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RESEARCH ARTICLE

PERFORMANCE OF PROMISING EARLY VARIETIES OF SUGARCANE (*SACCHARUM SPP. HYBRID COMPLEX*) AND THEIR ROLE TO BOOST SUGAR INDUSTRY UP IN WEST BENGAL, INDIA

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ABSTRACT

Sugarcane provides raw materials to the sugar industry (Khaitan India Ltd located at Plassey, Nadia) in West Bengal having very low cane crushing ability (69,000 Metric Ton) & recovery (5.1%) during 2017-18 leading to poor paying capacity to farmers. The main objective of this study is to introduce the newly released promising varieties of sugarcane with high sucrose and high recovery of commercial cane sugar and further testing of the varieties most suitable for this region. Replacing the existing old varieties like BO 130 and promoting early promising varieties is in urgent need to boost up the sugar industry is also one of the important objectives of this study. In this context, a field experiment was conducted during 2017-'18 and 2018-'19 crop season at Sugarcane Research Station, Bethuadahari, Nadia, West Bengal, India to assess the performance of promising early varieties of Sugarcane on yield and quality of juice. The experiment was laid out in randomized complete block design with five early varieties (viz. CoLk 94184, CoSe 01421, Co 0232, CoB 99161 &CoSe 95422) and BO 130 as check with four replications. The data were recorded on single cane weight, number of millable canes, cane yield, brix (%), sucrose (%), Commercial Cane Ssugar(CCS%) and CCS yield. There were significant difference among the varieties for yield and yield attributing characters. Pooled analysis of the results showed that the early variety CoLk 94184 recorded the maximum Commercial Cane Sugar (CCS) yield (10.23t/ha) followed by CoB 99161, CoSe 95422, CoSe 01421 and Co0232, whereas minimum CCS yield (6.28t/ha) was found with the standard variety BO 130. Therefore, the replacement of the existing standard varieties with the promising new early varieties would be most economic and profitable and can easily boost up the sugar factory by increasing the recovery (%) and able to produce sugar of improved quality.

KEYWORDS

Performance, Sugarcane Variety, Sucrose, Commercial Cane Sugar, Sugar Industry.

1. INTRODUCTION

Sugarcane (*Saccharum spp*. hybrid complex) is an important commercial C4 crop, belonging to Poaceae family and Andropogoneae tribe, cultivated in the tropical & sub-tropical regions globally and contribute to 75% of the worlds sugar production (Wang et al., 2010). India is the largest producer as well as consumer (about 25 million Metric ton) of sugar. It was not only provided raw materials to sugar industry, but also used as raw material in thousands of cottage industries like jaggery (gur) & khandsari, situated in rural areas. By products from sugar industry viz. molasses, bagasses and press mud serve as raw material for production of alcohol, /paper and bio-manures respectively. Sugar industry also provides livelihood security to 4% rural population by generating significant employment in ancillary and allied activities (Anonymous 2011).

Sugarcane (Ikshu/Aakh) is a traditional crop and making gur (jaggery) is also a traditional agro based cottage industry in West Bengal. There is only one sugar mill (Khaitan India Ltd located at Plassey, Nadia) in the state having very poor cane crushing ability (69,000 Mt) and recovery (5.1%) leading to poor paying capacity to farmers. In spite of that, it has an area of 17,000 hectares with average yield of 76.10 ton per hectare and total production of 12,94,000 Mt during 2017-18 (Anonymous, 2018). It is grown almost all the districts except hill areas with old varieties. Murshidabad, Nadia, Birbhum, North 24 Parganas, Paschim Medinipur, Malda, are the major sugarcane growing districts of this state. The production and productivity of sugarcane is under threat due to the worldwide changing climatic condition such as extreme temperature, drought and uncertain & uneven distribution of rainfall. Being a long duration crop, sugarcane cultivation is challenged by various biotic and abiotic stresses.

The yield of sugarcane crop was drastically declining from 118.77 Mt ha^{-1} to 84.49 Mt ha^{-1} from 2014-15 to 2018-19 crop season in West Bengal (Department of Agriculture, GoWB. 2018-19). The efficiency of sugar industry is mainly depended upon the availability of improved sugarcane varieties with better juice quality and tolerance to biotic and abiotic stresses. Lack of improved sugarcane varieties with higher sucrose and commercial cane sugar % among the sugarcane growers were the main limiting factor for less cane crushed and poor recovery %. So, replacing the existing old varieties like BO 130 and promoting early promising varieties is in urgent need to boost the sugar industry up in this state. In view of the above, the performance of promising early varieties of sugarcane and their role to boost sugar industry up in West Bengal acquired significant scope for study. The said experiment not only enhance the cane crushing ability

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of the industry but also able to increase the recovery % which ultimately promote socio economic development of the sugarcane growers of this state.

2. Materials and Methods

The experiment was conducted at the research farm of Sugarcane Research Station, Bethuadahari, Nadia, West Bengal, India for two consecutive years during 2017-'18 and 2018-'19 crop season. The experimental site was located at the longitude of 88^{0}22' 22"E and 23^{0}36' 54"'N latitude with 15 m altitude from mean sea level. The soil of the experimental field was sandy loam in texture with pH 7.2, EC 0.32 dcm^{-1}. The experiments involving five varieties (viz. CoLk 94184, CoSe 01421, Co 0232, CoB 99161 & CoSe 95422) and BO 130 as check of early maturing group (300 days). These varieties were laid out in Completely Randomized Block Design with 4 replications and were planted in east-west direction (rows) during spring (Feb-March). The date of planting during 2017-18 and 2018-19 crop seasons were 15th March, 2017 and 13th March, 2018 respectively.

The plot size was 6m length of 8 rows & 75cm inter row space with 3 budded setts @ 12 buds per meter. The standard package & practices for raising good crops were followed (Sundara, 1998). All the five promising varieties and standard were recommended for commercial cultivation in west Bengal and the details are given below (Table 1). The following observations, such as cane yield (t/ha) after 10 months at harvest, number of millable canes (NMC) (thousand/ha) after 10 months at harvest, Single cane weight (kg) after 10 months at harvest, Brix % at 8 & 10 months, sucrose % in juice at 8 & 10 months, purity % at 8 & 10 months, Commercial Cane Sugar (CCS) % at 8 and 10 months and CCS (t/ha) after 10 months at harvest were recorded.

Commercial Cane Sugar (CCS) yield was calculated from cane yield and CCS%. The cane yield recorded in test plots were converted into quantity(tonne) per hectare. Data were also recorded for number of millablecane (NMC) on plot basis and converted into thousands per hectare. Five canes were randomly selected from each plot at harvest (300 days after planting) for recording data of single cane weight and crushed them in a manual crusher and was clarified using lead sub acetate and juice was analysed as per standard methods (Meade and Chen, 1977). CCS% was worked out based on the formula;

CCS (%) = {S-(B-S) x 0.4} x 0.73, Where S is Sucrose % in juice and B is corrected Brix % (Cheng and Chen, 1993).

The data were statistically analysed for various characters as described and values within a column followed by the same letter are not significantly different at $p< 0.05$ using Duncan multiple range test (Panse and Sukhatme, 1985).

Table 1: Details of the sugarcane varieties used as experimental materials.

Name of Variety	Maturity Group	Year of Release and Notification	Cane Yield (t/ha)	Sucrose in Juice (%)	Reaction to Diseases & Insect-Pests.	Special Characters
CoLk94184 Birendra	Early	2008 2458(E)	76.00	18.00	MR to red rot.	Tolerant to drought & water logging. Good ratooner.
CoSe01421 Imarti	Early	2013 2817(E)	65.87	17.36	MR to red rot, smut & wilt.	Good ratooner.
Co0232 Kamal	Early	2009 454(E)	67.82	16.51	MR to red rot. Tolerant to top borer.	Tolerant to water logging & early drought.
CoB99161 Swapan	Early	SVRC released in 2015	88.00	16.8	MR to red rot & smut.	Non lodging. Tolerant to water submergence & drought.
CoSe95422 Rashbhari	Early	2001 1134(E)	67.80	17.66	MR to red rot.	Suitable for normal irrigation condition.

Co = Coimbatore (Tamil Nadu), B = Bethuadahari (West Bengal), Lk= Lucknow (Uttar Pradesh) Se = Seorahi (Uttar Pradesh), BO = Bihar Orissa, MR = Moderately Resistant.

Crop duration: Early (300 days) (Source: Shukla et al., 2018)

3. Results

Performance of promising early varieties of sugarcane on important quantitative and juice quality parameters during 2017-18, 2018-19 and the pooled data of two plant crops were presented in Table 2 and Table 3 respectively. There was significant difference among the varieties for yield and yield attributing characters.

3.1 Commercial cane sugar (CCS) yield(t/ha)

Pooled analysis of the results showed that the early variety CoLk 94184 recorded the maximum Commercial Cane Sugar (CCS) yield (10.23t/ha) followed by CoB 99161, CoSe 95422, CoSe 01421 and Co0232, whereas minimum CCS yield (6.28t/ha) was found with the standard variety BO 130 (Table 2). All the test varieties recorded significantly higher CCS yield over the standard variety BO 130during crop season 2017-18 and 2018-19 and also in pooled value of the crop seasons.

3.2 Cane yield(t/ha)

The variety CoB 99161 was recorded highest cane yield i.e. 86.14t/ha & 87.18t/ha during 2017-18 and 2018-19 crop season respectively. Pooled data of all the five test varieties viz. CoB 99161(86.66t/ha), CoLk 94184(79.35t/ha), CoSe 01421(73.20t/ha), CoSe 95422(71.09t/ha) and Co 0232(69.66t/ha) showed significantly higher cane yield as compared to the standard variety BO 130(59.76t/ha).

3.3 Number of millable cane (NMC)('000/ha)

Pooled analysis data presented in Table 2, showed that maximum NMC('000/ha) was recorded in variety CoB 99161(144.09) followed by CoLk 94184(138.76), CoSe 95422(118.26), CoSe 01421(112.45) and Co 0232(111.58) whereas minimum was found in standard variety BO 130(99.32).

Table 2: Quantitative characters of sugarcane varieties during 2017-18, 2018-19 and pooled data of two crop season.

Name of the Variety	2017-18				2018-19				Pooled of Two Crop Season			
	Single Cane Weight (kg)	NMC ('000/ha)	Cane Yield (t/ha)	CCS Yield (t/ha)	Single Cane Weight (kg)	NMC ('000/ha)	Cane Yield (t/ha)	CCS Yield (t/ha)	Single Cane Weight (kg)	NMC ('000/ha)	Cane Yield (t/ha)	CCS Yield (t/ha)
CoLk94184	0.726bc	141.11a	83.70à	10.91a	0.810a	136.42a	75.01b	9.56a	0.768a	138.76a	79.35b	10.23a
CoSe01421	0.762ab	113.42a	74.28a	8.46cd	0.751ab	111.48b	72.13b	8.17b	0.756a	112.45b	73.20bc	8.31b
Co0232	0.636de	108.51b	69.47ab	8.04d	0.642cd	114.66b	69.85b	8.06b	0.639bc	111.58b	69.66c	8.05b
CoB99161	0.795a	143.26c	86.14bc	10.01b	0.803a	144.93a	87.18a	10.04a	0.799a	144.09a	86.66a	10.02a
CoSe95422	0.678cd	125.80cd	81.09c	9.47bc	0.691bc	110.73b	61.09c	7.17c	0.684b	118.26b	71.09c	8.32b
BO130 (Standard)	0.607e	99.85d	59.31d	6.22e	0.612d	98.79c	60.22c	6.34d	0.609c	99.32c	59.76d	6.28c
SEm(±)	0.02	3.80	2.29	0.28	0.02	3.74	2.14	0.26	0.02	3.77	2.21	0.27
CD at 5%	0.06	11.44	6.91	0.86	0.06	11.28	6.44	0.78	0.06	11.36	6.67	0.82
CV	5.83	6.23	6.06	6.44	6.09	6.26	6.03	6.33	5.97	6.24	6.04	6.38

Values within a column followed by the same letter are not significantly different at $p< 0.05$ using Duncan multiple range test

3.4 Juice quality parameters

The sugarcane juice analysis done at harvest (300 days after planting) as indicated by Sucrose%, Brix%, and CCS% (Table 3) revealed significant difference among the varieties. Pooled analysis data of two consecutive crop season during 2017-18 and 2018-19 showed that maximum CCS% recorded in variety CoLk 94184(12.89%) followed by CoSe 95422(11.71%) was significantly higher than other varieties and minimum in standard variety BO 130(10.51%). Highest sucrose% found in variety CoLk 94184(18.51%) followed by CoSe 95422(16.91) were significantly better than other varieties and the lowest found in the standard variety BO 130(15.18%).

Table 3: Qualitative characters of sugarcane varieties during 2017-18, 2018-19 and pooled data of two crop season.

Name of the Variety	2017-18				2018-19				Pooled of Two Crop Seasons			
	Brix (%)	Sucrose (%)	Purity (%)	CCS (%)	Brix (%)	Sucrose (%)	Purity (%)	CCS (%)	Brix (%)	Sucrose (%)	Purity (%)	CCS (%)
CoLk94184	20.86^{a}	18.71^{a}	89.73^{a}	13.03^{a}	20.45^{a}	18.32^{a}	89.63^{a}	12.75^{a}	20.65^{a}	18.51^{a}	89.68^{a}	12.89^{a}
CoSe01421	18.67^{bc}	16.49^{bc}	88.37^{a}	11.40^{bc}	18.47^{b}	16.38^{bc}	88.73^{a}	11.34^{bc}	18.57^{bc}	16.43^{bc}	88.55^{a}	11.37^{c}
Co0232	18.75^{b}	16.69^{b}	89.05^{a}	11.58^{b}	18.68^{b}	16.64^{bc}	89.11^{a}	11.55^{bc}	18.71^{bc}	16.66^{bc}	89.08^{a}	11.56^{c}
CoB99161	18.80^{b}	16.76^{b}	89.16^{a}	11.63^{b}	18.74^{ab}	16.63^{bc}	88.75^{a}	11.52^{bc}	18.77^{bc}	16.69^{bc}	88.95^{a}	11.57^{c}
CoSe95422	19.25^{ab}	16.93^{b}	87.98^{a}	11.68^{b}	18.88^{ab}	16.89^{ab}	89.46^{a}	11.74^{ab}	19.06^{ab}	16.91^{b}	88.72^{a}	11.71^{b}
BO130 (Standard)	17.01^{c}	15.13^{c}	88.97^{a}	10.49^{c}	17.25^{b}	15.24^{c}	88.38^{a}	10.53^{c}	17.13^{c}	15.18^{c}	88.67^{a}	10.51^{c}
SEm(±)	0.57	0.51	-	0.36	0.57	0.51	-	0.35	0.57	0.51	-	0.35
CD at 5%	1.73	1.55	NS	1.08	1.71	1.53	NS	1.06	1.72	1.54	NS	1.07
CV	6.09	6.13	5.85	6.15	6.07	6.09	5.83	6.10	6.08	6.11	5.84	6.13

Values within a column followed by the same letter are not significantly different at $p< 0.05$ using Duncan multiple range test

4. Discussions

As sugarcane is an industrial crop, thus Commercial Cane Sugar (CCS) yield is the most important parameter. The main objective of any sugar industry is to increase the production of commercial cane sugar i.e. white sugar from sugarcane stalk. The CCS production can be enhanced through not only by increasing the cane yield but also equally important by increasing the sucrose% of sugarcane varieties. In this experiment, pooled analysis of the results showed that the early variety CoLk 94184 recorded the maximum Commercial Cane Sugar (CCS) yield (10.23t/ha) though the cane yield was highest in variety CoB 99161(86.66t/ha) because of highest sucrose % (18.51%). The variety CoLk 94184 recorded the maximum Commercial Cane Sugar (CCS) yield in Pusa & Motipur Centre, Bihar and Seorahi centre, Uttar Pradesh under North Central and Northeastern Zone under AICRP on Sugarcane published in Principals Investigator's Report, Varietal Improvement Programme, 2018-19.

It was also observed from the pooled analysis that all the five test varieties viz. CoB 99161(86.66t/ha), CoLk 94184(79.35t/ha), CoSe 01421(73.20t/ha), CoSe 95422(71.09t/ha) and Co 0232(69.66t/ha) showed significantly higher cane yield as compared to the standard variety BO 130(59.76t/ha). This is mainly due to the potentiality of those new varieties over the old prevailing varieties of West Bengal. The variety CoLk 94184 also recorded the maximum cane yield in Seorahi centre, Uttar Pradesh under North Central and Northeastern Zone under All India Coordinated Research Project (AICRP) on Sugarcane published in Principals Investigator's Report, Varietal Improvement Programme, 2018-19. Sugarcane yield was mainly a function of number millable canes available in the field and the composition of mother shoot, primary, secondary and tertiary tillers at the time of harvest. It is well known fact that higher number of mother shoots and initial tillers brings about higher cane yield.

In addition to the quantitative parameters, juice quality parameters as indicated by Sucrose%, Brix%, and CCS% are also equally important for sugar industry perspectives. Higher Sucrose% and CCS% are responsible for production of higher white sugar in any sugar industry. These juice quality parameters are highly influenced by the prevailing climatic condition. The variety CoLk 94184(12.89%) recorded highest sucrose% (18.51%) and CCS% (12.89%) followed by the variety CoSe 95422, sucrose% (16.91%) and CCS%(11.71%) were significantly higher than other varieties including check. This is mainly due to the tolerance of the varieties against climatic condition like drought, extreme temperature etc. The same phenomenon found in variety CoLk 94184 at Pusa & Motipur Centre, Bihar under North Central and Northeastern Zone under AICRP on Sugarcane published in Principals Investigator's Report, Varietal Improvement Programme, 2018-19.

5. Conclusion

It can be concluded that the performance of the existing variety BO 130 was very poor in terms of cane yield and juice quality parameters in the state of West Bengal. Thus the poor recovery % of this sugar industry was mainly due to this variety only. The result of the experiment clearly indicate the significant difference among the promising sugarcane varieties for sugar yield, cane yield and juice quality parameters. To achieve the sustained and increased production of white sugar in West Bengal, the variety CoLk 94184 is most suitable followed by CoB 99161, CoSe 95422, CoSe 01421 and Co0232. Therefore the replacement of the existing standard variety(BO 91) with the promising new early varieties like CoLk 94184, CoB 99161, CoSe 95422, CoSe 01421 and Co 0232 would be most economic and profitable for commercial cultivation in the adjacent areas of the sugar mill in West Bengal for boosting up the sugar industry and socio economic development of the sugarcane growers. The varietal replacement can easily boost up the sugar factory by increasing the recovery (%) and also changing into "Bio-refinery" or "Agri Business Complex" and able to produce sugar of improved quality. The future of this industry determine the livelihoods of thousands of farmers and able to create direct and indirect employment opportunities in this state.

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