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Strategies for Improving Sugar Recovery in Sugarcane

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SUMMARY

Sugar recovery is referred to as the percentage of sugar production expressed in metric ton to the sugarcane crushed in metric ton. Growing demands and little scope for expansion of area under sugarcane in India necessitate improvement in the scenario of sugar recovery in addition to rise in crop productivity. The sugar recovery rates in the country are low when compared to many other sugar growing countries. After harvesting, the crop loses its sugar content rapidly during storage, transport and processing. However, about 85 per cent of production in country comes from 5 states viz., Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra and Uttar Pradesh. Proper milling sanitation and utilization of effective biocides are important to enhance processing efficiency and sucrose recovery.

INTRODUCTION

India is the second largest producer of sugarcane after Brazil but this sector faces several constraints *viz.* low yields, short crushing season, supply of stale canes, rising production costs, fluctuating trends in production, size of mill and its inefficient machinery, low recovery rates etc. When compared to the international scenario, sucrose content of Indian cane is more or less same but the realized rate of sugar recovery is low, only around 10-10.5 per cent. The average recoveries in other countries like Brazil, Mexico, South Africa and Thailand are 14.6%, 13.5%, 12.2%, 12.1% and 11.3%, respectively (Wright and Aradhey, 2016; KRPL, 2015). Accumulation of sugar in the crop represents a balance between synthesis of sugar and its utilization. Under normal milling conditions sugar loss is estimated to be around 1.0 to 2.5 kg of sucrose per ton of cane ground between crusher juice and mixed juice depending on the factory conditions. About 13 per cent of this loss (crushing of stale cane) is due to chemical inversion, 25 per cent is due to the activity of cell free enzymes and about 62 per cent is eaten up by the microorganism present in juice and mills.

Important Strategies for Improving Sugar Recovery

The important strategies for improving sugar recovery are as follows:

- Varieties and varietal scheduling
- Staggered planting
- Use of early maturing cultivars possessing high sugar
- Healthy and efficacious seed production programmes
- Maintenance of optimum age at the time of harvesting
- Peak maturity of sugarcane
- Maturity survey should be based upon cutting orders
- Cleaner supply of canes
- Optimum harvesting rate of canes in order to meet the crushing rate
- Efficient cane harvest labour force
- Efficient communication system
- Efficient cane harvesting program

Some strategies are discussed below:

Varieties and varietal scheduling

- Selection of appropriate varieties feasible for individual factories
- Varietal performances differ considerably between various regions and divisions within a factory relying upon soil type, irrigation potential and quality, drainage facilities, pest and disease problem etc.
- Those factors have to be carefully studied and varieties must be properly selected based on the factors.

Use of early maturing and high sugar varieties

- Early maturing/high sugar varieties are an essential component of recovery improvement.
- The early season is depicted by poor recovery; therefore, incorporation of only early or a great percentage of early varieties would help to improve the recovery.
- Planting of early varieties earlier in the season and crushing them early would not only give higher recoveries but also higher yields.

Avoid lodging, bud sprouting and aerial rooting

- The tendency of lodging, sprouting of buds and aerial rooting may hamper the cane quality directly.
- Better earthing up operation, deeper planting method with the help of suitable technology, propping and paired row planting method can restrict lodging of the plants remarkably.
- De-trashing is a sound approach that can reduce bud sprouting.
- Application of Modus @ 300 ml/ha is needed in order to control excessive vegetative growth of many cotton varieties with an ultimate goal to reduce lodging.

Newer planting technologies to obtain quality cane

Deep planting, ring system of planting and poly bag transplanting give better quality cane and yield.

Healthy seed program

Under commercial cultivation, most of the sugarcane varieties degenerate due to build up of diseases particularly red rot, smut, wilt etc.; adverse growing situations *viz.* soil salinity, soil acidity and alkalinity, soil moisture stress, water logging or submerged condition etc. and improper crop management like dearth of available water and essential nutrients.

A healthy seed nursery programme is indispensable for maintaining a greater recovery level.

Optimum age at harvest

- Early varieties: 10 months
- Mid-late varieties: 12 months
- Late varieties: 14-15 months

Peak maturity of cane

Attributes of good quality cane:

- Accumulation of peak sucrose content in juice
- Low level of non-sugars and high purity percentage
- Optimum fibre content and the cane must not have flowered
- Nil or negligible quantities of unwanted materials like trash, binding materials, dead and dry canes, mud particles, and water shoots etc.
- Higher quantity of juice and absence of pith in canes

Pre harvest maturity survey

- It helps to assess the exact maturity status of sugarcane thereby obtaining the best quality cane for each day's crush.
- The sugar recoveries can be improved to an extent of 0.5-0.8%.
- The economics of the pre-harvest maturity survey indicates highly favourable net profits, with a higher benefit/cost ratio.

Varietal mix

Varietal mix involving a high quality cane is more advantageous than a single cultivar at any specific crushing period.

Harvesting of flowered cane

Harvesting should be completed within 3 months after flowering. When harvesting is delayed beyond the optimum period of time, the valuable sugar accumulated in the canes will be wasted.

Weather condition

Moderately lower maturity of 45-65%, restricted or insufficient water supply, low night temperature, warm and sunny days are generally favourable.

Pre harvest irrigation

Gradual withdrawal of moisture one month before the harvest of cane can hasten maturity and sugar recovery. During maturity phase, the moisture content in sheath must be brought down to approximately 74-76% from 84-85%.

Chemical ripeners

Spraying of Polaris, Sodium, Metasilicate, Ethrel etc. during early season can improve the quality of canes thereby obtaining better sugar recovery.

Method of harvest

Utilization of proper and efficient harvesting tools and implements, harvesting of canes at ground level, low topping and avoidance of extraneous materials like water shoots, trash and binding materials etc. are advantageous regarding this matter.

Transport of cane

- Transport management activities such as the rates of harvesting, transporting and crushing have to be synchronized.
- Only minimum yard balance must be maintained with an aim to meet the crushing during any break in transport system.
- The waiting time for trucks, tractors or bullock carts in the yard should not be more than 2 hours.

Effective communications

- An effective communication system should be maintained in order to coordinate the proper harvest management operations.

Factors affecting cane quality

The various factors which affect cane quality are discussed below:

Variety

- Quality of juice is primarily a varietal character.
- Varieties differ with respect to fibre and sugar content along with composition of juice.
- Higher percentage of fibre content in cane leads to lesser percentage of extraction and greater proportion of residual juice in bagasse thus higher milling losses.
- To improve the uniformity of sugar recovery constantly throughout the growing season, sugarcane fields having more than 16% of PoI *i.e.* Polarization or sucrose per cent and 85% purity should be taken into consideration.
- High sugar possessing cultivars with early maturity and better juice quality, longer duration in the field and tolerance to post harvest inversion are significant in selecting cane varieties.

Flowering

- It causes interrupted vegetative growth, leading to cane maturity and accelerated accumulation of sugar.
- In the case when flowering begins to occur quite earlier before maturity stage and the cane is permitted to remain on the field for a period of greater than 3 months after flowering, deterioration in juice quality is observed owing to inversion of sucrose into glucose and fructose.

Climate

- Climatic parameters like temperature, relative humidity and bright sunshine hours during maturity period are highly responsible for depicting the quality of canes.
- Maximum temperature in the range of 23-30^{0}C and minimum temperature in the range of 7-14^{0}C are beneficial for obtaining improved juice quality.

- Deterioration in juice quality sets in where maximum temperature comes down to between 7 and 13^{0}C and the minimum temperature falls below 3^{0}C.
- Precipitation in winter season accompanied by cold spell, temperature higher than the optimum, shading of crop by trees and cloudier days during maturity phase can also depress the juice quality.
- When the crop is extremely affected by drought or moisture stress situations, the sugarcane juice may contain optically active non-sugars that can give an apparent increase in sugar percentage leading to an enhancement in unknown losses at the time of manufacturing process.
- The juice may contain low amount of sugars and higher reducing sugar and non-sugar content when high temperature condition prevails.
- In the regions with longer growing periods, higher purity percentage is recoded.
- Bright sunshine hours during daytime and cool night can improve the quality of cane.

Soil

- The mineral composition of juice is regulated by the concentration of water soluble salts present in soil.
- Salt affected soils or saline soils, water logging, alkalinity etc. may produce inferior canes.
- Excess moisture or submerged soil condition may hamper proper aeration in rhizospheric region of the crop thereby affecting the absorption of nutrients and moisture; besides, plant metabolism and sucrose synthesis are also affected along with aerial root formation leading to sucrose inversion and facilitating early maturity with drastic reduction in quantity of sugar.
- Therefore, provision of quick and efficient drainage system is mandatory.
- Water logging during ripening phase has deleterious effect to achieve better juice quality.
- Under high salinity and alkalinity, total solid content may be more, but purity will be less and sucrose content will be drastically affected.
- Soil salinity along with high potash and chlorine content in soil can produce juices with low purity percentage.

Age of the crop

- Crop age can have an influential role in maintaining juice quality more specifically in the earlier part of the crushing season.
- Under aged canes may contain lesser amount of sucrose along with greater percentage of reducing sugars and low purity percentage.
- On the other hand, over aged canes have more fibre and less juice including more deadly and dry canes along with more pith.
- Optimum age for early varieties is 10–12 months, for mid late varieties is 12 months and for late varieties is 14–15 months.

Fertilizer

- Sugarcane crop can remove on an average 1.0 kg of N, 0.6 kg of P_2O_5 and 1.75 kg of K_2O per ton of cane.
- The nutrients should be applied in required proportions.
- Excess, deficit or imbalanced application of essential nutrients to the crop may affect not only yield but also quality of juice.
- Excess or late application of N beyond 90-120 days may depress the sucrose percentage besides increasing the quantity of non-sugars in juice leading to poor sugar recovery.
- On the other hand, high Nitrogen present in the tissues often results in constant vegetative growth, delayed maturity, production of late tillers and water shoots, increased sheath moisture content and soluble N content in juice.
- Lower sucrose percentage, higher reducing sugar content and lower purity percentage are common under application of excess nitrogen.
- Moreover, the phosphate content declines with increase in N at higher doses, thereby giving high N/P ratio which is negatively correlated with sucrose concentration in juice.

- Phosphate required for better processing is almost 300 ppm.
- In case of drought and water logged situations, late and additional application of potassium has a beneficial role in proper ripening.
- Excess application of K must be avoided owing to its harmful effect on juice quality as excess potassium content leads to loss of sucrose into molasses.
- Therefore, a well balanced application of N, P and K within time depending upon the soil test values can produce superior quality canes.
- At least 7 micronutrients including Iron, Zinc and Boron have a considerable role in improving juice quantity as well as quality.

Irrigation water

- Irrigation with water coming from the rivers may produce better quality juice compared to irrigation with well water.
- Reduced sheath moisture content through enhancement in the interval between irrigations at maturity phase particularly is conducive for increased sucrose percent.
- Besides, gradual moisture withdrawal at least one month before harvesting can hasten maturity along with improving juice quality.
- Use of saline water leads to accumulation of salts of sodium, chloride, potassium etc. in juice which creates a huge hindrance in sugar manufacturing process.

Pests and diseases

- These biological constraints can severely affect juice quality while showing lower sucrose percentage and higher non-sugar content in juice.
- Juice obtained from the infected/infested sugarcane by borers, red rot and smut disease may adversely hamper juice quality creating remarkable hardship in sugar recovery.
- It was documented that the red rot disease alone was able to cause yield loss to the extent of 30-70% and the wilt infection resulted in reduction in sucrose recovery by 29%.
- Moreover, the major quality parameters like brix, PoI and purity are also severely depressed.
- Sugarcane mosaic virus (SCMV) also leads to massive reduction in brix, sucrose and purity percentages.

CONCLUSION

Improved sugar recoveries are expected to meet growing sugar demands in future with same or even less land area allocation for sugarcane crop in view of difficulties in expanding area on account of other pressures on cultivable land and also water availability for irrigation. Greater emphasis should be imposed upon developing commercial climate resistant varieties that can withstand post-harvest stresses in early as well as late crushing periods for specific agro-ecological situations and therefore an integrated approach to overcome the losses at various stages *viz*. pre-harvest, harvest, post-harvest, milling procedures etc. is needed.

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