resource development institute, Batiaghata, Khulna to test the effect of different strength

of saline soil on emergence, growth and yield of cabbage plant. Plastic pots were used in conducting the experiment. The plastic pots were firstly washed and followed by rinsing with distilled water. Then those pots were dried in air. After drying the plastic pots were ready for the experiment. Finely prepared soil was filled up to 4.5 cm of the pot by saline soil. Necessary amount of salt treatment was given to create saline environment by saturating the soil before placing the cabbage seedling. The trial included the following treatments:  $T_1 = 2 \pm 0.2$  dS/m EC,  $T_2 = 4 \pm 0.2$  dS/m EC,  $T_3 = 6 \pm 0.2$  dS/m EC,  $T_4 = 8 \pm 0.2$  dS/m EC,  $T_5 = 10 \pm 0.2$  dS/m EC and  $T_6 = 12 \pm 0.2$  dS/m EC. The single factor experiment used completely Randomized design (CRD) with three replications. The experiment was divided into three equal replication blocks, each with six plots. As a result, the total number of unit plots was 18. The experiment's treatment combinations were randomized at random to 18 plots, each with three replications. 30 days knol khol seedlings were transplanted. Proper management about salinity control over the pot and growth of plants were observed. Time to time weeding, fertilizer application, irrigation, pot checking and special care to plant proper growth were following upto yield harvesting. Every three days later water application, pest controlling chemical and abiotic affect was observed. The data was collected at 60 days after knol khol transplanting. Intercultural operations were carried out when needed. The following parameters were measured: plant height (cm), numbers of leaves/plant, diameter of stem (cm), diameter of knob (cm), fresh weight of knob/plant (gm), days required for head formation /plant and gross yield/ plant.

#### *Preparation of saline soil*

For developing the expected soil salinity of 2 to 12 dS/m EC, salt affected soil was collected from different place of saline affected area. Different concentrations of soil salinity (2, 4, 6, 8, 10 and 12 ds/m) was applied to the transplanted seeding on plastic pot. The salinity level was maintained by assessing the salt level from laboratory test.

Initial Chemical properties of soil of pot

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				µg/g			
7.4	1.95	0.22	0.11	17.52	57.25	1.03	1.22
Slightly Acidic	M	M	L	M	VH	M	VH

#### *Statistical analysis*

The data obtained for different characters were statistically analyzed. The mean values of all the characters were evaluated and analysis of variance was performed by the 'F' test by using statistix software, version 10.

## Results and Discussions

All the characters of promoting vegetative growth and yield performance parameters at different DAT have been shown (table 1 and 2). Results on main and combined effect of different soil salinity strength and fertilizer management practices and their interactions have been presented and discussed here. The influence of different soil salinity caused a considerable variation in plant growth, production of yield and economic benefits of plants which was statistically significant at 20 DAT, 40 DAT, 60 DAT. After applying different strength of soil salinity in different pot, the expected parameters were changed.

Table 1: Different plants of different growth stages at different soil salinity strength.

Treatment	PH			NLP		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
T <sub>1</sub> (2±0.2 dS/m)	12.70a	28.46a	38.10a	6.66a	11.66a	20.00a
T <sub>2</sub> (4±0.2 dS/m)	11.80ab	21.46b	27.00b	6.66a	11.66a	14.33b
T <sub>3</sub> (6±0.2 dS/m)	11.30ab	14.03c	26.10b	5.66b	8.66b	12.33c
T <sub>4</sub> (8±0.2 dS/m)	10.50b	13.70c	25.16b	4.66c	6.66c	11.33c
T <sub>5</sub> (10±0.2dS/m)	10.23b	12.80c	14.16c	3.33d	5.33d	6.33d
T <sub>6</sub> (12±0.2dS/m)	0.00c	0.00d	0.00d	0.00e	0.00e	0.00d
LSD	1.67	1.47	1.98	0.93	0.94	1.10
CV (%)	10.00	5.48	5.12	11.71	7.19	5.82

\*EC determined by 1: 1 extraction Method

Plant height (cm)= PH, Number of leaves/ plant= NLP

### *Plant height*

The outside variation in plant height due to different soil salinity strength was statistically significant in Knol khol at 20, 40 and 60 days after transplanting (DAT) (Table 1). At 20 DAT the maximum plant height was 12.70 cm found in the treatment T<sub>1</sub> and the minimum plant height was found in the treatment T<sub>5</sub> 10.23 cm. In case of 40 DAT the maximum and the minimum plant height was 28.46 cm and 12.80 cm for the treatments T<sub>1</sub> and T<sub>5</sub> respectively. The highest plant height was 38.10 cm for the treatment T<sub>1</sub> and the lowest plant height was 14.16 cm was found in the treatment T<sub>5</sub> respectively at 60 DAT. It is stated that 12±0.2 dS/m of soil salinity strength knol khol plant had not given any plant growth at all.

### *Number of leaves per plant*

A lots of ingredients helps to produce plant leaves. The production of different numbers of leave per plant at different DAT has been shown in Table 1. Due to the influence of different soil salinity strength, a significant difference in number of leaves per plant was observed that was statistically significant at different DAT. At 20 DAT, the plants irrigated with T<sub>1</sub> and T<sub>2</sub> had the highest number of leaves per plant (6.66 leaves), but the lowest numbers of leaves per

plant (3.33) was T<sub>5</sub>, at 40 DAT the plants treated with T<sub>1</sub> had number of leaves per plant (11.66 leaves) and it was statistically similar to T<sub>2</sub> and the lowest numbers of leaves per plant (5.33) for treatment of T<sub>5</sub>. At 60 DAT the plants treated with T<sub>1</sub> had the highest number of leaves per plant (20.00). But the lowest number of leaves per plant (6.33 leaves) treated with T<sub>5</sub> (10 dS/m EC). T<sub>6</sub> (12 dS/m EC) had not given any plant.

Table 2: Different plants of different growth stages at different soil salinity strength.

Treatment	DS	DK	FWK	GY
T <sub>1</sub> (2±0.2 dS/m)	2.40a	12.16a	566.00a	947.67a
T <sub>2</sub> (4±0.2 dS/m)	2.16b	10.53b	454.33b	875.67b
T <sub>3</sub> (6±0.2 dS/m)	1.73c	8.23c	215.00c	579.67c
T <sub>4</sub> (8±0.2 dS/m)	1.1d	4.86d	62.33d	247.00d
T <sub>5</sub> (10±0.2dS/m)	0.96d	0.00e	0.00e	107.33e
T <sub>6</sub> (12±0.2dS/m)	0.00e	0.00e	0.00e	0.00f
LSD	0.14	0.72	29.77	54.04
CV (%)	5.86	6.82	7.74	6.61

\*EC determined by 1: 1 extraction Method

Diameter of Stem (cm) 60 DAT= DS, Diameter of knob (cm)=DK, Fresh weight of knob (gm)=FWK, Gross Yield/Plant (gm) =GY

#### *Diameter of stem (cm)*

Soil salinity strength has a profound effect on plant canopy and yield production characters and management had a significant effect on stem diameter (Table 2). The plants with the largest diameter of stem (2.40 cm) was grown with T<sub>1</sub> treatment while the plants with the smallest diameter of head (1.1 cm) was grown with the treatment of T<sub>4</sub> (8 dS/m EC). It is shown that at 10,12 dS/m EC of salinity strength tolerant knol khol had not given any stem formation due to soil salinity.

#### *Diameter of knob (cm)*

Effect of different soil salinity strength had a great significant influence on the diameter of knob (Table 2). The maximum diameter of knob (12.16 cm) was found with the treatment T<sub>1</sub> and the minimum diameter of knob (4.86 cm) was obtained from T<sub>4</sub> (8dS/m EC) treatment. As knol khol is a short duration crops and highly feeding crops it was not grow under 10 and 12 dS/m EC.

#### *Fresh weight of knob/plant (gm)*

Different intensity of saline soil salinity had a great significant effect on fresh weight of knob per plant (Table 2). The maximum fresh weight of knob per plant (566.00 gm) was obtained from the treatment T<sub>1</sub> and the minimum fresh weight of knob (62.33 gm) was found

from the T<sub>4</sub> treatment. The maximum weight of single tuber might be due to soil salinity effect and plant growth resistant. Interaction effects of different strength of soil salinity treatment were significant on fresh weight of knob.

#### *Gross yield/plant (gm)*

Application of different saline soil to knol khol plant for economic yield per plant revealed that variation among different soil salinity strength was statistically significant. It is obvious from the present study that the maximum marketable gross yield (947.67 gm) resulted from T<sub>1</sub> and the lowest marketable gross yield (107.33 gm) was found from treatment T<sub>5</sub> treatment. It was observed that the interaction effect of different soil salinity strength on economic yield per plant was statistically significant.

#### **Conclusion**

From the above discussion it is clear that, higher yield could be obtained by cultivating the knol khol variety early in different saline prone area under saline region of Bangladesh. Recommended soil salinity strength 2 dS/m produced maximum vegetative growth and economic yield (947.67 gm). So, we can consider the treatment T<sub>1</sub> (2dS/m EC) of soil salinity for our soil health, environmental benefits and crops production. Further experiment may be carried out before giving final recommendation.

## Effect of different strength of saline water on growth and yield of indian spinach

A Biswas, Md. Z Islam

### Abstract

Water salinity and nutrient depletion in soil are major constraints to crop production, especially for vegetable crops. The effects of salinity in saline water and nutrient deficiency on indian spinach (*Basella alba* L.) was evaluated in pot cultures under shade conditions. This review emphasized the restoring abilities of plants from salt stress after rewatering or dilution of salted water. Saline water and soil salinity is a most obstruction for crop production in salt affected area. Salinity causes probably very dangerous situation in soil microclimate level when crops are produced those affected region. To find out a solution for such a vast systematic problem a field experiment was carried out to investigate the effect of different water salinity strength on the growth and yield of indian spinach in kharif-1 season. This experiment was laid out in Completely Randomized Design (CRD) comprising of 18 treatments viz., T<sub>1</sub>- 2 dS/m EC, T<sub>2</sub> - 4 dS/m EC, T<sub>3</sub> – 6 dS/m EC, T<sub>4</sub> – 8 dS/m EC, T<sub>5</sub> – 10 dS/m EC, T<sub>6</sub> - 12 dS/m EC of saline water. Each replication was three times repeated. Saline water treatment was randomly arranged in each replications, that was divided into 18 pots. The results showed that the application of T<sub>1</sub>- 2 dS/m EC of saline water gave the maximum higher plant height at 45 DAT (63.50 cm), number of leaves/plant at 45 DAT (76 leaves), length of green leaf (18.26 cm), vine diameter of green indian spinach was 9.40 cm and fresh weight of leaves, stem and root was 573 gm. So, it may count that 2 dS/m EC of saline water for crop production can be practiced as a sustainable technology for better growth, yield and quality of a plant, also to improve the soil health and environment in long run.

**Keywords:** vegetable crops; salinity threshold; crop salt tolerance; ion imbalance; irrigation;

### Introduction

High strength of water salinity conditions in agricultural production and irrigation water is one of the most serious challenges faced by agricultural crops in the world. Indian spinach is cultivated for its fresh and green leaves ready to harvest in about 45-50 days after transplanting. Indian spinach has been used from a long time back for the treatment of many diseases like dysentery, diarrhea, anemia, cancer etc (R. Adhikari, 2012). Fresh leaves of Indian spinach are rich sources of several vital carotenoid pigment antioxidants such as  $\beta$ -carotene, lutein, zeaxanthin. These compounds play a healing role in aging and various disease processes (Anonymous, 2013). Indian spinach is characterized by high nutritive values and has a high content of dietary fibre and vitamins as well as mineral components. The nutritive value of Indian spinach is very high with a good content of minerals, vitamins and substantial amount of fibers (Ghosh and Guha, 1993). It is estimated that salt affected soils impact nearly 10% of the

land surface and 50% of irrigated land in the world (Ruan et al., 2010). The response of plants to salinity is complex and involves changes in morphology, physiology, and metabolism. Salinity effects on plants include cellular water deficit, ion toxicity, nutrient deficiencies, and oxidative stress, leading to growth inhibition, molecular damage, and even plant death (Orcutt and Nilsen, 2000). Salt stress reduced spinach germination, root elongation, seedling growth, chlorophyll content and photosynthesis, and increased membrane permeability (Delfine et al., 1998; Downton et al., 1985; Kaya et al., 2002; Robinson et al., 1983). Salinity affects photosynthesis by decreasing CO<sub>2</sub> availability as a result of diffusion limitations (Flexas, J. et al., 2007) and a reduction of the contents of photosynthetic pigments (Delfine, S., et al., 1999; Ashraf, M., et al., 2013). Salinity is a major abiotic constraint curtailing crop growth and yield all over the world. The soil salinity is a widespread global concern caused as a result of abundant seawater intrusion in coastal areas, occurrence of saline groundwater and inadequate irrigation and/or drainage (Souza Filho et al., 2003; Nadeem et al., 2014; Yepes et al., 2018). Water scarcity and salinity are two major constraints which affect the agricultural production all over the world and the adoption of different irrigation regimes is the key requisite to improve water use efficiency in agricultural practices (Nangare et al., 2016; Mosaffa and Sepaskhah, 2018). Therefore, knowledge on the understanding of the physiological responses that define the plants' tolerance to surpass salinity stress is essential. Vegetable crop production in arid and semiarid region with low rainfall and high temperature require a larger input of fresh water irrigation. However, water salinity increase is closely related to irrigation and management practices. Therefore, the objective of this review is to analyze the effects of water salinity on indian spinach growth and management practices of saline water irrigation in soil and how to mitigate the adverse effect of water salinity.

## **Materials and Methods**

### *Pot experiment*

This study was carried out at the salinity management and research center, under soil resource development institute, Batiaghata, Khulna to determine the effect of saline water irrigation on growth, yield and ions content of existing indian spinach cultivars. An effort was made to alleviate the effects of water salinity in spinach by applying salt water treatment. The findings of current research will be helpful to describe the level of saline water that can be used to attain acceptable spinach yield and to highlight the spinach cultivar that is tolerant to salinity. This is very important for saline area that if salinity is capable of producing production then a lot of land will come under cultivation. That's why this experiment was carried to test the effect of different water salinity strength on growth and vigor of indian spinach plant. For this experiment, Plastic pots were used in conducting the experiment. Those plastic pots were washed at starting time by washing powder and followed by rinsing with distilled water. Then those pots were dried in air. After drying the plastic pots were ready for the experiment. Finely

prepared different saline water was used as a medium for plant growing. Up to 12 cm of the pot was filled up by soil. Necessary amount of treatment was given to create saline environment by saturating the soil before placing the indian spinach seedling transplanting. The trial included the following treatments:  $T_1 = 2$  dS/m EC,  $T_2 = 4$  dS/m EC,  $T_3 = 6$  dS/m EC,  $T_4 = 8$  dS/m EC,  $T_5 = 10$  dS/m EC and  $T_6 = 12$  dS/m EC of saline water. The single factor experiment used completely randomized design (CRD) with three replications. The experiment was divided into three equal replication blocks, each with six plots. As a result, the total number of unit plots was 18. The experiment's treatment combinations were randomized at random to 18 plots, each with three replications. Intercultural operations and saline water application were carried out according to experiment. The following parameters were measured: Plant height (cm), Number of laves/plant at 45 DAT, Leaf length (cm), Vine diameter (cm), Fresh weight of leaves and stem and root at 45 DAT (gm). Treatments were randomly arranged in each replication, divided into 18 plots. The data recording of observation was done at 15 days after transplanting (DAT). The first light irrigation of saline water is given soon after transplanting to ensure proper growth and the subsequent saline water irrigation were given at the interval of 3-4 days. Plant protection measures were followed to control the pest and diseases. Soil treatment with proper fungicide was done to protect the seedling from fungal infection and pest attack.

#### *Preparation of different strength of saline water*

Application of saline water for the experiment of expected water salinity strength was 2 to 12 dS/m EC. Saline water was collected from different saline sources and then it was mixed with another sample of saline water for achieving the expected sample. Then different saline water sample was made for pot experiment. Different concentrations (2, 4, 6, 8, 10 and 12 ds/m EC) of saline water was applied to pot for the strong transplanting and plant growth. The salinity level was maintained by calculating the salt level, using EC meter. The experiment was laid out in the Completely Randomized Design (CRD) with three replications. The following treatments were 2, 4, 6, 8, 10 and 12 dS/m EC of saline water. The seedlings were transplanted to the planting medium. Disinfected and healthy seedlings were placed in plastic pots. Each Plastic pot was treated by 2, 4, 6, 8, 10 and 12 dS/m EC saline water.

#### *Plant growth observation*

Internal growth activity was monitored from the days of transplanting till yield collection carefully. The plant height and other parameters of plant of seedlings were recorded after 15 DAT (Days After Transplanting). The plant height (cm), Number of laves/plant at 45 DAT, Leaf length (cm), Vine diameter (cm), Fresh weight of leaves and stem and root at 45 DAT (gm) were recording very carefully. From each of the plastic pot the plant parameters were taken randomly and averaged. Centimeter (cm) scale was used for measuring plant parameters.

Proper management about the pot and growth of plants were observed. Time to time weeding, fertilizer application, pot checking and special care to plant proper growth were following up to yield harvesting. After three days later prepared saline water was applied, pest controlling chemical and abiotic affect was observed. The data was collected at 45 days after indian spinach was fully matured. Then yield contributing data was collected and then analyzed.

Initial Chemical properties of soil of pot

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				µg/g			
7.4	1.95	0.22	0.11	17.52	57.25	1.03	1.22
Slightly Acidic	M	M	L	M	VH	M	VH

#### Statistical analysis

The data obtained for different characters were statistically analyzed. The mean values of all the characters were evaluated and analysis of variance was performed by the 'F' test by using statistix software, version 10.

### Results and Discussions

#### *Soil salinity (EC: dS/m) of Experimental pot*

Initial Soil Salinity of pot soil was 1.74 dS/m. After applying different strength of saline water soil salinity of different pot was increased.

Table 1: Soil salinity of different pot after applying different strength of saline water.

Treatment	Soil Salinity (EC*: dS/m) of pot			
	5 DAT**	15 DAT	30 DAT	45 DAT
T <sub>1</sub> (2dS/m)	1.77	1.83	1.91	2.17
T <sub>2</sub> (4dS/m)	1.87	1.90	2.89	3.91
T <sub>3</sub> (6dS/m)	1.90	2.12	3.45	5.19
T <sub>4</sub> (8dS/m)	2.04	2.78	4.21	6.48
T <sub>5</sub> (10dS/m)	2.55	3.19	5.30	7.42
T <sub>6</sub> (12dS/m)	2.94	4.14	6.21	8.34

\*EC determined by 1: 1 extraction Method

\*\* DAT - Days after Transplanting

Indian spinach is such a good productive and edible appealing vegetable. The characters of indian spinach of promoting vegetative growth and yield performance parameters at different DAT have been shown (table 2). The growing attributes and other results on main and combined effect of different strength of saline water and other management practices and

their interactions have been presented and discussed here. The influence of different level of saline water salinity caused a considerable variation in plant growth, production of yield and economic benefits of plants which was statistically significant at different DAT. After applying different strength of water salinity in different pot, the expected parameters were changed and noticed that saline water created a vulnerable environment for yield.

Table 2: Indian spinach plant growth of different stages at different strength of water salinity

Treatment	Plant height (cm) at 45 DAT	Number of laves/plant at 45 DAT	Leaf length (cm)	Vine diameter (cm)	Fresh weight of leaves, stem and root at 45 DAT (gm)
T <sub>1</sub> ( 2dS/m)	63.50a	76a	18.26a	9.4a	573a
T <sub>2</sub> ( 4dS/m)	52.30b	63b	15.26b	8.5a	456b
T <sub>3</sub> ( 6dS/m)	31.50c	33c	12.40c	6.7b	291c
T <sub>4</sub> ( 8dS/m)	0d	0d	0d	0c	0d
T <sub>5</sub> (10dS/m)	0d	0d	0d	0c	0d
T <sub>6</sub> (12dS/m)	0d	0d	0d	0c	0d
LSD	4.49	3.91	1.72	1.03	42.49
CV (%)	10.30	7.67	12.64	14.19	10.86

\*EC determined by 1: 1 extraction Method

#### *Plant height*

The plant height is considered to be the most important morphological character of growth of plant. The height of Indian spinach was measured from base of plant to tip of top leaf. It was observed that the height of plants at different growth stages was significantly affected by saline water. The different variation of indian spinach plant height at different strength of water salinity was statistically significant at 45 days after transplanting (DAT) (Table 2). Plant height depends on several factors like genetic makeup, nutrient availability, climate, water salinity and up taking soil micro environment etc. The maximum plant height (63.50 cm) was found at the treatment of T<sub>1</sub> (2 dS/m EC of saline water) but the plant height (52.30 cm) was found at the treatment of T<sub>2</sub> (4 dS/m EC of saline water) and the minimum plant height was found (31.50 cm) in the treatment of T<sub>3</sub> (6 dS/m EC of saline water).

#### *Numbers of leaf/plant*

The number of leaves/plant of Indian spinach was recorded at 45 DAT (days after transplanting). The analysis of variance showed that the differences in the number of leaves/plant of Indian spinach under different strength of saline water were statically significant and the values are presented in table 2. It was evident from the results that the maximum

number of leaves/plant (76 leaves) was obtained with applying of saline water at the treatment of T<sub>1</sub> (2 dS/m EC of saline water) at 45 DAT but the numbers of leaves/plant was (63 leaves) found at the treatment of T<sub>2</sub> (4 dS/m EC of saline water), while the minimum number of leaves/plant (33 leaves) was found with the treatment of T<sub>3</sub> (6 dS/m EC of saline water). The maximum numbers of leaves/plant (76) was found at the treatment of T<sub>1</sub> (2 dS/m EC of saline water) but the lowest numbers of leaves/plant (33) was found in the treatment of T<sub>3</sub> (6 dS/m EC) respectively at 45 DAT. It is discussed that 8 dS/m EC, 10 dS/m EC and 12 dS/m of saline water salinity strength had not given any plant growth.

#### *Leaf length*

The leaf length of a indian spinach depends on plant vigour and growth habit. Indian spinach is a vigorous growing plant and water salinity at irrigation has a great significant effect on the length of leaves. In accordance with the present study, the negative role of saline water in enhancing leaves length was reported. Water salinity was statistically significant at 45 days after transplanting (DAT) (Table 2). Leaves length depends on several factors like genetic makeup, nutrient availability, climate, water salinity and up taking soil micro environment etc. The maximum leaf length (18.26 cm) was found at the treatment of T<sub>1</sub> (2 dS/m EC of saline water) but the leaf length 15.26 cm was found at the treatment of T<sub>2</sub> (4 dS/m EC of saline water) and the minimum leaf length was found (12.40 cm) in the treatment of T<sub>3</sub> (6 dS/m EC) of saline water.

#### *Vine diameter*

The significant increase in growth parameter of Indian spinach is due to application of different strength of saline water. Indian spinach can grow under different conditions of soil but moderate soil fertility is decreased with the application of saline water. Indian spinach is a vigorous growing plant and nitrogen had a significant effect on the diameter and length of vine. The maximum vine diameter (9.40 cm) was found at the treatment of T<sub>1</sub> (2 dS/m EC of saline water) but the vine diameter (8.50 cm) was found at the treatment of T<sub>2</sub> (4 dS/m EC of saline water) and the minimum vine diameter was found (6.70 cm) in the treatment of T<sub>3</sub> (6 dS/m EC of saline water).

#### *Fresh weight of leaves, stem and root*

The variation in growth response of Indian spinach in terms of fresh weight of leaves, stem and root is presented in table 2. Fresh weight of leaves, stem and root varied from transplanting to yield collection. Application of saline water to different growth stages resulted in significantly decrease in fresh weight of leaves, stem and root. The highest fresh weight of leaves, stem and root (573 gm) was found with the treatment of T<sub>1</sub> (2 dS/m EC of saline water) but application of T<sub>2</sub> (4 dS/m EC of saline water) doses, The fresh weight of leaves, stem and

root (456 gm) was found, while the lowest values was (291 gm) of these characters were found with T<sub>3</sub> (6 dS/m EC of saline water) treatment. However, they were significantly different in fresh weight of leaves, stem and root among the treatments of saline water.

### **Conclusion**

The results obtained in the present study indicated that applying different strength of saline water to indian spinach significantly affected the plant height, number of leaves/plant at 45 DAT, leaf length, vine diameter, fresh weight of leaves, stem and root. From the experiment it is clear that, the higher plant height at 45 DAT was 63.50 cm, number of leaves/plant at 45 DAT was 76 leaves, length of green leaf was 18.26 cm, vine diameter of green indian spinach was 9.40 cm, fresh weight of leaves, stem and root was 573 gm and higher potential yield could be obtained by cultivating the indian spinach crop at T<sub>1</sub> (2 dS/m EC of saline water) treatment early in different saline prone area under saline region of Bangladesh. The recommendation after that experiment, the strength of water salinity (T<sub>1</sub>- 2dS/m EC of saline water) produced the maximum vegetative growth and total economic yield. So, we can consider the treatment T<sub>1</sub> (2dS/m EC) of water salinity for our soil health, environmental benefits and crop production. Further experiment may be carried out in different area of saline zone of Bangladesh before giving final recommendation. On the basis of the results it is suggested generally that saline water had the potential adverse effect for growth and yield characters of Indian spinach comparing with other sources of fresh water.

## Effect of different strength of saline water on growth and yield of okra

A Biswas, Md. Z Islam

### Abstract

Saline water and soil salinity is a most obstruction for crop production in salt affected area. Salinity causes probably very dangerous situation in soil microclimate level when crops are produced those affected region. In south and south-western area of Bangladesh is overcoming a huge barrier of salt accumulation to soil and problematic condition for different agricultural activities. And for solving such a vast systematic problem a field experiment was carried out to investigate the effect of different water salinity strength on the growth and yield of okra (*Hibiscus esculentus* L.) kharif-1 season. This experiment was laid out in Completely Randomized Design (CRD) comprising of 18 treatments viz., T<sub>1</sub>- 2 dS/m EC, T<sub>2</sub> - 4 dS/m EC, T<sub>3</sub> – 6 dS/m EC, T<sub>4</sub> – 8 dS/m EC, T<sub>5</sub> – 10 dS/m EC, T<sub>6</sub> - 12 dS/m EC of water. Each replication was three times repeated. Treatment was randomly arranged in every replications, that was divided into 18 pots. The results showed that the application of T<sub>1</sub>- 2 dS/m EC of saline water gave the maximum plant height at 1st flowering (cm), length of green fruit (cm), diameter of green fruit (cm), weight of single green fruit (gm) and fruit yield/plant (gm). So, it may terminate that 2 dS/m EC of saline water for our soil health to cultivation, management of soil and cost effective for farmer level.

key word: salinity ; okra ; growth; yield ; kharif ; EC ; CRD

### Introduction

Salinity reduces water availability for plant use. High salt levels hinder water absorption, inducing physiological drought in the plant. The soil may contain adequate water, but plant roots are unable to absorb the water due to unfavorable osmotic pressure. This is referred to as the osmotic or water deficit effect of salinity. Plants are generally most sensitive to salinity during germination and early growth. High concentration of salts in the root zone decreases soil water potential and the availability of water (Lloyd, et al., 1989). The second effect of salinity is shown when excessive amounts of salt enter the plant in the transpiration stream and injure leaf cells, which further reduces growth. This is called the salt specific or ion excess effect of salinity (Greenway and Munns, 1980). Symptoms may include restricted root growth, marginal or leaf tip burning/browning, inhibited flowering, reduced vigor and reduced crop yields. Human induced salinity, combined with the natural, limits food production in most semiarid regions of the world (Rengasamy, 2010). The majority of the world's water is salty containing 30 g of sodium chloride per liter. The availability of saline water is greater than fresh water (Flower, 2004). Salt sensitive crop showing sign of stress including wilting even when there is adequate soil moisture (Maas and Hoffman,1977). Seed germination and early seedling growth

stages are more sensitive to salinity than later developmental stages (Tayyaba et al., 2010). Plant species respond to salinity stress either by exclusion or inclusion of toxic ions from their shoots or roots (Greenway, et al., 1980; Munns, 1993; Jacoby, 1999). The nutritional imbalance taking place as a result of high amount of sodium (Na<sup>+</sup>) may lead to metabolic disorder such as reduction in protein synthesis and enzyme activities. Studies on physiological mechanisms of salt tolerance revealed that plants may reduce damaging effects of salts by controlling salt uptake (Munns and Tester, 2008), reducing damage under excessive ion uptake (Flowers and Yeo, 1995) as well as by osmotic adjustment (Patade, et al., 2008; et al., Singh et al., 2010). In saline environment, plant growth is affected by complex interaction of hormones, osmotic effects, specific ion effects and nutritional imbalances, probably all occur simultaneously (Arbona et al., 2005). Salt stress is one of the major environmental constraints limiting agricultural productivity (Wei et al., 2003). Salinity is the buildup of soluble salts by which saline water are formed (Levy and Syvertsen, 2004). It is a popular vegetable among both the consumers and farmers because it is rich in vitamins and minerals (Oyelade et al., 2003). Almost all parts of okra plant are consumed, like fresh okra fruits are used as vegetable, roots and stems are used for clearing the cane juice (Chauhan, 1972) and leaves and stems are used for making fiber and ropes (Jideani and Adetula, 1993). Salinity alters the metabolic and biochemical activities of plants, negatively affecting their production due to the decrease in stomatal conductance and photosynthesis rate, inhibition of protein synthesis and enzymatic activities, and intensification of chlorophyll degradation (Liang, et al., 2018). The experiment was carried out to find out the effect of different strength of saline water on growth and yield of okra.

### **Materials and Methods**

The experiments were carried salinity management and research center, soil resource development institute, Batiaghata, Khulna to test the effect of different strength of saline water on emergence and growth of sweet gourd. Plastic pots were used in conducting the experiment. The plastic pots were firstly washed by washing powder and followed by rinsing with distilled water. Then these were dried in air. After drying the plastic pots were ready for the experiment. Finely prepared soil was used as a matrix for seed emergence. Up to 10 cm of the pot was filled up by soil. Necessary amount of salt treatment was given to create saline environment by saturating the soil before placing the okra seed.

#### *Preparation of different strength of saline water*

Application of saline water for the experiment of expected water salinity strength was 2 to 12 dS/m EC. Saline water was collected from different saline sources and then it was mixed with another sample of saline water for achieving the expected sample. Then different saline

water sample was made for pot experiment. Different concentrations (2, 4, 6, 8, 10 and 12 ds/m EC) of saline water was applied to pot for the strong transplanting and plant growth. The salinity level was maintained by calculating the salt level, using EC meter. The experiment was laid out in the Completely Randomized Design (CRD) with three replications. The following treatments were 2, 4, 6, 8, 10 and 12 dS/m EC of saline water. The seedlings were transplanted to the planting medium. Disinfected and healthy seedlings were placed in plastic pots. Each Plastic pot was treated by 2, 4, 6, 8, 10 and 12 dS/m EC saline water.

#### *Plant growth observation*

Internal growth activity was monitored from the days of seed sowing till yield collection carefully. The Plant height at 1st flowering (cm), Length of green fruit (cm), Diameter of green fruit (cm), Weight of single green fruit (gm), Fruit yield/plant (gm) were recording very carefully. Proper management about the pot and growth of plants were observed. Time to time weeding, fertilizer application, pot checking and special care to plant proper growth were following up to yield harvesting. Early prepared saline water was applied in every three days later, pest controlling chemical and abiotic affect was observed. The data was collected at 45 days after okra was fully matured. Then yield contributing data was collected and then analyzed.

#### *Initial Chemical properties of soil of pot*

pH	OM (%)	K meq/100 gm soil	Total N (%)	P	S	Zn	B
				µg/g			
7.4	1.95	0.22	0.11	17.52	57.25	1.03	1.22
Slightly Acidic	M	M	L	M	VH	M	VH

#### Statistical analysis

The data obtained for different characters were statistically analyzed. The mean values of all the characters were evaluated and analysis of variance was performed by the 'F' test by using statistix software, version 10.

### **Results and Discussions**

#### *Soil salinity (EC: dS/m) of Experimental pot*

Initial Soil Salinity of pot soil was 1.74 dS/m. After applying different strength of saline water soil salinity of different pot was increased.

Table 1: Soil salinity of different pot after applying different strength of saline water.

Treatment	Soil Salinity (EC*: dS/m) of pot			
	10 DAS**	20 DAS	30 DAS	40 DAS
T <sub>1</sub> (2dS/m)	1.76	1.81	1.92	2.21
T <sub>2</sub> (4dS/m)	1.88	1.93	2.91	3.99
T <sub>3</sub> (6dS/m)	1.92	2.15	3.46	5.23
T <sub>4</sub> (8dS/m)	2.05	2.79	4.25	6.52
T <sub>5</sub> (10dS/m)	2.56	3.20	5.32	7.46
T <sub>6</sub> (12dS/m)	3.45	4.15	6.46	8.99

\*EC determined by 1: 1 extraction Method

\*\* DAS- Days after sowing

Okra is a good nutritious and edible vegetable. The characters of okra of promoting vegetative growth and yield performance parameters at different days after sowing (DAS) have been shown (table 1). The growing attributes and other results on main and combined effect of different strength of saline water and other management practices and their interactions have been presented and discussed here. The influence of different level of saline water salinity caused a considerable variation in plant growth, production of yield and economic benefits of plants which was statistically significant at different DAS. After applying different strength of water salinity in different pot, the expected parameters were changed and noticed that saline water created a vulnerable environment for yield.

Table 2: Okra plant growth of different stages at different strength of water salinity

Treatment	Plant height at 45 DAS(cm)	Length of green fruit (cm)	Diameter of green fruit (cm)	Weight of single green fruit (gm)	Fruit yield/plant (gm)
T <sub>1</sub> (2 dS/m)	51.60a	12.20a	1.35a	12.36a	231a
T <sub>2</sub> (4 dS/m)	44.70b	11.90a	1.24a	11.02a	196b
T <sub>3</sub> (6 dS/m)	36.20c	10.40a	1.12a	10.53a	110c
T <sub>4</sub> (8 dS/m)	0d	0b	0b	0b	0d
T <sub>5</sub> (10 dS/m)	0d	0b	0b	0b	0d
T <sub>6</sub> (12 dS/m)	0d	0b	0b	0b	0d
LSD	2.76	1.87	0.27	2.37	18.40
CV (%)	7.05	8.14	12.22	10.52	11.56

\*EC determined by 1: 1 extraction Method

*Plant height at 1<sup>st</sup> flowering*

The variation of okra plant height due to different strength of water salinity was statistically significant at 45 days after sowing (DAS) (Table 2). Plant height depends on several factors like genetic makeup, nutrient availability, climate, soil salinity and up taking environment etc. The maximum plant height at was (51.60 cm) found at the treatment T<sub>1</sub> (2 dS/m EC of saline water) but the plant height 45 Days after seed sowing was (44.70 cm) found in the treatment T<sub>2</sub> (4 dS/m EC of saline water) and the minimum plant height at 45 days after seed sowing was (36.20 cm) found in the treatment T<sub>3</sub> (6 dS/m EC of saline water).

#### *Length of green fruit of okra*

Different organic ingredients helps to produce plant leaves which influenced by water salinity in soil. Production of okra depends on the nutrients that exists in soil and given by other application. Different length of green fruits okra per plant at 45 DAS have been shown in Table 2. Due to the application of different water salinity strength to plants, a significant difference in fruits length of green okra per plant was observed that was statistically significant at 45 DAS. Fruits length of green okra with T<sub>1</sub> (2dS/m EC of saline water) irrigation was 12.20 cm and with T<sub>2</sub> (4dS/m EC) the length of green fruits was 11.90 cm. The lowest length of green fruits of okra per plant (10.40 cm) was found at T<sub>3</sub> (6 dS/m EC of saline water).

#### *Diameter of green fruit*

The strength of water salinity has a profound effect on plant canopy, intra cellular nutrients communication and yield production. It shows variation in characters and management of okra plants. Saline water had a significant effect on growing of diameter of green okra (Table 2). The plants with the largest diameter of green fruits (1.35 cm) was grown with T<sub>1</sub> treatment (2 dS/m EC of saline water) while the plants with the T<sub>2</sub> treatment (4 dS/m EC of saline water), the diameter of green fruit was 1.24 cm. The smallest diameter of green fruit of okra (1.12 cm) was grown with the treatment of T<sub>3</sub> (6 dS/m EC of saline water).

#### *Weight of single green fruit*

Different intensity of water salinity had a great significant effect on fresh weight of single green fruit per plant (Table 2). The plants with the highest weight of single green fruit (12.36 gm) was grown with T<sub>1</sub> treatment (2 dS/m EC of saline water) while the plants with the T<sub>2</sub> treatment (4 dS/m EC of saline water), the weight of single green fruit was 11.02 gm. The smallest weight of single green fruit of okra (10.53 gm) was grown with the treatment of T<sub>3</sub> (6 dS/m EC of saline water). The maximum weight of single green fruit might be due to water salinity effect and plant growth resistant. Interaction effect of different strength of water salinity treatment was significant on fresh weight of single green fruit.

#### *Fruit yield/plant*

Okra crops growth with different saline water treatment that approach on economic fruit yield per plant. It revealed that the variation among different water salinity strength were statistically significant. The plants with the largest fruit yield/plant (231 gm) was grown with T<sub>1</sub> treatment (2 dS/m EC of saline water) while the plants with the T<sub>2</sub> treatment (4 dS/m EC of saline water), the fruit yield/plant was 196 gm. The smallest fruit yield/plant of okra (110 gm) was grown with the treatment of T<sub>3</sub> (6 dS/m EC of saline water). Saline water application to okra plants and production process on total economic yield per plant revealed that variation among different water salinity strength were statistically significant.

### **Conclusion**

From the experiment it is clear that, higher Plant height at 1st flowering (51.60 cm), length of green fruit (12.20 cm), diameter of green fruit (1.35 cm), weight of single green fruit (12.36 gm), fruit yield/plant (231 gm) and higher potential yield could be obtained by cultivating the okra crop at T<sub>1</sub> (2dS/m EC of saline water) treatment early in different saline prone area under saline region of Bangladesh. Further experiment may be carried out in different area of saline zone of Bangladesh before giving final recommendation.

**Effect of ground water table & salt concentration on top soil salinity**

### **Abstract**

The process of soil and water salinization that occurs in different geological, hydro-geomorphological, agricultural, and climatic environment is very complex reaction by various mechanisms. Specifically, the objective is to characterize and find out the groundwater conditions contributing to existing salinity problems. Salinization of land and water is brought about by physical and chemical processes that increase salt concentrations in soil ground water. The process responsible for the development of salinity in soil and water is intimately related to the transport of dissolved salt ion mass in groundwater flow systems. According to the experiment, when ground water level starts to down and the same time salinity in soil and water starts increase. In February, the ground water level was 5 feet 3 inch, the salinity in water was 2.1 dS/m, at single layer mulching, the salinity in soil was 2.2 dS/m and the highest soil salinity was 3.2 dS/m in open soil and the lowest salinity was in double mulching soil (1.8 dS/m). In June, the ground water level was in down at 9 feet 3 inch, salinity at water was 8.8 dS/m, in single layer mulching, the salinity was 11.2 dS/m and the lowest salinity was in double mulching covered top soil (8.3 dS/m), the salinity level was very high in open top soil (16.5 dS/m). This experiment shows that soil water level starts to decrease from February month to June (early dry season to early rainy season). It is very much significant that salinity increase relation has simultaneously co-relation with the decreasing of ground water level in soil.

### **Introduction**

Crop production in saline area is highly limited because of salinity in ground water. During kharif-1 season, salinity starts to increase from the January and it ranges to November. Saline water from the river water and seawater moves vertically and horizontally to other cropping area. This saline particle and mineral co-exist with other yield beneficial uptaking nutrient and those create a bilateral saline solution. This saline solution directly moves to ground water and turns the soil micro water into saline. Salinity increases very rapidly when evaporation of water from the top soil get started by sun rays. It influences the vertical upward of saline water at the root zone of plant. The main obstacle to intensification of crop production in the coastal areas is seasonally high content of salts at the root zone of the soil. The salts enter inland through rivers and channels, especially during the early part of the dry (winter) season, when the downstream flow of fresh water becomes very low. During this period, the salinity of the river water increases. The salts enter into the soil by flooding with saline river water or by seepage from the rivers, and the salts become concentrated in the surface water layers through evaporation and evapotranspiration. The saline water may also cause an increase in salinity of the ground water and make it unsuitable for irrigation. The increase in water salinity in ground water of these areas has created a limitation for cultivation. Utilization

of low quality ground water for crop irrigation because of prolonged dry spells in conjunction with heavy salt minerals is the principal source bringing about soil salinization. Scarcity of quality irrigation water during dry season limits cultivation of rabi (winter) crops and kharif-1 (March-July) season. Variability of rainfall, uncertain dates of onset and recession of seasonal floods and risk of drought restrict cultivation. Uncertain rainfall delays sowing/transplanting and flood damages of crops. The texture of most of the saline soils varies silt clay to clay. Land preparation becomes very difficult as the soil dries out. Deep and wide cracks develop and surface soil becomes very hard. These also necessitate deep and rapid tillage operations. Presence of saline ground water table throughout the year within top soil depth is another factor affecting crop production in the saline belt. Sea level rise and reduction of fresh ground water reservoirs due to changes in rainfall patterns are the two major climate change induced hydrological variables that can severely affect saltwater intrusion in coastal water bank. Tidal flooding occurs during wet season (June to October), direct inundation by saline water and upward on lateral movement of saline ground water during the dry season (February to May). In addition, cyclone and tidal surge is accelerating this problem. In the coastal areas of Bangladesh, salinization is one of the most serious types of land degradation as well as a major obstacle to the optimal utilization of ground water resources. Salinization is the process where the concentration of dissolved salts in water and soil is increased due to natural or human induced processes. Fresh water is lost through evapotranspiration and hydrolysis. Arid and semiarid climates are associated with water logging and ground water access. In all represented cases, ground water is the main geological agent for transmitting, accumulating, and discharging salt. Salinization in land and water is brought by physical and chemical processes that increase concentrations of salt in soil and water. The processes that responsible for the development of saline land and water is very complex and intimately related to the transport of dissolved salt mass in groundwater flow systems. The redistribution of soluble salts accumulated in a soil micro pore is evident mainly in topographically lower areas by terminal salt water in river, dry area and sea water. Evaporation, evapotranspiration, hydrolysis, and leakage lead salt accumulation in water. When mineralized groundwater near the ground surface continually evaporates and causes minerals to precipitate, it increases the salt concentration in root zone. This process involve the mineralization of the groundwater, the physical transport of dissolved salts, the discharge of saline base flow into streams and river and the precipitation of salts within the soil cropping zone. Most of the salt in the groundwater system comes from micro pore, which includes parent materials structures, salt dissolved in the water recharging system and salt contributed from mineral dissolution within the groundwater flow system. The most important process that add salt to groundwater is mineral dissolution reactions in the subsoil and to a lesser extent along the entire bilateral movement of saline water flow system. The land geography is low lying land, down ward movement of fresh water and inland along the sea coastal part of Bangladesh. According to salinity survey findings and

salinity monitoring information about 1.02 million ha (about 70%) of the cultivated lands are affected by varying degrees of soil salinity. Million hectares of lands is affected by very slight, slight, moderate, strong and very strong salinity respectively. Cropping intensity may be increased from very slight to slightly in saline areas by adopting proper soil and water management practices with introduction of salt tolerant varieties of different crops. To mitigate the salt water for fill up the demand of fresh water for irrigation, especial emphasis may be given to adopt ground water reservoir technology.

### **Materials and Method**

This experiment was conducted at the Salinity Management and Research Centre (SMRC), Soil Resource Development Institute, Batiaghata, Khulna, Bangladesh during the Kharif-1 season of 2023. Ground water depletion is a serious problem for irrigation in crop production. A deep pipe was installed directly into the soil vertically in the field at 01-02-2023. It was used for checking the ground water level measurement. Three beds were made for salinity level correction. One bed was open soil condition where no mulch was used, another one was made by single layer mulching bed where mulch was spread under the top soil and third one was double layer mulching bed where two layers of mulch was used. In double layer mulching bed, two layers of mulch was spread out, one was under the soil and another one was upper the top soil. Those three beds were made for measurement of soil salinity in every 15 days later.

### **Results and Discussion**

Every 15 days later, the ground water layer depletion was measured through the deep pipe. This collected water and soil salinity were measured and salinity level was recorded (table 1). In 15-02-2023, the ground water depth was 5 feet 3 inch, water salinity was 2.1 dS/m, at open soil layer, the highest soil salinity was 3.2 dS/m, at single mulching layer the salinity was 2.2 dS/m and at double mulching layer, the lowest soil salinity was 1.8 dS/m.

Table 1 : Different Salinity level at different dates of water and soil salinity

Parameter	15-02-2023	01-03-23	16-03-23	01-04-23	16-04-23	01-05-23	16-05-23	01-06-23
Water depth	5'3"	5'8"	6'4"	6'9"	7'4"	7'8"	8'5"	9'3"
Ground Water salinity (dS/m)	2.1	2.8	3.4	5.3	6.1	7.2	8.1	8.8
Soil salinity dS/m (open)	3.2	4.3	5.4	7.3	9.4	10.1	12.4	16.5
Soil salinity dS/m (SLM)	2.2	3.6	4.8	5.2	6.5	7.8	9.3	11.2
Soil salinity dS/m (DLM)	1.8	3.2	4.1	4.9	5.8	6.1	7.2	8.3

SLM- Single Layer Mulching

DLM - Double Layer Mulching

In 01-03-2023, the ground water depth was 5 feet 8 inch, water salinity was increased to 2.8 dS/m, at open soil layer soil, the highest soil salinity was 4.3 dS/m, at single mulching layer, the soil salinity was 3.6 dS/m but at double mulching layer, it was the lowest soil salinity was 3.2 dS/m. After 15 days later in 16-03-2023, the ground water depth was down to 6 feet 4 inch, water salinity was risen to 3.4 dS/m, at open soil layer soil, the highest soil salinity was 5.4 dS/m, at single mulching layer, the soil salinity was 4.8 dS/m and at double mulching layer, the lowest soil salinity down to 4.1 dS/m. Again 15 days later, in 01-04-2023, the ground water depth was measured at 6 feet 9 inch, water salinity was 5.3 dS/m, at open soil layer soil, the highest soil salinity ranged at 7.3 dS/m, at single mulching layer, the soil salinity was 5.2 dS/m and at double mulching layer, the lowest soil salinity was gained 4.9 dS/m. In 16-04-2023, the ground water depth was recorded at 7 feet 4 inch, water salinity was 6.1 dS/m, at open soil layer soil, the highest soil salinity was 9.4 dS/m, at single mulching layer, the soil salinity was 6.5 dS/m but at double mulching layer, the lowest soil salinity was found 5.8 dS/m. About 15 days later, in 01-05-2023, the ground water depth was measured at 7 feet 8 inch, water salinity was 7.2 dS/m, at open soil layer soil, the highest soil salinity was 10.1 dS/m, at single mulching layer, the soil salinity was 7.8 dS/m but at double mulching layer, the lowest soil salinity was 6.1 dS/m. In 16-05-2023, the ground water depth was decreased to 8 feet 5 inch, water salinity was 8.1 dS/m, at open soil layer soil, the highest soil salinity was calculated at 12.4 dS/m, at single mulching layer, the soil salinity was 9.3 dS/m and at double mulching layer, the lowest soil salinity was gone down at 7.2 dS/m. At the date of 01-06-2023, the ground water depth was reached at 9 feet 3 inch, water salinity was touched at 8.8 dS/m, at open soil layer soil, the highest soil salinity was 16.5 dS/m, at single mulching layer, the soil salinity was 11.2 dS/m and at double mulching layer, the lowest soil salinity was recorded at 8.3 dS/m. In seepage areas dry spell and waterlogging induces clay eluviation near the surface and salinization at water depth

in present day that reducing environments. When the water table rises to the surface, seepage areas are flushed by fresh water and salinization takes place. The resulting dis-equilibrium develops severe salinity environment land and degradation problems as a result of rising saline groundwater tables particularly when they act together in down surface positions of the land.

### **Conclusion**

Groundwater plays a major role in the mobilization, accumulation, and discharge of salts into the root zone plant. Salinity increases during these periods of low recharge where only deep water resources are present and the groundwater flows are insufficient. Saline groundwater flows along the vertical and horizontal streams and is accumulated in the soil system acts as a salt depository. This ground water store directly influence the upper soil surface layer salinity range and water uptake by plants. However, ground water is the critical geological agent in the development of salinization.