Characterization of Exotic Commercial Hybrid Clones of Sugarcane

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Fifteen exotic commercial hybrids were characterized for their morphological, agronomic and quality traits. The study showed wide morphological variation among the clones, though they are commercial canes developed for improved traits, including yield. For the agronomic data, the difference was significant only for the number of millable canes, HR brix, cane length and yield. Five clones had HR Brix value at 7th month (> 21%) indicating it's potential as a source for early high sucrose accumulation. One clone showed sucrose above 20% (SP 83-5073) at maturity and it may be a potential parent for improving the juice quality. Only one clone (SP 80-1816) was found yield on par with the best check Co 62175 for CCS yield/plot, indicating that most of the clones were not adapted to the local environment.

Key Words: Characterization, Exotic commercial hybrids, Germplasm, Sugarcane

Introduction

Sugarcane Breeding Institute, Research Centre, Kannur (Cannanore) has the mandate of maintaining and evaluating the germplasm of sugarcane, including commercial hybrids. Several catalogues were brought out as a result of elaborate characterization and evaluation of the world collection of sugarcane germplasm (Kandasami *et al*., 1983; Ramana Rao *et al*., 1985; Sreenivasan and Nair 1991; Nair and Sreenivasan, 1995; Nair *et al*., 1997; Sreenivasan *et al*., 2001a, 2001b; Balasundaram *et al*., 2005). Since1962, the world collection of sugarcane germplasm is maintained at this Centre. Apart from enhancing the indigenous germplasm collections made from within the country, the commercial hybrid germplasm was also enhanced by introducing more hybrid clones from other countries. During 2000-2001, 15 new clones were added to the collection *viz.*, eight SP hybrids from Brazil, six CP hybrids from USA and one hybrid from China. For understanding the adaptability and for effective utilization of the germplasm, extensive characterization of the newly introduced hybrid clones was carried out.

Materials and Methods

Fifteen commercial hybrid clones (Table 1) were grown in an augmented block design of 6 ft rows with an inter-row spacing of 90 cm. The test clones were plated in three blocks with two checks (Co 62175 and Co 8231) in each block. The crop was raised for three consecutive crop seasons, starting from 2004. The crop was planted in February and harvested in the month of January. The soil is sandy loam with a pH of 5.7 and the temperature ranges between 18º C and 36º C. The annual rainfall ranged from 2,852 to 3,695 mm during the period and the crop was properly irrigated with good quality water during summer months. Recommended packages and practices were followed for maintenance. Morphological observations were recorded during the 9th month in 2004-05 based on the descriptors by Artschwager and Brandes, 1958 (Table 2). Pollen fertility was studied by acetocarmine staining. The yield data were recorded from five canes each in all the three years (2005-07) during 11th month and the average was computed over the years. ANOVA is calculated using the online software for Augmented block analysis.

Results and Discussion

The clones characterized showed wide variation despite the fact that these clones are commercial hybrids selected from the population for desirable traits. Probably the

Table 1. Passport information of the hybrid clones

Clone	Source	Parents
CP 57-614	Canal Point, USA	CL 47-143xCP 53-17
CP 70-1133	-do-	CP 56-63 (poly cross)
CP 72-2086	-do-	CP 62-374xCp 63-588
CP 78-2114	-do-	Unknown
CP 79-318	-do-	CP 65-357X L65-69
CP 80-1827	-do-	CP 70-1133x CP 73-1311
Yuetang 85-177	China	Not available
SP 79-2233	Sao Paulo, Brazil	H 56-2954 (poly cross)
SP 80-185	-do-	BO 17 (poly cross)
SP 80-1816	-do-	SP 71-1088xH57-5028
SP 80-1842	-do-	SP 71-1088xH57-5028
SP 80-3280	-do-	SP 71-1088xH57-5028
SP 81-1763	-do-	Not available
SP 81-3250	-do-	CP 70-1547x SP 71-1279
SP 83-5073	-do-	SP 71-1406x SP 71-1088

Table 2. Descriptors and descriptor states for morphological characters

Descriptor(s)	Descriptor state(s)
Plant height	0-9 scale
Tillering	0-9 scale
Rind stripe	ST- striped, NS- Non striped
Rind colour (exposed and freshly exposed)	BP- Brownish purple, P- Purple, LP- Light purple, DP-Dark purple, YG- Yellowish green, GB- Greenish brown, GY- Greenish Yellow, LG- Light green, YB- yellowish brown, LG- Light green, GP Greenish purple, CRY-Creamy yellow, Y-Yellow, PG- Purplish green
Root band colour (exposed & freshly exposed)	-do-
Internode wax	NP- Not prominent, P-Prominent, VP- Very Prominent
Growth crack	A- Absent, FS- Few Shallow, FD- Few Deep
Internode shape (major & minor)	CYL- Cylindrical, OBC- Obconical, BOB- Bobbin shaped, CON- Conical, CUR- Curved
Internode alignment	ST- Straight, ZIG- Zig-zag
Internode cross section	R- Round, OV- Oval
Piping of stem	S- Solid, SLH- Slightly hollow, H- Hollow
Pithiness of stem	NP- No pith, SLP- Slightly pithy, PITH- Pithy
Wax band shape	FU- Funnel shaped, CON- Conical
Bud groove	A - Absent, IND- indicated, SS- Short shallow, DL- Deep long
Node swelling, root band swelling	NS- Not swollen SSW- Slightly swollen, SW- Swollen,
Root band shape	TUM- Tumultant, CYL- Cylindrical, OBC, Obconical,
Root eye alignment	IR-Irregular, R-Regular
Bud shape	OVT- Ovate, SQPE- Squarish pentagonal, RC- Round with central pore, RW- Round with wings
Bud size	MS- Medium small, MB- Medium Bold, SB- small bold, LB- Large Bold, MF- Medium flat
Bud extension	B-Below growth ring, T-Touching the growth ring
Bud germ pore	SA-Sub apical, C- Central
Canopy	OSD- Open semi droopy, OE-Open erect, OTD- Open tip droopy, FTD- Fans shaped tip droopy, CTD Compact tip droopy, FE- Fan erect,
Leaf sheath clasping	M- Medium, L- Loose
leaf sheath colour	G- Green, GPT- Green with purple tinge,
leaf sheath wax	M- Medium. L- Low, H- High, VH- Very high
leaf sheath scaries, wax band width	N- Narrow, M- Medium, W- Wide
leaf colour	G- Green DG- Dark green
Wax band, Root band, Corky cracks, Corky patches, Bud cushion, Hair group	P- Present, A- Absent

diverse environmental factors, diverse parents and different breeding conditions might have contributed to the inheritance of diverse traits into their progenies resulting in variation for morphological characters. All the clones showed good agronomical traits also as a result of selection for better yield. In general clones were medium tall or tall types with moderate to high tillering. Internode thickness ranged from 2.1 cm (SP 83-5073) to 3.2 cm (Yuetang 85-177) and nodal thickness from, 2.2 cm to 3.0 cm. All clones except CP 57-614 were having non striped rind. The exposed rind colour was ranging from yellowish green to dark purple and freshly exposed rind colour was yellowish green to light purple. Though rind colour is a quantitative character that is generally influenced by the environment, it is widely used in sugarcane for identifying and describing the commercial varieties. The rind wax was very prominent in eight clones. Growth cracks are one of the undesirable characters for commercial canes. CP 72-2086, CP 78-2114, SP 80-1816, SP 80-1842, SP 80-3280 and SP 81-3250 had few deep cracks and in CP 80-1827 few shallow cracks were observed. In all other clones, growth cracks were absent.

The predominant internode shape recorded was cylindrical, while in CP 72-2086 and CP 79-318 it was bobbin shaped, and in SP 79-2233, SP 80-185, SP 80-185 and SP 81-3250 it was conical. The stem of Yuetang 85-177 and CP 80-1827 did had pith, and in others the stem was having slight pith or had broad pith as in CP

72-2086, CP 78-2114 and SP 81-3250. The internode cross section of all CP varieties was round except in CP 79-318 where it was oval. Most of the SP clones showed oval cross section, except SP 79-2233, SP 81-3250 and Yuetang 85-177 where in it was round.

Prominent wax band was present in all the clones. In most of the clones it was funnel shaped while in SP 80-185, SP 80-1816 and SP 80-1842, it was conical. Root band colour was ranging from yellow to purple and root band width ranged from 4.3 cm (SP 81-1763) to 8.0 cm in CP 57-614. The number of root eyes was irregularly arranged in two rows in most of the cases except in SP 81-3250, CP 78-2114, CP 72-2086 and CP 57-614 in which it was in three rows. Bud size was medium small (CP 57-614) to large bold as in CP 79-318 with either ovate, squarish pentagonal or rhomboid in shape. The other bud characters *viz.*, bud groove, bud cushion, bud extension, bud germ pore, bud hair group 10 and 26 also showed variation among the clones (Table 3). The blade carriage determines the look of the variety in the field. The clones showed blade carriage ranging from compact erect (SP 81-1763) to open semi-droopy (CP 57-614).

Most of the clones had green or greenish purple leaf sheath or green sheath with purple tinge. Sheath wax was another character that was very prominent in most of the clones. High leaf sheath wax was observed in SP 80-1842 and SP 83-5073. Leaf sheath scaries was narrow in CP 78-2114, SP 80-185, SP 80-1842 and SP 81-1763 and in others it was wide. Leaf colour was green on all the clones, except Yuetang 85-117 where it was dark green. Hairiness of leaf blades and sheath can be used effectively for characterizing sugarcane clones. In sugarcane though leaf blade marginal hair group 53 is always present, the dorsal patch of hair on leaf sheath (hair Group 57) generally distinguishes clones on the basis of it extent (Moore,1987). HG 57 was dense in SP 80-1816, CP 80-1827 and CP 70-1133 and in other it was absent or slightly present whereas HG 56 was absent in all the clones. Flowering is an essential trait required for utilizing the clones for conventional breeding programme. In the germplasm collection of exotic hybrids, on an average 50% of the clones only flowers regularly. Of the 15 clones evaluated, 3 clones (SP 79-2233, SP 80-1842, and SP 81-1763) did not flower and other clones flowered in the month of November, from first week to fourth week. Pollen fertility ranged from 10-94% among the flowering clones. The detailed morphological traits are given in Table 3.

The yield evaluation of the clones revealed the adaptability of the introduced clones to the new environment. The variation for yield data was significant for number of millable canes, HR brix, cane length and yield (Table 4). The adjusted mean of yield data from augmented block design analysis are given in table 5. The number of millable canes was highest in SP 81-3250 and followed by SP 80-3280. Five clones CP 70-1133, CP 79-318, CP 80-1827, SP 80-1842 and SP 83-5073 had HR Brix value at 7^{th} month (> 21) indicating its potential as a source for early high sucrose accumulation. Among the early high brix clones, CP 70-1133 and CP 79-318 were having pollen fertility above 60 per cent which can be used as male parent and SP 83-5073 with low pollen fertility (16%) as female parent. However, intervention of artificial induction of flowering may be required in the case of SP 80-1842 for utilization in breeding programme as it did not flowering under normal condition. As the heavy rainfall coincides with the formative phase of the sugarcane at the evaluation site, the cane thickness is generally low and it ranged from 1.91 (CP 78-2114) to 2.65 cm in CP 80-1827. Single cane weight ranged from 0.58 kg (SP 79-2233) to 1.08 kg in SP 80-1816. At maturity the brix value ranged from 17.8 to 22.0 (SP 83-5073). Only one clone showed sucrose above 20% (SP 83-5073) at maturity and it may be a potential parent for improving the juice quality. Only one clone (SP 80-1816) was found yield on par with the best check Co 62175 for CCS yield/plot, indicating poor adaptability of the clones to the local environment with high rainfall and excess soil moisture condition.

Extensive evaluation is the first step for utilization for the germplasm. This study has revealed the potential of the introduced clones for different morphological, yield and quality traits which will be very useful for the crop improvement programme in sugarcane. The morphological characterization of the clones not only help to distinguish the clones and describe, but also enable the breeder to identify and select for morphological trait associated with more complex heritable processes such as stress resistance, disease resistance and yield (Rosario *et al.*, 1978; Mc David and Midmore, 1980).

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Table 3. Morphological traits of 15 exotic hybrids

		CP 57-614	CP 70-1133	CP 72-2086	CP 78-2114	CP 79-318	CP 80-1827	Yuetang 85-177	SP 79-2233	SP 80-185	SP 80-1816	SP 80-1842	SP 80-3280	SP 81-1763	SP 81-3250	SP 83-5073
1	Plant height (0-9 scale)	7	6	5	7	5	5	6	7	7	8	7	7	7	6	7
2	Tillering (0-9 scale)	5	6	3	7	5	5	4	6	5	7	6	7	7	7	8
3	Internode thickness (cm)	2.6	2.6	2.7	2.6	2.6	3.1	3.2	2.2	2.5	2.3	2.2	2.5	2.5	2.4	2.1
4	Node thickness (cm)	2.6	2.6	2.7	2.6	2.9	2.7	3.0	2.7	2.4	2.4	2.2	2.3	2.5	2.6	2.2
5	Rind stripe	ST	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
6	Rind colour exposed	BP	P	YG	BP	PG	LP	LP	BP	P	DP	LP	DP	YG	GB	DP
7	Rind colour freshly exp.	GY	LP	LG	CRY	LP	YG	YB	LG	GP	LP	LG	LP	GY	LG	YG
8	Internode wax	VP	VP	NP	P	VP	P	P	P	VP	VP	VP	VP	NP	VP	VP
9	Root band	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A
10	Corcky cracks	P	P	P	P	A	P	A	A	A	A	A	A	P	P	A
11	Corky patches	P	P	P	P	P	P	P	A	P	P	A	P	P	P	P
12	Growth crack	FD	A	FD	FD	A	FS	A	A	A	FD	FD	FD	A	FD	A
13	Internode shape major	OBC	CYL	BOB	CUR	BOB	CYL	CON	CON	CON	CYL	CYL	CYL	CYL	CON	CYL
14	Internode shape minor	CYL	CYL	CYL	CON	CYL	CYL	CON	CYL	CYL	CYL	CYL	CYL	BOB	CYL	BOB
15	Internode alignment	ST	ST	ZIG	SZIG	ST	ZIG	ST	SZIG	ST	ST	ST	ST	ST	ST	ST
16	Internode cross section	R	R	R	R	OV	R	R	R	OV	OV	OV	OV	OV	R	OV
17	Piping of stem	S	S	H	SLH	H	SLH	SLH	SLH	SLH	S	SLH	SLH	SLH	H	S
18	Pithiness of stem	SLP	SLP	PITH	PITH	SLP	NP	NP	SLP	SLP	SLP	SLP	SLP	SLP	PITH	SLP
19	Wax band	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
20	Wax band shape	FU	FU	FU	FU	FU	FU	FU	FU	CON	CON	CON	FU	FU	FU	FU
21	Wax band width	M	W	W	W	W	W	W	W	W	W	W	W	W	W	W
22	Bud groove	A	SS	IND	A	DL	IND	DL	A	A	IND	IND	IND	A	A	A
23	Node swelling	SSW	SW	NS	SW	SW	SW	SW	SW	SSW	SSW	NS	SSW	SSW	SW	SSW
24	Root band colour exposed	GY	G	YG	GB	YG	G	G	G	P	P	G	P	Y	G	P
25	Root band col. fresh. expo	CRY	CRY	LG	CRY	CRY	CRY	CRY	YG	CRY	YG	LG	LG	Y	LG	CRY
26	Root band width (cm)	8.0	6.7	6.3	6.0	5.0	6.3	6.7	6.0	7.7	7.3	6.3	7.3	4.3	8.3	5.3
27	Root band swelling	SW	SSW	NS	SW	SSW	NS	SW	SSW	SSW	SSW	SSW	SSW	SSW	SSW	NS
28	Root band shape	OBC	CYL	CYL	TUM	OBC	OBC	TUM	CYL	CYL	OBC	CYL	OBC	OBC	OBC	CYL
29	Number of root eyes	3	2	3	3	2	2	2	2	2	2	2	2	2	3	2
30	Root eye alignment	IR	IR	IR	IR	IR	IR	IR	IR	IR	IR	R	IR	IR	R	RR
31	Bud shape	OVT	SQPE	RC	OVT	RC	SQPE	OVT	SQPE	SQPE	OVT	OVT	SQPE	OVT	RW	OVT
32	Bud size	MS	MB	MB	MS	LB	MS	MB	MB	MB	MF	SB	MB	MB	MB	MS
33	Bud cushion	A	A	P	P	A	A	P	P	P	P	P	P	A	P	P
34	Bud Extension	B	B	B	B	T	B	T	B	T	T	B	T	B	B	B
35	Bud germpore	SA	C	C	SA	C	SA	SA	SA	SA	SA	SA	SA	SA	SA	SA
36	HG10 (bud)	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A
37	HG26 (bud)	A	A	A	A	A	A	P	A	A	P	A	A	P	A	A
38	Canopy	OSD	OE	FTD	OTD	OE	FE	FTD	FTD	OE	CTD	FE	FE	CE	CTD	FE
39	Leaf sheath clasping	M	M	L	M	L	M	L	L	M	M	L	L	L	L	L
40	leaf sheath colour	G	GPT	G	G	G	GPT	G	GPT	GPT	GPT	GPT	GPT	GPT	GPT	GPT
41	leaf sheath wax	M	M	M	M	L	H	M	H	M	H	VH	H	H	H	VH
42	leaf sheath scaries	N	M	W	N	W	W	M	M	N	M	N	M	N	M	M
43	leaf colour	G	G	G	G	G	G	DG	G	G	G	G	G	G	G	G
44	leaf length (cm)	155	146	155	160	154	150	136	193	141	166	157	152	163	186	150
45	leaf width (cm)	3.4	4	4.5	3.9	4.5	5.7	5.5	4.5	4.3	4.8	3.6	4	4.6	4.7	4.5
46	Hair group 53	A	A	P	A	A	P	A	A	P	A	A	A	P	P	P
47	Hair group 57	A	D	P	A	P	D	D	P	A	D	P	P	P	P	P
48	Hair group 60	A	P	A	A	A	A	P	A	A	P	A	A	A	A	A
49	Hair group 56	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
50	Flowering (week/month)	1/11	3/11	2/11	2/11	2/11	1/11	1/11	NF	1/11	2/11	NF	1/11	NF	3/11	4/11
51	Pollen fertility (%)	54	64	69	78	63	94	10	–	73	80	–	62	–	55	16

Table 4. ANOVA for 10 yield traits

Traits	Treatment Adjusted		Block adjusted		
	Df	MS	Df	MS	F
No. of millable canes	16	25.0547**	2	0.92	8.25
Hand refractometer brix	16	2.5416*	2	0.14	1.95
Cane thickness	16	0.0770	2	0.00	0.05
Cane length	16	897.6734**	2	27.13	4.25
Single cane weight	16	0.0588	2	0.00	1.44
Brix (%)	16	1.2764	2	0.07	0.79
Sucrose (%)	16	1.6939	2	0.04	0.36
Purity (%)	16	6.2232	2	1.05	0.95
Yield	16	11.9565*	2	1.70	13.51
Ccs/p (sugar yield/plot)	16	0.1331	2	0.03	1.34

Table 5. Adjusted mean of yield and quality traits

	Clone	NMC	HRBM	ctk	Cl	scwt	Brix (%)	Suc (%)	Purity (%)	Yield kg/p	ccs/p
1	CP 57-614	18.52	18.61	1.94	262.22	0.78	17.83	15.78	86.51	15.31	1.86
2	CP 70-1133	18.22	21.49	2.33	230.13	0.78	18.54	17.10	92.45	16.69	2.14
3	CP 72-2086	11.52	19.93	2.58	208.91	0.94	18.86	17.20	91.15	8.82	1.23
4	CP 78-2114	19.92	18.84	1.91	229.93	0.66	19.00	17.66	93.12	12.96	1.82
5	CP 79-318	15.92	22.41	2.24	227.44	0.82	18.90	16.81	89.42	13.74	1.71
6	CP 80-1827	14.72	21.81	2.65	213.86	0.92	19.02	17.39	90.83	13.68	1.60
7	Yuetang 85-177	11.32	19.93	2.57	220.95	0.92	18.15	15.42	84.88	12.21	1.09
8	SP 79-2233	21.05	18.73	2.05	188.00	0.58	18.22	16.77	91.71	11.86	1.26
9	SP 80-185	16.72	19.72	2.25	258.15	0.93	17.85	15.91	88.98	17.21	1.76
10	SP 80-1816	21.32	20.41	2.24	247.66	1.08	19.06	17.98	93.91	18.30	2.19
11	SP 80-1842	18.67	21.94	2.23	289.34	0.88	20.10	18.06	90.07	13.67	1.93
12	SP 80-3280	21.87	20.51	2.22	257.82	0.86	18.52	16.48	89.42	16.42	2.09
13	SP 81-1763	20.37	20.13	2.11	246.14	0.84	20.40	18.98	93.31	13.48	2.02
14	SP 81-3250	21.97	18.89	2.19	220.60	0.72	19.39	16.90	87.52	15.86	2.01
15	SP 83-5073	19.67	21.67	2.10	242.62	0.73	22.20	20.44	92.19	12.79	2.09
16	Co 62175	17.23	17.90	2.40	225.50	1.18	17.90	16.10	90.11	20.55	2.19
17	Co 8231	27.70	21.10	1.80	184.44	0.48	20.27	18.50	91.56	13.41	1.64
CD5%		**2.49**	**1.47**	**0.28**	**14.03**	**0.14**	**1.63**	**1.79**	**7.80**	**2.64**	**1.05**
CV		**1.71**	**1.31**	**5.5**	**1.11**	**2.94**	**1.54**	**1.86**	**1.10**	**2.30**	**7.60**

(NMC = Number of millable canes, HRB = Hand refractometer brix at middle of the cane at 7th month, Ctk = Cane thickness, cl = Cane length, brix = Brix %, Suc = Sucrose %, Pur = Purity%, Yld/P = Cane yield/plot, CCS/P (2 meter row) = Sugar yield/plot (kg)

block design analysis in the IASRI website and for guiding in the analysis of data.

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