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Optimizing Tomato Yield through Bioregulator Application for Flower and Fruit Drop Reduction in the North Agroclimatic Zone of Bihar

Udit Kumar[1]*, Kavyashree[1], Rajeev Kumar Yadav[1], Pramila[1], Neeraj[1], Dharminder[2], and Kaushal Kishor[2]

[1]*Department of Horticulture, PG College of Agriculture, RPCAU, Pusa, Samastipur (India)*
[2]*Department of Agronomy, PG College of Agriculture, RPCAU, Pusa, Samastipur (India)*

ABSTRACT

The tomato is highly sensitive to very hot, humid and cold conditions and it is directly or indirectly affecting the production and productivity of tomato. Due to increase in temperature there is more incidence of viral diseases as well as problem in pollination and fertilization This experiment was laid out in Randomized Block Design (RBD) having seven treatments and three replications. Treatments consist of different levels of NAA (T_1@10 ppm, T_2@ 20 ppm, and T_3@30 ppm), GA_3 (T_4@50 ppm, T_5@100 ppm, and T_6@150 ppm) along with control (T_7@ sprayed only with distilled water). These different concentrations of NAA and GA_3 were sprayed on the crop at 25, 50, and 75 days after transplanting to study the different parameters at all successive stages of crop growth. The result revealed that the morphological parameters were greatly affected by the different levels of NAA and GA_3 at all the successive growth stages except 25 days after transplanting. Treatment T_3 (NAA@30 ppm) produced maximum plant height, number of branches per plant, and number of leaves per plant which were at par with treatment T_5 (GA_3@100 ppm) at 50 and 75 days after transplanting respectively. All the flowering, physiological and yield-attributing parameters were also greatly influenced by the application of growth regulators (NAA and GA_3). It may be concluded that in the subtropical climate, farmers face flower and fruit drop problems due to high temperatures in the Kharif and late Kharif season. To overcome this problem, plant growth regulator GA_3@100ppm can be used to increase the flowering, fruit set, and fruit size and control the fruit drop.

Keywords: *Tomato, NAA, GA3, Physiological, Biochemical, Growth and Yield.*

Introduction

The vegetables are one of the major contributors to the balanced human died dur its richness in important nutrients and nutraceuticals compounds. Nutraceuticals are considered to be the substances found as a natural ingredient of foods or other ingestible forms which have been determined to be beneficial to the human body in order to heal one or more diseases or for the improvement of physiological performance beyond adequate nutritional effects in a way that is relevant to either improved state of health and well-being as well reduction of risk of disease. Among all the vegetables, tomato has been one of the most important in regular diets due to high health benefits. Tomato (*Solanum lycopersicum* L.) has a chromosome number of 2n=2x=24 and it is originated in the Peruvian and Mexican regions. It is widely accepted as the "No.1 processing vegetable" and universally tomato is treated as a "protective food" because of its demand not only in processing the industrial sector but also as a vegetable and protective food (1). It is cab be consumed either as raw or processed items like tomato paste, puree, syrup, sauce, ketchup, chutney and soup. It is considered a 'culinary vegetable' because it has low sugar content compared to other culinary fruits and vegetables and in ripe fruits, the total sugar content will be 2.5%. The fruit value of tomato is very high due to its higher contents of vitamins A, B, C, Ca and carotene [1]. Besides, it is frequently stated as "The poor man's orange", owing to its high vitamins and acids (maleic acid, citric acid) contents [2]. As per the government the national production of tomato is estimated to be approximately 208.19 Lakh Tonne from the area of approximately 8.50 lakh hectares in 2020. Madhya Pradesh, Karnataka and Andhra Pradesh were the leading producers of tomatoes across the country.

Although tomatoes have been cultivated in every climatic condition, it is sensitive to very hot, humid and cold conditions, as increasing temperatures increases incidence of viral diseases, forcing flower and fruit drops, reduces size and quality of the fruit [3]. Fruit set depends on the successful completion of pollination and fertilization [11]. Tomato requires day temperature of 21–28°C and a moderately cool night temperature (15-20°C) for proper fruit setting. High temperatures (both day and night), humidity, rainfall, and light intensity are the limiting factors of tomato production [12]. High day and night temperatures above 32°C and 21°C, respectively, was reported as limiting factors to fruit set due to an impaired complex of a physiological process in the pistil, which results in floral or fruit abscission [13]. High temperatures reduce fruit set, fruit production and yield in tomatoes [14]. There are various constraints leading to low productivity of tomato such as poor soil fertility, water scarcity, poor cultivation skills, attack of pest and disease, poor availability of inputs and harsh climate [4]. Lack of adaptive cultivars to adverse conditions and poor fruit setting of existing varieties especially during the hot/dry season where the demand for tomatoes is very high is one of the major challenges faced by tomato grower despite of potential land for cultivation. At the time of flowering and fruit setting it is affecting most because of heat and high humidity causing lead to poor pollination and fertilization in tomato. There are many ways of increasing fruit set during adverse climatic conditions.

*Corresponding Author: **Udit Kumar***

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It can be improved by developing heat tolerant varieties by conventional breeding or by alterations of genetic makeup of plant. The availability of complete genomic sequence data of *Arabidopsis thaliana* and *Oryza sativa* has provided vast information on different families of the heat shock protein (hsp) [5, 6, 7, 8]. Flowering and fruit setting can also be improved by growing tomatoes under controlled environment conditions. However, all these methods are highly time consuming require skilled labour as well as very costly. Using plant hormones on heat-tolerant variety might have better performance over hot and humid conditions. Plant hormones are used extensively to improve plant growth, fruit set, fruit size and yield of horticultural crops. Plant hormones could improve flowering and fruit setting and yield during the summer season [9]. Breeding for heat tolerance in tomato has been difficult because of many factors like moderate heritability as well as complex inheritance or the cultivars becoming lower in yield [10].

Generally, plant growth regulators (PGR) are used extensively in horticultural crops to reduce the above-mentioned problems also it enhances growth and significantly improve yield by increasing branching, flowering clusters, flower number, fruiting clusters, fruit number, fruit set and size of the fruit [1]. There are several studies have been done using PGRs in vegetable crops among them Gibberellic acid (GA) and Naphthalene acid (NAA) shown promising responses in tomato and many other vegetable crops. GA can stimulate rapid stem and root growth, induce mitotic division in the leaves of some plants, and increase seed germination rates. NAA is a synthetic auxin and used frequently to increase growth, flowering and fruiting in many commercial horticultural crops. Both NAA and GA3 influence flowering clusters, fruit retention capacity, quality of the fruits, and control flower and fruit drop very effectively. Therefore, NAA and GA_3 could be beneficial in the production of tomatoes.

The use of plant growth regulators might be a useful alternative to increase crop production [15]. Usually, NAA and GA_3 are synthetic and mostly applied exogenously to hormonal stimulation to set flowers and fruit [16]. The use of growth regulators had improved the production of tomatoes including other vegetables in respect of better growth and quality [17]. Fruit set in tomatoes are often increased by applying plant growth regulators to make amends for the deficiency of natural growth substances required for its development [11]. Induction of artificial parthenocarpy through the application of PGRs enables fertilization-independent fruit development which will reduce yield fluctuation in crops like tomato, pepper *etc.* [18]. Realizing the importance of plant growth hormones, the present investigation was carried out to study of the effect of plant bio-regulators (GA and NAA) in controlling of flower and fruit drops in tomato. It also includes an evaluation of the effect of plant growth regulators on yield and quality in tomatoes. The research is also aimed at analysing the economics of different concentrations of the bio-regulators on yield of tomato.

Materials and Methods

Experimental site and weather conditions: The present experiment was conducted at the Vegetable Research Farm of Dr. Rajendra Prasad Central Agricultural University, Bihar, Pusa (Samastipur) during the period of October 2019 to March 2020 and repeated again during October 2020 to March 2021 to find out the effect of plant growth regulators in the control of flower and fruit drop in tomato variety Kashi Vishesh (procured from ICAR-IIVR, Varanasi). This experimental site had the hot moist and semi-arid type of climate with alluvial, medium available water holding capacity. The mean values of minimum and maximum temperature recorded during growing seasons which, ranged from 19°C to 32°C (October) and 13.5°C to 30.3°C (March), respectively. The minimum to maximum relative humidity during both growing seasons of tomato was 56% to 85% and 44% to 75%, respectively. The average sunshine hours during the growing season of tomato ranged from 4.6 to 8.3hr/day while total amount of rainfall was 10.975 mm (October 2018 to March 2019) and 14.73 mm (October 2019 to March 2020), respectively.

Experimental details: The experiment was laid out in Randomized Block Design (RBD) with seven treatments and three replications. Treatments consist of NAA (T_1-10 ppm, T_2-20 ppm, and T_3-30 ppm), GA_3 (T_4-50 ppm, T_5-100 ppm, and T_6-150 ppm) along with control (T_7-sprayed only distilled water). These different concentrations of NAA and GA_3 were sprayed at 25, 50, and 75 days after transplanting (DAT) to study the different parameters at stages of crop growth.

The seeds of Kashi Vishesh were sown in a well-prepared nursery bed of 3.0 x 1.0m in size and were irrigated regularly. All curative measures were taken against pests and diseases for good establishment of seedlings. Solution of GA_3 and NAA solutions are prepared according to the treatment and at different growth stages as mentioned above.

Result and Discussion

Growth parameters like the height of the plant, branches per plant, and leaves per plant, were recorded at 25 DAT up to fruit harvesting. Flowering parameters like days to 50% flowering, flowering branches per plant and flowers per plant were recorded after 50% flowering of plants. Physiological parameters like leaf area index (LAI), relative water content (RWC) and estimation of shelf life were recorded at fruits harvesting stage. Yield and yield attributing parameters like number of fruit drop percentage, number of fruits per plant, number of fruit set per cent, the average weight of the fruit, equatorial diameter, and polar diameter of the fruit, yield per plant and yield per hectare were recorded after harvesting of fruits. Biochemical parameters including Abscisic acid (ABA), Total soluble solids (TSS), acidity, and ascorbic acid content of the fruit were significantly influenced by different concentrations of treatments.

It was observed from the experiment that in the different NAA applications, i.e. 10 ppm, 20 ppm, and 30 ppm. The tomato crop was substantially affected by increasing NAA concentrations (30 ppm) at all successive growth stages except 25 DAT. Since the higher NAA concentration (30 ppm) produced higher values for all morphological characters in all the successive growth stages *Viz.* 50, and 75 DAT over other NAA concentrations and compared to GA_3 concentrations (Table 1.1. and Table 1.2.). Since NAA stimulates shoot elongation, it promotes cell division, which enhances the plant length, increases distances between the nodes as well as promotes more branching and more side branches and inhibits the development of lateral buds (maintains apical dominance) and produces more leaves and increase more photosynthetic rate of leaves. Promoting fruit development, since NAA promotes flower development and stimulates the maturation of the ovary wall and all the steps in the full development of the fruit. [19] Concluded in his analysis that the improvement of morphological parameters was caused by cell elongation, cell enlargement, cell growth, and nucleic acid metabolism, a similar conclusion was given. [3], concluded that the main role of Auxin (NAA) has been to help the plants grow and to promote the elongation of plant cells. He also concluded that gibberellic acid induces cell elongation and makes the plants grow taller.

From investigation that the rising doses of GA_3 up to 100 ppm significantly affected the flowering parameters of tomatoes and fell dramatically to 50 per cent over the days and increased the number of flowering branches per plant and number of flowers per plant over a lower dose of GA_3 (50 ppm) and a higher dose of GA_3 (150 ppm) (Table 2). Different concentrations of GA3 reduced the days required to 50% flowering because it acts as a florigen or helps the production and transport of other signals and enhances the gene level for flower induction. GA_3 promoted flower primordia in tomatoes and increased the number of inflorescences per plant by increasing the number of branches and clusters of flowers [11]. Several workers have achieved similar results in various vegetables like snap bean okra and tomato [19].

Treatment T_5 (GA_3 @100 ppm) recorded significantly the highest LAI (3.20) which was at par with T_3 (NAA@30 ppm) *i.e.* 2.98 while the lowest LAI was observed in control (2.24). The RWC differed significantly due to growth regulators. Treatment T_5 (GA_3@100 ppm) recorded significantly highest RWC (1.473 %) which was at par with treatment T_3 (NAA@30 ppm) which recorded 1.47%, though managed the lowest RWC was observed (0.65 %). The estimation of shelf life was differed significantly due to growth regulators. Treatment T_5 (GA_3 @100 ppm) produced significantly highest days of shelf life (21.11 days) which was at par with T_3 (NAA@30 ppm) *i.e.*19.63 days while the lowest days of shelf life was observed in control (15.01 days) (Table 3).

At the different applications of GA_3, *i.e.,* (50 ppm, 100 ppm, and 150 ppm), it is evident that the concentration of 100 ppm of GA_3 shows higher values of physiological parameters. [20] observed an increase in LAI and total dry matter (TDM) production with GA_3 treatment and induced acceleration of vegetative growth resulting in an extensive photosynthetic apparatus and a relative increase in LAI. The RWC may be a useful measure of a plant's water balance, mainly because of which it expresses completely the amount of water required by the plant to achieve artificial maximum saturation [27]. [21] noted that gibberellic acid has a role to play in regulating fruit environment, pre-harvesting fruit drop, growing fruit yield, and extending shelf life. [22] confirmed that the time period for tomato fruits at ambient temperature was excellent.

The number of fruits drop per plant was differed significantly due to growth regulators. Treatment T_5 (GA_3@100 ppm) observed a minimum number of fruit drop per plant (0.44) which was at par withT_3 (NAA@30 ppm) *i.e.* (0.55) whereas the highest number of fruits dropped per plant, found under control (9.00). Among the major causes accounting for fruit, the drop is self-incompatibility, inadequate pollination, nutritional deficiency, water stress, insect-pest, and disease infestations and hormonal imbalances [23].

The number of fruits set per plant was differed significantly due to growth regulators. Treatment T_5 (GA_3 @100 ppm) provided the largest number of fruits per plant (67.22) which was at par with T_3(NAA@30 ppm) *i.e.* 66.88 though the lowest fruit set was observed under control (40.86). The collection of fruits was established because the transformation from a quiescent ovary to a fast-growing young fruit is a crucial phase in flowering plants being sexually transmitted.

The number of fruits set per plant differed significantly due to growth regulators. Treatment T_5 (GA_3 @100 ppm) provided the largest number of fruits per plant (67.22) which was at par with T_3 (NAA@30 ppm) i.e. 66.88 though the lowest fruit set was observed under control (40.86). The average weight of the fruit differed significantly due to growth regulators. Treatment T_5 (GA_3 @100 ppm) recorded the maximum weight of the fruit (102.637 g) which was significantly better to other treatments followed by T_3 (NAA@30 ppm) and T_6 (GA_3 @150 ppm) while the minimum weight of the fruit was observed in control (48.21 g). The equatorial diameter of the fruit was differed significantly due to growth regulators. Treatment T_5 (GA_3 @100 ppm) observed a significant maximum equatorial diameter of the fruit (5.17 cm) which was significantly superior over all the treatments, followed by T_3 (NAA@30 ppm) and T_4 (GA_3 @50 ppm) whereas the minimum equatorial fruit diameter was observed under control (3.40 cm). Treatment T_5 (GA_3 @100 ppm) observed a significant maximum polar diameter of the fruit (4.95 cm) which was at par with T_3 (NAA@30 ppm) *i.e.* 4.88 cm whereas the minimum polar diameter of the fruit was observed under control (3.34 cm). Treatment T_5 (GA_3 @100 ppm) observed a significant maximum yield per plant (2.64 Kg) this was substantially higher than overall treatments while the minimum yield per plant was tested under control (1.180 Kg). Treatment T_5 (GA_3 @100 ppm) produced a significant maximum yield per hectare (29.06 t/ha) which was superior to all the treatments followed by treatments T_3 (NAA@30 ppm) and T_2 (NAA@20 ppm) while the minimum yield per hectare was produced by T_7 control (18.46 t/ha) (Table 4).

It was observed in the present study that plants growth regulators enhanced the source-sink relationship and hormone-modified translocation of photosynthates, which will help in better retention of flowers and fruits and seed filling at the later stages of crop growth. There is great potential to increase the yield levels in tomatoes either by reducing the flower drop or by increasing the fruit set. This could occur because of auxin and gibberellins application at flowering time, reduced flowers resulting in better fruit setting, fruit length and a higher percentage of fruit set, [24] also reported that 4-chlorophenoxy acetic acid was found to be successful in improving the fruit of tomatoes set at higher temperatures, which is also in line with the findings of [22] where he obtained that the tomato plants treated with a mixture of 4-CPA and GAs displayed an increased collection of fruits and a proportion of regular fruits compared with 4-CPA-treated equivalent plants. [11] was found that plant growth regulators have good potential to promote summer tomato fruit duration. A spray of 2, 4-dichlorophenoxy acetic acid, 4-chlorophenoxy acetic acid, and Naphthalene acetic acid at flowering resulted in reduced fruit drop, increased fruit setting, and fruit size in tomatoes [11]. It was completely found that the application of 4-CPA enhances the fruit setting in summer tomatoes by growing the drop in flowers and fruits which contributed to higher fruit varieties per plant. This was in line with the observations of [25]. GA_3 has been found to generate a greater number of fruit plants over alternative plant growth regulators. It would result in the increased fruit in the tomato. This finding is in accordance with the findings of [23].

The ABA differed significantly due to growth regulators. Treatment T_5 (GA_3 @100 ppm) produced significantly the lowest ABA (0.018 %) which was superior overall in the treatments while the highest ABA was observed in control (0.082 %). Treatment T_5 (GA_3 @100 ppm) produced significantly highest

TSS (4.81^0 Brix) which was superior overall the treatments, followed by T_3 (NAA@30 ppm) and T_2 (NAA@20 ppm) while the lowest TSS was observed in control (3.57^0 Brix). Treatment T_5 (GA_3 @100 ppm) produced significantly lowest acidity of the fruits (0.42 %) which was at par with the treatment T_3 (NAA@30 ppm) i.e. 0.45 % while the highest acidity of the fruits was observed in control (0.69 %). Treatment T_5 (GA_3 @100 ppm) produced significantly highest ascorbic acid content of the fruits (11.66 mg/100g) which was at par with T_3 (NAA@30 ppm) and T_2 (NAA@20 ppm) and T_6 (GA_3 @150 ppm) although, the lowest ascorbic acid content of the fruit was observed in control (7.773 mg/100g) (Table 5).

From the experiment, it was inferred that GA_3 at 100 ppm influences the superior quality of the fruits. Tomato plant TSS is determined by the rate of assimilation of export from the leaves, the rate of import by plant, and thus the fruit carbon metabolism. Titrable acidity because of the application of GA_3 was recorded due to increased organic acid formation within the tissues which activates within the Krebs cycle and increases the production of vitamin C content in the cellular tissues and plasma membrane. It decreases plant abscission owing to the foliar spray of plant growth regulators enhances the longevity of attachment for days and reduces the production of more abscisic acid content in plants and fruits, by the application of NAA thereby regulating the physiological and biochemical process in the plants, *viz*. by reducing the vegetative growth and transmitting photosynthates towards reproductive parts and enhancing the quality characters of the fruit.

T_5 (GA_3 @ 100 ppm) showed minimum acidity of the fruit (0.420 %),), minimum ABA (0.018 %), maximum TSS content of the fruit (4.813^0 Brix), maximum ascorbic acid content of the fruit (11.660 mg/100g) over control T_7 (only distilled water) - maximum acidity of the fruit (0.69 %), higher ABA content (0.082 %), minimum TSS content of the fruit (3.57^0 Brix), minimum ascorbic acid content of the fruit (7.773 mg/100g).

The farmers in tropical and subtropical climates face a problem of flower and fruit drop due to high temperatures. To overcome that problem, they can use plant growth regulators to control and enhance production. In normal cultivation of crops, farmers must invest plenty of chemicals like fungicides, and pesticides whereas in modern cultivation we use plant regulators instead of chemicals to improve the grade of the crop. Cultivation of tomatoes by using plant regulators influences fruit retention and yields more with prime quality. It is also a source of good earnings for farmers using lower investments.

Conclusion

Contemplating the readings of the experiment, it is often concluded that, the appliance of various concentrations of NAA and GA_3 was found significantly superior at all growth parameters in the treatment T_3 (NAA @ 30 ppm) and the rest all the parameters were found superior in the treatment T_5 (GA_3 at 100 ppm) over control T_7 (only distilled water) in Pusa conditions.

Table 1.1.: Effect of plant growth regulators (NAA and GA_3) on Morphological parameters (pooled data of 2 years)

Treatments	Plant height (cm)			Number of branches per plant		
	25 DAT	50 DAT	75 DAT	25 DAT	50 DAT	75 DAT
T_1 (NAA- 10 ppm)	25.04	44.22	77.00	2.66	6.77	12.36
T_2 (NAA- 20 ppm)	24.59	49.33	79.28	3.22	7.33	12.44
T_3 (NAA- 30 ppm)	25.92	52.63	85.01	3.33	10.93	15.49
T_4 (GA_3- 50 ppm)	25.00	46.33	77.15	2.89	7.22	12.20
T_5 (GA_3 -100 ppm)	25.88	49.88	83.77	3.03	9.90	14.80
T_6 (GA_3 -150 ppm)	25.07	47.07	78.33	2.89	5.15	11.69
T_7 (Control-No spray)	25.04	40.11	67.27	2.55	4.99	10.00
C.D (0.05)	NS	5.044	6.611	NS	2.299	1.168
SE (m)	0.920	1.619	2.122	0.144	0.738	0.375
C.V (%)	6.657	6.081	5.027	7.731	18.410	5.313

Table: 1.2.: Effect of plant growth regulators (NAA and GA_3) on Morphological parameters (pooled data of 2 years)

Treatments	Number of leaves per plant		
	25 DAT	50 DAT	75 DAT
T_1 (NAA- 10 ppm)	107.55	177.00	207.12
T_2 (NAA- 20 ppm)	111.22	188.51	220.26
T_3 (NAA- 30 ppm)	112.33	198.66	237.48
T_4 (GA_3- 50 ppm)	112.59	181.56	213.46
T_5 (GA_3 -100 ppm)	111.55	195.44	228.15
T_6 (GA_3 -150 ppm)	108.55	180.19	217.76
T_7 (Control- No spray)	113.77	159.64	194.87
C.D (0.05)	NS	26.026	21.041
SE (m)	3.425	8.354	6.754
C.V (%)	5.361	7.503	5.381

Table 2: Effect of NAA and GA_3 on flowering characters (pooled data of 2 years)

Treatments	Days to 50% flowering	Number of flowering branches per plant	Number of flowers per plant
T_1 (NAA@10 ppm)	69.46	5.36	44.03
T_2 (NAA@ 20 ppm)	66.85	7.35	45.03
T_3 (NAA@30 ppm)	64.64	9.22	48.92
T_4 (GA_3@50 ppm)	67.53	8.16	41.54
T_5 (GA_3 @100 ppm)	56.32	10.58	49.95
T_6 (GA_3 @150 ppm)	77.72	8.26	42.09
T_7 (Control @No spray)	76.71	4.89	40.55
SE(m)	2.095	1.327	3.547
C.D(0.05)	6.258	0.426	1.139
CV (%)	5.299	10.366	4.428

Table 3: Effect of NAA and GA_3 on physiological characters.

Treatments	LAI	RWC (%)	Estimation of shelf life
T_1 (NAA@10 ppm)	2.73	0.87	18.61
T_2 (NAA@ 20 ppm)	2.85	0.92	17.72
T_3 (NAA@30 ppm)	2.98	1.27	19.63
T_4 (GA_3@50 ppm)	2.84	0.94	18.37
T_5 (GA_3 @100 ppm)	3.20	1.47	21.11
T_6 (GA_3 @150 ppm)	2.74	0.91	18.55
T_7 (Control @ No spray)	2.24	0.65	15.01
SE(m)	0.081	0.043	0.586
C.D (0.05)	0.252	0.132	1.825
C.V. (%)	5.004	7.329	5.502

Table 4: Effect of NAA and GA_3 on yield and yield attributing characters of Tomato (pooled data of 2 years)

Treatments	Number of fruit drop/plant	Percentage fruit set/plant	Number of Fruits/plants	Average weight of the fruit	Equatorial diameter of the fruit (cm)	Polar diameter of the fruit (cm)	Average yield/plant	Yield/ hectare (t/ha)
T_1 (NAA@ 10 ppm)	5.78	60.14	23.55	67.37	4.02	3.66	1.77	23.64
T_2 (NAA@ 20 ppm)	4.33	61.16	25.67	76.54	4.37	4.70	1.66	24.30
T_3 (NAA@ 30 ppm)	0.74	66.88	28.44	98.68	4.88	4.73	2.20	26.68
T_4 (GA_3@ 50 ppm)	3.56	56.51	23.11	78.01	4.69	4.43	2.11	23.75
T_5 (GA_3@ 100 ppm)	0.44	67.22	29.44	102.63	5.17	4.95	2.64	29.06
T_6 (GA_3@ 150 ppm)	3.11	60.77	23.77	86.40	4.39	4.47	1.85	24.78
T_7 (Control@ No spray)	9.06	40.86	18.33	48.21	3.40	3.34	1.18	18.46
SE(m)	0.557	5.586	2.397	12.222	0.416	0.506	0.323	2.789
C.D (0.05)	0.179	1.793	0.769	3.923	0.134	0.163	0.104	0.895
C.V (%)	8.094	5.256	5.414	8.526	5.238	6.502	9.366	6.360

Table 5: Effect of NAA and GA_3 on biochemical characters of Tomato fruit

Treatments	Abscisic acid (%)	TSS (^{0}Brix)	Acidity (%)	Ascorbic acid (mg/100g)
T_1 (NAA@10 ppm)	0.039	4.29	0.52	10.40
T_2 (NAA@ 20 ppm)	0.034	4.12	0.52	09.68
T_3 (NAA@30 ppm)	0.028	4.36	0.45	11.14
T_4 (GA_3@50 ppm)	0.026	4.23	0.59	08.92
T_5 (GA_3 @100 ppm)	0.018	4.81	0.42	11.66
T_6 (GA_3 @150 ppm)	0.029	4.16	0.49	10.37
T_7 (Control @No spray)	0.082	3.57	0.69	07.77
SE(m)	0.002	0.13	0.02	00.30
C.D (0.05)	0.007	0.39	0.05	00.93
C.V (%)	11.126	5.15	5.49	05.18

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