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Evaluation of Pre Released Sugarcane Clones under Late Planted Rainfed Conditions for Higher Cane Yield and Quality

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ABSTRACT: Late planting of sugarcane (May-June) purely under rainfed conditions with the onset of monsoon is common in North Coastal Zone of Andhra Pradesh. Cane yields obtained under rainfed situations range from 25-30 t/ha as the crop suffer from moisture stress both at formative and maturity phases. Identification of clones with high cane yield, juice sucrose and tolerance to moisture stress is the priority area in sugarcane research. Earlier field experiments conducted at RARS, Anakaplle indicated that Co 6907, 84A 125, 81A 99, 87A 298, Co 8201, Co 7219 and 97A 85 performed well under rained situations. Due to paucity of time and susceptibility to emerging pests & diseases, only 87A 298 was remained as a cosmopolitan variety. There is a dire need to identify new potential sugarcane clone for rainfed situation. Under this context this trial was conducted for evaluation of pre-release clones purely under rainfed conditions for two years (2019 & 2020) resulted in identification of superior clones with high yield and high sucrose. Among the clones 2011A 175 (74.6 t/ha) recorded higher cane yield and juice sucrose followed by sugarcane clones 2011A 260 (74.6 t/ha), 2001A 70 (70.11 t/ha), 2007A 81 (66.2 t/ha), 2003A 255 (65.0 t/ha), 2007A 241 (64.2 t/ha), 2009A 107 (63.7 t/ha), 2006A 223 (62.6 t/ha). These clones are also on par with the standards 87A 298 (66.2 t/ha) and Co 6907 (62.7 t/ha). The high cane yield clones also registered higher NMC, Root spread area, total dry matter production, specific leaf area, SPAD/SCMR values and leaf proline content during stress period at 120 -150 DAP denoting stress tolerance.

Keywords: Rainfed sugarcane, moisture stress, late planting, SPAD/SCMR values, leaf proline.

INTRODUCTION

On industrial scale over 103 countries are producing white sugar using sugarcane and sugar beet as raw material (FAOSTAT, 2018). Sugarcane is grown in about one lakh hectares under varied situation viz., irrigated, water logged, limited irrigated and rainfed conditions in Andhra Pradesh. Being a long duration crop affected by biotic and abiotic stress that have resulted due to climatic change in the near past (Saini and Guljar, 2021). Any biotic or abiotic stress in growing phase in the period of rapid growth, cane drastically reduce the yield as well as affect the potential for re growth and longevity of sugarcane crop (Manimekalai *et al.*, 2021). Rainfed sugarcane is predominant in Srikakulam, Vizianagaram and Visakhapatnam districts of Andhra Pradesh. Morpho physiological parameters like stalk population at harvest, root spread area, sheath moisture (%) and leaf chlorophyll content associated with drought tolerance is recorded high compared to drought susceptible clones (Mukunda Rao *et al.*, 2013). Since the crop is raised purely under rainfed conditions in soils characterized by moisture and fertility stress. The crop experiences moisture stress at all stage of crop growth. Reduction in plant height, Shoot/stalk population, length of millable cane and cane yields are the significant effects of moisture stress (Raja Rajeswari *et al.*, 2000 & Raja Rajeswari, 2004). The RWC (Relative Water content) of sugarcane leaves of susceptible varieties is lower than the tolerant ones (Rayes *et al.*, 2021). Cane yields realized under rainfed conditions (late planted) is low and range from 25 -30 t/ha. However, farmers of the

region continue to grow sugarcane under rainfed conditions with the onset of monsoon as it is the only crop, which give minimum guaranteed income under such situation. Presently 87A 298 is the monopoly variety growing predominantly under cultivation in rainfed situation. There is a need to identify clones which are superior to the currently cultivated for cane yield under late planted rainfed conditions to identify high yielding and sucrose rich clones suitable for late planted rainfed conditions.

MATERIAL AND METHODS

Pre-release clones in early group developed through fluff supply programme were evaluated purely under late planted (May-June) rainfed conditions over three years viz., two years (2018-2019 and 2019-20) at Anakapalle. Soils are light textured with neutral pH. Planting material selected from mature crop was planted after soaking in 10% lime solution for one hour. Each clone was raised in six rows of eight meters row length adopting 60cm spacing between rows. A recommended seed rate of 50,000 three budded setts per hectare (Four three budded setts/metre) was followed. Organic manure (25 tonnes of FYM/ha) and inorganic fertilizers (75kg N + 50kg P_2O_5 + 50 kg K_2O/ha) were applied. Trash mulching @ 3t/ha was applied on third day after planting. Early shoot borer was kept under check by spraying monocrotophos @ 1.6ml/litre. Deep ploughing & planting in deep furrows was adopted. Application of second dose of potassium was carried out as per recommendation. Metrological data recorded during crop was presented in Table 1 and 2. Data were recorded on Tiller population, root spread area, specific leaf area, SPAD/SCMR values, Total dry matter/stool, leaf proline content, Number of millable canes (NMC), and juice sucrose was determined by following standard procedures. Juice analysis was carried out in sucrolyzer (Meade & Chen, 1971). Data was analyzed statistically by Panse and Sukhatme, (1978).

Table 1: Weather parameters during sugarcane crop growth period 2019-20.

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	AN			
March, 2019	0006.9	007.2	1	1	+3.0	34.9	22.9	92	48	7.1	2.1	5.2
April, 2019	037.8	043.1	2	1	+5.3	36.6	24.2	82	47	8.1	-	7.1
May, 2019	094.0	009.4	4	1	-84.6	37.5	27.6	79	55	6.5	-	6.9
June, 2019	114.0	091.3	7	5	-22.70	35.2	25.4	79	55	3.7	6.1	6.1
July, 2019	133.5	055.3	9	5	-78.2	33.6	26.1	84	65	3.1	3	4.1
August, 2019	178.5	129.3	11	10	-49.2	33.6	25.8	87	64	3.2	1.8	3.7
September, 2019	223.5	376.1	12	19	+152.6	31.7	25.0	93	77	3.2	3.1	2.5
October, 2019	194.8	312.6	8	14	+117.8	31.8	24.3	95	74	4.6	2.7	2.7
November,2019	102.2	003.3	3	1	-98.90	31.8	21.4	90	52	6.2	2.6	3.2
December, 2019	028.7	000.2	1	0	-28.50	29.7	19.0	91	52	3.8	2.7	2.9
January, 2020	002.8	000.8	0.1	0	-2.00	30.3	18.5	95	54	4.2	3.0	3.2
February, 2020	002.6	017.6	0.4	3	+15.0	31.6	18.6	91	52	5.9	3.4	4.2
March, 2020	006.9	001.0	1	0	-5.9	32.0	21.4	90	52	3.0	5.2	4.4
	1126.7	1047.2	58.5	59		33.1	27.79	81.4	57.5	4.8	3.2	4.3

Table 2: Weather parameters during sugarcane crop growth period 2020-21.

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	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
Sep., 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
Dec. 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	4.5
March, 2021	016.4	000.0	0.7	0	-	35.5	21.6	92	41	6.9	3.2	5.2

RESULTS AND DISCUSSIONS

The pooled data for the traits studied in respect of clones commonly evaluated over 2 years was presented in Table 3 and Fig. 1, 2.

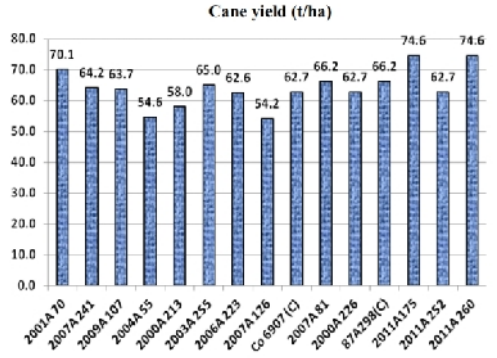

Fig. 1. Cane yield (t/ha) (Pooled data of 2019-20 & 2020-21) in Sugarcane clones.

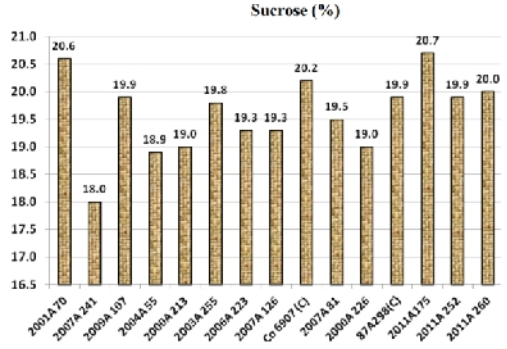

Fig. 2. Sucrose (%) (Pooled data of 2019-20 & 2020-21) in Sugarcanes clones.

The mean ancillary data was found to be high during 2020-21 for shoot populations, total dry matter for stools (NMC) root spread area, sheath moisture percent and cane yield due to timely and even distribution of rainfall during formative stage as well as maturity phase. Cane quality juice sucrose values were observed to be high during 2020-21 compared to 2019-20 because of wider differences between maximum and minimum temperatures and less rainfall during maturity stage. The weather parameters during crop growth period of 2019-20 and 2020-21 were given in Table 1 and 2 similar effects of temperature and rainfall on juice quality in sugarcane was also observed by Prasada Rao, (1988).

Tiller Production: Tiller population at 120 DAP varied from 89.98 (‘000/ha) (2003A255) to 118.89 (‘000 /ha) (2011A260).The standards 87A298 and Co6907 recorded a tiller production of 116.24(‘000/ha) and 105.20 (‘000/ha) respectively.

SPAD/SSCMR values: The SPAD chlorophyll meters readings at 120 DAP and 150DAP ranges from 37.30 (2007A81) to 45.25 (2009A107) and 26.75 (2007A81) to 46.20 (2004A55) respectively.

Specific leaf area SLA (cm^2/g): The SLA (cm^2/g) of sugarcane clones at 120 DAP ranged from 98.27 cm^2/g (2011A175) to 138.27 cm^2/g (2011A260). The lower SLA (cm^2/g) 98.27 was recorded with 2011A175 followed by 2009A107 (98.30 cm^2/g).

Per cent sheath moisture: The sheath moisture percent after cessation of rains during November month (150 DAP) was ranged from 69.05% (2011A175) to 74.43 (2009A107). Sheath moisture percent was high in sugarcane clones 2009A107 (74.43%) under stress conditions.

Number of millable canes (NMC): Number of millable canes at harvest over 2 years was observed to be high in 2011A260 (98.31 ‘000/ha) followed by 2011A252 (90.24 ‘000/ha) and 2000A226 (86.51 ‘000/ha).

Root Spread area (cm2/stool): at 180 DAP during post monsoon period under rainfed cultivation (June planting) that is under soil moisture stress conditions the root spread area (cm^2/stool) was varied from 1196 cm^2/stool (2011A255) to 1634 cm^2/stool (2007A241).

Total Bio-mass (g/stool) at 180DAP: The bio-mass production (g/stool) ranged from 1550.8 g/stool (2000A226) to 924.4 g/stool (2004A55).

Cane yield (t/ha): The cane yield (t/ha) varied from 58.0 t/ha (2000A213) to 74.36 t/ha (2011A175 and 2011A260). Higher cane yield as per mean data among 2 years 2019-20 and 2020-21 was high in 2011A175 and 2011A260 (74.6 t/ha).

Sucrose Per cent: The mean data of percent sucrose among 2 years was high in 2011A175 (20.7) followed by 2011A260 and 2001A70 (20.6). The cane quality in terms of percent sucrose was high in 2019-20 due to receipt of good rainfall during sugarcane crop growth period.

Leaf Proline content (µ moles/g fresh wt.): The leaf proline content was high in sugarcane clones 2007A241 (167.7µ moles/g fresh weight) followed by 2001A70 (165.41 µ moles/g fresh weight).

Single cane weight (kg): The single cane weight of tested sugarcane clones was varied from 0.91 kg/cane (2011A252) to 1.41 kg/cane (2007A126). Higher single cane weight was recorded in sugarcane clone 2007A126 (1.41 kg) followed by 2011A175 (1.29 kg) and 2006A223 (1.25 kg).

Sugarcane researchers across the state and country identified similar traits of sugarcane with higher cane yield and quality under soil moisture stress conditions. Sugarcane physiological parameters like sheath moisture (%) was high in drought tolerant clones compared to drought susceptible clones. Specific leaf area was low in drought tolerant clones which denote more dry matter accumulation per unit leaf area. SPAD/SCMR values and leaf proline content under stress conditions registered significant and positive correlation with cane yield. Similar observations were also made in study of sugarcane by Raja Rajeswari & Rameswaraswamy (1996); Raja Rajeswari *et al*., (2005 and 2009); Mukunda Rao *et al*., (2013 & 2017), Manimekalai *et al*., (2021), Sujatha and Jhansi (2016).

Table 3: Performance of sugarcane clones under rainfed condition (June Planting).

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Sugarcane clones	Tiller production (000/ha) at 120 DAP			SPAD/SCMR values (at 120 DAP)			SPAD / SCMR values (at 150 DAP)			SLA (Cm^2/ g.) (at 120 DAP)			Percent sheath moisture at 150 DAP			NMC (000'/ ha)		
	2019-20	2020-21	Mean	2019-20	2020-21	Mean	2019-20	2020-21	Mean	2019-20	2020-21	Mean	2019-20	2020-21	Mean	2019-20	2020-21	Mean
2001A 70	103.76	110.61	**107.19**	43.9	43.8	**43.85**	36.7	38.1	**37.40**	95.95	97.11	**96.53**	75.47	73	**74.24**	56.55	97.72	**77.14**
2007A 241	94.24	100.99	**97.62**	45.7	43.1	**44.40**	43.9	46.0	**44.95**	86.45	129.08	**107.77**	72.35	73	**72.68**	69.25	75.59	**72.42**
2009A 107	87.49	92.11	**89.80**	53.8	36.7	**45.25**	41.2	43.8	**42.50**	87.55	109.04	**98.30**	73.86	75	**74.43**	63.69	89.10	**76.39**
2004A 55	95.63	118.45	**107.04**	38.0	43.0	**40.50**	48.2	44.2	**46.20**	106.65	126.33	**116.49**	71.52	74	**72.76**	49.81	96.42	**73.12**
2000A 213	96.03	137.29	**116.66**	39.9	38.8	**39.35**	25.6	30.5	**28.05**	126.65	121.99	**124.32**	72.85	75	**73.93**	49.80	111.50	**80.65**
2003A 255	85.91	94.04	**89.98**	37.0	38.4	**37.70**	31.3	32.3	**31.80**	107.69	123.14	**115.42**	72.98	75	**73.99**	43.45	77.58	**60.52**
2006A 223	81.35	118.15	**99.75**	39.0	38.7	**38.85**	40.6	40.8	**40.70**	118.31	108.06	**113.19**	73.85	73	**73.43**	51.19	94.94	**73.07**
2007A 126	97.81	109.62	**103.72**	41.5	45.3	**43.40**	36.9	32.0	**34.45**	114.42	116.91	**115.67**	69.12	70	**69.56**	50.20	103.07	**76.64**
Co 6907 (C)	95.83	114.36	**105.10**	31.9	43.2	**37.55**	40.3	37.0	**38.65**	102.72	115.40	**109.06**	68.73	69	**68.87**	53.18	97.32	**75.25**
2007A 81	117.78	109.43	**113.61**	39.7	34.9	**37.30**	21.1	32.4	**26.75**	115.57	112.71	**114.14**	72.95	74	**73.48**	49.41	88.29	**68.85**
2000A 226	120.95	130.89	**125.92**	39.7	43.3	**41.50**	32.2	35.2	**33.70**	113.81	128.06	**120.94**	68.34	70	**69.17**	54.96	118.05	**86.51**
87A298(C)	109.12	123.36	**116.24**	34.0	44.1	**39.05**	32.3	34.9	**33.60**	94.06	132.73	**113.40**	73.69	66	**69.85**	56.35	99.40	**77.88**
2011A175	83.33	114.88	**99.11**	42.2	30.1	**36.15**	35.8	37.1	**36.45**	112.77	83.76	**98.27**	67.10	71	**69.05**	68.45	105.94	**87.20**
2011A 252	100.13	130.45	**115.29**	37.0	45.6	**41.30**	31.4	36.6	**34.00**	127.07	148.79	**137.93**	70.58	69	**69.79**	65.48	115.00	**90.24**
2011A 260	102.57	135.21	**118.89**	41.6	40.5	**41.05**	31.3	39.3	**35.30**	130.56	145.97	**138.27**	71.70	74	**72.85**	75.20	121.42	**98.31**
SEm±			**6.04**			**2.20**			**2.57**			**4.56**			**1.19**			**3.23**
CD (0.05)			**18.47**			**6.37**			**7.42**			**13.96**			**3.43**			**9.90**

contd..

Sugarcane clones	Root spread area /stool (Cm^2) at 180 DAP			Total biomass / stool (g) at 180 DAP			Cane yield (t/ha)			Sucrose (%)			Leaf proline (µ moles/g. fresh weight) at 150 DAP			Single cane weight (kg)		
	2019-20	2020-21	Mean	2019-20	2020-21	Mean	2019-20	2020-21	Mean	2019-20	2020-21	Mean	2019-20	2020-21	Mean	2019-20	2020-21	Mean
2001A 70	1218	1635	**1426.5**	1131.6	1685.0	**1408.3**	67.05	73.17	**70.1**	20.26	21.00	**20.6**	176.07	154.69	**165.4**	1.19	1.19	1.19
2007A 241	1462	1806	**1634.0**	1139.7	1818.9	**1479.3**	48.81	79.60	**64.2**	18.97	17.00	**18.0**	169.22	166.13	**167.7**	0.98	1.09	1.04
2009A 107	1826	1396	**1611.0**	1210.35	1170.0	**1190.2**	50.82	76.58	**63.7**	18.89	21.00	**19.9**	160.34	131.54	**145.9**	0.89	1.04	0.96
2004A 55	1516	1546	**1531.0**	786.15	1062.6	**924.4**	44.83	64.28	**54.6**	18.71	19.00	**18.9**	135.94	166.41	**151.2**	0.90	1.35	1.13
2000A 213	1539	1434	**1486.5**	905.3	1046.6	**976.0**	46.84	69.24	**58.0**	18.07	20.00	**19.0**	161.07	137.67	**149.4**	0.82	1.15	0.98
2003A 255	1497	1760	**1628.5**	887.95	1749.7	**1318.8**	46.26	83.72	**65.0**	18.53	21.00	**19.8**	107.25	163.22	**135.2**	0.95	1.16	1.06
2006A 223	1618	1058	**1338.0**	1612.5	886.9	**1249.7**	47.61	77.57	**62.6**	18.56	20.00	**19.3**	155.44	101.25	**128.3**	0.96	1.53	1.25
2007A 126	1040	1364	**1202.0**	819.00	1087.4	**953.2**	41.66	66.66	**54.2**	18.63	20.00	**19.3**	82.88	150.95	**116.9**	0.84	1.98	1.41
Co 6907 (C)	1278	1457	**1367.5**	642.00	1518.2	**1080.1**	43.25	82.13	**62.7**	19.30	21.00	**20.2**	136.69	154.22	**145.5**	0.77	0.74	0.76
2007A 81	1468	1392	**1430.0**	1251.05	1584.0	**1417.5**	56.54	75.79	**66.2**	18.99	20.00	**19.5**	145.78	142.78	**144.3**	0.82	1.08	0.95
2000A 226	1377	1454	**1415.5**	1563.90	1537.7	**1550.8**	47.62	77.77	**62.7**	19.06	19.00	**19.0**	155.63	147.38	**151.5**	0.68	1.04	0.86
87A298(C)	1344	1518	**1431.0**	1489.20	1483.5	**1486.4**	53.44	78.96	**66.2**	18.84	21.00	**19.9**	158.35	162.75	**160.6**	0.84	1.09	0.96
2011A175	1397	1368	**1382.5**	1371.90	1523.4	**1447.7**	66.07	83.13	**74.6**	20.49	21.00	**20.7**	155.25	162.89	**159.1**	1.15	1.43	1.29
2011A 252	1222	1170	**1196.0**	1500.45	1290.6	**1395.5**	44.50	80.95	**62.7**	19.86	20.00	**19.9**	146.63	165.70	**156.2**	0.75	1.07	0.91
2011A 260	972	1635	**1426.5**	1134.80	1685.0	**1408.3**	72.61	76.58	**74.6**	19.93	20.00	**20.0**	144.84	154.69	**149.8**	0.96	1.05	1.01
SEm±			**84.91**			**45.05**			**4.01**			**0.31**			**1.95**			**0.01**
CD (0.05)			**260.04**			**137.95**			**12.19**			**0.94**			**5.96**			**0.05**

CONCLUSION

Based on observations made in present study it is concluded that among sugarcane clones studied 2011A175 (74.6 t/ha), 2011A260 (74.6 t/ha), 2001A70 (71.8 t/ha), 2007A 81 (66.2 t/ha), 2003A 255 (65.0 t/ha), 2007A 241 (64.2 t/ha), 2009A107 (63.7 t/ha) 2006A223 (62.6 t/ha) recorded higher cane yield & juice sucrose percent on par to popular standards 87A298 (66.2 t/ha) and Co6907 (62.7 t/ha) in terms of cane yield and on par in terms of quality 19.9% and 20.0% respectively. These clones are to be tested in farmers' fields for observing the ground level performance with the feedback of the sugarcane growers prior to release for general cultivation.

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Conflict of interest. Nil.

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