

Original Research Article

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Yield and Juice Quality of Sugarcane As Influenced By Ethephon and Gibberellic Acid

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ABSTRACT

A field experiment was conducted during spring 2015-2016 at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (U.S. Nagar), Uttarakhand to see the effect of sugarcane sett soaking with ethephon and foliar application of gibberellic acid. Soil of the experiment plot was silty clay loam having high organic carbon (1.04%), high available phosphorus (32.5 kg/ha), medium in available potassium (256.2 kg/ha). pH of the soil was 7.2. Ten treatments i.e. conventional planting (T₁), overnight soaking of setts in water (T₂), overnight soaking of setts in 50 ppm ethephon (T₃), overnight soaking of setts in 100 ppm ethephon (T₄), T₁ + foliar application of GA₃ @ 35 ppm at 90, 120 and 150 DAP (T₅), T₂ + foliar application of GA₃ @ 35 ppm at 90, 120 and 150 DAP (T₆), T₃ + foliar application of GA₃ @ 35 ppm at 90, 120 and 150 DAP (T₇), T₄ + foliar application of GA₃ @ 35 ppm at 90, 120 and 150 DAP (T₈), soaking of setts for six hours in 50 ppm ethephon (T₉) and six hour soaking of setts in 100 ppm ethephon (T₁₀) were laid down in a randomized block design. All the treatments were replicated 3 times. It was observed that sett soaking with 100 ppm ethephon followed by foliar application of Gibberellic acid resulted highest yield. In addition to yield, the juice quality was also improved in terms of sucrose content (16.94%), available sugar percentage (11.60%) and commercial cane sugar yield (76.27 t/ha) in this treatment.

Keywords

Sugarcane,
Ethephon,
Gibberellic acid,
Yield, Juice quality

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Introduction

Indian sugar industry contributes significantly to the economy of India and to the socio-economic development of the rural population in the country.

Sugarcane (*Saccharum officinarum* L.) sustains second largest agro-industry i.e. sugar industry, next to textile industry. It has been

estimated that by 2030, India will require 520 million tonnes of sugarcane with average sugar recovery of 10.75 per cent.

The required productivity to achieve this target is 100-110 tonnes/ha as the area under sugarcane cultivation is expected to stabilize around 5.00 million hectares. Yield and recovery pattern of last few years shows that the target is a stiff one (Anonymous, 2011).

The existing management practice that largely focuses on good varieties, good quality seed material, nutrient management and pest management has not been able to achieve desired high productivity. Constraints like poor and delayed sprouting, poor tillering, poor growth and low sugar recovery has a bearing in low cane yield and sugar production. PGRs like ethephon and gibberellic acid has immense potential to ameliorate these constraints and thus has been effective in improving productivity and sugar recovery in sugarcane (Li and Solomon, 2003; Jain *et al.*, 2011; El Latieff and Bekheet, 2012). The tremendous potential of ethephon in increasing sett sprouting has been reported from many countries like India, Colombia and Hawaii. Biochemical study in ethephon treated setts reveals that, ethephon treatment increases acid invertase activity and ATPase activity that helps in better sprouting (Jain *et al.*, 2011). Better sprouting holds the key for optimum plant stand and hence yield. Improvement in sprouting percent, tiller population and yield due to ethephon treatment has been reported (Millhollon and Legendre 1995, Manoharan *et al.*, 1992; Rao *et al.*, 2005). Improvement in yield due to foliar application of Gibberellic acid has been reported by El-Lattief and Bekheet (2012).

Plant growth regulators have also been able to enhance juice quality of sugarcane. Most of the existing agro techniques have been unsuccessful in improving the juice quality of sugarcane and thus yields lower commercial cane sugar. Use of PGRs (ethephon and gibberellic acid) has been able to improve both the productivity as well as juice quality of sugarcane. Setts treated with ethephon, when planted have also been reported to improve tillering and sucrose accumulation in cane (Zhang *et al.*, 2001). Foliar application of gibberellic acid has been found effective for improving productivity as well as juice quality. Bull (1964) reported that application

of gibberellic acid increased stalk length, fresh weight and sugar content of sugarcane. Alexander (1968) also reported increase in yield and juice quality of sugarcane due to foliar application of Gibberellic acid.

In addition to PGRs some non-monetary techniques like sett soaking with water has also been found to improve productivity of sugarcane by improving sprouting and subsequent growth. There has been a strong influence of sett moisture on germination of sugarcane. Nodal water content of 72-74% has been found to be optimum for rapid and high germination (Verma and Sudama, 1965; Singh, 1975). The high water content in the setts is responsible for accelerating the conversion of carbohydrates into reducing sugars, resulting in higher germination percentage (Singh *et al.*, 2008). Germination of water soaked setts improved by 75.9% over the control (Anonymous 2010). The present study was planned to see the effect of sett soaking with water or ethephon alone as well as in combination with foliar application of Gibberellic acid on productivity and juice quality of sugarcane.

Materials and Methods

A field experiment was conducted during spring 2015-2016 at the N.E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (U.S. Nagar), Uttarakhand, India. The soil of the experiment plot was silty clay loam, rich in organic carbon (1.04%), high in available phosphorus (32.5 kg P₂O₅/ha) and medium in available potassium (256.2 kg K₂O/ha). pH of the soil was 7.2. Ten treatments i.e. conventional planting (T₁), overnight soaking of setts in water (T₂), overnight soaking of setts in 50 ppm ethephon (T₃), overnight soaking of setts in 100 ppm ethephon (T₄), T₁ + foliar application of GA₃ @ 35 ppm at 90, 120 and 150 DAP (T₅), T₂ +

foliar application of GA₃ @ 35 ppm at 90, 120 and 150 DAP (T₆), T₃ + foliar application of GA₃ @ 35 ppm at 90, 120 and 150 DAP (T₇), T₄ + foliar application of GA₃ @ 35 ppm at 90, 120 and 150 DAP (T₈), soaking of setts for six hours in 50 ppm ethephon (T₉) and six hour soaking of setts in 100 ppm ethephon (T₁₀) were laid down in a randomized block design with three replications. Three budded sugarcane setts of variety Co pant-3220 were planted in flat bed method at a row to row spacing of 75 cm. The crop was fertilized with 150 kg N, 60 kg P₂O₅ and 40 kg K₂O and other cultural practices were followed as per recommendation.

Before planting setts were either soaked with water or ethephon. For water soaking treatment, setts were soaked overnight in tube well water. Setts were soaked in 50 and 100 ppm ethephon solution for two different duration i.e. 6 hours and overnight.

Ethephon treated setts were used for planting immediately after completion of soaking duration. Gibberellic acid was sprayed @ 35 ppm at 90, 120 and 150 days after planting. In conventional planting the setts were planted without any sett soaking treatment.

Data on cane yield and different quality parameters like juice extraction percentage, sucrose content (%), available sugar (%) and commercial cane sugar yield (t/ha) were calculated as follow.

For estimating juice extraction percent the sample of five canes after recording their fresh weight was crushed by electric motor driven roller crusher. Weight of juice was recorded and the juice extraction per cent was worked out as:

$$\text{Juice extraction (\%)} = \frac{\text{Weight of juice (kg)}}{\text{Weight of cane (kg)}} \times 100$$

For estimation of sucrose content of cane, 100 ml of juice was taken in conical flask to which 1 g dry lead acetate was added followed by vigorous stirring. The impurities were filtered off by using Whatman No. 42 filter paper. The clear filtrate was taken in 20 cm polarimeter tube and pol reading was recorded with the help of polarimeter, using Hornal's Dry Lead Acetate method with dilute solution as described by Spencer and Meade (1955). Schmitz's table was used to calculate the sucrose per cent in juice by using corrected brix and pol reading.

Available sugar per cent in cane at harvesting was computed by using the following formula (Spencer and Meade, 1955).

$$\text{Available sugar (\%)} \text{ in cane} = [S - (B-S) \times 0.4] 0.73$$

Where,

S = Sucrose per cent in cane juice

B = Corrected brix of cane juice

The yield of commercial cane sugar (CCS) at harvest was worked out as follows:

$$\text{CCS yield (t/ha)} = \frac{\text{Available sugar (\%)} \text{ in cane} \times \text{Cane yield (t/ha)}}{100}$$

Results and Discussion

Cane yield

The results clearly revealed that the productivity of sugarcane varies with different treatments. Highest cane yield (114.06 t/ha) was obtained from the treatment of overnight soaking of cane setts in 100 ppm ethephon followed by three spraying of GA₃ @ 35 ppm at 90, 120 and 150 days after planting (Table 1). Corresponding cane yield in this treatment (T₈) was 67.85% higher than conventional method (no sett treatment). However the cane

yield was increased in all the treatments over conventional, though the response was different in different treatments. It was also observed that 100 ppm ethephon treated setts produced 9% higher cane over 50 ppm when the duration of sett soaking was 6 hours. The response was more encouraging in 100 ppm ethephon sett soaking over 50 ppm for same duration of soaking.

The highest cane yield in the treatment of overnight sett soaking in 100 ppm ethephon followed by GA₃ spray (35 ppm) at 90, 120 and 150 days after planting was the cumulative effect of overnight sett soaking with 100 ppm ethephon before planting and later on GA₃ spray (35 ppm) at 90, 120 and 150 DAP. Soaking of setts with ethephon might have resulted the favorable physio-biochemical changes resulting in better germination. Higher germination in T₈ helped in establishing a proper plant stand and helped in producing high yield. Higher germination in T₈ was due to sett treatment with 100 ppm ethephon. Jain *et al.*, (2011) found that ethephon enhances acid invertase and ATPase activity which improves the availability of reducing sugar and energy respectively. Reducing sugar directly serves as food material for sprouting buds whereas inorganic phosphorus released by the activity of ATPase provides the cell with carbon and energy that helps for synthesizing compounds necessary for sprouting.

Number of shoots, height of shoots, leaf area index, shoot dry matter, root growth was also highest in the treatment in which setts were planted after overnight soaking with 100 ppm ethephon followed by GA₃ spraying @ 35 ppm at 90,120 and 150 DAP. Due to all these favourable growth parameters the yield was maximum in T₈. Use of PGRs (ethephon and gibberellic acid) has been able to improve the productivity of sugarcane. Higher as well as faster germination along with higher tiller

production due to ethephon treatment has been reported (Jain *et al.*, 2011; Zhang *et al.*, 2001). Foliar application of gibberellic acid has been found effective for improving productivity as well as juice quality. Bull (1964) reported that application of gibberellic acid increased stalk length, fresh weight and sugar content of sugarcane. Alexander (1968) also reported increase in yield and juice quality of sugarcane due to foliar application of gibberellic acid.

Even 28.18% increase in cane yield was reported in overnight soaking in water as compared to conventional. The yield improvement in water soaking treatment was due to better emergence and crop stand. When water soaked setts are planted, due to high moisture content the conversion of carbohydrates into reducing sugar is favoured. Glucose being a simplified form of sugar is quickly mobilized and utilized by the growing point of the sugarcane bud. Better sprouting ensured better crop stand, vigorous growth and thus produced high yield in this treatment.

Quality parameters

Data regarding quality parameters i.e. juice extraction percentage, sucrose percentage, available sugar and CCS (commercial cane sugar) yield has been given in Table 1.

Juice extraction percentage was similar in all the treatments and statistically found non-significant. However other juice quality parameters like sucrose content, available sugar and commercial cane sugar yield improved significantly. The highest sucrose percentage was recorded in the treatment T₈ (overnight sett soaking in 100 ppm ethephon + GA₃ @ 35 ppm applied at 90, 120 and 150 DAP) which was significantly higher over rest of the treatments except the treatment T₄ (overnight soaking of setts in 100 ppm ethephon without GA₃ spraying).

Table.1 Yield and quality parameters of Sugarcane as influenced by various treatments

Treatment	Cane yield (t/ha)	Juice extraction (%)	Sucrose (%)	Available sugar (%)	Commercial cane sugar (t/ha)
T ₁	67.95	45.70	15.89	9.80	6.65
T ₂	87.10	46.50	16.19	10.36	9.26
T ₃	84.07	46.10	16.32	10.33	8.68
T ₄	104.06	49.00	16.65	11.08	11.53
T ₅	71.10	48.20	16.36	10.58	7.52
T ₆	89.43	48.70	16.53	10.81	9.42
T ₇	89.62	47.60	16.43	10.60	9.50
T ₈	114.06	49.70	16.94	11.60	13.23
T ₉	74.99	46.60	16.26	10.39	7.78
T ₁₀	81.29	48.70	16.20	10.42	8.46
CD (P=0.05)	6.06	NS	0.31	0.4	0.82

Lowest sucrose percentage (15.89) was recorded in conventional planting, where setts were planted without any sett treatment. The highest sucrose percent in treatment T₈ can be attributed to better photosynthesis and source-sink relation in the plant due to application of Gibberellic acid.

Significantly higher available sugar (11.60%) was recorded in T₈ over rest of the treatments. The lowest CCS (6.65 t/ha) was produced in conventional which was significantly lower than rest of the treatments. Significantly higher commercial cane sugar (13.23 t/ha) was produced in the treatment T₈ over rest of the treatments. Commercial cane sugar was almost doubled in T₈ over conventional. Overnight soaking the setts in water, soaking setts for 6 hours in 50 ppm ethephon also performed better over control. Improvement in commercial cane sugar due to foliar application of Gibberellic acid application was also observed by El-lattief and Bekheet (2012).

It can be concluded that overnight soaking of setts with 100 ppm ethephon followed by foliar application of Gibberellic acid @ 35

ppm at 90, 120 and 150 DAP is useful for improving yield and juice quality parameters of sugarcane. The low cost technique like soaking of setts in water was also found to be useful in improving yield as well as quality. As this production technology improves cane yield with simultaneous increase in sucrose content and commercial cane sugar yield, hence sugar industry will also be benefitted.

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