International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 737-743

Received: 22-03-2018
Accepted: 26-04-2018

Plant growth promoters effect on cane, quality and yield parameters in sugarcane (*Saccharum officinarum* l.)

Sujatha P, BNVS Ravi Kumar, NV Naidu, M Charumathi, Beby P and Jayachandra K

Sujatha P
Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Anakapalle, Visakhapatnam, Andhra Pradesh, India

BNVS Ravi Kumar
Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Anakapalle, Visakhapatnam, Andhra Pradesh, India

NV Naidu
Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Anakapalle, Visakhapatnam, Andhra Pradesh, India

M Charumathi
Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Anakapalle, Visakhapatnam, Andhra Pradesh, India

Beby P
Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Anakapalle, Visakhapatnam, Andhra Pradesh, India

Jayachandra K
Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Anakapalle, Visakhapatnam, Andhra Pradesh, India

Correspondence
Sujatha P
Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Anakapalle, Visakhapatnam, Andhra Pradesh, India

Abstract
Naphthalene acetic acid (NAA) at 150 ppm showed more percentage of germination at 30 DAP (64) followed by water soaking (59) compared to gibberellic acid (GA3) as 53. GA3 showed statistically significant effect on tillering (73,000/ha) at 75 DAP and shoot population (1, 13,000/ha) at 120 DAP followed by NAA compared to untreated control. GA3 also recorded numerically high cane length, cane girth and single cane weight. Sett treatment showed a significant effect on purity percentage (NAA 150 ppm as 88.43%), cane yield (GA3 150 ppm as 72.60 t/ha) and CCS yield (GA3 150 ppm as 8.27 t/ha) but not on number of millable canes (‘000/ha), brix, pol reading and percent juice sucrose. Foliar application of gibberellic acid 150 ppm at 45 DAP showed high number of millable canes (86,010 /ha), more pol reading (> 69.50) and cane yield (82.4 t/ha). High percent yield increase was observed with plant growth promoters at 45 DAP (6.21) followed by 30 DAP (5.53) compared to 60 DAP (2.23) compared to control.

Keywords: GA3, NAA, quality, sugarcane, cane yield

Introduction
Sugarcane is an important commercial crop of global importance providing 80% of world sugar requirement. It is commercially propagated through setts or stalk cuttings. Active bud sprouting and germination stage lasts for 45 days followed by the tillering stage upto about 120 days. Tillering is a major yield determining factor (Bell and Garside 2005) [2]. It is followed by the grand growth stage of around 70–170 days, includes internode expansion, structural development and elongation of culms. Finally, maturity stage in which sucrose accumulation begins in the lower internodes and this stage last for about 90 days until harvest of the crop (Fernandis and Benda 1985). Conventionally, about 30-35% of sugarcane buds germinates leading to huge loss in number of millable canes and loss in cane yield. The loss in germination accounts for nearly 25% of the operational cost (Devi *et al.,* 2011, Patel *et al.,* 2014) [6, 17]. Hence, it is the need of the hour to develop a technique that will improve the germination percentage and cane yield. Moreover, higher germination will also help to get more number of millable canes (NMC) and ultimately high yield. Delayed germination and high temperature also restricts tiller formation (Oh-e and others 2007) [15] and productivity. Number of tillers per plant at an early stage determines the number of millable canes, which is the key component of cane yield (Bell and Garside 2005) [2]. This causes severe reduction in the number of millable canes per hectare (NMC ha^{-1}) and cane yields (Bhullar and others 2002; Yadav and others 1997; Bonnett and others 2006) [3, 21, 4].
Application of plant growth regulators (PGRs) in sugarcane alters the sprouting and growth processes. Application of gibberellic acid remarkably increased internodal length in sugarcane (Moore 1980; Jain *et al.,* 2011 and Iqbal *et al.,* 2011) [14, 11, 10]. PGRs like ethephon and gibberellic acid has been found useful to ameliorate these constraints and thus has been effective in improving productivity in sugarcane (Li and Solomon, 2003; Jain *et al*., 2011; El Latieff and Bekheet, 2012) [13, 11, 7]. Higher as well as faster germination along with higher tiller production due to ethephon application has been reported (Page, 1983; Jain *et al*., 2011; Li and Solomon, 2003) [16, 11, 13]. However, no information is available on the application of NAA and GA3 at different growth stages for improving cane characters, quality and cane yield

parameters. Hence, a field experiment was aimed to improve germination /sprouting, tillering, shoot population, quality and yield parameters of sugarcane by the exogenous application of NAA and GA3 through sett treatment and foliar application.

Materials and Methods

Field experiments were conducted during 2009-10 and 2010-11 in the Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Anakapalle, Visakhapatnam, Andhra Pradesh, India. The experiments were laid out in randomized block design with three replications. Sett treatment experiment was conducted with eight treatments using two plant growth promoters (Naphthalene Acetic Acid and Gibberellic Acid) in four concentrations (0ppm, 100 ppm, 150 ppm, 200 ppm). For sett treatment, three budded sugarcane setts of variety 87 A 298 was soaked for 6 hours and planted at the rate of four three budded setts / metre in ridge and furrow method at a spacing of 80 cm between rows.

For foliar application experiment, twenty four treatments were executed using two plant growth promoters (Naphthalene Acetic Acid and Gibberellic Acid) in four concentrations (0 ppm, 100 ppm, 150 ppm, 200 ppm) at three crop growth periods (30 Days After planting, 45 DAP and 60 DAP). Three budded sugarcane setts of variety 87 A 298 were planted without sett treatment at the rate of four three budded setts / metre in ridge and furrow method at a spacing of 80 cm between rows. Plant growth promoters were applied exogenously by foliar spray at three crop growth periods. The crop was fertilized with 112 kg N+ 100 kg P_2O_5+ 120 kg K_2O/ha. The entire dose of phosphorus and potassium as basal at the time of planting. Nitrogen was applied in two equal splits at 30DAP and 60 DAP. Irrigation schedules were taken up once in a week till the break of monsoon period and once in 7-10 days from November. Other cultural practices were followed as per the crop recommendation. For both the experiments, the observations were recorded on cane characters like germination at 30 DAS (only for sett treatment), tillering at 75 DAP (‘000/ha), shoot population at 120 DAP (‘000/ha), cane length (m), cane girth at bottom, middle and top (cm) during cane growth period and single cane weight (kg), number of millable canes (‘000/ha), brix, pol reading, percent juice sucrose, CCS percent, purity percent, cane yield (t/ha) and CCS yield (t/ha) after harvesting.

Juice Brix refers to the total solids content present in the juice expressed in percentage. Brix includes sugars as well as non-sugars. Brix can be measured in the field itself in the standing cane crop using a Hand Refractometer. This is usually referred as a Hand Refractometer Brix or HR Brix. In the field using a pierce collect composite juice samples from several canes. Then place a drop of the composite juice sample in the Hand Refractometer and measure the Brix reading. The circular field gets darkened relative to the Brix level, which could be easily read. The HR Brix meter has graduations from 0 to 32 per cent. The HR Brix readings can be separately taken from both top and bottom. A narrow range indicates ripeness of the cane, while a wide difference indicates that the cane is yet too ripe. On the other-hand if the bottom portion of the cane has lower Brix value than the top, it means that the cane is over-ripened and reversion of sugar is taking place. Juice Sucrose or Pol Per Cent: The juice sucrose per cent is the actual cane sugar present in the juice. It is determined by using a polarimeter, hence sucrose per cent is also referred to as pol per cent. For all practical purposes pol % and sucrose% are synonyms. Now a days an instrument called sucrolyser is also available for determining sucrose% in juice. Purity Coefficient: It refers to the percentage of sucrose present in the total solids content in the juice. A higher purity indicates the presence of higher sucrose content out of the total solids present in juice. The purity percentage along with sucrose percent aids in determining maturity time. A cane crop is considered fit for harvesting if it has attained a minimum of 16% sucrose and 85% purity.

Purity Percentage = (Sucrose %/HR Brix)100.

Commercial Cane Sugar: The commercial cane sugar (CCS) refers to the total recoverable sugar percent in the cane. This could be calculated by the following formula:

CCS (tons/ha) = [Yield (tons/ha) x Sugar Recovery (%)] /100

Sugar Recovery (%) = [S - 0.4 (B - S)] x 0.73

Where, S= Sucrose % in juice and B= Corrected Brix (%)

The data obtained during the course of investigation were subjected to statistical analysis using analysis of variance technique prescribed for randomized block design (two factorial design for sett treatments and three factorial design for foliar application treatments), to test difference among treatment means by the ‘F-test’ (Gomez and Gomez, 1984).

Results

Cane Parameters

Effect of sett treatments with NAA and GA3

The data pertains to the effect of sett treatment with plant growth promoters (NAA and GA3) on cane characters of 87 A 298 is presented in the table 1. Statistically significant difference was observed among the plant growth promoters and control for cane characters like germination (%) at 30 days after planting (DAP), tillering at 75 days and shoot population at 120 days. But the effect was statistically non-significant with regard to cane length (m), cane girth (cm) and single cane weight (kg).

Sett treatment with NAA (Fig.1) showed more percentage of germination at 30 DAP (64) followed by water soaking (59) compared to GA3 (53). With regard to the effect of interactions of growth promoters and concentrations, NAA 150 ppm and 200 ppm showed significantly good effect on seed germination at 30 DAP compared to GA3 and control. Sett treatment with gibberellic acid showed statistically significant effect on tillering (73,000/ha) at 75 DAP and shoot population (1, 13,000/ha) at 120 DAP followed by NAA compared to untreated control (Fig. 2). With regard to shoot population at 120 DAP, GA3 at 100 ppm showed significant superiority over all other treatments. Gibberellic acid showed numerically high (table 1) cane length (2.27cm), cane girth (cm) at bottom (2.77), at middle (2.77), at top (2.73) and single cane weight (1.03kg).

Effect of foliar application of NAA and GA3

The data of the effect of foliar application of plant growth promoters on cane characters is presented in table 2. Plant growth promoters showed a significant effect on the number of tillers at 75 DAP and shoot population at 120 DAP (Fig 3 and 4) compared to untreated control. But the effect was statistically non-significant on cane length (m), cane girth (cm) and single cane weight (kg). Foliar application of gibbberellic acid 100 ppm at 30 DAP showed significantly high number of shoot population at 120 DAP (1, 34,500/ha).

Cane quality and yield parameters

The quality of sugarcane is normally measured by commercial cane sugar (CCS) value, which provides an estimate of the percentage of recoverable sugar (sucrose) from cane. It is used as a criterion to determine the sweetness quality of sugarcane and is calculated from a function of Brix and Pol in juice and cane fiber content (Albertson and Grof, 2004) [1].

Effect of sett treatment with NAA and GA3

Data presented in table 3 shows that there was a significant effect of growth promoters on the purity percentage, cane yield (t/ha) and CCS yield (t/ha). But there was no significant effect of plant growth promoters on number of millable canes (‘000/ha), brix, pol reading and percent juice sucrose. Among the interactions, NAA 150 ppm showed more purity percent (88.43). Sett treatment of GA3 150 ppm showed significantly high cane yield (72.60 t/ha) and CCS yield (8.27 t/ha) compared to all other treatments (table 3). Sett treatment with gibberellic acid (Fig.5 and Fig. 6) showed more cane yield and CCS yield (67.7 t/ha and 7.58 t/ha, respectively) followed by NAA (63.5 t/ha and 7.25 t/ha, respectively) compared to untreated control (62.6 t/ha and 6.76 t/ha, respectively).

Effect of foliar application of NAA and GA3

Data presented in table 4 reveals that there was a significant effect of foliar application of growth promoters on the number of millable canes (‘000/ha), pol reading, purity (%), cane yield (t/ha) and CCS yield (t/ha). But no significant effect was observed on brix, percent juice sucrose and CCS percent. Foliar application of gibberellic acid 200 ppm at 30 DAP and 150 ppm at 45 DAP showed high number of millable canes at 75 DAP (86,010 /ha) followed by NAA compared to untreated control (Figure 7). Gibberellic acid (table 4) of 150 ppm at 30 and 45 DAP showed more pol reading (> 69.50). Among the crop durations, foliar application of gibberellic acid at 45 DAP showed comparatively high pol reading. GA3 150 ppm at 30 DAP recorded high purity (88.00%) and CCS yield (8.97 t/ha) compared to all other treatments. Similarly, GA3 150 ppm at 45 DAP recorded more cane yield (82.4 t/ha) compared to other treatments. Plant growth promoters recorded more cane yield compared to control (Fig 8). The percent yield increase was observed to be high when the plant growth promoters applied at 45 DAP (6.21) followed by 30 DAP (5.53) compared to 60 DAP (2.23) compared to control.

Discussion

Cane Parameters

Similar finding of more germination with NAA and less with GA3 was reported by Jayesh *et al.,* 2013 as sett treatment with carbendazim (0.1%) + GA3 @ 100 ppm for 15 minutes (T2) had immense negative impact on germination. Similarly, Darpana Patel and Rinku Patel. (2014) [17] reported a non significant differences in cane yield, ccs yield and juice quality parameters due to sett treatment either with carbendazim @ % alone or along with gibberellic acid @ 100 ppm for 15 minutes. Sett treatment with carbendazim @ 0. 1% alone or along with gibberelic acid @ 100 ppm for 15 minutes had no beneficial effect on germination of buds, cane or sugar yields. Whereas, an improvement in emergence due to ethephon treatment has also been reported by many workers (Jain *et al*., 2011, Li and Solomon *et al*., 2003 and Solomon *et al*., 1998) [11, 13, 18]. Sett soaking with water also successfully improved emergence percent. Improvement in germination in water soaking treatment might be due to faster conversion of carbohydrates to reducing sugar. Higher bud sprouting due to soaking of setts in water has also been reported by Tudu *et al.* (2007) [20].

In the similar lines, improving photosynthetic efficiency due to Gibberellic acid application has also been reported by Iqbal *et al*. (2011) [10]. Improvement in stalk height due to foliar application of Gibberellic acid was also reported by El-lattief and Bekheet (2012) [7].

Cane quality and yield parameters

An improvement in cane height, cane thickness and number of millable canes and yield due to Gibberellic acid application has also been reported by Ellattief and Bekheet (2012) [7]. Similarly, overnight sett soaking with 100 ppm ethephon followed by foliar application of gibberellic acid @ 35 ppm at 90, 120 and 150 days after planting was found to be the best proposition to improve yield attributes and yield (Subhashisa *et al*., 2016) [19].

Table 1: Effect of sett treatment with plant growth promoters on different plant characters in 87 A 298

Treatment		Germination At 30 DAP (%)	Tillering at 75 DAP (‘000/ha)	Shoot Population At 120 DAP (‘000/ha)	Cane length (m)	Cane girth (cm)			Single Cane Wt (kg)
						Bottom	Middle	Top	
NAA	0 ppm	58.90	68.70	108.00	2.07	2.73	2.73	2.33	0.87
	100 ppm	65.70 cba	74.30 cba	110.00	2.17	2.67	2.73	2.23	0.90
	150 ppm	64.30 cba	66.30	110.00	2.07	2.63	2.63	2.13	0.94
	200 ppm	62.70 c	68.70	103.00	2.25	2.73	2.77	2.17	0.83
GA_3	0 ppm	58.30	68.30	106.00	2.13	2.73	2.57	2.37	0.90
	100 ppm	57.30	69.00	121.00cba	2.07	2.63	2.73	2.23	0.91
	150 ppm	56.00	74.70cb	109.00	2.27	2.77	2.77	2.37	1.03
	200 ppm	55.70	74.70 cb	108.70	2.13	2.73	2.73	2.33	0.93
Mean CD0.05		59.74	71.09	109.46	2.15	2.70	2.71	2.27	0.91
Growth Promoter (a)		1.792	3.056	2.903	0.262	0.353	0.168	0.178	0.197
Concentration (b)		2.534	4.322	4.105	0.371	0.499	0.237	0.252	0.279
Growth Promoter X Concentration (c)		3.584	6.112	4.806	0.524	0.706	0.336	0.357	0.395

Table 2: Effect of spraying of plant growth promoters on different plant characters in 87 A 298

Treatment			Tillering at 75 DAP ('000/ha)	Shoot Populn. at 120 DAP ('000/ha)	Cane length(m)	Cane girth (cm)			Single cane Wt (kg)
						Bottom	Middle	Top	
30 DAP	NAA	0 ppm	74.13	115.77	2.38	2.77	2.85	2.15	0.90
		100 ppm	76.33^{ge}	121.43	2.00	2.67	2.73	2.33	0.90
		150 ppm	74.00	127.33	2.28	2.80	2.82	2.15	1.06
		200 ppm	76.00^{ge}	119.00	2.37	2.73	2.84	2.30	0.92
	GA_3	0 ppm	74.07	123.00	2.35	2.63	2.50	2.21	0.87
		100 ppm	76.33^{g}	134.50^{*}	2.31	2.80	2.61	2.30	1.04
		150 ppm	75.53^{g}	103.33	2.30	2.57	2.49	2.46	0.97
		200 ppm	74.77^{g}	117.00	2.37	2.60	2.75	2.15	0.91
45 DAP	NAA	0 ppm	72.67	113.00	2.08	2.73	2.63	2.26	0.99
		100 ppm	74.00	116.00	2.14	2.59	2.58	2.25	1.00
		150 ppm	78.10^{*}	102.33	2.13	2.59	2.50	2.23	0.91
		200 ppm	70.83	106.67	2.23	2.77	2.70	2.35	0.97
	GA_3	0 ppm	72.73	107.03	2.27	2.73	2.80	2.41	0.93
		100 ppm	75.50^{g}	130.83^{g}	2.47	2.70	2.50	2.32	0.85
		150 ppm	74.50^{g}	134.27^{*}	2.40	2.77	2.62	2.23	0.95
		200 ppm	75.00^{g}	109.33	2.27	2.80	2.60	2.14	0.97
60 DAP	NAA	0 ppm	69.03	106.67	2.13	2.59	2.60	2.20	0.96
		100 ppm	73.67	134.00*	2.27	2.77	2.85	2.35	0.98
		150 ppm	79.33^{*}	124.17	2.33	2.87	2.90	2.41	0.89
		200 ppm	72.67	134.00*	2.37	2.83	2.79	2.32	0.97
	GA_3	0 ppm	70.87	107.33	2.20	2.67	2.84	2.31	0.97
		100 ppm	76.33^{ge}	116.00	2.13	2.67	2.83	2.26	0.97
		150 ppm	72.83	103.00	2.30	2.50	2.66	2.09	1.03
		200 ppm	69.67	104.67	2.20	2.83	2.75	2.20	1.05
Mean			74.12	117.11	2.26	2.71	2.70	2.27	0.96
CD0.05									
Days After Planting (a)			1.706	1.517	0.131	0.112	0.131	0.296	0.112
Growth Promoter(b)			1.393	1.239	0.107	0.092	0.107	0.242	0.091
Concentration(c)			1.970	1.753	0.152	0.130	0.151	0.342	0.129
Days After Planting X Growth Promoter (d)			2.412	2.147	0.186	0.159	0.185	0.419	0.158
Days After Planting X Concentration (e)			3.411	3.036	0.263	0.225	0.262	0.593	0.224
Growth Promoter X Concentration (f)			2.785	2.479	0.214	0.185	0.214	0.484	0.183
Days After Planting X Growth Promoter X Concentration (g) *** gfedcba**			4.826	4.294	0.421	0.281	0.437	0.888	0.263

Table 3: Effect of sett treatment with plant growth promoters on cane quality and yield in 87 A 298

Treatment		NMC ('000/ha)	Brix	Pol reading	Percent juice Sucrose	CCS percent	Purity percent	Cane Yield (t/ha)	CCS Yield (t/ha)
NAA	Control	70.10	19.70	68.90	16.60	11.21	84.10	61.73	6.92
	100 ppm	72.67a	19.40	67.70	16.90	11.61	85.00	64.83	7.52
	150 ppm	70.33	19.20	70.00	16.90	11.67	88.43^{cba}	65.20	7.61
	200 ppm	70.33	19.30	67.20	16.20	10.92	84.00	60.53	6.61
GA_3	Control	70.00	19.00	65.00	15.60	10.40	83.03	63.43	6.59
	100 ppm	70.27	19.20	67.50	16.30	11.05	85.33	65.67	7.26
	150 ppm	70.30	19.80	70.10	16.80	11.39	85.33	72.60^{cba}	8.27^{cba}
	200 ppm	70.33	19.70	68.30	16.50	11.11	83.83	64.83	7.20
Mean		70.62	19.41	68.09	16.48	11.17	84.92	64.85	7.25
CD0.05									
Growth Promoter (a)		1.579	1.741	2.681	1.223	0.966	2.049	1.963	0.251
Concentration (b)		2.191	2.462	3.792	1.730	1.366	2.898	2.777	0.355
Growth Promoter X Concentration (c)		3.099	3.482	5.363	2.447	1.932	4.099	3.927	0.502

Table 4: Effect of spraying of plant growth promoters on cane quality and yield in 87 A 298

Treatment			NMC ('000/ha)	Brix	Pol reading	Percent juice Sucrose	CCS percent	Purity percent	Cane Yield (t/ha)	CCS Yield (t/ha)
30 DAP	NAA	0 ppm	74.13	18.80	66.00	16.00	10.86	80.00	70.31	7.64
		100 ppm	74.23	19.55	67.23	16.20	10.85	83.14	67.97	7.37
		150 ppm	78.51	19.47	66.63	16.10	10.77	83.05	80.10	8.63
		200 ppm	82.03	18.60	66.00	16.00	10.92	86.00^{g}	76.56	8.36
	GA_3	0 ppm	76.03	19.47	64.00	15.41	10.06	79.30	72.66	7.31
		100 ppm	70.31	19.53	68.30^{ge}	16.44	11.10	84.01	71.10	7.89
		150 ppm	78.02	19.15	70.08^{*}	17.00	11.78	88.00^{*}	76.17	8.97

		200 ppm	86.01^{g}	19.45	67.18	16.20	10.88	83.21	78.52	8.54
45 DAP	NAA	0 ppm	70.13	19.05	67.00	16.23	10.90	85.00	71.00	8.09
		100 ppm	76.16	19.17	66.70	16.01	10.91	84.00	75.40	8.15
		150 ppm	70.34	19.42	67.60^{g}	16.30	10.92	84.40	76.00	8.24
		200 ppm	78.11	19.87	69.50^{*}	16.71	10.93	85.01	67.00	8.19
	GA_3	0 ppm	70.13	19.45	67.15	16.20	10.94	82.10	70.00	8.17
		100 ppm	70.31	19.62	69.20^{*}	16.66	11.04	85.00	75.40	8.28
		150 ppm	86.01^{g}	19.55	69.50^{*}	16.73	11.04	86.00^{g}	82.40^{*}	8.33
		200 ppm	70.30	18.90	64.10	15.50	10.94	82.00	75.40	8.25
60 DAP	NAA	0 ppm	70.17	19.50	64.30	15.50	10.95	80.10	70.00	8.21
		100 ppm	78.12	18.72	64.00	15.50	10.96	83.00	76.60	8.23
		150 ppm	78.12	19.10	61.00	15.00	10.97	79.00	65.23	8.24
		200 ppm	69.52	19.30	68.83^{gfed}	16.60	10.97	86.10^{g}	78.00	8.24
	GA_3	0 ppm	72.17	19.17	67.00	16.40	10.98	83.40	70.70	8.24
		100 ppm	78.13	19.17	67.00	16.10	10.98	84.11	60.12	8.25
		150 ppm	76.17	19.50	67.41^{g}	16.25	10.97	83.13	82.03^{g}	8.25
		200 ppm	73.46	19.65	69.00^{*}	16.60	10.97	85.00	69.53	8.24
Mean			76.94	19.32	66.91	16.15	10.94	83.77	74.11	8.21
$CD_{0.05}$										
Days After Planting (a)			1.172	0.322	0.986	0.781	0.705	0.878	0.783	0.717
Growth Promoter(b)			0.957	0.263	0.805	0.637	0.576	0.717	0.639	0.586
Concentration(c)			1.354	0.372	1.138	0.902	0.814	1.014	0.904	0.828
Days After Planting X Growth Promoter (d)			1.658	0.456	1.394	1.104	0.997	1.242	1.108	1.015
Days After Planting X Concentration (e)			2.345	0.645	1.972	1.562	1.410	1.757	1.567	1.435
Growth Promoter X Concentration (f)			1.915	0.527	1.610	1.275	1.152	1.435	1.279	1.172
Days After Planting X Growth Promoter X Concentration (g)			3.11	1.027	2.596	2.413	2.760	2.683	2.357	2.145

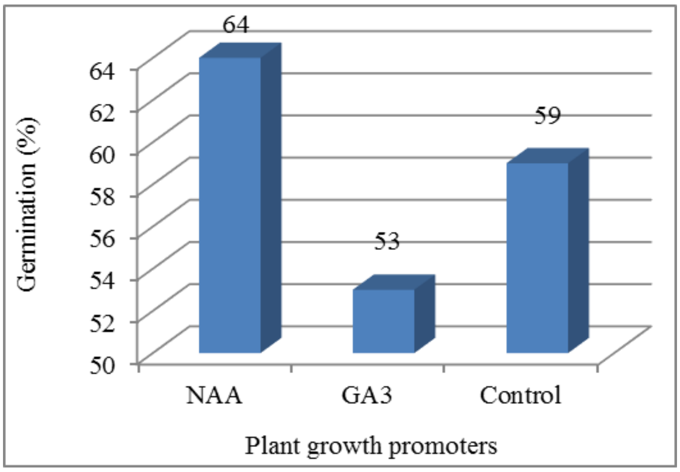

Fig 1: Effect of sett treatment on germination (%) at 30 days after planting

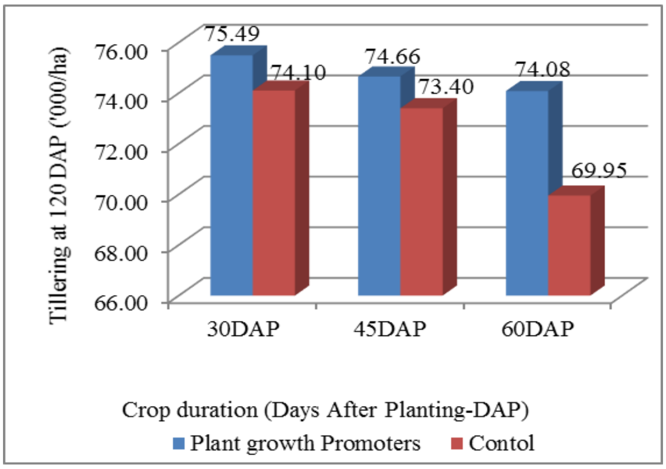

Fig 3: Effect of spraying of plant growth promoters on the tillering at 75DAP ('000/ha)

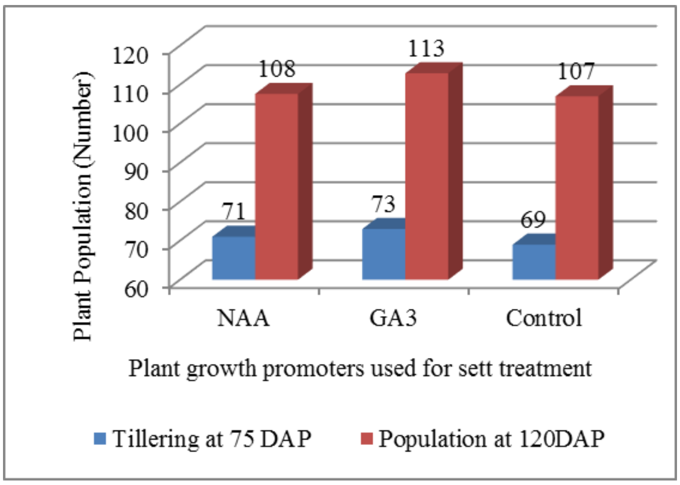

Fig 2: Effect of sett treatment on tillering and shoot population

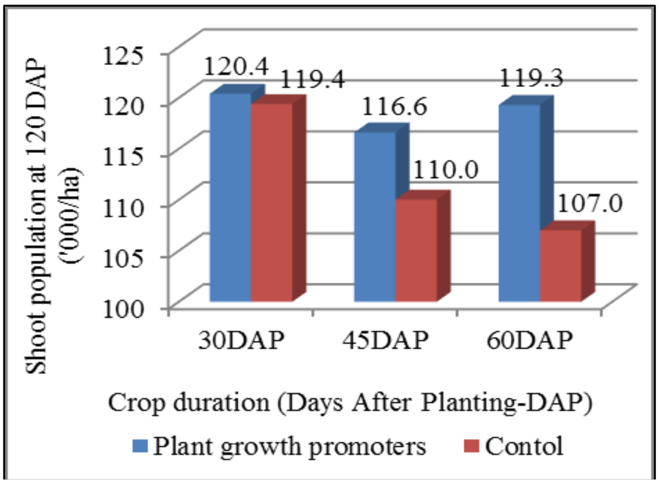

Fig 4: Effect of spraying of plant growth promoters on the shoot population at 120 DAP ('000/ha)

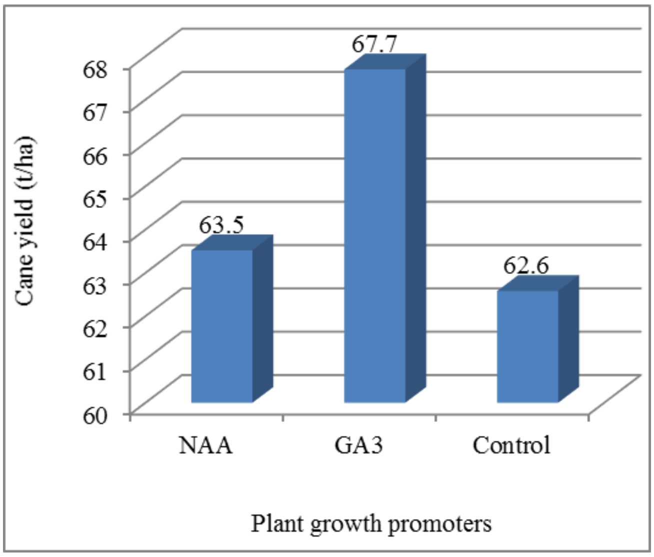

Fig 5: Effect of sett treatment on cane yield (t/ha)

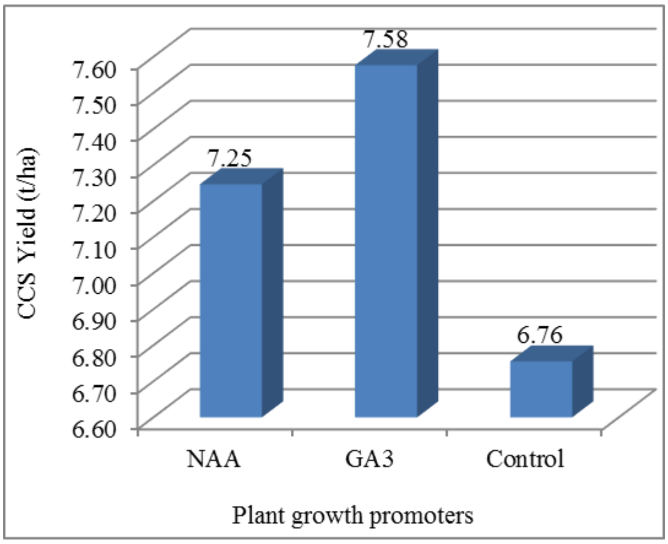

Fig 6: Effect of sett treatment on CCS yield (t/ha)

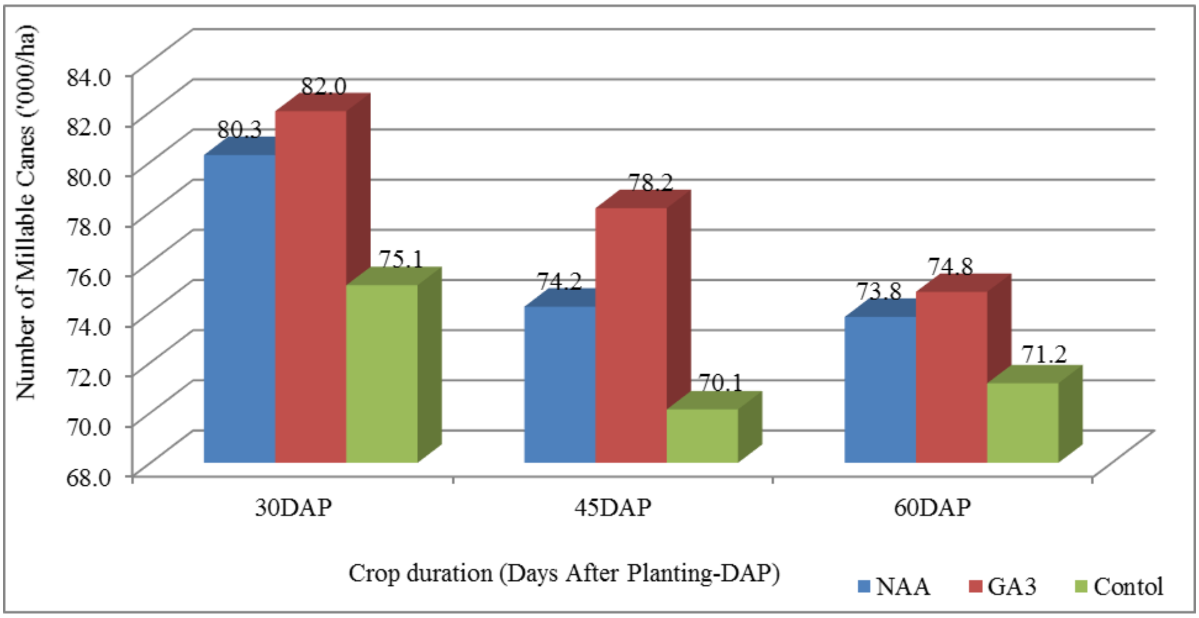

Fig 7: Effect of spraying of plant growth promoters on the number of millable canes (‘000/ha)

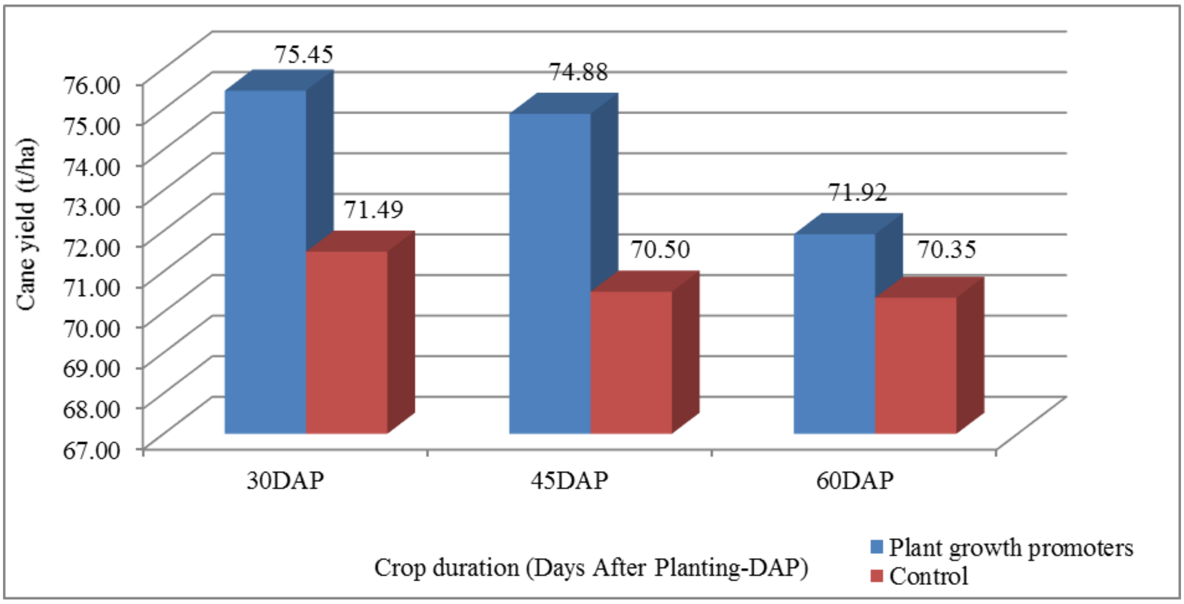

Fig 8: Effect of spraying of plant growth promoters at different crop growth intervals on cane yield (t/ha)

Acknowledgements

The authors gratefully acknowledge the financial help rendered by the Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad and technical support rendered by the staff of the Department of Genetics and Plant Breeding, Regional Agricultural research Station, Anakapalle.

References

1. Albertson PL, Grof CPL. The effect of hexose upon Pol, Brix and calculated CCS in sugarcane: A potential for negative Pol bias in juice from actively growing cane. Journal of the American Society of Sugar Cane Technologists. 2004; 24:185-198.
2. Bell MJ, Garside AJ. Shoot and stalk dynamics and yield of sugarcane crops in tropical and sub-tropical Queensland, Australia. Field Crops Res. 2005; 92:231-248.
3. Bhullar MS, Saini LK, Kapur ML, Singh S. Effect of Method and Density of Planting on Growth and Yield of Late Planted Sugarcane. Sugar Tech. 2002; 4(3,4):181-184.
4. Bonnett GD, Hewit ML, Glassop D. Effects of high temperature on the growth and composition of sugarcane internodes. Aust J Agric Res. 2006; 57:1087-1095.
5. Darpana Patel, Rinku Patel. Influence of sett size, seed rate and sett treatment on yield and quality of sugarcane. The Bioscan. 2014; 9(1):55-57.
6. Devi TC, Gouri V, Naidu NV, Rao KP. Studies on the effect of sett size, seed rate and sett treatment on yield and quality of sugarcane. Indian J. Sugarcane Technology. 2011; 26(2):59-60.
7. El-Lattief EAA, Bekheet MA. Quantitative and qualitative attributes of three sugarcane varieties as influenced by foliar spray of some growth regulators under upper Egypt conditions. Sugar Tech. 2012; 14(4):345-350.
8. Fernandis AC, Benda GTA. Distribution pattern of brix and fibre in primary stalk of sugarcane. Sugarcane. 1985; 5:8-13.
9. Gomez KA, Gomez AA. Statistical procedure for agricultural research. John Wiley and Sons, New York, 1984, 20-27.
10. Iqbal N, Nazar R, Khan MIR, Masood A, Kahan NA. Role of gibberellins in regulation of source-sink relations under optimal and limiting environmental conditions. Current Science. 2011; 100(7):998-1007.
11. Jain R, Solomon S, Chandra A. Some discernible Physiobiochemical changes associated with improved sprouting of sugarcane setts treated with Ethephon. Sugar tech 2011; 13(2):123-128.
12. Jayesh Singh, Rajender Kumar, Uppal SK. Effect of sett size, seed rate and sett treatment on growth and productivity of sugarcane (*Saccharum Officinarum* L.). J Res Punjab Agric Univ. 2013; 50(1, 2):5-7
13. Li Y, Solomon S. Ethephon: a versatile growth regulator for sugarcane industry. Sugar Tech. 2003; 5(4):213-223.*ne*
14. Moore PH. Additive and non-additive effects of serial applications of GA3 on sugarcane internodal growth. Physiol Plant. 1980; 49:271-276.
15. Oh-e I, Saitoh K, Kuroda T. Effects of high temperature on growth, yield and dry-matter production of rice grown in the paddy field. Plant Prod Sci. 2007; 10:412-422.
16. Page DL. Ethephon: A remarkably versatile growth regulator for sugarcane. Sugar Y Azucar. 1983; 78:12-14.
17. Patel D, Patel R. Influence of sett size, seed rate and sett treatment on yield and quality of sugarcane. The Bioscan. 2014; 9(1):55-57.
18. Solomon S, Singh I, Madan VK. Effect of 2-chloroethyl phosphonic acid on early growth and advancement of maturity in sugarcane. In: Proceedings of 60th annual convention of the Sugar Technologists Association of India, Shimla, 1998, 10-16.
19. Subhashisa Praharaj, Dheer Singh, Guru SK. Effect of ethephon and gibberellic acid on emergence, yield attributes and yield of *saccharum officinarum* l. The bioscan. 2016; 11(4):2675-2678.
20. Tudu S, Mandal D, De GC. Studies on sprouting and rooting of single Budded sugarcane setts in seedbed. Agric. Sci. Digest. 2007; 27(3):222-224.
21. Yadav RL, Singh RV, Singh R, Srivastava VK. Effect of planting geometry and fertilizer N on nitrate leaching, NUE and sugarcane yield. Trop Agric. 1997; 74:115-120.