

Original Research Article

Effect of plant growth regulators on growth, yield and quality of Tomato (*Solanumlycopersicum* L.)

ABSTRACT

The present investigation entitled “**Effect of plant growth regulators on growth, yield and quality of Tomato (*Solanumlycopersicum* L.)**” was carried out at the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during *kharif* season 2022-23 on the variety TMTH-234. The experiment was laid in Randomized block design with 19 treatments and 3 replications including control with different plant growth regulators. Different plant growth regulators (PGRs) (NAA, GA₃, and IAA), were used in different combinations and doses. Among the various treatments significant results were showed by T₁₈ (GA₃@90ppm + NAA@45ppm) best in terms of plant height (123.93 cm), days to first flowering (42.3 DAT), days to 50% flowering (49.83 DAT), days to first harvest (85.63 DAT), number of flower cluster per plant (7.87), fruit set per cluster (8.07), polar diameter (63.13 mm), equatorial diameter (63.33 mm), number of fruit per plant (17.27), individual fruit weight (112.63 g), average weight of 10 fruit (1126.33 g), average fruit yield per plant (1.95 Kg), total yield per plant (5.84 Kg), fruit yield per hectare (216.3 t), TSS (6.07°Brix), and ascorbic acid (20.3 mg/100g).

Keywords: NAA, GA₃, IAA, PGRs, TMTH-234.

1. INTRODUCTION

Tomato (*Solanumlycopersicum* L.) belongs to the family solanaceae. It is a herbaceous perennial typically cultivated as an annual. It has sprawling stems, compound leaves, and yellow, star-shaped flowers. The fruit, a false fruit or berry, varies in shape, size, and color. Tomato plants have a fibrous root system, and their growth habits can be determinate or indeterminate. They follow a seasonal lifecycle and are treasured for their culinary, versatility, and nutritional value. It is a good source of vitamin A and vitamin C and minerals like calcium, potassium etc.. It also contains organic acids like citric acid,

malic acid and acetic acid which are found in fresh tomato fruit. It promotes gastric secretion, acts as a blood purifier and works as an intestinal antiseptic. The nutritional value of red tomatoes (raw) per 100 g contains 18 kcal energy, 4.0 g carbohydrates, 2.6 g sugars, 1.0 g dietary fiber, 0.2 g fat, 1.0 g protein, 95 g water, 13 mg vitamin C. The antioxidant compounds present in tomato are lycopene, β carotene and ascorbic acid which protects against cancer and heart diseases (Zhang *et al.*, 2009). (PGRs) are extensively used in horticultural crops to enhance plant growth and improve yield with increased fruit number, fruit set and size. There has been a

global realization of the importance of PGRs in increasing the crop yield. PGRs help in both vegetative and reproductive growth and are indispensable for the production of foliage flowers, fruits and seeds. Although, plant growth regulators have great potential for growth improvement, their application has to be planned sensibly in terms of optimal concentration, stage of application, species specificity and seasons.

2. MATERIALS AND METHODS

The present investigation was done to study the impact of combine application and sole application of plant growth regulator on growth, Yield and Quality of Tomato (*Solanum lycopersicum* L.) The details of the materials used, and the methods adopted in the investigation, which was carried out at Horticultural Research Farm (HRF), Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS) Prayagraj during kharif season of 2022 (incomplete sentence). The experiment was conducted in Factorial Randomized Block Design with 19 treatments in three replications viz. T₀: Control, T₁:(NAA@20ppm), T₂:(NAA@45ppm), T₃:(IAA@30ppm), T₄:(IAA@45ppm), T₅:(GA₃@60ppm), T₆:(GA₃@90ppm), T₇:(NAA@30ppm+IAA@30ppm), T₈:(NAA@30ppm+IAA@45ppm), T₉:(NAA@45ppm+IAA@30ppm), T₁₀:(NAA@45ppm+IAA@45ppm), T₁₁:(IAA@30ppm+GA₃@60ppm), T₁₂:(IAA@30ppm+GA₃@90ppm), T₁₃:(IAA@45ppm+GA₃@60ppm), T₁₄:(IAA@45ppm+GA₃@90ppm), T₁₅:(GA₃@60ppm+NAA@30ppm), T₁₆:(GA₃@60ppm+NAA@45ppm), T₁₇:(GA₃@90ppm+NAA@30ppm),

T₁₈:(GA₃@90ppm+NAA@45ppm) with tomato hybrid TMTH-234 (Trimurti plant science pvt. Ltd.). Crop was transplanted with the spacing of 60cm X 45cm (RxP). The observation of randomly five selected plants from each plot was measured in cm by a 100 cm scale from ground level to tip of the shoot at 90 DAT stage. The data were analysed by the method suggested by Fisher and Yates, 1963. Observations were recorded at different stages of growth periods and studied for growth parameters like plant height (cm), days to first flowering, days to 50% flowering, days to first harvest, number of flower cluster per plant, fruit set per cluster, polar diameter (mm), equatorial diameter (mm), number of fruits per plant, individual fruit weight (g), average weight of 10 fruits (g), average fruit yield per plant (Kg), total yield per plant (Kg), fruit yield per hectare (tha⁻¹), T.S.S.(°Brix), and ascorbic acid (mg/100g).

3. RESULTS AND DISCUSSIONS

3.1. Growth Parameters

3.1.1. Plant Height for 30 DAT, 60 DAT, 90 DAT and harvest (cm)

Analysis of plants show a significant effect on plant height at 30, 60, 90 DAT and harvest (cm). The maximum plant height (13.93 cm) at harvest was observed with treatment T₁₈ (GA₃@90ppm + NAA@45ppm) and minimum plant height (99.47 cm) was observed in T₀ (control), these results are shown in Table:1. The foliar application and soil drenching have improved the soil physical and chemical properties and leading to the adequate supply of nutrients to the plants which promoted the maximum vegetative growth while the minimum plant growth was due to non-availability of nutrients. Similar

findings were reported by *Meena et al. (2008)* and *Kumar et al. (2014)*.

3.2. Earliness parameters

3.2.1. Days to first flowering (DAT), Days to 50% flowering (DAT) and Daysharvest (DAT)

Analysis of the plants shows a significant effect on days to first flowering, days to 50% flowering, and days to first harvest. Minimum days to first flowering, days to 50% flowering and days to first harvest was observed in T₁₈ (GA₃@90ppm + NAA@45ppm) with 42.3 DAT, 49.83 DAT and 85.63 DAT respectively while the maximum days to first flowering, days to 50% flowering and days to first harvest was recorded in T₀ (Control) with 52.6 DAT, 60.13 DAT and 95.63 DAT respectively, shown in Table:2. This is due to the reaction of plants to bio stimulant treatment depends on the flowering biology of the cultivars, particularly proportions of different flower phenotypes and their fertility. More intensive flower setting was elicited either by improved plant growth through seaweed extract application or by endogenous components, especially cytokinins, which enhance nutrient partitioning in vegetative plant organ and increase in the transport to assimilates to the growing fruits. A similar effect was observed for these findings are in conformity with the reports of *Tewari et al., (2001)* and *Shitalet et al., (2017)*.

3.2.2. Number of flower cluster per plant and fruit set per cluster

The data pertaining number of flower cluster per plant and fruit set per cluster varied significantly. Maximum number of flower cluster per plant was observed in T₁₈ (GA₃@90ppm + NAA@45ppm) with 7.87 and 8.07 respectively while the minimum number of flower cluster per plant was

recorded under T₀ (Control) with 1.27 and 2.07 respectively, shown in Table:2. PGRs promote the initiation and development of flowers. Auxins, gibberellins, and ethylene-releasing compounds enhanced the flowering process in tomatoes. By influencing hormonal balance and signaling pathways, these PGRs facilitate flower bud formation and subsequent cluster development. Increased flower clusters often lead to a higher fruit set. By promoting flower cluster development and enhancing flower fertility, PGRs increase the number of fruits produced per plant. Similar findings were reported by *Bhosle et al., (2002)* and *Uddain et al., (2009)*.

3.3. Yield parameters

3.3.1. Polar diameter (mm) and equatorial diameter (mm)

The data pertaining polar diameter varied significantly. Maximum polar diameter and equatorial diameter was observed in T₁₈ (GA₃@90ppm + NAA@45ppm) with 63.13mm and 63.33mm respectively while the minimum polar diameter and equatorial diameter was recorded under T₀ (Control) with 52.2 and 52.3 respectively, shown in Table:3. The effects of Plant Growth Regulators (PGRs) on the polar and equatorial diameter of tomatoes can vary depending on factors such as the type of PGR used, concentration, timing, and tomato cultivar. PGRs like gibberellins can promote cell expansion and elongation, potentially leading to an increase in both polar and equatorial fruit diameter. PGRs involved in fruit setting and development, such as auxins can influence hormonal balances and signaling pathways that impact fruit growth. Similar findings were reported in *Prasad et al., (2013)* and *Ranjeet et al., (2014)*.

3.3.2. Number of fruits per plant

The data pertaining number of fruits per plant varied significantly. Maximum number of fruits per plant was observed in T₁₈(GA₃@90ppm + NAA@45ppm) with 17.27 while the minimum number of fruits per plant was recorded under T₀ (Control) with 3.47 are shown in Table:3. PGRs played a role in optimizing pollination and fertilization processes in tomatoes. They can influence floral traits, attract pollinators, and enhance pollen viability and germination. By improving these aspects, PGRs can enhance the successful pollination and fertilization of flowers, leading to an increased number of fruits. Similar findings were recorded by Naemet *et al.*, (2001) and Yadav *et al.*, (2001).

3.3.3. Individual fruit weight (g) and Average weight of 10 fruits (g)

The data pertaining individual fruit weight varied significantly. Maximum individual fruit weight and average weight of 10 fruits was observed in T₁₈ (GA₃@90ppm + NAA@45ppm) with 112.63g and 1126.33g respectively while the minimum was recorded under T₀ (Control) with 90.4 g and 904g respectively, shown in Table:3. PGRs promote cell division and elongation, leading to larger fruit size potentially increasing fruit weight. Similar findings were recorded by Ujjwalet *et al.*, (2018) and Roy *et al.*, (2011).

3.3.4. Average fruit yield per plant (Kg), Total fruit yield per plant (Kg) and Fruit yield per hectare (t)

The data pertaining average fruit yield per plant varied significantly. Maximum average fruit yield per plant was observed in T₁₈ (GA₃@90ppm + NAA@45ppm) with 1.95Kg, 5.84Kg and 216.3t respectively while minimum was recorded T₀ (Control)

with 0.32 Kg, 0.95Kg and 35.18t respectively, shown in Table:4. Gibberellic acid (GA₃) promotes fruit set and vegetative growth, potentially increasing yield. Auxins improve fruit set and growth, contributing to higher yields. Ethylene-releasing compounds aid in uniform ripening, potentially boosting overall yield. Similar findings were reported in Meena *et al.*, (2008), Prasad *et al.*, (2013) and Yadav *et al.*, (2001).

3.4. Qualitative parameters

3.4.1. Total Soluble Solid (⁰Brix) and Ascorbic acid (mg/100g)

The data pertaining Total Soluble Solid varied significantly. Maximum Total Soluble Solid was observed in T₁₈ (GA₃@90ppm + NAA@45ppm) and ascorbic acid with 6.07 ⁰Brix and 20.3 respectively while Total Soluble Solid was recorded under T₀ (Control) with 1.03 ⁰Brix and 12.37 respectively, shown in Table:4. The use of Plant Growth Regulators (PGRs) significantly impacted the quality of tomato fruits. It has the potential to influence various attributes that contribute to the overall fruit quality. By promoting cell division and elongation, certain PGRs like gibberellins can result in larger tomato fruits. This can be advantageous for specific tomato varieties or market preferences that prioritize larger-sized fruits. PGRs also influenced fruit color development and ripening. Ethylene-releasing PGRs play a crucial role in accelerating the ripening process and improving fruit color. This can lead to more visually appealing tomatoes, enhancing their marketability and consumer appeal. Similar findings were reported by Naemet *et al.*, (2008), Tomaret *et al.*, (2017) and Ranjeet *et al.*, (2014).

4. CONCLUSION

According to the current research, the use of Plant growth regulators (PGRs) on the growth, yield and quality of tomato, it is concluded that T₁₈ (GA₃@90ppm + NAA@45ppm) was best in terms of plant height, days to first flowering, days to 50% flowering, days to first harvest, number of flower cluster per plant, fruit set per cluster, polar diameter, equatorial diameter, number of fruit per plant, individual fruit weight, average weight of 10 fruits, average fruit yield per plant, total yield per plant, fruit yield per hectare, TSS and ascorbic acid.

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UNDER PEER REVIEW

TABLE 1: Plant height (cm) at 30DAT, 60 DAT, 90 DAT and at harvest.

Treatment Notation	Treatment Details	Plant height [30 DAT]	Plant height [60 DAT]	Plant height [90 DAT]	Plant height [At Harvest]
T ₀	CONTROL	30.87	60.37	90.80	99.47
T ₁	NAA@30 ppm	34.20	62.50	92.93	101.60
T ₂	NAA@45 ppm	32.00	61.50	91.93	100.60
T ₃	IAA @30 ppm	34.47	63.23	93.67	102.33
T ₄	IAA@45 ppm	36.00	63.87	94.30	102.97
T ₅	GA ₃ @ 60 ppm	36.27	64.77	95.20	103.87
T ₆	GA ₃ @90 ppm	36.60	65.87	96.30	104.97
T ₇	NAA@30ppm + IAA@30ppm	37.33	67.50	97.93	106.60
T ₈	NAA@30ppm + IAA@45ppm	37.40	68.90	99.33	108.00
T ₉	NAA@45ppm + IAA@30ppm	37.73	69.77	100.20	108.87
T ₁₀	NAA@45ppm + IAA@45ppm	37.80	71.93	102.37	111.03
T ₁₁	IAA@30ppm +GA ₃ @60ppm	38.00	73.33	103.77	112.43
T ₁₂	IAA@30ppm +GA ₃ @90ppm	38.87	77.33	107.77	116.43
T ₁₃	IAA@45ppm +GA ₃ @60ppm	38.80	75.77	106.20	114.87
T ₁₄	IAA@45ppm +GA ₃ @90ppm	38.20	74.53	104.97	113.63
T ₁₅	GA ₃ @60ppm + NAA@30ppm	39.07	78.40	108.83	117.50
T ₁₆	GA ₃ @60ppm + NAA@45ppm	39.50	80.37	110.80	119.47
T ₁₇	GA ₃ @90ppm + NAA@30ppm	39.07	82.67	113.10	121.77
T ₁₈	GA ₃ @90ppm + NAA@45ppm	42.13	84.83	115.27	123.93
	F- TEST	S	S	S	S
	S.E. (d) ±	1.29	0.25	0.27	0.26
	C.D. _{0.05}	2.63	0.51	0.53	0.52
	C.V.	4.27	0.43	0.31	0.28

TABLE 2: Days to first flowering (DAT), days to 50% flowering (DAT), days to first harvest (DAT), number of flower cluster per plant and fruit set per cluster.

Treatment Notation	Treatment Details	Days to first flowering	Days to 50% flowering	Days to first harvest	Number of flower cluster per plant	Fruit set per cluster
T ₀	CONTROL	52.60	60.13	95.93	1.27	2.07
T ₁	NAA@30 ppm	51.00	58.53	94.33	2.53	2.87
T ₂	NAA@45 ppm	51.77	59.30	95.10	2.13	2.50
T ₃	IAA @30 ppm	50.23	57.77	93.57	2.87	3.13
T ₄	IAA@45 ppm	49.67	57.20	93.00	3.13	3.43
T ₅	GA ₃ @ 60 ppm	49.13	56.67	92.47	3.47	3.77
T ₆	GA ₃ @90 ppm	48.57	56.10	91.90	3.80	4.13
T ₇	NAA@30ppm + IAA@30ppm	48.07	55.60	91.40	4.13	4.57
T ₈	NAA@30ppm + IAA@45ppm	47.53	55.07	90.87	4.43	4.80
T ₉	NAA@45ppm + IAA@30ppm	47.13	54.67	90.47	4.87	5.13
T ₁₀	NAA@45ppm + IAA@45ppm	46.67	54.20	90.00	5.40	5.53
T ₁₁	IAA@30ppm +GA ₃ @60ppm	46.13	53.67	89.47	5.73	5.80
T ₁₂	IAA@30ppm +GA ₃ @90ppm	44.73	52.27	88.07	6.77	6.73
T ₁₃	IAA@45ppm +GA ₃ @60ppm	45.3	52.83	88.63	6.43	6.40
T ₁₄	IAA@45ppm +GA ₃ @90ppm	45.73	53.27	89.07	6.07	6.13
T ₁₅	GA ₃ @60ppm + NAA@30ppm	44.37	51.90	87.70	7.13	7.13
T ₁₆	GA ₃ @60ppm + NAA@45ppm	43.63	51.17	86.97	7.40	7.43
T ₁₇	GA ₃ @90ppm + NAA@30ppm	43.00	50.53	86.33	7.53	7.67
T ₁₈	GA ₃ @90ppm + NAA@45ppm	42.30	49.83	85.63	7.87	8.07
	F- TEST	S	S	S	S	S
	S.E. (d) ±	0.13	0.15	0.15	0.07	0.06
	C.D. 0.05	0.26	0.26	0.27	0.14	0.12
	C.V.	0.33	0.29	0.18	1.69	1.45

TABLE 3: Polar diameter (mm), Equatorial diameter (mm), Number of fruits per plant, Individual fruit weight (g) and Average weight of 10 fruits (g)

Treatment Notation	Treatment Details	Polar Diameter	Equatorial Diameter	Number of fruits per plant	Individual fruit weight	Average weight of 10 fruits
T ₀	CONTROL	52.20	52.20	3.47	90.40	904.00
T ₁	NAA@30 ppm	54.53	54.53	5.33	93.20	932.00
T ₂	NAA@45 ppm	53.63	53.63	4.70	92.37	923.67
T ₃	IAA @30 ppm	54.87	54.87	5.73	94.13	941.33
T ₄	IAA@45 ppm	55.33	55.33	6.33	95.20	952.00
T ₅	GA ₃ @ 60 ppm	55.73	55.73	6.87	96.23	962.33
T ₆	GA ₃ @90 ppm	56.13	56.13	7.43	98.07	980.67
T ₇	NAA@30ppm + IAA@30ppm	56.80	56.80	8.27	98.60	986.00
T ₈	NAA@30ppm + IAA@45ppm	57.13	57.13	8.93	99.37	993.67
T ₉	NAA@45ppm + IAA@30ppm	57.53	57.53	9.73	99.87	998.67
T ₁₀	NAA@45ppm + IAA@45ppm	58.13	58.13	10.40	100.47	1004.67
T ₁₁	IAA@30ppm +GA ₃ @60ppm	58.60	58.60	11.20	101.33	1013.33
T ₁₂	IAA@30ppm +GA ₃ @90ppm	61.13	60.93	14.33	105.13	1051.33
T ₁₃	IAA@45ppm +GA ₃ @60ppm	60.60	60.30	13.07	103.47	1034.67
T ₁₄	IAA@45ppm +GA ₃ @90ppm	60.13	59.13	12.10	102.57	1025.67
T ₁₅	GA ₃ @60ppm + NAA@30ppm	61.53	61.53	15.20	107.57	1075.67
T ₁₆	GA ₃ @60ppm + NAA@45ppm	62.13	62.13	15.93	108.50	1085.00
T ₁₇	GA ₃ @90ppm + NAA@30ppm	62.53	62.53	16.70	110.07	1100.67
T ₁₈	GA ₃ @90ppm + NAA@45ppm	63.13	63.33	17.27	112.63	1126.33
F- TEST		S	S	S	S	S
S.E. (d) ±		0.08	0.09	0.13	0.08	0.13
C.D. _{0.05}		0.16	0.19	0.26	0.16	0.27
C.V.		0.14	0.16	1.51	0.14	0.16

TABLE 4: Average fruit yield per plant (Kg), Total fruit yield per plant (Kg), Fruit yield per hectare (t), Total Soluble Solid (⁰Brix) and Ascorbic acid (mg/100g).

Treatment Notation	Treatment Details	Average fruit yield per plant	Total fruit yield per plant	Fruit yield per hectare	Total Soluble Solid	Ascorbic acid
T ₀	CONTROL	0.32	0.95	35.18	1.03	12.37
T ₁	NAA@30 ppm	0.50	1.49	55.19	1.57	13.37
T ₂	NAA@45 ppm	0.43	1.29	47.78	1.33	12.87
T ₃	IAA @30 ppm	0.54	1.63	60.37	1.77	13.73
T ₄	IAA@45 ppm	0.60	1.81	67.04	2.07	14.13
T ₅	GA ₃ @ 60 ppm	0.66	1.98	73.33	2.20	14.57
T ₆	GA ₃ @90 ppm	0.73	2.20	81.48	2.47	14.87
T ₇	NAA@30ppm + IAA@30ppm	0.82	2.45	90.74	2.87	15.47
T ₈	NAA@30ppm + IAA@45ppm	0.89	2.66	98.52	3.30	15.87
T ₉	NAA@45ppm + IAA@30ppm	0.97	2.92	108.15	3.63	16.27
T ₁₀	NAA@45ppm + IAA@45ppm	1.05	3.14	116.30	3.80	16.67
T ₁₁	IAA@30ppm +GA ₃ @60ppm	1.14	3.41	126.30	4.07	17.13
T ₁₂	IAA@30ppm +GA ₃ @90ppm	1.51	4.52	167.41	4.73	18.33
T ₁₃	IAA@45ppm +GA ₃ @60ppm	1.35	4.06	150.37	4.47	17.87
T ₁₄	IAA@45ppm +GA ₃ @90ppm	1.24	3.72	137.78	4.23	17.53
T ₁₅	GA ₃ @60ppm + NAA@30ppm	1.63	4.90	181.48	5.13	18.87
T ₁₆	GA ₃ @60ppm + NAA@45ppm	1.73	5.19	192.22	5.43	19.30
T ₁₇	GA ₃ @90ppm + NAA@30ppm	1.84	5.52	204.45	5.63	19.63
T ₁₈	GA ₃ @90ppm + NAA@45ppm	1.95	5.84	216.30	6.07	20.30
F- TEST		S	S	S	S	S
S.E. (d) ±		0.01	0.04	1.47	0.05	0.08
C.D. _{0.05}		0.03	0.08	2.99	0.11	0.17
C.V.		1.55	1.55	1.55	1.87	0.61