

**RESEARCH ARTICLE****Co 0212 - A PROMISING MIDLATE MATURING SUGARCANE CLONE SUITABLE FOR DIFFERENT AGRO-CLIMATIC REGIONS OF TAMIL NADU**

**C. Appunu<sup>1\*</sup>, A. Anna Durai<sup>1</sup>, Ravinder Kumar<sup>1</sup>, G. Hemaprabha<sup>1</sup>, S. Alarmelu<sup>1</sup>, M. N. Premachandran<sup>1</sup>, C. Mahadevaiah<sup>1</sup>, P. Parasuraman<sup>2</sup>, M. Jayachandran<sup>3</sup>, S. Pannerselvam<sup>4</sup>, B. Rajendran<sup>5</sup>**

**Abstract**

A promising midlate maturing clone, Co 0212 was developed from Co 7201 x ISH 106 at Sugarcane Breeding Institute (SBI), Coimbatore. Performance of Co 0212 was evaluated in different agro-climatic regions of Tamil Nadu under Coordinated Agronomic Evaluation (CAE) programme in collaboration with Tamil Nadu Agricultural University (TNAU) at 18 locations from 2011-2012 and 2012-2013 in two plant and one ratoon crops along with standard varieties Co 86032 and CoC 22. The clone Co 0212 registered an overall mean cane yield of 148.3 t/ha and commercial cane sugar (CCS) yield of 18.95 t/ha compared to best standard variety Co 86032 with cane yield of 129.5 t/ha and CCS yield of 16.11 t/ha. It recorded 14.52% increased cane yield over Co 86032 while the increase in CCS yield was 17.62%. Co 0212 is moderately resistant to red rot and smut diseases and tolerant to drought and salinity stresses. The clone has medium thick canes with erect growing habit and is of non-lodging nature. The clone can be distinguished by purple heavy wax coated canes with open drooping leaves, purple red dewlap, moderate spines, short lanceolate ligular process on both sides, broad and long leaves with open leaf carriage, light green foliage, purple green and easily trashable leaf sheath. The clone also possesses excellent ratoonnability. Co 0212 is suggested as an alternative to the prevailing variety Co 86032 for commercial cultivation in Tamil Nadu.

**Key words:** Sugarcane, Co 0212, cane yield, CCS%, Tamil Nadu

**Introduction**

Sugarcane (*Saccharum* spp.) is the central source of sugar or sucrose in India. It is grown in about 5.0 M ha of area which accounts to nearly 3% of the total cultivable area in both tropical and subtropical regions of the country (Cooperative Sugar, April 2014). Annually, nearly 340 million tonnes (Mt) of

cane are produced in the country, which in turn are used by about 536 sugar mills and thousands of jaggery / khandsari units in different states. This country shares about 20% of the area and 22.6% of the world sugar production. In India, Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Bihar, Andhra Pradesh and Gujarat are the major sugarcane growing states. These six states

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C. Appunu<sup>1\*</sup>, A. Anna Durai<sup>1</sup>, Ravinder Kumar<sup>1</sup>, G. Hemaprabha<sup>1</sup>, S. Alarmelu<sup>1</sup>, M.N. Premachandran<sup>1</sup>, C. Mahadevaiah<sup>1</sup>, P. Parasuraman<sup>2</sup>, M. Jayachandran<sup>3</sup>, S. Pannerselvam<sup>4</sup>, B. Rajendran<sup>5</sup>

<sup>1</sup>Sugarcane Breeding Institute, Coimbatore - 641 007

<sup>2</sup>Regional Research Station, Paiyur - 635 112

<sup>3</sup>Sugarcane Research Station, Cuddalore - 607 001

<sup>4</sup>Sugarcane Research Station, Sirugamani - 639 115

<sup>5</sup>Sugarcane Research Station, Melalathur - 635 806

\*email : cappunu@gmail.com

contribute about 90% total area and 91% production with an average productivity of 75.89 t/ha. In Tamil Nadu, sugarcane occupies about 3,46,000 ha and records annual production of 3,85,76,000 tonnes with productivity 111.2 t/ha (Cooperative Sugar, 2013). At present, the prominent variety Co 86032 occupies about 85-90% of sugarcane area in Tamil Nadu since its release for commercial cultivation about two decades back. The production potential of this variety is declining year by year due to its susceptibility to diseases, mainly yellow leaf diseases (YLD), insect pests and poor or unsuitability to saline and waterlogged conditions. Though Tamil Nadu ranked first in terms of sugarcane productivity (111.2 t/ha) in India, this is much lower than the production potential of 212 t ha<sup>-1</sup> for the crop (Waclawovsky et al. 2010). Sugarcane accounts for more than 70% of the cost of production of sugar and hence the efficiency of sugar industry is mainly dependent upon the availability of improved sugarcane varieties with better juice quality and tolerance to biotic and abiotic stresses. To meet the needs of the growing population expected to reach around 1.45 billion by the year 2025 and the increasing demand for sugar and sweeteners for internal consumption, the production and productivity of the crop need to be increased. For achieving the target, average cane productivity in India needs to be improved from the present level of 70 t/ha to 105 t/ha and sugar recovery from 10% to 11% by 2025 (Nair 2008). The increased requirement of sugar can be met through identification of location specific varieties to enhance production per unit area/time. Since land is limited, development of sustainable hybrids superior to the existing variety Co 86032 assumes importance in Tamil Nadu. Apart from serious sugarcane diseases viz., red rot and smut, YLD caused by sugarcane yellow leaf virus (ScYLV) seriously affects cane and juice yield in major sugarcane varieties under tropical zone

(Viswanathan et al. 2014). All these factors warrant development of high sugared varieties with high cane yield (t/ha) and good ratooning ability. Hence, research efforts were made to identify high sugar and high yielding varieties at Sugarcane Breeding Institute, Coimbatore.

## **Materials and methods**

### **Experimental materials**

A total of five promising midlate maturing sugarcane clones, three (Co 0211, Co 0212, Co 0213) from ICAR - Sugarcane Breeding Institute (SBI), one each (04 Si 043) from Sugarcane Research Station (SRS) Sirugamani (04 Si 043) and (06 C 857) from SRS, Cuddalore (06 C 857) were tested along with two check (Co 86032 and CoC 22) varieties for their yield and quality characters. Performance of Co 0212 was also evaluated in All India Coordinated Research Project (AICRP) on Sugarcane trials in 14 locations of peninsular zone during 2007-2009 with standards Co 86032 and Co 7219 (AICRP Annual Report on Sugarcane 2007-2008 and 2008-2009).

### **Experiment sites**

Field experiments were carried out under Coordinated Agronomic Experiments (CAE) on sugarcane programme in collaboration with Tamil Nadu Agricultural University (TNAU) at farmers' fields and sugarcane factory farm locations. Cane farm locations across the state namely the regions of Coimbatore (The Amaravathi Cooperative Sugar Mills Ltd., Udumalpet; Bannari Amman Sugars Ltd., Sathayamangalam; Sakthi Sugars Ltd., Bhavani; Ponni Sugars Ltd., Erode), Vellore (The Ambur Cooperative Sugar Mills Ltd., Ambur; The Vellore Cooperative Sugar Mills Ltd., Vellore), Dharmapuri (The Dharmapuri District Cooperative Sugar mills Ltd., Palacode; Tirupattur Cooperative Sugar Mills

Ltd., Kethandapatti; The Salem Cooperative Sugar Mills Ltd., Mohanur), Trichy (E.I.D. Parry (India) Ltd., Pugalur; E.I.D. Parry (India) Ltd., Pettavaithalai; Farmer's field, Trichy) and Cuddalore (E.I.D. Parry (India) Ltd., Nellikuppam; Rajshree Sugars & Chemicals Ltd., Mundiampakkam; The Pondicherry Cooperative Sugar Mills Ltd., Puducherry; Farmer's field, Cuddalore; New Horizon Sugar Mills Ltd., Ariyur; Kariyamanickam Research Farm, Pondicherry) were chosen for conducting the trials. Under AICRP(S), performance of this clone was evaluated in sugarcane research centers at Coimbatore, Akola, Basmath Nagar, Kolhapur, Mandya, Navsari, Padegaon, Powerkheda, Pravaranagar, Pugalur, Pune, Sameerwadi, Sankeshwar and Thiruvalla spread across six states (AICRP Annual Report on Sugarcane 2007-2008 and 2008-2009).

### **Experimental design and cultural practices**

Experiments were conducted during 2007-2009 under AICRP(S) in 14 locations (AICRP Annual Report on Sugarcane 2007-2008 and 2008-2009), and 2011-12 and 2012-13 under state trials with two plant crops and one ratoon crop in each of the 18 locations that represented five major sugarcane growing regions in Tamil Nadu. The trials were laid out in randomized block design (RBD) replicated thrice with a plot size of five rows of 5 m length spaced 80 cm apart. Standard sugarcane cultivation practices were followed (Sundara, 1998). Commercial cane sugar (CCS) yield was calculated from cane yield and CCS %. The cane yields recorded in test plots were converted into quantity per hectare. Five canes were randomly selected from each plot at the time of harvest and crushed in a small power crusher and juice was analysed for Brix, pol (%) and purity (%) as per standard methods of Meade and Chen (1977). Commercial cane sugar

% was worked out using the formula  $\{(Sucrose \% \times 1.022) - (Brix \times 0.292)\}$ . The data on cane yield (t/ha) and quality parameters (CCS %) were recorded 12 months after planting (at harvest). CCS yield was calculated by following the formula  $[(CCS \% \times Cane\ yield\ t/ha)/100]$ . The data of the two plant and one ratoon crops over 18 different locations of five different regions were pooled, analyzed and presented in Tables 2-3. The analysis of variance (ANOVA) for cane yield and juice quality parameter traits was worked out using TNAUStat programme. Red rot reaction of this clone was evaluated under natural and artificial conditions with predominant red rot causing pathotype Cf 671 in Peninsular regions as well as in Tamil Nadu state.

### **Results and discussion**

#### **Performance of Co 0212 across Peninsular zone under AICRP(S)**

The clone Co 0212 matures in 360 days and grouped under midlate category (SBI, Annual Report 2001-2002). In 10 centres of Peninsular zone where the clone was tested in two plant crops and one ratoon crop under AICRP(S), Co 0212 showed better average performance for cane yield, CCS%, sugar yield (CCS yield) and sucrose content than the best check (Table 1). Co 0212 recorded an average CCS yield of 14.67 t/ha from three crops against the standard Co 7219 (12.48 t/ha) and Co 86032 (14.31 t/ha). It showed 17.54 % improvement over Co 7219 and 2.51 % over Co 86032. This clone performed better than the standards in both the plant crop trials. The percent improvement over Co 7219 and Co 86032 was 17.41 % and 4.98 % in the first plant crop, 17.83 % and 2.36 % in the second plant crop and 17.35 % and -0.027 % in the ratoon crop respectively. Co 0212 recorded an average (three crops) cane yield of 106.94 t/ha against Co 7219 (91.89 t/ha) and Co 86032 (102.98 t/ha). It showed

**Table 1. Overall mean performance of Co 0212 in the varietal testing centres of Peninsular Zone of AICRP(S)\***

Entry/ Character	Co 0212				Co 7219				% increase of Co 0212 over Co 7219	Co 86032				% increase of Co 0212 over Co 86032
	PI	PII	R	Mean	PI	PII	R	Mean		PI	PII	R	Mean	
CCS yield (t/ha)	15.76	15.80	12.44	14.67	13.43	13.41	10.60	12.48	+17.54	15.02	15.44	12.48	14.31	+2.51
Cane yield (t/ha)	112.34	115.50	92.98	106.94	96.64	98.55	80.48	91.89	+16.37	106.30	111.19	91.45	102.98	+3.84
CCS (%)	13.81	14.03	13.39	13.74	13.71	13.67	13.63	13.67	+0.53	13.92	13.77	14.01	13.90	-1.13
Sucrose (%)	19.58	19.77	18.99	19.57	19.37	19.54	19.34	19.42	+0.77	19.59	19.41	19.68	19.56	+0.05

PI- I Plant, PII-II plant, R- Ratoon crop; Source: Principal Investigators' Report, AICRP on Sugarcane, Varietal Improvement 2007-2008; Principal Investigators' Report, AICRP on Sugarcane, Varietal Improvement 2008-2009;\* Performance of Co 0212 in eight locations

improvement of 16.37 % and 3.84 % over Co 7219 and Co 86032 respectively. In both plant and ratoon crops the clone showed improvement over both the standards.

However, Co 0212 exhibited superior performance for cane yield and quality parameters in Coimbatore and Pugalur locations in Tamil Nadu. In Coimbatore, this clone recorded 38.14% increase in sugar yield and 38.58% increase in cane yield, while in Pugalur this clone registered 19.8% increase in sugar yield and 16.24% increase in cane yield over Co 86032. Based on the better performance of Co 0212 at these AICRP(S) centres, potential and suitability of this clone was evaluated in different agro-climatic regions of Tamil Nadu under CAE programme in collaboration with TNAU.

### **Performance of Co 0212 across Tamil Nadu under CAE(S) programme**

The average plant crop performance of Co 0212 across Tamil Nadu in comparison to the best

standard variety Co 86032 is given in Table 2a & b. The data on quantitative characters revealed that the average cane yield was 155.21 t/ha and sugar yield was 19.89 t/ha, accounting for an improvement of 14.18% and 18.75% respectively over the standard Co 86032. In the ratoon crop, the cane yield and sugar yield were 141.26 t/ha and 18.04 t/ha respectively, with an improvement of 14.68% and 16.69% over the Co 86032. Superior performance of this clone compared to existing predominantly cultivated variety Co 86032 in CAE programme was in agreement with better performance of this clone against Co 86032 in AICRP(S). Parasuraman et al (2013) registered high sugar and cane yields when it was evaluated with a set of new promising clones in North West zone of Tamil Nadu. The per cent increase recorded for CCS% in Co 0212 was 2.65% and 3.65% respectively in plant crop and ratoon crops over Co 86032. Jayachandran et al. (2004) also made similar observation for the clone Si 96125 among a group

**Table 2a. Mean of two plant crops performance of Co 0212 in five different agro-climatic regions of Tamil Nadu state**

Entries	Coimbatore	Vellore	Dharmapuri	Trichy	Cuddalore	Mean	% increase over best check
Cane yield (t/ha)							
Co 0212	171.14	159.00	144.58	157.75	143.60	155.21	14.18
Co 86032	158.46	139.93	125.92	134.25	121.10	135.93	
CCS (%)							
Co 0212	12.35	12.97	12.96	12.91	12.95	12.82	3.81
Co 86032	11.66	12.79	13.00	11.65	12.69	12.36	
CCS yield (t/ha)							
Co 0212	21.13	20.62	18.73	20.36	18.59	19.89	18.82
Co 86032	18.47	17.90	16.37	15.64	15.37	16.74	

**Table 2b. Ratoon performance of Co 0212 in five different agro-climatic regions of Tamil Nadu state**

Entries	Coimbatore	Vellore	Dharmapuri	Trichy	Cuddalore	Mean	% increase over best check
Cane yield (t/ha)							
Co 0212	135.67	144.03	132.21	158.10	136.30	141.26	14.68
Co 86032	123.13	133.79	117.02	133.90	108.00	123.17	
CCS (%)							
Co 0212	12.55	12.85	12.72	13.00	12.68	12.76	1.67
Co 86032	12.00	12.65	12.77	12.70	12.65	12.55	
CCS yield (t/ha)							
Co 0212	17.02	18.51	16.81	20.55	17.28	18.04	16.69
Co 86032	14.78	16.92	14.95	17.01	13.66	15.46	

of midlate maturing promising clones tested in Tamil Nadu. Similarly, many midlate clones were identified after on-farm testing at state level (Bora et al. 2011; Charumathi et al. 2010).

Though Co 86032 is occupying more area under sugarcane cultivation in Tamil Nadu, the production potential of this variety is reported to be declining year after year due to its susceptibility mainly to

YLD caused by ScYLV. This is responsible for varietal degeneration in sugarcane (Lehrer et al. 2010). Viswanathan et al. (2014) established that among several physiological parameters, photosynthetic rate (A), stomatal conductance (gs) and SPAD metre values were significantly reduced in cultivars severely infected with ScYLV. Virus-infected cultivars exhibited significant reduction in

growth/yield parameters, viz. stalk height, stalk thickness and number of internodes. Plant growth reductions were found to be 42.9, 42.3 and 38.9% in susceptible cultivars CoPant 84211, Co 86032 and CoC 671, respectively. In addition to reduction in stalk weight, height and girth, YLD disease also reduced juice yield in the affected canes up to 34.15%. Similarly, comparison of diseased (virus-infected) and virus-free plants derived through meristem culture also revealed a drastic reduction in cane growth/physiological parameters and juice yield due to virus infection (Viswanathan et al. 2014). The incidence of the disease in commercial fields reached upto 100 % in susceptible cultivars (Rassaby et al. 2004). Consequently, this situation warrants a massive programme to provide healthy seed material of existing variety, cultivation of yellow leaf free new variety and initiate breeding for YL resistance in sugarcane. Cane productivity in the sugar mill area in Tamil Nadu showed a steady decline and reached the lowest of 77.5 t/ha from 95 t/ha in 10 years (Viswanathan et al. 2010). Yield loss of 6%, 11% and 14% due to reduced stalk number and tonnage in the plant crop, first and second ratoons of cultivar LCP82-89 was recorded in Louisiana (Grisham et al. 2001). The overall performance of Co 0212 in two plant crops and one ratoon crop across Tamil Nadu is shown in Fig. 1 that highlighted the superiority of Co 0212 over Co 86032. The

potential clone Co 0212 could be best alternate in stock for Co 86032 in Tamil Nadu.

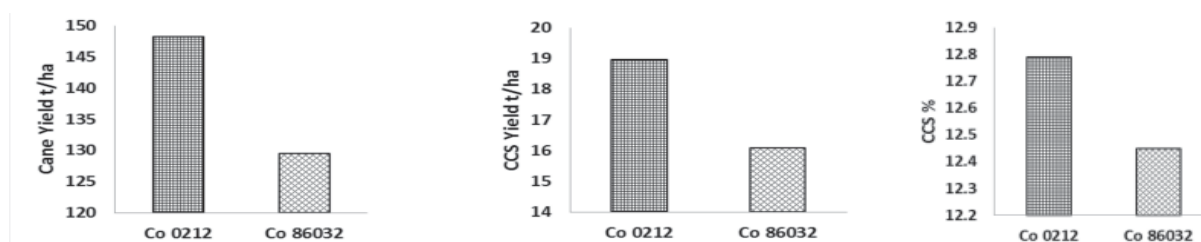
### Reaction to biotic and abiotic stresses

Response of Co 0212 and standards to biotic and abiotic stresses either under natural conditions and or artificial conditions showed Co 0212 to be moderately resistant to the predominant red rot pathotype cf671 under nodal and plug methods of inoculation testing. Incidence of smut disease and insect pests attack was not noticed under natural conditions. Till now, yellow leaf was not observed in this variety from any region. In addition, this clone recorded tolerance to drought and saline conditions. The chief morphological characters are presented in Table 3.

### Conclusion

Besides being a high yielding and good quality clone, Co 0212 is moderately resistant to red rot, tolerant to drought and salinity. Mean fibre values of Co 0212 were 13.88% in plant crop and 14.87 % in ratoon crop. This is a good ratooner with excellent field stand, with erect and medium thick canes. Co 0212 possesses A<sub>1</sub> quality jaggery. This variety exhibited 30% flowering during mid November at Coimbatore.

The results from different trials conducted indicated that Co 0212 was superior to Co 86032, the widely



**Fig. 1.** Overall mean performance of Co 0212 for cane yield and quality parameters in CAE trials across Tamil Nadu: Mean of two plant and one ratoon crops (Source: Proceedings of Half yearly CAE meeting cum workshop report on 1 July 2013)

**Table 3. Morphological characters for identification of the sugarcane variety Co 0212**

<b>Characteristic</b>	<b>Description</b>
Name of the station	Sugarcane Breeding Institute, Coimbatore
Clone number	Co 0212
Parentage	Co 7201 x ISH 106
Shoot habit	Erect
Stem colour (Exposed)	Purple
Stem colour (Unexposed)	Purplish green
Ivory marks (P/A)	Absent
Weather marks (Corky patches) (P/A)	Present
Internode shape (as per Artswager)	Cylindrical
Internode alignment (straight/zig zag)	Slightly zig zag
Pithiness (A/M/H)	Light
Splits (A/M/H)	Absent
Wax on the internode (L/M/H)	Heavy
Node swelling (swollen/not swollen)	Not swollen
Root zone colour (Exposed)	Purplish green
Root zone colour (Unexposed)	Light yellow
No. of root eye rows	Two
Arrangement (regular/irregular)	Irregular, regular in some
Bud size (B/M/S)	Small
Bud shape (Artswager)	Ovate
Bud cushion (P/A)	Absent
Bud gempore position (A/M/Sub M)	Apical
Bud groove (P/A)	Extending to half of the internode
Growth ring colour	Purplish green
Leaf width	5.0 cm
Leaf length (of 1 <sup>st</sup> transverse leaf at 180days)	150 cm
Lamina colour (LG/G/DG)	Light green
Leaf carriage shape	Open drooping
Leaf sheath colour	Purplish green
Leaf sheath waxiness (L/M/H)	Light
Leaf sheath spines (A/SM/SF/HM/HF)	Moderate
Leaf sheath clasping (ST/ET/TT)	Loose

**Table 3 Continued**

<b>Characteristic</b>	<b>Description</b>
Dewlap colour (at 10 month)	Purplish red
Ligule (P/A)	Deltoid lozenge
Shape of the auricle	Transitional on one side and L shaped on other side
Flowering	30%
Erectness	Non lodging
Distinguishing morphological characters	Purple heavy wax coated canes with open drooping leaves, purple red dewlap, moderate spines and short lanceolate ligular process on both sides

grown midlate variety of the zone, for sugar yield, cane yield and sucrose % juice. It is expected that this variety will improve sugarcane and sugar productivity in all the agro-ecological regions of Tamil Nadu.

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