EFFECT OF DIFFERENT PLANT GROWTH REGULATORS ON GROWTH AND YIELD OF TOMATO (*Lycopersicon esculentum*)

A. Poudel, A. Duwadi*, A. Acharya, P. Gyawali, R. Bhatt, S. Gautam and A. Srivastava
Agriculture and Forestry University, Nepal
*duwadi61@gmail.com

ABSTRACT

A field experiment was conducted at the research field of the Department of Horticulture, Agriculture and Forestry University, Rampur, Chitwan, to study the effects of plant growth regulators in an open-pollinated variety of tomato, Lycopersicon esculentum var. BL selection 410 in four replicates. The trial was laid out in Randomized Block Design with six treatments; Indole-3-butyric acid (IBA) at 25 ppm and 50 ppm, Gibberellic acid (GA3) at 25 ppm, and 50 ppm, and a cocktail of IBA and GA3 at 25 ppm each. Higher plant height was recorded in GA3 at 50 ppm. Similarly, maximum yield (39.6 MT/ha), individual fruit weight (19.1 gm), number of fruits per plant (55.5), and number of flower clusters per plant (17.65) was recorded with the combined application of IBA and GA3 at 25 ppm.

Keywords: *GA3, growth character, IBA, PGR, tomato*

INTRODUCTION

Tomato (*Lycopersicon esculentum*), a member of the Solanaceae family, is one of the most important vegetable crops in Nepal. It is an herbaceous annual grown for its edible fruit. Tomato has high nutritional values, having a good source of vitamin C, and lycopene. December – April is the favorable time for tomato cultivation in Chitwan, Nepal. Although tomato can be grown under a wide range of climate, it is highly sensitive to hot and humid conditions (Ahmad, 2002), which is prevalent in Chitwan as well. In many parts of our country, tomato cultivation can be done throughout the year.

Recently, several products of plant growth regulators (PGR) are available in Nepalese markets, but hardly a few systematic studies on their potentiality and effects on the growth and yield of tomato crop have been carried out. PGRs have been reported to enhance crop yield. Among them, auxin and gibberellin play a vital role in improving the growth and yield of vegetable crops. Gibberellic Acid-3 (GA3) is a hormone found in plants and fungi. It is responsible for cell elongation and cell division, thus affecting the growth and development of plants. Gibberellin regulates the mitotic activity of the sub-apical meristem. Physiological responses of GA3 are seen as stem elongation, parthenocarpic fruit formation, and an increase in the size of leaf and fruit (Gupta et al., 2013). Similarly, Indole Butyric Acid (IBA) is a synthetic plant hormone of the auxin family. It promotes faster and uniform rooting, reduces stress and disease incidence. The specific quantity of any growth hormone in the plant is responsible for the promotion, inhibition, and modification of the physiological processes (Singh, 1995). Therefore, this study was carried out to assess the effects of IBA and GA3 on an open-pollinated variety of tomato viz BL selection 410. BL Selection 410 takes less time to flower (22.00 days), fruiting (28.00 days), and first harvesting (72.00 days) after transplanting than other commonly cultivated varieties (Tiwari et al. 2014). It is also a widely cultivated variety of tomato in Chitwan.

MATERIALS AND METHODS

Site description

A field experiment was conducted at the research field of the Department of Horticulture, Agriculture and Forestry University, Rampur, Chitwan (27°38’ N, 84°20’ E) in the winter season of 2019-20. The experimental plot is 228 m above the average sea level. The climate is mild and warm temperate. The average annual temperature is 24 °C with annual average precipitation of 1993 mm.

Experiment design, and the treatments

The trial was laid out in Randomized Block Design with five treatments and four replicates. Each treatment consisted of various levels of growth regulator viz IBA @ 25 ppm and 50 ppm, GA3 @ 25 ppm and 50 ppm, and IBA 25 ppm+GA3 25 ppm. Thirty days old seedlings were transplanted on 26th December 2019, at the spacing of 60 cm

45 cm. In a plot, 20 seedlings of an open-pollinated variety of tomato BL selection 410 were planted in 4 rows and 5 columns. Sampling was done from central 6 plants excluding the border plants. Manure and fertilizers were applied in the field as recommended by the Ministry of Agriculture and Livestock Development. The recommended dose of farm-yard manure was 32 tons/ha and nitrogen, phosphorus, and potassium were 70 kg/ha, 50 kg/ha, and 40 kg/ha respectively (MoALD, 2019). Urea was applied in three split doses: - half as basal application and another half in two split doses at 30 and 50 days after transplanting (DAT). Gap filling was done three times after transplanting to maintain the plant population in the experimental plot. For the application of growth regulators, a stock solution of 1000 ppm of IBA and GA3 was prepared. The working solution of 25 ppm and 50 ppm each IBA and GA3 were prepared by diluting the stock solution with distilled water. The first spray was done after 20 days of transplanting and the second spray was done after 45 days of transplanting. The spraying was done by covering the plot with the plastic sheet from all the sides so that drift of spraying in one plot may not affect the next plot. Two hand-weeding cum inter-cultures were done at 25 and 45 DAT. Watering was done every 2-3 days during the early stages. Pruning of the unnecessary young shoots was done to increase productivity and for uniformity in the size of fruits. Staking was done on a bamboo branch with the support of a rope.

Sampling and statistical analysis

Observations were taken on various growth and yield attributing parameters. Sampling was done randomly by selecting five plants from each experimental plot. Plant height was recorded 30 and 60 DAT with the help of measuring tape. The observations on the number of flower clusters/plant were recorded on- 55 DAT. The fruits were harvested at the matured green stage. The number of fruits per plant and fruit weight was recorded. The data on days to first flowering was obtained by observing the plants daily.

The data were entered in MS-Excel and subjected to analysis of variance as per randomized block design (RCBD) using statistical analysis software R-4.0.2. The significance of differences among the treatments was compared using Least Significant differences (LSD) and Duncan Multiple Range Test (DMRT) at a 5 percent significant level for suitable interpretation of results (Gomez & Gomez, 1976).

RESULTS AND DISCUSSION

Plant height (30DAT)

Different concentrations of plant growth regulators showed a highly significant variation ($p<0.01$) on the height of the tomato plant at 30 DAT (Table 1). The plant height ranged from 19.3 cm to 32.8 cm. The maximum plant height was recorded for plants treated with GA3 50 ppm (32.8 cm) which was statistically at par with plants treated with GA3 25 ppm (30.7 cm) and GA3 25 ppm+ IBA 25 ppm (29.7 cm) (Table 1). The plant height was found to be 27.6 cm in IBA 25 ppm which was at par with IBA 50 ppm (24.3 cm). Lower plant height was found at 50 ppm IBA than 25 ppm which might be due to direct stimulation of auxin on ethylene synthesis in axillary buds, causing inhibition of their growth and potentiation of apical dominance (Auxin, 2020). This result is per the findings of Ullah Z. et al. (2013). The minimum plant height was recorded in control (19.3 cm). With the increasing dose of GA3, the plant also increased. Gibberellins are the key regulator of shoot growth in plants and this might be the cause for stem elongation. These results are in line with the findings of Nibhavanti et al. (2006).

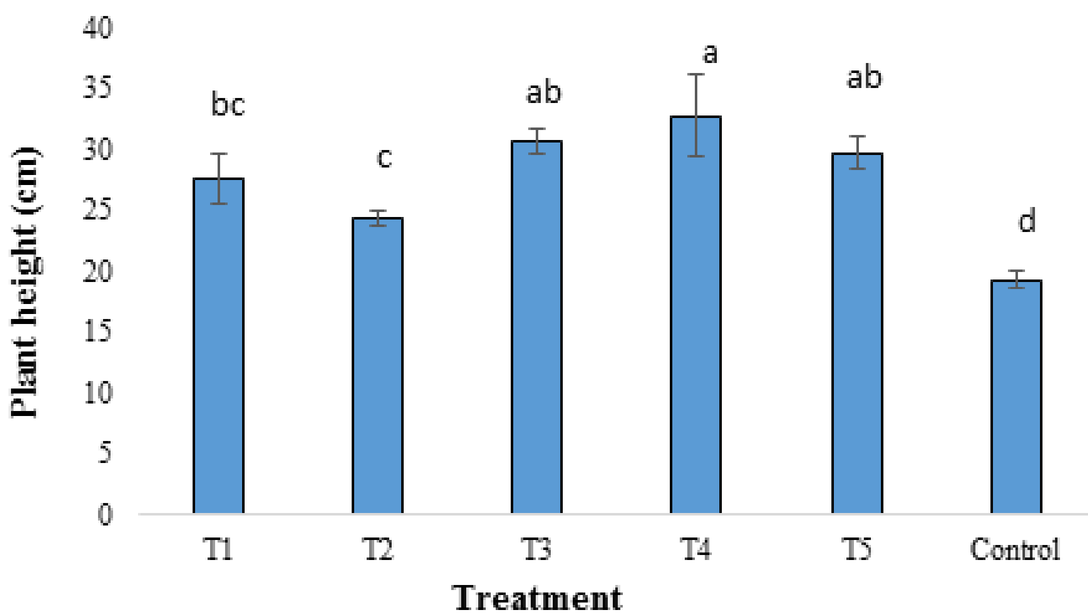

Figure 1. Average plant height on 30 DAT recorded in various treatments

Treatments were IBA 25ppm (T1), IBA 50ppm (T2), GA3 25ppm (T3), GA3 50ppm (T4), IBA 25ppm+ GA3 25ppm (T5), control. Error bar represents the standard error of the mean. . In each figure, means associated with a different lowercase letter are significantly different by Duncan's multiple range test.

Plant height (60DAT)

Different concentrations of plant growth regulators showed remarkable variation ($p<0.05$) on the height of the tomato plant at 60 DAT (Table 1). The plant height ranged from 57.9 cm to 77.2 cm. The maximum plant height was found in plants treated with GA3 50 ppm (77.2 cm) which was statistically at par with plants treated with GA3 25 ppm (70.3 cm) and IBA 25 ppm (70.0 cm).

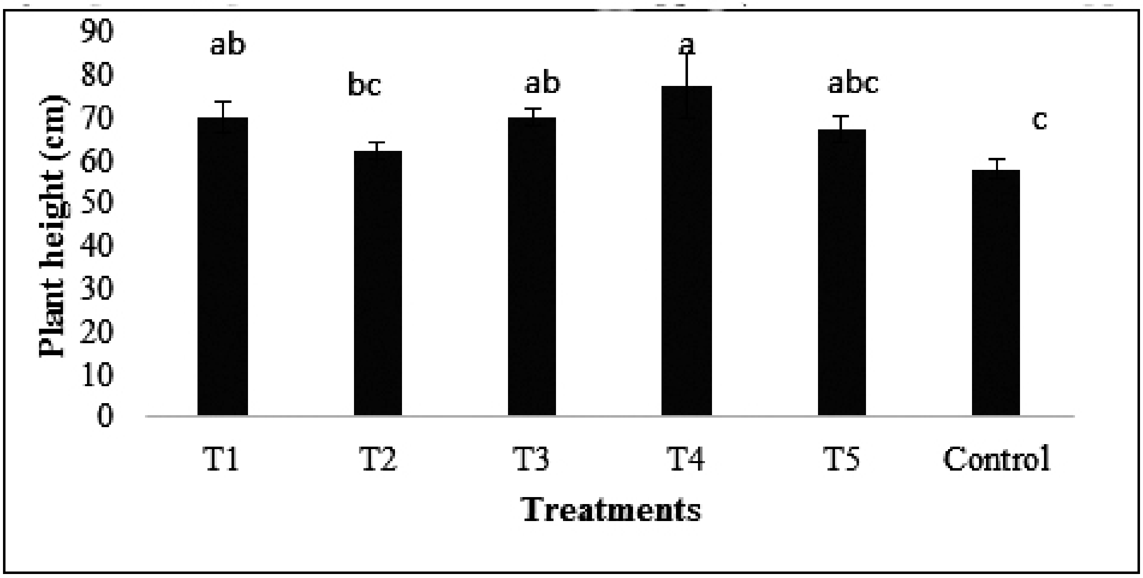

Figure 2. Average plant height on 60 DAT among various treatments in tomato
Treatments were IBA 25ppm (T1), IBA 50ppm (T2), GA3 25ppm (T3), GA3 50ppm (T4), IBA 25ppm+ GA3 25ppm (T5), control. Error bar represents the standard error of the mean. In each figure, means associated with a different lowercase letter are significantly different by Duncan's multiple range test.

The minimum plant height was recorded at control (57.9 cm). With the increasing dose of GA3, the data showed an increment in the heights of plants. Gibberellins are the key regulator of shoot growth in plants and this might be the cause for stem elongation. These results are in line with the findings of Nibhavanti et al. (2006).

Days to first flowering

The administration of GA3 and IBA significantly ($p<0.01$) decreased the days to first flowering. Earliness in days to first flowering was observed in IBA 50 ppm (32.1 days). The days to anthesis in IBA 25 ppm (34.3 days) was at par with IBA 25 ppm+ GA3 25 ppm (35.3 days) and GA3 25 ppm (35.5 days). The maximum days to anthesis was observed in control (39.4 days) (Table 1). The link between auxin and flower development was first established by Okada et al. (1991) with the isolation of auxin transport mutant pin 1 gene. The earliest day to anthesis in IBA 50 ppm was due to the action of auxin which played an essential role in the initiation of floral primordia (Galweiler et al., 1998). This observation holds close conformity to the research article published by Galweiler et al. (1998) and Okada et al. (1998).

Number of flower clusters per plant

The number of flower clusters per plant ranged from 9.9 to 17.65 clusters. The highest number of flower clusters was recorded in a blend of IBA 25 ppm+ GA3 25 ppm (17.65) followed by GA3 25 ppm (16.55), GA3 50 ppm (14.5), and IBA 25 ppm (14.3). The lowest numbers of flower clusters were recorded in control (9.9) (Table 1). The maximum flower cluster in the cocktail of IBA and GA3 might be due to the combined action of both auxin and gibberellin. The application of phytohormone increased the flower count in the plant.

The results of this study are supported by the findings of Uddain et al. (2009). GA3 promotes floral primordia increasing the flower clusters in the plant (Onofeghara, 1983). Though the number of clusters in GA3 @ 25ppm was found to be more than 50 ppm GA3, it might be due to differences in environmental conditions.

Number of fruits per plant

The number of fruits per plant showed notable variation ($p<0.05$) with the use of various growth regulators (Table 1). The number of fruits ranged from 31.1 to 55.5 per plant. The highest number of fruits per plant was recorded at the combined treatment of IBA 25 ppm+ GA3 25 ppm (55.5) followed by IBA 50 ppm (51.3) and GA3 50 ppm (50.0). The least number of fruits was recorded at control (31.1) which was statistically at par with GA3 25 ppm (38.8) (Table 1). The maximum number of fruits per plant in a mixture of IBA and GA3 might be due to rapid and better translocation of nutrients from root to apical parts of the plant. The results are close to those reported by Singh et al. (2001) and Bhosle et al. (2002).

Fruit weight

The average fruit weight varied significantly ($p<0.05$) with the application of various plant growth regulators (Table 1). The fruit weight ranged from 19.1 gm to 13.8 gm. The maximum fruit weight was recorded at IBA 25 ppm + GA3 25 ppm (19.1gm) which was similar to IBA 50ppm (17.1 gm) and GA3 50 ppm (16.9 gm). The least individual fruit weight was observed at control (13.8 gm) which was at par with the other remaining treatment. This might be due to the increased supply of photosynthetic materials and its efficient mobilization in plants, resulting in a stimulation of fruit growth and high fruit weight (Bhosle et al., 2002 and Pundir and Yadav, 2001).

Yield

Yield differed significantly ($p<0.05$) among treatments (Table 1). The highest yield was recorded with the application of IBA 25 ppm+ GA3 25 ppm (39.9 MT/ha) which was statistically at par with IBA 50 ppm (32.67 Mt/ha). The treatment IBA 25 ppm (22.7 Mt/ha) was statistically similar to GA3 25 ppm (19.8Mt/ha). The least yield was recorded in control (16.1 Mt/ha). The superiority in yield at the combined application of IBA and GA3 was most likely due to the increase in the number of flower clusters per plant and individual fruit weight in the combined PGR treatment. These results are in close conformity with the findings of Akhtar et al. (1996) and Saha et al. (2009).

Table 1. Effect of different plant growth regulators on yield and yield attributing characters of tomato at Rampur, Chitwan, 2019.

Treatment (Tn)	Days to First Flowering (Days)	No of fruit/ plant	Fruit Weight(gm)	Yield (MT/ha)	Number of Flower Clusters/plant
IBA 25ppm(T1)	34.3^{c}	40.8^{bc}	14.9^{b}	22.7^{c}	14.3^{abc}
IBA 50ppm(T2)	32.1^{d}	51.3^{ab}	17.1^{ab}	32.67^{ab}	11.25^{bc}
GA_3 25ppm(T3)	35.5^{bc}	38.8^{c}	13.8^{b}	19.8^{cd}	16.55^{ab}
GA_3 50ppm(T4)	36.1^{b}	50.0^{ab}	16.9^{ab}	31.5^{b}	14.5^{abc}
IBA 25ppm+ GA_3 25ppm(T5)	35.3^{bc}	55.5^{a}	19.1^{a}	39.6^{a}	17.65^{a}
Control	39.4^{a}	31.1^{c}	13.8^{b}	16.1^{d}	9.9^{c}
Sem (±)	0.433	3.50	0.42	2.27	1.89
LSD (0.05)	1.30	10.56	1.29	6.87	5.72
p value	<0.01	<0.01	<0.01	<0.01	<0.05
CV (%)	2.44%	15.71%	5.34%	16.84%	27.04%
Mean	35.44	44.60	15.97	27.08	14.0

Note: Sem: Standard error of the mean, LSD (0.05)-Least significant differences at 5% level of significance, CV: coefficient of variation, values with same letters on the column are not significantly different at 5% DMRT (Duncan's multiple range test)

CONCLUSION

This research was designed to study if the application of plant growth regulators affects the yield of tomato variety grown in Chitwan, Nepal. The results showed that tomato production can appreciably be enhanced by the exogenous application of plant growth regulators. Among various treatments, plants treated with combination of IBA and GA3 each at 25 ppm showed an increased number of fruits per plant, fruit weight and ultimately the yield. This result shows that PGRs can be applied judiciously by farmers in the future if available in convenient form to increase their crop yield.

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