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M Sai Abhinav
Department of Plantation Spices Medicinal and Aromatic crops, College of Horticulture, Rajendranagar, Hyderabad, Telangana, India

M Rajkumar
Principal Scientist (Horticulture), Head of Fruit Research station, Sangareddy, SKLTSHU, Telangana, India

M Sreenivas
Assistant Professor, College of Horticulture, Rajendranagar, Hyderabad, SKLTSHU, Telangana, India

S Praneethkumar
Scientist, Floricultural Research Station, ARI, Rajendranagar, Hyderabad, SKLTSHU, Telangana, India

Corresponding Author:
M Sai Abhinav
Department of Plantation Spices Medicinal and Aromatic crops, College of Horticulture, Rajendranagar, Hyderabad, Telangana, India

Effect of plant growth regulators on growth of garlic (*Allium sativum* L.) in Southern Zone of Telangana

M Sai Abhinav, M Rajkumar, M Sreenivas and S Praneethkumar

Abstract
The experiment entitled "Effect of Plant Growth Regulators on Growth of Garlic (*Allium sativum* L.)" in Southern Zone of Telangana" was conducted during the *Rabi* season of the year 2021-2022 at College of Horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University. Among the all treatments GA3 treatment concentration (100 ppm) proved highest plant height (85.6 cm), highest leaf length (52.43 cm), maximum number of leaves (9.4), highest neck thickness (13.3 mm), highest leaf area index (1.19), and maximum width (1.77 cm). Whereas, lowest values recorded under control treatment.

Keywords: GA3, *Allium sativum*

Introduction
Garlic is botanically known as *Allium sativum* L. also called as "Lashun". It is a well- known spice from Alliaceae family with chromosome number 2n=16. It is one of the most significant bulbous crops farmed globally, and the second most cultivated crop in Allium species after onion. It is frequently used in food flavouring, chutneys, pickles, curry powder, tomato ketchups and other preparations.

It's a frost resistant bulbous perennial with tall white thin flat leaves and tiny white flowers and bulbils. It is a multiple or compound bulb consists of smaller bulblets called 'cloves' and is surrounded by a thin white or pinkish papery sheath. Garlic cloves are the plant most cost-effective component. Due to dormancy, garlic cloves do not sprout immediately after harvesting and faded over time during storage. Cloves may be used as a spice and condiment. It contains 0.1 percent volatile oil. The major components of oil are diallyldisulphide (60%), diallyltrisulphide (20%) and allyl propyl trisulphide (6%), as well as potassium, phosphorus and magnesium.

In the current organic agricultural environment, garlic extracts and oil have the powerful effects against insecticides and fungicides (Kumar *et al*., 2014) [5]. Garlic aqueous extract contains allicin. It decreases cholesterol levels in human blood. Garlic is more nutrient dense than any other bulbous crops. Green garlic is high in carbohydrates (29%), protein (6.3%), minerals (0.3%) and essential oils (0.1-0.4%), as well as some fat, vitamin C, and sulphur (Memane *et al*., 2008) [8]. Ascorbic acid is the main component of green garlic. Garlic has Anti-bacterial properties (Arora and Kaur., 1999) [2] having anti-oxidant and anti-cancer properties (Meng *et al*., 1993; Harris *et al*., 2001) [7, 6].

Plant growth regulators play a vital role in seed germination and blooming and are employed in a variety of agricultural plants for root induction, weed control, fruit drop, flowering management, fruit setting, dormancy breaking, and organogenesis. Plant growth regulator presents a new possibility to break yield barrier, particularly imposed by the environment.

Application of growth regulators at a specific or critical growth stage influences the key processes of plants favouring manipulation of protein content of the crop. Similarly, the use of growth regulators increases production and productivity in garlic.

Materials and Methods
The present investigation entitled "Effect of Plant Growth Regulators on Growth of Garlic (*Allium sativum* L.)" in Southern Zone of Telangana" was carried out during the *Rabi* season of the year 2021-2022 at College of Horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University. Before sowing, cloves were treated with carbendazim to destroy fungal inoculums and healthy cloves are selected for sowing. The sowing was carried out at spacing of 10 cm between the cloves and 20 cm between beds.

The design adopted was Randomized Block Design with thirteen treatments replicated thrice. Treatments included T_1- GA3 50 ppm, T_2- GA3 100 ppm, T_3- GA3 150 ppm, T4- NAA 50 ppm, T_5- NAA 100 ppm, T_6- NAA 200 ppm, T_7- Kinetin 20 ppm, T_8-Kinetin 40 ppm, T_9- Kinetin 60 ppm, T_{10}- Thiourea 100 ppm, T_{11}-Thiourea 150 ppm, T_{12}-Thiourea 200 ppm and T_{13}- Control. Plant growth regulators sprayed on the foliage at 3 intervals *i.e*., @ 60, 90 and 120 Days After Planting (DAP) and the observations recorded were plant height (cm), length of the leaves (cm), breadth of leaves (cm), number of leaves plant^{-1}, neck thickness (mm) and leaf area index at 60, 90 and 120 days after planting. Were recorded and the data was statistically analysed.

Results and Discussion

Growth parameters

The effect of plant growth regulators on growth of Garlic (*Allium sativum* L.) and the results of the experiment were presented in Table 1 to 6.

Plant height (cm)

With respect to plant height in garlic, treatment the data of the plant height at 60 days after planting was found maximum under foliar application of GA3 @ 100 ppm (60.67 cm) and it was statistically followed by Kinetin @ 40 ppm (52.67 cm). Lowest plant height (37.27 cm) was recorded under Control i.e., foliar application with distilled water.

At 90 days after planting, height of the plant was ranged from 44.73 cm to 69.42 cm. Maximum height of plant was listed by the application of GA3@ 100 ppm (69.42 cm) and was followed by the plant treated with kinetin @ 40 ppm (65.81 cm) whereas the lowest plant height (44.73 cm) was recorded under control i.e., foliar application with distilled water. And at 120 days after planting, height of the plant was noted from 72.70 cm to 85.60 cm. Significant maximum height of plant was listed by the application of GA3 @ 100 ppm (85.60 cm) and was statistically *at par* with the plants treated with Kinetin @ 40 ppm (85.23 cm).While, in all the cases lowest plant height was registered under control (72.70 cm).

Leaf Length (cm)

The data recorded at 60 days after planting related to leaf length was varied from (32.93-43.7 cm). On the basis of data, the foliar application of T_3 - GA3 @ 100 ppm was recorded the highest leaf length (43.7 cm) and it was significantly superior over rest of the treatments, followed by T_1 -GA3 @ 50 ppm (40.63 cm). On other hand, treatment T_{11}-Thiourea @ 150 ppm recorded the lowest leaf length (32.93 cm). The data pertaining to leaf length after 90 and 120 days after planting also followed closely. At 120 days after planting, the length of leaf was varying from 41.07 cm to 52.43 cm. The maximum leaf length was observed under T_3 -GA3 @ 100 ppm (52.43 cm) and significantly superior to other treatments, which is statistically at par with T_4 -NAA @ 75 ppm (51.83 cm), T_5- NAA @ 100 ppm (51.97 cm), T_8- Kinetin @ 40 ppm (51.47 cm). Contradictorily, in all intervals the minimum leaf length had been recorded in control plots sprayed with distilled water.

From the above results, it was observed that there is a significant increase in leaf length from 60 to 90 days after planting. Thereafter, virtual decrease in leaf length had been observed at 120 days after planting. The similar trend was reported by Rashid (2010) [9] and the fact behind that is leaves may undergo senescence and drying of leaf tips which indicate maturity.

Breadth of Leaves (cm)

Among the treatments, T_3 - GA3 @ 100 ppm (1.74 cm) at 60 days after planting and was statistically at par with T_2- GA3 @ 75 ppm (1.69 cm), T_6-NAA@ 150 ppm (1.61 cm), T_9- Kinetin @ 60 ppm (1.69 cm) and T_8 -kinetin @ 40 ppm (1.71 cm). Meanwhile the lowest width of leaves was recorded under T_{13} -control (1.25 cm).

At 90 days after planting, highest width of leaves was also recorded in T_3 of GA3 @ 100 ppm (1.60 cm) and was statistically at par with T_{10}- Thiourea @ 1 00 ppm (1.46 cm), T_5- NAA @ 100 ppm (1.50 cm), T_1- GA3 @ 50 ppm (1.55 cm) and T8-kinetin @ 40 ppm (1.54 cm) and lowest was recorded in T_{13}- control (1.19 cm). At 120 days after planting, highest width of leaves was also recorded after the application of GA3 @ 100 ppm (1.77 cm) followed by kinetin @ 40 ppm (1.72 cm). However, lowest leaf width was reported under control at 90 and 120 days after planting. The results obtained from present experiment related to leaf width is in close conformity with the findings of (Abdhul Hye *et al*., 2002) [1] and Dwivedi banuja 2018 [3] in onion.

Number of leaves per plant

The maximum number of leaves per plant was counted under treatment T_3 -GA3 @ 100 ppm (8.00) at 60 days after planting, while lowest is recorded in T_{13} control (4.33). However, higher number of leaves at 90 and 120 days of planting showed significantly under the treatment applied with GA3 @ 100 ppm and proved the superiority of GA3 concentration. At 90 days after planting number of leaves per plant was ranged from 5.67 to 9.33. The maximum number of leaves counted under T_3 -GA3 @ 100 ppm 9.33. Meanwhile lowest is recorded in T_{13} control (5.67). At 120 days after planting number of leaves per plant was ranged from 7 to 9.4. The maximum number of leaves were counted under T_3 -GA3 @ 100 ppm (9.4) which was statistically at par with all treatments. Contradictory, treatment T_{13}- control (7.00) numerically listed the lowest number of leaves per plant during different crop stages i.e., 60, 90 and 120 days after planting. The results obtained from the experiment are symmetrically similar to the results of Memane *et al*., 2008 [8] in garlic. They also observed similar trend of behaviour in case of number of leaves per plant. The records from Goutham *et al*., 2S014 showed that highest number of leaves per plant recorded with foliar application of GA3 @ 50 ppm.

Neck thickness (mm)

Among the treatments, T_3 -GA3 @ 100 ppm registered highest average increase of neck thickness (8.6 mm) at 60 days after planting and was statistically at par with T_9 - Kinetin @ 60 ppm (8.53 mm), T_8- Kinetin @ 40 ppm (8.33 mm), T_2- GA3 @ 75 ppm (8.40 mm) and T_1- GA3 @ 50 ppm (8.10 mm). On other hand, minimum value of neck thickness (6.13 mm) was recorded from T_{13} –Control. Neck thickness in case of 90 and 120 days after planting also showed similar trend. At 90 days after planting, the neck thickness ranged from 10.00 to 12.00 mm. T_3 -GA3 @ 100 ppm recorded the maximum neck thickness (12.00 mm) of the plant and was superior over other treatments. Meanwhile, lowest neck thickness was recorded under T_{13}- control. At 120 days after planting T_3-GA3

@ 100 ppm recorded the maximum neck thickness (13.30 mm) of the plant and was at par with T9 -kinetin @ 40 ppm (12.10 mm), T_6- NAA @ 150 ppm (12.47), T_2- GA3 @ 75 ppm (12.60) and T_1- GA3 @ 50 ppm (12.47). Meanwhile, lowest neck thickness was recorded under T_{13} -Control (10.27).

Leaf area index

A thorough look into data analysis, clearly indicate that the plants treated with T_3-GA3 @ 100 ppm registered highest average increase of leaf area index (1.11) at 60 days after planting, and it was statistically followed by T_7 -Kinetin @ 20 ppm (0.51). On other hand, minimum value of leaf area index (0.31) was recorded from T_{13} -Control. The data collected at 90 and 120 days after planting also recorded similar trend. At 90 days after planting, the leaf area index ranged from (1.19 to 0.66 M2). T_3 -GA3 @ 100 ppm recorded the significantly maximum leaf area index (1.19) M2 of the plant and it was superior over other treatments followed by T_4- NAA @ 75 ppm (0.84). Meanwhile, lowest leaf area index was recorded under T_{13}- control. At 120 days after planting, leaf area index ranged from (1.15-0.52). T_3 -GA3 @ 100 ppm recorded the significantly maximum leaf area index (1.15 M2) of the plant and was superior over other treatments at par by T8 -kinetin @ 40 ppm (1.13 M2), T6- NAA @ 150 ppm (1.12 M2), T_7- Kinetin @ 20 ppm (1.13 M2) and Meanwhile, lowest leaf area index was recorded under T_1- GA3 @ 50 ppm (0.52 MS).

Table 1: Effect of plant growth regulators on plant height (cm) of Garlic cv. Ooty-1 at 60, 90 and 120 DAS

Treatments	60 Days	90 Days	120 Days
T_1 -GA3 50 ppm	51.00bc	62.43bc	77.1bc
T_2 -GA3 75 ppm	50.67bc	61.27c	76.57bc
T_3 -GA3 100 ppm	60.67a	69.42a	85.60a
T_4 -NAA 50 ppm	49.33bc	62.09c	79.59b
T_5 -NAA 100 ppm	51.33b	62.59bc	77.60bc
T_6 -NAA 150 ppm	51.67b	61.32c	80.03b
T_7 -Kinetin 20 ppm	45.67c	60.77c	79.07b
T_8 -Kinetin 40 ppm	52.67b	65.81b	85.23a
T_9 -Kinetin 60 ppm	45.67c	62.17c	77.23bc
T_{10} -Thiourea 100 ppm	45.67c	60.33c	74.40c
T_{11} -Thiourea 150 ppm	47.33bc	58.03cd	74.73c
T_{12} -Thiourea 200 ppm	41.33cd	55.37d	73.43c
T_{13} -Control	37.27d	44.73e	72.70c
SEM	2.10	1.19	1.22
CD @ 5%	6.13	3.47	3.57

Table 2: Effect of plant growth regulators on leaf length (cm) of Garlic cv. Ooty-1 at 60, 90 and 120 DAS

Treatments	60 Days	90 Days	120 Days
T_1 -GA3 50 ppm	40.63b	45.83cd	49.20bc
T_2 -GA3 75 ppm	39.00c	48.77b	50.17b
T_3 -GA3 100 ppm	43.70a	50.97a	52.43a
T_4 -NAA 50 ppm	39.07c	48.27bc	51.83ab
T_5 -NAA 100 ppm	40.10bc	48.06bc	51.97ab
T_6 -NAA 150 ppm	38.23c	45.17d	48.73bc
T_7 -Kinetin 20 ppm	38.67c	47.03bc	47.67c
T_8 -Kinetin 40 ppm	40.33bc	50.27a	51.47ab
T_9 -Kinetin 60 ppm	39.43bc	46.97c	48.00c
T_{10} -Thiourea 100 ppm	35.97d	44.07d	46.40cd
T_{11} -Thiourea 150 ppm	32.93e	43.57d	45.53d
T_{12} -Thiourea 200 ppm	34.40d	43.43d	46.33d
T_{13} -Control	34.63d	38.70e	41.07e
Sem	0.46	0.60	0.72
CD @ 5%	1.35	1.74	2.09

Table 3: Effect of plant growth regulators on width of leaves (cm) of Garlic cv. Ooty-1 at 60, 90 and 120 DAS

Treatments	60 Days	90 Days	120 Days
T_1 -GA3 50 ppm	1.52bc	1.55ab	1.66c
T_2 -GA3 75 ppm	1.69ab	1.42b	1.61d
T_3 -GA3 100 ppm	1.74a	1.60a	1.77a
T_4 -NAA 50 ppm	1.41c	1.42b	1.57e
T_5 -NAA 100 ppm	1.42c	1.50a	1.56e
T_6 -NAA 150 ppm	1.61ab	1.43b	1.55e
T_7 -Kinetin 20 ppm	1.58b	1.44b	1.57e
T_8 -Kinetin 40 ppm	1.71ab	1.54ab	1.72b
T_9 -Kinetin 60 ppm	1.69ab	1.40b	1.60de
T_{10} -Thiourea 100 ppm	1.33cd	1.46ab	1.55e
T_{11} -Thiourea 150 ppm	1.53bc	1.40b	1.51f
T_{12} -Thiourea 200 ppm	1.59b	1.27c	1.39g
T13 -Control	1.25d	1.19d	1.22h
SEM	0.05	0.05	0.01
CD @ 5%	0.14	0.15	0.03

Table 4: Effect of plant growth regulators on number of leaves of Garlic cv. Ooty-1 at 60, 90 and 120 DAS

Treatments	60 Days	90 Days	120 Days
T_1 -GA3 50 ppm	5.33b	8.67ab	9.33a
T_2 -GA3 75 ppm	6.00b	9.00a	8.67a
T_3 -GA3 100 ppm	8.00a	9.33a	9.40a
T_4 -NAA 50 ppm	5.33b	7.33b	8.30a
T_5 -NAA 100 ppm	6.00b	7.33b	9.00a
T_6 -NAA 150 ppm	6.33ab	7.67ab	8.80a
T_7 -Kinetin 20 ppm	5.67b	7.33b	8.67a
T_8 -Kinetin 40 ppm	6.67ab	8.33ab	9.33a
T_9 -Kinetin 60 ppm	6.00b	8.67ab	8.87a
T_{10} -Thiourea 100 ppm	6.00b	6.33b	8.40a
T_{11} -Thiourea 150 ppm	5.67b	6.67b	8.63a
T_{12} -Thiourea 200 ppm	4.67b	6.00b	8.43a
T13 -Control	4.33b	5.67c	7.00b
SEM	0.58	0.49	0.41
CD @ 5%	1.69	1.42	1.21

Table 5: Effect of plant growth regulators on neck thickness (mm) of Garlic cv. Ooty-1 at 60, 90 and 120 DAS

Treatments	60 Days	90 Days	120 Days
T_1 -GA3 50 ppm	8.10ab	11.87a	12.47ab
T_2 -GA3 75 ppm	8.40ab	11.73a	12.60ab
T_3 -GA3 100 ppm	8.60a	12.00a	13.30a
T_4 -NAA 50 ppm	7.57b	11.83a	12.07bc
T_5 -NAA 100 ppm	7.67b	11.47a	11.60bc
T_6 -NAA 150 ppm	7.73b	11.53a	12.47ab
T_7 -Kinetin 20 ppm	7.53b	11.40a	11.27c
T_8 -Kinetin 40 ppm	8.33ab	11.80a	12.10bc
T_9 -Kinetin 60 ppm	8.53ab	11.67a	13.00ab
T_{10} -Thiourea 100 ppm	7.40b	11.07a	11.77bc
T_{11} -Thiourea 150 ppm	7.33b	11.53a	12.27b
T_{12} -Thiourea 200 ppm	7.43b	11.80a	12.07bc
T_{13} -Control	6.13c	10.00b	10.27d
SEM	0.28	0.35	0.30
CD @ 5%	0.82	1.02	0.87

Table 6: Effect of plant growth regulators on leaf area index (cm) of Garlic cv. Ooty-1 at 60, 90 and 120 DAS

Treatments	60 Days	90 Days	120 Days
T_1 -GA3 50 ppm	0.48c	0.77d	0.52d
T_2 -GA3 75 ppm	0.42de	0.83b	1.10ab
T_3 -GA3 100 ppm	1.11a	1.19a	1.15a
T_4 -NAA 50 ppm	0.43d	0.84b	0.79d
T_5 -NAA 100 ppm	0.50b	0.78cd	1.03bc
T_6 -NAA 150 ppm	0.42de	0.76d	1.12ab
T_7 -Kinetin 20 ppm	0.51b	0.80c	1.13ab
T_8 -Kinetin 40 ppm	0.43d	0.74e	1.13ab
T_9 -Kinetin 60 ppm	0.44d	0.80c	1.07b
T_{10} -Thiourea 100 ppm	0.41e	0.74e	0.97c
T_{11} -Thiourea 150 ppm	0.38f	0.73e	0.96c
T_{12} -Thiourea 200 ppm	0.41e	0.71f	1.03bc
$T1_3$ -Control	0.31g	0.66g	0.79c
SEM	0.005	0.005	0.02
CD @ 5%	0.015	0.015	0.07

Conclusion

From the present study it can be concluded that, foliar application of plant growth regulators boosted the growth of garlic and based on the current experimental results, it may be concluded that foliar application of GA3 @ 100 ppm proved the best over other treatments of plant growth regulators followed by treatment with Kinetin @ 40 ppm.

Future scope

The future line of work may be carried out in following lines. Screening of suitable varieties of garlic for the region with integrated nutrient scheduling. In depth study using more number of bio-stimulants in more appropriate concentration for increased yield of better-quality bulb.

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Conflict of Interest: None

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