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Yield, quality and profitability of sugarcane (*Saccharum* spp. Hybrid complex) as influenced by plant growth regulators in sub-tropical India

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Abstract
A field experiment was carried out during the spring season of 2017-18 at Research farm of Sugarcane Research Institute, Dr. Rajendra Prasad Central Agricultural University, Pusa Samastipur, to study the influence of plant growth regulators on yield, quality and profitability of sugarcane (*Saccharum* spp. hybrid complex). The experiment was laid out in a randomized block design comprising of ten treatments with three replications. The results revealed that planting of setts after overnight soaking in 50 ppm ethrel solution + GA_3 spray @ 35 ppm at 90, 120 & 150 DAP showed significantly higher cane and sugar yield, and consequently higher juice recovery as compared to rest of the treatments. Planting of setts after overnight soaking in 50 ppm ethrel solution + GA_3 spray @ 35 ppm at 90, 120 & 150 DAP also registered higher gross returns (₹ 2,95,220.0/ha), net returns (₹ 1,67,988.0/ha) and benefit: cost ratio (1.32) followed by planting of setts after overnight soaking in 50 and 100 ppm ethrel solution and planting of setts after overnight soaking in 100 ppm ethrel solution + GA_3 spray @ 35 ppm at 90, 120 & 150 DAP.

Keywords: sugarcane, ethrel, gibberellic acid, yield, quality, profitability

Introduction
Sugarcane (Saccharum spp. hybrids) is an important cash crop and more than 70% of the world's sugar production comes from it. India is the largest consumer and second largest producer after Brazil producing nearly 15 and 25% of global sugar and sugarcane, respectively (Mohan and Kanaujia, 2017) [3]. In India, it occupies about 2.53% (4.9 million ha) of the gross cropped area of the country with an annual production of 303.6 million tonnes. In Bihar, it occupies an area of 0.3 million ha with the production of 14.7 million tonnes (ISMA, 2017) [1]. Typically sugarcane is a tropical crop, however more than 50% sugarcane area in India falls in the sub-tropical zone, hence, demarcation with respect to physiology and yield is bound to happen. The productivity of sugarcane in Bihar is far below (50 t/ha) as compared to tropical areas (80 t/ha). Extremes of climate and use of sub-optimal agro-technologies are mainly responsible for low sugarcane productivity in sub-tropical India. In this direction, plant growth regulators like ethrel and gibberellic acid in judicious integration have been found useful to ameliorate these constraints and thus have been effective in improving productivity and profitability of sugarcane. Considering the above facts, an attempt was made to find out the combined effects of ethrel and gibberellic acid on yield, quality and profitability of sugarcane in sub-tropical India.

Materials and Methods
The field experiment was conducted during the spring season of 2017-18 at Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar (25º59′ N, 85º40′ E, and 52.1 m above mean sea level). Soil of the experimental field was sandy loam, calcareous in nature (28.5% $CaCO_3$), pH 8.2 with electrical conductivity 0.28 dS/m, low in organic carbon (0.41%), low in available nitrogen (220 kg/ha) and medium in phosphorus (28.3 kg/ha) and potassium content (141.5 kg/ha). The crop received 1,134.6 mm of rainfall of which maximum was received in the month of July. The crop was planted on 18th March, 2017 and harvested on 30th January, 2018. Sugarcane variety 'BO 153' was grown maintaining row to row distance of 90 cm using furrow method of planting. To check the fungal infection, setts were treated with 0.1% solution of carbendazim for 10 minutes. Thimet 10 G (an insecticide) was applied in furrows

@ 15 kg/ha and mixed uniformly for soil treatment. The experiment was conducted in randomized block design with three replications having ten plots in each replication. The treatment comprised of ten treatments *viz*., conventional planting/farmers practice (T_1), planting of setts after overnight soaking in water (T_2), planting of setts after overnight soaking in cattle dung, cattle urine and water slurry in 1: 2: 5 ratios (T_3), planting of setts after overnight soaking in 50 ppm ethrel solution (T_4), planting of setts after overnight soaking in 100 ppm ethrel solution (T_5), T_1 + GA_3 spray @ 35 ppm at 90, 120 & 150 DAP (T_6), T_2 + GA_3 spray @ 35 ppm at 90, 120 & 150 DAP (T_7), T_3 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP (T_8), T_4 + GA_3 spray @ 35 ppm at 90, 120 & 150 DAP (T_9) and T_5 + GA_3 spray @ 35 ppm at 90, 120 & 150 DAP (T_{10}).
Observations recorded during the period of experiment along with their procedures are explained below:
Cane yield was recorded with the help of spring balance from net plot area of each plot and converted into tonnes per hectare.
In order to obtained commercial cane sugar yield, the commercial cane sugar per cent was multiplied with cane yield (tonnes/ha).

$$\text{CCS (t/ha)} = \frac{\text{CCS\% at harvest x Cane yield (t/ha)}}{100}$$

Qualitative parameters are determined using the following procedures:
Brix percent was recorded directly by using a brix hydrometer. These readings were corrected to the temperature at 20ºC using temperature correlation chart as described by Spencer and Meade (1964) [7].
Sucrose in juice was estimated as pol by the method described by Spencer and Meade (1964) [7]. It was estimated by Polariscope. Pol percentage in juice was calculated from Schimitz's table.
Purity was determined as coefficient of purity per cent.

$$\text{Coefficient of purity \%} = \frac{\text{Pol per cent in juice}}{\text{Corrected brix reading}} \text{ x } 100$$

Again, fifteen canes from each plot were randomly selected and weighed. Their juice so extracted was weighed and finally juice recovery was determined and expressed in percentage.

$$\text{Juice recovery (\%)} = \frac{\text{Weight of juice of 15 canes}}{\text{Weight of 15 canes}} \text{ x } 100$$

The CCS per cent was calculated with the help of brix and pol readings recorded in laboratory on the basis of the formula as described by Parthasarthy (1979) [4].

$$\text{CCS \%} = [S\text{-}0.4\ (B\text{-}S)] \times 0.73$$

Where,
S = Sucrose per cent in juice
B = Brix per cent in juice

For working out the economics in terms of profitability, prevailed market price for sugarcane, labour cost and inputs cost during 2017-18 were considered.
Gross returns was calculated by multiplying yield of cane (t/ha) with price of cane (₹/t).

Gross returns (₹/ha) = Cane yield (t/ha) × Cane price (₹/t)

Net returns was calculated by deducting cost of cultivation from the gross returns.

Net returns = Gross returns – cost of cultivation

Benefit: cost ratio gives net returns per rupee of money invested. It was calculated by dividing net returns with total cost of cultivation.

$$\text{Benefit: Cost ratio} = \frac{\text{Net returns}}{\text{Total cost of cultivation}}$$

The data were statistically analysed by using the 'Analysis of Variance Technique' for randomized block design (RBD) as per the procedures described by Rangaswamy (2006) [6].

Results and Discussion

Yield

Mean data showed that different treatments brought significant variation in cane and sugar yield in compared to conventional planting (Table 1). Planting of setts after overnight soaking in 50 ppm ethrel solution followed by GA_3 spray @ 35 ppm at 90, 120 and 150 DAP (T_9) resulted in highest cane yield (101.8 t/ha). However, it remained statistically at par with treatment T_4, T_5, T_8 and T_{10} and all of them significantly out yielded T_1, T_2, T_3, T_6 and T_7. It might be due to higher number of millable canes, cane length, length of internode as well as cane weight. Tan *et al.* (2007) [8] also showed that application of plant growth regulator like GA_3 significantly increased the number of valid stalks and yield of sugarcane.
Maximum sugar yield (12.40 t/ha) was recorded under planting of setts after overnight soaking in 50 ppm ethrel solution followed by GA_3 spray @ 35 ppm at 90, 120 and 150 DAP (T_9) which was closely followed by T_4, T_5, T_8 and T_{10}. This might be due to the fact that the significant effect on sugar yield was solely due to cane yield on which the effect of different treatments was significant. Xing *et al.* (2002) also demonstrated that ethrel promoted the differentiation and stimulated the plant growth and finally resulted in higher cane and sugar yield.

Quality

The results obtained on qualitative parameters were shown in Table 2. It was observed that different treatments had no significant effect on juice quality parameters except juice recovery per cent where treatment effect was significant. However, the maximum brix per cent was observed in treatment T_4 and T_9 (19.6%) and the minimum was observed in treatment T_7 (19.2%). Similarly, highest pol per cent was recorded in treatment T_9 (17.52%) and the lowest was recorded in treatment T_3 (16.98%). The purity percentage was found statistically similar in all the treatments. The CCS percentage in juice estimated at harvest showed unmarked effect due to different treatments. The average CCS percentage was obtained as 11.96%. Juice recovery percentage was significantly affected by different treatments. Planting of setts after overnight soaking in 50 ppm ethrel solution followed by GA_3 spray @ 35 ppm at 90, 120 & 150 DAP (T_9) registered significantly higher juice recovery percentage (68.7%) followed by T_4, T_5 and T_{10} and the lowest juice recovery was recorded planting of setts after overnight soaking in water followed by GA_3 spray @ 35 ppm at 90, 120 & 150 DAP (T_7) *i.e.*, 58.7%. This might be due to the positive effects of ethrel and gibberellic acid as ethrel increases the

activities of acid and neutral invertases thereby enhancing the sugar accumulation in the stalks (Yao *et al.,* 2002) [10] and gibberellic acid improves the cane juice quality at the harvest stage as it enhanced the export of carbon assimilates from the source to sink organ (Tan *et al.,* 2007) [8].

Profitability

The economics of cultivation was worked out in terms of gross returns, net returns and benefit: cost ratio (Table 3). Planting of setts after overnight soaking in 50 ppm ethrel solution followed by GA_3 spray @ 35 ppm at 90, 120 and 150 DAP (T_9) recorded significantly higher gross returns (₹ 2,95,220/ha), net returns (₹ 1,67,988.0/ha) and benefit: cost ratio (1.32) which was at par with treatment T_4, T_5 and T_{10}. The reason for higher net returns and benefit: cost ratio was due to higher cane yield. Similar findings were also reported by Praharaj *et al.* (2017) [5].

Table 1: Cane yield and sugar yield as affected due to different treatments

Treatment	Cane yield (t/ha)	Sugar yield (t/ha)
T_1: Conventional planting/farmers practice (03-bud setts)	71.4	8.55
T_2: Planting of setts after overnight soaking in water	78.9	9.33
T_3: Planting of setts after overnight soaking in cattle dung, cattle urine and water slurry in 1:2:5 ratios	81.5	9.58
T_4: Planting of setts after overnight soaking in 50 ppm ethrel solution	96.3	11.70
T_5: Planting of setts after overnight soaking in 100 ppm ethrel solution	94.5	11.47
T_6: T_1 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	77.6	9.23
T_7: T_2 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	83.5	9.84
T_8: T_3 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	87.2	10.29
T_9: T_4 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	101.8	12.40
T_{10}:T_5 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	98.7	11.93
SEm (±)	5.08	0.58
CD (P=0.05)	15.1	1.7
Mean	87.1	10.43

Table 2: Brix, pol, purity, juice recovery and CCS percentage percentage of cane juice as affected by different treatments

Treatment	Brix (%)	Pol (%)	Purity (%)	Juice recovery (%)	CCS (%)
T_1: Conventional planting/farmers practice (03-bud setts)	19.5	17.29	88.7	61.6	11.98
T_2: Planting of setts after overnight soaking in water	19.4	17.11	88.2	59.5	11.82
T_3: Planting of setts after overnight soaking in cattle dung, cattle urine and water slurry in 1:2:5 ratios	19.2	16.98	88.4	58.9	11.75
T_4: Planting of setts after overnight soaking in 50 ppm ethrel solution	19.6	17.49	89.2	66.2	12.15
T_5: Planting of setts after overnight soaking in 100 ppm ethrel solution	19.5	17.45	89.5	65.7	12.14
T_6: T_1 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	19.3	17.15	88.9	61.2	11.89
T_7: T_2 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	19.2	17.02	88.6	58.7	11.79
T_8: T_3 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	19.4	17.09	88.1	59.1	11.80
T_9: T_4 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	19.6	17.52	89.4	68.7	12.18
T_{10}:T_5 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	19.5	17.40	89.2	65.1	12.09
SEm (±)	0.41	0.30	1.2	1.99	0.23
CD (P=0.05)	NS	NS	NS	5.9	NS
Mean	19.4	17.25	88.8	62.5	11.96

Table 3: Economic analysis of sugarcane cultivation as influenced by different treatments

Treatment	Gross returns (₹/ha)	Net returns (₹/ha)	B: C ratio
T_1: Conventional planting/farmers practice (03-bud setts)	207060	85679	0.71
T_2: Planting of setts after overnight soaking in water	228810	106050	0.86
T_3: Planting of setts after overnight soaking in cattle dung, cattle urine and water slurry in 1:2:5 ratios	236350	113568	0.92
T_4: Planting of setts after overnight soaking in 50 ppm ethrel solution	279270	155961	1.26
T_5: Planting of setts after overnight soaking in 100 ppm ethrel solution	274050	150083	1.21
T_6: T_1 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	225040	99736	0.79
T_7: T_2 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	242150	115466	0.91
T_8: T_3 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	252880	126175	0.99
T_9: T_4 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	295220	167988	1.32
T_{10}:T_5 + GA_3 spray (35 ppm) at 90, 120 & 150 DAP	286230	158340	1.24
SEm (±)	14738	6207	0.049
CD (P=0.05)	43790	18442	0.15
CV (%)	10.1	8	8.4
Mean	252706	127905	1.02

Conclusion

It could be concluded that for sugarcane cultivation, planting of setts after overnight soaking in 50 ppm ethrel solution with or without GA_3 spray @ 35 ppm at 90, 120 & 150 DAP can be an efficient option in improving the tonnage, quality and profitability in sub-tropical India.

References

1. ISMA. Indian Sugar Mills Association. Indian Sugar 2017; 68(9):70-74.
2. Kumar N. Use of plant growth regulators for enhanced growth and yield of sugarcane (*Saccharum* species hybrid complex). In*:* Extended Summaries, Fourth International

Agronomy Congress on Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge, 22-26 November, 2016, Indian Society of Agronomy, New Delhi, India. 2016, 1310-1312.
3. Mohan N, Kanaujia AK. Biomass energy for economic & environmental sustainability in India. Sharkara. 2017; 48(3):24-26.
4. Parthasarthy SV. *Sugarcane in India*. 634–653 pp. K.C.P. Ltd., Madras, 1979.
5. Praharaj S, Singh D, Guru SK, Meena BR. Effect of plant growth regulators on tiller dynamics and yield of sugarcane (*Saccharum officinarum*). International Journal of Bio-resource and Stress Management. 2017; 8(1):75-78.
6. Rangaswamy R. *A Textbook of Agricultural Statistics*. 496 pp. New Age International (P) Limited, New Delhi, 2006.
7. Spencer GL, Meade GP. *Cane Sugar Hand Book*, 2nd edition. 433–437 pp. John Wiley and Sons, New York, 1964.
8. Tan XP, Li NM, Zhou YM, Zhang J, Wang Y, Chen Z. The effects of different concentration of gibberellin on the quality and yield of garden cane. Journal of Sugar and Cane Sugar. 2007; 4(8-13):27.
9. Xing YX, Yang LT, Li YR. Effect of ethephon on respiratory exchange in different sugarcane varieties. Chinese Journal of Tropical Crops. 2002; 23(3):66-72.
10. Yao RL, Li YR, Yang LT, Zhang GR. Effects of ethephon on ATPase and invertase activities in internodes of sugarcane at boom growth stage. Chinese Journal of Tropical Crops. 2002; 23(2):66-71.