Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(4): 2589-2592
Received: 11-05-2018
Accepted: 15-06-2018

Bharati Upadhaya
M.Sc Scholar, Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Navnit Kumar
Junior Scientist-cum-Assistant Professor, Department of Agronomy, Sugarcane Research Institute, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Correspondence
Bharati Upadhaya
M.Sc Scholar, Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Effect of plant growth regulators on germination and growth parameters of sugarcane (*Saccharum* spp. hybrid complex)

Bharati Upadhaya and Navnit Kumar

Abstract
A field experiment was conducted during the spring season of 2017 at Research farm of Sugarcane Research Institute, Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar to study the effect of plant growth regulators on germination and growth parameters on sugarcane (*Saccharum* spp. hybrid complex). The experiment was laid out in randomized block design and replicated thrice. 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}). Results revealed that planting of setts after overnight soaking in 50 ppm ethrel solution recorded higher periodic germination percentage followed by planting of setts after overnight soaking in 50 ppm ethrel solution + GA_3 spray @ 35 ppm at 90, 120 & 150 DAP. Planting of setts after overnight soaking in 50 ppm ethrel solution followed by GA_3 spray @ 35 ppm at 90, 120 & 150 DAP showed significantly higher leaf area index at all the growth stages. Plant height was found to be non-significant except at 210 and 240 DAP. Dry matter accumulation and root dry weight was found significantly higher in planting of setts after overnight soaking in cattle dung, cattle urine and water slurry in 1: 2: 5 ratios followed by GA_3 spray @ 35 ppm at 90, 120 & 150 DAP.

Keywords: ethrel, gibberellic acid, growth parameters, sugarcane

Introduction
Sugarcane (*Saccharum* spp. hybrid complex) as a cash crop occupies a very prominent position on the agricultural map of India. 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) [8]. 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) [2]. 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 and germination percentage is also very low, only 30-35% as compared to tropical India where it is about 70-80%. In addition to poor emergence, poor crop growth has a bearing in low sugarcane production. In this direction, plant growth regulators like ethrel and gibberellic acid in judicious integration has been found useful to ameliorate these constraints and thus has been effective in improving productivity in sugarcane. The highest germination percentage at 50 DAP were recorded from planting of setts after overnight soaking in 50 ppm ethrel solution which was significantly higher (50.1%) over conventional planting practice (Kumar, 2016) [5]. GA_3 helps in improving plant photosynthetic efficiency by influencing photosynthetic enzymes, leaf area index, light interception, and increased use of nutrients (Verma *et al.*, 2017) [11]. Hence, a field experiment was planned with objectives to improve emergence and growth parameters of sugarcane by sett treatment with ethrel and foliar application of gibberellic acid.

Materials and Methods
The field experiment entitled "Effect of plant growth regulators on germination and growth parameters of sugarcane (*Saccharum* spp. hybrid complex)" was conducted during the spring season of 2017 at Sugarcane Research Institute, Dr. Rajendra Prasad Central Agricultural

University, Bihar situated on the southern and western bank of the river *Burhi* Gandak at $25^0 59'$ N, $85^0 40'$ E and 52.1 m above mean sea level, which falls in sub-humid, sub-tropical climate with moderate rainfall, hot dry summer and cold winter. Total rainfall during the period of investigation was 1,134.6 mm. The experimental plot was upland and well drained with uniform topography. The soil of the experimental plot was 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 experiment was laid out in randomized block design and replicated thrice. The experiment 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}). Setts of variety 'BO 153' were treated differently with different treatments. Before planting, setts were treated with water, cattle dung, cattle urine and water slurry in 1: 2: 5 ratios, 50 and 100 ppm ethrel solution. Gibberellic acid was sprayed @ 35 ppm at 90, 120 and 150 DAP.

A total of five germination counts were made from net plot area of each plot at 10, 20, 30, 40 and 50 DAP and emergence per cent was computed as:

$$\text{Germination (\%)} = \frac{\text{Number of germinated buds per plot}}{\text{Number of buds planted per plot}} \times 100$$

In case of leaf area index, total number of leaves within marked row area were counted and categorized into different groups (small, medium and large). Leaf area of two leaves from each group were determined by multiplying length, width, number of specific leaves and a correction factor (0.6274) suggested by Bathla and Sharma (1978) [1]. LAI was determined by using the following formula:-

$$\text{LAI} = \frac{\text{Total leaf area of 100 cm row length}}{\text{Land area (100 cm} \times \text{90 cm)}}$$

Ten plants were tagged randomly in each plot and height of the tagged plants was taken from ground level to neck of the plant at 150, 180, 210 and 240 DAP and then averaged out in centimetre.

Dry matter accumulation was recorded on 120, 150, 180 and 210 DAP. Two numbers of plants were uprooted from each plot of each treatment from net plot area. Fresh weight of the whole plant (2 no.s) was taken and then averaged out. Then the plants were chopped into pieces and 100 grams of the total (homogenous samples) as representative sample from each sample were kept in paper bags was first air-dried and then oven dried at 70^0C in hot air oven until constant weight was attained. Thus, dry weight per plant per treatment was recorded. Similarly, with the help of sharp knife the roots were removed from the uprooted plants, washed carefully and fresh weight was taken and air-dried followed by oven dried at 70^0C until constant weight was attained and then the weight was averaged out. It was recorded at 120, 150,180 and 210 DAP.

The data obtained during the course of investigation were subjected to statistical analysis using analysis of variance technique as per the procedures described for randomized block design by Rangaswamy (2006) [9].

Results and Discussion

Germination percentage

Germination per cent was recorded at 10, 20, 30, 40 and 50 DAP (Table 1). Significant variation in germination per cent was observed due to different treatments at all the stages. At 10 DAP, treatment T_4 recorded significantly highest germination (3.5%) over rest of the treatments but remained at par with T_9. Similarly, at 20 DAP, treatment T_4 recorded significantly highest germination (15.8%), over rest of the treatments but remained at par with T_9. At 30 DAP, treatment T_4 showed significantly higher germination per cent (40.7%) and statistically comparable to T_5, T_9 and T_{10}. Similarly, at 40 DAP, the maximum germination percentage (52.4 %) was recorded in treatment T_4 which was statistically comparable to treatments T_5, T_9 and T_{10} but significantly superior over rest of the treatments. At 50 DAP, the highest germination percentage (56.1%) obtained in treatment T_4 which was statistically at par with treatment T_5, T_9 and T_{10} and found to be significantly superior over rest of the treatments. This might be due to fourfold increase in acid invertase (AI) and ATPase activity. Increase in enzyme activity of acid invertase and ATPase activity indicates enzyme activation during bud sprouting by growth promoting chemicals. Acid invertase hydrolyses sucrose into hexoses (glucose and fructose) and ATPase liberated inorganic phosphorus to provide cells with carbon and energy for the synthesis of different compounds essential for sprouting and subsequent growth of the underground buds (Jain *et al.*, 2007) [4]. Rao *et al.* (2005) [10] also reported that treating setts with 100 mg/L ethrel significantly improved germination compared to control.

Table 1: Germination per cent of sugarcane as affected by different treatments

Treatment	10 DAP	20 DAP	30 DAP	40 DAP	50 DAP
T_1	0.0	2.2	20.1	31.6	32.8
T_2	1.3	6.1	24.3	38.0	41.1
T_3	1.4	7.2	25.0	39.3	42.7
T_4	3.5	15.8	40.7	52.4	56.1
T_5	2.3	9.3	38.3	50.7	54.3
T_6	0.0	1.6	22.0	30.9	34.2
T_7	1.5	6.2	28.2	37.1	39.3
T_8	1.4	6.2	29.8	39.2	41.5
T_9	3.2	14.8	40.2	52.2	55.7
T_{10}	2.8	13.1	39.4	51.3	54.8
SEm (±)	0.14	0.70	1.91	2.82	2.91
CD (P=0.05)	0.4	2.1	5.7	8.4	8.6
Mean	2.2	8.3	30.8	42.3	45.3

Leaf area index

LAI was measured at 4 different growth stages starting from 120 to 210 DAP on monthly interval (Table 2). Significantly higher leaf area index, 1.84, 2.82, 3.41 and 3.81, respectively, was measured in 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) over rest of the treatments. It might be attributed to higher ethylene evolution due to ethrel treatment which leds to higher leaf area and thus greater light interception and photosynthesis (Mir *et al.*, 2010) [7]. The improvement in leaf area index might be due to foliar application of GA_3 because GA_3 improves the photosynthetic efficiency of the plant through its influence on photosynthetic

enzymes and improving nutrient use efficiency which ultimately enhanced the photosynthetic area of the plant and thus, leaf area index.

Table 2: Leaf area index (LAI) at different growth stages of sugarcane as influenced by different treatments

Treatment	120 DAP	150 DAP	180 DAP	210 DAP
T_1	1.56	2.36	3.02	3.35
T_2	1.59	2.56	3.05	3.45
T_3	1.75	2.79	3.32	3.75
T_4	2.05	3.13	3.62	4.08
T_5	2.02	2.96	3.51	3.94
T_6	1.60	2.61	3.25	3.63
T_7	1.64	2.66	3.21	3.66
T_8	1.88	2.85	3.38	3.88
T_9	2.18	3.25	3.90	4.22
T_{10}	2.16	3.07	3.85	4.13
SEm (±)	0.114	0.144	0.165	0.179
CD (P=0.05)	0.34	0.43	0.49	0.53
Mean	1.84	2.82	3.41	3.81

Plant height

Plant height was recorded at four successive stages from 150 DAP to 240 DAP at maturity level (Table 3). The increase in plant height per month from 150 to 180 DAP was 64.7 cm, 46.9 cm from 180 to 210 DAP and 20.9 cm from 210 to 240 DAP. The plant height under the study was comparatively higher at 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), though the variation at 150 and 180 DAP was found non-significant. It might be due to foliar application of GA_3 which resulted in increase in photosynthetic efficiency of the plant. Jain *et al.* (2013) [3] also reported that GA_3 promotes stem elongation by enhancing invertase activity in apical portion of the cane stalk.

Table 3: Plant height (cm) at different growth stages of sugarcane as influenced by different treatments

Treatment	150 DAP	180 DAP	210 DAP	240 DAP
T_1	155.0	215.0	252.0	268.0
T_2	156.0	219.0	264.0	279.0
T_3	159.0	218.0	263.0	282.0
T_4	169.0	229.0	273.0	292.0
T_5	162.0	222.0	262.0	285.0
T_6	168.0	231.0	281.0	301.0
T_7	163.0	236.0	286.0	310.0
T_8	165.0	233.0	283.0	312.0
T_9	180.0	251.0	307.0	324.0
T_{10}	171.0	241.0	293.0	320.0
SEm (±)	12.02	14.65	16.26	16.92
CD (P=0.05)	NS	NS	48.3	50.3
Mean	164.8	229.5	276.4	279.3

Dry matter accumulation and root dry weight

Significant variation in dry matter was observed from 120 to 210 DAP (Table 4). Significantly higher dry matter accumulation *viz.*, 91.7, 169.8, 220.2 and 257.4 g/plant, respectively was observed in planting of setts after overnight soaking in cattle dung, cattle urine and water slurry in 1: 2: 5 ratios followed by GA_3 spray @ 35 ppm at 90, 120 and 150 DAP (T_8) over rest of the treatments at 120, 150, 180 and 210 DAP. Significant increase in dry matter might be due to increase in leaf area and photosynthetic capacity. Maddoni *et al.* (2001) [6] also reported that canopy structure is strongly related to total amount of intercepted radiation, a vast canopy structure favours dry matter accumulation for maximizing crop yield. Similarly, significantly higher root dry weight *viz.*, 8.0, 15.0, 19.9 and 21.5 g/plant, respectively was observed in planting of setts after overnight soaking in cattle dung, cattle urine and water slurry in 1: 2: 5 ratios followed by GA_3 spray @ 35 ppm at 90, 120 and 150 DAP (T_8) at 120, 150, 180 and 210 DAP (Table 5). It might be due to GA_3 spray at phasic application enhanced root weight which might be due to GA_3-induced cell elongation and cell division activity in the apical meristem. Rao *et al.* (2005) [10] also observed that there is significant increased in root weight when treated with 100 mg/L ethrel.

The experimental evidences warrant the following specific conclusion which may be adopted for maximising germination percentage and for improving growth parameters in spring planted sugarcane in sub tropical areas of India. Among all the treatments, treatment T_4 (planting of setts after overnight soaking in 50 ppm ethrel solution) found most suitable to increase the extent of germination per cent of three budded setts of sugarcane. Treatment T_9 (T_4 + GA_3 spray @ 35 ppm at 90, 120 & 150 DAP) also found to be highly effective in increasing leaf area index, plant height, dry matter accumulation and root dry weight of sugarcane.

Table 4: Dry matter accumulation (g/plant) at different growth stages of sugarcane as influenced due to different treatments

Treatment	120 DAP	150 DAP	180 DAP	210 DAP
T_1	67.5	112.2	167.1	204.6
T_2	74.2	119.2	176.3	225.9
T_3	76.4	125.3	183.1	229.5
T_4	82.2	145.0	193.3	238.3
T_5	78.6	133.1	189.0	233.7
T_6	73.2	116.7	170.4	216.5
T_7	89.3	165.3	217.6	256.3
T_8	91.7	169.8	220.2	257.4
T_9	84.8	156.3	209.4	251.0
T_{10}	82.6	150.7	204.0	246.9
SEm (±)	5.03	6.54	9.15	11.97
CD (P=0.05)	14.9	19.4	27.2	NS
Mean	80.0	139.4	193.0	236.0

Table 5: Root dry weight (g/plant) at different growth stages of sugarcane as influenced due to different treatments

Treatment	120 DAP	150 DAP	180 DAP	210 DAP
T_1	6.6	11.1	16.9	19.4
T_2	6.9	13.5	18.7	19.9
T_3	7.3	14.4	19.1	20.5
T_4	8.2	15.6	20.1	21.7
T_5	7.6	14.8	19.6	21.1
T_6	6.7	12.8	17.6	19.6
T_7	9.4	17.2	22.1	23.5
T_8	9.8	17.8	22.6	24.2
T_9	9.1	16.5	21.5	22.7
T_{10}	8.6	16.1	20.8	22.2
SEm (±)	0.52	0.87	1.09	1.18
CD (P=0.05)	1.6	2.6	3.3	NS
Mean	8.0	15.0	19.9	21.5

References

1. Bathla AVL, Sharma HL. Measurement of leaf area of sugarcane (*Saccharum officinarum* L.) Indian Sugar Crops Journal. 1978; 5(1):16-17.
2. ISMA. Indian Sugar Mills Association. Indian Sugar. 2017; 68(9):70-74.
3. Jain R, Chandra A, Solomon S. Impact of exogenously applied enzymes effectors on sucrose metabolizing

enzymes (SPS, SS and SAI) and sucrose content in sugarcane. Sugar Tech. 2013; 15(4):370-378.
4. Jain R, Shrivastava AK, Solomon S, Yadav RL. Low temperature stress-induced biochemical changes in stubble bud sprouting in sugarcane (*Saccharum* spp. hybrid). Plant Growth Regulation. 2007; 53:17-23.
5. 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, November, Indian Society of Agronomy, New Delhi, India. 2016; 22-26:1310-1312.
6. Maddonni GA, Chelle M, Drouet JL, Andrieu B. Light interception of contrasting azimuth canopies under square and rectangular plant spatial distributions: simulations and crop measurements. Field Crops Research. 2001; 70:1-13.
7. Mir MR, Mobin M, Khan NA, Bhat MA, Lone NA, Bhat KA *et al*. Crop response to interaction between ethylene sources and nitrogen with special reference to oilseed crops. Journal of Phytology. 2010; 2(10):23-33.
8. Mohan N, Kanaujia AK. Biomass energy for economic & environmental sustainability in India. Sharkara. 2017; 48(3):24-26.
9. Rangaswamy R. A Textbook of Agricultural Statistics. New Age International (P) Limited, New Delhi, 2006, 496.
10. Rao MS, Krishnamurthi M, Weerathaworn P. Beneficial effect of ethrel on yield and sucrose productivity of sugarcane cultivars in Thailand. Sugar Tech. 2005; 7(2-3):48-52.
11. Verma I, Roopendra K, Sharma A, Jain R, Singh RK, Chandra A. Expression analysis of genes associated with sucrose accumulation in sugarcane under normal and GA_3-induced source-sink perturbed conditions. Acta Physiologiae Plantarum. 2017; 39:133.