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Response of sugarcane genotypes for saline irrigation water tolerance in coastal areas of Andhra Pradesh

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Abstract
A field experiment was conducted at SRS, Vuyyuru in order to study the performance of promising pre release clones of sugarcane under saline water irrigated conditions in sugarcane ratoon crop. The clones such as 2004 V 76, 2005 V 96, 2005 V 170, 2006 V 60, 2006 V 71 and 2006 V 87 were tested against check Co7219. The water used is having pH 7.60, E.C 2.41 dS m^{-1}, TDS 1566 mg/l, total hardness 540 ppm and chlorides 600 ppm. All the promising pre release clones recorded more yield, quality, nutrient uptake and nutrient availability in post harvest soils compared to check variety *i.e* Co 7219. Among the clones tested, 2006 V 71 recorded highest yield, CCS yield and 2005 V 96, 170 and 2006 V 87 were on par with 2006 V 71. Nutrient uptake was also more by 2006 V 71 followed by 2007 V 87 and 2005 V 96. E.C of post harvest soils has shown non significant effect. pH, organic carbon, nutrient availability of nitrogen, phosphorus and potassium were more in the soils harvested with 2006 V 71 and 2006 V 87, 2005 V 96 were on par with 2006 V 71.

Keywords: Sugarcane, saline irrigation water, sugarcane genotypes, promising pre-release clones, salt tolerance

Introduction
Soils affected by salts commonly appear in irrigated areas due to improper and irregular management of the irrigation and other agricultural management practices without aiming the conservation of the productivity of the soil, and hence, arable land is becoming more and more saline. The management practices include lack of an efficient drainage system, the use of inadequate quality water in inadequate amounts, and also the indiscriminate and excessive use of chemical fertilizers. Irrigation is an ancient agricultural practice, widely used throughout the world, principally in tropical regions where hot and dry climates prevails. Since all natural waters contain variable amounts of soluble salts, either meteoric (rain), surface (rivers, lakes, dams, etc.) or subterranean (aquifers) origin, the application of water to the soil by irrigation implies necessarily in the addition of salts to their profile. Thus salinization of a soil depends on the quality of the water used for irrigation, on the existence and level of natural and/or artificial drainage of the soil, on the depth of the water-bearing stratum and on the original concentration of salt in the soil profile.

The basic principle to avoid soil salinization is to maintain the equilibrium between the amount of salt provided to the soil by irrigation and the amount of salt removed by drainage. Further, Plant responses to salinity varied differently from soil to soil and from salt type to salt type, and the plant is different among crop species and growth phases. Growing tolerant crops can give good results on saline soils Bekmirzaev *et al* (2011) [2] and Bekmirzaev *et al* (2019) [3].

Andhra Pradesh is having coastal line of 972 km. In most of the areas, water is saline due to protruding of sea water or seepage of sea water in to sub surface layers. Sugarcane is growing in coastal areas of Andhra Pradesh especially in Krishna district in which saline water is used for irrigation leading to deterioration of soil quality finally resulting in reduced yield and quality compared to normal healthy soils and good quality irrigation waters. It is very much beneficial to the farmers to get good yields even under saline irrigated water conditions if salt tolerant varieties are used. Hence, the present study was taken up with the objective to screen out tolerant sugarcane genotypes for saline irrigation water.

Materials and Methods

A field experiment was conducted at Ayodhya, Challapalli mandal in the farmer`s field to study the performance of promising pre- release clones of sugarcane using saline water for irrigation. Six promising pre – release clones *viz.,* 2004 V 76, 2005 V 96, 2005 V 170, 2006 V 60, 71 and 87 were tested with standard Co 7219. Experiment was conducted in soil having pH 7.90, EC 0.641 dS m^{-1}. Soil is low in available nitrogen (257.5kg/ha) and high in available phosphorus (89 kg/ha) and potassium (600 kg/ha Table 1). Treatments were replicated thrice in R.B.D design. Irrigation water used has pH 7.60, E.C 2.41 dSm^{-1}, TDS 1566 mg/l, total hardness 540 ppm and chlorides 600 ppm (Table 2).

Table 1: Initial soil characteristics in which experiment was conducted

S. No.	Parameter	Value
1.	pH	7.90
2	E.C.	0.641 dS m^{-1}
3	Available nitrogen	257.5 $kgha^{-1}$
3	Available phosphorus	89 $kgha^{-1}$
4	Available potassium	600 $kgha^{-1}$
5	Available zinc	1.03 ppm
6	Available iron	21.50 ppm
7	Available copper	8.10 ppm
8	Available manganese	12.20 ppm

Table 2: characteristics of irrigation water used

S. No.	Parameter	Value
1.	pH	7.60
2	E.C.	2.41dS m^{-1}
3	T.D.S	1566 mg/l
4	Total hardness	540 ppm
5	Chlorides	600 ppm

Data was collected on germination percentage, shoot population at different stages of crop growth, cane yield and juice quality. Whole cane plant samples were collected at grand growth period, cut into pieces, oven dried, powdered and analysed for nutrient contents of N, P & K using standard methods (Bremner and Mulvaney 1982 [4], Jackson, 1973 [9] and Muhr *et al*, 1963 [12], respectively). Uptake of nutrients was calculated using the following formula…

$$\text{Uptake of nutrient (kg/ha)} = \frac{\text{\% Conc. of nutrient X Cane yield (t/ha) X 1000}}{100}$$

After harvesting the crop, post harvest soil samples were collected and were analysed for pH & EC in 1:2 ratio, available nitrogen using alkaline potassium permanganate method (Subbiah and Asija, 1956) [14], phosphorus using Olsen's method (Watanabe and Olsen, 1965) [17], and potassium using neutral normal ammonium acetate method (Muhr et al., 1963) [12]. All the data was statistically analysed using method described by Panse and Sukatme (1978) [13].

Results and Discussion

Response of clones of sugarcane on yield and quality

Plant tolerance to saline irrigation water is generally assessed by growth reduction. Tolerance to high salinity may be expected to vary with plant species and different growth stages of plants (Xue *et al;* 2019) [19]. 2006 V 71 was recorded highest yield of 108.93 t/ha and CCS yield of 15.18 t/ha. 2006 V 87 (103.36 t/ha), 2005 V 96 (103.67 t/ha) and 2005 V 170 (94.82 t/ha) were on par with 2006 V 71 in cane yield. 2005 V 96 (13.05 t/ha) and 2006 V 87 (13.87 t/ha) were on par with 2006 V 71 in CCS yield (Table 3 and Figure 1). Quality was non-significant among the clones tested. Brinda *et al* (2019) [5] reported that genotypes such as Co 85019 and Co 99004 are tolerant towards salt stress and gave better results compared to other genotypes and these genotypes could be used in saline lands for getting good yields. (Djajadi 2022) [6] also found that the tolerance of sugarcane variety had better growth than susceptible variety under saline stress. Major effects of moderate salt stress on growth could be attributed to a major investment of energy in defense mechanisms rather than in biomass production (Fahad *et al.* 2015) [7]. Dry biomass accumulation was severely affected and biomass allocation towards stem reduced drastically in sensitive types was proved by Vasanta *et al* 2010 [16].

Table 3: Response of promising pre-release clones of sugarcane on yield and quality under saline water irrigated conditions

S. No	Clone	Yield (t/ha)	Juice Sucrose (%)	CCS%	CCS Yield (t/ha)
1	2004 V 76	91.46	16.657	11.80	10.78
2	2005 V 96	103.67	17.483	12.57	13.05
3	2005 V 170	94.82	18.387	13.22	12.51
4	2006 V 60	88.10	19.15	13.95	12.22
5	2006 V 71	108.93	19.18	13.90	15.18
6	2006 V 87	103.36	18.617	13.43	13.87
7	Co 7219	84.76	16.33	11.58	9.80
	S.Em±	4.18	0.751	0.57	0.75
	CD	12.88	NS	NS	2.31
	CV	7.50	7.20	7.70	10.40

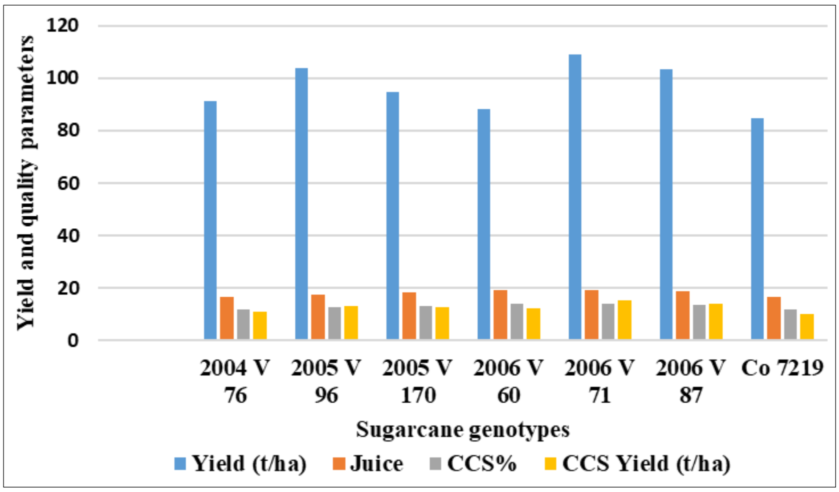

Fig 1: Response of promising pre-release clones of sugarcane on yield and quality under saline water irrigated conditions

Response of clones of sugarcane on nutrient uptake

Nitrogen, phosphorus and potassium uptake by sugarcane was more in all the promising pre-release clones of sugarcane compared to check (CO 7219) and was more by 2006 V 71 (1194.48, 93.43 and 960.70 kg/ha of nitrogen, phosphorus and potassium, respectively) followed by 2006 V 87 and 2005 V 96. 2006 V 87 recorded 958.16, 84.65 and 852.78 kg N, P and K, respectively and 2005 V 96 recorded 918.25, 81.22 and 812.29 kg N, P and K, respectively (Table 4 and Figure 2). The genotypes that are tolerant to salt stress resulted with more nutrient uptake of nutrients. Less nutrient contents in susceptible canes was might be due to the hindrance effect of high sodium absorption under saline water irrigation conditions. Djajadi (2022) [6] observed highest reduction of N and K nutrients absorption in the BL variety among the sugarcane varieties tested due to high sodium absorption occurred. Khan *et al* (2018) [10] clearly indicated that salinity level reduces the uptake of P and ultimately reduces the growth and yield by conducting experiment in *Ipomoea aquatica*. The final impact of salinity of soil solution on the concentration of phosphorus in plants mainly depends on plant species, phase of ontogenesis, the type and level of salinity and concentration of phosphorus that is already present in the soil. According to (Kochian 2000) [11], reduction of the availability of phosphorus in saline soils is the result of the antagonistic activity of ions which can reduce the activity of phosphate and phosphate transporters (of both high and low affinity), which are necessary for the uptake of phosphorus.

Table 4: Response of promising pre-release clones of sugarcane on nutrient uptake under saline water irrigated conditions

S. No	Clone	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
1	2004 V 76	620.34	56.29	644.19
2	2005 V 96	918.25	81.22	812.29
3	2005 V 170	711.15	65.25	646.94
4	2006 V 60	577.08	56.18	540.06
5	2006 V 71	1194.48	93.43	960.70
6	2006 V 87	958.16	84.65	852.78
7	Co 7219	451.86	43.46	480.84
	S.Em±	32.34	2.45	31.88
	CD	99.96	7.57	98.24
	CV %	7.24	6.20	7.80

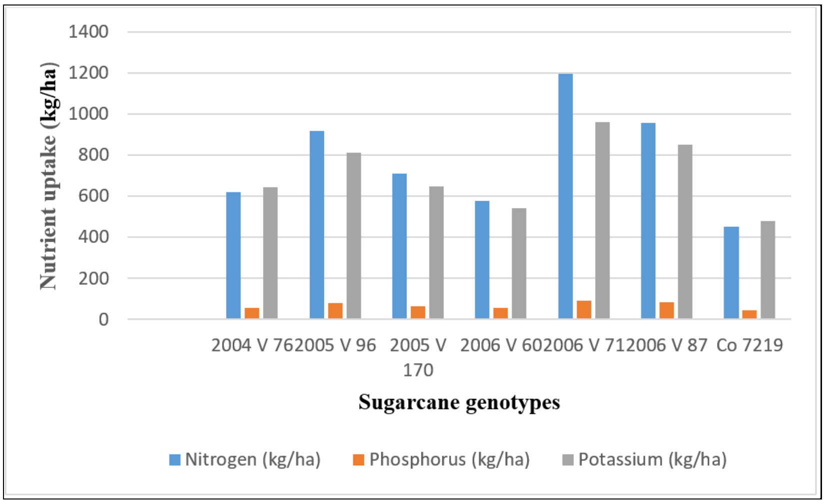

Fig 2: Response of promising pre-release clones of sugarcane on nutrient uptake under saline water irrigated conditions

Response of clones of sugarcane on nutrient availability in post harvest soils of sugarcane

pH was more in the soils harvested with 2006 V 87 and 2006 V 71 was on par with it while E.C. has shown non-significant effect. Organic carbon (0.915%), available nitrogen (242 kg/ha), phosphorus (64.18 kg/ha) and potassium (629.21 kg/ha) contents were more in soils harvested with 2006 V 87 and the clones viz., 2006 V 71 and 2005 V 96 were on par with it (Table 5 and Figure 3). This might be due to the fact that the excessive amounts of salts provided by irrigation waters can have adverse effects on the chemical and physical properties of the soils and on their biological processes (Garcia & Hernandez, 1996; Rietz & Haynes, 2003) [8, 15] which results in less availability of nutrients in soils. These effects include mineralization of the carbon and nitrogen and the enzymatic activity, which is crucial for the decomposition of organic matter and liberation of the nutrients that are necessary for sustainability of the production (Azam and Ifzal, 2006; Wong *et al*., 2008) [1, 18].

Table 5: Response of promising pre-release clones of sugarcane on physico-chemical properties and nutrient availability after harvest of sugarcane crop under saline water irrigated conditions

S. No	Clone	pH	E.C (dSm^{-1})	O.C (%)	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)
1	2004 V 76	7.37	0.66	0.810	218	50.17	460.13
2	2005 V 96	7.38	0.64	0.837	239	58.63	544.75
3	2005 V 170	7.46	0.62	0.738	228	55.74	540.99
4	2006 V 60	7.28	0.71	0.486	220	48.58	539.53
5	2006 V 71	7.58	0.63	0.821	248	60.28	609.48
6	2006 V 87	7.82	0.65	0.915	242	64.18	629.21
7	Co 7219	7.27	0.60	0.553	209	52.66	456.57
	S.Em±	0.11	0.04	0.042	7.14	2.15	18.47
	CD	0.341	NS	0.128	22.01	6.61	56.91
	CV%	2.60	11.70	9.80	5.40	6.70	5.90

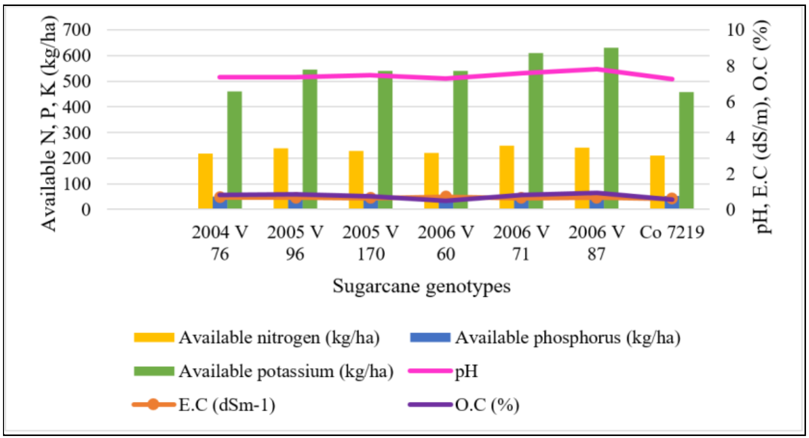

Fig 3: Response of promising pre-release clones of sugarcane on physico-chemical properties and nutrient availability after harvest of sugarcane crop under saline water irrigated conditions

Conclusion

Finally to summarise, 2006 V 71 resulted with highest cane yield, CCS yield, nutrient uptake of N, P, K and more nutrient status in post harvest soils and 2006 V 87 and 2005 V 96 were on par with 2006 V 71 in ratoon crop when saline water is used for irrigation. Hence, it can be concluded that 2006 V 71, 2006 V 87 and 2005 V 96 are tolerant to saline irrigation water and can be recommended to coastal soils of Andhra Pradesh for getting good yields when irrigation water is used for sugarcane crop.

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