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Ghodke SK

Central Sugarcane Research Station, Padegaon, Phaltan, Satara, Maharashtra, India

Bhilare RL

Central Sugarcane Research Station, Padegaon, Phaltan, Satara, Maharashtra, India

Thorave DS

Central Sugarcane Research Station, Padegaon, Phaltan, Satara, Maharashtra, India

Nalawade SV

Central Sugarcane Research Station, Padegaon, Phaltan, Satara, Maharashtra, India

Raskar BS

Central Sugarcane Research Station, Padegaon, Phaltan, Satara, Maharashtra, India

Use of plant growth hormones with different nutrients in sugarcane

Ghodke SK, Bhilare RL, Thorave DS, Nalawade SV and Raskar BS

Abstract

A field experiment was conducted at Central Sugarcane Research Station, Padegaon Farm Tal Phaltan Dist. Satara (M.S.) in pre-seasonal sugarcane (2018-19) with object of to assess effect of foliar sprays of plant growth regulators and fertilizer nutrients on yield and quality of sugarcane, nutrient uptake of sugarcane and to find out the most effective combination of plant growth regulators and fertilizer nutrients for yield maximization in sugarcane. It consists of main plot treatment as plant growth regulators with sub plot treatment comprising fertilizer nutrient spray. The total five successive foliar sprays of plant growth regulators and fertilizer nutrients were taken from 45 to 125 days after planting with an interval of 20 days. In plant growth regulators foliar spray of GA₃ + Six BA 40 ppm each recorded significantly higher cane yield, CCS yield, average cane weight and number of millable cane (187.19 t ha⁻¹, 24.97 t ha⁻¹, 1.91 kg and 102.33 '000' ha⁻¹, respectively) and at par with foliar spray of IBA + GA₃ + Six BA 40 ppm each. However, In foliar nutrient spray significantly higher cane yield, CCS yield, average cane weight and number of millable cane (186.52 t ha⁻¹, 24.92 t ha⁻¹, 1.92 kg and 101.89 '000' ha⁻¹, respectively) were observed in foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon and at par with foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient. The soil chemical properties were also improved in both foliar spray of plant growth regulators and nutrient fertilizer. Significantly the highest total nitrogen, phosphorus and potassium uptake were recorded in foliar spray of GA₃ + Six BA 40 ppm each in plant growth regulators and 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon in fertilizer nutrient spray. The spraying of plant growth regulators, nutrient and their interactions were found non-significant influence on juice quality parameters. In plant growth regulators higher gross return, net return and B:C ratio were recorded in foliar spray of GA₃ + Six BA 40 ppm each (Rs. 514773 ha⁻¹, Rs.371641 ha⁻¹ and 2.60, respectively) and in fertilizer nutrient foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon recorded significantly higher gross return and net return (Rs. 512930 ha⁻¹ and Rs. 364211 ha⁻¹) while higher B:C ratio (2.49) was noticed in foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient. The foliar application of Gibberellic Acid (GA₃) + Six Benzylaminopurine (Six BA) 40 ppm each with 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% Silicon with general recommended dose of fertilizer (FYM 25 t ha⁻¹, 340:170:170 N, P₂O₅ and K₂O kg ha⁻¹) were found most effective beneficial combination for increasing sugarcane and commercial cane yield.

Keywords: Plant growth regulators, fertilizer nutrients, foliar spray, chelated micronutrient, silicon

Introduction

Sugarcane is the important cash crop of the Maharashtra state. The cultivation of sugarcane is predominantly increasing in command areas of Maharashtra since last five to six decades. The area under sugarcane in Maharashtra state is about 10 lakh hectare and ranks 2nd in India, while productivity is 80 tonnes per hectare and ranks 4th in India. There are limitations to increase area under sugarcane but we have scope to increase per hectare productivity by improved technologies such as judicious use of nutrients, PGR, water etc. Sugarcane yield mainly depends on cane population and weight of each cane. Sugarcane has a high yield potential. According to Naidu and Venkatramana (1987) [3] the theoretical yield could be 340 t ha⁻¹. In spite of fulfilling all the agronomic inputs, the sugarcane yield levels could not go beyond 175 to 200 tonnes per hectare. Under field condition, there may be some factors which hamper the growth of crop viz., unexpected climatic factors, nutrient interactions, uptake of nutrient and water. Under such condition application of plant growth regulators could trigger the growth process (Yadav, 1993 and Devlin and Witham, 1986) [6, 2]. Considering all these possibilities the present study was proposed with object of to assess effect of foliar sprays of plant growth regulators and fertilizer nutrients on yield and quality of sugarcane, nutrient uptake of sugarcane and to find out the most effective combination of plant growth regulators

Corresponding Author:**Ghodke SK**

Central Sugarcane Research Station, Padegaon, Phaltan, Satara, Maharashtra, India

and fertilizer nutrients for yield maximization in sugarcane.

Materials and Methods

A field experiment was conducted at Central Sugarcane Research Station, Padegaon Farm Tal Phaltan Dist. Satara (M.S.) in preseasonal sugarcane (2018-19) with an object of to assess effect of foliar sprays of plant growth regulators and fertilizer nutrients on yield and quality of sugarcane, nutrient uptake of sugarcane and to find out the most effective combination of plant growth regulators and fertilizer nutrients for yield maximization in sugarcane.

The two eye bud sugarcane setts of variety CoM 0265 with row spacing 120 x 15 cm was planted in medium deep black soil with general recommended dose of fertilizer (FYM 25 t ha⁻¹, 340:170:170 N, P₂O₅ and K₂O kg ha⁻¹), experiment laid down in factorial randomized block design with three replications. It consists of four factors of plant growth regulators as main plot treatment viz, P₁-Control (without sprays), P₂-Foliar spray of IBA + Six BA 40 ppm each, P₃-Foliar spray of GA₃ + Six BA 40 ppm each and P₄-Foliar spray of IBA + GA₃ + Six BA 40 ppm each with four factor of fertilizer nutrient spray as sub plot treatment viz, N₁-Control (without sprays), N₂-Foliar spray of 1% 19:19:19, N₃-Foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient and N₄-Foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon (Aminosalicylic Acid). The total five successive sprays were taken start from 45 days up to 125 days at an interval of 20 days with knapsack spray pump. Firstly, all plant growth regulators were dissolving in their solvent then add these PGR and water soluble nutrient in water for making of stock solution which was used for spraying. The general recommended dose of fertilizer was common to all treatments. The soil and plant were analyzed by recommended standard method.

The initial soil status was pH 7.81, E.C.0.22 dS m⁻¹, O.C. 0.59%, available N 168.17 kg ha⁻¹, available P 23.14 kg ha⁻¹

and available K 307.84 kg ha⁻¹. Statistical analysis of the sugarcane data was worked out as per the method described by Panse and Sukhatme (1967) [4].

Results and Discussion

1. Growth and yield parameters

The data on growth and yield parameters of plant cane are presented in table 1 and showed that in foliar spray of plant growth regulators treatment P₃ receiving foliar spray of GA₃ + Six BA 40 ppm each recorded significantly higher tillering ratio, girth, number of internodes and millable height (3.65, 10.19 cm, 27.88 and 249.67 cm, respectively) and at par with treatment P₄ receiving foliar spray of IBA + GA₃ + Six BA 40 ppm each. In nutrient spray the significantly the highest tillering ratio, girth, number of internodes and millable height (3.54, 10.30 cm, 26.16 and 248.92 cm, respectively) were observed in treatment N₄ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon and at par with treatment N₃ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient. While non-significant results were showed in germination percentage.

In foliar spray of plant growth regulators treatment P₃ receiving foliar spray of GA₃ + Six BA 40 ppm each recorded significantly higher cane yield, CCS yield, average cane weight and number of millable cane (187.19 t ha⁻¹, 24.97 t ha⁻¹, 1.91 kg and 102.33 '000' ha⁻¹, respectively) however, it was at par with treatment P₄ receiving foliar spray of IBA + GA₃ + Six BA 40 ppm each. In nutrient spray the significantly the highest cane yield, CCS yield, average cane weight and number of millable cane (186.52 t ha⁻¹, 24.92 t ha⁻¹, 1.92 kg and 101.89 '000' ha⁻¹, respectively) were observed in treatment N₄ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon and it was at par with treatment N₃ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient. These findings are in conformity with results of Cong Truc Nguyen *et al.*, (2019) [1].

Table 1: Effect of foliar spray of plant growth regulators and fertilizer nutrients on growth and yield parameters of sugarcane at harvest

Treatments	Germination (%)	Tillering Ratio	Girth (cm)	Number of internode	Millable height (cm)	ACW (kg)	NMC ('000' ha ⁻¹)	Cane Yield (t ha ⁻¹)	CCS Yield (t ha ⁻¹)
Factor A: Plant growth regulators Spray									
P ₁ : Control (without sprays)	69.13	2.49	9.81	23.25	222.25	1.73	91.60	158.44	21.02
P ₂ : Foliar spray of IBA + Six BA 40 ppm each	67.54	3.61	9.98	24.33	239.55	1.77	97.64	175.11	23.45
P ₃ : Foliar spray of GA ₃ + Six BA 40 ppm each	72.71	3.65	10.19	27.88	249.67	1.91	102.33	187.19	24.97
P ₄ : Foliar spray of IBA + GA ₃ + Six BA 40 ppm each	72.25	3.45	10.03	26.87	243.78	1.88	99.73	184.10	24.74
SE+	2.12	0.12	0.06	0.39	2.53	0.04	1.00	1.53	0.24
CD at 5%	NS	0.34	0.17	1.03	7.13	0.11	2.97	5.29	0.82
Factor B: Nutrient sprays									
N ₁ : Control (without sprays)	68.46	2.64	9.71	24.91	236.17	1.76	92.12	160.12	21.25
N ₂ : Foliar spray of 1% 19:19:19	69.58	3.49	9.91	25.17	228.58	1.80	97.76	174.73	23.33
N ₃ : Foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient	72.67	3.53	10.09	26.09	241.58	1.81	99.53	183.48	24.68
N ₄ : Foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon (Aminosalicylic Acid)	70.92	3.54	10.30	26.16	248.92	1.92	101.89	186.52	24.92
S.Em+	2.30	0.04	0.13	0.31	3.71	0.04	1.00	2.20	0.60
CD at 5%	NS	0.11	0.37	0.79	10.82	0.11	2.99	5.67	1.78
C. Interactions									
SE+	4.59	0.16	0.25	1.22	7.41	0.09	2.15	8.40	1.19
CD at 5%	NS	NS	NS	NS	NS	0.27	NS	NS	NS
General Mean	7.83	3.53	10.02	25.58	238.81	1.71	76.82	140.56	17.96

IBA: Indole Butyric Acid GA₃: Gibberellic Acid Six BA: Six Benzyl Adenine
 CCS: Commercial Cane Sugar ACW: Average Cane Weight NMC: Number of Millable Cane

2. Soil chemical properties: The soil chemical properties have been analyzed before and after harvest of sugarcane are presented in table 2 and observed that the non-significant effect were noticed on soil pH, EC and organic carbon after harvest of sugarcane. In an effect of foliar spray of plant growth regulators treatment P₃ receiving foliar spray of GA₃ + Six BA 40 ppm each recorded significantly higher available nitrogen, phosphorus and potassium (188.10 kg ha⁻¹, 29.85 kg ha⁻¹ and 300.26 kg ha⁻¹, respectively) and it was at par with treatment P₄ receiving foliar spray of IBA + GA₃ + Six BA 40 ppm each. In nutrient spray the treatment N₄ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon recorded significantly higher available nitrogen, phosphorus and potassium (185.58 kg ha⁻¹, 29.84 kg ha⁻¹ and 300.90 kg ha⁻¹, respectively) and it was at par with treatment N₃ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient. These results were resembled with the findings

of Rao *et al.* (2002) [5].

3. Total nutrient uptake

The data on total nutrient uptake are presented in table 2 and showed that in effect of foliar spray of plant growth regulators significantly the highest total nitrogen, phosphorus and potassium uptake were recorded in treatment P₃ receiving foliar spray of GA₃ + Six BA 40 ppm each (272.98 kg ha⁻¹, 37.25 kg ha⁻¹ and 348.75 kg ha⁻¹, respectively) and it was at par with treatment P₄ receiving foliar spray of IBA + GA₃ + Six BA 40 ppm each. In nutrient spray treatment N₄ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon recorded significantly higher available nitrogen, phosphorus and potassium (271.98 kg ha⁻¹, 36.85 kg ha⁻¹ and 347.41 kg ha⁻¹, respectively) and it was at par with treatment N₃ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient.

Table 2: Effect of foliar spray of plant growth regulators and fertilizer nutrients on soil properties and total nutrient uptake of sugarcane at harvest

Treatments	pH (1:2.5)	EC (dS m ⁻¹)	OC (%)	Available nutrient (kg ha ⁻¹)			Total nutrient uptake (kg ha ⁻¹)		
				N	P	K	N	P	K
Factor A: Plant growth regulators Spray									
P ₁ : Control (without sprays)	7.86	0.21	0.58	164.97	15.60	254.76	229.86	20.00	291.25
P ₂ : Foliar spray of IBA + Six BA 40 ppm each	7.86	0.22	0.59	169.61	17.45	260.94	254.86	30.01	324.59
P ₃ : Foliar spray of GA ₃ + Six BA 40 ppm each	7.89	0.27	0.59	188.10	29.85	300.26	272.98	37.25	348.75
P ₄ : Foliar spray of IBA + GA ₃ + Six BA 40 ppm each	7.87	0.27	0.60	183.09	25.84	290.92	268.35	35.40	342.57
SE+	0.03	0.03	0.01	2.33	1.83	3.14	1.93	1.57	2.97
CD at 5%	NS	NS	NS	8.27	5.28	9.57	5.77	4.38	9.21
Factor B: Nutrient sprays									
N ₁ : Control (without sprays)	7.87	0.21	0.59	165.98	16.00	252.10	232.38	21.01	294.61
N ₂ : Foliar spray of 1% 19:19:19	7.86	0.26	0.58	170.54	17.82	262.18	254.29	29.78	323.83
N ₃ : Foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient	7.86	0.27	0.60	185.58	29.84	300.90	267.42	35.03	341.33
N ₄ : Foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon (Aminosalicylic Acid)	7.87	0.21	0.59	183.66	25.07	291.68	271.98	36.85	347.41
SE+	0.02	0.03	0.01	2.07	1.67	3.59	2.09	1.03	3.44
CD at 5%	NS	NS	NS	5.34	5.22	10.33	6.89	3.11	9.78
C. Interactions									
SE+	0.02	0.03	0.02	9.12	8.28	9.59	8.73	7.34	9.38
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
General Mean	7.87	0.24	0.59	176.44	22.18	276.72	256.51	30.67	326.79

IBA: Indole Butyric Acid GA₃: Gibberellic Acid Six BA: Six Benzylaminopurine
 EC: Electrical Conductivity OC: Organic Carbon NS: Non-Significant

4. Quality parameters and economics

The data on quality parameters and economics of different treatments are presented in table 3 and indicates that all quality parameters like brix (°), sucrose (%), CCS (%) and Purity (%) were found non-significant effect.

In an effect of foliar spray of plant growth regulators maximum gross return, net return and B:C ratio were recorded in treatment P₃ receiving foliar spray of GA₃ + Six BA 40 ppm each (Rs.514773 ha⁻¹, Rs.371641 ha⁻¹ and 2.60, respectively) followed by treatment P₄ receiving foliar spray

of IBA + GA₃ + Six BA 40 ppm each. In nutrient spray treatment N₄ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon recorded significantly higher gross return and net return (Rs.512930 ha⁻¹ and Rs.364211 ha⁻¹) followed by treatment N₃ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient. The higher B:C ratio (2.49) was noticed in treatment N₃ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient followed by N₄ receiving foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon.

Table 3: Effect of foliar spray of plant growth regulators and fertilizer nutrients on quality parameters and economics of sugarcane

Treatments	Quality parameters				Economics			
	Brix (°)	Sucrose (%)	Purity (%)	CCS (%)	Gross Return (RS. ha ⁻¹)	Cost of Cultivation (RS. ha ⁻¹)	Net Return (RS. ha ⁻¹)	B:C Ratio
Factor A: Plant growth regulators Spray								
P ₁ : Control (without sprays)	20.24	18.77	92.07	13.27	435710	138332	297378	2.15
P ₂ : Foliar spray of IBA + Six BA 40 ppm each	20.51	18.93	92.27	13.39	481553	142892	338661	2.37
P ₃ : Foliar spray of GA ₃ + Six BA 40 ppm each	20.62	19.00	92.27	13.34	514773	143132	371641	2.60
P ₄ : Foliar spray of IBA + GA ₃ + Six BA 40 ppm each	20.56	19.01	92.22	13.44	506275	145692	360583	2.47

SE+	0.12	0.11	0.13	0.09	--	--	--	--
CD at 5%	NS	NS	NS	NS	--	--	--	--
Factor B: Nutrient sprays								
N ₁ : Control (without sprays)	20.35	18.83	92.11	13.27	440330	138332	301998	2.18
N ₂ : Foliar spray of 1% 19:19:19	20.56	18.94	92.14	13.35	480508	142782	337726	2.37
N ₃ : Foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient	20.56	19.04	92.27	13.45	504570	144657	359913	2.49
N ₄ : Foliar spray of 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% silicon (Aminosalicyclic Acid)	20.45	18.89	92.31	13.36	512930	148720	364211	2.45
SE+	0.12	0.13	0.20	0.11	--	--	--	--
CD at 5%	NS	NS	NS	NS	--	--	--	--
C. Interactions								
SE+	0.24	0.27	0.40	0.29	--	--	--	--
CD at 5%	NS	NS	NS	NS	--	--	--	--
General Mean	20.48	18.90	90.20	13.33	--	--	--	--

IBA: Indole Butyric Acid GA₃: Gibberellic Acid Six BA: Six Benzylaminopurine
 CCS: Commercial Cane Sugar B:C: Benefit Cost ratio NS: Non-Significant

Conclusion

Foliar application of Gibberellic Acid (GA₃) + Six Benzylaminopurine (Six BA) 40 ppm each with 1% 19:19:19 + 0.25% chelated micronutrient + 0.5% Silicon with general recommended dose of fertilizer (FYM 25 t ha⁻¹, 340:170:170 N, P₂O₅ and K₂O kg ha⁻¹) were found beneficial for increasing sugarcane and commercial cane yield.

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