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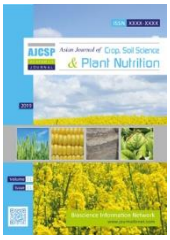

Response of Sweet pepper (*Capsicum annuum* L.) in saline region of Bangladesh

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ABSTRACT

Salinity is one of the major issues that lead to a reduction in crop productivity. This study aimed to investigate the response of sweet pepper (Capsicum annuum L.) to saline soil. The research was conducted in Agricultural Research Field at Noakhali Science and Technology University during 2018-19 with two sweet pepper varieties as treatment named Red Army (V_1) and California Wonder (V_2). The results indicated that there were significant variations between the two varieties in different parameters of growth as well as yield performance. The result showed that between the treatments V2 (California Wonder) gave the higher yield ie., 10.65 ton/ha while V1(Red Army) produced 9.61 ton/ha. Moreover, the taller plants and longer fruit were obtained from the V_2 which were 32.43 cm and 8.23 cm respectively. Even among the other parameters, V_2 gave higher growth and development than V_1. Furthermore, average single fruit weight/plant was recorded 76.33 g in California Wonder (V_2) whereas Red Army (V_1) provided 74.16 g. The finding of the experiment indicated that the overall better performance could be obtained from V_2 California Wonder variety of sweet pepper. This study evaluated the varietal performance of two varieties and it can be said from the experiment that the California Wonder is the best variety for cultivation in saline region in Bangladesh.

Key Words: *Sweet Pepper, Salinity, Growth and Yield*

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I. Introduction

Sweet pepper (*Capsicum annuum* L) is a member of the Solanaceous group. It is one of the popular vegetable crops cultivated which are commonly called "filfil akhdar", where "filfil" means pepper and "akhdar" means green. It is mainly used as a spice, salad and vegetables in Bangladesh. Sweet pepper covers a production area of 434757 acres in year 2014 according to the Ministry of Agriculture Statistics, Bangladesh (BBS, 2018). In the accreted region of Noakhali, the soil salinity shows a pronounced

seasonal cycle that influences cropping practices (Dasgupta et al., 2015). During the study on the soil salinity over nine years, it was observed that the maximum seasonal salinity decreases from the dry season (Rabi) to the wet season (Kharif) by ~ 1.5 dS/m for both accreted and non-accreted regions of the Noakhali district (Das et al., 2020). Soil salinization is a major factor contributing to the loss of productivity of cultivated soils. Although difficult to estimate accurately, the area of salinized soils is increasing, and this phenomenon is especially intense in irrigated soils. It was estimated that about 20% (45 million ha) of irrigated land, producing one-third of the world's food, is salt-affected (Shrivastava and Kumar, 2015). Salts affect plant growth due to increasing soil osmotic pressure and 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. Moreover, salt stress reduces plant growth due to specific-ion toxicities and nutritional imbalances or a combination of these factors (Machado and Serralheiro, 2017).

The accumulation of salt in the soil root zone adversely affects crop production by altering the nutritional balance of plants and causes toxicity in plants by excessive ions (Corwin and Yemoto, 2017). Moreover, pepper (*Capsicum annuum* L.) is an important widespread agricultural crop but considered sensitive to salinity. Furthermore, salt affected pepper shows severe decreases in growth, disturbances in membrane permeability, stomatal conductance, photosynthesis and ion imbalance (Wahb-Allah, 2013). The pepper plant is not a salt tolerant vegetable, about 14% of fruit yield loss occurs as a result of each increase in salt level of 1.0 dS/m (Abdelaal et al., 2020). Salinity affects primarily the total fruit yield (above 10 mM NaCl), and the average fresh fruit weight (above 25 mM NaCl) with the number of fruits per plant (above 50 mM NaCl). One of the most effective ways to overcome salinity problems is the introduction of salt tolerance crop variety. Among different varieties, there is variability in terms of salt stress tolerance (Hernández, 2019). Thus, the present research was evaluated the yield performance among different varieties of *Capsicum* that were grown under saline soil condition.

II. Materials and Methods

Experimental location

The study had been conducted from October 2018 to March 2019 during Rabi Season in the field of Noakhali Science and Technology University (NSTU), Noakhali which has sub-tropical climate conditions with significant rainfall in most months. The average annual temperature and rainfall are 25.6 °C and 3,302 mm individually. This area experienced a series of erosion and accretion phenomena due to the Meghna river estuary. The soil of the research field has a slightly too moderate amount of soil salinity which is ranging from 0.14 to 0.89 dS/m (Das et al., 2020).

Treatments

Two sweet pepper varieties used as treatments with three replication in this study.

V_1 = Red Army
V_2 = California Wonder

Fertilizer application

Cowdung (5 tons) was applied before the land preparation but whole amount of Gypsum, TSP, Boric acid and half of MOP were applied during the final land preparation (Table 01). Urea and rest amount of MOP were applied at three installments (15 days interval) in furrows made on circle of the seedling and mixed properly with soil.

Table 01. Recommended Doses of Fertilizers

Sl no.	Name of fertilizers	Dose/ha
1.	Cowdung	5 tons
2.	FYM	750 kg
3.	Urea	353 kg
4.	TSP	185 kg
5.	MOP	126 kg
6.	Gypsum	74 kg
7.	Boric acid	5 kg

Experimental design

The experiment was done in RCBD design with two treatments. Seedlings were planted at a spacing of 35 cm × 45 cm in area of 10 m^2. Each plot consisted of 5 plants with total of 2 plots for each bed. The

area of each plot is 3.20 m^2. Organic fertilizers were applied 2 weeks before planting whereas inorganic fertilizer was applied 2 weeks after planting.

Seedling transplant

Healthy seedlings were dibbled 5 cm deep on 18th November 2018 maintaining uniform distance of 35 x 45 cm.

Cultural practices

After transplanting continuous observation was made. It was observed that in three plots a single plant died. So there was a need for gap filling. Earthing up was done at 30 DAT. To protect the crops from Brown Hopper and Aphid. Diathen M 45 and Capture 75 WDG were sprayed at 15 days interval.

Data collection and analysis

After transplanting several data including plant height, leaf number, number of flower/plant, number of fruit/plant, fruit weight, and fruit length were taken from 4 plants/plots to assess plant growth. Fruits were harvested at 15days intervals with 3 harvestings. The collected data were statistically analyzed by using the SPSS software (version 15.0). Subjected to Analysis of Sample t-Test to check the significant differences among varietal performance at 5% probability according to Gomez and Gomez (1984).

III. Results

Response of varieties on vegetative traits

Plant height (cm): The result relating to the plant height indicated that there was no significant variation among the sweet pepper varieties in this study. According to Table 02, it was cleared that in both varieties, highest number of height was observed at 60 DAT of planting but they gave highest height in different replication i.e. variety 1 was provided highest height in third replication while variety 2 gave in second replication. Overall, the tallest plant height was recorded in variety 2 which was California wonder (33.9 cm).

Number of branches/plant: There was no significant variation among the varieties was observed in branch number per plant. From Table 02, it was revealed that number of branches per plant ranged from 4 to 9 in both varieties. The maximum number of branches per plant was 9 produced by both varieties. Similarly, the minimum number of branches per plant was found in the variety Red army variety which was 3.

Table 02. Vegetative traits performance of treatments

Treatments	Plant height (cm)			No. of Branch/plant			No. of Flower/plant		
	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT
V_1R_1	18.23	25.53	31.91	4	6	9	0	12	19
V_1R_2	19	24.1	30.2	3	5	6	2	15	22
V_1R_3	21.2	27.35	32.72	4	6	7	4	13	21
Mean	19.47	25.66	31.61	3.66	5.66	7.33	2	13.33	20.66
Level of Significance (5%)	*	*	*	*	*	*	*	*	*
V_2R_1	19.39	26.3	31.8	5	6	8	3	14	23
V_2R_2	17.25	25.8	33.9	4	7	8	0	11	19
V_2R_3	16.9	24.7	31.6	5	8	9	4	13	23
Mean	17.84	25.6	32.43	4.66	7	8.33	2.33	12.66	21.66
Level of Significance (5%)	*	*	*	*	*	*	ns	*	ns

Number of flower/plant and flower initiation (DAT): The number of flowers produced per plant was statistically non-significant in case of variety 2 whereas it was significant at variety 1. The maximum flowering was found in 60 DAT which was 23 in variety 2. However, the lowest flowering observed in variety 1, that was 19 (Table 02).

Response of varieties on fruit components

Number of fruit /plant: Data presented in Table 03 was observed and there was no significant variation found among the number of fruits per plant of the varieties i.e. the fruit number was ranged between 4-5 per plant individually.

Flower initiation (DAT): The number of flower initiation not varied significantly among the varieties studied. The first flowering observed in variety which was 28 (DAT), also it was revealed that 50% flower initiation was found in variety 2 which was 39 (DAT) while variety 1 was noticed to produced 41 (DAT) (Table 03).

Table 03. Performance of treatments on fruit development

Treatment	First Flower initiation (DAT)	50% Flower initiation (DAT)	Fruit (number/plant)
V_1R_1	32	43	4
V_1R_2	29	41	5
V_1R_3	28	43	4
Mean	29.66	42.33	4.33
Level of Significance (5%)	ns	*	*
V_2R_1	28	41	5
V_2R_2	33	39	4
V_2R_3	28	42	5
Mean	29.66	40.66	4.66
Level of Significance (5%)	ns	*	*

Fruit length and diameter (cm): According to Table 04, it was showed that there was a significant difference of fruit length diameter at both varieties at the mature stage. The highest length (9 cm) was found in variety 2 whereas the lowest fruit length (6.5 cm) was observed in variety 1 which was much lower than variety 2. But in case of fruit diameter variety 2 was noticed to give maximum diameter i.e. 21.60 cm followed by variety 2 fruit diameter 21.53 cm. The minimum diameter was 18.5 cm in variety 1 and 18.92 cm in variety 2 respectively.

Single fruit weight (g): Both of the varieties was showed some variation in the weight of single fruit (Table 04). The maximum weight of fruit was 79.86 g recorded in Variety 2 that was obtained at second replication in the experiment. In every trial, this variety gave significant fruit weight which was much similar to each other. However, the minimal weight was observed in variety 1 which was 73 g followed by 74.33 g that was produced by variety 2.

Table 04. Performance of treatments on fruit yield and it's components

Treatment	Fruit length (cm)	Fruit diameter (cm)	Single fruit weight (g)	Yield (ton/ha)
V_1R_1	6.5	20	75	9
V_1R_2	8	21.6	73	11
V_1R_3	7	18.5	74.5	9
Mean	7.16	20.03	74.16	9.3
Level of Significance (5%)	*	*	*	*
V_2R_1	7.5	21.53	74.71	11.21
V_2R_2	9	20.31	79.86	9.58
V_2R_3	8.2	18.92	74.33	11.16
Mean	8.23	20.25	76.33	10.65
Level of Significance (5%)	*	*	ns	*

Fruit yield (ton/ha): Variation was observed for yield parameters in both varieties. From Table 04, it was shown that California Wonder variety was recorded mean maximum yield, 10.65 ton/ha, on the other hand, Red Army gave 9.61 ton/ha. The satisfactory yield of both varieties might be influenced due to the proper physiological maturity and adaptability of varieties under climatic conditions of experimental site.

IV. Discussion

Sweet Pepper is moderately sensitive to salt stress which is showing yield losses when it grows in soils with an electrical conductivity as low as 1.5 dS m-1 (Tanji et al., 2002). Several pepper varieties have been evaluated for salt stress tolerance. However, their tolerance level has been tested only on short-term responses where soil salinization occurs throughout the growing season (Giorio, 2020). Our results demonstrate that varietal differences were observed in all of the plant traits such as number of branch/plant, plant height, number of flower/plant, first flower initiation, 50% flower initiation, fruit number/plant, fruit length, fruit diameter, single fruit weight, yield ton/ha. The salinity level in coastal region of Noakhali is less than the tolerant value i.e. ranging from 0.14 to 0.89 dS/m which is suitable for the cultivation of sweet pepper and their performance would not influenced by the salinity level much. The varieties differed significantly in their yield component and yields. The result showed that there was no significant variation between the varieties in respect of number of branches/plant. It was observed that the highest number of branches (9) was produced by variety 2. In variety 1 i.e. Red Army it was 6 branches. The result of the experiment showed that plant height of the varieties exhibited a wide range of variation. It was found that the variety California Wonder produced the tallest plant (33.9 cm) and Red Army produced (32.72 cm). The height weight of fruit was produced by California Wonder (79.86 gm.). The Red Army (75 gm.) was similar in single fruit weight but below the average value. Similar findings on pepper plants were reported by Chartzoulakis and Klapaki, (2000), Savvas et al. (2007), Kaya et al. (2009) and Rubio et al. (2009). Their studies clarified that higher concentration of salinity lower the yield of fruits and their components. In saline soils, plants accumulate high levels of chloride that has been proven to be more dangerous than sodium ion. Consequently, chloride toxicity in plants induces leaf chlorosis and photosynthesis, which causes severe growth and yield loss (Tavakkoli et al., 2011). In our experiment, California Wonder variety gave highest yield (10.65 ton/ha) while the variety of Red Army gave minimal yield (9.61 ton/ha).

V. Conclusion

Considering the above statement, it is concluded that four green manures *viz*. *S. rostrata, S. aculeata, C. juncea* and *V. unguiculata* were found to be effective green manures in terms of nitrogen contribution and especially its incorporation into soil revealed the significant and positive effect of subsequent and succeeding crop yield. The increased rice grain yields (52%) were obtained due to growing and incorporation of *Sesbania rostrata* followed by *S. aculeata* (46%) prior to T. Aman rice. These crops when incorporated into soil with 50% N produced higher and satisfactory yield of T. Aman rice compared to that of 100% NPK. The residual effect of *S. rostrata* and *S. aculeata* had also a positive impact on the following crop mustard. The 50% reduction of chemical fertilizer can be recommended for subsequent T. Aman rice and succeeding mustard crop from followed by growing *Sesbania rostrata, Sesbania aculeata, Crotalaria juncea* or *Vigna unguiculata* as a preceding green manuring crop.

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