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Evaluation of midlate maturing sugarcane clones for cane yield and quality characters in plant and ratoon crops

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Abstract
The present study was conducted with midlate group of sugarcane clones for cane yield, its components and juice quality parameters in plant crops and ratoon crop and also tested for disease reaction to major diseases during the year 2019-20 to 2020-21 at Regional Agricultural Research Station, Anakapalle, Andhra Pradesh. Eight midlate sugarcane clones along with three standards were evaluated for cane yield and juice quality characters. The clones 2015A 230, 2015A 233 and 2015A 228 were found promising over plant and ratoon crops with high cane yield, CCS yield, quality parameters and red rot resistant against the midlate national standards 83 V15, 2000A 225 and Co86249. Red rot screening for the clone was done by plug method for three different pathotypes that are prevalent in the zone.

Keywords: Sugarcane, cane yield, sucrose, red rot

Introduction
Sugarcane (*Saccharum officinarum* L.) is one of the major cash crops grown extensively all over in the world from tropical to sub tropical regions. Most of the sugar factories could not achieve the full installed capacity utilization of sugar units due to dearth of raw material. Hence, increasing of cane area production and productivity are to be considered seriously in the state of Andhra Pradesh. Evolving of improved clones with high cane yield, juice quality and tolerance to biotic and abiotic stress continues to be the prime objective of varietal improvement programme.

Development of varieties for different maturity groups is a paramount importance in sugarcane cultivation to realize higher recoveries in sugar mills. The proper choice of varieties, season and suitable agronomic technologies coupled with balanced nutrient application play an important role in sugarcane production (Nair, 2009) [7]. Among the components, varieties play paramount role in sugar mills. Hence it is imperative to identify new sugarcane varieties to replace the deteriorating commercial varieties through which the overall productivity could be stabilized. Therefore, to meet the need of sugarcane farming community and sugar factory, there is a need of high sugar varieties having high tonnage, good rationing ability to meet the challenges for improving sugar recovery. The plant characteristics of sugarcane associated with ratoonability studies for possible use as selection criteria in breeding (Ferraris *et al*. 1993) [1].

As the crop prevails throughout the year, the chance of damage due to various pests and diseases is also high. Red rot and smut are the major diseases recorded in various sugarcane growing areas of the state in different varieties cultivated, thereby reducing cane yield and juice quality. Losses due to red rot disease are enormous as the pathogen infects sugar accumulating parenchyma cells of the stalk (Uys *et al*., 2007) [12], thus reducing sugar recovery, juice quality and cane yield (Viswanathan and Samiyappan, 2000) [13]. Hence, the research efforts were made to identify midlate maturing clones with sustained high cane yield, sugar yields and red rot resistance at Regional Agricultural Research Station, Anakapalle.

Material and Methods
The present study was conducted with eight clones along with three standards in midlate group at Regional Agricultural Research Station, Anakapalle, Andhra Pradesh during the year 2019-20 to 2020-21 in two plant crops and ratoon crop. Clones were grown in eight rows of 8m length with a spacing of 80 cm between rows. The experiment raised in RBD with three

replications. Recommended package of practices were followed to raise healthy crop. Data were recorded for cane yield, yield contributing characters and juice quality parameters. A sample of 10 stalks was used to measure stalk length and diameter and 10 stalks was crushed and juice was analyzed to determine quality characters. Juice analysis was done as per standard procedures given by Meade and Chen, 1977 [6].

Observations were recorded for number of millable canes (thousands/ha), stalk length (cm), stalk diameter, cane yield (t/ha), CCS yield (t/ha) and fibre %. Juice quality traits viz. brix%, sucrose%, purity% and CCS% recorded at 11thmonth in plant and ratoon crops. Statistical analysis of data was carriedout as per Panse and Sukhatme (1967) [8]. Red rot resistance was done under artificial inoculation conditions. The genotypes were classified into different groups of resistance or susceptibility based on 0-9 scale in plug method of inoculation (Kalaimani, 2000) [5]. For Smut and wilt study artificially inoculated by soaking setts in a viable spore suspension at a concentration of 1 x 10^6, for half an hour and planted. A sticker at 1 ml / 2 litres was added to the suspension.

Results & Discussion

The data of two plant crops and one ratoon crop presented in tables from 1 to 3 and reaction of clones to diseases in table 4.

Number of millable canes (thousand/ha): It directly influences the cane yield. Singh *et al*. (1985) [11] reported that number of millable canes is a major yield contributing factor followed by cane height and girth.In the pooled mean of I st, II nd and ratoon crop Number of millable canes ranged from 94.42 thousand/ha (Co86249) to 113.23 thousand/ha (2015A 230). Among the test clones 2015A 230 recorded more number of millable canes (110.24 thousand/ha) followed by 2015A 233 (109.59 thousand/ha).

Stalk length (cm): Height of the cane contributes materially towards final cane yield. According to Jackson and McRao (2001) under good growing conditions, individual seedling clones may produce up to about 200 cm cane can be planted to the next selection stage. Stalk length in the present study ranged from 230.79 cm (2015A 59) to 282.13 (2015A 223). The standard 83V15 recorded highest stalk length (270.27 cm) next to 2015 A 233 (282.13 cm).The research carried out by Shanmuganathan *et al*. (2015) [10] is accordance with the present findings.

Stalk diameter (cm): Canes that grow tall and thin may be more prone to lodging, the tall clones with thick stalked canes that resist lodging may have great potential to be the high yielding varieties in future. Stalk diameter is an important yield contributing character and large stalk diameter would enhance the acceptability of varieties from commercial point of view. From the mean data of 1stplant,IInd plant and ratoon crops for stalk diameter the clone 2015A 233 recorded highest stalk diameter of 3.11 cm followed by 2015A 230 (3.06 cm). This finding is analogous with Junefo *et al*. (2010) [4] who also found variable cane thickness among the twelve genotypes under their study.

Cane yield (t/ha): Cane yield is a major parameter to find out the economic potential of a variety. It is the combination of functions like environmental responses and genetic potential of a strain. High cane yielding varieties showed best environmental response and hence revealed good performance of cane yield as compared to the other varieties. The increase in cane and sugar yield in our country is mainly due to an increase in the acreage (Hashmi, 1995). Therefore, the evolution of high yielding clones is needed which could increase the cane and sugar yield per unit area. Cane yield in Ist plant ranged from 57.20 t/ha (2015 A 59) to 119.68 t/ha (2015A 233) with a mean of 101.19 t/ha. In IInd plant it ranged from 91.48 t/ha (2015A 59) to 123.56 t/ha (2015A 228) with a mean of 111.59 t/ha where as in ratoon crop cane yield ranged from 44.58 t/ha (2015A 93) to 112.15 t/ha (2015A 233). Overall mean of cane yield in I st plant, II nd plant and ratoon ranged from 80.91 t/ha (2015A 59) to 117.62 t/ha (2015A 233). The clone 2015A 233 was found superior over the best standard 2000A 225 (96.96) followed by 2015A 230 (112.45 t/ha). *Sabitha et al*, 2015 also identified superior clones than standards for cane yield in their study.

Commercial Sugar Yield (CCS yield t/ha): From the pooled data of 1stplant, IInd plant and ratoon it ranged from 9.91 t/ha (2015A 59) to 15.03 t/ha (2015A 230) with a mean of 12.59 t/ha.

Fibre %: From the pooled data of Plant I and Plant II ranged from 12.32% (2015A 233) to 14.60% (2015A 230) with a mean of 13.89%.

The research of varieties that, besides having desirable characteristics, exhibit high sugar content is an important aspect in sugarcane breeding. Sugar recovery stands the factor of prime importance both from millers and breeding point of view. The data regarding on brix %, CCS%, Sucrose % and purity% recorded at 11th month presented in table 3 for Ist plant crop, II nd Plant crop and ratoon crop.

Brix% plays an important role in determining the sugar recovery per cent of the sugarcane. In present study, significant differences were observed among the genotypes for Brix%. The Brix% over the cycle of Plant crops and ratoon ranged from 19.39% (2015A 59) to 20.62% (2015A 230) with a mean of 19.83%. The results are in agreement with the findings of Shanmuganathan *et al*. (2015) [10] who studied a number of sugarcane varieties and found different levels of Brix %.

Sucrose (%): The sucrose percent is useful in deciding the quality of sugarcane and it influences the sugar recovery and sugar production in sugar mill. Sucrose % also recorded significant differences among the clones. Pooled Juice sucrose% at 11th month varied from 17.51% (2015A59) to 18.89% (2015A 230). Purity% ranged from 90.33 (2015A 59) to 92.86 (2015A 51) with a mean of 91.78%.

CCS%: It gives the commercial cane sugar available in the cane juice. Mean of CCS% for the Ist Plant, IInd Plant and ratoon ranged from 12.20% (2015A 59) to 13.29% (2015A 230) and the clone 2015A230 recorded highest (13.29%) CCS% followed by the standards83V15 (13.10%) and 2000A 225 (12.95%) with a mean of 12.76%.

The disease reaction of midlate clones presented in table 4 for diseases red rot, smut, wilt and YLD (under natural conditions). Selected clones recorded moderately resistant to resistant reaction for red rot, highly susceptible to moderately susceptible reaction for smut, moderately resistant to resistant reaction for wilt and YLD.

The clones 2015 A 230, 2015A 233 and 2015A 228 in sugarcane cycle of I[st] plant II[nd] Plant and ratoon crops were found promising with high cane yield, CCS yield, quality parameters and resistance to red rot, moderately resistant (2015A 230) to resistant (2015A 233 & 2015A 228) for wilt and moderately resistant (2015A 228) to resistant (2015A 230 & 2015A 233) for YLD under natural conditions.

Table 1: Pooled data of two plant and one ratoon crops for NMC, Cane length and Cane girth (2019-2021)

S. No	Entry	No. of Millable canes (NMC) ('000/ha)				Stalk Length (cm)				Stalk diameter (cm)			
		I P	IIP	Ratoon	Mean	I P	IIP	Ratoon	Mean	I P	IIP	Ratoon	Mean
1	2015A 233	105.65	120.06	103.07	109.59	306.73	280.00	259.67	282.13	3.35	3.22	2.78	3.12
2	2015A 230	106.73	127.16	96.82	110.24	273.46	252.00	227.67	251.04	3.14	3.00	3.03	3.06
3	2015A 228	110.05	111.32	89.00	103.46	273.93	255.00	248.00	258.98	2.90	2.80	2.54	2.75
4	2015A 51	103.33	117.1	108.28	109.10	250.27	230.00	225.33	235.20	2.84	2.60	2.80	2.75
5	2015A 93	105.88	104.12	95.49	101.83	259.07	230.00	209.67	232.91	2.58	2.50	2.34	2.47
6	2015A 137	104.88	110.29	104.28	106.48	237.67	246.00	254.00	245.89	2.55	2.40	2.17	2.38
7	2007A 81	111.36	110.39	100.12	107.29	260.47	240.00	261.67	254.04	2.44	2.35	2.25	2.35
8	2015A 59	105.96	105.56	107.12	106.21	237.03	220.00	235.33	230.79	2.54	2.30	2.28	2.37
9	83V15 (C)	98.24	99.54	87.76	95.18	272.81	258.00	280.00	270.27	2.37	2.20	2.30	2.29
10	2000A 225 (C)	103.72	100.51	100.17	101.47	253.13	240.00	239.33	244.16	2.35	2.20	2.46	2.34
11	Co 86249 (C)	86.90	93.11	103.24	94.42	256.41	260.00	258.67	258.36	2.20	2.00	2.20	2.14
	Mean	103.88	109.01	99.58	104.12	261.91	246.45	245.39	251.25	2.66	2.51	2.47	2.55
	CD (0.05)	11.10	10.53	10.32	8.69	30.36	28.0	33.0	28.50	0.19	0.20	0.29	0.25
	CV (%)	7.77	9.26	6.02	7.26	6.86	6.0	7.97	7.0	4.25	5.00	6.82	6.0

Table 2: Pooled data of two plant and one ratoon crops for Cane Yield, CCS Yield and Fibre (%) (2019-2021)

S. No	Entry	Cane Yield (t/ha)				CCS Yield (t/ha)				Fibre (%)			
		I P	IIP	Ratoon	Mean	I P	IIP	Ratoon	Mean	I P	IIP	Ratoon	Mean
1	2015A 233	119.68	121.02	112.15	117.62	15.18	14.50	14.70	14.79	12.32	12.32	-	12.32
2	2015A 230	117.16	122.25	97.95	112.45	15.25	16.60	13.23	15.03	14.60	14.60	-	14.60
3	2015A 228	116.37	123.56	97.36	112.43	13.72	16.55	10.06	13.44	12.50	12.60	-	12.55
4	2015A 51	112.00	107.43	76.45	98.63	13.67	13.79	12.53	13.33	14.21	14.21	-	14.21
5	2015A 93	106.49	118.51	44.58	89.86	13.38	15.05	5.50	11.31	14.56	14.42	-	14.49
6	2015A 137	100.31	100.45	97.49	99.42	12.70	12.78	12.73	12.73	12.60	15.00	-	13.80
7	2007A 81	93.94	122.54	79.88	98.79	12.25	16.89	10.60	13.25	15.00	12.50	-	13.75
8	2015A 59	57.20	91.48	94.05	80.91	6.93	11.56	11.25	9.91	14.42	14.16	-	14.29
9	83V15 (C)	101.85	105.3	75.41	94.19	12.80	14.05	10.08	12.31	14.16	14.20	-	14.18
10	2000A 225 (C)	100.05	116.99	73.84	96.96	12.35	15.15	9.99	12.50	14.20	14.26	-	14.23
11	Co 86249 (C)	88.07	97.94	51.26	79.09	10.91	12.34	6.51	9.92	14.26	14.56	-	14.41
	Mean	101.19	111.59	81.86	98.21	12.65	14.48	10.65	12.59	13.89	13.89	-	13.89
	CD (0.05)	14.02	11.25	11.31	12.80	1.87	1.15	1.56	2.18				
	CV (%)	8.13	10.54	8.11	9.57	8.71	9.45	8.59	9.62				

Table 3: Pooled data of two plant and one ratoon crops for Brix %, Sucrose % and CCS % different characters (2019-2021)

S. No	Entry	Brix %				Sucrose %				Purity %				CCS (%)			
		I P	IIP	Ratoon	Mean	I P	IIP	Ratoon	Mean	I P	IIP	Ratoon	Mean	I P	IIP	Ratoon	Mean
1	2015A 233	20.21	19.25	19.64	19.70	18.75	17.05	18.46	18.09	92.78	88.57	93.99	91.78	12.68	11.98	13.13	12.60
2	2015A 230	20.88	21.03	19.95	20.62	18.71	19.02	18.93	18.89	89.61	90.44	94.89	91.65	13.02	13.31	13.53	13.29
3	2015A 228	18.46	21.22	20.12	19.93	16.81	19.25	18.65	18.24	91.06	90.72	92.69	91.49	11.79	13.40	13.19	12.79
4	2015A 51	19.26	19.52	19.45	19.41	17.44	18.50	18.14	18.03	90.55	94.77	93.26	92.86	12.20	12.84	12.86	12.63
5	2015A 93	20.00	20.23	18.91	19.72	18.02	18.72	17.47	18.07	90.10	92.54	92.38	91.67	12.58	13.27	12.33	12.72
6	2015A 137	20.15	20.22	20.13	20.17	18.14	18.25	18.53	18.31	90.02	90.26	92.05	90.78	12.65	12.72	13.06	12.81
7	2007A 81	19.35	20.00	19.19	19.51	17.51	18.30	18.47	18.09	90.49	91.50	96.25	92.75	12.24	12.75	13.27	12.76
8	2015A 59	18.95	20.12	19.09	19.39	17.19	18.22	17.13	17.51	90.71	90.56	89.73	90.33	12.04	12.63	11.93	12.20
9	83V15 (C)	19.99	20.63	19.83	20.15	18.01	19.11	18.75	18.62	90.10	92.63	94.55	92.43	12.57	13.35	13.38	13.10
10	2000A 225 (C)	19.55	20.50	19.49	19.85	17.67	18.50	18.83	18.33	90.38	90.24	96.61	92.41	12.35	12.95	13.55	12.95
11	Co 86249 (C)	19.66	19.55	19.79	19.67	17.75	18.10	18.07	17.97	90.28	92.58	91.31	91.39	12.40	12.59	12.69	12.56
	Mean	19.68	20.21	19.60	19.83	17.82	18.46	18.31	18.20	90.55	91.35	93.43	91.78	12.41	12.89	12.99	12.76
	CD (0.05)	0.79	0.65	0.94	0.86	0.64	0.65	1.37	1.22	2.9	3.2	3.8	3.12	0.40	0.32	1.19	1.02
	CV (%)	2.48	1.22	2.83	2.54	2.12	1.22	4.41	2.89	1.8	2.2	2.5	2.0	1.91	1.46	2.39	2.62

Table 4: Reaction of Midlate clones to Diseases

S. No	Clone No.	Red Rot			Smut	Wilt	Reaction to YLD under natural conditions
		Plug Method					
		Cf 04	Cf 06	Cf 05			
1	2015A 233	R	R	R	MS	R	R
2	2015A 230	R	R	R	MS	MR	R
3	2015A 228	R	R	R	HS	R	MR
4	2015A 51	R	R	R	HS	R	MR
5	2015A 93	MR	MR	MR	S	R	MR
6	2015A 137	MR	MR	MR	MS	R	MR
7	2007A 81						
8	2015A 59	R	R	R	HS	MR	R
9	83V15 (C)	MR	MR	MR	MR	HS	MS
10	2000A 225 (C)	R	R	R			
11	Co 86249 (C)	R	R	R	MR	R	MR

R: Resistant, S: Susceptible, MR: Moderately Resistant,
MS: Moderately Susceptible, HS: Highly Susceptible.

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