

Original Research Article

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Response of Promising Sugarcane Genotypes for Salinity Tolerance

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ABSTRACT

Keywords

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An experiment was conducted to evaluate salinity tolerance of promising sugarcane genotypes with microplot techniques at Agricultural Research Station, Perumallapalle, ANGRAU, Andhra Pradesh during 2018-19. Nine sugarcane genotypes along with four checks were studied for salinity tolerance with two treatments *viz.*, control and salt treatment. Soil EC of 6 dS m⁻¹ was developed in salt treatment with external addition of salt water. Results revealed that the mean germination, single cane weight, sucrose and commercial cane sugar (CCS) were significantly differed by genotypes. The control treatment recorded higher mean germination (65%), single cane weight (1.062 kg) and sucrose (17.44%) than salt treatment (54%, 1.000 kg and 15.83%, respectively). Among genotypes Co 86032, 2012 T 58, 2012 T 72 showed less reduction in germination, 2012 T 81, Co 86032, 2012 T 58, 2012 T 72 and 2012 T 58 recorded less reduction in cane weight under saline conditions. The genotypes Co 86032, 2012 T 72 and 2003 V 46 showed maximum K/Na ratio than other genotypes. Consider these parameters, 2012 T 58, 2012 T 72, 2012 T 180 and Co 86032 genotypes showed salt tolerance.

Introduction

The beginning of 21st century is marked by global scarcity of water resources, environmental pollution and increased salinization of soil and water. Increasing human population and reduction in land available for cultivation are two threats for agricultural sustainability (Shabhaz and Ashraf, 2013). Various environmental stresses *viz.*, high winds, extreme temperature, soil salinity, drought and flood have affected the production and cultivation of agricultural crops, among these soil salinity is one of the most devastating environmental stresses,

which causes major reduction in cultivated land area, crop productivity and quality. It has been estimated that worldwide 20% of total cultivated and 33% of irrigated agricultural lands are affected by high salinity. Furthermore, the salinized area is increasing at a rate of 10% annually for various reasons, including low precipitation, high surface evaporation, weathering of native rocks, irrigation with saline water and poor cultural practices. Problematic soils are a major limiting production factor for every major crop (Bacilio *et al.*, 2004; Shannon and Grieve 1999).

Sugarcane (*Sacharun officinarum* L.) is a typical glycophyte grown in arid and semiarid regions and frequently subjected to soil salinity (Lingle and Weigand, 1997). The crop is moderately sensitive to salinity. Salinity inhibits plant growth by ion toxicity, nutritional imbalances, osmotic effect and oxidative stress (Chinnusamy *et al.*, 2005). Using the salt tolerant crops is one of the most important strategies to solve the problem of salinity. Salt tolerance in crops will also allow the more effective use of poor quality irrigation water. (Manchanda and Garg., 2008). The differential growth performance of plant species / genotypes under salinity may be related to their ability to uptake, transport of ions and salt exchange mechanisms. Salt tolerant genotypes compromises either in yield or quality and thus able to perform mechanisms. Keeping this in view present experiment was designed to study the relative salt tolerance of sugarcane genotypes grown in saline soils with EC of 6 dS m⁻¹.

Materials and Methods

The experiment was conducted at Agricultural Research Station, Perumallapalle, Tirupati, ANGRAU, Andhra Pradesh during 2018-2019 by using micro plot, technique. Nine pre release sugarcane genotypes along with four standard checks were evaluated with two treatments *viz.*, control and salt treatment (soil EC @ 6 dS m⁻¹) for salinity tolerance. The experiment was laidout in factorial RBD design with two replications. Ten single bud setts per each pot were planted during February, 2018 and harvested in January, 2019. The initial soil samples were collected and analyzed by following standard procedures. The analyzed data has been presented in table 1. Before planting of setts, soil EC was developed to 6 dS m⁻¹ and maintained until harvest with addition of salt water contains NaCl, CaCl₂ and Na₂SO₄ in ratio of 2:2:1 to salt treated pots. The plant

samples were collected at grand growth stage for determination of K and Na content. The data on germination, cane length, girth, single cane weight, juice quality parameters like sucrose, commercial cane sugar (CCS), purity, K/Na ratio in plant tissue were recorded in both the treatments for all genotypes. Data obtained from the experiment was statistically analysed by method described ny Panse and Sukhatme (1985).

Results and Discussion

Characteristics like germination, cane weight, Na accumulation and K⁺/Na⁺ ratio have been considered useful guide to assess plants for salt tolerance. Selection of genotypes on this basis is an important strategy to minimize yield losses in saline soils (Santa maria and Epstein, 2001).

Germination

The germination of sugarcane significantly influenced by genotypes, treatments as well as with their interaction (Table 2). Maximum mean germination percent (76%) was recorded with 2012 T 58, but was found at par with Co 86032 (67%). Among the treatments control pot showed significantly the highest mean germination (65%) than salt treated pots (54%). In interaction effect, genotype 2012 T 58 in control treatment recorded higher germination (80%) and it was on par with other genotypes. Percent reduction on germination was less (3% only) with Co 86032 followed by 2012 T 58 (8%), 2012 T 72 (8%), 2012 T 78 (8%) under saline conditions. This data indicates that the genotypes Co 86032, 2012 T 58, 2012 T 72 showed salt tolerance than other genotypes. Recent reports also show that salinity adversely affects plant growth and development, hindering germination, seedling growth and enzyme activity (Seckin *et al.*, 2009).

Table.1 Initial soil properties

Particulars	Value
Soil pH	7.37
Soil EC (dS m ⁻¹)	0.391
Organic carbon (%)	0.47
Available N (kg ha ⁻¹)	221
Available P ₂ O ₅ (kg ha ⁻¹)	42
Available K ₂ O (kg ha ⁻¹)	210

Table.2 Effect of salinity on germination and single cane weight of sugarcane genotypes

Genotypes	Germination %				Single cane weight (kg)			
	Control	Salt treated	Mean	% reduction	Control	Salt treated	Mean	% reduction
2012 T58	80	72	76	8	1.017	1.004	1.010	1.4
2012 T 72	68	60	64	8	1.011	0.999	0.999	1.2
2012 T 73	65	55	60	10	0.990	0.880	0.935	11.2
2012 T 78	65	58	61	8	1.283	1.188	1.235	7.4
2012 T 81	63	53	58	10	1.046	1.039	1.042	0.7
2012 T 106	40	30	35	10	1.012	0.988	1.000	2.4
2012 T 115	60	45	53	15	0.929	0.900	0.929	3.1
2012 T 180	58	23	40	35	0.966	0.910	0.938	5.8
2012 T 182	60	48	54	13	1.268	1.184	1.226	6.6
2003 V 46	75	55	65	20	1.022	0.985	1.022	3.6
Co 99004	73	55	64	18	1.226	1.049	1.137	14.4
2005 T 52	75	65	70	10	1.011	0.953	1.011	5.7
CO 86032	68	65	67	3	0.931	0.928	0.930	0.4
Mean	65	54			1.062	1.000		
	CD	SE(m)			CD (0.05)	SE(m)		
Varieties	9.25	3.17			0.091	0.044		
Treatments	3.62	1.24			0.036	0.018		
VxT	13.08	4.49			N.S.	0.063		

Table.3 Effect of salinity on sucrose and CCS of sugarcane genotypes

Genotypes	Sucrose (%)				CCS *%)			
	Control	Salt treated	Mean	% reduction	Control	Salt treated	Mean	% reduction
2012 T58	16.81	15.85	16.33	5.7	11.67	11.27	11.47	3.4
2012 T 72	16.75	16.40	16.57	2.1	11.25	10.53	10.89	6.4
2012 T 73	16.82	15.98	16.40	5.0	11.69	10.84	11.26	7.2
2012 T 78	17.30	15.98	16.64	7.6	11.68	10.89	11.29	6.8
2012 T 81	16.20	15.48	15.84	4.5	10.98	10.26	10.62	6.6
2012 T 106	18.11	15.14	16.63	16.4	12.86	10.05	11.45	21.9
2012 T 115	18.40	16.08	17.24	12.6	12.88	10.87	11.88	15.6
2012 T 180	17.17	16.61	16.89	3.3	12.50	11.60	12.05	7.2
2012 T 182	19.30	17.20	18.25	10.9	12.51	12.49	12.50	0.1
2003 V 46	17.84	15.46	16.65	13.3	12.45	10.74	11.59	13.8
Co 99004	17.14	15.39	16.26	10.2	11.82	10.35	11.08	12.5
2005 T 52	16.66	15.16	15.91	9.0	11.39	10.17	10.78	10.7
CO 86032	16.87	15.62	16.25	7.4	11.45	10.53	10.99	8.1
Mean	17.44	15.83			12.02	10.80		
	CD (0.05)	SE(m)			CD (0.05)	SE(m)		
Varieties	0.359	0.444			1.389	0.476		
Treatments	0.916	0.174			N.S.	1.215		
VxT	N.S.	0.629			N.S.	1.719		

Table.4 Effect of salinity on K and Na ratio in plant of sugarcane genotypes

Genotypes	K/Na ratio	
	Control	Salt treated
2012 T58	5.17	4.35
2012 T 72	5.38	4.33
2012 T 73	5.20	4.18
2012 T 78	5.23	4.40
2012 T 81	5.24	4.28
2012 T 106	5.20	4.34
2012 T 115	5.10	4.28
2012 T 180	5.00	4.40
2012 T 182	5.20	4.38
2003 V 46	5.23	4.26
Co 99004	5.13	4.47
2005 T 52	5.12	4.26
CO 86032	5.48	4.52

Single cane weight

The data pertaining to single cane weight was presented in table 2. Genotypes and treatments showed significant effect on single cane weight where as interaction effect was non significant. 2012 T 78 has higher mean single cane weight (1.235 kg) which was at par with 2012 T 182 (1.226 kg). Control pot showed significantly the highest single cane weight (1.062 kg) over salt treated pot. The genotype Co 86032 showed less percent reduction in single cane weight (0.4%) under salt toiled pots followed by 2012 T 81 (0.7%), 2012 T 72 (1.2%) and 2012 T 58 (1.4%). Reduction in cane weight of sugarcane genotypes in salt treatment might be due to toxicity of Na^+ ions which causes imbalance of other nutrients like K^+ and Ca^+ . It consequently resulted in metabolic imbalances which reduces growth and yield. Chinnasamy *et al.*, 2005 also reported that under salt stress, the predominant cause of reduced plant growth appeared to be ion toxicity rather than osmotic stress. The magnitude of decline in cane weight among sugarcane genotypes varied possibly because of their differential selectivity for K^+ ions over Na^+ (Ashraf *et al.*, 2007; Asch *et al.*, 2000).

Sucrose

Sugarcane genotypes grown in control pots resulted significantly the highest mean sucrose (17.44%) than salt treated pots (15.83%). The sucrose content in sugarcane genotypes has significant difference (Table 3). Even though 2012 T 182 showed the highest mean sucrose (18.25%), deterioration of sucrose is more under salt treated pots (10.9%). Among genotypes, 2012 T 72 showed less deterioration (2.1%) followed by 2012 T 180 (3.3%), 2012 T 81 (4.5%) and 2012 T 58 (5.7%) under saline conditions. The interaction effect between genotypes and treatments was non significant. Similar

findings were also observed by Vajantha *et al.*, 2017.

Commercial cane sugar (ccs)

A perusal of data in table 3 indicated that declining of CCS (10.80%) under salt treatment than control (12.02%). CCS was significantly influenced by genotypes. Among the genotypes 2012 T 182 recorded higher mean CCS (12.50 %) and was found to at par with 2012 T 180, 2012 T 115, 2003 V 46, 2012 T 106, 2012 T 58, 2012 T 73 and 2012 T 72. The interaction between genotypes and treatments was found to non significant. Wahid *et al.*, (1997) also observed that the CCS has been differed with different sugarcane genotypes.

Potassium sodium ratio in plant

The K/Na ratio was more in control than salt treatment. Applied salinity causes increased Na^+ concentration and consequently reduced K^+/Na^+ ratio, however it varied widely among various sugarcane genotypes. Among the genotypes Co 86032 showed minimum K^+/Na^+ ratio (5.48) followed by 2012 T 72 (5.38) and 2003 V 46 (5.23). The K^+/Na^+ ratio in plant under control conditions ranged from 5.00 to 5.48. It reduced to the range from 4.18 to 4.52 under saline conditions. Reduction in K^+/Na^+ ratio of sugarcane genotypes in the presence of salinity could be due to the antagonism of Na^+ and K^+ . (Mohmoud Shoneili *et al.*, 2011 and Vajantha *et al.*, 2017.

From this data, it is concluded that sugarcane genotypes showed significant difference in germination, single cane weight, sucrose and K^+/Na^+ ratio when grown under saline conditions. The genotypes 2012 T 58, 2012 T 72, 2012 T 180 and Co 86032 were suitable for saline conditions.

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