The Andhra Agric. J 61(2): 382-388, 2014

Effect of Delayed Harvest on Yield and Juice Quality of Promising Early Maturing Sugarcane Clones

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ABSTRACT

Five promising early sugarcane clones from yield trials were selected and evaluated along with two checks to know their tolerance to delayed harvest. Cane weight and juice quality parameters were studied from November (10^{th} month) to March (14^{th} month) at monthly intervals. Decline in per cent juice sucrose was observed in all the clones with increase of crop maturity *i.e.,* from November to March. The rate of decrease was low in Co C 671, 2006 T36 and Co 94008. Similar trend was observed with cane weight, whereas reducing sugars increased with increase in crop maturity. The clones Co C 671, 2006 T36 , 2006 T3 and Co 94008 recorded low reducing sugars even at 14^{th} month (March) of crop age among all test clones which indicated their tolerance to delayed harvest. Based on the results of present study it can be concluded that the early clones 2006 T36, 2006 T3 are suitable for delayed harvest along with Co C 671 and Co 94008.

Key words : Delayed harvest, Juice sucrose % , Reducing sugars, Sugarcane.

Sugarcane is one of the most important cash crop grown in India, providing employment to a large number of people and contributing to growth of rural economy. Nearly 35-40 million farmers, 3.5 lakh skilled and unskilled workers are engaged in sugar production chain in India. Globally 70 % of white crystal sugar comes from sugarcane, which popularized the crop as kalpavriksha (or) wonderful crop.

However, now-a-days the farmers and sugar factories are facing adverse situations due to harvesting of canes without proper crop maturity and scientific harvesting procedures. Maturity of cane is a major factor in the inversion and subsequent reduction of stored sucrose. As, physiological maturity increases the extent of sucrose loss is enhanced. Harvesting of immature (or) over mature cane should be avoided to cut down sugar losses.

The harvesting of sugarcane, in Indian tropics generally starts from the month of November and continues till April or in certain cases extends upto May and June as per recommendation of the government and availability of raw materials due to which sugar losses are as high as 15 kg tonne^{-1} of cane in summer, high sugar losses are also reported from certain areas of Tamil Nadu and Andhra Pradesh where temperature is high. On an average, Indian sugar mills lose about 5-10 kg per tonne^{-1} of cane which was earlier reported by Uppal and Sharma, 1999 and Uppal *et al*.2000.

Solomon *et al* (1997) reported the average sugar recovery in cane growing belts of India hovers between 8.5-9.5 % during peak crushing season. Harvesting of post maturity crop has detrimental effect on sugar recovery and presently a serious economic problem to sugar mills in India and many cane producing countries. Therefore, identification of sugarcane clones suitable for delayed harvest is needed to devise maturity wise harvesting of crop with minimal loss of recoverable sugar. In this connection the present study was carried out to select sugarcane clones which are suitable for delayed harvest.

MATERIAL AND METHODS

The experiment was carried out at Agricultural Research Station, Perumallapalle during *Rabi*, 2011-2012. Five promising early sugarcane clones from yield trials along with two checks were selected. The field experiment was laid out in RBD with three replications. The selected clones were planted in the month of January with a seed rate of 40,000 three budded setts ha^{-1} along with irrigation. A spacing of 80 cm between furrows was followed. Atrazine @ 2kg a.i. ha^{-1} was sprayed

as pre-emergence herbicide at 3rd day after planting. Fertilizer dose of 224:112:112 of N : P_2O_5 : K_2O kg ha^{-1} 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 per cent, Brix per cent, Purity per cent, Commercial Cane Sugar per cent, Reducing sugar per cent etc., were recorded starting from opening of sugar mill *i.e.,* from November to till closing of sugar mill upto March. The above data was recorded in every month *i.e*., in November, December, January, February and March to know the tolerance of early clones for delayed harvest.

Total soluble solids were measured by using brix hydrometer with the method given by Meade and Chen (1977) and the reading was corrected to temperatures by referring to tables (Brown and Zerban, 1941). Sucrose was analyzed in cane juice and expressed in per cent sucrose in juice by using Schmitz's table (Hawaiian Sugar Technology Association, 1931). Juice purity is determined by the ratio between the brix (total solids) and amount of sucrose present in juice. Reducing sugars in cane juice were analysed colorimetrically by alkaline potassium ferricyanide method (Chiranjivi Rao and Asokan, 1974) and expressed in percentage. Cane weight for five canes in each clone was recorded and mean cane weight for single cane was calculated. Juice extraction percent was calculated from each treatment by taking the cane weight and weight of juice obtained after crushing and expressed as percentage. The data were subjected to statistical scrutiny by split-plot method outlined by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Brix per cent (TSS):

There was progressive increase of brix at all months of crop age as shown in figure (1). The clones Co C 671 (19.82), Co 94008 (19.26) and 2006 T36 (19.49) showed higher per cent of brix, while the clone 2006 T 23 (17.10) recorded low brix per cent among all clones. The data on different months revealed that the lowest brix (17.28) was noticed in November (10th month) while the highest (20.39) was recorded at March (14th month) due to high temperatures. Bhatia *et al.*(2009) reported the gradual increase in TSS(Total Soluble Solids) due to effect of environmental conditions.

Per cent juice sucrose:

Significant differences were observed in per cent juice sucrose among the clones at different months of harvest (Table 1). Among the clones, Co C 671 resulted significantly the highest per cent sucrose (17.58) followed by 2006 T 36 (17.36) and Co 94008 (17.17), while the clone 2006 T 23 recorded the lowest (14.08).

All the clones showed an increase in sucrose % upto January (12thmonth) and there after marked reduction was observed. The highest sucrose % (16.97) was recorded in January (12th month) compared to all other months. This could be attributed to high diurnal variation in the month of January (12th month) compared to November (10th month) and December (11th month). Also during the months of November and December rainfall of 240.2 mm and 112.3 mm was recorded respectively. This may the reason for recording low sucrose % in these two months, while the lowest per cent juice sucrose (15.87) and (15.10) was recorded during February (13th month) and March (14th month) respectively due to high temperatures which may cause inversion of sucrose. The results are in accordance with Rakkiyappan *et al.*(2009). The interaction effect was found significant and showed that the clone Co C 671 recorded the highest per cent juce sucrose at all months of harvest followed by 2006 T36, 2006 T3 and Co 94008, which indicates their tolerance to delayed harvest.

Commercial cane sugar per cent (CCS per cent):

There was progressive decrease of CCS per cent due to delayed harvest of crop among the clones as shown in Table (2). However, the clones Co C 671 (12.52), 2006 T36 (12.17) and Co 94008 (12.07) recorded higher CCS per cent, while 2006 T8 (9.22), 2006 T23 (9.36) and 2006 T19 (9.52) recorded low CCS per cent. However, the data revealed that highest CCS per cent (11.03) was recorded at November (10th month), while the lowest (9.58) was noticed at March (14th month). Singh et al.(2006) studied the magnitude of post harvest sucrose losses and its relationship with acid invertase and dextran sucrose enzymes during late milling season. There was significant relationship between reduction in CCS per cent and in the activities of the enzymes.

Table 1. Effect of delayed harvest on per cent juice sucrose in promising early sugarcane clones.

Clones	Months of harvest					
	November (10th month)	December (11th month)	January (12th month)	February (13th month)	March (14th month)	Mean
2006 T3	16.31	16.95	17.73	15.81	15.22	16.40
2006 T8	15.19	15.27	15.90	15.03	14.13	15.10
2006 T19	14.87	15.38	15.95	14.82	13.64	14.93
2006 T23	14.04	14.55	15.06	13.91	12.83	14.08
2006 T36	17.24	17.78	18.03	17.12	16.64	17.36
Co C 671	17.63	17.98	18.10	17.44	16.76	17.58
Co 94008	17.03	17.30	18.01	16.97	16.53	17.17
Mean	16.05	16.46	16.97	15.87	15.10	16.09

	SED	LSD (0.05)
Clones (C)	1.03	2.21
Months (M)	0.39	0.83
C x M	0.28	0.60
M x C	0.86	1.85

Table 2. Effect of delayed harvest on commercial cane sugar per cent in promising early sugarcane clones.

Clones	Months of harvest					
	November (10th month)	December (11th month)	January (12th month)	February (13th month)	March (14th month)	Mean
2006 T3	10.59	10.69	10.88	9.95	9.14	10.25
2006 T8	9.52	9.66	9.83	8.99	8.10	9.22
2006 T19	9.91	10.11	10.29	9.07	8.24	9.52
2006 T23	9.55	9.81	9.98	9.12	8.36	9.36
2006 T36	12.51	12.47	13.01	11.96	10.94	12.17
Co C 671	12.80	13.00	13.16	12.19	11.45	12.52
Co 94008	12.33	12.51	12.70	11.99	10.86	12.07
Mean	11.03	11.18	11.41	10.47	9.58	10.73

	SED	LSD (0.05)
Clones (C)	1.47	3.18
Months (M)	0.37	0.79
C x M	0.26	0.56
M x C	0.77	1.66

The interaction effect was found significant and showed that the clone Co C 671 recorded the highest CCS percent at all months followed by Co 94008, 2006 T36 and 2006 T3 indicating their tolerance to delayed harvest.

Purity per cent:

Harvesting beyond 12th month lead to decrease in purity per cent in all the clones. The clones Co C 671 (96.48), Co 94008 (96.18) and 2006 T36 (96.04) recorded higher purity per cent,

Table 3. Effect of delayed harvest on single cane weight (kg) in promising early sugarcane clones

Clones	Months of harvest					
	November (10th month)	December (11th month)	January (12th month)	February (13th month)	March (14th month)	Mean
2006 T3	1.49	1.61	1.88	1.35	0.88	1.44
2006 T8	0.95	1.05	1.26	0.77	0.32	0.87
2006 T19	1.13	1.25	1.46	0.79	0.46	1.02
2006 T23	1.31	1.45	1.60	1.06	0.72	1.23
2006 T36	2.02	2.12	2.30	1.82	1.59	1.97
Co C 671	2.06	2.17	2.37	1.91	1.64	2.03
Co 94008	1.78	1.91	2.16	1.64	1.34	1.77
Mean	1.53	1.65	1.86	1.33	0.99	1.47

	SED	LSD (0.05)
Clones (C)	0.33	0.71
Months (M)	0.21	0.43
C x M	0.18	0.38
M x C	0.20	0.43

while the clone 2006 T23 (85.69) registered the lowest purity per cent at all months indicating their susceptibility to delayed harvest as represented in the figure (2). The decrease in purity per cent was heavier in canes harvested in February (13th month) and March (14th month) due to high temperatures than in canes harvested at 12th month (January) was reported earlier by Rakkiyappan *et al.*(2009).

Reducing sugars (%):

Progressive increase in percent reducing sugars was observed due to delayed harvest among all the clones as depicted in figure(3). Percent reducing sugars were found to be low in Co C 671 (1.79), Co 94008 (2.00) and 2006 T36 (2.14), while higher rates were recorded in 2006 T19 (3.12) and 2006 T23 (3.30) at all months. The data revealed that the lowest per cent reducing sugars (2.22) was recorded at November (10th month) and the highest (2.78) was noticed at March (14th month).

The juice gets concentrated due to loss in moisture which probably results in increase in invertase activity (Uppal, 2003). The insulating effect provided by higher water content on cellular temperature gets diminished during storage due to loss of water, resulting in activity of invertases (Batta and Singh, 1991). However, decrease of sucrose concentration was not proportional to increase of reducing sugar concentration. (Uppal & Sharma, 1997; Magdum *et al.*1987; Ahmad and Khan,1988; Gour and Desai, 1988).

Single cane weight (Kg):

All the sugarcane clones showed an increase in cane weight up to 12th month of crop age (January) and a marked reduction was noticed in all clones after 12th month as shown in Table(3). However, the clones Co C 671 (2.03), 2006 T36 (1.97) and Co 94008 (1.77) recorded low loss of cane weight at all months which positively reflected on cane yield (Bhite *et al*. 2008), while the clone 2006T8 (0.87) recorded low cane weight indicating the higher moister loss. (Mukunda Rao *et al*. 2010).

Significant interaction effect was found between clones and months and the data showed that CO C 671, CO 94008, 2006 T36 and 2006 T3 recorded higher cane weight at all months indicating their tolerance to delayed harvest with less moisture loss.

Juice extraction percent:

Juice extraction per cent differed significantly between clones and months of harvest. There was notable decrease in juice extraction per

Fig. 1. Effect of delayed harvest on brix per cent in promising early sugarcane clones.

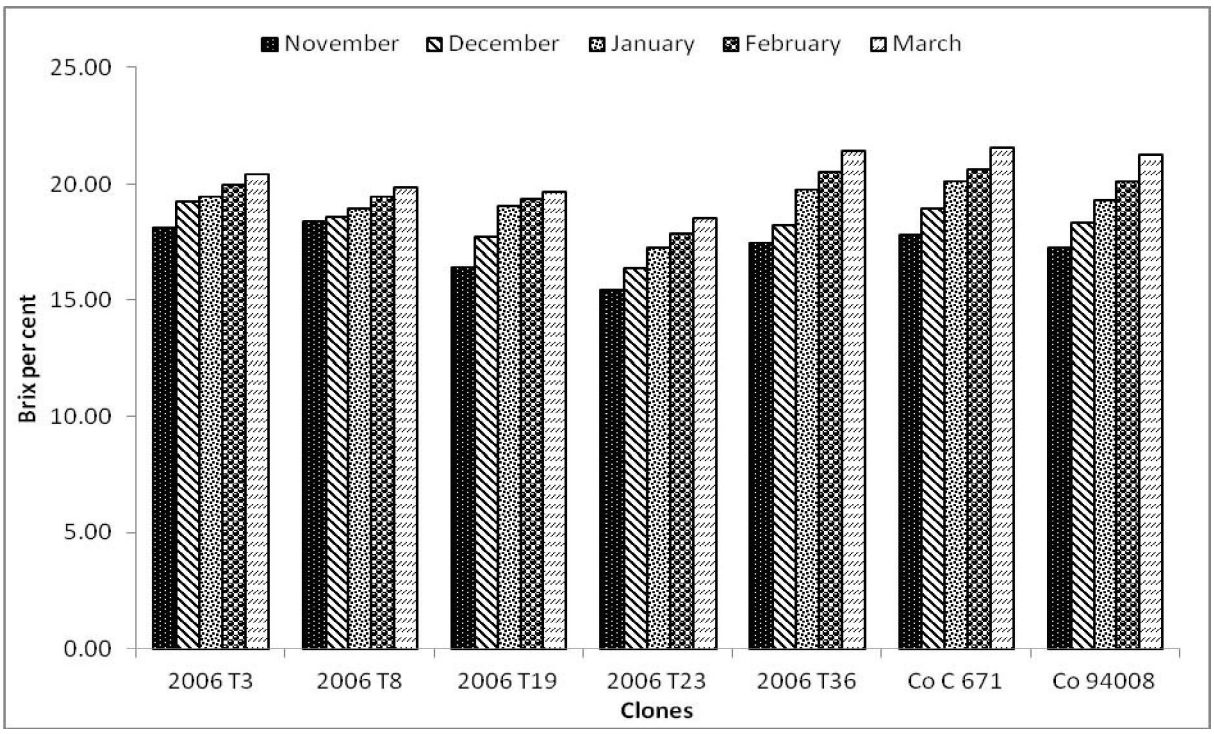


Fig. 2. Effect of delayed harvest on purity per cent in promising early sugarcane clones.

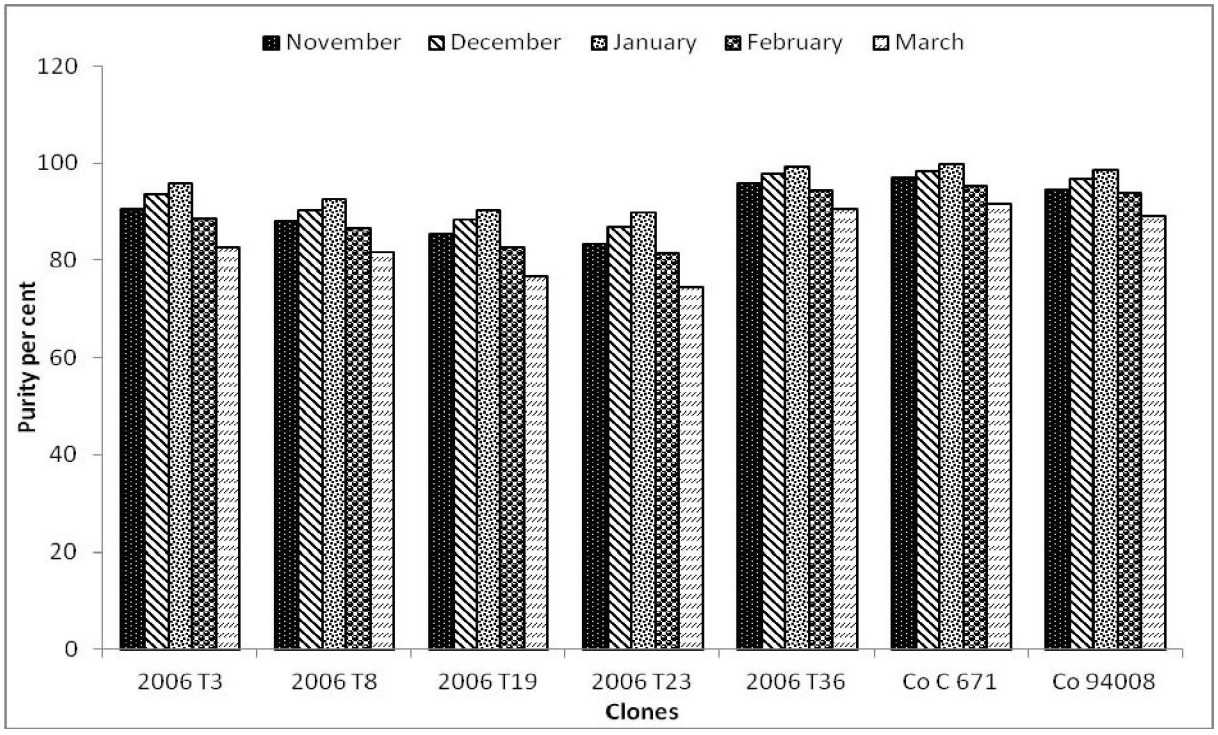


Fig. 3. Effect of delayed harvest on per cent reducing sugars (%) in promising early sugarcane clones.

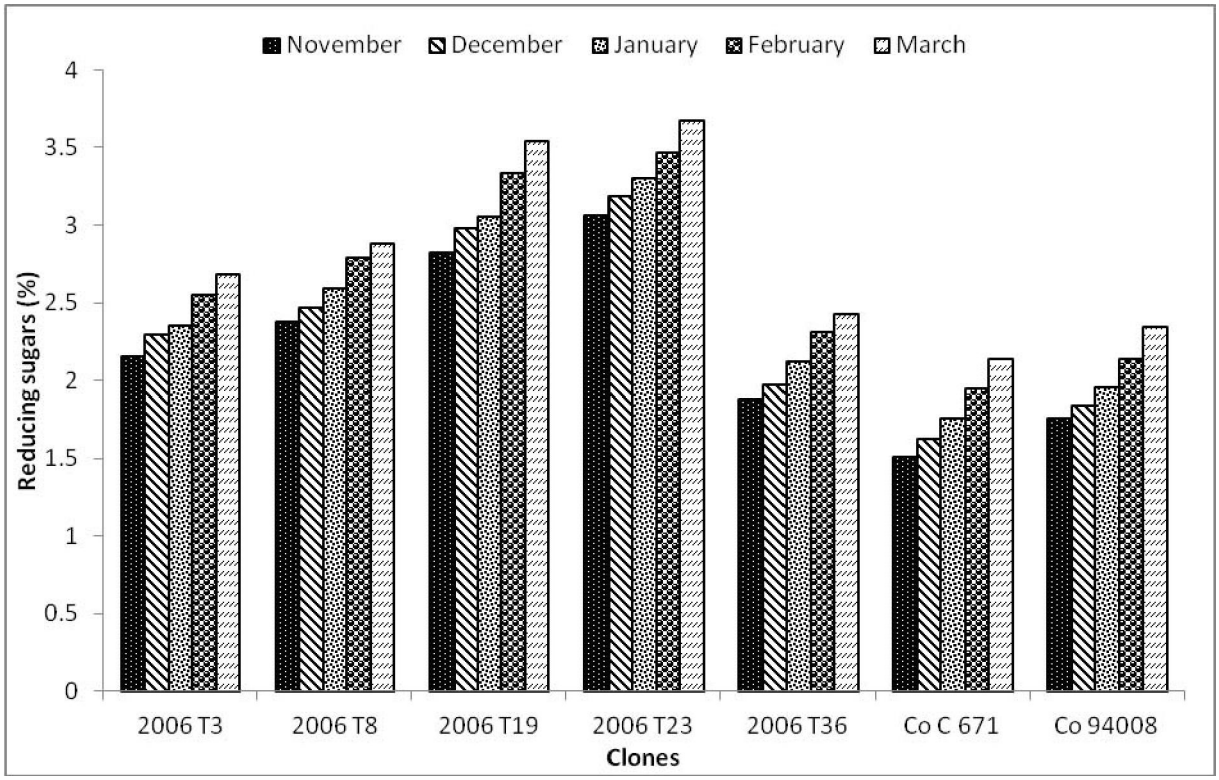
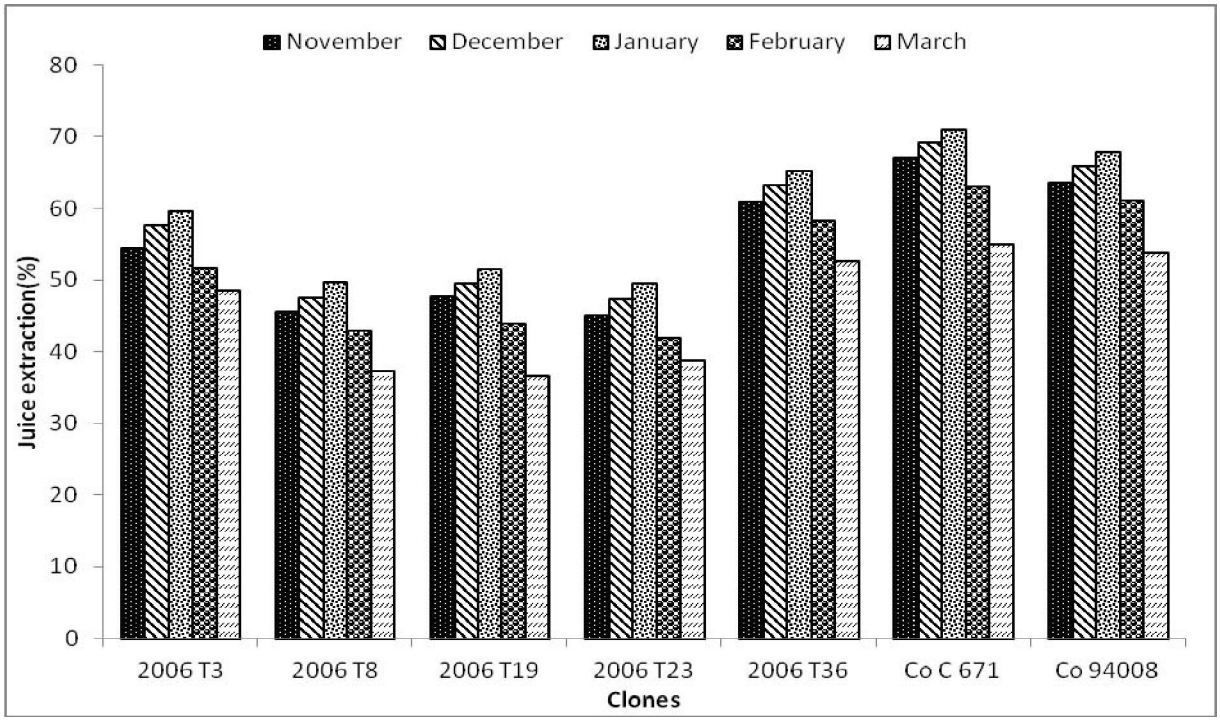


Fig. 4. Effect of delayed harvest on juice extraction per cent in promising early sugarcane clones.



cent after 12th month of crop age as depicted in the figure (4). The clones CO C 671 (64.96), CO 94008 (62.37) and 2006 T36 (60.02) recorded the highest juice extraction indicating the less loss of moisture, while the clone 2006 T23 (44.50), recorded the lowest juice extraction per cent with highest loss of moisture indicating their low tolerance to delayed harvest, however it had significant positive association with cane volume, cane yield and sugar yield (Thangavelu, 2004).

Based on the results of present study it was concluded that clones 2006 T36, 2006 T3 showed tolerance to delayed harvest along with two checks *viz.,* Co C 671 and Co 94008. Hence, these two clones 2006 T36 and 2006 T3 can be considered as suitable clones for delayed harvest.

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(Received on 19.05.2012 and revised on 09.09.2012)