### Effect of plant growth regulators on growth and yield of tomato (*Solanum* *lycopersicum* L.) Cv. MAHY-701 under Bhubaneswar condition

### ABSTRACT

Exogenous application of plant growth regulators play a vital role on effectively enhancing plant growth along with crop output. In order to determine theeffect of plant growth regulators and the ideal concentration of GA₃ and NAA for improved tomato growth and yield (*Solanum* *lycopersicum* L.) cv. MAHY-701 under Bhubaneswar condition, a field experiment was conducted in Rabi 2022 at Agricultural Research Station, Binjhagiri, Institute of Agricultural Sciences, Siksha "O" Anusandhan (Deemed to be) University, Bhubaneswar, Odisha using plant growth regulators, namely GA₃ and NAA. The experimental design was randomized block design, which consisted of three replications and seven treatments. When compared to the control treatment, all growth, yield, and quality parameters were shown to be significantly better at various concentrations of GA₃ (30, 60, and 90 ppm) and NAA (25, 50, and 75 ppm). The findings of the investigation reinforce the claim that, as compared to the control, tomato growth and yield were considerably affected by both GA₃ and NAA. The results categorically demonstrated that the treatment where the plant was sprayed with GA₃ @ 90 ppm had the highest total soluble solids (4.33°Brix), acidity (0.42%), and shelf life (18.73), as well as the highest number of fruits per plant (42.90), fruit length (6.40cm), fruit diameter (6.80cm), weight of fruit (118.80g), yield per plot (31.70kg), yield per ha. (423.50qt), and other quality attributes.In conclusion,farmers may be suggested to apply GA₃ at 90 ppm and NAA at 50 ppm when raising tomatoes in Bhubaneswar Agroclimatic environments for MAHY-701.

**Keywords:** *Solanum lycopersicum*, Tomato, fruit weight, fruit yield, TSS, acidity, Plant growth regulators**,** GA₃ **,** NAA

**Introduction**

As a preventive food, vegetables are the most essential part of a balanced diet. India is the world's second-largest producer of vegetables, behind China, and holds a prominent position in this regard. India's diverse agroclimatic conditions allow for the year-round cultivation of a large range of vegetable crops. As a valuable supply of carbohydrates, proteins, vitamins, minerals, element salts, and crude fibers, vegetables are crucial to a balanced diet. A 300g daily intake of vegetables (125g of leafy vegetables, 100g of root and tuber vegetables, and 75g of other vegetables) is what dieticians recommend for an adult to maintain good health. But in India, the average person consumes only 175 g of veggies per day, which is far less than the suggested amount.

Tomato, which places second behind potato among vegetables, is one of the most cultivated and well-liked crops worldwide. Soup, juice, ketchup, puree, paste, and powder are all made with a lot of tomatoes. Tomatoes are widely used in pickles because they are exceptionally high in vitamin C and give food a range of colours and flavours. Green tomatoes are also used in pickles. Because of its abundance in lycopene, in addition to other minerals and vitamins like ß-carotene and ascorbic acid, which are antioxidants and support good health, tomatoes perform a vital role in human nutrition. The tomato has a great medicinal significance since its pulp and juice are mildly noticeable, easily digested, promote gastric secretion, detoxify blood, and are believed to have antiseptic properties for the intestines. It is beneficial for persistent dyspepsia and activates the torpid liver. It is one of the important veggies that maintains the wellness of our intestines and stomach. Within every 100 grams of fruit pulp, tomato fruit contains 93.1 g of water, 1.9 g of protein, 0.1 g of fat, 3.6 g of carbohydrates, 0.6 g of mineral matter, 20 mg of calcium, 36 mg of phosphorus, 0.3 mg of iron, 320 IU of carotene (vitamin A), 2.27 mg of thiamine, 0.4 mg of nicotinic acid, 0.01 mg of riboflavin, and 31 mg of ascorbic acid. It also includes inhibitors linked to pantothenic acid, biotin, vitamin K, folic acid, and biotin.

An organic substance, either manufactured or natural, a growth regulator alters or regulates one or more particular physiological processes in a plant, while its sites of action and synthesis are distinct. Plant growth regulators include both naturally occurring plant hormones and hormones produced in a lab. In comparison to plants' needs for minerals and vitamins, the concentration of hormones needed for plant response is extremely low. Plant hormones are more widely distributed and not often locally synthesized within the plant. Plant hormones are compounds, not nutrients, that in limited amounts impact and promote the division, growth, and development of cells and tissues.

Gibberellic Acid (GA₃) and Naphthalene Acetic Acid (NAA) are two growth promoters that are particularly effective at enhancing vegetable crop output and plant growth. One of the key compounds that stimulates cell division and elongation, aiding in the growth and development of several plants, is GA₃. NAA influences physiological functions, accelerates fruit ripening, and enhances fruit quality. Numerous chemical and cultural methods are used to boost crop yields. Numerous experts have stressed the use of plant growth regulators to increase the quantity and quality of numerous vegetable crops (Pundir and Yadav, 2001 and Bhosle *et al.,* 2002). Nonetheless, the concentration of the plant growth regulator and the timing of administration are the primary determinants of improved crop output and quality. Indole-3-acetic acid (IAA), a significant auxin generated by plants, is an important hormone. Apical dominance, root initiation and development, parthenocarpy, inhibition of the abscission layer, and blooming are among the functions of auxin. Essential plant hormones known as cytokinins (CKs) are identified to play an essential part in controlling a number of characteristics of plant growth and development, such as cell division, senescence of leaves, lateral stem and root conformation, stress tolerance etc. The most frequently used growth regulators are GA3, NAA, 4 - CPA, 2, 4-D. However, there are significant differences in the crop's improvement based on the type of growth regulators used , concentration , time and method of application.

**Materials and methods**

The experiment **“**Effect of plant growth regulators on growth and yield of tomato (*Solanum lycopersicum* L.)” was conducted at Institution of Agricultural Sciences, Siksha “O” Anusandhan (Deemed to be) University, Bhubaneswar, Situated at 73 km away from the Bay of Bengal at an altitude of 25.5m above mean sea level (MSL). Geographically, it is located at latitude 20.23° North and longitude 85.67° East. The study site is located 25.5 meters above mean sea level (MSL) in latitude 20˚25' N and longitude 85˚67' E. The distance to the Bay of Bengal is roughly 73 kilometers. Bhubaneswar is located in the Eastern Coastal Plain Agro Ecological Region, which is part of the state's East and South Eastern Coastal Plain Agroclimatic Zone. The cropping season's mean weekly maximum and mean weekly minimum temperatures were found to be 28.37˚C and 17.22˚C, respectively, based on weather data. During the cropping season, the maximum (95%) relative humidity was observed in the month of February and minimum (47%) was observed in the month of January. The experiment was conducted at its optimum concentration to standardize the best growth regulator for better growth and yield of tomato with seven treatments in RBD (Randomized Block Design) method with three replications on tomato variety MAHY 701. Seedling of 20-25 days were transplanted during afternoon hours of 16th November 2021 at a spacing of 50 x 50cm. A total of 9 treatments using three different concentration of each growth regulator i.e. GA₃ @ 30 ppm, 60 ppm and 90 ppm & NAA @ 25 ppm, 50 ppm, 75 ppm were used in the study. A total fifteen distinguishing parameters namely plant height, plant girth, number of branches, number of leaves, number of flowers per plant, leaf area, number of fruits per plant, fruit length, fruit diameter, fruit weight, yield per plot, yield per hectare, total soluble solids, acidity and shelf life were taken during the experiment procedure. **RESULTS AND DISCUSSIONS:**

**Growth Characters:**

The table showed that the application of GA₃ and NAA resulted in a substantial increase in plant height. The highest plant height of 72.90 cm was observed with the application of GA₃ @ 90 ppm and the next greatest height was 70.50 cm with NAA @ 50 ppm. This may be because developing cells elongate and divide quickly, stimulating RNA and promoting improved growth and development. These findings are consistent with the research conducted by Mehrotra *et al.* (1970) and Rappaport (1975). The application of GA₃ and NAA was shown to result in a considerable rise in the number of branches. 5.80 in with the application of GA₃ @ 90 ppm followed by 5.26 with NAA @ 50 ppm is the maximum number of branches whereas 4.30 branches are the bare minimum that was noted in Control treatment. The number of branches per plant has been found to be strongly impacted by several growth regulators. The notable rise in the number of branches per plant may be attributed to the plant's vegetative development, which is caused by increased cell division and elongation Gupta and Gupta (2000). Rai *et al.* (2006) and these results are in agreement. The application of GA₃ and NAA was found to significantly increase the quantity of leaves. With the application of GA₃ @ 90 ppm had the highest leaves per plant i.e 19.20 followed by NAA @ 50 ppm with18.70 number of leaves per plant. All concentrations of GA₃ and NAA generally result in more leaves per plant; however, the effect of GA₃ @ 90 ppm was more noticeable than that of other concentrations. This could be as a result of GA3's potential to promote cell elongation and division. The same conclusion has been published by Chauhan *et al.* (2017), Kumar *et al.* (2014), and Prasad *et al.* (2013). Application of GA₃ @ 90 ppm yielded the maximum plant girth, surpassing all other treatments. This could be attributed to the growth stimulating hormones' ability to replenish the natural growth chemicals that are vital for cell division and elongation. The current result corroborated with the findings of Rahman *et al.* (2015) and Bokade *et al.* (2006). The largest leaf area recorded was 64.30 sq.cm with the application of GA₃ @ 90 ppm and 61.20 sq.cm with NAA @ 50 ppm. The results mentioned above coincided those of Uddain *et al.* (2009). The data showed that the application of GA₃ and NAA resulted in a substantial rise in the number of blooms per plant. Application of GA₃ @ 90 ppm had the highest number of flowers, measuring 61.20 , while NAA @ 75 ppm had the second-greatest number, measuring 59.70 flowers. The number of floral clusters increased by GA₃ treatments could be the cause of this rise. The results mentioned above match those of Uddain *et al.* (2009).

**Yield characters:**

The use of GA₃ and NAA has been demonstrated to greatly increase the number of fruits. Application of GA₃ @ 90 ppm produced the greatest number of fruits per plant, 42.90 . GA₃ @ 90 ppm produced the greatest number of fruits per plant; this may be since those hormones perform a role to encourage pollen germination, fertilization, cell division, and elongation following pollination. The current result corresponded with the findings of Rahman *et al.* (2015) and Kumar *et al.* (2014). The treatment with GA₃ @ 90 ppm showed the maximum fruit length, and NAA @ 50 ppm showed the next-best results. Since growth-stimulating hormones are known to improve pollen germination, fertilization, and elongation following pollination, GA₃ @ 90 ppm may be more desirable. Siwna (2019) reported on this activity. An further explanation for this could be the increased a build up of carbohydrates as a result of enhanced photosynthesis, which led to the rise in fruit length that Kumar *et al.* (2018) reported. Uddain *et al.* also reported similar results (2009). The fruit diameter considerably grew after applying GA₃ and NAA, as seen in the table. The maximum fruit diameter 6.80 cm was seen with the application of GA₃ @ 90 ppm and 6.50 cm with NAA @ 50 ppm. Control had the lowest fruit diameter, averaging 4.40 cm. According to Bhosle *et al.* (2002) and Pundir and Yadav (2001), the maximum fruit diameter was measured by GA₃ @ 90 ppm. This may be explained by the increased availability of photosynthetic materials and their effective mobilization in plants, which leads to increased stimulation of fruit growth and ultimately an increase in fruit length. The greatest fruit weight, 118.80g was obtained with the application of GA₃ @ 90ppm followed by the application of NAA @ 50ppm having fruit weight of 115.20g. Fruit weight superiority has been proven by GA₃ @ 90ppm. The observed increase in fruit weight can be due to GA₃, as its characteristic of cell elongation has facilitated the growth of all vegetative parts, thereby providing more food material for fruit development. Additionally, Kumar *et al.* (2018) reported that plant anabolic processes are other factors leading to the higher fruit weight. GA₃ @ 90 ppm yielded the highest output per plot, measuring 31.70 kg , which was followed by the application of NAA @ 50 ppm averaging 31.30 kg . GA₃ @ 90ppm produced the highest yield per plot and was demonstrated to be superior for all yield attributes; this may help enhance the number of fruits per plant and reduce fruit falling.   
The advantageous impacts of PGRs on numerous physiological and biochemical processes, as well as enhanced nutrient mobilization in the treated plants. The use of growth regulators might have enhanced tomato yield because of better vegetative development, higher fruit set, and bigger fruits. The highest possible yield per hectare was recorded with the application of GA₃ @ 90 ppm i.e 423.50q which was followed by and 418.60q with NAA @ 50 ppm. The application of GA₃ @ 90 ppm increased the yield because it kept the plant physiologically more active, allowing it to gather enough food stocks for developing flowers and fruits. This increased fruit set subsequently led to a higher yield, as reported by Kumar *et al.* (2018). These results coincided with what Uddain *et al.* (2009) had discovered.

**Quality characters:**

The TSS levels were found to vary from 2.83° to 4.33° Brix. Maximum TSS was seen in with the application of GA₃ @ 90 ppm i.e 4.33° Brix and was followed by 3.83° Brix with GA₃ @ 30 ppm .Ali et al. (2020), Kumar *et al.* (2014), and Singh *et al.* (2022) all acquired similar results.The findings discovered that the range of acidity values was 0.33% to 0.42%. The treatment with the highest acidity, 0.42% with GA₃ @ 30 ppm, proved to be the most acidic, followed by 0.41% with the application of NAA @ 50 ppm. Shelf life observations show that it falls around 18.73 and 13.60. The treatment with the application of GA₃ @ 30 ppm ppm had the greatest acidity i.e 18.73, followed NAA @ 25 ppm. The reduction in ripening throughout the storage period may be the cause of the decrease in decay loss following GA₃ treatment. The results of the present research show that the fruits treated with GA₃ had a lesser level of degradation. These results were consistent with the outcomes published by Nirupama *et al.* (2010). In addition, the outcome agrees with Singh and Patel (2014).

**CONCLUSION**

The results of this study suggest that, as compared to the control, tomato growth and yield were significantly impacted by both GA₃ and NAA. The study demonstrated that GA₃ @ 90ppm surpassed the other growth regulator in terms of boosting growth parameters such as plant height, number of branches, and number of leaves, as well as yield features like fruit weight, diameter, and length, as well as yield per hectare and plot. In contrast, NAA at 50 ppm excelled the other growth and yield standards. Therefore, farmers may be suggested to apply GA₃ at 90 ppm and NAA at 50 ppm when raising tomatoes in BBSR Agroclimatic environments for MAHY-701.

**Table.1. E**ffect of different concentrations of GA₃ and NAA on vegetative characters of tomato var. MAHY 701:



**Table.2.** Effect of different concentrations of GA₃ and NAA on Yield characters of tomato var. MAHY 701:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sl. No. | Treatment | No. of Fruit per Plant | Fruit Length(cm) | Fruit Diameter(cm) | Fruit Weight(g) | Yield per Plot(kg) | Yield per Ha(q/ha) |
| 1 | Control | 33.80 | 4.50 | 4.40 | 74.60 | 26.20 | 350.60 |
| 2 | GA₃ @ 30 ppm | 37.10 | 5.50 | 5.90 | 94.80 | 29.20 | 390.20 |
| 3 | GA₃ @ 60 ppm | 34.20 | 4.80 | 4.90 | 80.50 | 28.60 | 382.40 |
| 4 | GA₃ @ 90 ppm | 42.90 | 6.40 | 6.80 | 118.80 | 31.70 | 423.50 |
| 5 | NAA @ 25 ppm | 35.40 | 5.30 | 5.50 | 85.10 | 29.10 | 388.50 |
| 6 | NAA @ 50 ppm | 38.80 | 6.10 | 6.50 | 115.20 | 31.30 | 418.60 |
| 7 | NAA @ 75 ppm | 37.50 | 5.70 | 6.10 | 98.60 | 29.70 | 396.50 |
| SE(m)± | | 0.32 | 0.34 | 0.20 | 0.28 | 0.30 | 0.30 |
| CD | | 1.00 | 1.06 | 0.64 | 0.87 | 0.95 | 0.95 |

**Table.3.** Effect of different concentrations of GA₃ and NAA on quality parameters of tomato var. MAHY 701:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sl. No. | Treatment | Total Soluble Solid (degree Brix) | Acidity (%) | Shelf Life(days) |
| 1 | Control | 3.00 | 0.33 | 13.90 |
| 2 | GA₃ @ 30 ppm | 3.83 | 0.37 | 16.20 |
| 3 | GA₃ @ 60 ppm | 3.83 | 0.35 | 14.40 |
| 4 | GA₃ @ 90 ppm | 4.33 | 0.42 | 18.73 |
| 5 | NAA @ 25 ppm | 3.83 | 0.36 | 16.20 |
| 6 | NAA@ 50 ppm | 3.16 | 0.41 | 15.70 |
| 7 | NAA @ 75 ppm | 2.83 | 0.39 | 13.60 |
| SE(m)± | | 0.37 | 0.01 | 0.20 |
| CD | | NS | 0.05 | 0.63 |

**REFERENCE:**

Ali M R, Quddns A, Tanjila S, Mohamad M R, Asaduzzaman. 2020. Influence of plant growth regulators on growth & yield & quality of tomato grown under high temperature tropics in summer. *International Journal of Vegetable Science,* ***28***(1): 59-75.

Bhosle A B, Khorbhade S B, Sanap P B, Gorad M J. 2002. Effect of plant hormones on growth and yield of summer tomato (*Lycopersicon esculentum* L.). *Orissa J Hort*, **30**(2): 63-65.

Bokade N, Bhalekar M N, Gupta N S, Deshpande A. 2006. Effect of growth regulators on growth and yield of summer tomato. *J. Maharashtra Agric. Univ*, **31**(1): 64-65.

Chauhan S A, Patel N B, Mehta D R, Patel J B, Zalaishita M, Vaja A D. 2017. Effect of plant growth regulators on seed yield and its parameters of tomato (*Lycopersicon esculentum* L.). *Int. J. of Agric. Sci*, **9**(8): 3906-3909.

Gupta P K, Gupta A K. 2000. Efficacy of plant growth regulators (IAA and NAA) and micronutrient mixtures on growth, flowering, fruiting and shelf life of tomato (*Lycopersicon esculentum* L.). *Bioved*, **11**(1/2): 25-29.

Kumar A, Biswas T K, Singh N, Lal E P. 2014. Effect of gibberellic acid on growth, quality and yield of tomato (*Lycopersicon esculentum* L.). *IOSR* *Journal of Agriculture and Veterinary Science*, **7**(7): 2319-2372.

Kumar A, Biswas T K, Singh N, Lal E P. 2014. Effect of gibberellic acid on growth, quality and yield of tomato (*Lycopersicon esculentum* L.). *IOSR* *Journal of Agriculture and Veterinary Science*, **7**(7): 2319-2372.

Kumar A, Biswas T K, Singh N, Lal E P. 2014. Effect of gibberellic acid on growth, quality and yield of tomato (*Lycopersicon esculentum* L.). *IOSR* *Journal of Agriculture and Veterinary Science*, **7**(7): 2319-2372.

Kumar P, Pathak S, Amarnath K S, Teja P V B, Dileep B, Kumar K, Siddique A. 2018. Effect of growth regulator on morpho-physiological attributes of chilli: A case study. *Plant Archives*, **18**(2): 1771-1776.

Kumar S, Singh R, Singh V, Singh M K, Singh A K. 2018. Effect of plant growth regulators on growth, flowering, yield and quality of tomato (*Solanum lycopersicum* L.). *Journal of Pharmacognosy and Phytochemistry*, **7**(1): 41-44.

Mehrotra O, Garg N, Garg RG, Singh I.1970. Growth, fruiting and quality of tomato as influenced by growth regulators. *Progressive Horti*, **2**(1): 57-64.

Nirupama P, Neeta B G, Ramana Rao T V. 2010. Effect of post-harvest treatments on physicochemical characteristics and shelf life of tomato fruits during storage. *American-Eurasian Journal of Agriculture and Env Science,* **9**(5): 470-479.

Prasad R N, Singh S K, Yadav R B, Chaurasia S N S. 2013. Effect of GA₃ and NAA on growth and yield of tomato. *Vegetable* *science*, **40**(2): 195-197.

Pundir J P S, Yadav P K. 2001. Effect of GA₃ and NAA on growth, yield and quality of tomato. *Current* *Agric*, **32**(1&2): 137-138.

Rahman M S, Haque M A, Mostofa M G.2015. Effect of GA3 on biochemical attributes and yield of summer tomato. *Journal of Bioscience and Agriculture Research*, **3**(02): 73-78.

Rahman M, Nahar M A, Sahariar M S, Karim M R. 2015. Plant growth regulators promote growth and yield of summer tomato (*Lycopersicone sculentum* L.). *Progressive agriculture*, **26**(1): 32-37.

Rai N, Yadav D S, Patel K K, Yadav R K, Asati B S and Chaudey T. 2006. Effect of plant growth regulators on growth, yield and quality of tomato (*Lycopersicon esculentum* L.). *Veg* *Sci*, **33**(2): 180-182.

Rappaport L. 1975. Growth regulating metabolites. *Caif. Agric*, **10**(12): 4-11.

Singh Neha, Biswas K Tarun, Sharma Richa. 2014. Impact of Plant Growth Regulators on Vegetative Characters, Quality and Yield Attributes in Chilli (*Capsicum annuum* L*.*) Cv. G-4. *New Agriculturist Journal*, **25**(2): 227-233.

Singh V, Singh V, Shahi P B, Singh N, Somvanshi S P S. 2022. Impact of Gibberellic Acid on Physiological Yield and Quality Attributes of Tomato (*Lycopersicon esculentum* L.) Underneath Semi-Arid Condition of Eastern U.P. *Biological Forum-An International Journal*, **14**(2): 400-402.

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