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Study on effect of plant growth regulators and boron on growth attributes of tomato (*Solanum lycopersicum* Mill.)

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Abstract
The field experiment was conducted during Rabi season of 2017-18 at the Horticultural research cum Instructional farm, BTC CARS, Bilaspur (C.G.). The Experiment was laid out in Randomized Block Design (RBD) replicated thrice including ten treatments *viz.*, Treatments T1 (control), T2 (GA3 @ 50 ppm), T3 (GA3 @ 75 ppm), T4 (NAA @ 75 ppm), T5 (NAA @ 100 ppm), T6 (Boron @ 75 ppm), T7 (GA3 @ 50 ppm + Boron @ 75 ppm), T8 (GA3 @ 75 ppm + Boron @ 75 ppm), T9 (NAA @ 75 ppm + Boron @ 100 ppm) and T10 (NAA @ 100 ppm + Boron @ 75 ppm). The significantly highest plant height (65.40 cm, 111.63 cm, 161.40 cm and 163.03 cm at 40, 80, 120 DAT and at harvest respectively.) was recorded in (T8). The significantly maximum number of primary branches (23.73) was recorded at harvest by treatment (T8). The significantly maximum number of flower per plant (53.86) recorded from (T8) and the significantly maximum number of cluster per plant (7.80) was recorded by treatment (T8).

Keywords: NAA, GA3, boron and tomato

Introduction
Tomato (*Solanum lycopersicum* MILL.) is one of the most important solanaceous vegetable crop grown throughout the world because of its wider adaptability, high yielding potential and suitability for various uses in fresh as well as processed food industries. In world, it ranks second in importance after potato, but tops in the list of processed vegetables. Tomato being a moderate nutritional crop is considered as good source of potassium, folate, vitamin E, soluble and insoluble dietary fibers, vitamin A, C including calcium and carotene.
In India, tomato is grown on an area of 0.79 million hectare with an annual production of 17.39 million tonnes (Anon. 2015) [2], In Chhattisgarh, tomato is being cultivated in area of thousand hectare and production of 868.60 thousand tonnes with a productivity of 15.89 tonne/ha (Anon. 2015) [2]. It is cultivated in almost all districts of Chhattisgarh *viz.*, Raigarh, Durg, Jashpur, Sarguja, Jagdalpur, Bemetra, Balodabazar, Kabirdham, Raipur, Kondagaon, Mungeli, Balod, Bilaspur, Surajpur & Rajnandgaon.
Tomato juice has become an exceedingly popular appetizer and beverage. The well ripe tomato (per100 g of edible portion) contains water (94.1%), energy (23calories), calcium (1.0 g), magnesium (7.0 mg), vitamin A (1000 IU), ascorbic acid (22 mg), thiamine (0.09 mg), riboflavin (0.03 mg) and niacin (0.8 mg) (Davies and Hobes, 1981) [4]. It is also a very good source of income for small and marginal farmers and also contributes to the nutrition of the consumer (Singh *et al*., 2010) [10].
Plant growth regulators and micronutrients are an important part of plants and affect their physiology in several ways. Micronutrients and plant growth regulators together play an important roles. They help in both vegetative and reproductive growth and are indispensable for the product of foliage flowers, fruits and seeds. Studies have revealed the beneficial effect of plant growth regulators and micronutrients has increased the growth, yield, total acids and total soluble solids. (Saha, 2009) [9].

Material and Methods
Plant height (cm)
The height of five tagged plants in each plot were recorded in centimeter from ground level upto the growing point with the help of meter scale at 40,80,120 DAT and at harvest. The mean height was computed by dividing the summation with number of plants under observations.

Number of primary branches

The number of branches that arises from the main stem were recorded as primary branches. Total number of primary branches were counted at 40, 80, 120 DAT and at harvest five random plants from the net plot and the values were averaged.

Number of flower per plant

The numbers of flowers per plant was recorded under each treatment combinations.

Number of cluster per plant

The number of clusters per plant was recorded under each treatment combination.

Result and Discussion

Plant height (cm)

Plant height is an important character of the vegetative phase and indirectly influences the yield components. In the present study height of the selected plants was recorded at 40, 80, 120 DAT and at harvest. The data presented in Table 1.

It is obvious from data depicted in Table 1. that height of the tomato plants increased throughout the growing season. The rapid rate of growth was observed up to 80 DAT, but after that the rate was slow.

At 40 DAT the plant height ranges from 44.46 cm to 65.40 cm. Application of NAA @ 75 ppm + Boron @ 75 ppm (T9) resulted significantly highest plant height (65.40 cm) which was at par with T8 (GA3 @ 75 ppm + Boron @ 75 ppm) 64.80 cm, T10 (NAA @ 100 ppm + Boron @ 75 ppm 64.26 cm, T4 (NAA @ 75 ppm) 61.86 cm and T7 (GA3 @ 50 ppm + Boron @ 75 ppm) 61.26 cm. Significantly minimum plant height 44.46 cm was recorded under T1 (control).

At 80 DAT the plant height ranges from 77.73 cm to 111.63 cm. which were significantly differ due to treatments. Application of GA3 @ 75 ppm + Boron @ 75 ppm (T8) resulted significantly highest plant height 111.63 cm but it was at par with T3 (GA3 @ 75 ppm) 108.86, T7 (GA3 @ 50 ppm + Boron @ 75 ppm) 106.10 cm and T2 (GA3 @ 50 ppm) 104.50 cm. Significantly minimum plant height was observed under T1 (control) 77.73 cm.

At 120 DAT the plant height ranges from 94.56 cm to 161.40 cm. which were significantly differ due to treatments. Application of (GA3 @ 75 ppm + Boron @ 75 ppm) T8 resulted highest plant height 161.40 cm which was at par with T3 (GA3 @ 75 ppm) 155.70 cm and T7 (GA3 @ 50 ppm + Boron @ 75 ppm) 148.46 cm followed by T10 (NAA @ 100 ppm + Boron @ 75 ppm) 139.73 cm. significantly minimum plant height observed (94.56 cm) under T1 (control).

At harvest the plant height ranges with minimum value of 96.70 cm to maximum value of 163.03 cm. The maximum plant height (163.03 cm) was recorded with the application of GA3 @ 75 ppm + Boron @ 75 ppm (T8) which was at par with T3 (GA3 @ 75 ppm) 156.33 cm, T7 (GA3 @ 50 ppm + Boron @ 75 ppm) 149.63 cm, T10 (NAA @ 100 ppm + Boron @ 75 ppm) 149.63 cm and T2 (GA3 @ 50 ppm) 140.73 whereas the minimum plant height was recorded 96.70 cm under T1 (control).

The data presented in Table 1. resulted in general that the treatment T8 was recorded heighted plants, whereas minimum plant height was observed in control (T1).

The plant height of tomato increased with combine effect of plant growth regulators and boron. The favourable influence of combined application of GA3 and Boron was noticed on the plant height as compared to other treatments. Gibberellins stimulate cell elongation and cause plants to grow taller and also Gibberellins promotes shoot growth by accelerating the cell elongation and cell division in the sub apical meristem region which increases the length of internodes. These results are in agreement with those of Ranjeet *et.al*. (2014) [8], Akand *et al*. (2015) [1] and Kumar *et.al*. (2014) [6]. Boron is very essential for growth of tomato. It helps in the development of cell wall, occurrence of cell division, formation of vascular bundle (phloem) and transport of CH2 O (sugar). Therefore it seems that when plants are treated with GA3 and boron combinely that increases the plant height as compared to other treatments. Similar findings has also been reported by Naz *et al*. (2012) [7], Ullah *et al*. (2015) [14] and Shukla *et al*. (2017) [13].

Table 1: Effect of plant growth regulators and boron on plant height (cm) of tomato

	Treatment details	Plant height (cm)			
		40 DAT	80 DAT	120 DAT	At harvest
T1	Control	44.46	77.73	94.56	96.70
T2	GA3 @ 50 ppm	56.73	104.50	135.00	140.73
T3	GA3 @ 75 ppm	58.80	108.86	155.70	156.53
T4	NAA @ 75 ppm	61.86	85.73	125.10	125.56
T5	NAA @ 100 ppm	59.26	82.53	129.33	130.20
T6	Boron @ 75 ppm	53.33	78.73	111.53	113.90
T7	GA3 @ 50 ppm + Boron @ 75 ppm	61.26	106.10	148.46	149.63
T8	GA3 @ 75 ppm + Boron @ 75 ppm	64.80	111.63	161.40	163.03
T9	NAA @ 75 ppm + Boron @ 75 ppm	65.40	87.13	135.96	136.80
T10	NAA @ 100 ppm + Boron @ 75 ppm	64.26	95.46	139.73	140.86
SEm±		1.53	4.55	7.77	8.35
CD (P=0.05)		4.55	13.51	23.08	24.81

Number of primary branches

The data pertaining to number of primary branches / plant as affected by various level of plant growth regulators and boron has been presented in Table 2. It can be observed from the data (Table 2.) that various level of plant growth regulators and boron had a significant effect on number of primary branches per plant. The significantly maximum number of primary branches (23.73) was recorded at harvest by treatment T8 (GA3 @ 75 ppm + Boron @ 75 ppm) but it was found at par with treatment T7 (GA3 @ 50 ppm + Boron @ 75 ppm) (22.70) and T3 (GA3 @ 75 ppm) (21.70). However, minimum number of primary branches (14.53) was observed by T1 (control).

Table 2: Effect of plant growth regulators and boron on no. of primary branches of tomato

Treatment	Treatment details	No. of primary branches (at harvest)
T1	Control	14.53
T2	GA3 @ 50 ppm	19.73
T3	GA3 @ 75 ppm	21.70
T4	NAA @ 75 ppm	16.10
T5	NAA @ 100 ppm	18.63
T6	Boron @ 75 ppm	15.26
T7	GA3 @ 50 ppm + Boron @ 75 ppm	22.70
T8	GA3 @ 75 ppm + Boron @ 75 ppm	23.73
T9	NAA @ 75 ppm + Boron @ 75 ppm	19.46
T10	NAA @ 100 ppm + Boron @ 75 ppm	20.03
SEm±		1.17
CD (P=0.05)		3.48

The number of primary branches of tomato increased with combine effect of plant growth regulators and boron. The favourable influence of combined application of GA3 and Boron was noticed on the number of primary branches as compared to other treatments. It may be due to their effect on cell elongation, cell growth, respiration and nucleic acid metabolism. This result was in agreement with Ranjeet *et al*. (2014) [8], Kumar *et al*. (2014) [6], Naz *et al*. (2012) [7] and Shukla *et al*. (2017) [13].

Number of flower per plant

Number of flower per plant of tomato showed statistically significant variation due to application of different plant growth regulator. The number of flowers per plant ranges from
32.33 to 53.86. The maximum number of flowers per plant 53.86 was recorded from GA3 @
75 ppm + Boron @ 75 ppm (T8). which was at par with T7 (GA3 @ 50 ppm + Boron @ 75 ppm) 52.60, T10 (NAA @ 100 ppm + Boron @ 75 ppm) 48.80 and T9 (NAA @ 75 ppm + Boron
@ 75 ppm) 48.53. The minimum number of flowers per plant 32.33 was recorded from (T1) control. (Table 3).

Table 3: Effect of plant growth regulator and boron on number of flowers per plant of Tomato

Treatment	Treatment details	No. of flower per plant
T1	Control	32.33
T2	GA3 @ 50 ppm	41.10
T3	GA3 @ 75 ppm	44.46
T4	NAA @ 75 ppm	46.26
T5	NAA @ 100 ppm	46.46
T6	Boron @ 75 ppm	37.83
T7	GA3 @ 50 ppm + Boron @ 75 ppm	52.60
T8	GA3 @ 75 ppm + Boron @ 75 ppm	53.86
T9	NAA @ 75 ppm + Boron @ 75 ppm	48.53
T10	NAA @ 100 ppm + Boron @ 75 ppm	48.80
SEm±		2.23
CD (P=0.05)		6.64

The higher number of flowers per plant of tomato was resulted from combine effect with GA3 and boron. The superior results in respect of number of flowers per plant was found in GA3 application. This might be due to promotion of flower primordia production in tomato plants in the effect of GA3. Similar findings have been reported by Ranjeet *et.al*. (2014) [8], Verma *et.al*. (2014) [15] and Akand *et.al*. (2015) [1]. Whereas, Boron also played an important role in flowering and fruit formation because Boron helped in the crop plants for cell division, nucleic acid synthesis, uptake of calcium and transport of carbohydrates. Similar findings also have been reported by Singh *et.al*. (2011) [11] and Naz *et.al*. (2012) [7].

Number of cluster per plant

The data revealed that the number of cluster per plant have been presented in Table 4. A maximum number of clusters per plant i.e. 7.80 was recorded by application of GA3 @ 75 ppm + Boron @ 75 ppm (T8), which was at par with T7 (GA3 @ 50 ppm + Boron @ 75 ppm) 7.50, T10 (NAA @ 100 ppm + Boron @ 75 ppm) 7.13, T9 (NAA @ 75 ppm + Boron @ 75 ppm) 6.73 and T5 (NAA @ 100 ppm) 6.70. while the minimum number of cluster per plant (5.23) was recorded from control (T1).

Table 4: Effect of plant growth regulator and boron on number of cluster per plant of Tomato

Treatment	Treatment details	No. of cluster per plant
T1	Control	5.23
T2	GA3 @ 50 ppm	5.90
T3	GA3 @ 75 ppm	6.23
T4	NAA @ 75 ppm	6.43
T5	NAA @ 100 ppm	6.70
T6	Boron @ 75 ppm	5.36
T7	GA3 @ 50 ppm + Boron @ 75 ppm	7.50
T8	GA3 @ 75 ppm + Boron @ 75 ppm	7.80
T9	NAA @ 75 ppm + Boron @ 75 ppm	6.73
T10	NAA @ 100 ppm + Boron @ 75 ppm	7.13
S.Em±		0.45
CD(P=0.05)		1.32

The results indicate that plant growth regulator and boron combinely increases the number of cluster per plant in tomato. It might be due to GA3 promotion of flower primordia production by resulted increase in number of cluster. Similar findings found by Ranjeet *et al*. (2014) [8] and Verma *et al*. (2014) [15]. On the other hand boron plays an important role in water regulation and in carbohydrate metabolism (Haque *et al*., 2011) [5] Thus, the higher number of flowers per cluster could be due to sufficient availability of carbohydrates for flower formation and fruit setting in tomato (Smit *et al*., 2011) [12]. These results are in conformity with the Naz *et al*. (2012) [7] and Ullah *et al*. (2015) [14].

References

1. Akand Md, Hassnuzzam, Mazed HEM, Khairul Pulok, Md Ashraful, Islam Choudhry, *et al*. Growth and yield of tomato (*Lycopersicon esculentum*) as influenced by different level of gibberelic acid application, International journal of Applied Research. 2015; 1(3):71-74.
2. Anonymous. Department of agriculture cooperation and farmer welfare 2015. www.agricoop.nic.in
3. Anonymous. IGKV Agriculture diary, 2016.
4. Davies GM, Hobes G. The constituent of tomato fruit the influence of environment nutrition and genotypes. Critical Rev. Food Sci. & Nutri. 1981; 15:205-280.
5. Haque ME, AK Paul, JR Sarker. Effect of nitrogen and boron on the growth and yield of tomato (*Lycopersicon esculentum* M.) IJBSM. 2011; 2:277-282.
6. Kumar A, Biswas TK, Singh N, Lal EP. Effect of gibbrelic acid on Growth, Quality and Yield of Tomato (*Lycopersicon esculentum* Mill). J Agri. Vet. Sci. 2014; 7(4):28-30.
7. Naz RMM, Muhammad S, Hamid A, Bibi F. Effect of boron on flowering and fruiting of tomato. Sarhad J Agric. 2012; 28(1):37-40.
8. Ranjeet RB, Ram JP, ML Meena. Growth, flowering, fruiting, yield and quality of tomato (*Lycopersicon esculentum* Mill.) as influenced plant bio regulators. Int. J Plant Sci. 2014; 9(1):67-71.
9. Saha P. Effect of NAA and GA3 on Yield and quality of tomato (*Lycopersicon esculentum* Mill). Enviro. Eco. 2009; 27(3):1048-1050.
10. Singh RK, Rai N, Singh SN. Response of tomato genotypes to tomato leaf curl virus. Indian J Agril. Sci. 2010; 80(8):755-8.
11. Singh Y, Singh SS. Effect of different concentration of plant growth regulators on the yield and quality attributes of tomato (*Lycopersicon esculentum* Mill). Veg. Sci. 2011; 38(2):228-230.
12. Smit JN, NJJ Combrink. Pollination and yield of winter-grown greenhouse tomatoes as affected by boron nutrition, cluster vibration and relative humidity. South African Journal of Plant Soil. 2004; 22:110-115.
13. Shukla PC, Dixit Amit. Effect of foliar application of micronutrients on growth and yield of tomato (*Lycopersicon esculentum* Mill) cv. Arka Rakshak. Trends in biosciences. 2017; 10(32):6736-6738.
14. Ullah R, Ayub G, Ilyas M, Ahmad M, Umar M, Mukhtar S. *et al*. Growth and yield of Tomato (*Lycopersicon esculentum* L.) as influenced by different levels of Boron as foliar application. American-Eurasian J Agric. & Environ. Sci. 2015; 15(12):2495-2498.
15. Verma P, Pratap S, Meena, ML, Meena KS. Influence of plant growth regulators on growth, Flowering and quality of Tomato (*Lycopersicon esculentum* Mill), cv. H-86. Indian Journal of Hill Farming. 2014; 27(2):19-22.