

Sugarcane Clones for soil moisture stress / drought conditions of Andhra Pradesh

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ABSTRACT

Fifteen pre-release sugarcane clones were tested against sugarcane varieties 87A 298 and 83V 15 as checks for their suitability to early planted conditions (January planting) under moisture stress/drought at Regional Agricultural Research Station, Anakapalle during 2020-21, 2021-22, and 2022-23. Sugarcane clones tolerant to moisture stress is the need of the hour as sugarcane yields are drastically reducing due to moisture stress/drought. Field experiments were conducted with stress and non-stress treatments for the evaluation of sugarcane clones' tolerance to soil moisture stress/drought. Among fifteen pre-release sugarcane clones tested sugarcane clones 2015A 51 (96.06 t/ha), 2015A 233 (94.14 t/ha), 2015A 183 (89.12 t/ha) and 2015A 93 (84.09 t/ha) recorded higher cane yield over other clones tested. The standards 87A 298 and 83V 15 recorded a cane yield of 73.02 t/ha and 85.076 t/ha which are lower than the superior clones. These clones also recorded significantly low SLA which indicates more photosynthetic assimilates per unit area. SPAD/SCMR values at 120 DAP under stress conditions (summer). These sugarcane clones also recorded significantly higher SPAD/SCMR values with standard 87A 298. The ancillary data denoting stress tolerance like sheath moisture per-cent, root spread area, total bio-mass production per stool under stress, and physiological parameters like leaf-proline content is also high in these sugarcane clones. Based on three years of findings, sugarcane clones 2015A 51, 2015A 233, 2015A 183 and 2015A 93 were found to be suitable for drought/soil moisture stress conditions of cane cultivation based on cane yield, ancillary data, and physiological traits in relation to moisture stress tolerance. The drought tolerance efficiency per-cent was high in 2015A 59 (92.08%) followed by 2015A 233 (89.33%) and 2015A 93 (87.98%) over other clones tested. The standards 87A 298 and 83V 15 recorded a drought tolerance efficiency per cent of 72.27 and 67.52 respectively.

Keywords- Moisture stress/drought/limited irrigations, CSI (Chlorophyll Stability Index), SPAD/SCMR, leafproline, cane yield, Membrane injury index, percent juice sucrose, root spread area, Number of millable canes and Fibre per cent.

Introduction

In India UP, Karnataka and Maharashtra are the three states that accounted for more than 80% of Indian sugar production [3]. AP stands 11th position in area and production and 10th position in productivity in the country [2]. Sugarcane is grown under soil moisture stress/drought conditions in sizeable areas under early planting (December – January) in North Coastal districts in addition to rainfed cane cultivation. Nearly 40-50% of cane cultivation of the North Coastal zone is under moisture-stress conditions/rainfed cane cultivation. The crop experiences moisture stress at all crop growth stages. Moisture stress affects germination, cane length, cane diameter, single cane weight, cane elongation, biomass production, NMC, and cane yields under early planted rainfed conditions [13], [14] [11]. The relative water content (RWC) of sugarcane leaves of susceptible varieties to drought is lower than the tolerance once [15]. An abiotic or biotic stress in the growing phase in the period of rapid growth, cane drastically reduces the yield as well as affects the potential for regrowth and longevity of sugarcane crop [5]. The cane yields obtained are ranged from 40 - 45 t/ha under moisture stress conditions of Andhra Pradesh. SPAD/SCMR values, SOD values and carbon isotope discrimination values indices of moisture stress tolerance in field conditions [9]. In tolerant clones, high values of SPAD and other ancillary parameters with cane yield of sugarcane were recorded high under moisture stress conditions [16] [7]. Under drought management sugarcane variety also plays an important

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role along with other management practices to mitigate the yield loss to some extent [10].

In A.P., sugarcane varieties 87A 298 and 2003V 46 are the leading varieties occupying a considerable area of sugarcane which were released nearly 15 years back. Now due to degeneration of existing good varieties, there is a dire need of ample number of new sugarcane varieties especially with drought tolerance and higher cane yield and quality. Abiotic stresses are common factors lowering yields of A.P. Under these circumstances, this study was initiated with 15 pre-release sugarcane clones with an objective to identify sugarcane clones tolerance to moisture stress/drought during crop season especially of the formative stage of sugarcane which coincides with summer and maturity stage which coincides with the winter season.

Material and Methods

Fifteen promising pre-release clones were studied with 87A 298 as check variety under early planted moisture stress conditions at Regional Agricultural Research Station, Anakapalle during 2020-21, 2021-22, and 2022-23 for three years. The design adopted was RBD with 2 replications. Each clone was planted in six rows of eight meters in length with a spacing of 80 cms between rows. The date of planting was in the month of January 2020, 2021 and 2022. Moisture stress I_0 treatment was imposed by withholding irrigation from March, 15th except two life irrigations at 10 DAP and 40 DAP till harvesting of sugarcane, where as check I_1 (Normal) treatment was imposed by need-based monthly one irrigation from planting to harvesting of cane. Trash mulching @ 3 t/ha was done at 3rd day after planting. Soils are of light to medium texture with low to medium N and medium P and K nutrient status. Crop was raised by following all good management practices. Management of early shoot borer and white fly was carried out by spraying Monocrotophos @ 1.6ml/lit and biologically controlled using *Trichocards*. A fertilizer dose of 112 kg N + 100 kg P_2O_5 + 120 Kg K_2O /ha was adopted. Nitrogen was applied into two equal splits at 45 and 90

DAP, (and $\times$) P and K was applied as basal. Detrashing and spreading of dried leaves was carried out in between two rows to conserve soil moisture after the cessation of rains (November month). Data was recorded on cane yield, per-cent juice sucrose, ancillary data [6] and NMC at harvest, SCMR values at 120 DAP and leaf proline at 120 DAP were recorded by adopting standard procedures [4], duly following soil moisture data at the formative stage during summer months. Statistical analysis was carried out by methods given by [12].

Result and Discussion

The analyzed data on cane yield, yield components and other quality parameters with ancillary data are given in Table 1, 2, 3 & Fig D. The results obtained are presented on character-wise. The weather parameters including soil moisture data was given for 2020-21, 2021-22, 2022-23 in Table A, B & C. The soil moisture was low in stress treatment when compared to irrigation treatment in the months of soil sampling. The rainfall pattern during the sugarcane crop season at RARS, Anakapalle (2020, 2021, 2022) was given in figures A, B, C emphasizing the stress period at March 15th to June 15th (formative stage) and October 15th to January 15th (Maturity stage).

Table A: Weather parameters during 2020-21, 2021-22 and 2022-2023 crop season at Regional Agricultural Research Station, Anakapalle

2020-20

Month	Total rainfall (mm)		No. of rainy days		Rainfall + /	Temp. oC		RH %		Bright sunshine hrs.	Wind velocity (km.ph)	Evaporation (mm)
	Normal	Actual	N	A		Max	Min.	FN	AN			
March 2020	19.2	125.2	0.8	3	+106.0	33.8	22.2	90	50	7.0	3.3	5.4
April 2020	47.6	116.0	2.1	2	+ 68.4	35.6	24.7	90	52	7.8	4.3	6.1
May 2020	82.8	060.3	3.8	3	- 22.5	35.4	25.8	86	61	6.8	3.8	5.4
June 2020	119.1	183.0	6.8	9	+ 63.9	34.2	26.0	85	65	3.6	3.6	4.3
July 2020	131.0	243.8	7.9	11	+112.8	33.3	25.4	90	68	4.3	3.3	4.1
August 2020	182.9	139.1	10.7	9	- 43.8	32.4	25.3	91	69	2.5	4.3	3.5
September 2020	216.9	152.2	12.0	15	- 64.7	33.6	25.2	90	68	5.2	3.1	3.6
October 2020	217.8	446.6	8.0	11	+228.8	32.1	24.0	92	69	3.3	2.6	2.6
November 2020	073.0	132.9	2.2	6	+59.9	30.7	20.0	86	58	5.6	2.8	3.2
December 2020	011.0	000.0	1.0	0	-	30.0	16.0	91	53	6.8	2.4	2.8
January 2021	002.1	000.0	0.1	0	-	31.1	18.0	93	47	4.9	2.4	3.2
February 2021	002.3	000.0	0.4	0	-	32.2	17.6	90	38	6.9	3.0	4.5
March 2021	016.4	000.0	0.7	0	-	35.5	21.6	92	41	6.9	3.2	5.2

Soil Moisture percent (2020-2021)

Month	March	April	May	June
I_0	6.92	5.81	5.84	7.63
I_1	8.68	9.13	8.36	9.16

Weather and crop condition (2020-21)

During 2020-21 sugarcane cropping period (March 2020- March 2021) a total of 1599.1 mm of rainfall was received against normal rainfall of 1122.1 mm. An average of 54.25% deficit rain fall was received during August & September months. An excess of 228.8 mm rainfall was received in October *Nivar toofan*. An average of 33.0^oc and 22.4^oc was recorded as monthly maximum and minimum temperatures respectively. The diurnal temperatures variation during the sugarcane maturity period recorded as 12.4 ^oc. The monthly average of RH % at FN is 89.69% and AN is 56.84%. Monthly average bright sunshine hours recorded as 5.51. The monthly average wind velocity is at 3.24 KMPH and evaporation is at 4.13 mm. During the August – September months crops suffered due to moisture stress because of deficit rainfall.

Table B: 2021-22

Month	Total rainfall mm		No. of rainy days		Rainfall+ /	Temp. °C		RH%		bright sunshine hours	wind velocity (kmph)	evaporation (mm)
	Normal	actual	Normal	Actual		Max	Min	FN	AN			

March-2021	16.4	0	0.7	0	-16.4	35.5	21.6	92	41	6.9	3.2	5.2
April-2021	42.8	37.6	2.0	3.0	-5.2	35.5	25.0	89	58	6.7	4.4	5.4
May-2021	74.4	121.5	4.1	10.0	47.1	35.7	26.0	86	57	5.4	3.8	5.2
June-2021	120.7	39.6	7.1	4.0	-81.1	35.3	27.1	81	57	4.5	4.8	4.9
July-2021	130.4	128.9	7.9	10.0	-1.5	33.0	25.8	90	69	3.8	3.6	3.8
August-2021	192.0	235.1	10.7	12.0	43.1	34.0	25.7	90	70	5.0	3.7	4.4
September-2021	243.2	469.3	12.8	15.0	226.1	32.1	25.0	94	76	3.1	2.1	3.1
October-2021	226.2	135.3	8.2	7.0	-90.9	32.8	24.7	94	67	5.0	2.6	3.1
November-2021	85.4	124.1	3.0	7.0	38.7	29.8	22.5	92	69	3.3	2.1	2.1
December-2021	10.5	15.0	1.0	1.0	4.5	29.3	18.4	85	55	5.1	3.1	3.6
January-2022	2.2	1.3	0.1	0	-0.9	30.1	16.2	87	55	5.9	3.1	1.6
February-2022	2.3	0	0.4	0	-2.3	32.1	16.8	87	53	6.9	3.4	3.3
March-22		0		0	0	35.7	17.0	81	42	7.3	3.4	5.0

Soil Moisture percent (2021-2022)

Month	March	April	May	June	January	February
I ₀	7.19	10.87	6.37	8.18	4.82	8.20
I ₁	10.07	11.63	11.11	12.69	10.49	9.54

Weather and crop condition (2021-22)

During 2021-22 sugarcane cropping period (March 2021- March 2022) a total of 1307.7 mm rainfall was received against normal rainfall of 1146.5 mm. An average of 90.9 % deficit rain fall was received during October month. An excess of 269.2 mm of rainfall was received in August and September months. An average of 33.1°C and 22.4°C was recorded as monthly maximum and minimum temperatures respectively. The diurnal temperatures variation during sugarcane maturity period was recorded as 8.76 °C. The monthly average of RH % at FN is 88.30 % and AN is 59.2%. Monthly average bright sunshine hours recorded as 5.3 Monthly average wind velocity is at 3.3 KMPH and evaporation is at 3.9mm. During June - July months crops suffered due to moisture stress because of deficit rainfall

Table C: 2022-23

Month	Total rainfall mm		No. of rainy days		Rainfall+/-	Temp. °C		RH%		bright sunshine hours	wind velocity (kmph)	evaporation (mm)
	Normal	actual	Normal	Actual		Max	Min	FN	AN			
March-2022	16.4	0	1	0	-16.4	35.6	18.9	83	53	6.7	4.1	4.8
April-2022	42.3	0	2	0	-42.3	36.5	24.8	83	68	7.3	6.2	5.4
May-2022	88.1	178.2	4	6	90.1	35.7	24.7	83	70	6.3	5.4	4.7
June-2022	134.7	184.4	8	11	49.7	34.0	24.9	85	74	4.5	4.0	3.9
July-2022	120.2	66.4	8	6	-53.8	32.7	25.8	85	79	2.8	3.1	3.2
August-2022	189.5	158.6	10	9	-30.9	33.0	25.4	84	76	3.2	3.0	3.1
September-2022	243.7	257.2	13	18	13.5	32.3	25.1	88	77	3.7	1.8	2.1
October-2022	230.6	185.7	8	10	-44.9	31.4	23.7	89	82	4.7	2.1	3.0
November-2022	57.0	10	3	1	-47	31.8	21.2	89	81	5.1	2.9	2.4
December-2022	14.5	39.5	1	3	25	30.5	18.9	87	82	4.5	2.8	1.7
January-2023	0.2	0	0	0	-0.2	30.6	16.6	90	77	5.8	2.8	1.8
February-2023	1.8	0	0	0	-1.8	33.1	18.2	89	60	7.0	3.4	3.6
March-23	26.5	105.9	1	3	79.4	34.4	19.0	90	57	6.5	3.7	3.7

Soil Moisture percent (2022-2023)

Month	March	April	May	June	January	February
I ₀	5.4	3.5	7.2	12.4	12.1	12.6
I ₁	11.9	8.6	14.4	13.0	14.7	13.5

Weather and crop condition (2022-23)

During 2022-23 sugarcane cropping period (March 2022- March 2023) a total of 1185.9 mm of rainfall was received against normal rainfall of 1165.5 mm. An average of 42.35mm deficit rain fall was received during July and August months. An excess of 69.9 mm of rainfall was received in May and June months. An average of 33.2°C and 22.1°C was recorded as monthly maximum and minimum

temperatures respectively. The diurnal temperatures variation during the sugarcane maturity period recorded as 11.08°C. The monthly average of RH % at FN is 86.30 % and AN is 72.0%. Monthly average bright sunshine hours recorded as 5.2 Monthly average wind velocity is at 3.5 KMPH and evaporation is at 3.3mm. During the July-August months crops suffered due to moisture stress because of deficit rainfall.

Sugarcane cane yield and other ancillary data.

Tiller population: The data on tiller production at the formative stage under stress varied from 72.78 000/ha (2015A 187) to 107.29 000/ha (2015A 93). Tiller production at formative state was higher at normal irrigation (91.18 000/ha) which is lower than stress (79.51 000/ha). Among 15 sugarcane clones tested, sugarcane clone 2015A 93 recorded higher tiller production of 107.29 000/ha, followed by 2015 A59 (95.26 000/ha) and 2015A 51 (89.18 000/ha). The standards 87A 298 and 83V 15 recorded a tiller production of 97.95 000/ha and 86.46 000/ha respectively.

Number of millable canes: The number of millable canes are high under normal irrigation (73.07 000/ha) over stress conditions (63.21 000/ha). Among the 15 sugarcane clones tested, sugarcane clones 2015 A59 (75.36 000/ha), 2015 A93 (74.87 000/ha) and 2015A 51 (92.74 000/ha) recorded significantly higher millable canes over other clones tested and these clones are on par with the standards 87A 298 (74.81 000/ha) and 83V 15 (66.1 000/ha).

Cane yield: Cane yield was significantly higher in I1 treatment (89.71 t/ha) over I0 treatment (73.52 t/ha). Higher cane yields were recorded in sugarcane clone 2015A 512 (96.06 t/ha) followed by 2015A 233 (94.14 t/ha), 2015A 183 (89.12 t/ha), and 2015A 93 (84.09 t/ha). The standard 87A 298 and 83V 15 recorded a cane yield of 73.02 t/ha and 85.07 t/ha respectively. Regarding drought tolerance efficiency, sugarcane clone 2015A 59 recorded a higher drought tolerance efficiency percent 92.08 followed by sugarcane clones 2015A 233 (89.33%) and 2015A93 (87.98%). The standards 87A298 and 83V15 recorded a drought tolerance efficiency percent of 72.27 and 67.52% respectively.

Sucrose percent: Percent sucrose was high under I1 treatment (18.22%) over stress (I0) treatment (16.37%). The quality in terms of sucrose percent was high in sugarcane clone 2015A 59 (18.62%) followed by sugarcane clones 2015A 93 (18.13%) and 2015A 230 (18.05%). The standards 87A 298 and 83V 15 recorded a percent sucrose percent of 16.79% and 17.95% respectively.

SPAD / SCMR values: The SPAD/ SCMR value at the formative stage is higher under normal irrigation (37.95) over stress conditions (34.47). Higher SPAD/SCMR value was recorded in sugarcane clones 2015A 187 (43.52) followed by 2015A 59 (41.11) and 2015A 51 (39.52) at the formative stage (150 DAP) of sugarcane clones. The standards 87A 298 (38.08) and 83V 15 (41.87) were recorded on par SPAD/SCMR values with sugarcane clones 2015A187, 2015A 59 and 2015A 51.

Chlorophyll stability index (CSI): The Chlorophyll stability index of sugarcane clones under the formative stage was high under normal irrigation (59.29) over stress conditions (44.15%). The CSI was not significantly influenced by the sugarcane clones tested.

Specific leaf area (SLA cm²/g): The parameter indicating Assimilation of photosynthesis in leaf in SLA (cm²/g). It is lower under normal irrigation (110.76 cm²/g) stress conditions (113.76 cm²/g) which indicates accumulation of some accumulates under normal conditions. This parameter was significantly not influenced by the sugarcane clones tested.

Root spread area: The parameter root spread area (cm²) /stool at 120 DAP (Formative stage) was low under normal irrigation (118.6 cm²) over stress (131.4 cm²) which indicates the spread of roots under stress conditions for the search of moisture in the soil. The root spread area was not statistically influenced by the sugarcane clones tested.

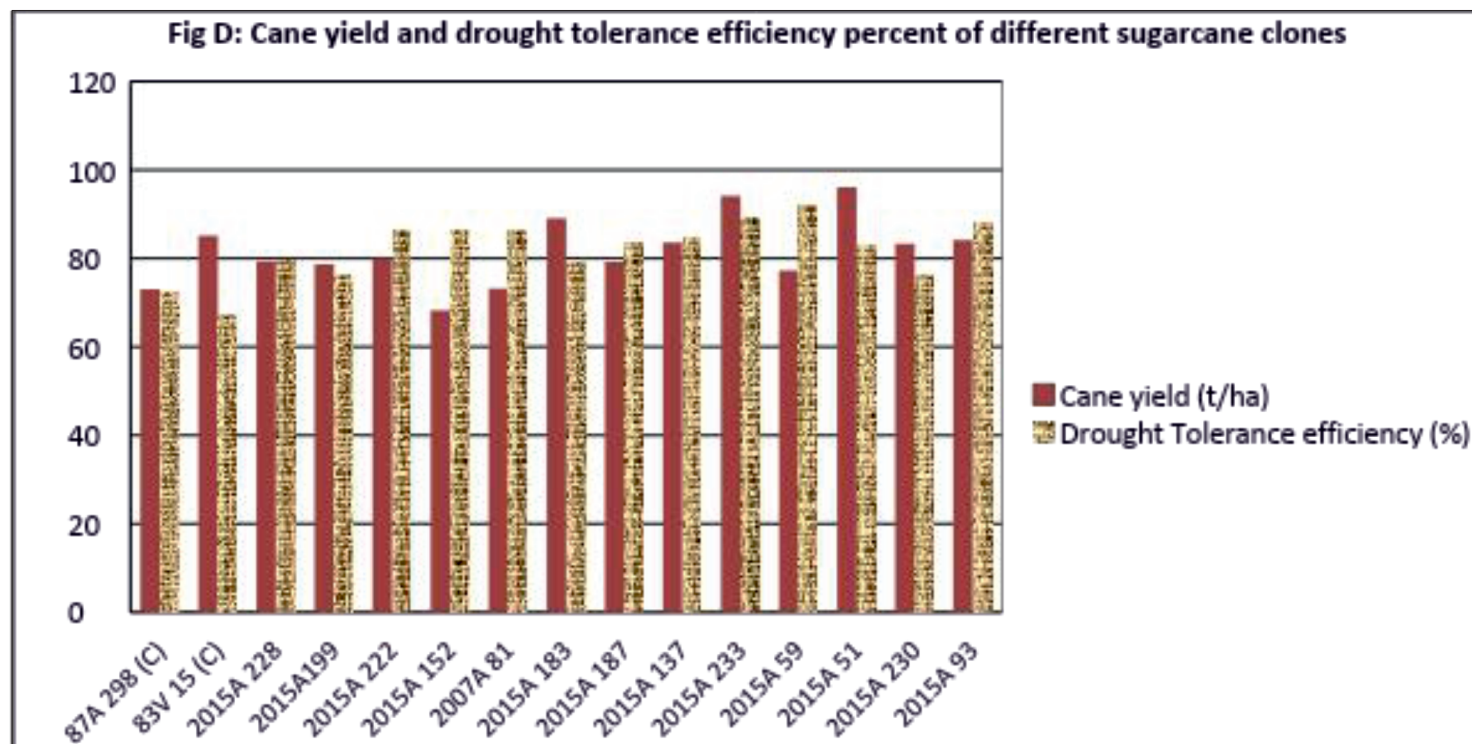
Root volume (ml): The parameter root volume /stool (ml) at the formative stage was higher under normal irrigation (47.75 ml/stool) over stress 128.84 ml/stool. Among 15 sugarcane clones tested, root volume (ml/stool) was higher in sugarcane clones 2015A 59 (55.42), 2015A 187 (55.42), and 2015A 233 (54.17) which are on par with each other and superior over standards 87A 298 (25.17) and 83V 15 (28.42). Regarding interaction with sugarcane clones 2015A 59 and 2015A 233 recorded a root volume of 75.83 and 72.50 ml/stool under normal irrigation.

Leaf temperature (°C): The temperature of the leaf in sugarcane during the formative stage under normal irrigation was low (230.4 °C) over stress (25.47 °C). Due to intermittent rainfall recorded during the summer season (formative stage), the leaf temperature °C was not influenced by the sugarcane clones tested under stress and normal irrigation treatments.

Leaf proline (μ moles/g fresh weight): Leaf proline content, which is a drought tolerance triggering amino acid content was higher under stress treatment (152.8 μ moles/g fresh weight) over normal irrigation (100.52 μ moles/g fresh weight). The leaf proline content at formative state was high in sugarcane clones 2015A 233 (139.25 μ moles/g fresh weight), 2015A 183 (197.5 μ moles/g fresh weight), 2015A 511 (135.90 μ moles/g fresh weight), which are significantly on par with each other and on par with standard 87A 298 (132.36 μ moles/g fresh weight). Regarding interaction higher leaf proline content was recorded with sugarcane clone 2015A 183 (175.33 μ moles/g fresh weight) under stress conditions.

Total dry matter / stool (g) (TDM): The total dry matter /stool (g) at the formative stage was higher under normal irrigation (389.28 g/stool) over stress (322.36 g/stool). Significantly higher TDM/stool was recorded in sugarcane clone 2015A 199 (43.38 g/stool), followed by 2015A 233 (430.9 t/ stool) and 2015A 51 (374.45) and are superior over standards 87A 298 (263.7 g/stool) and 83V 15 (337.50 g/stool).

Sheath moisture percent: The trait sheath moisture percent at the formative stage of sugarcane was higher under normal irrigation (77.69%) over stress conditions (71.49%). Significantly higher sheath moisture per-cent was recorded in sugarcane clones 2015A 233 (76.40%), 2015 A59 (75.25%), 2007A 81 (75.75%) and 2015A 183 (75.07%) which are par with the standards 87A 298 (74.25%) and 83V 15 (74.85%). Many sugarcane researchers identified similar traits of sugarcane with higher cane yield and quality under soil moisture stress conditions. Sugarcane physiological parameters like sheath moisture per-cent, leaf proline content, chlorophyll



1: Performance of sugarcane clones under limited irrigated conditions (Early planting)
(Pooled data of 2020,2021 & 2022)

Variety(s)	Tiller population (000'/ha) (at 120 DAP)			NMC (000/ha)			Cane yield (t/ha)			Drought Tolerance efficiency (%)
	I ₀	I ₁	Mean	I ₀	I ₁	Mean	I ₀	I ₁	Mean	
87A 298 (C)	88.25	107.65	97.95	65.10	84.52	74.81	61.27	84.78	73.02	72.27
83V 15 (C)	74.30	98.62	86.46	59.77	73.44	66.61	68.57	101.56	85.07	67.52
2015A 228	83.32	89.99	86.66	67.99	70.10	69.04	70.48	88.23	79.36	79.88
2015A199	83.91	93.63	88.77	67.44	71.35	69.40	68.24	89.11	78.68	76.57
2015A 222	67.93	78.45	73.19	57.21	65.54	61.38	74.24	85.94	80.09	86.39
2015A 152	75.67	83.16	79.41	57.06	64.00	60.53	63.37	73.06	68.22	86.72
2007A 81	75.68	82.67	79.18	62.56	69.94	66.25	64.74	81.59	73.17	86.72
2015A 183	76.28	91.31	83.79	66.25	65.34	65.79	82.17	96.06	89.12	79.34
2015A 187	69.73	75.83	72.78	63.43	67.06	65.25	72.05	86.28	79.16	83.49
2015A 137	72.02	80.68	76.35	61.11	72.89	67.00	76.67	90.56	83.62	84.66
2015A 233	70.20	79.80	75.00	58.51	68.55	63.53	88.83	99.44	94.14	89.33
2015A 59	91.49	105.02	98.26	69.44	81.29	75.36	74.07	80.44	77.26	92.08
2015A 51	86.11	92.24	89.18	63.89	81.58	72.74	87.09	105.02	96.06	82.93
2015A 230	79.75	92.25	86.00	59.72	79.28	69.50	72.25	94.23	83.24	76.66
2015A 93	98.14	116.44	107.29	68.62	81.13	74.87	78.71	89.46	84.09	87.98
Mean	79.51	91.18		63.21	73.07		73.52	89.72		
	SEm±	CD (0.05)		SEm±	CD (0.05)		SEm±	CD (0.05)		
Irrigation (I)	1.83	5.19		1.19	3.38		1.64	4.65		
Variety (V)	5.01	4.23		3.26	9.26		4.49	12.75		
I x V	7.09	NS		4.61	NS		6.35	NS		

Table 2: Performance of sugarcane clones under limited irrigated conditions (Early planting)
(Pooled data of 2020,2021 & 2022)

Variety(s)	Sucrose (%)			SPAD / SCMR values (at 150 DAP/ stress)			CSI (Chlorophyll Stability Index)			SLA (cm ² /g) values (at 150 DAP/ stress)			Root spread area (cm ²)/ stool at 120 DAP		
	I ₀	I ₁	Mean	I ₀	I ₁	Mean	I ₀	I ₁	Mean	I ₀	I ₁	Mean	I ₀	I ₁	Mean
87A 298 (C)	15.71	17.86	16.79	35.73	40.43	38.08	50.64	51.93	51.28	118.19	99.22	108.71	1180.0	870.3	1025.1
83V 15 (C)	17.09	18.80	17.95	39.30	44.45	41.87	43.43	51.83	47.63	98.36	114.30	106.33	1324.3	978.0	1151.1
2015A 228	15.88	18.16	17.02	34.28	33.97	34.12	49.40	51.65	50.52	105.11	112.16	108.64	1564.6	1287.5	1426.0

2015A199	16.94	18.49	17.72	31.01	33.16	32.08	35.50	49.62	42.56	112.65	111.21	111.93	1333.3	1236.6	1285.0
2015A 222	17.06	18.25	17.66	33.29	35.72	34.51	54.12	55.29	54.70	123.40	118.50	120.95	1710.6	1239.3	1475.0
2015A 152	14.79	15.90	15.35	34.69	35.48	35.08	49.74	84.47	67.10	113.44	99.57	106.50	986.0	1044.0	1015.0
2007A 81	14.03	18.21	16.12	32.21	36.42	34.32	44.49	50.34	47.42	98.44	103.75	101.09	1572.3	1163.3	1367.8
2015A 183	16.19	17.10	16.65	35.24	34.44	34.84	45.93	57.94	51.93	157.13	99.03	128.08	1312.6	1194.6	1253.6
2015A 187	16.72	18.41	17.57	42.88	44.17	43.52	52.48	69.33	60.90	106.70	114.86	110.78	1440.0	1202.0	1321.0
2015A 137	15.80	17.92	16.86	32.51	36.09	34.30	36.24	49.27	42.75	109.25	119.60	114.43	1458.6	1619.3	1539.0
2015A 233	15.41	18.57	16.99	33.79	36.26	35.02	27.31	63.00	45.16	112.08	108.61	110.34	1577.3	1405.3	1491.3
2015A 59	18.23	19.02	18.62	39.03	43.19	41.11	47.87	85.02	66.44	118.83	115.63	117.23	1276.0	1251.0	1263.5
2015A 51	16.87	18.73	17.80	35.82	43.21	39.52	44.88	46.82	45.85	120.82	102.35	111.59	1095.3	939.3	1017.3
2015A 230	17.15	18.95	18.05	29.94	32.79	31.37	47.75	65.32	56.53	107.51	127.48	117.50	1177.0	1061.3	1119.1
2015A 93	17.64	18.97	18.31	27.31	39.51	33.41	32.92	57.61	45.26	104.84	115.17	110.01	1413.3	1218.0	1315.6
Mean	16.37	18.22		34.47	37.95		44.18	59.29		113.78	110.76		1361.4	1180.6	
	SEm±	CD (0.05)		SEm±	CD (0.05)		SEm±	CD (0.05)		SEm±	CD (0.05)		SEm±	CD (0.05)	
Irrigation (I)	0.24	0.68		0.54	1.53		3.22	9.38		1.15	2.86		52.28	148.70	
Variety (V)	0.65	NS		1.48	4.21		8.63	NS		8.64	NS		143.19	NS	
I x V	0.92	NS		2.09	NS		12.49	Ns		12.22	Ns		202.51	NS	

Table 3: Performance of sugarcane clones under limited irrigated conditions (Early planting)
(Pooled data of 2020, 2021 & 2022)

Variety(s)	Root volume (ml) at 120 DAP			Leaf temperature (°C) at formative stage(at 120 DAP)			Leaf proline (μ moles / g.fr.wt.) during stress			Total dry matter / stool (g) at 150 DAP			Sheath moisture percent		
	I ₀	I ₁	Mean	I ₀	I ₁	Mean	I ₀	I ₁	Mean	I ₀	I ₁	Mean	I ₀	I ₁	Mean
87A 298 (C)	23.67	26.67	25.17	26.35	21.65	24.00	160.68	104.03	132.36	242.90	284.53	263.71	72.41	76.04	74.23
83V 15 (C)	22.67	34.17	28.42	26.45	22.83	24.64	157.79	101.60	129.70	311.89	363.11	337.50	72.86	76.84	74.85
2015A 228	25.00	26.67	25.83	25.78	23.65	24.71	111.57	102.32	106.95	513.50	581.47	547.48	71.49	74.54	73.01
2015A199	28.33	74.17	51.25	24.35	22.53	23.44	166.34	87.70	127.02	363.89	498.86	431.38	69.97	78.01	73.99
2015A 222	21.67	29.17	25.42	25.20	22.53	23.86	127.13	97.56	112.34	267.31	342.69	305.00	73.20	79.46	76.33
2015A 152	21.33	22.50	21.92	24.68	23.03	23.85	122.22	89.98	106.10	300.34	362.92	331.63	68.96	77.04	73.00
2007A 81	25.83	35.00	30.42	24.68	22.28	23.48	125.85	85.69	105.77	376.00	484.78	430.39	72.52	78.97	75.75
2015A 183	26.67	41.33	34.00	25.35	23.88	24.61	173.33	101.69	137.51	272.40	342.37	307.38	72.14	78.00	75.07
2015A 187	35.00	75.83	55.42	24.83	24.23	24.53	168.88	99.63	134.26	275.63	247.08	261.35	69.29	77.31	73.30
2015A 137	39.17	63.33	51.25	26.93	24.20	25.56	165.15	104.91	135.03	305.40	398.29	351.84	70.51	79.16	74.84
2015A 233	35.83	72.50	54.17	24.78	22.55	23.66	168.00	110.50	139.25	394.49	467.33	430.91	75.12	77.68	76.40
2015A 59	35.00	75.83	55.42	26.38	22.35	24.36	157.91	105.55	131.73	314.16	330.02	322.09	72.84	77.66	75.25
2015A 51	29.17	44.17	36.67	25.05	22.40	23.73	165.34	106.45	135.90	316.80	432.11	374.45	70.95	76.29	73.62
2015A 230	27.50	43.33	35.42	26.55	24.43	25.49	162.19	106.48	134.34	270.53	279.38	274.95	69.23	79.62	74.42
2015A 93	35.83	51.67	43.75	24.65	23.08	23.86	159.73	105.25	132.49	310.10	424.23	367.16	70.90	78.76	74.83
Mean	28.84	47.76		25.47	23.04		152.81	100.62		322.36	389.28		71.49	77.69	
	SEm±	CD (0.05)		SEm±	CD (0.05)		SEm±	CD (0.05)		SEm±	CD (0.05)		SEm±	CD (0.05)	
Irrigation (I)	0.82	2.34		0.30	0.87		0.54	1.53		11.36	32.22		1.25	3.5	
Variety (V)	2.26	6.42		0.83	NS		1.47	4.19		31.09	88.26		0.45	1.3	
I x V	3.19	9.08		1.17	NS		2.09	5.93		43.97	NS		1.78	NS	

Conclusion

Among 15 sugarcane clones studied in comparison with 87A 298 under early planted stress conditions, sugarcane clones 2015A 51, 2015A 233, 2015A 183, 2015A 93 are found suitable for cane cultivation under stress situations of limited irrigated conditions based on cane yield and quality parameters in relation to ancillary yield parameters and physiological stress tolerance traits.

Future scope:

The sugarcane clones identified under limited irrigated conditions (January planting) are to be tested in on-farm testing in sugar factory operational areas and based on their performance and acceptance by sugarcane farmers, proceed further for release for general cultivation by State Varietal Release Committee (SVRC).

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