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Promising High Yielding and Sucrose Rich Early Maturing Clones Suitable for East Coast Zone of India

M. Charumathi
Senior Scientist (Breeding),
Regional Agricultural Research Station, Anakapalle – 531 001
Email: mmcakp@gmail.com

N. V. Naidu
Director of Extention,
Acharya N.G. Ranga Agril University; Hyderabad

Abstract – **Nine clones were tested in All India Coordinated Varietal Trials at Regional Agricultural Research Station, Anakapalle from 2011-12 to 2012-13 for their performance in two plant crops and one ratoon crop. The clones differed significantly for the traits tested. Among the clones, 2004A 55 (114.50t/ha and 14.57t/ha) and 2003A 255 (114.34t/ha and 14.52t/ha) registered significantly higher cane and sugar yields compared to best standard 87A 298 (111.25t/ha and 14.43t/ha). For juice quality parameters the clone 2003V46 recorded higher brix (21.32), sucrose (18.88), CCS (13.17) and purity per cent (89.63) and found to be significantly superior over the best standard 87A 298 (21.25, 18.68, 12.61 and 89.06) respectively. The clones 2003A 255, 2004A 55 and 2003V46 recorded higher yield components of cane length, cane diameter, single cane weight, shoot population and were resistant to red rot under nodal method of inoculation where as moderately resistant reaction was noted in 2003A255, 2004A55 and moderately susceptible reaction was recorded by 2003V46 under plug method of inoculation. The clones 2003A255 and 2003V46 were resistant and moderately resistant reaction to smut under artificially inoculated conditions.**

Keywords – **Sugarcane-Promising Clones-High Yield and High Quality-East Coast Zone.**

I. Introduction

Globally, sugarcane is cultivated over an area of 25.56 million hectare with a production of 1774.00 metric tones (Anonymons, 2014) with a productivity of 64.70 tonnes per hectare. In India it is grown in an area of 53.41 lakh hectars producing 3456.00 lakh tones of cane with a productivity of 64.70 tha^{-1} (2013-14), while in Andhra Pradesh, it is grown in an area of 1.40 lakh hectares productivity 100.00 lakh tones of cane with a productivity of 72.00 tha^{-1}. To meet the demands of growing population it is necessary to increase cane productivity levels to a 100 tha^{-1}.

Production and productivity of sugarcane is governed by varieties, season and agronomic package of practices besides balanced nutrition. Among the components, varieties plays paramount role in sugar mills. Hence, it is imperative to identify new sugarcane varieties to replace the deterioting commercial varieties through which the overall productivity could be stabilized. Sugarcane varieties have been found to be vary widely in yield potential and quality characters (Balasundaram and Bhagyalakshmi, 1978).

Therefore, to meet the immediate need of sugarcane farming community/grower and sugar factory, there is a need of more number of early maturing, high sugared varieties having high tonnage, good ratooning ability and disease resistance to meet the challenges for improving sugar recovery, especially during the beginning of the crushing season. Hence, the research efforts were made to identify early maturing clones with sustained high cane and sugar yields at Regional Agricultural Research Station, Anakapalle.

II. Materials and Methods

The present investigation was conducted with nine clones viz., 2003A 255, 2004A 55, CoC 08336, CoC 09336, 2003V46, PI 09376 as test clones and Co6907, CoC01061 and 87A298 as standards at RARS, Anakapalle from 2011-12 to 2012-2013 in two plant crops and one ratoon crop. The experiment was laid out in a Randomized Block Design with three replications. Each clone was planted in 38.4 Sqm plot area adopting a seed rate of four three budded setts per meter. Recommended dose of fertilizer 112kg N+100 kg P_2O_5 +120 kg K_2O/ha was applied. Irrigations were accorded at weekly intervals during formative phase of the crop. Weeding, earthing up, T.T propping were carried out as per the recommendation. Spraying with endosulphan @ 2ml/lt was adopted against early shoot borer. Data on number of millable canes, length of cane, cane diameter, single cane weight and cane yield per plot were recorded at harvest. Juice sucrose was determined at harvest (10^{th} month) following the standard procedure (Meade and Chen, 1977). Estimated CCS yield was determined based on CCS per cent and cane yield. Statistical analysis was performed as per the procedure of Panse and Sukhatme (1978).

III. Results and Discussion

The chief morphological characteristics and data on number of millable canes, cane yield, sugar yield, juice quality parameters, yield components and reaction to diseases are furnished in Table 1 to 5 respectively.

NMC (000s/ha):

Mean performance of clones over two plant and one ratoon crops was analysed and presented in Table 2(a). The best standard CoC 01061 (125.00 thousands/ha) recorded maximum number of millable canes when compared to test clones. However the clones 2004A 55(114.09 thousands/ha) and 2003V46 (110.42 thousands/ha) were found to be on par with the best standard CoC 01061 for NMC but significantly superior over the other two standards Co 6907(97.42 thousands/ha) and 87A 298 (104.00 thousands/ha). The per cent increase

for NMC in test entries 2003A 255 and 2004A 55 over the standard Co 6907 was 4.71 and 17.11 respectively where as the per cent increase in 2003V 46 over the standard 87A 298 was 6.18 for number of millable canes.

Cane Yield (t/ha):

Mean data on the performance of early maturing clones in two plant and one ratoon crops was presented in Table 2(b). The clones 2004A 55 (114.50 t/ha) and 2003A 255 (114.34 t/ha) recorded maximum cane yield when compared to best standard 87A298 (111.25 t/ha). The per cent increase for cane yield in 2003A 255 over the three standards i.e, Co 6907(16.86), CoC01061(17.77) and 87A 298 (2.78) respectively, while the increase over the three standards in 2004A55 was 17.03, 17.93 and 2.92 respectively. The clones CoC08336 (110.40 t/ha) and 2003V46(104.09t/ha) recorded higher mean cane yield when compared to other two standards Co6907(97.84 t/ha) and CoC 01061 (97.09 t/ha).

Sugar Yield (t/ha):

Mean data on the performance of early maturing clones in two plant and one ratoon crops was presented in Table 2(c). The clones 2004A 55 recorded higher mean sugar yield of 14.57 t/ha and 2003A 255 (14.52t/ha) when compared to best standard 87A 298 (14.43 t/ha). The per cent increase for sugar yield in 2004A 55 over the three standards Co 6907 (19.03), CoC 01061 (18.17) and 87A 298 (0.97) while the increase over the three standards in 2003A 255 was 18.63, 17.76 and 0.62 respectively. The clones CoC 08336 (14.19 t/ha) and 2003V 46 (13.27 t/ha) recorded significantly higher mean sugar yield when compared to other two standards Co 6907 and CoC01061 tested in the trial.

III. Juice Quality Parameters

Brix and Juice sucrose per cent:

Mean performance of early maturing clones in two plant and one ratoon crops for quality parameters were presented in tables 3(a) and 3(b). The clone 2003V46 recorded higher brix per cent (21.32) and sucrose per cent (18.88) when compared to three standards Co 6907(20.69 and 17.82), CoC 01061 (20.33 and 18.00) and 87A 298 (21.28 and 18.68) respectively and the per cent increase over the standards was 5.95, 4.89 and 1.07 respectively for brix and sucrose per cent.

CCS and Purity Per cent:

The test entry 2003V46 recorded significantly higher CCS (13.17) and purity per cent (89.63) when compared to standards Co 6907(12.71 and 85.47), CoC 01061 (12.80 and 88.56) and 87A298 (12.81 and 89.06). However, the clone CoC 08336 (12.84 and 89.43) recorded significantly higher CCS and purity per cent when compared to standard Co 6907 and CoC 01061. The per cent increase in the test entries i.e, 2003V46 and CoC 08336 over standards Co 6907 was 3.61 and 1.02 per cent; CoC 01061 was 2.89 and 0.32 per cent and 87A298 was 2.81 and 0.23 per cent respectively for CCS and purity per cent.

IV. Performance of Early Maturing Clones for Yield Components

Mean performance of early maturing clones in two plant and one ratoon crops for yield components was presented in table 4. The clones 2004A 55 (288.78cm), 2003V46(260.22cm) and 2003A 255 (259.33cm) recorded higher cane length when compared to standards Co6907(259.11cm), CoC 01061(257.22cm) and 87A 298 (256.33cm), while the clones 2003A 255 (2.52cm and 1.32kg) and 2003V 46(2.62cm and 1.30kg) recorded maximum cane diameter and single cane weight when compared to standards Co 6907 (2.17cm and 1.05kg), CoC 01061 (2.10cm and 1.00kg) and 87A 298 (2.52cm and 1.20kg) respectively. The promising clone 2004A55 recorded maximum number of shoots and germination per cent (146.55 thousands/ha and 68.67 percent) compared to best standard CoC 01061 (142.33 thousands/ha and 68.34 per cent) respectively.

V. Reaction to Red Rot and SMUT

Reaction of test clones for red rot under natural and artificial conditions and for smut under artificial conditions was studied and presented in Table 5. The clones 2003A255, 2004A 55, CoC 08336 and 2003V46 were resistant to red rot under nodal method of inoculation where as moderately resistant reaction was noted for 2003A255, 2004A55 and moderately susceptible reaction was recorded by 2003V46 under plug method of inoculation. The clones 2003A255 and 2003V46 were resistant and moderately resistant reaction respectively to smut under artificially inoculated conditions.

VI. Conclusion

Of the six clones, the clones 2003A 255, 2004A 55, 2003V46 were found to be promising for cane yield and sugar yield, where as for quality attributes, the clones 2003V46 and CoC 08336 recorded higher brix, sucrose, CCS and purity per cent and found to be superior to currently grown popular standards Co 6907, CoC 01061 and 87A 298. The clones were also found to be resistant to red rot under natural conditions and resistant to smut under artificially inoculated conditions. Hence, the clones can be recommended for commercial cultivation in sugar factory operational areas of East Coast Zone comprising of parts of Tamilnadu,Orissa and Andhra Pradesh.

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Table I: Morphological Description of Promising Early Maturing Clones

S. No.	Name of the descriptor		Descriptor Status		
1	Clone number	:	2004A 55	2003A 255	2003V46
2	Stool habit	:	Erect	Erect	Erect
3	Stem colour (exposed)	:	Yellow	Green	Purple with black encrustation
4	Stem colour (unexposed)	:	Yellow	Pale green	Yellow purple
5	Ivory marks	:	Present	Present	Rarely present
6	Weather marks (corky patches)	:	Absent	Absent	Absent
7	Internode shape	:	Cylindrical	Tumescent	Slight obconcidal
8	Internode alignment	:	Straight	Straight	Straight
9	Pithiness	:	Absent	Absent	Absent
10	Splits on Internode	:	Absent	Absent	Absent
11	Wax on Internode	:	Absent	Absent	Present
12	Node swelling	:	Absent	Absent	Absent
13	Root zone colour (exposed)	:	Yellowish white	Green	Purple green
14	Root Zone colour (unexposed)	:	Pale white	Pale green	Green
15	Number of root eye rows	:	Three	Two	Three
16	Arrangement of root eye rows	:	Irregular	Irregular	Irregular
17	Bud size	:	Small	Small	Medium
18	Bud shape	:	Round	Oval	Obovate
19	Bud cushion	:	Absent	Absent	Absent
21	Bud groove	:	Absent	Absent	Absent
22	Leaf length	:	Medium	Medium	Medium to long
23	Leaf width	:	Medium	Medium	Medium to broad
24	Lamina colour	:	Green	Green	Dark green
25	Leaf carriage shape	:	Open tip drooping	Open tip drooping	Open, slightly droopy leaf carriage
26	Leaf sheath colour	:	Pale green	Greenish purple	Purple
27	Leaf sheath waxiness	:	Absent	Absent	Heavy waxy coating
28	Leaf sheath spines	:	Absent	Absent	Weak deciduous spines
29	Leaf sheath clasping	:	Loose	Loose	Loose clasping
30	Presence/absence of ligular process	:	Present	Absent	Absent
31	Percent flowering	:	10 per cent	Absent	Absent

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Table II (a): Mean performance of early maturing clones over two plant and one ratoon crops for NMC (thousands/ha) in AICRP Coordinated trials,
(2011 – 2012 to 2012 – 2013)

S.No	Clone No.	PI	PII	Ratoon	Mean	per cent increase over Co 6907	per cent increase over CoC 01061	per cent increase over 87A 298
1	2003A 255	108.00	112.67	93.67	102.01	4.71	-18.39	-1.91
2	2004A 55	127.00	130.00	99.67	114.09	17.11	-8.73	9.70
3	CoC 08336	100.00	105.33	87.00	94.84	-2.65	-24.13	-8.81
4	CoC 09336	89.33	98.33	80.67	87.25	-10.44	-30.20	-9.16
5	2003V 46	118.00	121.67	101.00	110.42	13.34	-11.66	6.18
6	PI 09376	107.67	108.00	83.67	95.76	-1.70	-23.40	-7.92
	Standards							
1	Co 6907	109.00	110.00	85.33	97.42			
2	CoC 01061	138.00	140.00	111.00	125.00			
3	87A 298	116.00	120.00	90.00	104.00			
	Mean	112.56	116.22	92.44				
	S.Em±	9.42	5.87	3.86				
	CD at 5%	28.39	17.61	11.58				
	CV (%)	9.65	8.75	10.24				

Table II (b): Mean performance of early maturing clones over two plant and one ratoon crops for Cane yield (t/ha) in AICRP Coordinated trials,
(2011 – 2012 to 2012 – 2013)

S.No	Clone No.	PI	PII	Ratoon	Mean	per cent increase over Co 6907	per cent increase over CoC 01061	per cent increase over 87A 298
1	2003A 255	112.00	138.00	103.67	114.34	16.86	17.77	2.78
2	2004A 55	136.67	125.33	98.00	114.50	17.03	17.93	2.92
3	CoC 08336	127.67	125.33	94.30	110.40	12.83	13.71	-0.76
4	CoC 09336	110.33	108.00	78.00	93.59	-4.34	-3.60	-15.87
5	2003V 46	102.67	113.67	100.00	104.09	6.39	7.21	-6.44
6	PI 09376	93.67	95.33	85.00	89.75	-8.27	-7.56	-12.05
	Standards							
1	Co 6907	111.67	113.67	83.00	97.84			
2	CoC 01061	106.00	107.67	87.33	97.09			
3	87A 298	125.67	126.67	96.33	111.25			
	Mean	114.04	116.74	91.74				
	S.Em±	10.85	5.62	3.65				
	CD at 5%	33.69	16.86	10.65				
	CV (%)	11.30	8.34	9.90				

Table II (c): Mean performance of early maturing clones over two plant and one ratoon crops for Sugar yield (t/ha) in AICRP Coordinated trials,
(2011 – 2012 to 2012 – 2013)

S.No	Clone No.	PI	PII	Ratoon	Mean	per cent increase over Co 6907	per cent increase over CoC 01061	per cent increase over 87A298
1	2003A 255	13.09	17.37	13.10	14.52	18.63	17.76	0.62
2	2004A 55	16.32	16.05	12.94	14.57	19.03	18.17	0.97
3	CoC 08336	16.06	16.00	12.34	14.19	15.93	15.09	-1.66
4	CoC 09336	12.80	12.28	9.86	11.20	-8.50	-9.16	-22.38
5	2003V 46	12.42	14.66	13.00	13.27	8.42	7.62	-8.04
6	PI 09376	11.15	11.43	10.98	11.14	-8.99	-9.65	-22.80
	Standards							
1	Co 6907	12.84	15.18	10.46	12.24			
2	CoC 01061	12.54	13.86	11.46	12.33			
3	87A 298	15.19	17.19	12.67	14.43			

	Mean	13.62	14.82	11.90				
	S.Em±	1.31	0.90	0.53				
	CD at 5%	4.00	2.98	1.60				
	CV (%)	11.26	7.58	7.81				

Table III (a) :Mean performance of early maturing clones over two plant and one ratoon crops for Quality attributes in AICRP coordinated trials, (2011 – 2012 to 2012 – 2013)

S.No	Clone No.	Brix Per cent							Sucrose Per cent						
		PI	PII	Ratoon	Mean	per cent increase over Co 6907	per cent increase over CoC 01061	per cent increase over 87A 298	PI	PII	Ratoon	Mean	per cent increase over Co 6907	per cent increase over CoC 01061	per cent increase over 87A298
1	2003A 255	19.09	21.34	20.22	20.22	-2.27	-0.54	-4.98	16.83	17.80	18.23	17.62	-1.12	-2.11	-5.67
2	2004A 55	19.41	20.74	20.88	20.34	-1.69	0.05	-4.42	17.20	18.00	18.30	17.83	0.05	-0.95	-4.55
3	CoC 08336	19.84	21.33	20.41	20.53	-0.77	0.98	-3.52	17.70	18.00	18.53	18.08	1.46	0.44	-3.21
4	CoC 09336	19.59	19.80	20.17	19.85	-4.05	-2.36	-6.72	17.38	17.50	17.80	17.56	-1.46	-2.44	-5.99
5	2003V 46	19.75	22.20	22.00	21.32	3.04	4.87	0.19	17.88	19.40	19.67	18.88	5.95	4.89	1.07
6	PI 09376	18.71	11.75	20.80	19.75	-4.54	-2.85	-7.19	16.55	17.00	18.00	17.18	-3.59	-4.56	-8.03
	Standards														
1	Co 6907	19.75	20.59	21.73	20.69				17.25	18.00	18.20	17.82			
2	CoC 01061	19.87	20.44	20.67	20.33				17.50	18.10	18.40	18.00			
3	87A 298	20.07	21.79	21.89	21.25				17.92	18.73	19.40	18.68			
	Mean	19.56	20.90	20.97					17.32	17.95	18.43				
	S.Em±	0.25	0.22	0.30					0.26	0.15	0.21				
	CD at 5%	0.80	0.67	0.89					0.86	0.47	0.64				
	CV (%)	1.57	1.85	2.46					1.90	1.52	2.00				

Table III (b): Mean performance of early maturing clones over two plant and one ratoon crops for Quality attributes in AICRP coordinated trials (2011 – 2012 to 2012 – 2013)

S.No	Clone No.	CCS Per cent							Purity Per cent						
		PI	PII	Ratoon	Mean	per cent increase over Co 6907	per cent increase over CoC 01061	per cent increase over 87A 298	PI	PII	Ratoon	Mean	per cent increase over Co 6907	per cent increase over CoC 01061	per cent increase over 87A 298
1	2003A 255	11.97	12.59	12.63	12.40	-2.44	-3.13	-5.85	88.16	84.51	89.05	87.24	2.07	-1.49	-2.67
2	2004A 55	12.24	12.81	13.20	12.75	0.32	-0.40	-3.19	88.60	85.85	88.76	87.74	2.66	-0.93	-2.11
3	CoC 08336	12.67	12.77	13.09	12.84	1.02	0.32	0.23	89.21	89.40	89.69	89.43	4.63	0.98	-0.22
4	CoC 09336	12.32	11.37	12.64	12.11	-4.72	-5.39	-8.05	88.51	89.43	88.29	88.74	3.83	0.20	-0.99
5	2003V 46	12.80	13.15	13.57	13.17	3.61	2.89	2.81	89.30	91.00	88.60	89.63	4.20	0.56	-0.70
6	PI 09376	11.76	11.99	12.91	12.22	-2.44	-4.53	-7.21	88.44	86.09	87.70	87.41	2.27	-1.30	-2.48
	Standards														
1	Co 6907	12.18	13.35	12.59	12.71				87.35	83.77	85.28	85.47			
2	CoC 01061	12.41	12.87	13.12	12.80				88.05	88.60	89.04	88.56			
3	87A 298	12.54	12.90	13.00	12.81				89.02	88.94	89.22	89.06			
	Mean	12.32	12.66	12.95					88.52	86.29	88.07				
	S.Em±	0.22	0.29	0.16					0.71	1.21	0.74				
	CD at 5%	0.70	0.87	0.49					2.16	3.63	2.21				
	CV (%)	2.19	3.99	2.21					0.93	2.43	1.45				

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Table IV: Mean performance of early maturing clones over two plant and one ratoon crops for Yield components, (2011 – 2012 to 2012 – 2013)

S.No	Clone (s)	Cane length (cm)				Cane Diameter (cm)				Single cane weight (Kg)				No. of shoots at 240 DAP ('000/ha)				Germination per cent			
		PI	PII	Ratoon	Mean	PI	PII	Ratoon	Mean	PI	PII	Ratoon	Mean	PI	PII	Ratoon	Mean	PI	PII	Ratoon	Mean
1	2003A 255	266.00	253.00	259.00	259.33	2.47	2.46	2.63	2.52	1.30	1.33	1.29	1.32	119.67	124.00	115.00	119.56	68.00	57.33	-	62.67
2	2004A 55	291.00	286.67	288.67	288.78	2.42	2.35	2.47	2.41	1.23	1.23	1.20	1.22	162.33	149.00	128.33	146.55	75.33	62.00	-	68.67
3	CoC 08336	250.00	255.33	238.67	248.00	2.07	2.12	2.30	2.16	1.01	1.08	1.05	1.05	115.33	118.00	133.67	122.33	61.67	62.00	-	61.84
4	CoC 09336	246.00	251.00	236.00	244.33	2.03	2.00	2.20	2.08	1.00	0.99	1.00	0.99	115.33	117.67	116.67	116.56	65.33	58.67	-	62.00
5	2003V 46	264.00	269.00	247.67	260.22	2.56	2.56	2.73	2.62	1.29	1.34	1.28	1.30	127.67	130.33	124.33	127.44	47.00	53.67	-	50.34
6	PI 09376	239.00	246.00	228.00	237.67	2.41	2.40	2.40	2.40	1.07	1.08	1.13	1.09	124.00	123.33	124.67	124.00	56.00	60.33	-	58.17
	Standards																				
1	Co 6907	251.00	263.67	262.67	259.11	2.12	2.18	2.20	2.17	1.03	1.08	1.04	1.05	127.00	126.33	130.33	127.89	63.33	60.67	-	62.00
2	CoC 01061	264.00	251.67	256.00	257.22	2.08	2.10	2.13	2.10	1.00	1.00	1.00	1.00	144.00	145.00	138.00	142.33	76.00	60.67	-	68.34
3	87A 298	257.00	257.33	254.67	256.33	2.36	2.57	2.63	2.52	1.19	1.20	1.21	1.20	136.67	128.00	134.00	132.89	70.00	66.00	-	68.00
	Mean	260.81	259.85	252.37		2.28	2.30	2.41		1.12	1.15	1.14		130.22	129.07	127.56		64.74	60.15	-	
	S.Em±	7.65	4.59	4.18		0.09	0.05	0.09		0.03	0.02	0.04		8.25	4.77	3.41		4.06	1.76		
	CD at 5%	23.10	13.76	12.52		0.27	0.16	0.29		0.08	0.06	0.13		24.79	14.28	10.22		12.24	5.26		
	CV (%)	3.38	3.06	2.87		3.64	4.04	7.07		2.72	3.04	6.71		7.29	6.39	4.63		7.24	5.06		

Table V : Reaction to Diseases

S.No	Clone No.	Red Rot						Smut
		Nodal			Plug Method			
		Cf 04	Cf 06	Cf 05	Cf 04	Cf 06	Cf 05	
1	2003A 255	R	R	R	MR	MR	MR	R
2	2004A 55	R	R	R	MR	MR	MR	MS
3	CoC 08336	R	R	R	R	R	R	HS
4	CoC 09336	-	-	-	-	-	-	-
5	2003V 46	R	R	R	MS	MS	MS	MR
6	PI 09376	-	-	-	-	-	-	-
	Standards							
1	Co 6907	MS	MS	MS	HS	HS	HS	HS
2	CoC 01061	HS	HS	HS	HS	HS	HS	HS
3	87A 298	R	R	R	R	R	R	HS

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

2003 V 46

2003A255

2004A55