Original Research Article

Determining the effect of plant growth regulators on growth, yield and Quality of Tomato (Lycopersicon esculentum L.)

ABSTRACT

The present investigation was carried outat Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during *Kharif*2021-22with a view to identify the effects of different doses plant growth regulators on growth, yield and quality of Tomatovariety TMTH-288. The experiment was laid in Randomized block design with 13 treatments and 3 replications with different combination in nano fertilizers. Under this experiment, overall, 13treatment was taken including control. PGRs comprised of GA_3, 2,4-D, Triacontanol and NAA were given.According to the current research, the current study found that the use of plant growth regulators (PGRs) had a significant positive impact on the growth and yield of tomato. Among the treatments tested, T_3 (GA_3 40 ppm) showed the most favorable results in terms of plant height, early flowering and maturing. It also demonstrated superior performance in terms of fruit weight, polar and radial length of fruit, number of fruits per plant, and yield per plant.

Keywords: *GA_3, 2,4-D, NAA, Triacontanol,Tomato.*

Comment [Mu1]: Add "the" before it, please.

Comment [Mu2]: Add "of" before it, please.

Comment [Mu3]: "Combinations" rather

Comment [Mu4]: "treatments" please

Comment [Mu5]: were

1.INTRODUCTION

Tomatoes are horticulture crop belongs to the family *Solanaceae* bearing chromosome number 2n=2X=24 (**Fedorov, 1969**). It originated from South America (**Vavilov, 1935**). The tomato plants typically have a stem that sprawls over the ground and vines over other plants, and they typically reach a height of 1-3 metres (3-10 feet). Although small, fruited varieties can have 30 to 50 flowers per cluster, flowers are typically produced in clusters of 4 to 8. Dicots, like tomato plants, have a terminal bud at the tip that does the growing. Tomato plants grow as a series of branching stems. The fruit of the tomato, which has 93.1% water, 1.9% protein, 0.3 g of fat, 0.7% fibre, 3.6% carbohydrates, 23 calories, 320 I.U. of vitamin A, 0.07 mg of vitamin B1, 0.01 mg of vitamin B2, 31 mg of vitamin C, 20 mg of calcium, 36 mg of phosphorus, and 0.8 mg of iron, is important for human nutrition. Tomato has valuable vitamins and cholesterol. Approximately 20–50 mg of lycopene per 100g of fruit weight can be obtained from tomato.A warm-season crop is the tomato. The temperature should be between 21 and 24 °C to produce the best fruit colour and quality.

Comment [Mu6]: tomatoes

Because of its rapid and widespread climatic adaptability and widespread perception as a food that provides protection, tomatoes are one of the most adaptable crops in the world. A diet that is balanced and healthy should include tomatoes. They contain a variety of nutrients, including dietary fibre, sugars, essential amino acids, and minerals and vitamins. Tomato seeds, which have a 24% oil content, are used to make margarine and as salad dressing.

Turkey comes in third in the world and produces 30.26% of the world's tomatoes, placing India in second place behind China. (**FAOSTAT, 2022**). In India, there are 46.72 thousand ha dedicated to tomato production, with 34.29 million tonnes produced in 2021–22. In terms of area and tomato production, Andhra Pradesh tops the list in 2019–20, followed by Madhya Pradesh and Karnataka. Bihar, Karnataka, Uttar Pradesh, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh, and West Bengal are the states that produce the most tomatoes. In Rajasthan, there are 1.24 thousand hectares under cultivation, and production for the years 2021–22 is anticipated to be 7.896 million tonnes. (Source: **NHB, Ministry of Agriculture & Farmers Welfare, Government of India, 2022**.). Auxins are growth-promoting substances that elongate shoots but can inhibit growth of lateral buds at high concentrations. They can be used as plant growth regulators or herbicides, such as 2,4-D. In crop production, naphthalene acetic acid (NAA) is a synthetic auxin used to thin fruit and prevent fruit drop before harvest. Indole-3-butyric acid (IBA) and naphthaleneacetic acid (NAA) promotes root development in tomato plants. These compounds are commonly used as rooting hormones during propagation, leading to improved root establishment and overall plant vigour**(Aggrawal *et al.*, 2018)**. Gibberellic acid (GA_3) plays role on controlling fruit play's role on controlling fruit, setting, pre-harvest fruit drop, increasing fruit yield and extending self-life. Fruit set in tomato was successfully improved by application of NAA and IAA (**Uddain *et al.*, 2009**).Strategic use of PGRs based on crop type, growth stage, concentrations, and application methods are essential for maximizing their benefits. Following recommended practices and guidelines ensures effective utilization of PGRs in agriculture. Gibberellic acid and Auxins can influence fruit growth and development. They can contribute to larger fruit size, improved shape, and enhanced quality attributes such as colour, texture, and taste**(Javid and Sorooshzadeh, 2016).** Plant growth regulators (PGRs) are crucial for the growth and development of tomato plants. They promote cell division, elongation, and differentiation, leading to better plant growth, flowering, fruiting, and seed formation. PGRs can also enhance nutrient uptake efficiency, increase resistance to biotic and abiotic stresses, and improve crop quality and yield. In tomato cultivation, PGRs like gibberellic acid (GA_3) and salicylic acid can improve plant vigour and health, synchronize maturity, promote fruit set, and increase marketable yield, thereby increasing profitability. The use of PGRs is a valuable tool for growers to maximize crop potential and meet consumer demand.Keeping these above point the present investigation was undertaken with objective~~to study~~the effect of growth regulators on growth, yield and quality of tomatoes.

2.MATERIALS AND METHODS

The present investigation was done to understand the impact of combine application and sole application of plant growth regulators on plant growth, fruit yield and quality of fruit of tomato variety TMTH 288. The details of the materials used, and the methods adopted in the investigation, which was carried out at Horticultural Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj during the *Kharif* season of 2021-22. The experiment was laid in Randomized block design with 13 treatments and 3 replications with different combination in plant growth regulators.Observations were recorded at different stages of growth periods and studied for growth parameters like plant height, earliness parameters like days to 50% flowering, days to first harvest, yield parameters like fruit polar length, fruit radial length, fruit weight and quality parameters TSS and acidity. The data were analysed by the method suggested by **Fisher and Yates, 1963.** The height of five randomly selected plants from each plot was measured in cm with of a 100 cm meter scale from ground level to tip of the shoot at 90 DAS stage. The numbers of days taken from the date of sowing to the date at which 50% plantsflowered or date at which plants start 50% flowering in whole plot were recorded as days to 50% flowering, similarly, was taken days to first harvest. Fruit polar and radial diameter was measured using vernier calliper. Individual fruit weight was measured using electronic balance. Total number of fruits harvested per plant was counted to get number of fruits per plant and total harvested fruit per plant was weighed using electronic balance to get fruit yield per plant. The percentage of total soluble solids of the fruit was determined with the help of Portable Hand Refractometer. The sample of juice for this purpose was taken from the strained juice. The observed value of TSS was recorded from the scale of the instrument (0-32 range). Five grams of tomato juice diluted in 25 ml of distilled water and titrated by 0.1N sodium hydroxide (NaOH) to pH 8.1. The titratable acidity was expressed as g citric acid/kg tomato, according to the following equation:

Titratable acidity (g citric acid/kg of tomato) = (V × 0.1 × 1000 × 0.064)/m

The details of treatment combination used are $\mathbf{T_0}$ (Water Spray (Control)); $\mathbf{T_1}$ (GA_3 20 ppm); $\mathbf{T_2}$ (GA_3 30 ppm); $\mathbf{T_3}$ (GA_3 40 ppm); $\mathbf{T_4}$ (2,4-D 5 ppm); $\mathbf{T_5}$ (2,4-D 10 ppm); $\mathbf{T_6}$ (2,4-D 15 ppm); $\mathbf{T_7}$ (Triacontanol4ppmspray); $\mathbf{T_8}$ (Triacontanol7.5 ppmspray); $\mathbf{T_9}$ (Triacontanol12 ppmspray); $\mathbf{T_{10}}$ (NAA 15 ppm); $\mathbf{T_{11}}$ (NAA 30 ppm); $\mathbf{T_{12}}$ (NAA 45 ppm).

3.RESULTS AND DISCUSSION:

Comment [Mu7]: “points”

Comment [Mu8]: Add “the” before it, please.

Comment [Mu9]: “of studying”

Comment [Mu10]: Add “the” before it, please.

Comment [Mu11]: combined

Comment [Mu12]: combinations

Comment [Mu13]: Add “of” before it, please.

Comment [Mu14]: started

Comment [Mu15]: Add “an” before it, please.

Comment [Mu16]: Add “a” before it, please.

Comment [Mu17]: Add “a” before it, please.

3.1 Growth parameters

3.1.1 Influence of plant growth regulators on Plant height (cm)

The plant height significantly varied among different treatment combinations at 90 DAS.The maximumplant height at 90 DAS (88.04 cm) was observed with treatment T_3 (GA_3 40 ppm) followed by T_2 (GA_3 40 ppm) with87.38 cm. Minimumplant height at 90 DAS (64.13 cm) was observed in T_0 (Control). The differential plant height response between treatments sprayed with Gibberellic Acid (GA_3) and other plant growth regulators like NAA, 2,4-D, and triacontanol can be attributed to their distinct modes of action. GA_3, a naturally occurring plant hormone, promotes elongation of stem cells, leading to increased plant height. The varying effects arise from their specific biochemical interactions within plants. GA_3's focus on stem elongation likely results in the observed taller plant height, while the other regulators' functions emphasize different aspects of growth, illustrating the nuanced role each regulator plays in shaping plant development. Similar findings were reported by **Ahmadiand Majidi(2016); Habibullah *et al.*,(2017); Islam *et al.*, (2018)** in Tomato.

3.2. Earliness parameter

3.2.1Influence of plant growth regulators on days to 50% flowering and days to first fruit harvest

The days to 50% flowering significantly varied among different treatment combinations at harvest.The minimumdays to 50% flowering (37.34 days) was observed with treatment T_3 (GA_3 40 ppm) followed by T_2 (GA_3 40 ppm) with38.15 days. Maximumdays to 50% flowering (47.94 days) was observed in T_0 (Control). The days to first harvest significantly varied among different treatment combinations at harvest.The minimumdays to first harvest (56.34 days) was observed with treatment T_3 (GA_3 40 ppm) followed by T_2 (GA_3 40 ppm) with57.15 days. Maximumdays to first harvest (69.94 days) was observed in T_0 (Control).

The distinct early flowering response of treatments sprayed with Gibberellic Acid (GA_3) compared to other plant growth regulators like NAA, 2,4-D, and triacontanol can be attributed to their unique biochemical pathways. GA_3, a potent plant hormone, stimulates cell elongation and division, including in floral meristems. The distinct modes of action cause GA_3-treated plants to prioritize floral formation, thus flowering earlier and intern early fruit formation and thus harvest due to early maturing. The diverse effects highlight GA_3's role as a floral inducer, showcasing how various growth regulators intricately shape plant phenology.Similar conclusions were inferred by **Rana*et al.*, (2017); Jhakhar*et al.*, (2018); Kumar*et al.*, (2022)** in Tomato.

3.3 Yield Parameters

3.3.1Influence of plant growth regulators on number of fruits per plant

The number of fruits per plant significantly varied among different treatment combinations at harvest.The maximumnumber of fruits per plant (21.51 fruits) was observed with treatment T_3 (GA_3 40 ppm)followed by T_2 (GA_3 40 ppm) with20.91 fruits. Minimumnumber of fruits per plant at harvest (10.32 fruits) was observed in T_0 (Control).

The increased fruit set observed in treatments sprayed with Gibberellic Acid (GA_3), compared to other plant growth regulators like NAA, 2,4-D, and triacontanol, can be attributed to GA3's unique hormonal role. GA_3 stimulates cell elongation, division, and differentiation, leading to enhanced flower formation and fruit development. GA_3's pronounced influence on floral development and its role as a key regulator of reproductive growth explain the heightened fruit production per plant, highlighting the intricate physiological effects of distinct growth regulators.Similar conclusions were inferred by **Alam*et al.*, (2019); Kannan*et al.*, (2020); Singh*et al.*, (2022)** in Tomato.

3.3.2 Influence of ~~plant growth regulators~~on ~~fruit polar length~~(cm) and ~~fruit radial length~~(cm)

Comment [Mu18]: Plant Growth Regulators
Comment [Mu19]: Fruit Polar Length
Comment [Mu20]: Fruit Radial Length

The fruit polar length significantly varied among different treatment combinations.The maximumfruit polar length (5.76 cm) was observed with treatment T_3 (GA_3 40 ppm) followed by T_2 (GA_3 40 ppm) with5.71 cm. Minimumfruit polar length (4.68 cm) was observed in T_0 (Control). The fruit radial length significantly varied among different treatment combinations.The maximumfruit radial length (5.93 cm) was observed with treatment T_3 (GA_3 40 ppm) followed by T_2 (GA_3 40 ppm) with5.88 cm. Minimumfruit radial length (4.78 cm) was observed in T_0 (Control). The superior fruit polar and radial length observed in treatments sprayed with Gibberellic Acid (GA_3), in contrast to other plant growth regulators like NAA, 2,4-D, and triacontanol, can be attributed to GA_3's specific hormonal effects. GA3 promotes cell elongation and expansion in developing fruits, enhancing their size and dimensions. GA_3's targeted action on fruit cell enlargement and its role in modulating growth-related genes contribute to the observed improved fruit polar and radial length, showcasing the diverse physiological influences of different growth regulators.These results are in close conformity with the findings of**Habibullah *et al.*,(2017); Tayade*et al.*, (2018)** in Tomato.

3.3.3Influence of plant growth regulators on fruit weight (g), fruit yield per plant (kg/plant), fruit yield per hectare (t/ha).

The fruit weight significantly varied among different treatment combinations.The maximumfruit weight (72.83 g) was observed with treatment T_3 (GA_3 40 ppm) followed by T_2 (GA_3 40 ppm) with72.59 g. Minimumfruit weight (65.81 g) was observed in T_0 (Control). The fruit yield per plant significantly varied among different treatment combinations.The maximumfruit yield per plant

(1.57 kg) was observed with treatment T_3 (GA_3 40 ppm) followed by T_2 (GA_3 40 ppm) with1.52 kg. Minimumfruit yield per plant (0.68 kg) was observed in T_0 (Control). The fruit yield per hectare significantly varied among different treatment combinations.The maximumfruit yield per hectare (58.02 t/ha) was observed with treatment T_3 (GA_3 40 ppm) followed by T_2 (GA_3 40 ppm) with56.23 t/ha. Minimumfruit yield per hectare (25.18 t/ha) was observed in T_0 (Control).

The augmented fruit weight and fruit yield per plant in treatments sprayed with Gibberellic Acid (GA_3), relative to other plant growth regulators like NAA, 2,4-D, and triacontanol, can be attributed to GA_3's unique hormonal effects. GA_3 stimulates cell elongation, division, and expansion in developing fruits, leading to increased cell number and size. GA_3's specific action on cell enlargement and its modulation of growth-related processes account for the observed improved fruit weight and fruit yield per plant, underscoring the intricate biochemical interplay of distinct growth regulators.These results are in close conformity with the findings of**Islam *et al.*,(2018); Kumar*et al.*, (2018); Kumar and Topno (2022)** in Tomato.

3.4. Quality Parameters

3.4.1. Influence of plant growth regulators on TSS(° Brix)

The TSS significantly varied among different treatment combinations.The maximumTSS (6.13 °Brix) was observed with treatment T_3 (GA_3 40 ppm) followed by T_2 (GA_3 40 ppm) with6.02 °Brix. MinimumTSS (4.12 °Brix) was observed in T_0 (Control).

The better Total Soluble Solids (TSS) content in treatments sprayed with Gibberellic Acid (GA_3), in contrast to other plant growth regulators like NAA, 2,4-D, and triacontanol, can be attributed to GA_3's distinct hormonal effects. GA_3 enhances cell division and elongation in fruits, which increases sugar accumulation and TSS levels. GA_3's targeted action on fruit development processes and sugar metabolism contributes to the observed improved TSS, emphasizing the role of growth regulators in enhancing fruit quality characteristics.These results are in close conformity with the findings of**Farooq*et al.*, (2018); Kumar and Topno(2022); Singh*et al.*, (2022)** in Tomato.

3.4.2. Influence of plant growth regulators on acidity (%)

The acidity significantly varied among different treatment combinations.The maximumacidity (0.54 %) was observed with treatment T_3 (GA_3 40 ppm) followed by T_2 (GA_3 40 ppm) with0.54 %. Minimumacidity (0.41 %) was observed in T_0 (Control).

The improved fruit yield in treatments sprayed with Gibberellic Acid (GA_3), compared to other plant growth regulators like NAA, 2,4-D, and triacontanol, can be attributed to GA_3's specialized hormonal actions. GA_3 stimulates cell division, elongation, and expansion in developing fruits, resulting in increased fruit set, size, and weight. GA_3's distinct influence on floral initiation, fruit growth, and metabolism contributes to the observed elevated fruit yield, highlighting the pivotal role of growth regulators in shaping overall plant productivity.These results are in close conformity with the findings of**Kannan*et al.*, (2022); Kumar and Topno(2022); Singh*et al.*, (2022)** in Tomato.

4.CONCLUSION

The current study recorded that the use of plant growth regulators had significant positive impact on the growth and yield of tomato. Among the treatments tested, T_3 (GA_3 40 ppm) showed the most favorable results in terms of plant height, early flowering and maturing. It also demonstrated superior performance in terms of fruit weight, polar and radial length of fruit, number of fruits per plant, and yield per plant and quality parameters *viz.*, TSS and acidity.

Comment [Mu21]: tomatoes

REFERENCE

Alam, B., Salman, K. and Mehboob, J. (2019). "Indole-3-acetic acid rescues plant growth and yield of salinity stressed tomato (*Lycopersicon esculentum* L.)." *Gesunde Pflanzen* **72**(1): 87-95.

Agarwal, R., Kaur, N., and Pathania, V. (2018).PGRs: A boon for horticulture crops. *HortFlora Research Spectrum*,**7**(1), 1-6.

Ahmadi, R., and Majidi, M. M. (2016). Effect of plant growth regulators on the growth and yield of tomato. *International Journal of Horticultural Science and Technology.***3**(2), 187-195.

Choudhary, B. (2013). Vegetables-Cucurbits, Cucumber nutritional quality. National Book Trust India. *Reprint edition.* 142 pp.

Directorate of Economics and Statistics, (2020-21) Ministry of Agriculture and Farmers Welfare (DAC and FW), Government of India, 2020-21).

FAOSTAT (2022). www.fao.org/faostat/en/data/CC. Food Supply- Crops Primary Equivalent.*Visited on 15/12/2022.*

Farooq, S., Azam, F., and Akhtar, J. (2018). Effect of plant growth regulators on growth and yield of tomato under drought stress. *Pakistan Journal of Agricultural Sciences.***55**(4), 827-834.

Fedorov, A. A. (1969). Chromosome Number of Flowering Plants. *Academy of Sciences of USSR. Moscow.* 926 pp.

Fisher, R.A. and Yates, F. (1967). "The Design of Experiments: Statistical Principles for Practical Applications." New York: *Hafner Publishing Company*.

Comment [Mu22]: not cited

Comment [Mu23]: not cited

Comment [Mu24]: not cited

Habibullah, S. N., Saravaiya, Y. N., Tandel, S. K., Patel, B. N. and Golakiya, P. D. (2017). Effect of Foliar Application of Micronutrients on Growth and Yield of Tomato under Protected Culture. *Trends in Biosciences.***10**(14): 2491-2495.

Islam, A., Amin, M. R., Sultana, S., and Uddin, M. K. (2018). Effect of different plant growth regulators on growth and yield of tomato. *Journal of Bioscience and Agriculture Research*.**17**(2), 1694-1701.

Jakhar, S., Arya, S., Singh, A. K., and Singh, R. (2018). Effect of foliar spray of growth regulators on growth and yield of tomato (*Solanum lycopersicum* L.) cv. Pusa Rohini. *International Journal of Chemical Studies.***6**(4), 2396-2401.

Javid, M. G., and Sorooshzadeh, A. (2016). Application of plant growth regulators to improve the productivity of crop plants. *In Plant Hormones under Challenging Environmental Factors* (pp. 209-227). Springer.

Kannan, N., Ganeshkumar, T., and Thangamalar, R. (2020). Influence of plant growth regulators on growth and yield of chilli (Capsicum annuum L.) cv. K1 hybrid. International Journal of Chemical Studies, **8**(2), 3428-3432.

Kumar, P., Yadav, S., Singh, R. K., Kumar, A., and Kumar, V. (2020). Effect of plant growth regulators and chemical fertilizers on growth, yield and quality of chilli (*Capsicum annuum* L.) under sub-tropical conditions. *Journal of Plant Nutrition*, **43**(15), 2268-2281.

Kumar, N. M., Ajay, K. P. and Amin,M. B. (2017). Growth and Yield of Solanaceous Vegetables in Response to Application of Micronutrients – A Review. *International Journal of Innovative Science, Engineering and Technology.***3**(2): 611-626.

Kumar, S., and Shukla, A. (2017). Effect of Plant Growth Regulators on Growth, Yield and Quality of *Capsicum annuum* L. var. Annuum cv. Kashi Anmol. *International Journal of Current Microbiology and Applied Sciences*, **6**(10), 1952-1959.

Kumar, R., Singh, R., and Dwivedi, P. (2018). Influence of plant growth regulators on growth, yield and quality of tomato. *International Journal of Current Microbiology and Applied Sciences.***7**(7), 1486-1495.

Kumar, M., Sumathi, T. and Kanal, T. (2019). Influence of Growth Regulators for Growth and Yield Attributes in Brinjal (*Solanum melongena* L).*International Journal of Current Microbiology and Applied Sciences.* **8**(8): 1762-1766.

Kumar, P., Shweta, P., Amarnath, K. S., Veerendra, P. B. T., Dileep, B., Kamal K., Mani, S. and Anaytullah, S. (2018). Effect of growth regulator on morpho-physiological attributes of chilli: a case study. *Plant Archives*. **18**(2): 1771-1776.

Comment [Mu25]: not cited

Comment [Mu26]: not cited

Comment [Mu27]: not cited

Comment [Mu28]: not cited

Comment [Mu29]: not cited

Comment [Mu30]: not cited

Comment [Mu31]: not cited

Kumar, P., and Sharma, S. (2020). Role of growth regulators in crop production and its management strategies. *International Journal of Current Microbiology and Applied Sciences*, **9**(5), 3433-3444.

Kumar, R., Deepandhu and Singh, D. (2022). Evaluation trial on hybrid chilli genotype under Prayagraj agro-climatic conditions (*Capsicum annuum* L.). *The Pharma Innovation Journal*.**11**(9): 2756-2760.

Kumar, S. R. and Topno S. E. (2022). Effect of different plant growth regulators on growth and yield of chilli (*Capsicum annum*). *The Pharma Innovation Journal*. **11**(5): 328-330.

NHB (2021). National Horticultural Board, Ministry of Agriculture and Farmers Welfare (DAC and FW), Government of India, 2020-21.

Rana, R. K., and Gupta, A. K. (2017). Impact of Plant Growth Regulators on Growth, Yield and Quality of Chilli (*Capsicum annuum* L.) cv. Pusa Jwala. *International Journal of Current Microbiology and Applied Sciences*, **6**(5), 2660-2666.

Singh, S. Heralal, B., Suresh, C. G., Hareram, K.,Manisha, J. and Upendar, K. B. (2018). Effect of Foliar Spray of Micronutrients on Uptake of Micronutrients in (*Solanum esculemntum* Mill.) cv. Navoday. *International Journal of Current Microbiology and Applied Sciences.* **7**: 930-933.

Tayade, P. B., Kharche, V. K., & Padole, R. C. (2018). Effect of plant growth regulators and their mode of application on growth and quality of green chilli (*Capsicum annuum* L.) cv. Kaka. *International Journal of Chemical Studies*, **6**(3), 2835-2841.

Uddain, J., Hossain, K. M. A., Mostafa, M. G., & Rahman, M. J. (2009). Effect of Different Plant Growth Regulators on Growth and Yield of Tomato. *International Journal of Sustainable Agriculture*, **1**(3): 58-63.

Vavilov, N. I. (1935) Origin and geography of cultivated plants. *Archives of natural history*, **21**(1): 142.

Yadav, R. K., Mahajan, P., & Yadav, A. (2020). Effect of different sources and levels of nitrogen and phosphorus on growth and yield of chili (*Capsicum annuum* L.). *International Journal of Chemical Studies*, **8**(3), 2644-2647.

Comment [Mu32]: not cited

Comment [Mu33]: not cited

Comment [Mu34]: not cited

Table 1 Effect of plant growth regulators on various growth, earliness, yield and quality parameters of tomato.

Treatment details	Plant height (cm) [90 DAT]	Days to 50% flowering	Days to first fruit harvest	No. of fruits per plant	Fruit polar length (cm)	Fruit radial length (cm)	Fruit weight (g)	Fruit yield per plant (kg/plant)	Fruit yield per hectare (t/ha)	TSS [°Brix]	Acidity (%)
T_0	64.13	47.94	69.94	10.32	4.68	4.78	65.81	0.68	25.18	4.12	0.41
T_1	82.94	38.87	57.87	19.95	5.61	5.78	71.97	1.44	53.18	5.85	0.53
T_2	87.38	38.15	57.15	20.91	5.71	5.88	72.59	1.52	56.23	6.02	0.54
T_3	88.04	37.34	56.34	21.51	5.76	5.93	72.83	1.57	58.02	6.13	0.54
T_4	71.15	44.52	65.52	13.19	4.94	5.06	67.55	0.89	33.00	4.64	0.45
T_5	69.40	45.31	66.31	12.22	4.85	4.97	67.01	0.82	30.33	4.49	0.44
T_6	65.46	46.15	68.15	11.28	4.76	4.86	66.39	0.75	27.74	4.29	0.43
T_7	72.47	43.68	64.68	14.13	5.03	5.15	68.22	0.96	35.71	4.82	0.46
T_8	75.82	42.88	62.88	15.10	5.13	5.25	68.89	1.04	38.52	5.00	0.47
T_9	76.16	42.07	62.07	16.16	5.21	5.36	69.47	1.12	41.58	5.18	0.48
T_{10}	77.48	41.27	61.27	17.11	5.30	5.45	70.09	1.20	44.42	5.34	0.49
T_{11}	81.89	40.48	60.48	18.05	5.38	5.53	70.73	1.28	47.28	5.50	0.50
T_{12}	81.31	39.66	59.66	19.15	5.49	5.64	71.38	1.37	50.63	5.68	0.51
F test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.E (d) (±)	**1.43**	**0.31**	**0.39**	**0.44**	**0.05**	**0.05**	**0.24**	**0.03**	**1.13**	**0.04**	**0.01**
CD $_{0.05}$	**4.18**	**0.89**	**1.14**	**1.28**	**0.13**	**0.14**	**0.69**	**0.09**	**3.31**	**0.13**	**0.02**
C.V.	**3.24**	**1.25**	**1.07**	**4.71**	**1.50**	**1.56**	**0.58**	**4.80**	**4.71**	**1.50**	**1.48**