

## Sugarcane Clones under Early Planting (January) suitable for Moisture Stress Conditions of Andhra Pradesh

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**ABSTRACT:** Fifteen prerelease 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 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 evaluation of sugarcane clones tolerance to soil moisture stress/drought. It is a great challenge to identify a drought tolerant sugarcane clone for adoption by the sugarcane farmers to reap higher tonnage of nearly 15-20 t/ha as an extra yield which is great boon to the sugarcane cultivators. Among fifteen prerelease 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 findings, sugarcane clones 2015A 51, 2015A 233, 2015A 183 and 2015A 93 were found to be suitable for drought/soil moisture stress condition 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, CSI, SPAD/SCMR, leaf proline, cane yield, Membrane injury index.

### INTRODUCTION

In India UP, Karnataka and Maharashtra are the three states accounted for more than 80% of Indian sugar production (Bhakshiram, 2021). AP stands 11<sup>th</sup> position in area and production and 10<sup>th</sup> position in productivity in the country (Anonymous, 2021a). Sugarcane is grown under soil moisture stress/drought conditions in sizeable area under early planting (December – January) in North Coastal districts in addition to rainfed cane cultivation. Nearly 40-50% of cane cultivation of North Coastal zone is under moisture stress conditions/rainfed cane cultivation. Climatic variables are the main factors determining the crop productivity, and these undergo changes in

the course of time (Verma *et al.*, 2020).

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 (Raja Rajeswari *et al.*, 2003 and 2009 and Mukunda Rao *et al.*, 2022). The relative water content (RWC) of sugarcane leaves of susceptible varieties to drought is lower than the tolerance once (Raya *et al.*, 2021). An abiotic or biotic stress in 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 (Manimekalai *et al.*,

2021). 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 (Mukunda Rao *et al.*, 2021a). In tolerant clones, high values of SPAD and other ancillary parameters with cane yield of sugarcane were recorded high under moisture stress conditions (Sujatha and Jhansi, 2016; Mukunda Rao *et al.*, 2017). Under drought management sugarcane variety also plays an important role along with other management practices to mitigate the yield loss to some extent (Mukunda Rao *et al.*, 2021b).

In A.P., sugarcane varieties 87 A 298 and 2003 V 46 are the leading varieties occupying 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 which are common factors lowering yields of AP. Under these circumstances this study was initiated with 15 prerelease sugarcane clones under an objective to identify sugarcane clones tolerance to moisture stress/drought during crop season especially of formative stage of sugarcane which coincides with summer and maturity stage which coincides with winter season.

## MATERIAL AND METHODS

Fifteen promising prerelease 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 length with spacing of 80

cm between rows. Date of planting was in the month of January 2020, 2021 and 2022. Moisture stress I<sub>0</sub> treatment was imposed by withholding irrigation from March, 15<sup>th</sup> except two life irrigations at 10 DAP and 40 DAP till harvesting of sugarcane, whereas check I<sub>1</sub> (Normal) treatment was imposed by need based monthly one irrigation from planting to harvesting of cane. Trash mulching @ 3 t/ha was done at 3<sup>rd</sup> 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 Monochrotophos @ 1.6ml/lit and biologically controlled with using *Trichocards*. A fertilizer dose of 112 kg N + 100 kg P<sub>2</sub>O<sub>5</sub> + 120 Kg K<sub>2</sub>O/ha was adopted. Nitrogen was applied into two equal splits at 45 and 90 DAP, (and ×) 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 cessation of rains (November month). Data was recorded on cane yield, per cent juice sucrose, ancillary data (Meade and Chen, 1971) and NMC at harvest, SCMR values at 120 DAP and leaf proline at 120 DAP were recorded by adopting standard procedures (Dhopte and Manuel Livera 1989), duly following soil moisture data at formative stage during summer months. Statistical analysis was carried out by methods given by Panse and Sukhatme (1978).

## 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. 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 and C.

**Table A: Weather parameter during 2020-21 at RARS, Anakapalle.**

Month	Total rainfall (mm)		No. of rainy days		Rainfall (+/-)	Temp. (°C)		RH (%)		Bright sunshine hrs.	Wind velocity (km.ph)	Evaporation (mm)
	Normal	Actual	N	A		Max	Min.	FN	A N			
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 <sub>0</sub>	6.92	5.81	5.84	7.63
I <sub>1</sub>	8.68	9.13	8.36	9.16

**Table B: Weather parameter during 2021-22 at RARS, Anakapalle**

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

**Soil Moisture percent (2021-2022)**

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

**Table C: Weather parameter during 2022-23 crop season at RARS, Anakapalle**

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 <sub>0</sub>	5.4	3.5	7.2	12.4	12.1	12.6
I <sub>1</sub>	11.9	8.6	14.4	13.0	14.7	13.5

The soil moisture was low in stress treatment when compared to irrigation treatment in the months of soil sampling. During 2020-21 sugarcane cropping period (March 2020- March 2021) a total of 1599.1 mm rainfall was received against normal rainfall of 1122.1 mm. An average of 54.25% deficit rain fall was received during August and September months. An excess of 228.8 mm rainfall was received in October *Nivar toofan*. An average of 33.0°C and 22.4°C was recorded as monthly maximum and minimum temperatures respectively. The diurnal temperatures variation during sugarcane maturity period recorded as 12.4°C. Monthly average of RH % at FN is 89.69% and AN is 56.84%. Monthly average bright sunshine hours

recorded as 5.51. Monthly average wind velocity at 3.24 KMPH and evaporation is at 4.13 mm. During August – September months crops suffered due to moisture stress because of deficit rainfall.

**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 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

recorded as 8.76°C. 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 at 3.3 KMPH and evaporation is at 3.9mm. During June - July months crops suffered due to moisture stress because of deficit rainfall.

**Weather and crop condition (2022-23):** During 2022-23 sugarcane cropping period (March 2022- March 2023) a total of 1185.9 mm 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 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 sugarcane maturity period recorded as 11.08°C. 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 at 3.5 KMPH and evaporation is at 3.3mm. During 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 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:** 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 were significantly higher in I1 treatment (89.71 t/ha) over I0 treatment (73.52 t/ha). Higher cane yield 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 higher drought tolerance efficiency percent 92.08 followed by sugarcane clones 2015A 233 (89.33%) and 2015A 93 (87.98%). The standards 87A 298 and 83V 15 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 SAPD/ SCMR value at 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 formative stage (150 DAP) of sugarcane clones. The standards 87A 298 (38.08) and 83V 15 (41.87) recorded on par SPAD/SCMR values with sugarcane clones 2015 A187, 2015A 59 and 2015A 51.

**Chlorophyll stability index (CSI):** The Chlorophyll stability index of sugarcane clones under 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 cm<sup>2</sup>/g):** The parameter indicating Assimilation of photosynthesis in leaf in SLA (cm<sup>2</sup>/g). It is lower under normal irrigation (110.76 cm<sup>2</sup>/g) stress conditions (113.76 cm<sup>2</sup>/g) which indicates accumulation of some assimilates under normal conditions. This parameter significantly not influenced by the sugarcane clones tested.

**Root spread area:** The parameter root spread area (cm<sup>2</sup>) /stool at 120 DAP (Formative stage) was low under normal irrigation (118.6 cm<sup>2</sup>) over stress (131.4 cm<sup>2</sup>) which indicates spread of roots under stress conditions for search of moisture in soil. The root spread area was not statistically influenced by the sugarcane clones tested.

**Root volume (ml):** The parameter root volume /stool (ml) at 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), 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 leaf in sugarcane during formative stage under normal irrigation was low (230.4 °C) over stress (25.47 °C). Due to intermittent rainfall recorded during summer season (formative stage), the leaf temperature °C were 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 stage 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  $\mu$  moles/g fresh weight) under stress conditions.

**Total dry matter / stool (g) (TDM):** The total dry matter /stool (g) at 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 formative stage of sugarcane was higher under normal irrigation (77.69%) over stress conditions (71.49%). Significantly higher sheath moisture percent 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%).

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

Variety(s)	Tiller population (000'/ha) (at 120 DAP)			NMC (000/ha)			Cane yield (t/ha)			Drought Tolerance efficiency (%)
	I <sub>0</sub>	I <sub>1</sub>	Mean	I <sub>0</sub>	I <sub>1</sub>	Mean	I <sub>0</sub>	I <sub>1</sub>	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 and 2022).**

Variety(s)	Sucrose (%)			SPAD / SCMR values (at 150 DAP/ stress)			CSI (Chlorophyll Stability Index)			SLA (cm <sup>2</sup> /g) values (at 150 DAP/ stress)			Root spread area (cm <sup>2</sup> / stool at 120 DAP)		
	I <sub>0</sub>	I <sub>1</sub>	Mean	I <sub>0</sub>	I <sub>1</sub>	Mean	I <sub>0</sub>	I <sub>1</sub>	Mean	I <sub>0</sub>	I <sub>1</sub>	Mean	I <sub>0</sub>	I <sub>1</sub>	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 and 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 <sub>0</sub>	I <sub>1</sub>	Mean	I <sub>0</sub>	I <sub>1</sub>	Mean	I <sub>0</sub>	I <sub>1</sub>	Mean	I <sub>0</sub>	I <sub>1</sub>	Mean	I <sub>0</sub>	I <sub>1</sub>	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	71.12	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	

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 in terms of SPAD/SCMR values, CSI, Membrane Injury Index, specific leaf area (SLA cm<sup>2</sup>/g) under stress conditions registered significant and positive correlation with cane yield. Similar type of findings on performance of sugarcane clones under stress situation and moisture stress conditions of sugarcane was also studied and reported by Raja Rajeswari *et al.* (2009); Sujatha and Jhansi 2016; Mukunda Rao *et al.* (2017, 2021 and 2022). Similar type of screening of sugarcane clones study under moisture stress with similar performance of physiological traits under moisture stress and normal condition was also reported (Anonymous, 2021).

### 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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