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Impact Studies on Delayed Crush on Post-Harvest Deterioration of Promising Sugarcane Clones

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was conducted with five promising early maturing sugarcane clones at Regional Agricultural Research Station, Rudrur [latitude of 18^{o}-300' north and 77^{o}-510' longitude to the east at an elevation of 404 m above mean sea level], Nizamabad district, T.S., India during Rabi 2014-

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15. The key objective of the present investigation was to study the impact of a delayed crush on postharvest deterioration of promising sugar cane clones. Different biochemical aspects like percent juice sucrose, commercial cane sugar percent, juice extraction percent and reducing sugars % were assayed from 0-72 h. The results of the study indicated that the clones such as Co 99004 and 2011 R 42 indicated the highest sucrose percent (22.29% & 20.87%) and CCS percent (15.84% & 14.87%) respectively, percent reduction in single cane weight of Co 99004 and 2010 R 305 (1.83 and 1.63) and juice extraction percent of clones 2010 R 305 & 2011 R1 were 55 & 53 percents respectively. Among the five clones tested 2010 R 305 maintained its cane quality up to 72 hours with minimum percent reduction of 4.05, 4.30, 2.80 and 4.25 for to sucrose content, CCS percent, juice extraction percent and percent reduction in single cane weight, respectively followed by 2011 R 1 and Co 99004. The Present study concluded that 2010 R 305 was found to possess tolerance to Post- harvest deterioration.

Keywords: Sugarcane; post-harvest deterioration; promising clones.

1. INTRODUCTION

Sugar has grown in importance as a commodity in the current era of economic Liberaliation, both for human consumption and trade. One of the nation's largest economic enterprises is the sugarcane industry, which is regarded as one of its organized sectors. Sugarcane and Sugarbeet are the main sources of sugar extraction. Sugarcane is the source of 70% of the world's white crystal sugar, earning the crop the nickname "kalpavriksha" (or "wonderful crop").

Sugar cane (*Saccharum officinarum*) is a widely grown crop in India. In India, the crop is cultivated in almost all the states under diverse conditions area under sugar cane is 47.53 lakh ha, with 362.07 Mt production and productivity of 76.0 t/ha. In Telangana area under cultivation is 50,000 ha and the production is 2.45 Mt with productivity of 74.24 t/ha (DAC, New Delhi, 20-2021). It the productivity employs to over a million people directly or indirectly besides contributing significantly to the national exchequer. However, sugarcane is a perishable commodity it should be processed into sugar quickly after it is harvested. Sucrose losses after the harvest of cane due to delayed transport and unfavorable environmental conditions are one of the most serious problems in the sugar recovery process. One of the sugar industry's most concerning issues, post-harvest sugar loss has received a lot of attention recently. However, if the cane is crushed within 24 hours following harvesting, little damage is done. According to Solomon [1], staling for longer than 24 hours causes a significant loss in cane weight due to moisture loss and a decrease in the sugar concentration of the juice. Sharma and Sunita [2] claim that over one-fourth of the crushed cane used in Indian sugar refineries is of poor quality. It has been calculated that decreased sugar recovery will cost the Indian sugar sector an average of Rs. 1600 crores annually.

Reddy and Naga Madhuri [3] evaluated seven promising early maturing sugarcane clones at the Agricultural Research Station, Perumallapalle, A.P., India during Rabi 2011-2012. Different biochemical aspects like percent juice sucrose, TSS, commercial cane sugar percent, reducing sugars %, juice pH & juice extraction percent were assayed from 0-120 hrs. The clones 2006T36 and 2006T3 were shown to be resistant to post-harvest deterioration and to have the greatest sucrose% (16.37%,15.18%) and lowest reducing sugars (2.50%,2.70%) values, respectively. While the 2006T23 clone had the highest reducing sugar content (3.72%) and lowest sucrose content (12.39%), these results showed a decline in quality. However, Co C 671 (1.64 kg), Co 94008 (1.42 kg), and 2006T36 (1.49 kg) had the highest cane yields. The sugar recovery is stable and mainly depends on cane quality, the efficiency of mills, planting and harvesting dates as well as stalling due to delay in crushing after harvest. The genetic particulars of a clone play a key role in determining the cane yield and sugar recovery [4].

We hypothesized that delayed crushing of sugarcane will greatly impact the postharvest deterioration of promising sugar cane clones. Therefore, our key objective was to evaluate the impact of a delayed crush on the post-harvest deterioration of promising sugarcane clones.

2. MATERIALS AND METHODS

2.1 Experimental Details

The experiment was carried out at the Regional sugar cane and Rice research station, Rudrur

Nizamabad district, Telangana State during Rabi 2015-2018. The study area is located at the latitude of 18°-300' north and 77°-510' longitude to the East at an elevation of 404 m above mean sea level. The mean maximum temperature goes up to 44.5°C during May and the mean minimum temperature 16.5°C.

Five promising early sugarcane varieties from yield trials along with two checks were selected. The field experiment was laid out in RBD with three replications. The selected varieties were planted in January with a seed rate of 40,000 three - budded setts/ha along with irrigation. A spacing of 80 cm between furrows was followed. Atrazine @ 2kg a.i./ha was sprayed as a pre-emergence herbicide on 2nd day after planting. A fertilizer dose of 224:112:112 of $N:P_2O_5:K_2O$ kg/ha was followed. Other cultural operations like hand weeding, earthing up, trash twist propping *etc..,* were practiced as per recommendation. The data on yield and juice quality parameters *viz.,* Sucrose%, Brix%, Commercial cane sugar%, Reducing sugar%, etc., were recorded after staling of cane from 0-72 hr.

2.2 Laboratory Analysis

The data on yield and juice quality parameters *viz..,* sucrose percentage was analyzed in cane juice and expressed in percent sucrose in juice by using Schmitz's table [5]. Reducing sugars in cane juice were analyzed colorimetrically by alkaline potassium ferricyanide method [6] and expressed in percentage. Juice extraction percent was calculated from each treatment by taking the cane weight and weight of juice obtained after crushing and expressing as a percentage.

2.3 Statistical Analysis

The data was subjected to statistically scrutiny by Randamazied block design method outlined by Panse and Sukhatme [7]. The standard deviation (SD) and standard error mean (SEM) values were analyzed by SPSS 17.0 Version software.

3. RESULTS AND DISCUSSION

3.1 Effect of the Staling Period on Percent Juice Sucrose

The sucrose content was significantly ($p<0.05$) influenced by varieties and stalling period (Fig. 1). During storage, the inversion of sucrose starts resulting in the formation of inverted sugar resulting loss of recoverable sugar. The data on the effect of the staling period on the percent juice sucrose of sugarcane clones were presented in Table 1.

All the clones showed a decreasing trend in the percent juice sucrose with an increase in staling period from 0 hrs to 72 h. During storage, the inversion of sucrose starts resulting in the formation of inverted sugar which leads to the loss of recoverable sugar [3]. Significantly the highest percent juice sucrose was observed at 0 h (20.37) after harvest but a significant decrease was observed after 72 h of staling period and the lowest percent juice sucrose was observed at 72 h (7.35) of the staling period. The decline in sucrose percent was slow during the first two days of storage, but it was faster later [8]. The Interaction effect of clones and staling period was noticed.

3.2 Effect of the Staling Period on Commercial Cane Sugar Percent

There was a progressive decrease of CCS% with the increase of staling period from 0 h to 72 h as mentioned in Table 1 & Fig. 2. About clones Co 99004 (15.84) recorded the highest CCS% followed by 2011 R 42 (14.87), 2010 R 305 (14.80) and the lowest was noticed in 2011 R 1 (13.26) indicating its higher quality deterioration. The CCS % has decreased from 1st day to 5th day in all the early and mid-late clones [3]. Similar results were reported by Indrajith and Natarajan [9] for promising sugarcane clones.

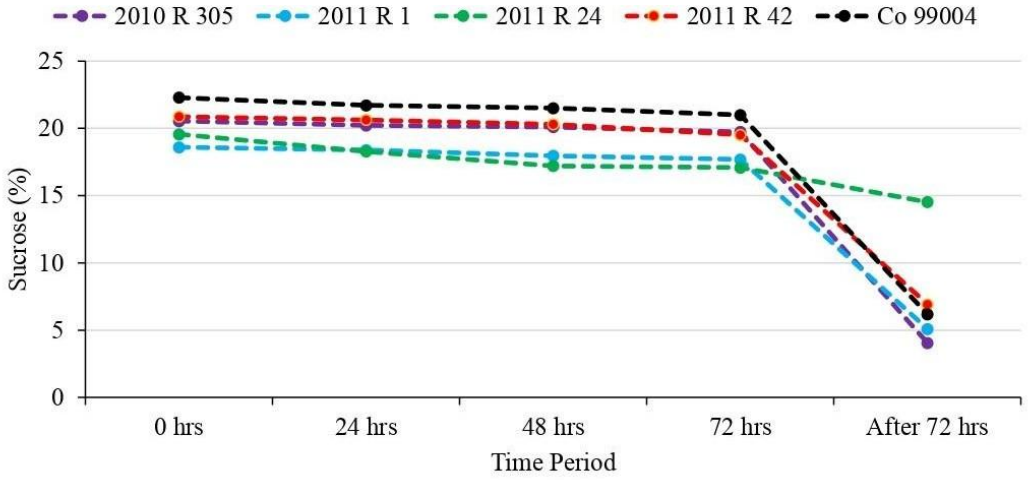
The grouped data on staling period revealed that there was a progressive decrease in CCS% with an increase in staling period. The highest CCS% was recorded at 0 hrs (14.53) after harvest indicating the quality of juice, while the lowest was recorded at 72 hrs (6.20) after staling indicating the deterioration of juice quality. Similar results were reported by Bhite et al. [10] recorded a reduction in CCS% from 14.53 to 6.20 on staling. An interaction effect was recorded as significant among the clones and staling period.

3.3 Effect of the Staling Period on Juice Extraction Per Cent

There was progressive decrease in juice extraction percent with an increase of the staling period as shown in Table 2 & Fig. 3. The Data revealed that the clone 2010 R 305 (55) recorded significantly the highest juice extraction per cent followed by 2011 R 42 (51) recorded low juice extraction per cent. Similar results were reported by Thangavelu [11] for other promising sugarcane clones.

Table 1. Studies on the rate of post-harvest deterioration in promising sugarcane clones

Varieties	Sucrose %					CCS %				
	0 hrs	24 hrs	48 hrs	72 hrs	% reduction after 72 hrs	0 hrs	24 hrs	48 hrs	72 hrs	% reduction after 72 hrs
2010 R 305	20.54	20.22	20.10	19.74	4.05	14.8	14.61	14.55	14.19	4.30
2011 R 1	18.59	18.39	17.96	17.69	5.09	13.26	13.01	12.69	12.54	5.74
2011 R 24	19.56	18.28	17.21	17.08	14.52	13.88	13.32	13.12	12.74	8.95
2011 R 42	20.87	20.62	20.3	19.52	6.92	14.87	14.48	14.32	14.09	5.54
Co 99004	22.29	21.71	21.5	20.99	6.19	15.84	15.44	15.17	14.88	6.45

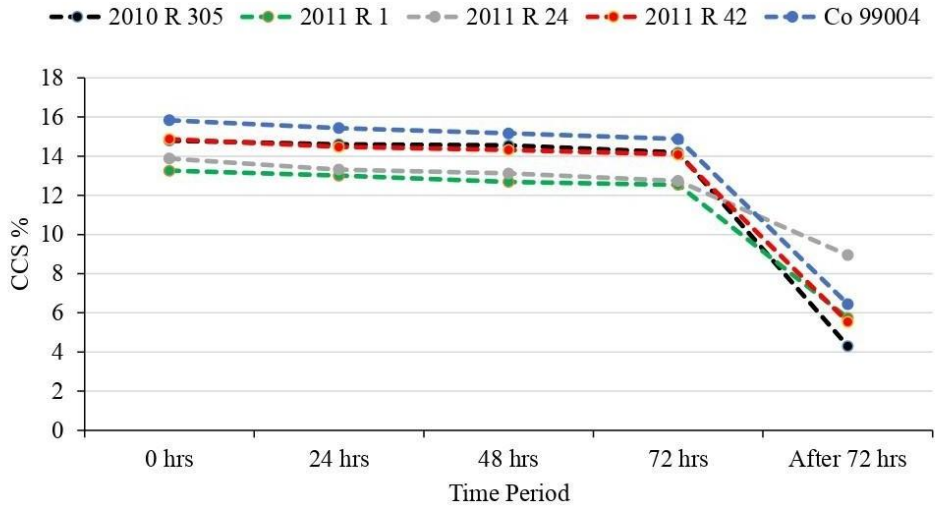


	0 hrs	24 hrs	48 hrs	72 hrs	After 72 hrs
Mean	20.37	19.84	19.41	19.00	7.35
SD	1.40	1.48	1.77	1.60	4.15
SEM	0.624	0.663	0.793	0.713	1.857

Fig. 1. Effect of the staling period on percent juice sucrose

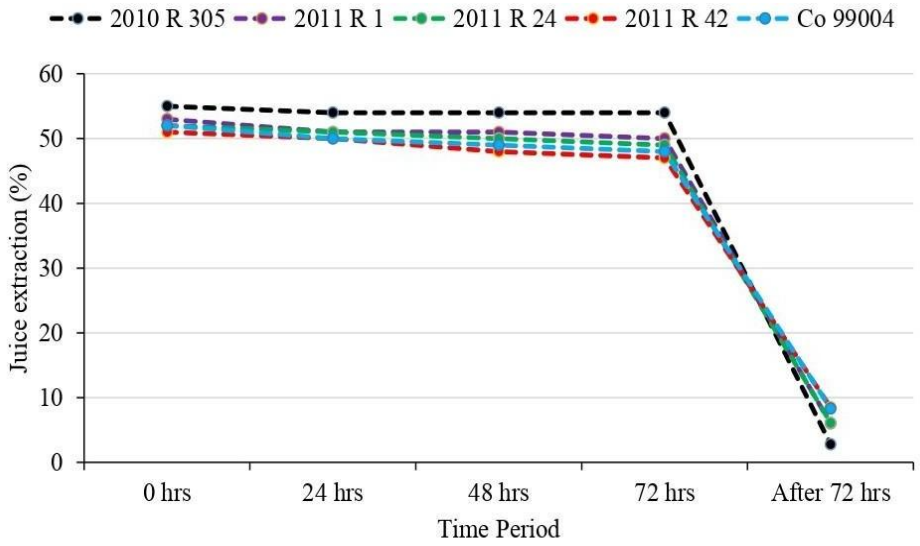
Table 2. Studies on the rate of post-harvest deterioration in promising sugarcane clones

Varieties	Juice extraction %					Percent reduction in single cane weight at				
					%					%
	0 hrs	24 hrs	48 hrs	72 hrs	reduction after 72 hrs	0 hrs	24 hrs	48hrs	72hrs	reduction after 72 hrs
2010 R 305	55	54	54	54	2.8	1.63	1.61	1.6	1.58	3.5
2011 R 1	53	51	51	50	6	1.47	1.44	1.43	1.42	4
2011 R 24	52	51	50	49	6.12	1.33	1.32	1.3	1.29	3.6
2011 R 42	51	50	48	47	8.51	1.22	1.2	1.18	1.17	5
Co 99004	52	50	49	48	8.33	1.83	1.8	1.79	1.77	3.7



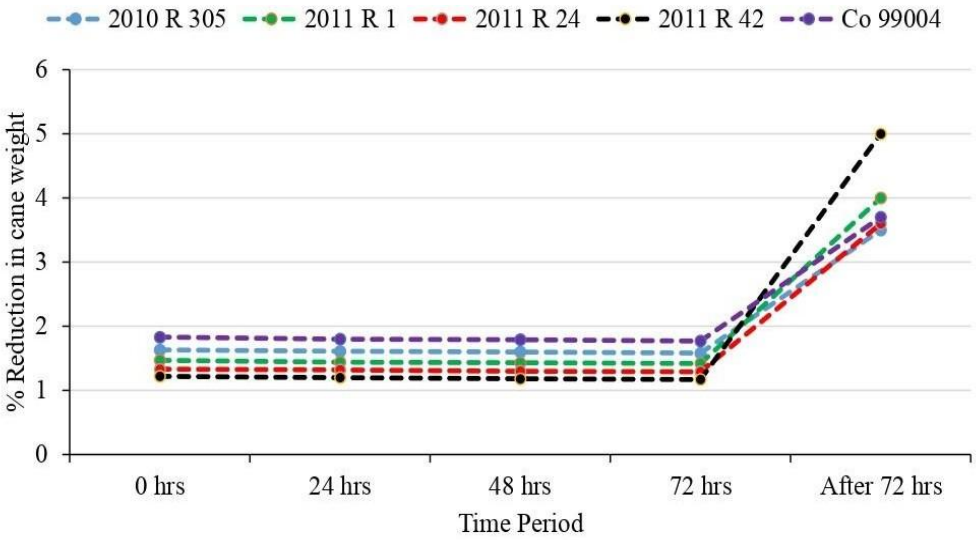
	0 hrs	24 hrs	48 hrs	72 hrs	After 72 hrs
Mean	14.53	14.17	13.97	13.69	6.20
SD	0.99	1.00	1.03	1.01	1.72
SEM	0.444	0.446	0.462	0.450	0.771

Fig. 2. Effect of the staling period on commercial cane sugar percent



	0 hrs	24 hrs	48 hrs	72 hrs	After 72 hrs
Mean	52.60	51.20	50.40	49.60	6.35
SD	1.52	1.64	2.30	2.70	2.31
SEM	0.678	0.735	1.030	1.208	1.034

Fig. 3. Effect of a staling period on juice extraction percent



	0 hrs	24 hrs	48 hrs	72 hrs	After 72 hrs
Mean	1.50	1.47	1.46	1.45	3.96
SD	0.24	0.24	0.24	0.24	0.61
SEM	0.108	0.106	0.108	0.106	0.273

Fig. 4. Effect of the staling period on percent reduction in cane weight

The data revealed that the highest juice extraction percent was noticed at 0 h (52.60) and a significant reduction was noticed after 72 h of the staling period, while the lowest juice extraction per cent was noticed at 72 h (6.35) of the staling period. A gradual decrease in juice

extraction percent was noticed with simultaneous increase in TSS%, Titrable acidity, Dextran and activities of acid and neutral invertases with an increase in staling period were reported by Bhatia et al. [12]. However, a significant interaction effect was found between clones and staling period.

3.4 Effect of the Staling Period on Single Cane Weight

The data on the effect of the staling period on single cane weight is presented in Table 2 & Fig. 4. The data revealed that clone Co 99004 recorded significantly the highest single cane weight (1.83 kg) when compared to other clones but on par with 2010 R 305 (1.63 kg) and 2011 R 1 (1.47 kg), whereas the clone 2011 R 42 (1.22 kg) recorded the lowest single cane weight.

The cane weight was decreased with increasing stalling periods from the 1st day to the 5th day. Cane weight loss is mainly attributed to evaporation loss and respiratory loss [4]. All the clones showed a decreasing trend in cane weight with an increase in staling period from 0 to 72 h. The results were similar to the findings of Siddhant et al. [13] and Reddy et al. [3]. However, higher fresh cane weight was recorded immediately after harvest at 0 hrs (1.50 kg) after 72 h single cane weight loss was observed indicating the effect of staling period on cane weight. Cane weight is mainly attributed to evaparator loss and respiratory losses [14]. The interaction effect of clones and staling period was found significant between the clones and staling period.

4. CONCLUSION

Based on results from the present study, it was found that the clone 2010 R 305 maintained its cane quality up to 72 hours with minimum percent reduction of sucrose content, CCS percent, juice extraction percent and percent reduction in single cane weight, followed by 2011 R 1 and Co 99004. Thus, it is concluded that 2010 R 305 was found to possess tolerance to post- harvest deterioration. Therefore, 2010 R 305 clone can be recommended for general cultivation for delayed crushing.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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