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SHORT COMMUNICATION

Performance of Different Sugarcane Genotypes under Salinity Stress

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The Environment Program of United Nations estimates that approximately 20% of the world's agricultural land and nearly 50% of all irrigated land is adversely affected by soil salinity (Flowers & Yeo, 1995). It is a worldwide problem, but most acute in North and Central Asia, Australia and South America (Pessarakli, 1999). Some of the most serious problems occur in semi-arid regions associated with the great river systems of South-East Asia. In Bangladesh, over 30% of the net cultivable area lies in the coastal zone of Bay of Bengal, of which approximately53% is affected by varying degrees of salinity. The salt affected area in the coastal zone of the country was about 0.83 million ha in 1966-76, which expanded to 3.1 million ha over the last two decades In addition, more area in that zone is expected to become saline affected in future due to increase in sea water level as a consequence of the greenhouse effect. The other concern is that the area under irrigation is increasing worldwide day by- day leaving more area to be affected by salinity stress. As estimated by FAO, about 20-30 million ha of irrigated lands worldwide were seriously damaged in 2002 due to the build-up of salts (Martinez-Beltran & Manzur, 2005). Moreover, in the same investigation it was also reported that every year 0.25-0.50 million ha of irrigated lands worldwide are lost from production due to salts build-up.

Depending on the ability to grow in saline environment plants can be grouped as halophytes and glycophytes. Halophytes are native to saline soils (around 500 mM NaCl) and able to complete their life cycle in that environment (Colmer, Flowers & Munns, 2006). Glycophytes or non-halophytes, on the other hand, can not survive at a high salt concentration. Most of the agricultural crops are glycophytes although some of them like sugar beet, barley, wheat etc. can tolerate salt to some extent. Rice is one of the most sensitive plants to salinity with the critical tolerance level 40 mM (Glenn, Brown & Khan, 1997).

Sugarcane is a typical glycophyte and hence exhibits stunted growth or no growth under salinity, with its yield falling to 50% or less than its true potential. To sustain sugarcane production and to improve the productivity, tolerance to biotic and abiotic stresses, nutrient management, improved sugar recovery are some of the concerns. Both the conventional and biotechnological methods have greatly contributed in solving some of these constraints.

In Bangladesh sugarcane is an important cash-cum industrial crop but its yield is very low (about 50t/ha). One of the main causes of low yield in sugarcane is the vulnerability of the crop to environmental stresses. Among the environmental stresses, salinity is one of the major problem in reducing crop yield. About 0.833 million hectares of available lands of southern districts of Bangladesh are affected by varying degrees of soil salinity. Sugarcane cultivation in saline areas received no attention in the past, but due to increased demand for sugar and gur, it has become imperative to explore the potentials of these lands where sugarcane is being cultivated years together without adopting modern technologies.

Plants develop a plethora of biochemical and molecular mechanisms to cope with salt stress. A number of nitrogen-containing compounds accumulate in plants exposed to saline stress. The most frequently accumulating nitrogen-containing compounds include amino acids, amide, proteins, quaternary ammonium compounds, and polyamines. The specific nitrogen containing compounds that accumulate in saline environments vary with plant species. Many plants accumulate proline as a nontoxic and protective osmolyte under saline conditions (Jain et al., 2001; Pujol et al., 2001; Parida et al., 2002).

Some morphological traits associated with tolerance under salinity, however are yet to be identified. Main objective of this experiment was to find out the suitable varieties for cultivation in saline areas of Bangladesh.

The experiment was conducted at salinity prone area at Terokhada (Khulna) during 2010- 2011 cropping seasons. Ten promising genotypes and three commercial varieties (standard) were tested. The experiments were laid out in RCB design with three replications. Two budded setts were planted at trenches following end to end method of planting. NPKS fertilizers were applied @ 325 kg urea, 250 kg TSP, 190 kg MP, 180 kg Gypsum and 9 kg ZnSO4 per hectare. Urea was applied in 3 splits and MP in two splits. Intercultural operations were done as and when required. Data on tillers, millable canes and yield production were recorded at harvest. Salinity level was determined in different months from planting to harvesting period.

Brix was determined by Brix refractometer. Proline concentrations were determined on a mg/g fresh weight basis using the method of Bates *et al* (1973).

Statistical analysis was performed and mean values were compared using LSD at 5% level of significance (Gomez and Gomez, 1984).

Different genotypes have significant effects on tiller, millable cane, yield, brix percentage and proline. Highest tiller was produced by the clone I 189-04 (177.7 t ha^{-1}) followed by Isd 39 (171.7 t ha^{-1}) and Isd 40 (172.7 t ha^{-1}). Highest Millable cane was produced by the clone I 189-04 (124.6 t ha^{-1}) followed by Isd 39 (118.1 t ha^{-1}) and Isd 40 (119.9 t ha^{-1}). Highest yield was obtained by the clone I 189-04 (114.6 t ha^{-1}) followed by Isd 39 (102.7 t ha^{-1}) and Isd 40 (105.5 t ha^{-1}). Highest Brix was obtained by the genotypes Isd 38 (23%) and Isd 40 (23%). Tiller, millable cane and yield of the clones I 111-03 is 137.9 tha^{-1} 92.7 tha^{-1}, 74.2 tha^{-1}, I 6-04 is 91.9 tha^{-1} 67.7 tha^{-1}, 71.1 tha^{-1}, I 152-04 is 138.9 tha^{-1} 89.2 tha^{-1}, 75.8 tha^{-1}, I 91-05 is 144.2 tha^{-1} 94.8 tha^{-1}, 81.5 tha^{-1}, I 94-05 is 157.7 tha^{-1} 99.4 tha^{-1}, 85.5 tha^{-1}, Isd 18 (T_2) is 144.4 tha^{-1} 95.8 tha^{-1}, 81.4 tha^{-1} and Isd 38 is 145.6 tha^{-1} 96.2 tha^{-1}, 89.3 tha^{-1} which are not so poor and greater than our national average yield of sugarcane. Brix percentage of that genotypes are 21.9 is for I 111-03, 17.3 is for I 6-04, 16.0 is for I 152-04, 21.3 is for I 91-05, 21.5 is for I 94-05, 19.6 is for Isd

18 (T_2) which is not so bad for gur making because Terokhada (Khulna) is a non mill zone area where the produced sugarcane is used for gur making. All the above performance were showed by the genotypes upto 17.2 dS/m salinity level in the month of April. On the otherhand, the genotypes I 139-05, I 150-05 and I 25-04 produced poor tiller, millable cane and yield upto this level of salinity.

Highest proline percentage was obtained by the genotype Isd 39 (1.519 mg/g) followed by I 189-04 (.998 mg/g) and Isd 40 (.929 mg/g). Proline accumulation in salt stressed plants is a primary defense response to maintain the osmotic pressure in a cell, which is reported in salt tolerant and salt sensitive cultivars of many crops (de Lacerda *et al.*, 2003; Kumar *et al.*, 2003; de Lacerda, *et al.*, 2005; Demiral & Türkan, 2005; Mansour *et al.*, 2005; Misra & Gupta, 2005; Desingh & Kanagaraj, 2007; Koca *et al.*, 2007; Veeranagamallaiah *et al.*, 2007). In the present study, proline accumulation in the salt sensitive genotype I 150-05 is 0.322 mg/g, I 139-05 is 0.325 mg/g and I 25-04 is 0.337 mg/g.

Jaleel et. al., 2008 observed that growth performance of the plants was estimated by measuring plant height, leaf area, root length, and total fresh weight and dry weight under NaCl stress and observed that plant growth was negatively affected. Shoot growth is of prime importance among a number of growth parameters in appraising the salt tolerance of plants. It may vary with species or cultivars, or even within a population. There is a lot of material available on salt-induced growth reduction, even in halophytic species, e.g., Qian *et al.*, (2001) in Kentucky bluegrass, Gulzar *et al.* (2003) in coastal salt marsh grass *Urochondra setulosa* and Alshammary *et al.*, (2004) in Kentucky bluegrass, tall fescue, alkaligrass, and saltgrass. The main reason of growth reduction could be due to decrease in turgor developed by water potential imbalance (Bohnert *et al.*, 1995). Natural populations have ability to limit the assimilation rate, and ultimately enhance water use efficiency, so such reduction in growth may be an important adaptation in salt tolerant populations to cope with harsh climatic conditions (Monteverdi *et al.*, 2008).

Salinity is one of the major limitations on crop productivity and quality in the world. Katerji et al. (1998) and Hoorn et al. (2002) has shown that the negative effects of salinity are reducing the growth rate, biomass reduction, shorter stature, smaller leaves, osmotic effects, nutritional deficiency as well as mineral disorders. The decline in growth observed in many plants subjected to salinity stress is often associated with a decrease in their photosynthetic capacity (Qiu and Lu, 2003). The decrease in photosynthesis induced by salt stress is mainly associated with decrease in stomatal conductance or gs (Centritto et al., 2003) and/or the non-stomatal limitation involved in the dark enzymatic process of CO2 conductance and assimilation (Centritto et al., 2003). A decrease of Pn under saline conditions has been reported for some plant species (Delfine et al., 1999; Loreto et al., 2003; Qasim et al., 2003; Qiu et. al., 2003). However, photosynthesis in some plant species is not reduced by the salinity and is even stimulated by low salt concentrations (Kurban et al., 1999). Many attempts have been made to detect differences in salinity tolerance of crop species or cultivars by measuring photosynthetic parameters (Ashraf et al., 2002; Loreto et al., 2003; Lee et al., 2004).

Screening sugarcane against Salinity stress. (Location :Khulna, Terokhada)

Varieties/ Genotypes	Tiller (103 ha^{-1})	Millable cane (10^3 ha^{-1})	Yield TCH	Brix	Proline (mg/g)
I 111-03	137.9 e	92.7 ab	74.2 f	21.9 ab	0.378 g
I 6-04	91.9 f	67.7 bc	71.1 c	17.3 fg	0.501f
I 152-04	138.9 e	89.2 ab	75.8 f	16.0 g	0.514 f
I 189-04	177.7 a	124.6 a	114.6 a	19.7 cde	0.998 b
I 91-05	144.2 b	94.8 ab	81.5 e	21.3 abcd	0.525 f
I 94-05	157.7 c	99.4 ab	85.5 d	21.5 abc	0.807 e
I 139-05	84.4 g	61.7 bc	58.0 i	20.6 bcd	0.525 f
I 150-05	55.0 f	40.9 c	40.1 j	18.5 ef	0.322 h
I 25-04	66.7 h	42.1 c	40.4 j	21.7 ab	0.337 gh
Isd 18 (T_2)	144.4 d	95.8 ab	81.4 e	19.6 de	0.889 cd
Isd. 38	145.6 d	96.2 ab	89.3 d	23.0 a	0.839 de
Isd. 39	171.7 b	118.1 a	102.7 c	19.7 cde	1.519 a
Isd. 40	172.7 b	119.9 a	105.5 b	23.0 a	0.929 c
LSD (0.05)	1.678	43.90	1.678	1.678	0.05307

Different letter indicates significance difference as per LSD at 5% level

Average salinity level of the experimental plots are stated bellow:

Months	Salinity level EC (dS /m)	Growing phase of the sugarcane plant
November, 2010	1.10	Germination stage
December, 2010	1.03	
January, 2011	2.43	Growth stage
February, 2011	4.21	
March, 2011	6.4	Tillering stage
April, 2011	17.2	
May, 2011	5.4	
June, 2011	2.1	Crop formative stage
July, 2011	2.9	
August, 2011	3.4	
September, 2011	3.7	
October, 2011	2.2	
November, 2011	1.3	Harvesting stage

From the above discussion it may be concluded that most of the genotypes except I 139-05, I 150-05 and I 25-04 showed better performance under saline stress condition may be selected as tolerant genotypes for salinity stress. The genotypes I 189-04, Isd 38, Isd 39 and Isd 40 showed better performance under salinity stress condition and they also produced more proline than other genotypes which helps them to better performance under salinity stress than other genotypes. So, we can say that the genotypes I 189-04, Isd 38, Isd 39& Isd 40 is much better and I 111-03, I 6-04, I 150-04, I 91-05, I 94-05 and Isd 18 (T_2) is better for cultivation under salinity stress condition. All these information would help to develop strategies for identifying salinity tolerant sugarcane genotypes.

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