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EFFECTS OF SALINITY ON GROWTH, YIELD AND NUTRIENTS CONTENT OF TWO ONION CULTIVARS

M. A. Razzaque[1], S. S. Zamil[2], M. M. Hasan[3] and M. Siddika[4]

ABSTRACT

A pot experiment was conducted using two factors Completely Randomized Design with three replications at the net house of the department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka during October, 2020 - March 2021 to study the effect of five salinity levels (0, 3, 6, 9 and 12 dSm^{-1}) on growth, yield and nutrients content of two onion cultivars (BARI piaz 1 and BARI piaz 6). Results of the experiment showed that plant height, leaf number & fresh leaf weight $plant^{-1}$, bulb diameter and percent (%) N, P, K, S and Na content in bulb of onion were not significantly influenced by varieties but leaf & bulb length and individual bulb weight significantly influenced, where BARI piaz 6 achieved maximum results. Different salinity levels significantly influenced on growth and yield parameters of two onions, where the maximum plant height (43.99 cm), leaf number $plant^{-1}$ (6.82), leaf length (37.29 cm), fresh leaf weight $plant^{-1}$ (2.07 g), bulb length (30.33 mm), bulb diameter (31.50 cm) and individual bulb weight (34.26 g) of onion were obtained at 0 dSm^{-1} level of salinity and they gradually decreased until salinity level at 12 dSm^{-1}. The combined effects of two varieties and five salinity levels had significant influence on above growth and yield parameters. The maximum leaf number $plant^{-1}$, leaf length, fresh leaf weight $plant^{-1}$, bulb length and individual bulb weight were found in BARI piaz 6 with 0 dSm^{-1} level of salinity and also at 3, 6, 9 and 12 dSm^{-1} salinity levels showed better results than BARI piaz 1. The main effect of different salinity levels and combined effects of two varieties & five salinity levels showed statistically significant variation of percent (%) N, P, K, S and Na content in onion bulb, where N, P and K concentrations decreased with increasing salinity levels and S, Na concentrations increased with increasing salinity levels in both the cultivars, where the highest Na content (1.76 %) was recorded in BARI piaz 1 with 12 dSm^{-1} level of salinity. The BARI piaz 6 had better expression of morphological and yield contributing characters than BARI piaz 1.

Keywords: growth, onion, salinity, yield

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the family Alliaceae and is one of the most important spice crops. Onion is also an important vegetable crop worldwide, ranking third among all vegetables in economic importance next to potato and tomato. Onion contributes significant nutritional value to the human diet and has medicinal properties and is primarily consumed for their unique flavor and also ability to enhance the flavor of other foods. The production of onion is not sufficient to meet up the demand of our huge population. Due to limitation of land in Bangladesh, it is very hard to expand the cultivable land area under onion cultivation. Salinity is a major environmental constraint to crop productivity throughout the arid and Semi-arid regions of the world (Foolad and Lin, 1997). About 20% of the net cultivable land of Bangladesh coastal region is affected by different degrees of salinity (Karim *et al.*, 1990). Bangladesh is a deltaic country with total area of 174,570 km^2. A one meter sea level rise will affect the vast coastal area and flood plain zone of Bangladesh (Sarwar, 2005). If the rising of the sea level is continued, some districts of our country like Rajbari, Faridpur, Madaripur, Jessore, Khulna, Barisal etc which are the major onion producing areas may also be affected by salinity and in that condition the production of spices especially onion will be hampered. Salinity has an adverse effect on the growth and development of most salt-sensitive plant species (Mandhania, *et al.*, 2006). Salinity causes both ionic and osmotic stresses and affects plant growth and development (Keshavarzi, *et al.*, 2011). The mechanism of salt tolerance cell turgor and depressed rates of root and shoot elongation, suggesting that environmental salinity acts primarily on water uptake (Agami, 2014). Furthermore, high intracellular concentrations of both Na^+ and Cl^- can inhibit the metabolism, dividing and expanding cells, retarding germination and even leading to seed death (Adsul, *et al.*, 2015; Sai-Sudha, *et al.*, 2015). It is necessary to screen onion genotypes for salt tolerance, so that improved varieties can be developed.

[1&2]Professor, [4]Assistant Professor, [3]MS Student, Department of Agricultural Chemistry, SAU, Dhaka

MATERIALS AND METHODS

The experiment was undertaken in October, 2020 to March 2021 in the net house of Agricultural Chemistry Department, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to study the effect of salinity on growth, yield and nutrients content of two onion cultivars. The experiment was set in Completely Randomized Design (CRD) having two factors with three replications. Factor 1: Two cultivars (V_1 = BARI piaz 1 and V_2 = BARI piaz 6) and Factor 2: Five salinity levels (S_0 = 0 dSm^{-1}, S_1 = 3 dSm^{-1}, S_2 = 6 dSm^{-1}, S_3 = 9 dSm^{-1} and S_4 = 12 dSm^{-1}). The soil was non-calcareous Red Brown Terrace soil with loamy texture belonging to the AEZ 28 (Madhupur Tract). The collected soil was dried in the sun, crushed carefully and thoroughly mixed. An amount of 8 kg sun dried soil was taken in each pot and each pot was fertilized with 0.88 g urea, 0.45 g triple super phosphate, 0.66 g muriate of potash and 0.48 g gypsum. The all fertilizers were applied at the final preparation of the pots. Thereafter, the soil in the pots was moistened with water and commercial NaCl salt was added to develop salinity at the rate of 640 mg salt per liter distilled water for 1 dSm^{-1} salinity level. Healthy and disease free 35 days' old 3 hills or onion seedlings were transplanted in each pot. Necessary watering was done in each pot to hold the constant moisture and salt concentration.

The onion growth, yield and nutrients content data were collected at maturity stage and after harvesting. The plant height, leaf number, leaf length were measured before harvesting. Fresh leaf weight, bulb diameter & length and bulb weight were measured after harvesting. The nutrient content in onion bulb were determined after digestion the samples according to the outline of Jackson (1973). The collected data were analyzed statistically following CRD design by MSTAT-C computer package programme developed by Russel (1986) and the treatment means were compared by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Two onion varieties (BARI piaz 1 and BARI piaz 6) have been selected for present study in order to observe effects of salinity on growth, yield and nutrients content of two onion cultivars. The plant height (cm), leaf number $plant^{-1}$ and fresh leaf weight $plant^{-1}$ (g) of the onion varieties were non-significantly influenced by variety but leaf length (cm) differed significantly. The tallest plant (40.90 cm) was found in BARI piaz 1 and the shortest plant height (40.39 cm) was in BARI piaz 6 (Table 1). Probably the genetic makeup of varieties was responsible for the variation in plant height. This confirms the reports of BINA (1992), Shamsuddin *et al.* (1988) that plant height differed due to varietal variation. In case of leaf number (5.39) $plant^{-1}$, leaf length (34.65 cm) and fresh leaf weight (1.73 g) $plant^{-1}$ were higher in BARI piaz 6 and the lower values (4.40, 1.63g and 32.43cm, respectively) found in BARI piaz 1(Table 1). The plant height, leaf number, leaf length and fresh leaf weight of the onion varieties were significantly influenced by different levels of salinity. The highest plant height (43.99 cm), leaf number (6.82) $plant^{-1}$, leaf length (37.29 cm) and fresh leaf weight $plant^{-1}$ (2.07 g) were observed at 0 dSm^{-1} level of salinity and they gradually decreased until salinity level at 12 dSm^{-1} (Table 1). Salinity might be led to osmotic inhibition, toxic effect of ions and nutritional imbalance of elements by lowering down the uptake of essential nutrient elements and finally culminates in decreased growth (Adsul, *et al.* 2015; Sai-Sudha, *et al.*, 2015). The results are in also in confirmation with the findings of Keshavarzi, *et al.* (2011). Interaction effect of varieties and salinity levels had significant influence on plant height, leaf number $plant^{-1}$, leaf length and fresh leaf weight $plant^{-1}$ of onion. The plant height, leaf number, leaf length and fresh leaf weight of two onion cultivars significantly decreased with increase in different salinity levels (Table 1). The highest (44.73 cm) plant height was found in BARI piaz 1 at 0 dSm^{-1} salinity which was statistically similar with BARI piaz 6 at 0 dSm^{-1} salinity level and the lowest (37.25 cm) plant height was found in BARI piaz 1 at12 dSm^{-1} level of salinity, which was statistically similar with BARI piaz 6 at 12 dSm^{-1} level of salinity. The leaf number was highest (7.53) in BARI piaz 6 at 0 dSm^{-1} level of salinity and lowest in BARI piaz 1 at12 dSm^{-1} level of salinity. In case of leaf length and fresh leaf weight, the highest values (37.55 cm and 2.14 g, respectively) were observed in BARI piaz 6 and the lowest results (28.77 cm and 1.38 g,

respectively) were found in BARI piaz 1 at12 dSm^{-1} level of salinity. Reduced or the lowest results under salinity might be due to inhibited cell division and cell enlargement. Choi *et al.* (2003) observed that the plant height decreased in the 0.5% saline water in the soil. During vegetative period, the most common salinity effect was stunting of plant growth, whereas leaf withering was less apparent (Alam *et al.*, 2001).

Table 1. Effects of onion varieties, different salinity levels and their interaction on plant height, leaf number, leaf length and fresh leaf weight of onion

Variety	Salinity (dSm^{-1})	Plant height (cm)	Leaf number $plant^{-1}$	Leaf length (cm)	Fresh leaf weight (g) $plant^{-1}$
Effect of variety					
V_1 (BARI piaz 1)		40.90	4.40	32.43	1.63
V_2 (BARI piaz 6)		40.39	5.39	34.65	1.73
Level of significant		**NS**	**NS**	*	**NS**
$LSD_{0.05}$		-	-	0.63	-
CV (%)		5.87	10.49	5.46	8.67
Effect of salinity					
	0	43.99 a	6.82 a	37.29 a	2.07 a
	3	42.53 ab	5.77 b	35.66 ab	1.75 ab
	6	40.41 bc	4.75 c	32.72 bc	1.54 b
	9	38.90 cd	3.92 cd	31.77 c	1.53 b
	12	37.38 d	3.21 d	30.24 c	1.53 b
Level of significant		*	*	*	*
$LSD_{0.05}$		2.53	0.90	3.63	0.49
CV (%)		5.87	8.75	5.46	8.67
Interaction effect of variety and salinity					
V_1 (BARI piaz 1)	0	44.73 a	6.10 b	37.03 a	1.99 ab
	3	43.08 ab	5.53 bc	35.11 bc	1.75 bc
	6	40.10 c-e	4.24 c	31.10 ef	1.61 cd
	9	39.35 d-f	3.34 d	30.14 fg	1.43 cd
	12	37.25 f	2.75 e	28.77 g	1.38 d
V_2 (BARI piaz 6)	0	43.26 ab	7.53 a	37.55 a	2.14 a
	3	41.99 bc	6.00 b	36.21 ab	1.74 bc
	6	40.72 cd	5.25 bc	34.34 cd	1.47 cd
	9	38.45 ef	4.50 c	33.41 d	1.63 cd
	12	37.52 f	3.67 cd	31.72 e	1.68 b-d
Level of significant		*	*	*	*
$LSD_{0.05}$		1.99	1.58	1.40	0.30
CV (%)		5.87	10.49	5.46	8.67

Values having similar letter(s) in a column do not differ significantly at 0.05 level of probability
*Significant at 0.05 level of probability

There was no significant difference between BARI piaz 1 and BARI piaz 6 in the bulb diameter but the length of bulb and individual bulb weight of two selected onion varieties were significantly differed due to the mean effect of different salinity treatments (Table 2), where the highest bulb length (30.33 mm) and individual bulb weight (30.56 g) were found in cultivar BARI piaz 6 and the lowest results (23.13 mm and 25.21 g, respectively) were recorded in BARI piaz 1.

The different levels of salinity showed significant variation in the bulb diameter, bulb length and individual bulb weight of onion, where the highest results were found at 0 dSm^{-1} level of salinity and they gradually decreased until salinity level at 12 dSm^{-1} (Table 2). Salinity might be led to osmotic inhibition, toxic effect of ions and nutritional imbalance of elements by lowering down the uptake of

essential nutrient elements and finally culminates in decreased growth (Levitt, 1992). The results are also in confirmation with the findings of Sta-Baba *et al.* (2010).

Table 2. Effects of onion varieties, different salinity levels and their interaction on bulb diameter, length of bulb and Individual bulb weight of onion

Variety	Salinity level (dSm^{-1})	Bulb diameter (mm)	bulb length (mm)	Individual bulb weight (g)
Effect of variety				
V_1 (BARI piaz 1)		29.00	23.13	25.21
V_2 (BARI piaz 6)		28.93	30.33	30.56
Level of significant		NS	*	*
LSD0.05		-	2.36	2.83
CV (%)		8.05	11.57	7.37
Effect of salinity				
	0	31.50 a	30.33 a	34.26 a
	3	30.33 a	26.83 ab	33.33 a
	6	28.33 ab	26.33 ab	26.69 b
	9	28.00 ab	26.17 ab	24.64 b
	12	26.67 b	24.00b	20.51 c
Level of significant		*	*	*
LSD0.05		3.46	5.34	2.36
CV (%)		8.05	11.57	7.37
Interaction effect of variety and salinity				
V_1	0	33.00a	24.67 cd	31.83 ab
	3	29.67 a-c	22.33 d	30.46 a-c
	6	27.67 bc	22.67 d	24.59 cd
	9	29.00 a-c	24.33 cd	21.89 de
	12	25.67 c	21.67 d	17.29 e
V_2	0	30.00 a-c	36.00 a	36.70 a
	3	31.00 ab	31.00 ab	36.20 a
	6	29.00 a-c	29.67 bc	28.79 b-d
	9	27.00 bc	29.33 bc	27.40 b-d
	12	27.67 bc	25.67 b-d	23.73 c-e
Level of significant		*	*	*
LSD0.05		3.97	5.27	6.33
CV (%)		8.05	11.57	7.37

Values having similar letter(s) in a column do not differ significantly at 0.05 level of probability
*Significant at 0.05 level of probability

The bulb diameter, length of bulb and individual bulb weight of onion were showed significant variation among the treatment combinations of two varieties and five levels of salinity (Table 2). The maximum diameter of bulb (33.00 mm) was found in BARI piaz 1 with 0 dSm^{-1} level of soil salinity, whereas the minimum diameter of bulb (25.67 mm) was found in same onion with 12 dSm^{-1} level of soil salinity. In case of bulb length and individual bulb weight of two onion varieties, the highest bulb length (36.00 mm) and individual bulb weight (36.70 g) were found in BARI piaz 6 with 0 dSm^{-1} level of soil salinity and the lowest results (21.67 mm and 17.29 g, respectively) were obtained in BARI piaz 1 at 12 dSm^{-1} level of salinity. Chang and Randle (2004) observed that the leaf and bulb fresh weight of onion plants decreased with increasing NaCl concentrations in nutrient solutions and they also stated that onion plants react to salinity by reducing growth.

In case of single effect of variety, it appears from the results presented in table 3 that there was no significant variation of percent (%) N, P, K, S and Na content in bulb of two selected onion varieties

under mean effect of different salinity levels. But the single main effect of different levels of salinity showed a statistically significant variation of percent (%) N, P, K, S and Na content in onion bulb, where N, P and K concentrations decreased with increasing salinity levels and S, Na concentrations increased with increasing salinity levels (Table 3).

Table 3. Effects of onion varieties, different salinity levels and their interaction on N, P, K, S and Na content of onion

Treatment						
Variety	**Salinity levels (dSm^{-1})**	**N (%)**	**P (%)**	**K (%)**	**S (%)**	**Na (%)**
Effect of variety						
V_1 (BARI piaz 1)		0.024	0.09	1.03	0.15	1.13
V_2 (BARI piaz 6)		0.025	0.07	1.06	0.13	1.13
Level of significant		NS	NS	NS	NS	NS
CV (%)		5.08	6.08	6.11	9.60	7.54
Effect of salinity						
	0	0.029 a	0.10 a	1.23 a	0.10 b	0.73 b
	3	0.028 ab	0.09 ab	1.15 ab	0.12 ab	0.85 b
	6	0.025 ab	0.08 ab	1.04 ab	0.13 ab	0.91 b
	9	0.021 b	0.08 ab	0.90 b	0.14 ab	1.52 a
	12	0.020 b	0.05 b	0.85 b	0.17 a	1.64 a
Level of significant		*	*	*	*	*
$LSD_{0.05}$		0.005	0.04	0.29	0.06	0.41
CV (%)		5.08	6.08	6.11	9.60	7.54
Interaction effect of variety and salinity						
V_1	0	0.028 a	0.10 a	1.11 ab	0.09 b	0.68 b
	3	0.027 a	0.10 a	1.10 ab	0.13 ab	0.79 b
	6	0.023 ab	0.09 a	1.05 ab	0.13 ab	0.91 b
	9	0.021 b	0.08 ab	1.00 ab	0.15 ab	1.52 a
	12	0.019 b	0.06 b	0.81 b	0.18 a	1.76 a
V_2	0	0.029 a	0.10 a	1.35 a	0.10 ab	0.79 b
	3	0.028 a	0.10 a	1.21 ab	0.11 ab	0.91 b
	6	0.026 ab	0.06 b	1.04 ab	0.12 ab	0.91 b
	9	0.021 b	0.06 b	0.92 ab	0.12 ab	1.52 a
	12	0.020 b	0.05 b	0.89 b	0.16 ab	1.52 a
Level of significant		*	*	*	*	*
$LSD_{0.05}$		0.007	0.04	0.47	0.07	0.53
CV (%)		5.08	6.08	6.11	9.60	7.54

Values having similar letter(s) in a column do not differ significantly at 0.05 level of probability
*Significant at 0.05 level of probability

The interaction effect of two onion varieties and five levels of salinity showed significant variation of percent (%) N, P, K, S and Na content in onion bulb (Table 3). The N, P and K concentrations (%) decreased with increasing salinity levels and S, Na concentrations (%) increased with increasing salinity levels in both the cultivars, where the highest Na content (1.76 %) was recorded in BARI piaz 1 with 12 dSm^{-1} level of salinity (Table 3). Increasing the levels of irrigation salinity decreased contents of K, Ca, N, P, Mg, Fe, Zn, Cu and B in onion bulb and increased contents of Na, Cl and Mn (Kuscu *et al.*, 2020). Chang and Randle (2004) observed that the bulb Na^+ and Cl^- content increased in response to increasing NaCl concentrations in nutrient solutions and also stated that increasing bulb S content indicating less S was entering in the S metabolic stream.

Based on the above results it may be concluded that the BARI piaz 6 had better expression of growth and yield contributing characters than BARI piaz 1 in all cases except plant height and BARI piaz 1 contained higher amount of Na. Generally, the tolerant cultivar showed lower Na concentration

reflecting the dilution effect of tolerance mechanism, where the plant breeder may adapt the technique of selection or screening the genotypes and develop salt tolerant onion cultivars.

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