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SHORT COMMUNICATION

Co 16030: a new improved sugarcane variety for North West Zone of India

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Abstract

The focus of sugarcane improvement programs in India has been on the cultivation of improved varieties for diverse agro-ecological regions. The inclusion of mid-late maturing varieties along with early maturing varieties, enables strategic planning of sugarcane varieties across the zones, ensuring prolonged and an efficient operation of sugar mills. In view of this, ICAR-Sugarcane Breeding Institute, Regional Centre, Karnal has developed a mid-late maturing sugarcane variety Co 16030 (Karan-16) for commercial cultivation in sugarcane growing states of North West Zone. Co 16030 was tested in nine locations of the North West Zone (NWZ) of India along with three standards CoS 767, CoPant 97222 and Co 05011 during 2019-20 to 2021-22. The variety exhibited significant performance over the standards Co 05011, CoPant 97222 and CoS 767. In the AICRP(S) trials, it recorded a cane yield of 94.97 t/ha^{-1}, sucrose content of 17.90% and sugar yield of 11.96 t /ha^{-1} at 360 days. The variety exhibited resistant to moderately resistant reaction against red rot (CF8 and CF9) and was susceptible to the major insects. Karan-16 was identified for notification by the variety release committee of AICRP (Sugarcane) held at ICAR-Indian Institute of Sugarcane Research, Lucknow during October 14 & 15, 2022 and was notified for release in the zone, vide Gazette notification No. S.O. 4222(E) dated 23 September 2023.

Keywords: Co 16030; Sugarcane variety; Mid-late; Sub-tropical climate; North Western Zone; High-yielding

Introduction

The effective utilization of the inherent genetic variation within the existing gene pool is fundamental to any crop improvement programme. Sugarcane, being a complex polyploid, exhibits a considerable level of genetic diversity present in the cultivated varieties, genetic stocks, species level clones, and related genera (Aitken and Mc Neil, 2010; Hemaprabha and Ram 1997; Govindaraj et al. 2014; Durai et al., 2019). Utilization of this genetic variation has led to the development of numerous improved sugarcane varieties characterized by higher yields and sugar content, tailored to various sugarcane growing region across India (Anonymous, 2016& 2017). In the sub-tropical India, there has been notable enhancement in the overall sugar and cane yield in the zone. However, the continuous cultivation of a single variety for a long period without proper replacement of healthy seed lead to 'Vertifolia effect' and varietal break down. Hence, incorporation of novel genes and gene combinations, coupled with overall increase in variability within cultivated clones, offers a promising prospect for identifying the genotypes resistant against red rot along with high sugar and cane yield capabilities. The sugarcane breeding program at ICAR-Sugarcane Breeding Institute, Regional Centre, Karnal has led to development of many high yielding and high sugar varieties suitable for North West Zone of the country. Among them, early varieties like Co 0118, Co 0238 and Co 15023 are being cultivated in more

than 80% area of the zone. The mid-late group varieties like Co 05011, Co 13035 and Co 16030 are also gaining popularity in the zone. To sustain the sugar industry and farmers, it is recommended to maintain the varietal balance under sub-tropical climate. This entails allocation of 40% area to early varieties and remaining 60% area under mid and late maturing varieties in each zone (Ram, 2010). The current study is on recently developed high yielding sugarcane Co16030 which had reported a greater economic advantage (almost 12.14% improvement for cane yield and Rs. 4160 additional income to best standard Co 05011) over the check varieties.

Materials and methods

The bi-parental crossing was initiated at National Hybridization Garden (NHG) in 2008-10 and fluff was raised and seedlings were transplanted and ratooned during 2009-10. Seedlings were screened for NMC, stalk length, stalk diameter, morphological traits & HR brix in ground nursery and elite clones were selected for planting in first clonal (C_1) trial during 2010-11.The clone Co 16030 was given as seedling no. K07-471. In the first clonal trial, good performing clones based on quality exhibiting a mean HR brix value more than 18 % during October, were selected based on other morphological traits and forwarded to preliminary trial for evaluation against red rot, quality and cane yield parameters. Similarly, best performing clones were selected and planted under pre-zonal varietal trial (PZVT) during 2015-16. The best performing clones based on morphological traits, cane quality, yield and red rot resistance were selected for assigning Co-cane status. The genotype was recommended for inclusion in multi-location testing under All India Co-ordinated Research Project (Sugarcane) designated as Co 16030 under the mid-late category. The entry Co 16030 was tested under AICRP (Sugarcane) trials in nine locations during 2019-20 to 2021-22 (IVT to AVT-II Plant & Ratoon). Agronomic trial was also conducted to assess the overall performance of the clones under recommended culture practices. After initial varietal trial, advanced varietal trial comprising two plant and one ratoon crops, involving test entries CoLk 16203,CoLk 16204, CoS 16232 and CoS 16233 were tested along with three standard varieties Co 05011, CoPant 97222 and CoS 767.

The experiment was laid out in RBD design with three replications and plot size of 8 rows of 6 meter and inter-row spaced of 0.90 m was maintained. Recommended agronomic practices were followed as per the technical programme. The observation on cane quality and yielding traits including number of millable canes (NMC), single cane weight (SCW), stalk length, stalk diameter, Brix%, sucrose % in juice, purity%, fibre%, CCS% and CCS (t/ha) were recorded following the prescribed procedure. Statistically analyzed (RBD) data collected from various locations was published in the Principal Investigator's report- Varietal improvement programme. Variety Co 16030 was characterized based on DUS testing norms for 27 morphological characters (Singh et. al, 2017). The molecular profiling of Co16030 was conducted using NKS 2, NKS 3, NKS 5, NKS 6, NKS 8, NKS 9, NKS 31, NKS 38, NKS 40, NKS 48, NKS 57, and NKS 68 primers before proposing the variety for identification.

Results and discussion

The experimental trials of Co 16030 (Karan-16) were conducted at nine locations in the North West Zone of AICRP (Sugarcane). Over the course of the trial during 2019-20 and 2021-23 seasons, performance of two plant and one ratoon crops were examined at these locations. The test entry was assessed for cane yield and yield component traits, as well as quality parameters such as sugar

and fibre content. In addition, evaluation was made for ratoonability and reaction to major diseases and pests, along with general agronomic traits.

Performance of Co 16030 in the NWZ (North West Zone) trials of AICRP (S)

The trials of Co 16030 were conducted at 9 locations in the AICRP(S) program in the North West Zone of the country during 2019-20 to 2021-22 for two plant and one ratoon crop along with four other entries and three standards. Co 16030 emerged as the best entry combining high cane yield and quality. Cane yield and its components such as NMC, SCW, stalk length and diameter were studied in all the tested entries in comparison to standards. The mean cane yield of Co 16030 in all the location was 94.97 t/ha. The percent improvement for cane yield over the standards CoS 767, CoPant 97222 and Co 05011 were 17.60, 13.85 and 12.14% respectively. The mean NMC of entry Co 16030 was 88.25 ('000/ha) and statistically at par with the standardCoPant 97222 (87.06 ('000/ha). Similarly, for single cane weight, the mean SCW of Co 16030 was 1.46 kg, the improvement over the standards CoS 767, CoPant 97222 and Co 05011 were 13.98, 11.97 and 12.43% respectively.

The overall performance of the entry Co 16030 was 94.97 t/ha^{-1}cane yield, 17.90 % sucrose and 11.96 t/ha^{-1} sugar yield at 360 days (Table 1.) The percent increase over the standard Co 05011 for cane yield, sucrose % and sugar yield were 12.14, -2.49 and 9.18 respectively. Consistent higher yields of Co 16030 under varied agro-climatic conditions across the zone indicates it's wider adaptability and stability in yield and quality performance. It is a good ratooner and recorded 13.89 % pol in cane. The field view of the Co 16030 is presented in Fig 1.

Figure 1. Field view of Co 16030 (Karan-16)

Table1. Comparative performance of Co 16030 in AICRP(S) trials for cane yield and juice quality along with standards at 12 months

Entry	CCS (t/ha^{-1})	Cane yield (t/ha^{-1})	Sucrose %	Pol % in cane
Co 16030	11.96	94.97	17.90	13.89
Standards				
CoS 767	9.91	80.71	17.59	13.56
CoPant 97222	10.57	83.32	18.30	14.12
Co 05011	10.94	84.57	18.36	14.00
Percent improvement over standards				
CoS 767	20.55	17.60	1.79	1.51
CoPant 97222	13. 01	13.85	-2.18	-0.95
Co 05011	9.18	12.14	-2.49	-0.45

* Mean value for the parameters averaged over the 9 locations for 2 plant crops and 1 ratoon crop

Co 16030 (Karan-16) has been notified for cultivation in North West Zone of India comprising the states of Haryana, Punjab, Rajasthan, Uttarakhand, Central and Western Uttar Pradesh as mid-late maturing variety in the 90th meeting of Central Sub-Committee on Crop Standards' Notification and Release of Varieties for Agricultural Crops, Government of India, vide Gazette notification of India (S.O.No. 4222(E) dated 23th Sept 2023). Co 16030 is evolved from the cross Co 0238 x Co 8347 (Seedling no K07-471)effected at ICAR-Sugarcane Breeding Institute, Coimbatore and further evaluation at Regional Centre, Karnal (Haryana). This variety combines high cane yield and red rot resistance along with medium sucrose content at harvest stage of the crop. The variety exhibited notable performance over standards Co 05011, CoPant 97222 and CoS 767 in the AICRP(S) trials. The centre wise details of performance for CCS t/ha is given in table 2. It has showed 23.56%, 23.36% and 10.94% improvement for with respect to the standards CoS 767, Co Pant 97222 and Co 05011 respectively.

Reaction to pests and diseases

The standard procedure for screening were adopted in the field for artificial inoculation and screening against the prevalent races of red rot pathogens *C. falcatum*(Cf 08 and Cf 09) particular to the zone. Co 16030 exhibited 'Resistant' (R) to 'Moderately Resistant' (MR) reactions to both cotton swab and plug methods of inoculation at the most of the locations (Table 3). Based on natural incidence, Co 16030 was rated as R/ MR for yellow leaf disease (YLD) and R/MR for smut. No natural incidence of grassy shoot disease (GSD) was observed in Co 16030 at all the tested locations. Co 16030 was recorded as 'least susceptible' against the top borer, stalk borer and shoot borer pests in the zone.

The proposed clone combines resistance to red rot and other major diseases. Co 16030 emerge as superior alternative to Co 05011, which has succumbed to wilt and smut diseases in the region. It promises to enhance overall cane yield and generate higher income for farmers, thereby ensuring the sustainability if the sugar industries in the North West Zone.

Table 2. Centre-wise performance of Co 16030 for CCS yield (t/ha) at harvest in AICRP(S) trials in North West Zone

Parameters	Entry	Faridkot	Kapur thala	Karnal	Kota	Lucknow	Muzaffar nagar	Pant nagar	Shahjah anpur	Mean
Pooled mean of CCS t/ha	**Co 16030** Standards	12.41	10.88	17.48	10.79	11.31	11.37	12.07	12.33	11.97
	CoS 767	10.55	10.39	10.87	8.78	9.10	9.47	7.36	10.19	9.69
	CoPant 97222	11.92	9.07	13.04	9.20	10.83	9.91	10.62	10.29	10.56
	Co 05011	13.78	10.68	13.53	10.29	9.31	10.42	9.46	10.28	10.79
% Improvement over	CoS 767	17.60	4.68	60.76	22.90	24.25	20.10	63.99	20.97	23.56
	CoPant 97222	4.08	19.92	34.01	17.25	4.40	14.80	13.65	19.79	13.36
	Co 05011	-9.94	1.81	29.23	4.86	21.49	9.11	27.59	19.87	10.94

Table 3. Red Rot reaction of Co 16030 in AICRP(S) trial

Location	Proposed Variety Co 16030				ZS1: CoS 767				ZS2: CoPant 97222				ZS3/Latest release variety: Co 05011			
	AVT (Midlate) I Plant (Year: 2020-21)															
	Plug method		Cotton Swab		Plug method		Cotton Swab		Plug method		Cotton Swab		Plug method		Cotton Swab	
	CF08	CF09	CF08	CF09	CF08	CF09	CF08	CF09	CF08	CF09	CF08	CF09	CF08	CF09	CF08	CF09
Kapurthala	MR	MR	R	R	HS	HS	S	S	MR	MR	R	R	MR	MR	R	R
Karnal	R	MR	R	R	S	MR	S	R	MR	MR	R	R	MR	MR	R	R
Lucknow	MS	MS	R	R	HS	S	-	-	-	-	-	-	-	-	-	-
Pantnagar	MR	MR	R	R	S	S	R	R	MS	MR	R	R	MR	MR	R	R
Shahjahanpur	MR	MR	R	R	HS	HS	S	S	MR	MR	R	R	MR	MR	R	R
Uchani	MR	MS	R	R	HS	HS	S	S	MR	MR	R	R	MR	MR	R	R
AVT (Midlate) II Plant (Year: 2021-22)																
Kapurthala	MR	MR	R	R	HS	MR	S	R	MR	HS	R	S	MR	HS	R	S
Karnal	MR	MR	R	R	-	-	-	-	MR	HS	R	S	MR	HS	R	S
Lucknow	MS	MS	R	R	-	-	-	-	-	-	-	-	-	-	-	-
Pantnagar	R	MR	R	R	S	MS	R	S	S	S	S	R	MS	MS	R	S
Shahjahanpur	MR	MR	R	R	HS	MR	S	R	MR	HS	R	S	MR	S	R	S
Uchani	MR	MR	R	R	HS	MR	S	R	HS	HS	R	S	MR	HS	R	S
Kapurthala	MR	MR	R	R	HS	MR	S	R	MR	HS	R	S	MR	HS	R	S

Distinguishing characteristics and molecular profiling

This variety has distinct morphological features presented in Figure 2; and also important distinct characteristics based on the DUS testing norms (Meena et al., 2018; Table 4.). It has tall, semi erect, medium thick light wax coated canes with greyed brown colour long obconoidal internodes, smooth rind surface appearance and with ivory marks below nodes. It has yellowish green dewlap, arched canopy with broad leaves and sheath with no spines and semi-clasping nature. The other characters are ovate, medium sized buds with bud cushion, bud tip touching the growth ring, deltoid ligule, deltoid inner auricle incipient outer auricle ,growth ring is not swollen. The molecular profiling of this variety was generated using STMS markers (Fig 3.), and distinct banding pattern observed specifically for this test variety. The National Active Germplasm at ICAR-Sugarcane Breeding Institute, Coimbatore, assigned the index number SBI/2022/Co 16030/306 to the variety. National Identity Number, IC 647640 was allotted to the variety by ICAR-NBPGR, New Delhi. Subsequently, this variety was officially notified for release by the Central Sub-Committee on Crop Standards' Notification and Release of Varieties for Agricultural Crops, Government of India, vide Gazette notification of India (S.O.No. 4222(E) dated 23th Sept 2023).

Figure 2. Morphological feature of sugarcane variety Co 16030

Significance and suitability of variety to the present conditions

The persistent practice of cultivation of a single major variety in the sugar mill area posses a significant risk of red rot disease in the zone, leading to growing concern among the farmers. To

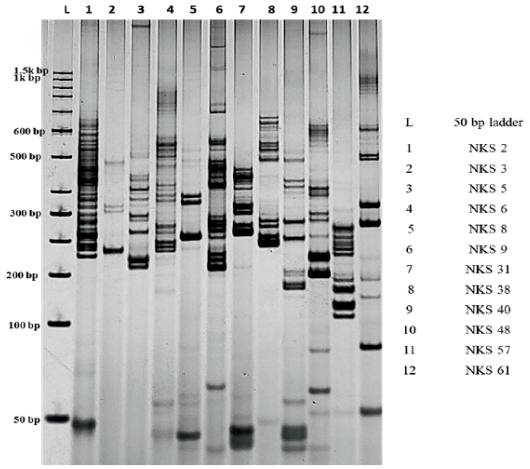

Figure 3. Molecular Profile of Co 16030 using STMS Markers

Table 4. Distinct DUS Description of Co 16030 (Karan 16)

Sl. No	Descriptor	Descriptor state as per DUS guidelines
1	Plant Growth Habit	Erect
2	Leaf Sheath Hairiness	Absent
3	Leaf sheath: Shape of ligule	Deltoid
4	Leaf sheath: Shape of inner auricle	Deltoid and outer incipient
5	Leaf sheath: Colour of dewlap	Yellow Green (N144A)
6	Leaf blade: Curvature	Arched
7	Leaf blade: Width (cm)	5.2 cm
8	Plant: Adherence of leaf sheath	Semi -clasping
9	Internode colour (not exposed)	Yellow Green (151C)
10	Internode colour (exposed to sun)	Greyed Brown (199 A)
11	Internode diameter (cm)	Medium (2.7 cm)
12	Internode shape	Obconoidal mostly
13	Internode: Zig -zag alignment	Present
14	Internode: Growth crack (split)	Absent
15	Internode: Rind surface appearance	Mostly smooth (Light corky patche s are present in few internodes)
16	Internode: Waxiness	Light
17	Internode: Shape of bud	Mostly Oval
18	Node: Size of bud (cm)	Medium (0.80 cm)
19	Node: Bud groove	Absent
20	Node: Bud cushion	Presen t
21	Node: Bud tip in relation to growth ring	Touching GR
22	Node: Prominence of Growth Ring	Not swollen
23	Node: width of root band (cm)	Medium (0.9 cm)
24	Internode: Cross section	Round
25	Internode: Pithiness	Present light
26	Plan t : Number of millable canes (NMC) / stool	Medium (5.00)
27	Plant: Cane height (cm)	Medium (245.00 cm)

address this issue, implementation of well-thought-out varietal planning that include a proper mix of early and mid-late varieties becomes crucial in the sugarcane breeding program. It is advisable for sugar mill to maintain a proper balanced ratio, preferably 40:60 under early and mid-late maturing varieties, to ensure the sustainability of the sugar industry. Cultivation of mid-late varieties offers the advantage of an extended harvesting window, allowing more flexible scheduling for both the sugar industry and farmers, when weather condition, labour availability and logistic obstacles, which may otherwise disrupt the timely harvesting operation of the crop.

Considering higher cane yield advantage of Co 16030 and susceptibility of dominant variety Co 0238 in the zone could be of the region for release of a mid-late maturing variety in the zone. Additionally Co 16030 is derived from Co 0238 x Co 8347 and it showed moderately resistant (MR) reaction against the reed rot pathotypes CF13.

This high yielding variety with excellent crop performance in the zone may serve as a suitable substitute for existing mid-late varieties under cultivation i.e. CoS 767, CoPant 97222 (succumbed to red rot in the zone) and Co 05011 (succumbed to wilt).Co 16030 is poised to contribute to increased cane yield and enhanced revenue for the farmers, thereby ensure the sustainability of the sugar industries in the Zone.

Considering the above results, the variety Co 16030 (Karan-16) emerged as most suitable mid-late maturing variety for the North West Zone among all test entries. Over the years, sugarcane breeding extensively relied on existing variability within population, complemented by other interventions (Nair, 2014; Meena, et al .,2024). A well-designed varietal planning strategy, incorporating a balanced mixture of early and mid-late maturing varieties, remains as an essential component of sugarcane development programs for the sugar industry. Red rot, a significant disease in sugarcane, results in considerable economic losses if not managed effectively (Viswanathan, 2018). Co 16030 exhibiting a MR to R reaction to red rot and least susceptible to major insects, present a promising solution to tackle this challenge. Additionally, its commendable performance in ratoon crops provides an added advantage, particularly considering the substantial proportion of sugarcane cultivation in the country devoted to ratoon crops. Based on DUS descriptors, this variety exhibits highly distinct characteristics compared to its reference varieties. The molecular profiling using STMS markers revealed its unique and distinct pattern will aid in the timely detection and prevention of varietal mixture in farmer's fields.

Conclusion

North-West Zone is an important sugarcane growing zone of the country, which confronts various biotic and abiotic stresses during the crop period. The recent outbreak of red rot in the popular variety Co 0238 has created a wide spread disruption among the farmers and sugar industry, prompting an urgent search for suitable alternatives. This zone is actively seeking on utilization of innovative technologies and high-yielding and high sugar varieties. Co 16030 is a high yielding mid-late maturing variety, and may play a pivotal role in enhancing the productivity, profitability and sustainability of sugarcane cultivation in the NWZ.

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