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Effect of Plant Growth Regulators on Yield and Quality of Tomato (*Solanum lycopersicum* L.) under Mid-hill Conditions of Himachal Pradesh

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Abstract

Tomato (*Solanum lycopersicum* L.) member of family solanaceae is the world's most popular vegetable crop due to its wider adaptability to various agroclimatic conditions and multifarous uses. Plant growth regulators play an important role in increasing the growth, yield as well as quality of the produce if applied in suitable forms and at appropriate concentrations. Field experiments were conducted for two consecutive years during 2014 and 2015 to study the effect of plant growth regulators on tomato cultivar Solan Lalima. Six treatments of plant growth regulators viz. Vipul Booster (1 and 1.5 ml l^{-1}), Triacontanol (1 and 1.5 ml l^{-1}) and NAA (20 and 30 mg l^{-1}) were applied to tomato plants 15 days after transplanting and were compared to untreated control. Observations on growth parameters, yield contributing traits and fruit quality as affected by PGR,s were recorded. All the hormonal treatments were found to enhance vegetative growth, yield attributes and fruit quality of tomato, especially Triacontanol. Application of triacontanol @ 1.5 ml l^{-1} (T_4) recorded the maximum plant height (3.12 m), maximum number of leaves (39.5) , number of branches per plant (7.6), number of fruits per cluster (5.67) , number of fruits $plant^{-1}$ (52.50), highest average fruit weight (72.2 g) and fruit yield per plant (3.79 kg). Thus considering yield and other parameters, Triacontanol @1.5 ml l^{-1}, 15 days after transplanting was found best to increase the yield in tomato as compared to other treatments under study.

Keywords: Tomato, fruit size, plant growth hormones, quality, triacontanol, yield

1. Introduction

The cultivated tomato (*Solanum lycopersicum* L.) a member of family Solanaceae has originated in Peruvian and Mexican regions as reported by Tigchelaar (1986). Tomato is one of the most important vegetable crops in the world, not only because of its volume but also because of its overall contribution to nutrition. A day's requirement of calcium is present in a medium sized tomato fruit and its protein content is same as that of mother's milk. Furthermore tomato is a rich source of lycopene which is a powerful antioxidant that scavenges free radicals and has a high protective effect against cancer as suggested by Watzman (2000). In Himachal Pradesh tomato is being cultivated on an area of 9930 ha producing 413709 tons crop, annually. The growth, yield and quality of any crop are affected by many factors. Plant growth regulators play an

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important role in increasing the growth, yield as well as quality of the produce if applied in suitable forms and at appropriate concentrations. Some of the plant growth regulators are very effective to increase the fruit set, fruit size, growth as well as yield and quality under low and high temperature environment as per the findings of Singh and Lal (2002). The beneficial response of plant growth regulators in tomato has also been reported by Phookan.et al. (1991); Singh and Singh (1996); Singh and Singh (1993). Phyto-hormones as plant growth regulators play a crucial role in plant growth and development process as suggested by Mishra and Panda (2017). Apart from traditional plant hormones studied so far i.e. auxin, gibbrellins, cytokinins, abscic acid and ethylene various other biomolecules are being reported to act as hormones. At present a number of plant growth regulators are available in different formulations, but their effect varies among crops, seasons, climatic conditions, growing stage and concentrations used. In order to obtain desired results, it is important to identify most suitable growth regulators, their concentration and time of application in specific crops. Keeping this in view the present investigations were conducted to evaluate some growth regulators in tomato under mid hill conditions of Himachal Pradesh.

2. Materials and Methods

An experiment was conducted to assess the effect of plant growth regulators on vegetative growth, yield and quality of tomato at Experimental Farm of Krishi Vigyan Kendra, Chamba, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh representing subtropical climate. The experimental site was situated at an altitude of 1050 m amsl, 32° 33′19.12′′ N latitude and 76°07′35.29′′E longitude. The annual rainfall of the experimental site is 2213mm with average annual temperature of 20.7 °C. The nursery of tomato cultivar Solan Lalima was raised during March, 2014 and 2015 and was transplanted at a spacing of 90x30 cm in first week of April. The crop was raised strictly as per the recommended practices by the University. Six treatments of plant growth regulators viz. vipul booster (1 and 1.5 ml l^{-1}), triacontanol (1 and 1.5 ml l^{-1}) and NAA (20 and 30 mg l^{-1}) were applied to the tomato plants fifteen days after transplanting and were compared to an untreated control. The experiment was laid out as per randomized block design with four replications for each treatment. Observations on growth parameters, yield contributing traits and fruit quality as affected by PGR, s were recorded from time to time. The pickings were made at half ripe stage for computing yield per plant as suggested by Thompson and Kelly (1985). For estimation of shelf life, vine ripe fruits from each treatment were kept at room temperature (27±2 °C) and their firmness was recorded by penetrometer at harvest and subsequently at a gap of two days. The data obtained during two years was pooled according to the standard procedure given by Gomez and Gomez (1984).

3. Results and Discussion

The effect of PGR, s on growth of tomato is presented in Table 1. Perusal of data revealed that there was significant effect of hormonal application on enhancing vegetative growth in tomato. Application of triacontanol @ 1.5 ml l^{-1} (T_4) recorded the maximum (3.12 m) plant height which was statistically at par with treatments vipul booster @ 1.5 ml l^{-1} (2.94 m), triacontanol @ 1ml l^{-1} (2.88 m), NAA @ 30 ppm (2.86 m) and NAA @ 20 ppm(2.81 m). Lowest plant height (2.55 m) was recorded in control. Number of leaves and number of branches were also affected in a similar way and maximum (39.5 and 7.6 respectively) values were observed in treatment T_4 (Triacontanol @ 1.5 ml l^{-1} followed by T_3 (Triacontanol @ 1 ml l^{-1}) and T_2 (Vipul Booster 1.5 ml l^{-1}). All the hormonal treatments were found to be efficient in enhancing number of leaves and number of branches per plant over control which recorded the lowest values (28.2 and 5.6, respectively). The beneficial effects of PGR, s in enhancing vegetative growth might be due to reduction in the environmental stress on various physiological and biochemical processesand increased mobilization of nutrients in the treated plants.The results are in line of those by Khan et al. (2009) who reported a significant effect on plant height, number of leaves and leaf area with foliar application of triacontanol.

The days to flowering were found to reduce with application of growth regulators. Minimum number of days to flowering (28.4) were recorded in treatment T_4 (Triacontanol @1.5 ml l^{-1}) whereas maximum (37.4 days) in control. The days to first picking (Table1) corresponded to the data on days to flowering and plants treated with triacontanol @ 1.5ml l^{-1} took 69.5 days to first picking which was statistically at par with treatments T_1 (74.5 days), T_2 (73.2 days) and T_3 (72.5 days).

Higher number of fruits per plant and per cluster are very desirable traits for maximization of total yield. The beneficial effect of triacontanol application on these traits is evident from the data (Table 1). All the hormonal applications were observed to significantly improve number of fruits per cluster and number of fruits per plant over control (4.61 and 40.96, respectively) with highest value in treatment T_4 (5.67 and 52.50, respectively). The higher number of fruits per plant and per cluster may be attributed to increased fruit setting and fruit retention by application of growth regulators.

Highest average fruit weight and fruit yield per plant (72.2 g and 3.79 kg) were observed in treatment T_4 (Triacontanol @ 1.5 ml l^{-1}) which was statistically at par with treatments T_3 (68.2 g and3.40 kg) and T_2 (66.2 g and 3.18 kg). The lowest fruit weight (58.3 g) and yield per plant (2.39 kg) was recorded in control. The increase in yield of tomato by application of growth regulators might be due to better vegetative growth, increased fruit set and higher fruit size. Application of triacontanol has been reported to increase absorption and uptake of nutrients, enhance photosynthetic rate and finally increase translocation of photosynthetic products from

Table 1: Effect of PGR,s on growth and yield attributes in tomato (Pooled data for two years)

Treatments	PH	NL	NB	DF	DFP	NFC	NFP	FSI	FSI	FW	YP
Vipul booster @ 1 ml l^{-1}	2.78	31.5	6.7	32.6	74.5	5.18	44.98	0.92	30.64	64.4	2.90
Vipul booster @ 1.5 ml l^{-1}	2.94	33.2	6.8	30.2	73.2	5.34	48.10	0.97	28.59	66.2	3.18
Triacontanol @ 1 ml l^{-1}	2.88	36.5	7.2	32.6	72.5	5.36	49.91	0.91	33.15	68.1	3.40
Triacontanol @ 1.5 ml l^{-1}	3.12	39.5	7.6	28.4	69.5	5.67	52.50	0.95	29.70	72.2	3.79
NAA @ 20 ppm	2.81	33.2	6.6	31.5	76.2	5.10	46.03	0.92	27.35	63.9	2.94
NAA @ 30 ppm	2.86	31.5	6.4	33.7	75.5	5.23	47.51	0.98	25.14	65.2	3.09
Control	2.55	28.2	5.6	37.4	79.2	4.61	40.96	0.93	26.22	58.3	2.39
Mean	2.82	33.4	6.7	32.34	74.37	5.21	47.14	0.94	28.68	65.5	3.10
SEm±	0.17	1.78	0.76	1.62	2.42	0.37	1.98	0.04	1.09	2.13	0.33
CD (*p*=0.05)	0.32	5.45	1.20	4.15	5.80	0.72	4.90	NS	3.11	6.42	0.86

PH: Plant height (m); NL: No. of leaves; NB: No. of branches; DF: Days to flowering (days); DFP: Days to first picking (days); NFC: No. of fruits cluster^{-1}; NFP: No. of fruits plant^{-1}; FSI: Fruit shape index; FSI: Fruit size index (cm^2); FW: Fruit weight (g); YP: Yield plant^{-1} (Kg)

source to sink as reported by Singh et al. (2011) and Naeem et al. (2011). Similar results were obtained by Khan et.al. (2009); Tiwari and Singh (2014) and Jakhar et al. (2018) who reported increased total yield with triacontanol application in tomato. Harvest duration was found to increase significantly with application of triacontanol @ 1.5 ml l^{-1} (47.3 days) and vipul booster @ 1.5 ml l^{-1} (44.4 days) as depicted in Table 2. All other hormonal treatments failed to enhance the harvest duration and were statistically at par with control (38.5 days). Singh (1996) reported that pericarp thickness, fruit firmness and shelf life are closely related traits. In present studies, fruit firmness was significantly and positively influenced by application of PGR,s especially triacontanol with maximum value (0.84 kg 0.503 cm^{-2}) in treatment T_4 (Triacontanol @ 1.5 ml l^{-1}). The increase in fruit firmness may be due to higher juice content in the treated fruits. No growth regulator could cause significant enhancement in TSS content over control. Shelf life of the fruits was directly affected by fruit firmness and maximum shelf life (19.8 days) were recorded in the treatment T_4 (Triacontanol @ 1.5 ml l^{-1}) and minimum (13.6 days) in control.

Table 2: Effect of PGR,s on fruit quality in tomato (pooled data for two years)

Treatments	Firmness (Kg 0.503 cm^{-2})	Pericarp thickness (mm)	Total soluble solids (°B)	Harvest duration (Days)	Shelf life (Days)
Vipul booster @ 1 ml l^{-1}	0.79	5.25	5.38	41.3	15.5
Vipul booster @ 1.5 ml l^{-1}	0.81	5.24	5.42	44.4	18.8
Triacontanol @ 1 ml l^{-1}	0.82	5.20	5.54	42.8	16.2
Triacontanol @ 1.5 ml l^{-1}	0.84	5.26	5.48	47.3	19.8
NAA @ 20 ppm	0.80	5.14	5.28	39.2	15.2
NAA @ 30 ppm	0.78	5.16	5.37	42.3	13.4
Control	0.74	5.12	5.24	38.5	13.6
Mean	0.80	5.20	5.39	42.26	16.07
SEm±	0.04	0.03	0.04	2.19	1.16
CD (*p*=0.05)	0.06	NS	NS	5.23	3.78

4. Conclusion

Application of triacontanol @ 1.5 ml l^{-1} (T_4) recorded the maximum plant height (3.12 m), maximum number of leaves (39.5) , number of branches per plant (7.6), number of fruits per cluster (5.67), number of fruits per plant (52.50), highest average fruit weight (72.2 g) and fruit yield per plant (3.79 kg). Thus triacontanol @ 1.5 ml l^{-1}, fifteen days after transplanting produced best results in terms of plant height, fruit weight, yield per plant and fruit quality followed by vipul booster and NAA.

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