



## Research Article

# SUGAR RICH IMPROVED VARIETIES FOR SUSTAINABILITY OF SUGAR INDUSTRY

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**Abstract:** One of the major strategies to enhance sugarcane and sugar productivity in the sub-tropical India is to select elite sugarcane clones having high sucrose content and a longer tillering duration for commercial cultivation and their scientific harvesting schedule. A study was conducted at The Uttar Pradesh Council of Sugarcane Research, Shahjahanpur to assess the sucrose content of five early maturing and five mid-late maturing varieties. The varieties were harvested from the month of early crushing (October) to late crushing (April). The early varieties, CoS 8436, CoS 08272, CoSe 8231, Co 0238, and Co 0118 showed high percent sucrose, percent fibre and pol percent in cane in comparison to the mid-late varieties CoS 767, CoS 97261, CoS 08279, CoS 07250, and CoSe 01434. Percent juice sucrose of early maturing varieties was 12.9-16.9% during October, and gradually increased until April where the range was 20.1-21.2%. The sucrose percent in juice of mid-late maturing varieties was 13.5-14.7% in October, and increased to 18.9-19.7% in April. Although, the overall superiority of the early maturing varieties continued throughout the harvesting period and the mid-late maturing varieties showed promising performance equivalent to early maturing varieties from February onwards. Values for Pol percent cane showed a similar trend. Percent fibre of the early varieties was 12.4-13.2%, and increased by an average of 1.5 units by April in all the varieties. In mid-late maturing varieties, the percent fibre was 13-13.3% in October, and increased by 0.5-1.0 units by April. These results show that proper balance of the area under early and mid-late maturing varieties and their scientific harvesting schedule will improve sugar recovery in this part of the country.

**Keywords:** Early maturing, Mid-late maturing, Sugar, Varieties, Sugarcane, Sugar recovery, Harvesting schedule

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## Introduction

India is the second largest producer and top most consumer of the sugar in the world, but the industry lacks in sustainability and cyclic ups and downs of the sugar production have become the trademark of the sugar industry. However, sustained efforts on developing high yielding and high sugared varieties resulted into a turnaround in the situation in the state of Uttar Pradesh during the last couple of years. Crushing starts during October/November and lasts until March/April. The composition of varieties in the cane supply has a major impact on sugar recovery and total sugar production of this region. Sugarcane is considered to be mature and ready for harvest when the cane juice has over 16% sucrose and 85% purity. Varieties that attain this level at 10 and 12 months age if planted in January/February are classified as early and mid-late maturing types, respectively [1-3]. However, a compromise is made depending upon the accruing total revenue *pro vis a vis* cost of inputs. There is a need to assess the value of balance of area grown to improved early maturing varieties possessing high sugar contents. Studies by Singh *et al* [4] also emphasized that a proper balance of early and mid-late maturing sugarcane varieties is very important for longer crushing periods and sugar recovery. The availability of adequate amount of good quality sugarcane during the crushing season is the major factor for the low cost of production of sugar and profitability of the sugar industry. For increasing productivity of sugarcane and production of sugar besides use of scientific package of practices Varietal scheduling helps cane growers and cane managers in determining the allocation of land to different varieties, their plant and ratoon crops and in planning the harvesting and crushing schedule during the peak ripening curve of varieties covering the possible crushing period to provide economic return to both growers and millers.

Recently, several improved early and mid-late maturing varieties have been developed through varietal improvement programme by different research institutes. The sucrose% of these elite early maturing varieties is found to increase across the crushing season [Table-3]. Though the area under such early maturing varieties has increased in 2015-16, which resulted in the enhanced recovery of the state, however, there is still scope for increasing the area of early maturing varieties and completely discarding the area under rejected varieties [Table-2]. The proper varietal planning of early and mid-late maturing varieties and harvesting schedule [Table-1] together for the target area may help to a great extent in sustaining the sugar production also. The efficiency of the sugar industry is mainly dependent on the production and availability of good quality cane in adequate quantity. Hence the quality of sugarcane is of paramount importance carrying proper recommended scientific harvesting schedule and in achieving a uniform high sugar recovery throughout the crushing season in order to meet the domestic and export requirements of sugar and sugar based sweeteners with economic viability of the sugar industry [5,6]. Now there is increasing demand only for early and mid-late ripening varieties. This will make the crushing by the factories more profitable from October to April and this is the urgent need of the industry today. Selection of appropriate early and mid-late varieties can increase the sugar recovery. The present study was carried out to evaluate sugarcane cultivars for sugar recovery in the sub-tropical region of northern India to assist in guiding the appropriate balance of varieties for the region.

## Materials and Methods

The study was conducted at Council of Sugarcane Research, Shahjahanpur, Uttar Pradesh, India (sub-tropical region) during the 2015-16 and 2016-17 harvest seasons.

Table-1 *Harvesting Schedule: Maturity based harvesting schedule leads to 10-25 % more yield and 0.5-1.5% increased sugar recovery*

Oct	Nov	Dec	Jan	Feb	Mar	Apr
EMV -ratoen(autumn,spring)	EMV -ratoen(autumn,spring)	Autumn EMV-plant MLMV-ratoen	MLMV-ratoen Spring EMV-plant	Spring MLMV-ratoen & plant	Spring MLMV - plant	Late maturing plant

EMV = Early maturing varieties, MLMV= Mid-late maturing varieties

Five early maturing and five mid-late maturing varieties were planted in February in an experiment with a randomised complete-block design with three replications, and grown with normal cane husbandry practices. Varieties regarded as early maturing were CoS 8436, CoS 08272, CoSe 98231, Co 0238 and Co 0118, and those regarded as mid-late maturing were CoS 767, CoS 97261, CoS 08279, CoS 07250 and CoSe 01434. We harvested 10 randomly selected stalks from each variety, topped, and de-trashed, at 30-day intervals between October and April. The juice was extracted in a clean power-operated vertical crusher and subsequently precipitated using lead acetate and filtered. Percent sucrose (%Pol) was then measured in filtered juice using an Autopol Rudolph polarimeter. Brix was measured using a Rudolph automated brix hydrometer. Bagasse pol of each variety was measured after extraction in a Rapipol extractor using the method of Meade and Chen [7]. Pol% in cane was calculated by combining Pol% in juice and Pol% in bagasse. Percent fibre was calculated by mixing 250g of bagasse with 2 L of water, followed by extraction in a Rapipol extractor until a zero Pol value was reached. It was then washed and dried in an oven. Fibre content (%) was calculated by using the formula described by Meade and Chen [7].

Table-2 *Varietal spectrum of sugarcane in U.P. during the years 2013-14 to 2017-18*

Varieties (%)	2013-14	2014-15	2015-16	2016-17	2017-18
EMV	14.57	21.35	34.47	52.83	70.46
MLMV	70.20	63.71	40.14	37.44	24.40
Rejected	15.23	14.94	25.39	9.72	5.14
Recovery%	9.26	9.54	10.60	10.61	10.85

Table-3 *Sucrose content (%) of juice of early and mid-late varieties*

Variety	Month							Mean
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Early maturing								
CoS8436	12.9	15.6	16.1	17.7	18.3	19.7	20.1	17.2
CoS08272	13.9	15.1	16.6	17.4	18.1	19.2	20.5	17.3
CoSe98231	14.5	16.2	16.6	17.1	17.7	18.5	19.5	17.2
Co0238	15.3	16.4	17.1	17.6	17.7	18.8	20.7	17.7
Co0118	16.9	17.4	17.7	18.1	18.5	19.5	21.2	18.5
Mid-late maturing								
CoS767	13.5	15.1	15.8	16.9	17.18	17.3	18.9	16.4
CoS97261	13.9	15.9	16.2	16.7	16.9	17.7	19.5	16.7
CoS08279	13.8	16.1	16.4	16.6	17.44	18.2	19.1	16.8
CoS07250	14.7	16.4	16.5	17.1	17.3	18.4	19.2	17.1
CoSe01434	13.9	16.0	16.1	16.5	17.4	18.4	19.7	16.9
Least significant difference (P<0.05) =0.53								

Table-4 *Pol percent cane of early and mid-late varieties*

Variety	Month							Mean
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Early maturing								
CoS8436	10.1	11.3	11.9	13.4	13.6	13.9	14.0	12.6
CoS08272	10.5	11.7	12.2	12.7	13.3	13.8	14.1	12.6
CoSe98231	11.	11.8	12.3	12.8	13.0	13.7	13.9	12.6
Co0238	11.4	11.8	12.4	12.9	13.2	13.7	13.9	12.8
Co0118	12.1	12.6	13.0	13.6	13.8	14.2	14.4	13.4
Mid-late maturing								
CoS767	10.6	11.0	11.7	12.4	12.7	13.2	13.3	12.1
CoS97261	10.3	11.2	11.5	12.3	12.5	12.7	12.9	11.9
CoS08279	10.4	11.4	11.6	12.1	12.7	13.2	13.3	12.1
CoS07250	10.1	11.5	11.8	12.4	12.8	13.1	13.3	12.2
CoSe01434	10.3	11.4	11.7	12.5	12.7	13.1	13.3	12.1
Least significant difference (P<0.05) = 0.258								

## Results and Discussion

For early maturing varieties, sucrose content ranged from 12.9 to 16.9% in October (early crushing period), which is the recommended month of harvest for early varieties. For late-maturing varieties, sucrose content was lower, ranging from 13.5 to 14.7% [Table-4]. At the end of the crushing period (April), the sucrose content of early maturing varieties was 20.1-21.2%, but for the late-maturing varieties the range was 18.9-19.7% [Table-3]. A similar trend was seen for Pol percent cane [Table-4]. There was a gradual increase in percent Pol and sucrose content between the early and late crushing periods for both the early and mid-late maturing varieties, but the early maturing varieties maintained consistently higher levels throughout the crushing season. The fibre content of early maturing varieties ranged from 12.4 to 13.2% during the early crushing period (October), and increased by 1.5 units, on average across all varieties by the April harvest. The increase in fibre across the season was less pronounced for the mid-late maturing varieties, with October levels of 13-13.3%, increasing by 0.5-1.0 units by April [Table-5]. Our data clearly show that no variety reached its full potential for sugar recovery until near the end of the crushing season. However, early maturing high-sugar varieties are available for harvest during the first and second months of crushing, and have higher sugar content than the later-maturing varieties. This high sugar content means the early maturing varieties yield more sucrose per tonne of crushed cane, rendering them more valuable to the sugar factory. These early maturing varieties are also valuable late in the season as their sugar content continues to increase with age (until April) and surpasses that of the mid-late maturing ones. All of the five early-maturing varieties under evaluation in this study had significantly higher sugar and fibre contents throughout the crushing season. Increasing the area planted to early-maturing varieties in the sub-tropical area of India would clearly improve sugar recovery in the region.

Table-5 *Fibre content (%) of cane of early and mid-late varieties*

Variety	Month							Mean
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Early maturing								
CoS8436	12.8	13.2	13.4	13.6	13.7	14.	14.3	13.6
CoS08272	13.2	13.2	13.47	13.3	13.8	14.2	14.5	13.7
CoSe98231	12.9	13.3	13.5	13.7	14.	14.2	14.6	13.7
Co0238	12.4	12.7	13.	13.3	13.7	14	14.2	13.3
Co0118	12.8	13.1	13.3	13.5	13.9	14.2	14.5	13.6
Mid-late maturing								
CoS767	13.3	13.6	13.8	14.1	14.4	14.7	14.9	14.1
CoS97261	13.0	13.5	13.8	14.1	14.3	14.5	14.7	14.0
CoS08279	13.1	13.3	13.7	13.9	14.2	14.5	14.9	14.0
CoS07250	13.3	13.6	13.7	14.	14.2	14.4	14.6	14.0
CoSe01434	13.3	13.6	13.8	14.0	14.2	14.5	14.7	14.0
Least significant difference (P<0.05) = 0.09								

## Conclusion

Differences in sucrose contents among varieties were consistent throughout the entire harvesting season. Varieties regarded as early maturing varieties retained the same level of superiority for sugar content over mid-late maturing varieties across all months, so keeping the balanced area under these elite varieties will increase sugar recovery in this part of India. Sugarcane as a raw material accounts for about 65% of the total cost of sugar production, so balanced area of these early and mid-late maturing varieties will reduce the cost of processing and increase the sugar recovery. However, more information about cane yield is needed to determine relative profitability of both early and mid-late maturing varieties to both farmers and growers and so determine the optimal mix of varieties.

**Application of research:** Sugarcane as a raw material accounts for about 65% of the total cost of sugar production, so balanced area of these early and mid-late maturing varieties will reduce the cost of processing and increase the sugar recovery.

**Research Category:** Sugarcane research

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**Study area / Sample Collection:** U. P. Council of Sugarcane Research, Shahjahanpur, Uttar Pradesh

**Cultivar / Variety name:** Sugarcane (*Saccharum officinarum*) - EMV, MLMV

**Conflict of Interest:** None declared

**Ethical approval:** This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

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