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Research Article

CoG 6 - A high yielding and quality sugarcane variety

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Abstract
CoG 6 is an early maturing, high yielding, high sugared, variety with high quality jaggery developed through hybridization and selection from a cross between HR 83-144 x CoH 119 at Sugarcane Research Station, Melalathur, Vellore District, Tamil Nadu. The variety CoG 6 possess medium thick, erect greenish yellow coloured non-lodging, non-flowering canes. It possesses the high tillering ability and convert more tillers to millable canes. It is a good ratooner. It has a greenish purple leaf sheath with deciduous spines and loose clasping nature which ensures clean cane at harvest. CoG 6 is moderately resistant to red rot and resistant to smut disease. The variety is resistant to sugarcane woolly aphid and less susceptible to shoot and internode borer. Under normal soil conditions at Station trials, in plant crop the variety recorded a cane yield of 140.56 t/ha and sugar yield of 18.39 t/ha. In ratoon crop, it produced 136.16 t/ha of cane yield and sugar yield of 17.74 t/ha in comparison with the standard check CoG 94077 with cane and sugar yield of 122.67 t/ha of and 15.75 t/ha, respectively. It also surpassed the check in ratoon performance as well. In ART trials conducted during 2012-14 seasons comprising Coimbatore, Tiruchirapalli, Cuddalore and Vellore region, the variety CoG 6 performed well and also recorded a 17.66 per cent increase in cane yield (135.73 t/ha) and 19.07 per cent increase in sugar yield (17.75 t/ha) over the check Co 86032 with 115.36 t/ha cane yield and 14.91 t/ha CCS yield. In the On Farm Trials conducted at salt affected areas in Vellore district during 2014-16 crop seasons, the variety CoG 6 recorded the highest cane yield of 131.74 t/ha and CCS per cent of 13.04 in plant crop which showed an increase of 33.09 and 39.22 per cent over the checks Co 86032 (98.98 t/ha) and CoG 94077 (94.63 t/ha), respectively. In the ratoon crop also the variety CoG 6 recorded a maximum cane yield of 120.21 t/ha and sugar yield of 15.64 t/ha. It recorded an increase of 31.12 and 34.40 per cent for cane yield and 32.99 and 36.71 per cent increase for sugar yield over the checks Co 86032 and CoG 94077, respectively. The sugarcane variety CoG 6 possess superior jaggery qualities *viz*., juice recovery (64.5%), juice purity (90.98%) and jaggery recovery (11%) and recorded a higher jaggery yield of 14.49 t/ha which is 41.50, 49.38 and 46.66 per cent higher than the checks Co 86032 (10.24 t/ha), CoG 94077 (9.70 t/ha) and salt tolerant variety CoG 95076 (9.88 t/ha), respectively.

Key words: Sugarcane, CoG 6, salt affected soils, quality jaggery.

INTRODUCTION

Sugarcane is a precious plant cultivated in different parts of the globe. The plant owes its origin in South East Asia and is widely used in the production of sugar alongside other industrial products. Over 120 countries across the globe are known to grow sugarcane and Brazil is the leading largest sugarcane producing country in the world, has the capacity to produce of massive 739.3 million metric tonnes of product each year according to the latest report produced by United Nations Food and Agricultural organization (https://www.investopedia.com). India is the second largest producer of cane products with 341.2 million metric tonnes of sugarcane and with a share of around 15.39 per cent in the world sugar production.

The sugar industry is the second largest agro-based industry in India and contributes significantly to the socio-economic development of the rural population. It supports 50 million farmers and their families and provides direct employment to over 0.5 million skilled and semi-skilled persons in sugar mills and integrated industries. The Indian sugar industry plays a leading role in the global sugar market being the world's second largest producer after Brazil, producing nearly 15 and 25 per cent of global sugar and sugarcane, respectively. The sugar industry which encompasses 599 operating sugar mills, 309 distilleries and 180 cogeneration plants and numerous pulp, paper and chemical making units is supported by four leading sugarcane research institutions, twenty-two state sugarcane research stations, world class sugar machinery manufacturers, suppliers and technical experts. Currently, the industry produces around 300–350 million tonnes (Mt) cane, 20–22 Mt white sugar and 6–8 Mt jaggery and khandsari to meet the domestic consumption of sweeteners.

In Tamil Nadu, out of 2.8 lakh hectares of sugarcane area, 36 per cent of cane is cultivated for jaggery production. Annually 10 lakh metric tonnes of jaggery are produced in the local villages of the following districts *viz.*, Vellore, Salem, Thiruvannamalai, Erode, Dindigul, Tiruppur, Coimbatore, Theni, Villupuram, Thiruvallur, Karur, Trichy, Namakkal, Ariyalur, Virudhunagar and Madurai. Jaggery is mainly sold for local consumption (30 %) and export to the nearby states (40%) like Kerala, Karnataka, Andhra Pradesh and Northern states (25%) and other countries (5%).

The major yield limiting factors in Tamil Nadu are drought, salinity and red rot disease. In the Vellore District of Tamil Nadu, large numbers of tanneries are functioning in Vaniyambadi, Ambur, Pernambut, Gudiyattam, Ranipet, and Walaja blocks, which are affecting a cultivable area of 16,000 hectares. Due to the tannery effluent, the well water in these areas is polluted. Continuous irrigation with such polluted water affects the soil quality and health. Due to the toxic effects on soil and water, the metabolic process of the crop is altered resulting in low cane productivity. The choice of a suitable sugarcane cultivar for this agro-ecological zone decides the ultimate productivity. Keeping this in view, breeding and evolution work was initiated at Sugarcane Research Station, Melalathur that resulted in the identification of a promising high yielding, high sugared early variety CoG 6 (clone number G 2005 019). This variety was tested in Coimbatore, Tiruchirapalli, Cuddalore and Vellore regions under Adaptive Research Trials during 2012-14 seasons. This clone was tested in salt affected areas of Tamil Nadu comprising 20 locations in two plant and one ratoon crops during 2014-16 seasons and CoG 6 was identified and released by the State Variety Release Committee in 2018 for cultivation in sugarcane growing areas of Tamil Nadu.

MATERIALS AND METHODS

The hybridization work was done involving a biparental cross of HR83-144 x CoH 119 at ICAR–Sugarcane Breeding Institute, Coimbatore and further screening and evaluation (2005 – 2016) was done at Sugarcane Research Station, Tamil Nadu Agricultural University, Melalathur, Vellore District. Fluff and ground nursery was raised during 2005. The progeny row trial and initial yield trials were conducted during 2006-2008. Based on the performance of G 2005019 in IYT, it was promoted to Advance Yield Trial (2008-2011) along with two checks *viz.,* Co 86032 and CoG 94077. The performance was assessed in two plant crops and one ratoon crop. The Adaptive Research Trial (ART) was conducted at four agroclimatic regions of Tamil Nadu *viz.,* Coimbatore, Tiruchirapalli, Cuddalore and Vellore regions during 2012-2014. The Adaptive Research Trial (ART) was conducted in Randomized Block Design in three replications with five early clones *viz.*, 06 C 138, G 2005 019, G 2005 047, 06 Si 021 and Co 0314 and two check varieties CoC 24 and Co 86032. During the 2012-13 cropping season the first plant crop was raised and it was ratooned during the 2013-14. The second year plant crop was also raised during 2013-14 cropping season. On Farm Trials were conducted in 20 locations in salt affected areas of Vellore district during 2014-16 seasons along with three standards *viz.*, Co 86032, CoG 95076 and CoG 94077. During the 2014-15 cropping season first plant crop was raised and was ratooned during 2015-16. The second year plant crop was also raised during 2015-16 cropping season. All the recommended packages of practices were adopted. The mean of two plant crops and ratoon crops were considered for evaluation. Observations on cane yield, juice quality parameters and the incidence of pests and diseases were recorded at tillering and grand growth stages. Juice quality parameters from each treatment were analysed for brix (%), pol (%) and purity (%) at 315 days as per the procedure suggested by Meade and Chen (1977) from which the commercial cane sugar per cent was worked out. The data were statistically analyzed by the method of Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

The mean yield of plant and ratoon crops in station trials are presented in **Table 1**. At Sugarcane Research Station, Melalathur under normal soil conditions, the variety, CoG 6 recorded a cane yield of 140.56 t/ha and a sugar yield of 18.39 t/ha. In the ratoon crop, the clone recorded 136.16 t/ha of cane yield and 17.74 t/ha of sugar yield against the standard CoG 94077 which recorded 122.67 t/ha of cane yield in plant and 115.22 t/ha of cane yield in ratoon.

The ART trials were conducted in four regions *viz.,* Coimbatore, Tiruchirapalli, Cuddalore and Vellore. In each region, the ART was conducted at various sugar mills (12) for two years with two plant crops and one ratoon crop. The overall mean yield of plant crop and

Table 1. Performance of CoG 6 in normal soil (mean of two years)

S.No.	Entry	Cane yield (t/ha)		CCS (%)		Sugar yield (t/ha)	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	CoG 6	140.56	136.16	13.08	13.03	18.39	17.74
2	Co 86032	111.16	106.74	13.05	12.99	14.51	13.87
3	CoG 94077	122.67	115.22	12.84	12.72	15.75	14.66
4	% increase over Co 86032	26.44	27.56	0.23	0.31	26.74	27.90
5	% increase over CoG 94077	14.58	18.17	1.87	2.44	16.76	21.00

Table 2. Performance of CoG 6 in adaptive research trials in normal soil

S.No.	Entry	Cane yield (t/ha)		CCS (%)		Sugar yield (t/ha)	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	CoG 6	138.91	129.39	13.09	13.15	18.14	16.98
2	Co 86032	118.27	109.56	13.00	12.75	15.38	13.97
3	CoC 24	123.49	116.00	12.61	12.59	15.57	14.57
4	% increase over Co 86032	17.45	18.10	0.65	3.12	17.95	21.51
5	% increase over CoC 24	12.48	11.55	3.77	4.43	16.51	16.53

ratoon crop in ART trial is presented in **Table 2**. In ART trials of 2012-14 seasons, in plant crop the variety CoG 6 recorded a 17.45 per cent increase in cane yield (138.91 t/ha) over the check Co 86032 (118.27 t/ha) and 17.95 per cent increase in sugar yield (18.14 t/ha) compared to the check Co 86032 (15.38 t/ha). In the ratoon crop the variety CoG 6 recorded an 18.10 per cent increase for cane yield (129.39 t/ha) and a 21.51 per cent increase in sugar yield (16.98 t/ha) over the check Co 86032 (109.56 t/ha cane yield and 13.987 t/ha sugar yield).

On Farm Trials were conducted in 20 locations in salt affected areas of Vellore district during 2014-16 crop seasons along with three standards *viz.,* Co 86032, CoG 95076 and CoG 94077 as two plant crop and one ratoon crops. The mean yield of plant crop and ratoon crop in On Farm Trials under salt affected soil are presented in **Table 3.** Under salt affected stress conditions the variety CoG 6 recorded a higher cane yield of 131.74 t/ha in plant and 120.21 t/ha in ratoon crop as against the salt tolerant variety CoG 95076 with 96.42 t/ha of cane yield in plant and 93.25 t/ha cane yield in ratoon. It showed an increase of 36.63 per cent in plant and 28.91 per cent in ratoon over Co G 95076. For sugar yield also, the variety CoG 6 recorded an overall mean of 17.19 t/ha in plant and 15.64 t/ha in ratoon, which is a 42.66 and 35.88 per cent increase over salt tolerant variety CoG 95076, respectively.

Most of the high sugar content sugarcane varieties are susceptible to borers *viz*., early shoot borer (*Chiloinfuscatellus* (Snellen)) and internode borer (*Chilosacchariphagus* (Kapur)) which causes 20 per cent crop loss in a farmers field and 15 per cent sugar recovery

Table 3. Performance of CoG 6 in salt affected soils (mean of 60 trials in each of the plant and Ratoon crops)

S.No.	Entry	Cane yield (t/ha)		CCS (%)		Sugar yield (t/ha)		Jaggery Yield (t/ha)	
		Plant	Ratoon	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
1	CoG 6	131.74	120.21	13.05	13.01	17.19	15.64	14.49	13.28
2	Co 86032	98.98	91.68	12.85	12.82	12.72	11.76	10.24	9.52
3	CoG 94077	94.63	89.44	12.81	12.80	12.12	11.44	9.70	9.21
4	CoG 95076	96.42	93.25	12.50	12.35	12.05	11.51	9.88	9.55
5	% increase over Co 86032	33.09	31.12	1.56	1.48	35.14	32.99	41.50	39.49
6	% increase over CoG 94077	39.22	34.40	1.87	1.64	41.83	36.71	49.38	44.19
7	% increase over CoG 95076	36.63	28.91	4.44	5.34	42.66	35.88	46.66	39.06

loss to the sugar mill's (Sardana and Amerika Singh, 2002). The variety CoG 6 was found to be less susceptible to the early shoot borer and internode borer (**Table 4**). The sugarcane varieties Co 86032 and CoG 94077 are the popularly grown varieties which often succumbs to pests and diseases of which the borer's cause a major loss in cane yield and loss of sugar % (Thirumurugan *et al*., 2004). The variety CoG 6 is less susceptible to major borer pests and suitable for present ecological conditions to increase cane yield, which benefits the farmer and increase recovery which benefits the millers.

The reaction to red rot and smut disease was observed under natural and artificial conditions. The scoring of disease incidence under artificial conditions was recorded (**Table 5**) and it reveals that the variety CoG 6 was moderately resistant to red rot with less number of white spots and nodal transgression than the standard varieties. The variety CoG 6 is moderately resistant to smut.

The early sugarcane variety CoG 6 possess superior jaggery qualities (**Table 6**) *viz*., juice recovery (64.5%), juice purity (90.98%) and jaggery recovery (11%) and recorded a higher jaggery yield of 14.49 t/ha which is 41.50, 49.38 and 46.66 per cent higher than standard *viz.,* Co 86032 (10.24 t/ha), CoG 94077 (9.70 t/ha) and salt tolerant variety CoG 95076 (9.88 t/ha), respectively.

The early maturing sugarcane variety CoG 6 has the ideal plant characters *viz*., tall, erect plant type with non-lodging attractive green yellow coloured canes **(Table 7 & Fig.1 to 4).** The variety is a non flowering type. It has greenish purple leaf sheath with deciduous spines and with loose leaf sheath clasping which indicates self detrashing nature of the clone. The variety exhibits excellent field stand and is a good ratooner. It is moderately resistant to red rot and resistant to smut diseases. The variety CoG 6 is also resistant (does not have natural incidence) to sugarcane woolly aphid and less susceptible to shoot

Table 4. Reaction to major pests

S. No.	Variety/ Clone	Early shoot borer		Internode borer	
		% of cumulative incidence	Grade	% of cumulative incidence	Grade
1	CoG 6	11.53	LS	21.79	LS
2	Co 86032	18.40	MS	24.50	
3	CoG 94077	13.83	LS	20.72	LS
4	CoG 95076	16.74	MS	21.34	LS

Table 5. Reaction to red rot and smut diseases

S.No.	Variety/ Clone	Red rot reaction by plug method				Total	Grade	Smut grade
		Condition of the crop	Lesion width	Number of white spots	Nodal trans-gression			
1	CoG 6	--	1.4	1.4	0.40	3.20	MR	4.30 MR
2	Co 86032	--	0.9	1.4	0.36	2.66	MR	5.40 MR
3	CoG 94077	--	1.4	1.5	0.50	3.40	MR	7.05 MR
4	CoG 95076	--	0.8	1.2	0.40	2.40	MR	6.25 MR

Table 6. Milling quality of the CoG 6 over Co 86032 and CoG 94077

Parameters	Clones / variety		
	CoG 6	CoG 94077	Co 86032
Cane yield (t/ha)	131.74	94.63	98.98
CCS (%)	13.05	12.81	12.85
Juice recovery (%)	64.50	58.0	58.0
Brix (%)	21.75	21.0	21.4
Purity (%)	90.98	89.35	90.55
Jaggery recovery (%)	11.00	10.21	10.35
Fibre content (%)	13.49	14.02	13.76
Jaggery yield (t/ha)	14.49	9.70	10.24

Fig. 1. Field stand of G2005 019 at 240 days

Fig. 2. Field stand of G2005 019 of 120 days

Fig. 3. Cane top of G2005 019

Fig. 4. Cane nodal region of G2005 019

Table 7. Morphological description of sugarcane variety CoG 6

S.No	Descriptor	Descriptor State
1	Pedigree	HR 83-144 X CoH 119
2	Shoot habit	Erect
3	Stem colour (Exposed) Stem colour (Unexposed)	Green Yellow Yellow green
4	Ivory marks (P/A)	Present
5	Weather marks (Corky patches) (P/A)	Absent
6	Internode shape	Cylindrical
7	Internode alignment (straight/zigzag)	Straight
8	Pithiness (A/M/H)	Absent
9	Splits (A/M/H)	Absent
10	Wax on the internode (L/M/H)	Low
11	Node swelling (swollen/not swollen)	Not swollen
12	Root zone colour (Exposed)	Green Yellow
13	Root zone colour (Unexposed)	Light yellow
14	Number of root eye rows	Three
15	Arrangement (regular/irregular)	Irregular
16a	Bud size (B/M/S)	Medium
16b	Bud Shape	Ovate
17	Bud Cushion (P/A)	Absent
18	Bud germpore position (A/M/Sub M)	Apical
19	Bud groove (P/A)	Present
20	Growth ring colour	Green Yellow
21	Leaf width	4.8 cm
22	Leaf length (of 1st transverse leaf at 180 days)	140 cm
23	Lamina colour (LG/G/DG)	Light green
24	Leaf carriage shape	Open droopy
25	Leaf sheath colour	Greenish Purple
26	Leaf sheath waxiness (L/M/H)	Low
27	Leaf sheath spines (A/SM/SF/HM/HF)	Deciduous spines
28	Leaf sheath clasping (ST/ET/TT)	Loose
29	Dewlap colour (at 10 month)	Green
30	Ligule (P/A)	Present (Crescent shaped)
31	Shape of the auricle	Lanceolate
32	Flowering	Non Flowering
33	Erectness	Non lodging
34	Distinguishing morphological characters	Tall, erect, medium thick green canes with green dewlap, deciduous spines in leaf sheath, open droopy and non-flowering

borer and internode borer. It grows well in salt affected soils and also produces good quality jaggery. Thus this variety is expected to improve productivity in normal and salt affected soils of Tamil Nadu.

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