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The Pharma Innovation

**ISSN (E): 2277- 7695**
**ISSN (P): 2349-8242**
**NAAS Rating: 5.23**
TPI 2022; 11(1): 652-654
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www.thepharmajournal.com
Received: 10-11-2021
Accepted: 12-12-2021

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# Application of different growth regulators in garlic (*Allium sativum* L.) in Prayagraj agro-climatic condition

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**Abstract**
An investigation was carried out during 2020-2021 at Research field, Department of Horticulture SHAUTS, Prayagraj. The experiment was conducted in Randomized Block Design (RBD) in which the application of Naphthalene acetic acid, Indole-3-acetic acid and Gibberellic acid with different combinations were applied. Ten treatment combinations *viz*. $T_0$ Control, $T_1$ Naphthalene acetic acid @ 50ppm, $T_2$ Naphthalene acetic acid @ 100ppm, $T_3$ Naphthalene acetic acid @ 150ppm, $T_4$ Indole-3-acetic acid @ 50ppm, $T_5$ Indole-3-acetic acid @ 100ppm, $T_6$ Indole-3-acetic acid @ 150ppm, $T_7$ Gibberellic acid @ 50ppm, $T_8$ Gibberellic acid @ 100ppm, $T_9$ Gibberellic acid @ 150ppm, were applied during the research work on Garlic (Bhima Purple cv.). The growth regulators, Naphthalene acetic acid, Indole-3-acetic acid and Gibberellic acid were found to be effective in terms of plant growth, yield and quality of garlic. However, Gibberellic acid @ 150ppm proved to be most effective in term of plant height (46.47cm), leave length (38.17cm), number of leaves (6.93), neck thickness (61.33mm) collar diameter (10.62cm), polar diameter of bulb (36.93cm), equatorial diameter of bulb (39.57 cm), fresh bulb weight per plot (24.25 g), marketable bulb weight per plot (23.25g), fresh yield per plot (889g), marketable yield per plot (584 g), bulb yield (58.4 q $ha^{-1}$), (32.49) Total Soluble Solid, minimum acidity (0.25% $^0$Brix) and Ascorbic acid (12.48 mg/100g). From the findings of present study it is concluded that Gibberellic acid @ 150ppm was found to be the best treatment for better plant growth, yield and quality of Garlic (Bhima Purple cv.) with maximum benefit cost ratio (4.59:1).

**Keywords:** garlic, naphthalene acetic acid, indole-3-acetic acid and gibberellic acid

## Introduction
Garlic (*Allium sativum* L.) is the second most widely used cultivated vegetable cum spice crop after onion, under the genus *Allium* and belongs to the family Alliaceae. The native place of garlic is Central Asia and Southern Europe, especially the Mediterranean region. Garlic is a herbaceous annual crop whose underground edible stem is a composite bulb made up of numerous smaller bulbs known as cloves. The wild species of *Allium longicuspis* is considered to be closest relative and revealed as the ancestor of the garlic (Regel, 1875) [6]. The characteristic odour and pungent principle of garlic is due to diallyl di- sulphide (DDS) which is found in alliinin and allylradicle form. Garlic helps to prevent blood clots from forming, thus reducing the possibility of strokes and thromboses. Garlic helps to remove heavy metals such as lead and mercury from the body.

Plant growth regulator presents plays a vital role in modifying the growth behavior of plants resulting in increasing growth, quality and finally increases the yield. Naphthalene acetic acid (*NAA*) is synthetic auxin, that can bring changes in the phenotype of plants and affects growth it increase in growth rate of shoot and root and finally increase in yield, Patel and Patel, (2010) [7]. Indole-3-acetic acid (IAA) is the main auxin in plants, controlling many important physiological processes including cell enlargement and division, tissue differentiation. It increases the root number, root length and root weight, bulb diameter and bulb weight, Govind *et al*. (2015) [2] Gibberellic acid ($GA_3$) is a growth stimulating substance which promotes cell elongation and cell division thus help in the growth and development of many plants. $GA_3$ has the potentiality to break dormancy and accelerates the sprouting of garlic. Gibberellic acid play a major role in diverse growth processes including seed development, organ elongation, senescence and control of flowering time, Ouzounidou *et al*., (2008) [5]; Yamaguchi, (2008) [10].

## Materials and Method

The present investigation entitled, "Application of different growth regulators in Garlic *(Allium sativum* L.) in Prayagraj Agro-climatic condition" was carried out at the Department of horticulture, Naini Agricultural institute, Sam Higgingbottom University of Agriculture, Technology and Sciences, Prayagraj during the rabi season (2020-2021). Naphthalene acetic acid (*NAA*), Indole-3-acetic acid (IAA) and Gibberellic acid ($GA_3$) were used in which ten treatment combinations *viz*. $T_0$ Control, $T_1$ Naphthalene acetic acid @ 50ppm, $T_2$ Naphthalene acetic acid @ 100ppm, $T_3$ Naphthalene acetic acid @ 150ppm, $T_4$ Indole-3-acetic acid @ 50ppm, $T_5$ Indole-3-acetic acid @ 100ppm, $T_6$ Indole-3-acetic acid @ 150ppm, $T_7$ Gibberellic acid @ 50ppm, $T_8$ Gibberellic acid @ 100ppm, $T_9$ Gibberellic acid @ 150ppm were applied.

## Results and Discussion

The data presented in table 1 shows that the plant height were significantly varied under different treatments. The maximum plant height (46.47cm) was recorded with treatment $T_9$ Gibberellic acid @ 150ppm and minimum plant height (34.67cm) was recorded with treatment $T_0$ (control). The increase in plant height may be due to cell division and promotion of cell division and cell elongation in the meristemic region which could be associated with $GA_3$ causing increase length of the internodes and increase in number of cells resulting in the increase of height, Castaneda *et al*. (2002) [1]. The maximum and significant leave length (38.17cm) was recorded with treatment $T_9$ Gibberellic acid @ 150ppm and minimum leave length (29.50) cm was recorded with treatment $T_0$(control). The maximum and significant number of leaves (6.93) was recorded with treatment $T_9$ Gibberellic acid @ 150ppm and minimum (6.07) number of leaves was recorded with treatment $T_0$(control). The maximum value for neck thickness **(**61.33 mm) was recorded with $T_9$ Gibberellic acid @ 150ppm and minimum neck thickness (41.67 mm) was recorded with $T_0$ (control). It might be due to their effect of $GA_3$ in cell division resulting into more number of leaves per plant which induces maximum number of leaves and as such it gradually increases leaf number with the concentration of $GA_3$. Similar result was obtained by Patel *et al*. (2010) [7].

**Table 1:** Effects of application of different growth regulators on growth parameter of garlic.

| Treatments | Growth Parameters | | | | | | |
|---|---|---|---|---|---|---|---|
| | Plant height (cm) | Leaves length (cm) | Number of leaves | Neck thickness (mm) | Collar diameter (cm) | Polar Diameter (mm) | Equatorial Diameter (mm) |
| $T_0$ | 34.67 | 29.50 | 6.07 | 41.67 | 6.07 | 30.63 | 33.03 |
| $T_1$ | 43.80 | 35.97 | 6.47 | 54.33 | 8.62 | 35.00 | 37.37 |
| $T_2$ | 42.43 | 35.27 | 6.53 | 58.67 | 8.76 | 33.30 | 35.63 |
| $T_3$ | 43.20 | 35.57 | 6.60 | 55.33 | 8.66 | 31.30 | 35.50 |
| $T_4$ | 41.37 | 33.90 | 6.53 | 53.67 | 9.28 | 32.53 | 35.80 |
| $T_5$ | 43.87 | 34.27 | 6.60 | 53.67 | 8.43 | 33.43 | 36.80 |
| $T_6$ | 45.80 | 37.57 | 6.67 | 58.00 | 10.25 | 35.33 | 37.67 |
| $T_7$ | 43.07 | 34.40 | 6.60 | 52.00 | 8.59 | 33.87 | 36.07 |
| $T_8$ | 38.87 | 30.90 | 6.60 | 54.67 | 8.59 | 31.60 | 34.90 |
| $T_9$ | 46.47 | 38.17 | 6.93 | 61.33 | 10.62 | 40.17 | 42.50 |
| S.Ed (±) | 2.29 | 2.15 | 0.19 | 2.00 | 0.11 | 1.49 | 1.19 |
| C.D. (5%) | 4.82 | 4.51 | 0.39 | 4.21 | 0.24 | 3.13 | 2.50 |
| C.V | 6.64 | 7.61 | 3.49 | 4.52 | 1.59 | 5.42 | 3.98 |

In table 2 the data revealed that maximum collar diameter (10.62cm) was recorded with $T_9$ Gibberellic acid @ 150ppm and minimum collar diameter (6.07cm) was recorded with $T_0$ (control). It might be due to $GA_3$ effect on cell division resulting in increase in collar diameter $GA_3$ induced maximum increase in collar. Similar results were obtained by Hye *et al*. (2002) [4] and Patel *et al*. (2010) [7]. The polar diameter was Significantly affected by different treatments where the maximum value for polar diameter (40.17mm) was recorded with $T_9$ Gibberellic acid @ 150ppm and minimum polar diameter (30.63mm) was recorded with $T_0$ (control). Similarly with equatorial diameter the maximum value for equatorial diameter (42.5mm) was recorded with $T_9$ Gibberellic acid @ and minimum equatorial diameter (33.03mm) was recorded with $T_0$ (control). The $GA_3$ accelerates the nutrients partitioning towards cells and active growth sites along nutrient absorption which reinforce minerals absorption and their related bio-molecules accretion in leaves and apical shoots passing active growth and development. The increased leaf length leads to increased surface area of leaves and this resulted in more absorption of nutrients and higher photosynthetic efficiency leading to increase in bulb diameter, Kashyap (2012) [3], Hye *et al*. (2002) [4].

From table 2 the fresh bulb weight per plot the maximum value (24.25g) was observed with $T_9$ Gibberellic acid @ 150ppm and minimum fresh bulb weight per plot (13.99g) was recorded with $T_0$ (control). This may be dues to $GA_3$ as it helps in carbon assimilation and better accumulation of carbohydrates in the plants as a result of increase in the vegetative characters due to enhanced cell division and quick cell multiplication. Results of the present investigation were also in confirmatory with findings of, Thakur (2018) [9], Govind *et al*. (2015) [2]. The marketable bulb weight per plot the maximum value (23.25g) was observed with $T_9$ Gibberellic acid @ 150ppm and minimum marketable bulb weight per plot (13.02g) was recorded with $T_0$ (control). In respect to fresh yield per plot the maximum value (889g) was recorded in $T_9$ Gibberellic acid @ 150ppm and minimum fresh yield per plot was 521.33g with $T_0$ (control). The Use of $GA_3$ has increased yield, which is due to the increase in the different types of characters, bulb weight and bulb diameter. Better growth of garlic plants, higher photosynthesis and accumulation of metabolites resulting in higher yield of garlic. Govind *et al*. (2015) [2]. The marketable yield per plot the maximum value (584g) was recorded with $T_9$ Gibberellic acid @ 150ppm and minimum marketable yield per plot was (206g) with $T_0$ (control). For bulb yield per hectare the maximum value (58.4q) was observed with $T_9$ Gibberellic acid @ 150ppm and minimum marketable yield per hectare

was (20.6q) with $T_0$ (control). The total soluble solid the maximum value (32.49 °Brix) was observed with $T_9$ Gibberellic acid @ 150ppm and minimum total soluble solid value was (28.17 °Brix) with $T_0$ (control). Similarly, maximum value (12.48 mg/100g) was observed with $T_9$ Gibberellic acid @ 150ppm and minimum ascorbic acid (9.27 mg/100g) was recorded in $T_0$ (control). $T_9$ Gibberellic acid @ 150ppm proved to promote the maximum Net return (Rs.423750) and minimum net return (Rs.46500) was found in $T_0$ (control). The maximum B:C ratio (3.64: 1) was observed in $T_9$ Gibberellic acid @ 150ppm and minimum B:C ratio (1.29: 1) was observed in $T_0$ (control).

**Table 2:** Effects of application of different growth regulators on yield and quality parameter of garlic.

| Treatments | Fresh bulb weight per plot (g) | Marketable bulb weight per plot (g) | Fresh yield per plot (g) | Marketable yield per plot (g) | Bulb yield per hectare (q) | Total soluble solid (°Brix) | Ascorbic acid (mg/100g) |
|---|---|---|---|---|---|---|---|
| $T_0$ | 13.99 | 13.02 | 521.33 | 206.00 | 20.60 | 28.17 | 9.27 |
| $T_1$ | 16.82 | 15.85 | 743.00 | 420.33 | 42.03 | 31.16 | 9.71 |
| $T_2$ | 17.71 | 16.68 | 638.67 | 321.33 | 32.13 | 30.24 | 11.46 |
| $T_3$ | 17.40 | 16.40 | 727.00 | 405.00 | 40.50 | 29.89 | 10.51 |
| $T_4$ | 21.20 | 20.67 | 655.00 | 347.33 | 34.73 | 30.28 | 10.33 |
| $T_5$ | 17.60 | 16.66 | 687.33 | 371.33 | 37.13 | 31.22 | 9.83 |
| $T_6$ | 18.31 | 17.34 | 683.33 | 384.67 | 38.47 | 29.53 | 10.26 |
| $T_7$ | 17.16 | 16.16 | 635.67 | 342.67 | 34.27 | 29.78 | 9.56 |
| $T_8$ | 17.48 | 16.45 | 675.00 | 362.67 | 36.27 | 30.09 | 10.34 |
| $T_9$ | 24.25 | 23.25 | 889.00 | 584.00 | 58.40 | 32.49 | 12.48 |
| S.Ed (±) | 1.52 | 1.47 | 66.62 | 66.91 | 6.69 | 0.42 | 0.09 |
| C.D. (5%) | 3.20 | 3.08 | 139.97 | 140.56 | 14.06 | 0.87 | 0.19 |
| C.V | 10.25 | 10.41 | 11.90 | 21.88 | 21.88 | 1.68 | 1.05 |

**Table 3:** Economics of different treatments and benefit cost ratio of garlic

| Treatment No. | Treatment | Cost of cultivation | Bulb Yield | Selling Rate | Gross return | Net return | Benefit cost ratio |
|---|---|---|---|---|---|---|---|
| | | Rs. $ha^{-1}$ | q $ha^{-1}$ | Rs. $q^{-1}$ | Rs. $ha^{-1}$ | Rs. $ha^{-1}$ | |
| $T_0$ | Control (spray of plain water) | 159500 | 20.60 | 10000 | 206000 | 46500 | 1.29: 1 |
| $T_1$ | Naphthalene acetic acid @ 50ppm | 160520 | 42.03 | 10000 | 420300 | 259780 | 2.62: 1 |
| $T_2$ | Naphthalene acetic acid @ 100ppm | 161300 | 32.13 | 10000 | 321300 | 160000 | 1.99: 1 |
| $T_3$ | Naphthalene acetic acid @ 150ppm | 162500 | 40.50 | 10000 | 405000 | 242500 | 2.49: 1 |
| $T_4$ | Indole-3-acetic acid @ 50ppm | 160265 | 34.73 | 10000 | 347300 | 187035 | 2.17: 1 |
| $T_5$ | Indole-3-acetic acid @ 100ppm | 160985 | 37.13 | 10000 | 371300 | 210315 | 2.31: 1 |
| $T_6$ | Indole-3-acetic acid @ 150ppm | 161750 | 38.47 | 10000 | 384700 | 222950 | 2.38: 1 |
| $T_7$ | Gibberellic acid @ 50ppm | 159755 | 34.27 | 10000 | 342700 | 182945 | 2.15: 1 |
| $T_8$ | Gibberellic acid @ 100ppm | 159995 | 36.27 | 10000 | 362700 | 202705 | 2.27: 1 |
| $T_9$ | Gibberellic acid @ 150ppm | 160250 | 58.40 | 10000 | 584000 | 423750 | 3.64: 1 |

## Conclusion

From the present investigation it is concluded that $T_9$ Gibberellic acid @ 150ppm was assessed to be the optimum treatment in respect to plant height, length of leaves, number of leaves, neck thickness, collar diameter, polar diameter, equatorial diameter, fresh bulb weight per plot, marketable bulb weight per pot, fresh yield per plot, marketable yield per plot bulb yield per hectare (q/ha) and quality parameter total Soluble Solid, ascorbic acid. $T_9$ gave maximum net return as well as maximum benefit cost ratio.

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