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Reducing sugars and Dextrans as indicators of tolerance to post harvest deterioration in Sugarcane (*Saccharum spp.*)

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A B S T R A C T

Fifteen sugarcane clones including two checks 2003V 46 and CO 86032 were studied in two plant and one ratoon across three farming situations from 2022-23 to 2023-24 to identify clones tolerant to delayed harvest (10 to 13th months of crop age) and delayed crushing (0, 24,48 and 72 hrs) after harvest. Data was recorded on cane and estimated sugar yield at harvest. Juice quality parameters (Sucrose and purity) and juice quality deterioration characters (Dextrans and Reducing sugars) were determined at 10, 11, 12 and 13th months of crop age at 24 hrs interval (from immediately after harvest to 72 hrs after crop harvest. Among the test clones, the high cane and sugar yielding clones *viz;* 2016T 7, 2003V 46 TC, CO A 14328 in early and 2009V 89 and COA 19322 in midlate recorded low per cent reducing sugars and dextrans and higher per cent juice sucrose and purity compared to the check CO 86032 but on par with the best check 2003V 46 TC under delayed harvest and delayed crushing at each harvest in all the farming situations. Dextrans increased linearly among the clones upto 12th months of crop age and then decreased at 13th month of crop age while per cent reducing sugars increased progressively with the increase in the crop age (10 th to 13th month). Both per cent reducing sugars and dextrans progressively increased with increase in time lag intervals of crushing (0 to 72 hrs after harvest). Dextrans were found high in early clones while per cent reducing sugars were observed to be high in midlate clones. Dextrans were found to be high in ratoons whereas percent reducing sugars were high in plant crops. Among the three- farming situation FSI: Sandy soils with bore well irrigation followed by FSII: Garden lands with limited irrigation and FSIII: Wetlands with well irrigation were observed to be the favorable environments in quality retention for longer period.

Introduction

Postharvest deterioration of sugarcane is a severe problem for the sugar industry causing 20-30 per cent sucrose losses in cane producing countries (Eggleston, 2001; Solomon, 2009 and 2011). Microbial agents are the major contributors for the inversion of sucrose followed by enzymes and chemicals. The cut ends of canes

facilitate invasion of microbes particularly *Leuconostoc* bacteria which converts sucrose into dextrans (Kim and Robyt, 1995). Invertase enzymes hydrolyze sucrose into glucose and fructose. Inversion of sucrose by plant and microbial invertases leads formation of organic acids and dextrans largely influence loss of recoverable sugar after harvest of cane. Formation of organic acids by microorganisms results in loss of sucrose and lowering of juice PH. Dextrans, a polysaccharide is the major contributor to postharvest sucrose loss. Dextrans are formed due to utilization of glucose by *Leuconostoc* bacteria and left over by- product fructose is an indication of cane deterioration (Eggleston 2002, 2008). Dextrans formation depends on time lag between harvest and milling, size of cane files, varietal characters, ambient temperature and humidity (Solomon *et al.,* 2011). Solomon *et al.,* (2008); (Bhatia *et al.,* 2009) and Singh *et al.,* (2015) also observed increase in reducing sugars and PH in sugarcane under delayed harvest and staling. Reducing sugars are highly prone to rapid bio-deterioration resulting in undesirable and harmful products (ethanol, acids, polysaccharides) Postharvest deterioration in sugarcane becomes more pronounced with the increase in the time lag between harvest and crushing. Two clones viz; 2003V 46 and CO 86032 are under extensive cultivation in Andhra Pradesh. However, CO 86032 is highly susceptible to postharvest deterioration and yellow leaf disease while 2003V 46, a sucrose rich early clone is susceptible to delayed harvest and yellow leaf disease. Adoption of planting material derived through micropropagation in sugarcane aid restoration of yield potential and prolonging the shelf life of clones. Through the present investigation 13 clones including 2003V 46 TC derived from micropropagation were tested against O86032 and 2003 V 46 to identify clones possessing tolerance to delayed harvest and crushing and also characterize stable juice quality parameters as indicators of postharvest deterioration in sugarcane.

Materials and Methods

The experimental material comprising 15 sugarcane clones including two popular clones as checks (2003V 46 and CO 86032) were grown in a randomized block design with three replications in two plant and one ratoon from 2022-23 to 2023-24 under three farming situations *viz:* FSI: Sandy soils with bore well irrigation; FSII: Grden lands with limited irrigation and FSIII: wetlands with well irrigation in M/s. S.N. J. Sugars and Products Ltd. Chittoor, A. P. All the recommended package of practices were adapted for raising a healthy crop. Data were recorded on Juice sucrose and purity per cent (Meade and Chen, 1977) following standard procedures. Per cent reducing sugars were determined by adopting Dinitrosalysic acid reagent method (DNS) (Miller, 1959) while Dextrans were determined using Dextran Pocket Refractometer from 10^{th} to 13^{th} months of crop age and at 24 hrs of time intervals (0, 24, 48 and 72 hrs) at each month of harvest. Mean data were analyzed following the methods suggested by Panse and Sukhatme, (1985).

Results and Discussion

Mean data pertaining to per cent juice sucrose, purity, reducing sugars and dextrans for all the top clones studied over six plant crops and three ratoons (Two plant crops and on ratoon from 2022-23 to 2023-24 across three farming situations) were furnished in Tables 1a to 4d. Results were presented hereunder on character-wise

Juice sucrose (%)

Among the high cane and sugar yielding clones, 2016T 7 (20.4 and 20.9) 2003V 46 TC (20.8 and 21.1), COA 14328 (17.4 and 18.6) and CO A 19322 (18.3 and 17.8) recorded higher per cent juice sucrose at 11t h months of crop age in plant and ratoons, respectively compared to the check CO 86032 (17.4 and 17.7) but on par with the best check 2003V 46 (20.3 and 20.8) across the three farming situations. Ratoon crops recorded higher per cent juice sucrose than plant crop across farming situations. A progressive reduction in juice sucrose was noted from 0 hrs of crushing after harvest to 72 hrs of crushing after harvest at each month of harvest. Per cent juice sucrose declined after 11^{th} months of crop age in all the clones except 2009V 89. Per cent sucrose immediately after harvest (0 hrs) varied 13.8 (2008V257 and 2009V 89) to 20.4 (2003V 46 TC) with a mean of 16.2 over six crops and from 14.2 (2008V 257) to 20.7 (2003V 46T C) with a mean of 16.6 over three ratoon crops whereas it ranged from 12.7(COA 20327) to 19.5 (2003V 46 TC) with a mean of 15.2 over six plant crops and from13.0(COA 20327) to 19.8(2003V 46 TC) with a mean of 15.6 over three ratoon crop at 72 hrs after crop harvest across the farming situations at 10^{th} months of crop harvest. Across farming situations at 13^{th} months of crop harvest, per cent sucrose varied from 15.3 (CO 0238) to 19.5 (2003V 46 TC) with a mean of 17.4 over six crops and from 15.5(CO 0238) to 19.8 (2003V 46 TC and 2016T 7) with a mean of 17.7 over three ratoon crops at o hrs after harvest while it ranged from 14.3(CO 0238) to 18.5

(2003V 46 TC) with a mean of 16.2 over six plant crops and from 14.6 (CO 0238) to 18.7 (2003V 46 TC)with a mean of. 16.5 over three ratoon crops at 72 hrs after crop harvest. (Table 1a to 1d)

Juice purity (%)

The clones *viz;* 2016T 7 (89.2 and 89.6) and 2003V 46 TC (91.0 and 90.5) recorded higher per cent juice among the top high cane and sugar yielding clones in plant and ratoon crops, respectively upto 11th months of crop age while COA 19322 (88.6 and 87.2) and COA 14328 (87.0 and 89.0) maintained higher per cent purity upto 12 th months of crop age in plant and ratoon crops, respectively. However, per cent purity declined in all the clones from 0 hrs of crushing to 72 hrs after crushing. Reduction in per cent purity was found to be low in 2003V 46 TC and 2016T 7 compared to all other clones and checks CO 86032 and 2003V 46 across farming situations. Ratoon crop recorded higher per cent juice purity over plant crop across farming situations. A progressive reduction in juice sucrose was noted from o hrs of crushing after harvest to 72 hrs after harvest at each month of harvest. Per cent juice purity declined after 11th months of crop age in all the clones except 2009V 89. Per cent purity immediately after harvest (0 hrs) varied from 71.0 (2009V 127) to 90.1 (2009V89) with a mean of 86.0 over six crops and from 78.7 (2009V 127) to 91.2 (2009V89) with a mean of 86.9 over three ratoon crops whereas it ranged from 61.0 (2009V 127) to 83.4(2003V 46 TC) with a mean of 76.2 over six plant crops and from 67.5 (2009V 127) to 82.9(2003V 46TC) with a mean of 77.0 over three ratoon crop at 72 hrs after crop harvest across farming situations at 10th months of crop harvest. Across farming situations at 13th months of crop harvest, per cent purity varied from 74.8 (2008V 257) to 91.0 (CO A 20324) with a mean of 84.5 over six crops and from 75.1 (2008V 257) to 91.3 (CO A 20324) with a mean of 84.8 over three ratoon crops at 0 hrs after harvest while it ranged from 60.2(COA 19321) to 80.6 (COA14328) with a mean of 74.0 over six plant crops and from 60.4 (COA 19321) to 80.3 (CO A 14328) with a mean of 74.3 over three ratoon crop at 72 hrs after crop harvest. (Table 2a to 2d)

Reducing sugars (%)

The top high cane and sugar yielding clones, 2016T 7 and 2003V 46 TC recorded lower per cent reducing sugars at all months of crop harvest compared to the checks CO 8632 and 2003V 46 across all farming situations. Mean per cent reducing sugars were observed to be high in plant crops compared to the ratoon crops in all the clones studied and at all-time intervals of crushing and all months of crop harvest across all farming situations.

A progressive increase in reducing sugars was recorded in all the clones tested with concomitant increase in time lag between harvest and crushing and reached higher value at 72 hrs after crushing at each month of harvest. Per cent reducing sugars increased 10th months of crop age in all the clones. Per cent reducing sugars varied from 0.27 (2003V46 TC) to 0.73 (CO0238) with a mean of 0.47 over six crops and from 0.17 (COA 19322) to 0.36 (CO0238) with a mean of 0.26 over three ratoon crops at 0 hrs of crushing (immediately after harvest)whereas it ranged from 0.29(2003V46 TC) to 0.63 (2008V257) with a mean of 0.44 over six plant crops and from 0.25 (COA 19322) to 0.64(COA 20321) with a mean of 0.44 over three ratoon crop at 72 hrs of crushing after harvest across farming situations at 10th months of crop harvest. Across farming situations at 13th months of crop harvest per cent reducing sugars varied from 0.26 (2016T7) to 0.76 (2008V257) with a mean of 0.45 over six crops and from 0.21 (COA 19322) to 0.41 (2009V127) with a mean of 0.33 over three ratoon crops at 0 hrs after harvest while it ranged from 0.48 (2003V46 TC) to 1.21(2008V257) with a mean of 0.85 over six plant crops and from 0.45(2003V46 TC) to 0.74 (CO0238) with a mean of 0.54 over three ratoon crops at 72hrs after harvest. (Table 3a to 3d). Reducing sugars in juice is an important indicator of cane deterioration.

It is considered as the governing factor in sugarcane growth process and quality maintenance. A sharp increase in acid invertase activity leads to an increase in reducing sugars. Similar results on progressive increase in reducing sugars with the increase in staling period as observed in the present study were also reported by Magdum *et al.,* (1987); Verma *et al.,* (2012) and Singh *et al.,* (2020) in sugarcane.

Dextrans

Mean dextrans content was found to be higher in ratoon compared to the plant crops in all the farming situations. Dextrans were noted to be low in all the high cane and sugar yielding clones compared to the check CO 86032 but on par with the best check 2003 V 46. Dextrans progressively increased from 0 hrs of crushing to 72 hrs of crushing at all months of crop harvest.

Table.1a Per cent juice sucrose at 10th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	13.8	14.6	13.5	14.3	13.2	14.0	13.1	13.8
2	2016T7	19.6	20.1	19.4	19.8	19.2	19.6	19.0	19.5
3	COA 14328	16.1	17.1	15.5	16.7	15.0	16.2	14.6	15.9
4	COA 19322	16.8	16.4	16.3	15.8	15.9	15.2	15.6	14.9
5	2003V 46 TC	20.4	20.7	20.3	20.5	19.7	20.0	19.5	19.8
6	2003V 46(C)	19.6	20.1	19.5	19.9	19.2	19.6	19.0	19.4
7	CO 86032(C)	16.1	16.5	15.8	16.1	15.5	15.8	14.9	15.2
	Mean	16.2	16.6	15.9	16.3	15.5	15.9	15.2	15.6
	SEm	0.10	0.10	0.11	0.10	0.11	0.10	0.09	0.09
	C. D at 5%	0.28	0.28	0.31	0.30	0.31	0.32	0.28	0.27
	C.V (%)	1.03	1.04	1.16	1.09	1.20	1.19	1.09	1.03

Table.1b Per cent juice sucrose at 11th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	15.5	15.6	15.3	15.4	15.0	15.1	14.7	14.8
2	2016T7	20.4	20.9	20.3	20.8	20.1	20.6	19.9	20.3
3	CO A 14328	17.4	18.6	17.2	18.5	16.7	17.9	16.4	17.6
4	COA 19322	18.3	17.8	18.1	17.6	17.5	17.0	17.3	16.8
5	2003V 46 TC	20.8	21.1	20.6	20.9	20.2	20.4	19.5	19.7
6	2003V 46(C)	20.3	20.8	19.9	20.4	19.6	20.0	19.4	19.9
7	CO 86032(C)	17.6	18.0	17.3	17.7	17.0	17.4	16.7	17.1
	Mean	17.4	17.7	17.1	17.4	16.7	17.0	16.3	16.7
	SEm	0.11	0.11	0.12	0.12	0.13	0.14	0.09	0.09
	C. D at 5%	0.32	0.31	0.34	0.35	0.38	0.40	0.27	0.28
	C.V (%)	1.10	1.03	1.20	1.20	1.36	1.39	0.97	0.99

Table.1c Per cent juice sucrose at 12th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	18.2	18.6	17.7	18.1	17.2	17.6	16.9	17.2
2	2016T7	19.4	19.8	19.1	19.5	18.7	19.2	18.4	18.9
3	CO A 14328	18.4	18.3	17.9	17.8	17.6	17.5	17.2	17.1
4	COA 19322	17.9	18.7	17.4	18.3	17.1	17.9	16.7	17.5
5	200346 TC	19.5	19.8	19.3	19.5	18.9	19.1	18.5	18.7
6	2003V 46(C	19.0	19.5	18.8	19.2	18.4	18.8	18.1	18.5
7	CO 86032(C)	16.7	17.1	16.1	16.5	15.6	16.0	15.4	15.8
	Mean	17.4	17.7	16.9	17.3	16.6	16.9	16.2	16.5
	SEm	0.15	0.05	0.12	0.12	0.12	0.11	0.09	0.09
	C. D at 5%	0.43	0.43	0.33	0.34	0.35	0.33	0.28	0.26
	C.V (%)	1.47	1.45	1.19	1.16	1.28	1.17	0.98	0.96

Table.1d Per cent juice sucrose at 13th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	16.5	16.9	16.4	16.7	16.3	16.6	15.8	16.10
2	2016T7	18.3	18.8	17.9	18.3	17.6	18.0	17.3	17.7
3	COA 14328	17.7	17.6	17.4	17.4	17.1	17.0	16.5	16.0
4	COA 19322	17.2	18.0	17.0	17.7	16.6	17.4	16.3	16.8
5	200346 TC	18.3	18.5	17.7	17.9	17.2	17.4	16.9	17.1
6	2003V 46	17.7	18.1	17.1	17.5	17.0	17.4	16.8	17.1
7	CO 86032	16.3	16.6	15.3	15.7	14.8	15.2	14.6	14.9
	Mean	16.2	16.5	15.8	16.1	15.5	15.8	15.1	15.4
	SEm	0.13	0.13	0.14	0.13	0.11	0.11	0.11	0.10
	C D at 5%	0.40	0.38	0.14	0.13	0.28	0.29	0.28	0.28
	C.V (%)	1.45	1.33	1.53	1.42	1.09	1.14	1.11	1.09

Table.2a Per cent purity at 10th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	90.1	91.2	82.5	83.7	77.0	78.3	74.3	75.6
2	2016T7	87.7	88.0	85.9	86.3	84.8	85.2	83.9	84.2
3	COA 14328	84.9	85.9	79.8	82.2	76.1	79.1	73.3	76.4
4	COA 19322	85.5	85.1	81.9	80.0	78.8	76.3	76.1	73.5
5	2003V 46 TC	89.7	89.1	88.0	87.5	84.7	84.2	83.4	82.9
6	2003V 46 (C)	86.6	87.6	84.8	85.9	82.3	83.3	80.5	81.5
7	CO 86032(C)	80.5	80.8	76.8	77.1	74.5	74.8	71.0	71.2
	Mean	86.0	86.9	82.3	83.1	78.7	79.5	76.2	77.0
	SEm	0.73	0.72	0.69	0.71	0. 70	0.72	0.46	0.46
	C. D at 5%	2.11	2.09	2.00	2.06	1.98	2.08	1.33	1.34
	C.V (%)	1.46	1.44	1.45	1.48	1.51	1.56	1.05	1.04

Table.2b Per cent purity at 11th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	87.0	87.6	83.9	84.5	81.3	81.8	79.0	79.5
2	2016T7	89.2	89.0	88.5	88.9	87.0	87.4	85.1	85.4
3	CO A 14328	86.1	87.7	83.8	84.6	80.1	80.2	78.4	78.5
4	COA 19322	87.3	86.3	84.2	83.9	79.9	80.3	78.2	78.6
5	2003V 46 TC	91.0	90.5	86.2	85.7	82.9	82.4	79.3	78.9
6	2003V 46(C)	86.4	87.5	83.4	84.5	81.5	82.5	80.0	81.0
7	CO 86032(C)	82.8	83.1	71.1	87.4	79.3	79.6	77.9	78.2
	Mean	85.9	86.7	82.9	83.7	80.1	80.8	77.5	78.2
	SEm	0.55	0.55	0.76	0.71	0.75	0.73	0.64	0.65
	C. D at 5%	1.59	1.61	2.19	2.06	2.17	2.12	1.85	1.88
	C.V (%)	1.09	1.11	1.58	1.47	1.63	1.57	1.42	1.43

Table.2c Per cent purity at 12th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	94.4	94.9	91.0	91.4	85.4	85.8	81.5	81.9
2	2016T7	86.5	86.9	85.0	85.3	82.7	83.0	79.3	79.6
3	COA 14328	87.0	89.0	83.6	84.7	81.2	82.5	77.4	79.2
4	COA 19322	88.6	87.2	84.4	83.8	82.2	81.4	78.9	77.6
5	2003V 46 TC	89.7	89.2	88.0	87.5	84.5	84.1	81.7	81.3
6	2003V 46(C)	87.3	88.4	85.2	86.3	83.1	84.2	81.5	82.6
7	CO 86032(C)	77.4	77.7	71.8	72.1	68. 7	69.0	67.0	67.3
	Mean	86.2	86.5	82.5	82.8	79.8	80.1	76.7	76.9
	SEm	1.02	1.02	0.81	0.82	0.85	0.85	0.61	0.60
	C. D at 5%	2.95	2.96	2.35	2.36	2.47	2.46	1.77	1.74
	C.V (%)	2.05	2.05	1.70	1.70	1.85	1.83	1.38	1.36

Table.2d Per cent purity at 13th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	86.8	87.7	84.5	84.9	83.3	83.7	79.9	60.3
2	2016T7	87.3	87.7	84.6	84.9	81.8	82.1	78.1	78.4
3	CO A 14328	89.2	88.3	86.7	85.8	83.8	82.9	80.6	80.6
4	COA 19322	87.9	89.3	85.4	86.8	82.5	84.0	80.3	80.8
5	2003V 46 TC	87.5	86.9	82.7	82.2	79.1	78.7	75.5	75.1
6	2003V 46(C)	82.4	83.4	79.6	80.6	78.3	79.3	76.8	77.7
7	CO 86032(C)	78.3	78.6	70.4	70.6	67.9	68.1	66.2	66.4
	Mean	84.5	84.8	79.9	80.2	77.2	77.5	74.0	74.3
	SEm	0.85	0.87	0.77	0.75	1.07	1.08	0.61	0.62
	C. D at 5%	2.46	2.53	2.22	2.19	3.09	3.12	1.78	1.77
	C.V (%)	1.74	1.78	1.66	1.63	2.39	2.41	1.44	1.42

Table.3a Per cent reducing sugars at 10th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	0.47	0.26	0.32	0.28	0.39	0.38	0.57	0.41
2	2016T7	0.33	0.26	0.16	0.27	0.29	0.36	0.32	0.41
3	C1OA 14328	0.39	0.21	0.25	0.26	0.28	0.31	0.32	0.34
4	COA 19322	0.39	0.17	0.16	0.19	0.23	0.24	0.30	0.25
5	2003V 46 TC	0.27	0.22	0.18	0.27	0.23	0.36	0.29	0.40
6	2003V 46(C)	0.30	0.27	0.22	0.30	0.25	0.42	0.31	0.44
7	CO 86032(C)	0.37	0.30	0.24	0.32	0.29	0.42	0.36	0.57
	Mean	0.47	0.26	0.27	0.30	0.37	0.40	0.44	0.44
	SEm	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	C. D at 5%	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.03
	C.V (%)	3.03	4.13	4.13	3.81	3.11	4.99	3.21	3.73

Table.3b Per cent reducing sugars at 11th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	0.30	0.29	0.43	0.30	0.47	0.42	0.57	0. 44
2	2016T7	0.20	0.30	0.24	0.32	0.33	0.39	0.35	0.49
3	COA 14328	0.28	0.34	0.36	0.40	0.39	0.47	0.42	0.51
4	COA 19322	0.21	0.20	0.27	0.23	0.39	0.27	0.42	0.32
5	2003V 46 TC	0.19	0.29	0.23	0.33	0.27	0.38	0.35	0.43
6	2003V 46(C)	0.23	0.30	0.28	0.37	0.30	0.42	0.40	0.47
7	CO 86032(C)	0.27	0.33	0.32	0.38	0.37	0.47	0.44	0.60
	Mean	0.32	0.31	0.40	0.35	0.47	0.45	0.54	0.57
	SEm	0.01	0.02	0.01	0.03	0.01	0.03	0.01	0.02
	C. D at 5%	0.04	0.05	0.04	0.08	0.03	0.08	0.03	0.04
	C.V (%)	6.65	10.15	5.72	1.37	3.03	10.60	3.30	5.00

Table.3c Per cent reducing sugars at 12th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	**Ratoon**	**Plant**	**Ratoon**	**Plant**	**Ratoon**	**Plant**	**Ratoon**
1	2009V89	0.35	0.30	0.47	0.31	0.53	0.43	0.63	0.45
2	2016T7	0.22	0.31	0. 26	0.33	0.37	0.40	0.40	0.50
3	COA 14328	0.33	0.36	0.42	0.42	0.45	0.49	0.49	0.53
4	COA 19322	0.25	0.20	0.29	0.24	0.45	0.28	0.46	0.33
5	2003V 46 TC	0.21	0.30	0.26	0.34	0.31	0.39	0.39	0.44
6	2003V 46 (C)	0.23	0.31	0.29	0.38	0.32	0.43	0.42	0.48
7	CO 86032(C)	0.30	0.34	0.35	0.39	0.41	0.49	0.48	0.62
	Mean	0.36	0.32	0.45	0.36	0.53	0.47	0.62	0.53
	SEm	0.01	0.02	0.02	0.03	0.01	0.03	0.01	0.02
	C. D at 5%	0.03	0.05	0.04	0.08	0.03	0.08	0.03	0.05
	C.V (%)	5.90	10.20	5.90	13.60	3.13	10.71	3.01	5.30

Table.3d Per cent reducing sugars at 13th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	0.41	0.31	0.60	0.32	0.64	0.45	0.77	0.47
2	2016T7	0.26	0.32	0.31	0.34	0.46	0.41	0.61	0.52
3	COA 14328	0.45	0.37	0.54	0.43	0.58	0.51	0.63	0.54
4	COA 19322	0.30	0.21	0.31	0.24	0.51	0.29	0.57	0.34
5	2003V 46 TC	0.28	0.31	0.34	0.35	0.38	0.41	0.48	0.45
6	2003V 46(C)	0.30	0.32	0.36	0.39	0.39	0.44	0.54	0.50
7	CO 86032(C)	0.34	0.35	0.38	0.41	0.52	0.50	0.62	0.64
	Mean	0.45	0.33	0.56	0.37	0.66	0.48	0.85	0.54
	SEm	0.01	0.02	0.02	0.03	0.01	0.03	0.02	0.02
	C. D at 5%	0.03	0.06	0.05	0.09	0.03	0.09	0.05	0.05
	C.V (%)	5.40	10.20	5.30	13.60	3.03	10.90	3.40	5.33

Table.4a Dextrans at 10th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	13.0	18.8	15.2	19.1	15.4	19.9	15.9	19.5
2	2016T7	12.4	18.1	13.2	18.4	12.9	18.9	13.3	19.2
3	CO A 14328	12.3	18.1	13.1	18.3	13.8	19.2	14.2	19.1
4	COA 19322	12.2	16.1	12.8	16.4	13.3	17.3	13.7	16.9
5	2003V 46 TC	12.9	18.0	12.9	18.1	13.9	18.3	14.2	18.9
6	2003V 46(C)	13.0	18.0	13.0	18.4	14.1	18.4	14.4	19.0
7	CO 86032(C)	14.2	19.0	14.9	19.5	15.3	20.2	15.5	19.8
	Mean	13.3	18.5	14.3	18.9	14.7	19.3	15.1	19.6
	SEm	0.16	0.13	0.09	0.13	0.17	0.16	0.17	0.10
	C. D at 5%	0.47	0.38	0.27	0.37	0.49	0.45	0.49	0.30
	C.V (%)	1.83	1.23	1.11	1.17	1.82	1.42	1.81	0.95

Table.4b Dextrans at 11th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	15.9	18.9	16.6	19.6	17.3	19.3	19.2	19.5
2	2016T7	15.0	19.2	15.4	19.7	16.7	19.8	17.3	20.0
3	CO A 14328	14.6	18.6	15.4	19.2	17.0	19.4	18.4	19.8
4	COA 19322	13.8	15.9	15.0	17.0	16.0	17.8	17.6	18.4
5	2003V 46 TC	14.4	18.5	15.6	18.5	17.0	19.6	18.0	19.8
6	2003V 46 (C)	14.6	18.4	15.8	18.7	17.3	19.7	18.3	19.9
7	CO 86032(C)	16.0	18.9	16.7	20.0	17.8	19.6	20.9	20.2
	Mean	15.4	18.9	16.7	19.4	18.1	19.7	19.2	20.0
	SEm	0.14	0.12	0.10	0.15	0.09	0.15	0.15	0..30
	C. D at 5%	0.41	0.35	0.29	0.43	0.27	0.45	0.43	0.92
	C.V (%)	1.59	1.12	1.05	1.30	0.89	2.04	1.33	2..71

Table.4c Dextrans at 12th month of harvest and different time intervals of crushi

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	17.3	20.0	18.1	19.4	18.8	19.7	18.6	20.6
2	2016T7	16.4	19.7	16.7	19.8	17.5	20.0	18.2	20.6
3	CO A 14328	17.1	19.4	17.4	19.7	18.1	20.1	18.4	20.7
4	COA 19322	16.4	17.4	16.8	18.0	17.6	18.9	17.6	19.1
5	2003V 46 TC	16.6	18.4	17.2	19.5	17.2	19.9	18.0	19.6
6	2003V 46(C)	17.0	19.1	17.4	19.5	17.7	20.1	18.2	20.1
7	CO 86032(C)	19.5	20.5	20.0	20.2	20.5	20.6	20.4	21.5
	Mean	18.0	19.6	18.5	19.9	18.9	20.2	19.6	20.7
	SEm	0.16	0.09	0.12	0.14	0.09	0.30	0.13	0.09
	C. D at 5%	0.45	0.25	0.36	0.39	0.26	0.93	0.36	0.28
	C.V (%)	1.50	0.81	1.15	1.19	0.82	2.16	1.13	0.81

Table.4d Dextrans at 13th month of harvest and different time intervals of crushing

S.No.	Clone	0 hrs		24hrs		48hrs		72hrs	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	2009V89	13.9	18.9	14.6	19.3	15.8	19.7	16.7	19.9
2	2016T7	13.7	19.0	13.8	19.6	14.6	20.0	15.5	20.3
3	COA 14328	13.7	18.3	14.4	19.1	15.6	19.8	16.9	20.4
4	COA 19322	13.0	16.0	13.7	16.2	14.2	18.2	15.6	19.4
5	2003V 46 TC	13.4	18.1	14.2	18.9	15.2	19.9	16.1	20.1
6	2003V 46 (C)	13.5	18.3	14.4	18.7	15.4	20.0	16.3	20.3
7	CO 86032(C)	14.6	19.1	15.5	19.3	16.5	20.1	17.6	21.2
	Mean	14.2	18.6	14.9	19.2	16.0	20.0	17.0	20.5
	SEm	0.13	0.14	0.11	0.14	0.12	0.19	0.13	0.17
	C. D at 5%	0.38	0.41	0.32	0.41	0.34	0.58	0.36	0.48
	C.V (%)	1.43	1.30	1.20	1.26	1.26	6.83	1.24	1.40

A progressive increase in dextrans was noted from o hrs of crushing after harvest to 72 hrs after harvest at each month of harvest (Table 5a & 5b). Per cent dextrans increased from 10th to 13th months of crop harvest in all the clones across all farming situations.

Dextrans varied at 0 hrs of crushing from12.2 (COA19322) to 14.4 (2012V123) with a mean of 13.3 over six crops and from 16.1 (COA19322) to 20.0 (2009V127) with a mean of 18.5 over three ratoon crops whereas it ranged from 13.7(COA19322) to 16.1(COA19321) with a mean of 15.1 over six plant crops and from 16.9 (COA19322) to 20.9(2009V127 and 2012V123 with a mean of 19.6 over three ratoon crop at 72 hrs after crushing at 10th months of crop harvest across farming situations. Across farming situations at 13th months of crop harvest dextrans varied from 13.0 (COA19322) to 15.1 (2012V123 and COA2 0327) with a mean of 14.2 over six crops and from 16.0 (COA19322) to 19.7 (2009V127) with a mean of 18.6 over three

ratoon crops at 0 hrs of crushing after harvest while it ranged from 15.5(2016T7) to 18.3 (COA19321) with a mean of 17.0 over six plant crops and from 19.4 (COA19322) to 21.4(2012V123) with a mean of 20.5 over three ratoon crop at 72 hrs of crushing after crop harvest(4a to 4d). The clones *viz*; 2016T 7, 2003V 46 TC, COA 19322 and COA 14328 recorded lower dextrans at all months of months of crop age. Higher contents of dextrans in cane juice observed in the present study in ratoon crops as compared to plant crops is contradicting the findings of Kouzi and Kontro (2024) However, the findings are in tune with the results reported by Bhatia *et al.,* (2009) and Saxena *et al.,* 2010).

Per cent juice sucrose, purity, reducing sugars and dextrans determined at different months of crop age(10, 11, 12 and 13th months) and at 24 hrs intervals of crushing (0, 24, 48 and 72 hrs) indicated that per cent sucrose and purity progressively decreased with the increase in the time lag interval of crushing (0 to 72 hrs.).

Dextrans increased linearly among the clones upto 12th months of crop age and then decreased at 13th month of crop age whereas per cent reducing sugars increased progressively with the increase in the crop age (10th to 13th month). Both per cent reducing sugars and dextrans linearly increased with increase in time lag intervals of crushing (0 to 72 hrs after harvest. Dextrans were found high in early clones while per cent reducing sugars were observed to be high in midlate clones. Dextrans were found to be high in ratoons whereas percent reducing sugars were high in plant crops. Among the three farming situation Sandy soils with bore well irrigation followed by Garden lands with limited irrigation and Wetlands with well irrigation were observed to be the favourable environments for higher cane and sugar yields and quality retention for longer period. The high cane and sugar yielding clones 2003V 46 TC, 2016T 7, CO A 14328 CO A 19322and 2009V 89 were found to possess higher shelf life and tolerant to postharvest deterioration and may be recommended for commercial cultivation in the state.

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Author Contributions

N. V. Naidu: Investigation, formal analysis, writing—original draft. M. Sreedhar: Validation, methodology, writing—reviewing. N. Sabitha:—Formal analysis, writing—review and editing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

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