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PHENOTYPIC VARIATION AND YIELD PERFORMANCE OF PUMPKIN VARIETIES IN COASTAL AREA

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Abstract

The experiment was conducted to evaluate the phenotypic expression and yield attributes of different pumpkin varieties in response to saline stress. The research work was carried out at Satkhira (AEZ-11) in the experimental field of Bangladesh Agricultural Research Institute (BARI), On-Farm Research Division, Khulna from November 2020 to February 2021. The result indicated that the maximum vine length at harvest (330 cm), number of leavesvine^{-1} (40), fresh weight of root (179 g), dry weight of root (14.9 g), fresh weight of shoot (499.8 g), dry weight of shoot (93.7 g), root length (11.8 cm), female flowervine^{-1} (2), number of fruitplant^{-1} (5), individual fruit weight (4230 g), fruit yield (33.9 tha^{-1}), flesh thickness (4.9 cm) were recorded from pumpkin var. BARI Misti Kumra-1 and number of node for 1st male flower (6), number of node for 1st female flower (29), total Soluble Solid (9.9) and β-carotene (110.2 µg/g) were recorded from BARI Misti Kumra-2. The fruit yields of the varieties ranged from 19.4 to 33.9 tha^{-1}. BARI Misti Kumra-1 might have the mechanism that is responsible for salt tolerance as well as will be useful for selection and improvement of Cucurbitaceous species.

Keywords: Coastal saline, Phenotypic variation, Pumpkin,Yield

Introduction

Being a member of Cucurbitaceae family Pumpkin (*Cucurbita moschata*) is a very popular vegetable with great socio-economic importance and is grown extensively in many tropical and sub-tropical countries (Ahamed *et al.,* 2011). Pumpkin (*Cucurbita moschata*: Cucurbitaceae) is a very popular vegetable in many tropical and sub-tropical countries. In Bangladesh it ranks next to brinjal and radish in terms of cultivation area and production. According to the Bangladesh Bureau of Statistics (BBS) the total production of pumpkin was about 140483.9 metric tons (MTs) produced from 29941 acres of land and the average yield of pumpkin 30-35 t ha^{-1} (BBS, 2022).

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Soil salinity is the most brutal environmental factor for crop production worldwide that damages agricultural land. In Bangladesh, the coastal area has been severely impacted by salinity intrusion increasing with 83.3 million hectares to 102 million hectares between1973 to 2010.Over the last 35 years, salinity has increased to 26% within the country (Rabbani et al., 2018). In Bangladesh, 30% of cultivable land is covered by coastal area in addition 1.689 million hectares of coastal land about 1.056 million hectares are affected by various degrees of soil salinity. In coastal region yield is severely decreased i.e. approximately average 20-40% in major crops (cereals, potato, pulses, oil seeds, vegetables, species and fruit crops) (Miah *et al.,* 2020). Most of the literatures indicate that vegetable crops are more sensitive to salt at the vegetative stage than germination stages.

In pumpkins, carotenoid is a natural plant pigment which is responsible to give the orange color. Azizah *et al.,* (2009) reported that pumpkins consist of β-carotene and lycopene.Though soil salinity reduces the productivity of coastal regions but cultivation of pumpkin encouraging but they cannotcultivate extensively due to lack of salt tolerant variety as well as intercultural practices like irrigation, drainage, and mulching area very expensive. Through this research work attempt had been taken to know the considerable level of salinity for better performances of the three varieties.

Materials and Methods

This experiment was carried out in the experimental field of BARI, OFRD, Dawlatpur, Khulna from November 2020 to February 2021. The location of the experimental site was at the High Ganges River Flood Plain (22.8875 N latitude and 89.5167 E longitudes).The soil was clay loam heavy 7.15 P^H and 1.05% organic matter.

In this research work three varieties were used, namely BARI Misti Kumra-1, BARI Misti Kumra-2 and a local one. Local variety was collected from the market of khulna and BARI Misti Kumra-1, BARI Misti Kumra-2 from Bangladesh Agricultural Research Institute, Gazipur. The experiment was laid out in a Randomized Complete Block Design (RCBD) with 4 replications. The field soil was well pulverized and dried in the sun and decomposed cowdung was mixed with the soil. A basal dose of urea, triple super phosphate (TSP), muriate of potash (MP) and molybdenum were used as the source of nitrogen, phosphorus, potassium and molybdenum applied at the rate of @ 1500, 210, 120, 100 and 1kgha^{-1}, respectively. Urea was applied as top dressing in 2 equal splits at 15 and 30 days after transplanting (DAP). The entire amount of cowdung, TSP, MOP and molybdenum were applied at the time of final land preparation. Seeds were treated by provax @ 2 g/kg seed. Treated seeds were sown in the seedbed on 09 October 2020. Healthy and uniform sized 30 days old seedlings were transplanted on 08 November 2020. To prevent the competition of weeds with plants weeding was done 6 times and mulching is also done to keep the soil moist and aerated by breaking the soil crust. Four times irrigation at regular intervals during the growing season was applied. The parameters such as vine length at harvest (cm), number of leavesvine^{-1}, fresh weight of root (g), dry weight of root (g), fresh weight of shoot (g), dry weight of shoot (g), root length (g), number of node for 1st male flower, number of 1st female flower, male flower, female flowervine^{-1}, number of fruitplant^{-1}, individual fruit weight (g), fruit yield

(tha^{-1}), flesh thickness (cm), total soluble solid and β-carotene were determined.t. Soil salinity was varied from 2.8 to 9.2 dS m^{-1}. Collected data were statistically analyzed by Software R (version 4.1.2) (R Core Team, 2021) and significance of the difference between pairs of mean by the DMRT test at 5% level of probability.

The soil salinity level during crop growing period is presented in Fig. 1. Soil salinity ranged from 2.8 dS/m to 9.2 dS/m. The lowest salinity 2.8 dS/m showed during month of November and the highest 9.2 dS/m represent at the end of March. It indicates that after the rainy season the salinity level drastically reduced but in the dry season like in march it reaches in its peak marks.

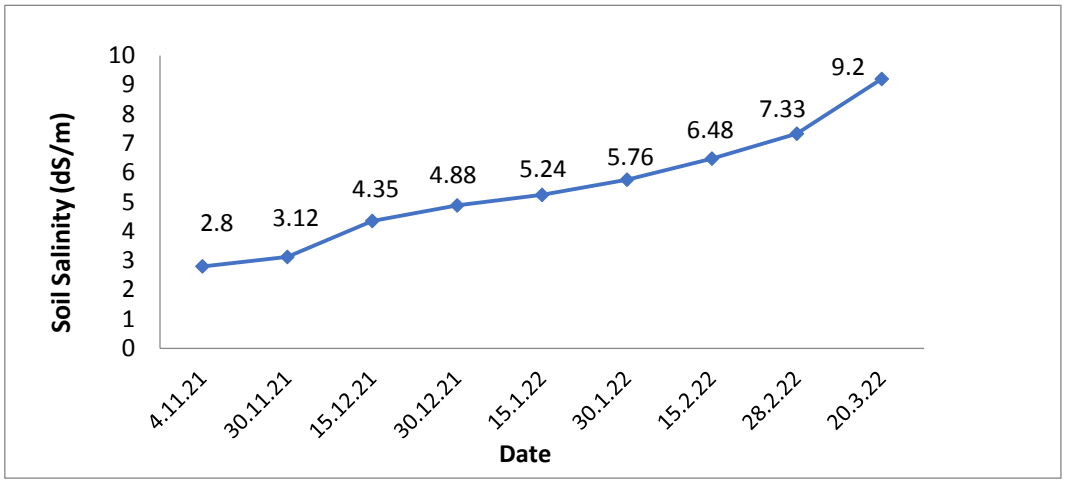

Fig. 1. Soil salinity during crop growing period in the experimental field

Results and Discussion

Pumpkin var. BARI Misti Kumra-1 was high rounded fruit having flesh color deep orange with golden yellow skin color at maturity. While BARI Misti Kumra-2 had the orange patch skin color at maturity, deep orange flesh color, flat rounded shape. Local variety had light yellow colored skin at maturity, slightly rounded in shape having flesh color yellowish. The fruit is typically orange and have many creases running from the stem to the bottom (Table 1).

Table 1. Fruit morphological parameters of different varieties of pumpkin

Variety	Fruit skin color at maturity	Flesh color	Shape
BARI Misti Kumra-1	Golden yellow	Deep orange	High Round
BARI Misti Kumra-2	Orange patch	Deep orange	Flat Round
Local	Light yellow	Yellowish, slightly rounded	High Round

Number of leavesvine^{-1} indicated great phenotypic variability under salinity conditions that has been elucidated in the (Table 2). In this observation, maximum number of leavesvine^{-1} was found in BARI Misti Kumra-1 (40) which was statistically similar with BARI Misti Kumra-2 (34) while in local variety (27). This result is confirmed by a Gabriel Filho*et al.,* 2022; who reported that leaves number reduces due to salinity. In root length of pumpkin, decreased significantly with increasing of salinity levels. The maximum root length (11.8 cm) was obtained from BARI Misti Kumra-1 which was statistically identical to BARI Misti Kumra-2 (10.4 cm) and the lowest value (7.6 cm) from local variety (Table 2). Highest reduction of fresh root weight (g) was found in local variety (135.7 g) which was closely related with BARI Misti Kumra-2 (168.1 g) whereas, lowest growth reduction in BARI Misti Kumra-1 (179.1 g) which was followed by BARI Misti Kumra-2 (168.1 g). The maximum fresh shoot weight (g) was obtained from BARI Misti Kumra-1 (499.8 g) which was parallel with BARI Misti Kumra-2 (492.52g) and minimum in local variety (359.2 g) and it was statistically identical with BARI Misti Kumra-2 (492.5 g). These results were found similar in the previous research findings of Kabir *et. al.*, (2020) in dry weight of root (g), dry weight of shoot (g) the effect of salinity was found to be significant with the increase of salt concentration (Table 2). The maximum fresh weight of root (179.1 g) was observed by BARI Misti kumra-1 as well as the maximum dry weight of root (g) was observed BARI Misti Kumra-1 (14.9 g) which was statistically similar with BARI Misti Kumra-2 (13.2 g) and minimum in local variety (11.2 g). The maximum dry weight of shoot (93.7 g) was observed BARI Misti Kumra-1 which was statistically identical with BARI Misti Kumra-2 (82.9 g) and minimum (48.9 g) was found in local variety. The results are in agreement by Kurum *et al.,* (2013) and Dadashpour (2012).

Table 2. Effects of varieties on morphological characters of pumpkin as affected by salinity during growth phases

Variety	Number of leavesvine^{-1}	Vine length at harvest (cm)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)	Root length (cm)
BARI Misti Kumra-1	40 a	330.1 a	499.8 a	93.7 a	179.1 a	14.9 a	11.8 a
BARI Misti Kumra-2	34.2 ab	272.5 b	492.5 a	82.9 a	168.1 ab	13.2 ab	10.4 ab
Local	27.1 b	177.7 c	359.2 b	48.9 b	135.7 b	11.2 b	7.6 b
CV (%)	14.7	12.5	8.6	16.7	14.7	9.0	16.7

The number of node for 1st male flower was found significant (Table 3) where maximum number of node for 1st male flower was 6 that from BARI Misti Kumra-1 but identical to BARI Misti Kumra-2 (5). Local variety had lowest number of node for 1st male flower (4) and decreased in number of node for 1st female flower was found in local

variety (17). The maximum number of node for 1st female flower was found in BARI Misti Kumra-1(22), which was statistically identical to BARI Misti Kumra-2 (20); Similar result was recorded by Kumanan and Devi (2021). Flesh thickness ranged from 2.9 cm to 4.9 cm. The thickest flesh was recorded from BARI Misti Kumra-1 (4.9 cm), which was statistically identical to BARI Misti Kumra-2 (4.5 cm). On the contrary, thinnest flesh was recorded in local variety (2.9 cm). An increase of the total soluble solid content was observed the highest in BARI Misti Kumra-1 (9.9) while salinity caused a highest reduction in local variety (7.3). These findings are supported by Mahmud *et al.,* (2016) and Del Amor *et al.,* (1999) indicating the phenotypic variability, heritability. Vine length ranged from 177.67 cm to 330.1 cm. The longest vine length at harvest (cm) was found in BARI Misti Kumra-1 (330.1cm) while the lowest from local variety (177.7cm). Number of fruit/plant was observed maximum in BARI Misti Kumra-1 (5), which was statistically identical to BARI Misti Kumra-2 (5) whereas local variety had minimum value (3) in number of fruitplant^{-1}. Tamilselvi and Jansirani (2017) corroborates with the present findings. In male flowervine^{-1}, the maximum increase was observed in BARI Misti Kumra-1 (29) while minimum in BARI Misti Kumra-2 (19).

Considering the female flowervine^{-1}, no significant difference was observed among the varieties. Sultana et al. (2015) also examined high variability in number of female flowers plant^{-1}, number of male flowers plant^{-1}.Significant differences were observed in TSS (%) which ranged from 7.3 to 9.9 %. The maximum TSS was found in BARI-Mistikumra-2(9.90%) which was statistically similar to BARI Misti kumra-1 (8.89%) while he lowest was found in local variety (7.3 %). Ahmed *et al.,* 2017 reported that TSS ranged from 7.38 to 10.75 % in 19 pumpkin genotypes; Rouf *et al.,* (2011) also found TSS in pumpkin varied from 6.10 to 9.10% which supports the present findings. The highest content of β-carotenoids was found in the BARI Mistikumra-2 (110.2 µg/g) and the lowest content was in local cultivar (43.8 µg/g). (Kulczynski and Gramza-Michałowska, 2019) also reported the variation in β-carotene from eleven cultivars ranged from 38.7 to 115.3 µg/gwhere the highest β-carotene was found from Melonowa Zolta (115.29 ± 0.95) and lowest was Porcelain Doll (38.67 ±1.7).

Table 3. Effects of varieties on yield and yield contributing characters of pumpkin as affected by salinity during their growth phase.

Variety	Number of node for 1st male flower	Number of node for1st female flower	Male flower vine^{-1}	Female flower vine^{-1}	Number of fruit plant^{-1}	Flesh thickness (cm)	Totale Soluble Soid	β-carotene (µgg^{-1})
BARI Misti Kumra-1	6 a	22 a	24 b	2.3	5 a	4.9 a	8.9 b	87.0 b
BARI Misti Kumra-2	5 a	20 a	29 a	2.3	5 a	4.5 a	9.9 a	110.2 a
Local	4 b	17 b	19 c	1.5	3 b	2.9 b	7.3 c	43.8 c
CV (%)	7.47	6.85	9.61	26.33	14.70	16.4	6.51	7.57

Some variations appeared in individual fruit weight (Fig. 2 (a)). The maximum weight of individual fruit was 4230 g which was recorded from BARI Misti Kumra-1 while minimum in local variety (1535 g). Variations were observed for fruit yield among the varieties under salinity conditions (Fig. 2(b)). Fruit yield (tha^{-1}) ranged from 19.4 to 33.87 tha^{-1}. The figure presented maximum fruit yield was obtained from BARI Misti Kumra-1 (33.8 tha^{-1}) and minimum was from local variety (19.4 tha^{-1}).

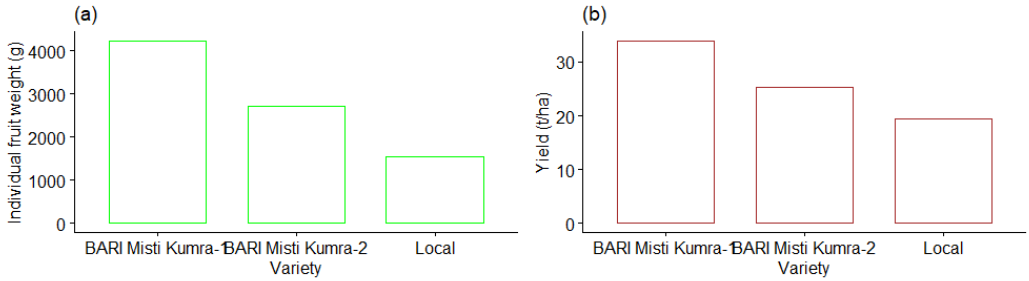

Fig. 2. (a) Individual fruit weight (b) Total Yield of different varieties affected by salinity in their growth phase

Pearson correlation analysis showed that maximum parameters have the strong positive correlation among them though they are non-significant in nature (Fig. 3). However, the highest positive correlation was found between the correlation of individual fruit weight and yield.

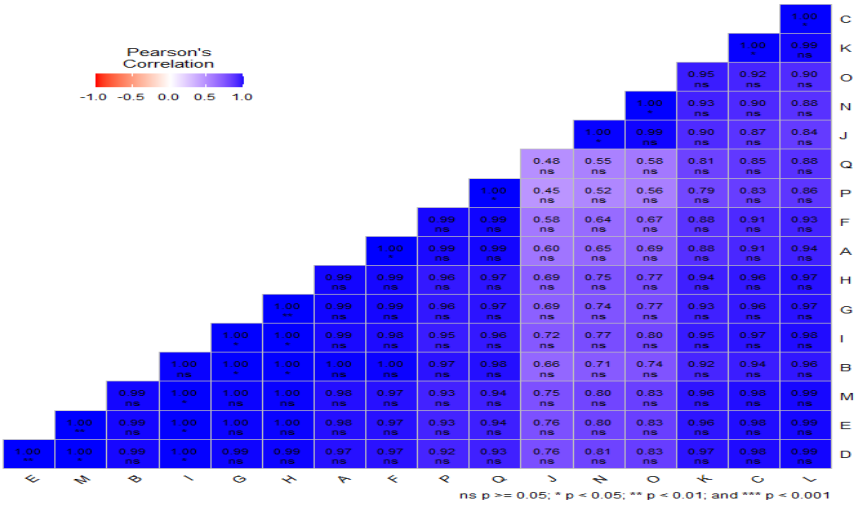

Fig. 3. Pearson correlation co-efficient of recorded parameters of pumpkin varieties.

A=Number of leaves vine^{-1}, B=Vine length at harvest (cm), C=Fresh weight of shoot (g), D=Dry weight of shoot (g), E=Fresh weight of root (g), F=Dry weight of root (g), G=Root length (cm), H=Number of node for 1st male flower, I=Number of node for1st female flower, J=Male flower vine^{-1}, K=Female flower vine^{-1}, L=Number of fruitplant^{-1}, M=Flesh thickness(cm), N=Total Soluble Soid, O=β-carotene (µg g^{-1}), P=Yield (t ha^{-1}), Q= Individual fruit weight (g)

Conclusion

This study examined the effects of salt concentrations on three pumpkin varieties (BARI Misti Kumra-1, BARI Misti Kumra-2 and local) in coastal saline area of Bangladesh. Though pumpkin is moderately salt tolerant but productivity decreases with increasing salinity. From the findings of this investigations, it may be concluded that in saline conditions, among three varieties, BARI Misti Kumra-1 renders the highest phenotypic attributes such as vine length,number of fruitplant^{-1},individual fruit weight, fruit yield, flesh thickness, TSS and β-carotene performance. On the other hand, the most affected pumpkin variety was local variety.

Conflicts of Interest

The authors declare no conflicts of interest regarding publication of this manuscript.

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