Choice of Clones in Early Clonal Generations in Sugarcane *(Saccharum* complex Hybrids) Breeding

PK Chandrakant Singh and Ravi Kant
Department of Plant Breeding, Sugarcane Research Institute, Rajendra Agricultural University, Pusa, Samastipur-848 125 (Bihar)

Eighty four clones including three checks in first and second consecutive clonal generations were undertaken with the objective to identify reliable yield attributing traits for formulation of selection indices and selection of suitable clones in early clonal generation. A consistent trend for the significance of mean sum of square due to checks, entries, check vs entries, range of variation and coefficient of variation was observed in both clonal generations. Correlation coefficient study revealed that only three quantitative traits i.e., number of shoots at 120 days, number of millable cane at harvest and single cane weight showed consistent trend of significant association with cane yield in both the clonal generations. Path coefficient analysis revealed that number of millable cane at harvest and single cane weight were major direct contributor in both clonal generations. Multiple regression analysis revealed that single cane weight act as most reliable traits in predicting performance in early clonal generations. Preliminary selection in early clonal generation should be based on quantitative traits i.e. single cane weight, number of shoots at 120 days and number of millable canes and quality traits should be delayed to latter generation till the character stabilize.

Key words: Sugarcane, Selection criteria, Early clonal generation, Correlation, Path analysis, Multiple regression

Sugarcane is one of the most important cash crops in India. The importance of sugarcane increased tremendously in recent years, as Government of India decided to mix ethanol in suitable proportion to petroleum fuel. Plant breeders responsibility has enhanced tremendously for genetic improvement of this crop to cope with changing ecological and economical necessity of country. Breeding cycle which usually takes ten years, i.e., from making crosses to final evaluation trial, can be shortened to much lower extent if breeders will be able to predict the promising genotypes in early stage of screening.

Thus the present investigation was conducted to predict the performance of genotypes for yield and quality attributes in early clonal generations, with objectives: (a) To study variability and association of quantitative traits with yield; (b) to generate information on direct and indirect effects of yield and quality components in different clonal generations; (c) to identify reliable yield attributes for formulation of selection indices in early clonal generation; and d) to identify reliable clones in early clonal generation.

Materials and Method

In the present investigation, eighty one clones with three checks, i.e. B0110, B0128 and BO130 of sugarcane *(Saccharum complex* hybrids) were grown in augmented design in two consecutive clonal generation, i.e., first

clonal and second clonal generation during spring season of 2003-2004 and 2004-2005 respectively. The experimental materials were grown in research farm of Rajendra Agricultural University, Pusa, Samastipur, (Bihar). In first clonal generation, experimental materials were planted in two rows of 3 m x 90 cm apart. In second clonal generation, all experimental materials were planted in four rows of 6 m x 90 cm apart. All the recommended package of practices for north Bihar condition were followed throughout the crop season.

Data were recorded for germination per cent at 45 days, number of shoots per hectare at 120 days, number of millable canes per hectare, cane height at harvest, single cane weight, cane diameter at harvest, refractometric brix (in mid November, December and January, sucrose per cent in juice in January), commercial cane sugar (CCS) per cent in January and the cane yield. The mean data collected were subjected to statistical analysis for variance and variability were found. Correlation and path coefficient analysis were worked out as per the method described by Wright (1921) and Dewey and Lu (1959).

Results and Discussion

There was consistent trend of significant variation for almost all the characters in first and second clonal generation among eighty one entries except cane diameter at harvest and refractometric brix in mid December in second clonal generation and for sucrose percent in juice

in first clonal generation (Table 1). Regarding variation among check varieties, similar trends of significant variations were observed in both the generations for the characters germination percent at 45 days, number of shoots per hectare at 120 days, single cane weight, refractometric brix in mid November, CCS per cent in January and cane yield (t/hec). However, the traits such as number of millable cane per hectare represented similar trend of non significant variation in both the generations. Remaining traits showed dissimilar trend of variation in either generations. The presence of substantial variability for agronomic and quality characters was reported by Nagarajan *et al.* (2000). Presence of variability in germination percent, variability in number of millable canes, cane height, single cane weight and number of shoots was also reported by Kamat and Singh (2001). The presence of variability in quality character, refractometric brix was also reported by Mishra (1988) were as Verma *et al.* (1999) reported variability in CCS per cent in January.

This trend of variability was expected, as the entries are the crosses among highly heterozygous parents for most of the loci, such characteristics are the complex interaction of hereditary and environmental elements, as genes cannot be responsible for an observed character in absence of suitable environmental conditions for its to appear, nor can any association of environmental conditions alone cause a character to develop in absence of necessary genes.

The range of variation showed almost similar trend in both the clonal generations, for example the highest range of variation was observed for number of millable cane per hectare followed by cane yield, germination percent, number of shoot per hectare at 120 days in both the clonal generations. Almost similar trends were observed for coefficient of variation for all the traits in both clonal generations. In second clonal generation, a decrease in average mean for quantitative traits were recorded whereas it was more for quality traits. This trend of change in the mean performance of clones of first and second clonal generation for both qualitative and quantitative characters can rather be distinguished as "Settle down behaviour" as suggested by early workers (Hill, 1935).

Correlation coefficient for both quantitative and qualitative traits with cane yield and among themselves were studied (Table 2). The quality traits which showed positive significant correlation among themselves in both the clonal generations were: Refractometric brix in mid

Table 1. Analysis of variance for twelve quantitative characters in sugarcane (first and second clonal generation)

Sl. No.	Character Degree of freedom	Generation		Mean sum of square due to		
			Block	Check	Entries	Check Vs entries
			8	2	80	1
1.	Germination percent at 45 days	I	1.126	29.427**	143.407**	2965.710**
		II	0.805	49.090**	98.545**	33.511**
2.	No. of shoots per hectare at 120 days (in thousand)	I	73487055**	346863133**	12697752717**	1503078437**
		II	49142969	197366575*	4734697528**	11732728947**
3.	No. of millable canes per hec (in thousand)	I	14802855	12512098	575765508**	5782926520**
		II	23360863	8246447	385504354**	20351748791**
4.	Cane height at harvest (cm)	I	331.676	172.259	1006.228*	51302.25**
		II	156.917	892.111**	1756.936**	35031.361**
5.	Cane diameter at harvest (cm)	I	0.012	0.230**	0.064*	0.933**
		II	1.707	1.174	0.102	0.252
6.	Single cane weight (kg)	I	0.0003**	0.007**	0.018**	0.008**
		II	0.0002	0.012**	0.013**	0.022**
7.	Refractometric brix (mid November)	I	0.644	11.574**	3.084*	10.311**
		II	0.714	2.935*	2.624**	7.922**
8.	Refractometric brix (mid December)	I	0.953	12.218**	2.148**	8.059**
		II	1.173	2.973	1.955	6.362*
9.	Refractometric brix (mid January)	I	1.330	8.917**	2.145**	1.467
		II	0.328	0.606	1.582**	0.001
10.	Sucrose percentage in juice (in January)	I	1.156	0.145	2.207	18.395**
		II	0.042	1.139**	13.135**	0.025**
11.	CCS percent in January	I	0.010	0.374**	1.052**	15.230**
		II	0.008	0.414**	0.830**	0.028**
12.	Cane Yield (t/hec)	I	2.782	52.742**	215.651**	1386.818**
		II	5.236	83.834**	165.917**	5138.314**

*, **: Denote significance at 5% and 1% probability level respectively
I&II: Denote first and second clonal generation respectively

Table 2. Phenotypic correlation coefficient between pair of twelve quantitative characters (first and second clonal generation)

Characters		Gener-ation	No. of shoots at 120 days	No. of millable canes	Cane height (cm)	Cane diameter (cm)	Single cane weight (kg)	Brix (mid Nov)	Brix (mid Dec)	Brix (mid Jan)	Sucrose percent	CCS%	Cane yield
Germination percent at 45 davs	(X$_1$)	I	0.482**	0.085	0.159	-0.238*	0.045	-0.095	0.033	0.125	0.325**	0.277*	0.331**
		II	0.027	0.00	-0.050	-0.201	-0.129	-0.039	-0.109	-0.098	0.077	0.064	-0.002
No. of shoots at 120 days	(X$_2$)	I		0.247*	0.169	-0.104	0.071	-0.217*	-0.141	-0.147	0.021	0.12	0.683**
		II		0.958**	0.184	0.054	-0.013	-0.080	-0.020	-0.054	-0.022	0.019	0.791**
No. of millable canes at harvest	(X$_3$)	I			0.299	-0.003	0.222*	-0.200	-0.292**	-0.292**	-0.179	-0.192	0.319**
		II			0.158	0.034	-0.061	-0.093	-0.028	-0.103	-0.108	-0.053	0.815**
Cane height at harvest (in cm)	(X$_4$)	I				-0.227*	0.079	-0.096	-0.167	-0.071	0.125	0.070	0.195
		II				0.112	0.045	-0.042	-0.004	0.178	0.152	0.117	0.137
Cane diameter at harvest (in cm)	(X$_5$)	I					0.074	-0.053	-0.005	-0.042	-0.084	-0.064	-0.057
		II					-0.081	0.098	0.049	0.213	-0.131	-0.092	0.023
Single cane weight (kg)	(X$_6$)	I						-0.140	-0.098	-0.008	0.178	0.195	0.558**
		II						0.202*	0.308**	0.236*	0.088	0.095	0.238*
Brix in mid November	(X$_7$)	I							0.764**	0.654**	0.418**	0.385**	-0.328**
		II							0.865**	0.526**	0.259*	0.229*	0.048
Brix in mid December	(X$_8$)	I								0.796**	0.457**	0.411**	-0.226*
		II								0.515**	0.202	0.202	0.079
Brix in mid January	(X$_9$)	I									0.571**	0.512**	-0.151
		II									0.302**	0.219*	-0.029
Sucrose percent in juice in January	(X$_{10}$)	I										0.956**	0.035
		II										0.917**	0.047
CCS% in juice in January	(X$_{11}$)	I											0.043
		II											0.087

*, **: Denote significance at 5% and 1% probability level respectively
I & II: Denote first and second clonal generation respectively.

November with refractometric brix in mid December and mid January, sucrose percent in juice and CCS percent in January. Refractometric brix in mid December with refractometric brix in mid January. Refractometric brix in mid January was found to be correlated with sucrose percent in juice and CCS percent in January. Sucrose percent in juice was correlated with CCS percent in January. The significant negative association of brix in mid November and December with cane yield changed in second clonal generation to non significant. While taking quantitative traits into consideration, three traits which showed positive significant correlation with yield in both the clonal generations were number of shoots at 120 days, number of millable canes at harvest and single cane weight. The component traits number of shoots at 120 days and number of millable canes were found positively and significantly correlated among themselves in both the clonal generations. The present finding of significant correlation of brix with commercial cane sugar (CCS) had also been reported by Battan *et al.* (1985), sucrose and CCS percentage were also reported to be positively correlated by Das ef til. (1997). Puncet *et al.* (2002) also reported that the interrelationship between the quality traits was high and positive which supports present findings. Kumar and Singh (1999) had reported

positive and significant correlation among yield vs among shoots at 120 days, whereas correlation among yield and number of millable cane was also reported by Ramesh and Varghese (1995). The component traits, number of millable canes per hectare and number of shoots at 120 days were also reported to be positively and significantly correlated by Kumar and Singh (1999).

Perusal of Table 3 revealed that only the single cane weight and the number of millable canes at harvest had positive direct effects towards cane yield in both clonal generation and out of these two traits, only the single cane weight was positive direct contributor in both clonal generation. Indirect effect of number of shoots per hectare at 120 days via number of millable canes and cane height at harvest via number of millable canes was positive and more in second clonal generation. No consistent contribution of different qualitative and quantitative traits towards cane yield were observed in both the clonal generations. For instance, the trait, number of shoots per hectare at 120 days had positive direct and larger effect towards cane yield in first clonal generation whereas it was having negative little direct effect in second clonal generation. Similar case was observed with other traits namely germination percent at 45 days, cane height, cane diameter and quality traits.

Table 3. Direct (Diagnol) and indirect effect of different quantitative characters towards cane yield in first (I) and second (II) clonal generation

Characters	Generation	Germination percent X₁	No. of shoots at 120 days X₂	No. of millable canes X₃	Cane height (cm) X₄	Cane diameter (cm) X₅	Single cane weight (kg) X₆	Brix (mid Nov.) X₇	Brix (mid Dec.) X₈	Brix (mid Jan.) X₉	Sucrose percent in Jan. X₁₀	CCS% in Jan. X₁₁	Cane yield Y
Germination percent at 45 days (X₁)	I	-0.0053	0.2916	0.0029	0.0059	0.0079	0.0222	0.0140	0.0004	0.0078	-0.0331	0.0175	0.3310**
	II	0.0123	-0.0027	0.0000	0.0003	-0.0071	-0.0257	-0.0066	0.0104	0.0067	0.0102	-0.0002	-0.0020
No. of shoots at 120 days (X₂)	I	-0.0025	0.6050	0.0083	0.0063	0.0035	0.0350	0.0320	-0.0017	-0.0082	-0.0021	0.0076	0.6830**
	II	0.0003	-0.0986	0.9021	-0.0013	0.0019	-0.0026	-0.0136	0.0019	0.0037	-0.0029	-0.0001	0.7910**'
No. of millable canes at harvest (X₃)	I	-0.0040	0.1494	0.0336	0.0111	0.0001	0.1095	0.0295	-0.0036	-0.0164	0.0183	-0.0121	0.3190**
	II	0.0000	-0.0945	0.9416	-0.0011	0.0012	-0.0121	-0.0158	0.0027	0.0071	-0.0143	0.0001	0.8150**
Cane height at harvest (in cm) (X₄)	I	-0.0008	0.1022	0.0101	0.0372	0.0075	0.0390	0.0141	-0.0021	-0.0040	-0.0127	0.0040	0.1950
	II	-0.0006	-0.0181	0.1488	-0.0068	0.0040	0.0090	-0.0071	0.0004	-0.0122	0.0201	-0.0003	0.1370
Cane diameter at harvest (in cm) (X₅)	I	0.0013	-0.0629	-0.0001	-0.0085	-0.0332	0.0365	0.0078	-0.0010	-0.0024	0.0086	-0.0040	-0.0570
	II	-0.0025	-0.0053	0.0320	-0.0008	0.0355	-0.0161	0.0166	-0.0047	-0.0146	-0.0173	0.0003	0.0230
Single cane weight (kg) (X₆)	I	-0.0002	0.0430	0.0075	0.0029	-0.0025	0.4933	0.0206	-0.0012	0.0004	-0.0182	0.0123	0.5580**
	II	-0.0016	0.0513	-0.0574	-0.0003	-0.0029	0.2490	0.0342	-0.0295	-0.0162	0.0117	-0.0003	0.2380*
Brix in mid November (X₇)	I	-0.0005	-0.1313	-0.0067	-0.0036	-0.0018	-0.0691	-0.1474	0.0094	0.0367	-0.0426	0.0243	-0.3280**
	II	-0.0005	0.0079	-0.0876	0.0003	0.0035	0.0402	0.1694	-0.0828	-0.0361	0.0343	-0.0006	0.0480
Brix in mid December (X₈)	I	-0.0002	-0.0853	-0.0098	-0.0062	0.0002	-0.0483	-0.1126	0.0123	0.0446	-0.0466	0.0260	-0.2260*
	II	-0.0014	0.0020	-0.0264	0.0000	0.0017	0.0613	0.1465	-0.0957	-0.0354	0.0267	-0.0005	0.0790
Brix in mid January (X₉)	I	-0.0007	-0.0889	-0.0077	-0.0026	0.0014	0.0039	-0.0964	0.0098	0.0561	-0.0582	0.0324	-0.1510
	II	-0.0012	0.0053	-0.0970	-0.0012	0.0076	0.0470	0.0891	-0.0493	-0.0687	0.0400	-0.0006	-0.0290
Sucrose percent in juice in January (X₁₀)	I	-0.0017	0.0127	-0.0057	0.0047	0.0028	0.0878	-0.0616	0.0056	0.0320	-0.1020	0.0604	0.0350
	II	0.0010	0.0022	-0.1017	-0.0010	-0.0047	0.0175	0.0439	-0.0193	-0.0207	0.1324	-0.0025	0.0470
CCS% in juice in January (X₁₁)	I	-0.0015	0.0073	-0.0065	0.0026	0.0021	0.0962	-0.0567	0.0050	0.0287	-0.0975	0.0632	0.0430
	II	0.0008	-0.0019	-0.0499	-0.0008	-0.0033	0.0189	0.0388	-0.0193	-0.0150	0.1214	-0.0027	0.0870

I & II : Denotes first mid second clonal generation respectively. (Residual effect- first generation=0..5071 & second generation=0.5241)

The present findings of positive direct effect of number of millable cane per hectare and single cane weight on cane yield was reported by various workers time to time viz. Balasundram and Bhagyalakshmi (1978), Hooda *et ai* (1988), Bakshi and Choudhary (2000) and Krishna and Singh (2004) etc.

The efficiency of multiple regression equation (Table 4 and 5) in present study for first and second clonal generation were observed to be same i.e r^2 (Cn)=74.7, r^2 (C|$_2$)=72.7, r^2 (C$_2$i)=72.5 and r^2 (C$_{22}$)=70.8, where r^2 (C$_{11}$) and r^2 (C$_{21}$) were degree of determination for observed cane yield by taking all eleven characters in first and second clonal generation respectively and r^2 (C$_{12}$) and r^2 (C$_{22}$) were degree of determination of predicted cane yield by taking two characters (number of shoots per hectare at 120 days and single cane weight) *in first clonal generation and three characters (number of* millable cane per hectare, single cane weight and refractometric brix in mid November) in second clonal

generation. These stated that efficiency of selection remained almost unaffected even after deleting nine characters in first clonal generation and eight character in second clonal generation.

Rank correlation between ranking of clones in both clonal generations based on selection indices also remained strong as more than fifty percent of identified clones in first clonal generation and more then eighty percent of identified clones in second clonal generation were found quite closer in ranking in both the criteria. Top ten ranking clones of first clonal generation (Table 6) viz, CoX02120, CoX02138, CoX02177, CoX02244, CoX02129, CoX02027, CoX02058, CoX02217, CoX02061 and CoX02007 were found on the basis of eleven cane yield component characters. Top ten ranking clones after considering two cane yield *component characters in first clonal generation were as* follow: CoX02117, CoX02120, CoX02121, CoX02314, CoX02027, CoX02138, CoX02289, CoX02244,

Table 4. Partial regression coefficient for first clonal generation

Sl. No.	Characters	When all eleven characters were included	After deleting nine characters
1.	Germination percent at 45 days	0.01652±0.08654	
2.	Number of shoots per hectare at 120 days	−0.00006+0.00014	0.00024±0.00002
3.	Number of millable canes per hectare	0.00059+0.00015	
4.	Cane height at harvest (in cm)	−0.00235±0.02072	
5.	Cane diameter at harvest (in cm)	1.4817±2.9361	
6.	Single cane weight (in kg)	19.818+6.9359	57.938±6.7094
7.	Refractometric brix in mid November	1.3243+1.0637	
8.	Refractometric brix in mid December	−0.75505+L0730	
9.	Refractometric brix in mid January	−0.66779+0.83316	
10.	Sucrose percent in juice in January	1.3856±1.8547	
11.	CCS percent in juice in January	−0.00257+2.3188	
	R^2	74.7	72.7

Y = 3.910–0.136X, +0.00023X$_2$ + 0.000002 X$_3$ + 0.0164 X$_4$ – 1.578 X$_5$ +0.0000056 X$_6$ – 1.196 X$_7$ +0.1102 X$_8$ +0.6452, X$_9$–0.9589 X$_{10}$ +0.7276 Xn

Y = −11.299 + 0.00024 X$_2$ +57.940 X$_6$

Table 5. Partial regression coefficient for second clonal generation

Sl. No.	Characters	When all eleven characters were included	After deleting nine characters
1.	Germination percent at 45 days	−0.01362±0.09934	
2.	Number of shoots per hectare at 120 days	0.00022±0.00027	
3.	Number of millable canes per hectare	0.00002±0.00004	0.00052±0.000038
4.	Cane height at harvest (in cm)	0.01614±0.02972	
5.	Cane diameter at harvest (in cm)	−1.5775±3.0907	
6.	Single cane weight (in kg)	55.881±7.5069	16.945±6.2741
7.	Refractometric brix in mid November	−1.1957±0.81962	0.07168±0.04978
8.	Refractometric brix in mid December	0.11022±1.2757	
9.	Refractometric brix in mid January	0.64527±1.2369	
10.	Sucrose percent in juice in January	−0.95885±2.5297	
11.	CCS percent in juice in January	0.72756±3.1605	
	R^2	72.5	70.8

Y = 27.592 + 0.0166 Xi −0.000642 X$_2$ + 0.000592 X$_3$ −0.00236 X$_4$ + 1.48 X$_5$ + 0.198 X$_6$ +1.32 X$_7$ −0.755 X$_8$ −0.668 X$_9$ + 1.39 X$_{10}$ −0.00257 Xn

Y = −18.232 + 0.000518 X$_3$ +0.7168 X$_7$ +16.95 X$_6$

Table 6. Top ten genotypes ranked on the basis of observed value in first clonal generation

Sl. No.	Genotypes	X-value	X-rank	Y value	Y rank
1.	CoX02120	85.90	1	80.35	2
2.	CoX0213S	79.11	2	70.07	6
3.	CoX02177	78,87	3	80.84	1
4.	CoX02244	76.32	4	68.36	8
5.	CoX02129	70.37	5	65.00	11
6.	CoX02027	68.54	6	72.74	5
7.	CoX02058	67.66	7	61.42	15
8.	CoX02217	66.82	8	56.43	18
9.	CoX02061	66.63	9	55.28	21
10.	CoX02007	65.18	10	61.83	13

X- value = Observed yield value
Y-value = Predicted yield value

CoX02243 and CoX02238. Among the top ten ranking clones in first clonal generation CoX02117, CoX02120, CoX02027, CoX02138 and CoX02244 were having almost similar ranking under both criteria.

Similarly, in case of second clonal generation top ten ranking clones (Table 7) on the basis of eleven component traits were CoX02217, CoX02177, CoX02182, CoX02150, CoX02058, CoX02148, CoX02001, CoX02307, CoX02176 and CoX02027 and top ten ranking clones on the basis of three yield components are CoX02150, CoX02182, CoX02155, CoX02058, CoX02027, CoX02001, CoX02148, CoX02217, CoX02130 and CoX02177. Among the top ten ranking clones in second clonal generation CoX02150, CoX02182, CoX02058, CoX02027, CoX02001, CoX02148, CoX02217 and CoX02177 were having almost similar ranking under both the criterias.

Obviously, in the selection programme stress on number of shoots per hectare at 120 days and single cane weight in first clonal generation will be easier to follow and equally-rewarding than taking all eleven characters. Similarly stress given to the characters single cane weight,

number of millable cane per hectare and refractometric brix in mid November in second clonal generation will be easier to follow and equally rewarding than taking all eleven characters. The standard partial regression coefficient in both first and second clonal generation for single cane weight was high valued, while formulation of selection criterion by deducing non-significant cane yield contributing traits so trend in third and subsequent clonal generation might be studied to get reliable results.

Bakshi and Choudhary (2000) reported number of millable canes or number of shoots as most reliable character for selection. Single cane weight was also reported as best criterion for selection in the breeding program by Bakshi and Kumar (1999). Similar observations were also reported by Krishna and Singh (2004) while studying genotypic variability in subtropical sugarcane. Overall this study of two consecutive generations suggested that selection in early clonal generation should be done on the basis of single cane weight coupled with number of shoots at 120 days as well as number of millable canes. Single cane weight was most reliable trait for selecting genotypes

Table 7. Top ten genotypes rankedon the basis of observed value in second clonal generation

Sl. No.	Genotypes	X-value	X-rank	Y-value	Y-rank
1.	CoX02217	66.17	1	58.21	8
2.	CoX02177	65.64	2	57.82	10
3.	CoX02182	64.64	3	61.35	2
4.	CoX02150	64.53	4	62.12	1
5.	CoX02058	64.42	5	59.73	4
6.	CoX02148	64.15	6	58.67	7
7.	CoX02001	63.02	7	59.31	6
8.	CoX02307	60.70	8	48.05	20
9.	CoX02176	60.58	9	45.88	24
10.	CoX02027	58.46	10	59.35	5

X-value = Observed yield value; Y-value = Predicted yield value

in both the generations. The positive and significant correlation among number of shoots at 120 days and number of millable canes in both the generations advocated its inclusion in selection procedure as these were among the major contributor to cane yield. Consideration of settling behaviour of individual character is also advocated to make selection more effective in early generations.

The changing behaviour of correlation of brix in mid November and mid December with cane yield in both the generations and non-significant association of other

quality traits with cane yield advocate preliminary selection on the basis of cane yielding ability than to score these for juice quality. It can also be suggested that the scoring of genotypes for quality traits should be delayed to later generation till the stabilize.

Finally, two clones, *viz* CoX02217 and CoX02177 were selected for subjecting directly for varietal evaluation trial and as parent in hybridization programme for improvement of sub-tropical sugarcane. Details about these two clones in comparison to best check BO 128 are listed in Table 8.

Table 8. Mean performance of a top two identified genotypes of second clonal generation for all the twelve quantitative traits in both the generations

| Sl. No. | Character | Genotypes | | | | | |
| | | CoX02217 | | CoX02177 | | BO 128 | |
		1st gen	2nd gen	1st gen	2nd gen	1st gen	2nd gen
1.	Germination percent at 45 days	43.33	42.52	66.53	45.75	31.56	32.88
2.	No. of shoot per hectare at 120 days (in thousand)	106.30	109.79	184.35	106.75	121.49	115.72
3.	No. of millable canes per hectare (in thousand)	96/78	96.49	101.51	97.63	101.86	110.49
4.	Cane height at harvest (in cm)	247	217	238	248	213	219
5.	Cane diameter at harvest (in cm)	2.27	2.86	2.67	2.39	2.16	1.89
6.	Single cane weight (in kg)	0.730	0.635	0.829	0.708	0.587	0.595
7.	Refractometric brix in mid November	17.90	21.88	15.30	21.01	20.78	19.80
8.	Refractometric brix in mid December	19-16	20.49	18.56	22.02	21.64	20.82
9.	Refractometric brix in mid January	22.04	21.92	19.70	22.46	22.07	21.82
10.	Sucrose percent in juice in January	15.02	16.21	16.86	16.21	17.28	17.29
11.	CCS percent in juice in January	10-32	11.10	11.52	11.33	11.95	11.93
12.	Cane yield (t/ha)	66.82	66.17	78.87	65.64	59.60	59.41

References

Bakshi Ram, S Kumar, BK Sahi BK, BK Tripathi, B Ram, V Singh and V Kumar (1999) Traits for selecting elite sugarcane clones under water and self stress conditions. Proceedings of the XXIII ISSCT Congress, New Delhi. India, 22-26 February, 1999,. Vol. 2 431-439.

Bakshi Ram, BS Choudhary, DK Yadav and B Ram (2000) Effect of visual selection methods-tin characters interrelationships in sugarcane. *Indian Journal of Agricultural Research* **34(1):** 39-43.

Balasundaram N and KV Bhagyalakshmi (1978) Variability, heritability and association among yield and yield components in sugarcane. *Indian J. Agri. Sci.* **48(5):** 291-295.

Battan KR, BS Choudhary and JP Kadian (1985) Studies on correlation and path coefficient analysis for quality attributes in sugarcane. *Agricultural Science Digest* **5(2):** 87-89.

Das PK, BC Jena and N Nayak (1997) Character association and path analysis of sugar yield in sugarcane. *Indian Sugar* **46(10):** 805-808.

Ghosh J (1991) Studies on genetic.evaluation in mid late maturing clones of sugarcane. M.Sc. (Ag.) Thesis RAU, Pusa, Bihar 125 p.

Deway OK and KM Lu (1959) A correlation and path coefficient analysis of components of crested–Wheat grass seed production. *Agron. J.* **51:** 515-518

Hapase RS and JM Repale (1999) Variability correlation and path analysis in sugarcane. Proceedings of the 61st Annual convention of the Sugar Technologies Association of India, New Delhi, India, 7-9 September, 1999.

Hill AG (1935) The maintenance of first year characters in new sugarcane clones. *Sugarcane Res Stn.* Mauritius. Bull. No. 8.

Hooda MS, S Singh and BS Chaudhary (1988) Correlation and pail\ coefficient analysis in sugarcane, *Crop Improvement*, **15(2):** 206-208.

Kamat DN and JRP Singh (2001) Variability in sugarcane under rainfed condition. *Sugar-Tech.* **3(1-2):** 65-67.

Krishna K, PK Singh and JRP Singh (2004) Genetic variability and characters association in sub-tropical clones of sugarcane *(Saccharum complex* hybrid). *Indian Sugar,* June, 2004, 189-198.

Kumar R and JRP Singh (1999) Path analysis in sugarcane under waterlogged condition. *J. App. Biol.* **9(2):** 137-139.

Mishra SN (1988) Variability and correlation studies in seedling and clonal generation of sugarcane. M.Sc. (Ag.) Thesis RAU, Pusa.

Nagarajan R, S Alarmelv and RM Shanthi (2000) Studies on variation on interspecific hybrids of *Saccharum*. *Sugar-Tech*, **2(3):** 42-46.

Puneet Jain, Rishi Pal, ML Saini, Lajpat Rai, P Jain, R Pal and L Rai (2002) Character association among morphological traits in sugarcane. *Annals of Agri. Bio. Res.* **7(1):** 21-23.

Ramesh V and S Varghese (1995) Correlation and path coefficient analysis of yield and its attribute of sugarcane. *Indian Sugar* **44(10):** 769-772.

Verma PS, S Pal and NK Karma (1999) Genetic variability and correlation studies in sugarcane. *Indian Sugar* **5(49):** 125-128.

Wright S (1921) Correlation and causation. *Agric. Res.* **20:** 557-585.