

**SYNOPSIS**

**DISSERTATION-I**

**Response of Plant Growth Regulators On Growth And Yield Parameters Of Tomato**

in partial fulfillment of requirements for the Award of Degree of

**Masters of Science  
In  
Horticulture (Vegetable Science)**

**SUBMITTED TO**

Department of Horticulture

School of Agriculture

Lovely Professional University

Phagwara (Punjab)



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## DECLARATION

Certified that this synopsis of Deepak Kumar, registration number 11717883, entitled “**Response Of Plant Growth Regulators On Growth And Yield Parameters of Tomato**” has been formulated and finalized by the student himself on the subject.

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### List of symbols and Abbreviations

Sr.no.	Symbol	Legends
1.	&	And
2.	@	At the rate of
3.	<sup>0</sup> C	Degree Celsius
4.	Cm	Centimeter
5.	DAT	Days after transplanting
6.	et al.	And others
7.	Etc.	And the rest
8.	G	Gram
9.	Ha	Hectare
10.	i.e.	That is
11.	Kg	Kilogram (s)
12.	M	Meter (s)
13.	Sr.no.	Serial number
14.	T	Tones
15.	RH	Relative humidity
16.	Viz.	Namely
17.	%	Percent
18.	PGR	Plant growth regulator
19.	+, -	Plus or minus
20.	NAA	Naphthalene acetic acid
21.	GA <sub>3</sub>	Gibberellic acid

## INTRODUCTION

The meaning of "vegetable" as a "plant grown for food" was not established until the 18th century. In 1767, the word was specifically used to mean a "plant cultivated for food, an edible herb or root". The year 1955 saw the first use of the shortened, slang term "veggie". In everyday usage, vegetables are certain parts of plants that are consumed by humans as food as part of a savory meal. Vegetables can be eaten either raw or cooked and play an important role in human nutrition, being mostly low in fat and carbohydrates, but high in vitamins, minerals and dietary fiber. Dietician says that we should take 300g vegetables every day.

Tomato (*Solanum lycopersicum L.*) belongs to the *Solanaceae* family and has the origin in Central and South America. Tomato use as a food originated in Mexico and spread throughout the world following the Spanish colonization of the Americas. China is the leading producer of tomato. In 2014, the global area of production under tomato 46.16 lakh ha with world production of tomatoes 170.8 million tones, China accounting for 31% of the total, followed by India, the United States and Turkey as the major producers. In 2014, tomatoes accounted for 23% of the total fresh vegetable output of the European Union with more than half of this total coming from Spain, Italy and Poland.

India is the second largest producer of tomato in the world. The total area of production under tomato in India is 865000 thousand ha and with production 16826000 thousand tons and with productivity 19.5 tons/ha. India shares 11% of world production of tomato.

Andhra Pradesh is the leading producer state in India. The total area of production under tomato in Andhra Pradesh is 93.73 thousand ha and with production 2142.76 thousand tons and Andhra Pradesh shares 8.99% production of tomato (Anonymous, 2014). Major producing states of tomato in India are Madhya Pradesh total area of production is 70.23 thousand ha and with production 2177.00 thousand tons and shares 13.29% of country production of tomato (Anonymous, 2014), Karnataka (12.42%), Orissa (8.39%), Gujarat (7.68%), West Bengal (7.02%), Telangana (6.60%), Bihar (6.39%), Chhattisgarh (5.30%), Maharashtra (4.65%), Punjab (1.13%) and others (18.14%).

Tomato is consumed in diverse ways, including raw, as an ingredient in many dishes, sauces, salads and drinks. While tomatoes are botanically berry-type fruits, they are

considered culinary vegetables being ingredients of savory meals. Tomato cooked in various ways in curries, fried, boiled, baked and used in soup making and pickles. Besides fresh consumption of tomato provides very good raw material for processing industry as it is processed in the form of sauces, ketchup, chips, canned food, cosmetics. They are highly valued for their flavor and nutritional value in supplying minor constituents such as minerals and trace elements.

Tomato are packed with nutrients. One cup of chopped or sliced raw tomatoes contains:32 calories (kcal), 170.14 g of water, 1.58 g of protein, 2.2 g of fiber, 5.8 g of carbohydrate, 0 g cholesterol.Tomatoes also have a wealth of vitamin and mineral content, including:18 mg of calcium, 427 mg of potassium, 43 mg of phosphorus, 24.7 mg of vitamin C, 1499 international units (IU) of vitamin A.Tomatoes also contain a wide array of beneficial nutrients and antioxidants, including:alpha-lipoic acid, lycopene, choline, folic acid, beta-carotene, lutein.The cooking of tomatoes appears to increase the availability of key nutrients, such as the carotenoids lycopene, lutein, and zeaxanthin. Stewed tomatoes provide more lutein and zeaxanthin than sun-dried tomatoes and raw cherry tomatoes.

Plant growth regulators (PGRs) are used extensively in horticulture to enhance plant growth and improve yield by increasing fruit number, fruit set and size. Several research workers have studied the effect of plant growth substances on vegetable crops. Among them, gibberellins particularly GA<sub>3</sub> and naphthalene acetic acid (NAA) have been reported to show promising effect on tomato crop. Thus, it is Imperative to determine their concentration, Gibberellic acid and naphthalene acetic acid both are one of the most important growth stimulating substance used in horticulture. Gibberellic acid is a chemical substance that occurs naturally in many plants. It regulates various important functions such as elongation of stems, creation of proteins and germination of seed plants. The effectiveness of gibberellic acid and naphthalene acetic acid in tomato and many other vegetable crops solely depends on the right quantity applied, time of application, Soil condition as well as prevailing temperature.

It was observed that the highest plant height, number of leaves, fresh fruit weight, ascorbic acid, total soluble solid (TSS) estimated in the application of gibberellic acid (GA<sub>3</sub>) @50 ppm (Biswas *et al.*, 2014).

The application of gibberellic acid and 2,4-Dichlorophenoxy acetic acid spray on vegetative growth, fruit anatomy and seed setting of tomato. Data is collected on qualitative

parameters (vegetative, reproductive growth and external fruit color) through visual observation and quantitative parameters (seed number per fruit, seed weight per unit etc.). The result indicates that tomato plant treated with, 2,4-D intended to have increased stem thickness, decreased leaf size induced epinastic and flower bud abscission in cultivar while GA<sub>3</sub> treatment has no retarded growth and flower bud abscission (Desalegn *et al.*, 2013)

## **Problem Background**

Plant growth regulators (PGRs) are used extensively in horticulture to enhance plant growth and improve yield by increasing fruit number, fruit set and size. Several research workers have studied the effect of plant growth substances on vegetable crops. Among them, gibberellins particularly GA<sub>3</sub> and naphthalene acetic acid (NAA) have been reported to show promising effect on tomato crop. Thus, it is Imperative to determine their concentration, Gibberellic acid and naphthalene acetic acid both are one of the most important growth stimulating substance used in horticulture.

## **REVIEW OF LITERATURE**

Tomar *et al.* (2015) conducted a trial to find out the role of Plant Hormones on Vegetative Growth of Tomato (*Lycopersicon esculentum* Mill.). Different plant growth regulator viz., Gibberellic acid, naphthalene acetic acid and 2,4-D were used on tomato cv. Azad T-6. Different concentration of GA<sub>3</sub> (@10 ppm, 20 ppm and 30 ppm), NAA (@20 ppm, 25 ppm and 30 ppm) and 2,4-D (@5 ppm, 10 ppm and 15 ppm) were sprayed on the crop to study the vegetative growth behavior attributes of tomato. It was found that there was a linear increase in growth parameters like plant height and number of branches per plant with increasing level of GA<sub>3</sub> and NAA. The maximum plant height was recorded as 99.03 cm and 85.47 cm with the application of GA<sub>3</sub> @ 30 ppm and NAA @ 30 ppm, respectively at the time of harvesting.

Uddain *et al.* (2014) carried out an experiment on the effect of different plant growth regulators on tomato at Horticulture Farm in Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh, during September 8, 2008 to January 19, 2009. Four plant growth regulators were use in the experiment, viz. PGR<sub>1</sub> (Control, No application of plant growth regulator), PGR<sub>2</sub>(Naphthalene acetic acid) @ 30 ppm, PGR<sub>3</sub>(Gibberellic Acid) @ 30 ppm and

PGR<sub>4</sub>(2, 4- Dichloro-phenoxy acetic acid) @ 30 ppm in the study. The growth and yield parameters were record at different time periods after transplanting of tomato. The best growth and yield were found in PGR<sub>2</sub> and with minimum growth and yield in control treatment.

Kumar *et al.* (2014) conducted a study to determine the effect of Gibberellic acid (GA<sub>3</sub>) on growth, fruit yield and quality of tomato. The golden variety of tomato used under experiment and six treatments with five level of GA<sub>3</sub> (@10 ppm, 20ppm, 30ppm, 40ppm and 50ppm). The highest plant height, Number of leaves, Number of fruits, Fresh fruit weight, ascorbic acid, total soluble solid (TSS) was estimated for GA<sub>3</sub> @50 ppm.

Pargi *et al.* (2014) sprayed naphthalene acetic acid (NAA) to determine the biochemical parameters, growth and yield of tomato. Experiment carried out the five-level naphthalene acetic acid spray (@10ppm, 20ppm, 30ppm, 40ppm and 50ppm) on the vegetative, growth, yield and quality parameters of tomato. The conclusion of this experiment was that spray of Naphthalene acetic acid proved beneficial for all parameters.

Tiwari and Singh (2014) experimented to find out the most suitable plant growth regulator and their appropriate concentration to increase the production of tomato. Seven different plant growth regulators used (Alar, Ethephon, Cipa, GA<sub>3</sub>, 2,4-D, NAA, Paclobutrazol). Each plant growth hormone with two concentrations such as 50 and 100ppm; 50 and 100ppm; 10 and 20ppm; 10and 20ppm; 5and 10 ppm; 20and 40ppm; 10and 20 ppm respectively and control (water) were used as foliar spray at 30, 45 and 60 days after transplanting of the seedlings of the cultivar “Pant T-3”. Cipa @20ppm, 2-4-D @5ppm, alar @50ppm were found better than the other concentration of PGR and can be recommended to the grower for the better production tomato during winter season under tarai condition in Uttarakhand.

Sattigeri *et al.* (2014) applied nutrients and plant growth regulator to determine the effect on yield and biochemical parameters of tomato. The experiment consists two organic fertilizers viz., FYM and vermicompost at two different level of concentration, one p- solubilize nutrients viz., KNO<sub>3</sub> and FeSO<sub>4</sub> and plant growth regulator salicylic acid and gibberellic acid (GA<sub>3</sub>). The result shows that the plant height increase significantly due to the application of salicylic acid (50

ppm) and P-solubilizer (2.5 kg/ha). Among various treatments the application of GA<sub>3</sub> (20 ppm), P-solubilizer (2.5 kg/ha) and vermicompost (2 t/ha) were effective in increase plant height, leaves, fruit diameter, & number of fruit. The biochemical parameters tested, like chlorophyll content was significantly higher with GA<sub>3</sub> (20 ppm) followed by vermicompost (2 and 1t/ha).

Gelmesa *et al.* (2013) examined the Effects of Gibberellic acid and 2,4-Dichlorophenoxy Acetic Acid Spray on Vegetative Growth, Fruit Anatomy and Seed Setting of Tomato (*Lycopersiconesculentum*Mill.). the objective to evaluate the effects of different concentrations and combinations of 2,4-dichlorophenoxyacetic acid (2,4-D) and gibberellic acid (GA<sub>3</sub>) spray on vegetative and reproductive growth components of tomato. The experiment consists of two tomato varieties, one processing (Roma VF) and one fresh market (Fetan), three levels of 2,4-D (@0, 5 and 10 ppm) and four levels of GA<sub>3</sub> (@0, 10, 15 and 20 ppm). Data were collected on qualitative parameters (vegetative, reproductive growth and external fruit color) through visual observation, and quantitative parameters (seed number per fruit, seed weight per fruit, fruit shape index and average fruit weight). The result indicated that tomato plant treated with 2,4-D intended to have increased stem thickness, decreased leaf size induced epinastic and flower bud abscission in both cultivars while GA<sub>3</sub> treatment has no retarded growth and flower bud abscission. Application of 2,4-D has responsible in the development of seedless parthenocarpic fruit with increased size but with unfilled cavities especially at higher concentration. On the other hand, GA<sub>3</sub> at lower concentration results in normal fruit and seed development but as its concentration increases it results in the development of more proportion of smaller fruits per plant and formation of blotchy ripening on thefruit.

Baliyan *et al.* (2013) conducted a field experiment to know the effect of 4-chlorophenoxy acetic acid, plant growth regulator on the fruit set, yield and economic of growing tomato in high temperatures in Botswana (South Africa). In the field experiment tomato flower were treat with the four-different concentration of 4-CPA @0ppm (control), 15ppm, 45ppm and 75ppm. Data collected involved number of fruit set, weight of small tomato, weight of cracked tomatoes, weight of cat face tomatoes, weight of rotten tomatoes, weight of pest damaged tomatoes and marketable tomatoes. The 75-ppm concentration of 4-CPA resulted not only the highest increase



in fruit set but also increased the tomato yield and hence economic benefit in tomato production increased.

Abbasi *et al.* (2013) reported the effect of naphthalene acetic acid and calcium chloride application nutrient uptake, growth, yield and post-harvest performance of tomato fruit. The foliar sprayed naphthalene acetic acid (NAA) @0.02% and calcium chloride (CaCl<sub>2</sub>) @0.5% and 1% individually as well as in combination to determine its effect on growth, nutrient uptake, incidence of blossom end rot, fruit yield, and enhancement of shelf life. The results showed increased absorption of calcium in tomato plants and fruits, which were treated with NAA in combination with CaCl<sub>2</sub>. Higher level of CaCl<sub>2</sub> (1%) with NAA (0.02%) increased plant growth and yield by improving mineral uptake of tomato plants. The improved calcium absorption also resulted in lowering occurrence of blossom end rot in tomato fruits.

Desai *et al.* (2011) conducted an experiment to find out the effect of different plant growth regulators and micronutrient on fruit characters and yield of tomato cv. GT-3. Eleven different treatments consisted of four plant growth regulators and three micronutrients were used, viz., T<sub>1</sub> (gibberellic acid) @ 50 ppm, T<sub>2</sub> (gibberellic acid) @ 75 ppm, T<sub>3</sub>(naphthalene acetic acid) @ 50 ppm, T<sub>4</sub>(naphthalene acetic acid) @ 75 ppm, T<sub>5</sub>(boron @50ppm), T<sub>6</sub>(boron @75 ppm), T<sub>7</sub>(zinc @0.5%), T<sub>8</sub>(zinc @1%), T<sub>9</sub>(iron @100ppm), T<sub>10</sub>(iron @150ppm) and T<sub>11</sub>(Control) in the study. The fruit characters and yield parameters in plant significantly differed due to different plant growth regulators and micronutrient on tomato. The maximum fruit length (7.57 cm), girth (6.47 cm) and pulp-seed ratio (12.93) was found in gibberellic acid @ 75 ppm, whereas fruit weight (57 g), yield/plant (2.47 kg) and yield/hectare (913.258 q/ha) were found in treatment naphthalene acetic acid @ 75 ppm and the minimum for all the parameters were found in control treatment.

Desai *et al.* (2011) find out the effect of different plant growth regulators and micronutrient on fruit quality and micronutrient content of tomato at Horticulture Farm, Junagadh Agricultural University, Junagadh, Gujarat, India. Four different plant growth regulators and three micronutrients with eleven treatments were used viz., T<sub>1</sub>(Gibberellic Acid) @ 50 ppm, T<sub>2</sub> (Gibberellic Acid) @ 75 ppm, T<sub>3</sub> (Naphthalene acetic acid) @ 50 ppm,

T<sub>4</sub>(Naphthalene acetic acid) @ 75 ppm, T<sub>5</sub> (Boron) @50 ppm, T<sub>6</sub> (Boron) @75 ppm, T<sub>7</sub> (Zinc) @0.5%, T<sub>8</sub>(Zinc) @1%, T<sub>9</sub> (Iron) @100 ppm, T<sub>10</sub> (Iron) @150 ppm and T<sub>11</sub> Control (No application of plant growth regulator and micronutrients) in the study. The maximum acidity per cent (1.41%) and ascorbic acid (109.33 mg/100g pulp) were found in T<sub>4</sub> (Naphthalene acetic acid) @ 75 ppm, maximum reducing sugars (1.68%), non-reducing sugars (1.98%), total sugars (3.67%) and TSS (4.33 °Brix) were found in treatment T<sub>2</sub> (GA<sub>3</sub> @75 ppm), whereas maximum boron content (31.00 ppm), Fe content (31.00 ppm) and Zn content (22.33 ppm) were found in treatment T<sub>8</sub> (Boric acid 75 ppm), T<sub>10</sub> (FeSO<sub>4</sub> @150 ppm) and T<sub>6</sub> (ZnSO<sub>4</sub> @1%), respectively the minimum for all the parameters were found in control treatment.

Choudhury *et al.* (2011) recorded the growth and yield of summer tomato as influenced by plant growth regulator at Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh. Different plant growth regulator was use in the experiment viz., PGR<sub>0</sub> (control), PGR<sub>1</sub> [4-chloro phenoxy acetic acid (4-CPA)] @20ppm, PGR<sub>2</sub> (GA<sub>3</sub>) @20 ppm and PGR<sub>3</sub> (4-CPA + GA<sub>3</sub>) @20 ppm. The positive result were observe in PGR<sub>3</sub>.

Gelmesa *et al.* (2011) reviewed a literature on Regulation of tomato (*Lycopersicon esculentum* Mill.) fruit setting and earliness by gibberellic acid and 2,4-dichlorophenoxy acetic acid application. The experiment consisted of one processing (Roma VF) and one fresh market (Fetan), tomato varieties, three levels of 2,4-D (0, 5 and 10 ppm) and four levels of GA<sub>3</sub> (@0, 10, 15 and 20 ppm). The result of experiment shows that application of 2, 4-D at 5 and 10 ppm reduced plant growth and hastened early flowering and fruiting with concentrate pick harvest. On the contrary, GA<sub>3</sub> applications at all concentrations seem to promote vegetative growth and extended maturity time and harvest.

Megbo (2010) used plant growth regulator to control the fruit drop and development in tomato. Gibberellic acid (GA<sub>3</sub>), naphthalene acetic acid, 2-4-D, aminothoxyvinylglycine (AVG) were used in the experiment. The result show that Fruit drop can be controlled by the exogenous application of plant growth regulators such as auxins and gibberellins. These plant growth regulators tend to delay the senescence and reduce unwanted fruit abscission (i.e. fruit drop). The application of 2,4-dichlorophenoxyacetic acid (2-4-D) or gibberellic acid (GA<sub>3</sub>) or

aminotheoxyvinylglycine (AVG) increase the flowering, fruit set, fruit size and control the fruit drop.

Oaliya *et al.* (2010) evaluated the biochemical effect of auxin on nutritional quality of tomato. The effect of Indole-3-acetic acid (IAA), Indole-3-butyric acid (IBA) and Naphthalene acetic acid (NAA) at 60, 100 and 140 mg/L was evaluated on some biochemical indices of the nutritional quality of tomato. The parameters evaluated were crude proteins, crude fat, crude fiber, ash, dry matter, titratable acidity, total carbohydrate, total soluble solids (<sup>0</sup>Brix), pH and <sup>0</sup>Brix/Acid ratio. The results showed that all the concentrations of IAA, IBA and NAA increased the levels of crude proteins, crude fat, crude fiber, ash, titratable acidity but decreased the total carbohydrate content.

Meena (2008) applied foliar spray of gibberellic acid (GA<sub>3</sub>) at 50 ppm and 75 ppm recorded significantly lower fruit drop percentage. Significantly higher total soluble solids, ascorbic acid content and TSS/acid ratio and lower acidity percentage were observed with the application of GA<sub>3</sub> at 50 ppm. The maximum benefit-cost ratio of 5.57 was recorded with application of GA<sub>3</sub> at 50 ppm followed by NAA at 50 ppm (3.04). Significantly more plant height and plant spread at 60 DAT and at harvest, leaf area per plant at harvest, number of flowers per plant, fruit set percentage, number of fruits per plant, average fruit weight and fruit yield and lower fruit drop percentage were recorded with the application of boron as foliar spray @ 2.0 kg/ha. Application of boron at 2.0 kg ha<sup>-1</sup> produced pooled fruit yield of 282.92 q ha<sup>-1</sup> which was higher by 41.2 and 15.3 per cent over the application of boron at 1.0 and 1.5 kg/ha, respectively. The economic evaluation of treatments indicated that application of GA<sub>3</sub> at 50 ppm in combination with boron at 2.0 kg/ha gave significantly the highest benefit-cost ratio of 3.85.

Bakrim *et al.* (2007) checked the effect of plant hormones and 20-hydroxyecdysone on tomato (*Lycopersicon esculentum*) seed germination and seedlings growth. In experiment they compared the effect of 20-hydroxyecdysone (20E) with the phytohormones: gibberellic acid (GA<sub>3</sub>), naphthalene acetic acid (NAA), benzyl amino purine (BAP). NAA, GA<sub>3</sub> and BAP provoked a decrease in proline content during seedlings, while the effect of 20E on proline levels varied during germination and plantlet development. This work showed that 20E

like phytohormones fulfil some bioactive actions during germination and seedlings growth in tomato.

Bhalekar *et al.* (2006) studied the effects of GA<sub>3</sub>, NAA, 4-CPA and boron @ 25 ppm and 50 ppm on the growth and yield of tomato cv. Dhanshree. The final result shows that the greatest plant height with GA<sub>3</sub> @ 25 ppm and 50 ppm (74.21 and 75.33 cm, respectively), and 4-CPA at 50 ppm (72.22 cm). The number of primary branches per plant did not significantly vary among the treatments. GA<sub>3</sub> @ 50 ppm resulted in the lowest number of primary branches per plant (69.55). The number of fruits per plant (38.86) was highest 50 ppm boron. The highest yields were recorded for boron at 25 and 50 ppm (254.2 and 264.4 q/ha).

Alam and Khan (2002) reported the fruit yield of tomato as affected by the naphthalene acetic acid. Different concentration of NAA (@0 ppm, 5 ppm, 10 ppm, 15 ppm, 20 ppm and 25 ppm) were used in the experiment. The spray application of naphthalene acetic acid at different concentration significantly increased the fruit yield of tomato, as compared to the control. The nutrient contents were also increased in most of the case.

Yadav *et al.* (2001) investigated the effect of GA<sub>3</sub> at 25 ppm significantly increased the growth characters, yield and yield components and also improved the quality of tomato cv. Punjab Chhuhara. The result observed that the application of NAA increase total soluble solid percentage significantly and the Application of 2,4-D at 5 ppm also increased the yield, but retarded the growth attributes and yield at higher concentration.

### Proposed Research Objectives

- To study the effect of different concentrations and stages of foliar application of growth regulators on growth, yield and quality.
- To find out the suitable growth regulators or its combinations for better growth, yield and quality of Tomato.
- To find out the influence of plant growth regulators on quality in tomato.

### Proposed Research Methodology

#### Experimental Site

The experiment will conduct at main Agriculture field of School of Agriculture, Lovely Professional University, Phagwara (Punjab) 144411.

#### Methodology

An experiment will be carried out at main agriculture field of school of agriculture, Lovely Professional University, District Kapurthala (Punjab).

The Kapurthala District is separate in two non-contiguous parts about 32 KM apart- Kapurthala and SultanpurLodhi tehsils forming one piece and the Phagwara Tehsil the other. The former lie between north latitude 31 0-07' and 31 0-39' and east 740-57' and 750- 36', while the Phagwara tehsil lies between north latitude 31 0-10' and 31 0- 22' and east longitude 750-40' and 75-55'. The entire area of the district 167000 Hectares. The driest month is November with 5 mm precipitation and the most precipitation falls in July with average 247 mm. June is warmest month with average temperature 33.4°C and the January is coolest month with average temperature 12.4°C. The average annual temperature is 23.8°C and the average annual rainfall is 719 mm.

#### (A) Experiment Details:

1.	Name of crop	Tomato
2.	Planting time	Summer season 2018

<b>3.</b>	Design	Randomized Block Design (RBD)
<b>4.</b>	Number of treatments	13 (Thirteen)
<b>5.</b>	Number of replication	03 (Three)
<b>6.</b>	Spacing	50 X 50 cm
<b>a.</b>	Row to row distance	50 cm
<b>a.</b>	Plant to plant distance	50 cm
<b>7.</b>	Plot to plot distance	0.5 m
<b>9.</b>	Replication border	0.5m
<b>10.</b>	Length of plot	2.0 m
<b>11.</b>	Width of plot	1.5 m
<b>12.</b>	Total length of experimental area	8 m
<b>13.</b>	Total width of experimental area	33 m
<b>14.</b>	Total experimental area	264 m <sup>2</sup>
<b>15.</b>	Number of plots	39 (Thirty nine)
<b>16.</b>	Number of plants/ plot	10
<b>17.</b>	Date of nursery sowing	January 2018
<b>18.</b>	Date of transplanting	March 2018
<b>19.</b>	Layout	RBD

**(B) Treatments Details:**

<b>Sr. No.</b>	<b>Treatments</b>	<b>Reference</b>
<b>1.</b>	T <sub>1</sub>	NAA @10 ppm
<b>2.</b>	T <sub>2</sub>	NAA @15 ppm
<b>3.</b>	T <sub>3</sub>	NAA @20 ppm
<b>4.</b>	T <sub>4</sub>	NAA @30 ppm
<b>5.</b>	T <sub>5</sub>	GA <sub>3</sub> @60 ppm
<b>6.</b>	T <sub>6</sub>	GA <sub>3</sub> @90 ppm
<b>7.</b>	T <sub>7</sub>	NAA @10 ppm + GA <sub>3</sub> @30 ppm
<b>8.</b>	T <sub>8</sub>	NAA @15 ppm + GA <sub>3</sub> @60 ppm
<b>9.</b>	T <sub>9</sub>	NAA @20 ppm + GA <sub>3</sub> @90 ppm
<b>10.</b>	T <sub>10</sub>	GA <sub>3</sub> @30ppm + NAA @10 ppm
<b>11.</b>	T <sub>11</sub>	GA <sub>3</sub> @60 ppm + NAA @15 ppm
<b>12.</b>	T <sub>12</sub>	GA <sub>3</sub> @90 ppm + NAA @20 ppm
<b>13.</b>	T <sub>13</sub>	Control

**(C) Treatment allotment Details**

<b>R1</b>	<b>R2</b>	<b>R3</b>
T1	T11	T2
T2	T5	T12
T3	T9	T11
T4	T6	T10
T5	T2	T1
T6	T3	T4
T7	T8	T3
T8	T1	T7
T9	T7	T8
T10	T12	T9
T11	T4	T6
T12	T10	T5
Control	Control	Control



**(D) Observations:**

<b>Sr. no.</b>	<b>Observations</b>	<b>Interval</b>
<b>A.</b>	<b>Growth Observations</b>	
<b>1.</b>	Plant height (cm)	30, 60 and 90 DAT
<b>2.</b>	Number of branches	30, 60 and 90 DAT
<b>3.</b>	Number of leaves per plant	30, 60 and 90 DAT
<b>4.</b>	Leaf surface Area	90 DAT
<b>B.</b>	<b>Yield Attributes</b>	
<b>1.</b>	Number of flower cluster per plant	30, 60and 90 DAT
<b>2.</b>	Number of fruit cluster per plant	30, 60and 90 DAT
<b>3.</b>	Number of fruits per plant	30, 60and 90 DAT
<b>4.</b>	Fruit length (cm)	After Harvesting
<b>5.</b>	Fruit weight (gm)	After Harvesting
<b>6.</b>	Fruit diameter (cm)	After Harvesting
<b>7.</b>	Number of locules per fruit	After Harvesting
<b>8.</b>	Pericarp thickness	After Harvesting
<b>9.</b>	Fruit yield (kg/plant)	After Harvesting
<b>10.</b>	Fruit yield (q/ha)	After Harvesting

<b>11.</b>	1000 seed weight	After Harvesting
<b>C.</b>	<b>Quality Characters</b>	
<b>1.</b>	Fruit color	After Harvesting
<b>2.</b>	Fruit shape	After Harvesting
<b>3.</b>	Fruit size	After Harvesting
<b>4.</b>	Ascorbic acid	After Harvesting
<b>5.</b>	Total soluble solids (TSS)	After Harvesting
<b>6.</b>	Specific Gravity	After Harvesting

### **Statistical Analysis**

Replicated data from each treatment will be subjected to statistical analysis by using software SPSS .20(SPSS. Inc, Chicago, USA).

### **Expected Research Outcomes**

The interaction effect of GA3 and NAA showed significant effect on various characters. It is observing that of T<sub>6</sub> (GA3 @90ppm) in maximum result while the minimum value was recorded under T<sub>1</sub>till date.

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