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# Effect of plant growth regulators on growth parameters of okra (*Abelmoschus esculentus* L. Moench)

**TV Baraskar, PP Gawande, NV Kayande, SS Lande and MS Naware**

**Abstract**
The field experiment was conducted at Chilli and Vegetable Research Unit, Dr. PDKV, Akola during *kharif* season of 2017 with three replications and thirteen treatments in randomized block design. The experiment consisted of one genotype (AKOV-107) and four different plant growth regulators study was carried out to evaluate the foliar sprays of plant growth regulators $GA_3$, NAA, salicylic acid and chitosan at three different concentrations of each and one control (without spray) replicated three time. Observations recorded on 11 different parameters like plant height, number of branches per plant, number of leaves per plant, leaf area, internodal distance (cm), average fresh weight per plant, dry wet per plant, node to first flowering, fruit length (cm), fruit diameter (cm) and yield per plot. Foliar application of 150 ppm $GA_3$ and 200 ppm NAA have beneficial role on plant characters and yield of okra.

**Keywords:** Okra, growth, yield, plant growth regulators, $GA_3$, NAA, salicylic acid, citoson

## Introduction
Okra (*Abelmoschus esculentus* L. Moench*)* popularly known as 'Bhendi' (ladies finger) is an important warm season vegetable, widely cultivated for its tender, green fruits. Okra is a tall annual dicotyledonous plant related to cotton and thought to be of African origin. It is self-pollinated, but occasionally up to 20% cross pollination happens by insects. Okra pods are harvested when they reach the maximum size but still tender around 5-10 days after opening of flower depending on the cultivar grown. Average nutritive value (ANV) of okra is 3.21 which is higher than tomato, eggplant and most of the cucurbits, except bitter gourd (Grubben, 1977) [7]. Okra dry seed contains 18-20 per cent oil and 20-23 per cent crude protein. Growth regulators mainly regulate the plant physiological and biochemical processes. For example, play a major role in dormancy, organ size, crop improvement, flowering and fruit set, regulation of chemical composition of plants and control of mineral uptake from the soil. Okra produces fruits for a long time and needs balanced and sufficient supply of plant growth regulators for higher yield and better quality. Hence, there is a need to study the influence of plant growth regulators on growth parameters, yield and its components in okra to boost the productivity. With this background, the present investigation was carried to find out the suitable growth regulators to increase the yield potential in okra cv. AKOV-107.

## Materials and Methods
An investigation entitled as "Effect of plant growth regulators on growth and yield of okra (*Abelmoschus esculentus* L. Moench)" was conducted at the experimental field of Chilli and Vegetable Research Unit, Dr. PDKV, Akola during *kharif* season of 2017. The treatments include in this experiment viz.

| Treatment No. | Treatment details |
|---|---|
| $T_1$ | (NAA-100 ppm) |
| $T_2$ | (NAA-150 ppm) |
| $T_3$ | (NAA-200 ppm) |
| $T_4$ | ($GA_3$-100 ppm) |
| $T_5$ | ($GA_3$-150 ppm) |
| $T_6$ | ($GA_3$-200 ppm) |
| $T_7$ | Chitosan-100 ppm |
| $T_8$ | Chitosan-125 ppm |
| $T_9$ | Chitosan-150 ppm |
| $T_{10}$ | Salicylic acid-500 ppm |
| $T_{11}$ | Salicylic acid-1000 ppm |
| $T_{12}$ | Salicylic acid-1500 ppm |
| $T_{13}$ | Control(without spray) |

The experiment was laid in a randomized block design (RBD) with three replications. Okra variety AKOV-107 was sown on 12-07-2017 at 60 x 60 cm spacing with grass plot area of 6.00 m x 2.20 m. All the cultural practices were followed to raise good crops. Foliar application of different plant growth regulators are done at 15, 30 and 45 days after sowing. Observations were recorded on five randomly selected plants from each treatment per replication. The data recorded on 11 different growth parameters like plant height, number of branches per plant, number of leaves per plant, leaf area, internodal distance (cm), average fresh weight per plant, dry wet per plant, Node to first flowering, fruit length (cm), fruit diameter (cm) and yield per plot. The data were analyzed statistically as per standard method of Panse and Sukhatme.

**Results and Discussion**

The response with growth regulators depend upon the amount of particular compound absorbed by the seed or plant and ability of the stimulus of the chemical applied. It is however, believed that the mechanism of the action of a growth regulator in plant through same fundamental process involving the activities of the enzyme concerned in the process.

**1. Plant height (cm)**

The data presented in table 1 indicated that, at 30 DAS significantly the maximum 32.73 cm plant height of okra crop was recorded in the treatment $T_5$ ($GA_3$ at 150 ppm) followed by treatment $T_3$ (NAA at 200 ppm) 31.46 cm whereas, minimum 22.83 cm plant height ware recorded in treatment $T_{13}$ (control). At 60 DAS, significantly the maximum plant height 95.60 cm was recorded with treatment $T_5$ ($GA_3$ at 150 ppm) which was followed by $T_3$ (NAA at 200 ppm) 93.90 cm whereas, the minimum plant height 66.93 cm was observed in treatment $T_{13}$ (Control).

At 90 DAS, significantly the maximum plant height 117.73 cm were recorded with treatment $T_5$ ($GA_3$ at 150 ppm) which was followed by $T_3$ (NAA at 200 ppm) 117.73 cm whereas, minimum plant height 80.27 cm was observed in treatment $T_{13}$ (Control). Height is visible measure of plant growth and is a function of internodal elongation and increasing nodes per plant since leaves are born on the stem, leaf development and biomass shows close relationships with plant height. The effect of plant growth regulators differed significantly for the plant height at all the stages of plant growth. Similar results were reported by Kokare *et al.* (2006) [9], Dhage *et al.* (2011) [5] and Ayyub *et al.* (2012) in okra.

**2. Number of branches per plant**

Data presented in table 1 showed that at 30 DAS, the numbers of branches per plant were found to be statistically non-significant. At 60 DAS, significantly the maximum number of branches per plant 2.93 were recorded with treatment $T_5$ ($GA_3$ at 150 ppm) which was followed by $T_3$ (NAA at 200 ppm) 2.83 branches whereas, the minimum number of branches 1.20 was observed in treatment $T_{13}$ (Control). At 90 DAS, significantly the maximum 3.47 number of branches were recorded in the treatment $T_5$ ($GA_3$ at 150 ppm) which was followed by treatment $T_3$ (NAA at 200 ppm) 3.40 branches whereas, the minimum 1.83 number of branches per plant was recorded in treatment $T_{13}$ (Control) in okra plant. With the advancement of crop growth period in okra crop, there was increase in the number of branches. The results are supported by Patil *et al.* (2010) [14] in okra.

**3. Number of leaves per plant**

The data presented in table 1 showed that at 40 DAS, the number of leaves per plant was found to be statistically non-significant. At 55 DAS, significantly the maximum number of leaves per plant 22.73 were recorded with treatment $T_5$ ($GA_3$ at 150 ppm) which was followed by $T_3$ (NAA at 200 ppm) 22.50 leaves per plant whereas, the minimum numbers of leaves per plant 11.93 were observed in treatment $T_{13}$ (Control). At 70 DAS, significantly the maximum number of leaves per plant were recorded with treatment $T_5$ ($GA_3$ at 150 ppm) which was 31.10 followed by $T_3$ (NAA at 200 ppm) 30.53 leaves per plant whereas, the minimum number of leaves per plant 17.60 was observed in treatment $T_{13}$ (Control). It is well established fact that $GA_3$ act by cell elongation resulting in increased number of leaves. The similar results were also reported by Singh and Kumar (2005), Mandal *et al.* (2012) and Chowdhury *et al.* (2014) [3] in okra.

**4. Leaf area ($cm^2$)**

The data presented in table 1 at 30 DAS leaf area ($cm^2$) were found to be statistically non-significant. At 45 DAS, significantly the maximum leaf area ($cm^2$) was recorded in treatment $T_5$ ($GA_3$ at 150 ppm) 171.00 $cm^2$ followed by $T_3$ (NAA at 200 ppm) 168.00 $cm^2$ whereas, minimum leaf area 124.67 $cm^2$ was observed in treatment $T_{13}$ (Control). At 60 DAS, significantly the maximum leaf area was recorded in okra plant with treatment $T_5$ ($GA_3$ at 150 ppm) 220.00 $cm^2$ followed by $T_3$ (NAA at 200 ppm) 216.33 $cm^2$ while, the minimum leaf area 170.00 $cm^2$ was observed in treatment $T_{13}$ (Control).

Under the influence of plant growth regulators like $GA_3$, NAA, chitosan and salicylic acid, elongation and multiplication of cell takes place and it may have resulted in large and broader blade size of leaf. It is observed fact, that $GA_3$ act in cell elongation or cell enlargement resulting in increased in size of leaves. Similar result was also reported by Kokare *et al.* (2006) [9] and Elumalai *et al.* (2013) in okra.

**Table 1:** Effect of plant growth regulators on growth regulators on plant height, number of branches, number of leaves and leaf area ($cm^2$).

| Treatments | Plant height (c.m) | | | Number of branches | | | Number of leaves | | | leaf area ($cm^2$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS | 40 DAS | 55 DAS | 70 DAS | 30 DAS | 45 DAS | 60 DAS |
| T1: NAA-100 ppm | 24.87 | 81.97 | 106.40 | 1.03 | 1.70 | 2.43 | 8.33 | 14.17 | 23.20 | 107.00 | 149.33 | 180.33 |
| T2: NAA-150 ppm | 28.13 | 88.93 | 114.77 | 1.23 | 2.13 | 2.93 | 9.67 | 17.20 | 26.37 | 113.33 | 159.00 | 205.33 |
| T3: NAA-200 ppm | 31.47 | 93.90 | 117.27 | 1.73 | 2.83 | 3.40 | 10.67 | 22.50 | 30.53 | 119.33 | 168.00 | 216.33 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T4: GA3-100 ppm | 28.67 | 92.30 | 115.23 | 1.37 | 2.27 | 3.03 | 10.00 | 18.03 | 28.07 | 116.67 | 164.67 | 208.33 |
| T5: GA3-150 ppm | 32.73 | 95.60 | 117.73 | 1.77 | 2.93 | 3.47 | 11.00 | 22.73 | 31.10 | 118.33 | 171.00 | 220.00 |
| T6: GA3-200 ppm | 25.12 | 78.57 | 106.20 | 1.03 | 1.90 | 2.50 | 8.67 | 14.57 | 24.97 | 109.67 | 154.00 | 187.67 |
| T7: Chitosan-100 ppm | 31.03 | 93.60 | 116.03 | 1.53 | 2.80 | 3.27 | 10.33 | 22.17 | 30.47 | 118.67 | 166.00 | 215.33 |
| T8: Chitosan-125 ppm | 27.23 | 86.90 | 112.97 | 1.20 | 2.07 | 2.90 | 9.33 | 16.50 | 26.53 | 113.33 | 157.00 | 198.67 |
| T9: Chitosan-150 ppm | 24.23 | 81.27 | 103.77 | 1.03 | 1.30 | 2.27 | 8.00 | 13.50 | 22.90 | 108.33 | 143.67 | 179.33 |
| T10: Salicylic acid-500 ppm | 26.63 | 83.50 | 113.43 | 1.13 | 2.00 | 2.57 | 9.33 | 15.83 | 24.47 | 109.33 | 154.33 | 193.00 |
| T11: Salicylic acid-1000 ppm | 30.73 | 92.70 | 116.11 | 1.33 | 2.53 | 3.23 | 10.00 | 20.93 | 29.73 | 117.00 | 166.00 | 214.33 |
| T12: Salicylic acid-1500 ppm | 24.33 | 77.40 | 98.67 | 1.00 | 1.23 | 1.87 | 8.33 | 13.43 | 22.23 | 105.33 | 132.33 | 179.67 |
| T13: Control | 22.83 | 66.93 | 80.27 | 1.00 | 1.20 | 1.83 | 7.67 | 11.93 | 17.60 | 92.00 | 124.67 | 170.00 |
| mean | 27.54 | 85.66 | 109.14 | 1.26 | 2.07 | 3.00 | 9.33 | 17.19 | 26.01 | 111.41 | 154.62 | 197.56 |
| SE m ± | 2.09 | 5.13 | 6.78 | 0.19 | 0.20 | 0.17 | 0.74 | 1.03 | 1.66 | 8.0 | 9.52 | 10.48 |
| CD @ 5% | 6.09 | 14.96 | 19.78 | NS | 0.59 | 0.49 | NS | 2.99 | 4.85 | NS | 27.79 | 30.56 |

**5. Internodal distance (cm)**

The data presented in table 2 showed that significantly minimum Internodal distance was recorded in treatment $T_5$ ($GA_3$ 150 ppm) 5.13 cm followed by treatment $T_3$ (NAA 200 ppm) 5.15 cm while maximum intermodal distance (6.99 cm) was recorded in $T_{13}$ (control). Optimum quantity of application of plant growth regulators increases number of node per plant which helps in reduction of Internodal distance of okra plant. The similar results were also reported by Patil *et al.* (2008) [13] in okra.

**6. Node to first flowering**

The data presented in table 2 showed that significantly lowest node to flowering was recorded in treatment $T_5$ ($GA_3$ 150 ppm) at 3.40 node followed by treatment $T_3$ (NAA 200 ppm) 3.53 node while highest node to flowering 5.30 was found in $T_{13}$ (control). Similar result was also reported by Shingh *et al.* A (2012) okra.

**7. Fruit length (cm)**

The data regarding presented in table 2 showed that significantly the maximum length of fruit was obtained in the treatment $T_5$ ($GA_3$ at 50 ppm) 15.96 cm followed by $T_3$ (NAA 200) 15.93 cm however, the minimum 11.26 cm length of okra fruit was recorded in treatment $T_{13}$ (Control).

These results could be attributed mainly to the stimulatory effect of $GA_3$ on plant growth, which resulted in higher rates of biosynthesis and therefore higher amounts of assimilates available for distribution to the pods. The similar results were also reported by Dhankhar and Singh (2009), Patil and Patel (2010) [14] and Ayyub *et al*. (2013) [1] in okra.

**8. Fruit diameter (cm)**

The data presented in table 2 showed that significantly the maximum fruit diameter was recorded in the treatment $T_5$ ($GA_3$ at 150 ppm) 1.85 cm followed by $T_3$ (NAA at 200 ppm) 1.78 cm whereas, the minimum diameter of fruit diameter 1.31 cm was recorded in treatment $T_{13}$ (Control). These results could be attributed mainly to the role of $GA_3$ to promote cell division and cell elongation. Similar results were also reported by Kokare *et al.* (2006) [9], Patil *et al.* (2010) [14], singh *et al.* B (2012) [17, 18] and Ayuub *et al.* (2013) [1],

**9. Average fresh weight per plant (gm)**

The data presented in table 2 showed that significantly maximum average fresh weight per plant at final harvest was recorded in treatment $T_5$ ($GA_3$ 150 ppm) 95.33 gm followed by treatment $T_7$ (chitosan 100 ppm) 94.67 gm while the minimum fresh weight per plant 65.00 gm was found in $T_{13}$ (control), The results were also reported by Hamdia; M. and Abd El-Samad *et al*. (2013) in wheat.

**10. Dry weight per plant (gm)**

The data presented in table 2 showed that, significantly maximum dry weight per plant 18.92 gm was recorded in treatment $T_5$ ($GA_3$ 150 ppm) followed by treatment $T_3$ (NAA 200 ppm) 17.84 gm while minimum dry weight per plant (9.04 gm) was found in $T_{13}$ (control). Dry weight per plant and its portioning is an important yield contributing characters. Knowledge of the periodical pattern of dry per plant and its distribution in different plant part would give better understanding of the varieties in relation to its economic productivity. The yield is an ultimate expression of different metabolic process of the plant. The growth regulators might have affected the informal metabolic processes of plant. The similar result was reported by Chowdhury *et al.* (2014) [3] in okra.

**Table 2:** Effect of plant growth regulators on growth regulators on internodal distance(cm), node to first flowering, fruit length(cm), fruit diameter (cm), fresh wt/plant(gm), dry wt/plant(gm) and yield kg/plot

| Treatments | Internodal distance | Node to first flowering | Fruit length | Fruit diameter (cm) | Fresh wt/plant(gm) | Dry wt/plant(gm) | Yield kg/plot |
|---|---|---|---|---|---|---|---|
| T1: NAA-100 ppm | 6.04 | 4.30 | 14.84 | 1.46 | 75.33 | 11.34 | 11.60 |
| T2: NAA-150 ppm | 5.51 | 4.03 | 15.15 | 1.58 | 87.67 | 14.32 | 12.77 |
| T3: NAA-200 ppm | 5.15 | 3.53 | 15.93 | 1.78 | 94.33 | 17.85 | 13.60 |
| T4: GA3-100 ppm | 5.47 | 3.87 | 15.16 | 1.66 | 88.67 | 15.33 | 12.90 |
| T5: GA3-150 ppm | 5.13 | 3.40 | 15.96 | 1.85 | 95.33 | 18.93 | 13.86 |
| T6: GA3-200 ppm | 5.98 | 4.17 | 14.97 | 1.46 | 82.00 | 12.58 | 11.80 |
| T7: Chitosan-100 ppm | 5.32 | 3.67 | 15.82 | 1.73 | 94.67 | 16.99 | 13.37 |
| T8: Chitosan-125 ppm | 5.61 | 3.93 | 15.12 | 1.52 | 85.67 | 14.12 | 12.33 |
| T9: Chitosan-150 ppm | 6.11 | 4.53 | 14.80 | 1.39 | 75.33 | 10.73 | 11.40 |
| T10: Salicylic acid-500 ppm | 5.69 | 4.07 | 15.08 | 1.45 | 85.00 | 13.56 | 12.10 |
| T11: Salicylic acid-1000 ppm | 5.44 | 3.73 | 15.28 | 1.71 | 94.00 | 16.37 | 13.13 |
| T12: Salicylic acid-1500 ppm | 6.89 | 4.67 | 14.30 | 1.36 | 76.33 | 10.07 | 10.90 |
| T13: Control | 6.99 | 5.30 | 11.26 | 1.31 | 65.00 | 9.04 | 9.58 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| mean | 5.79 | 4.09 | 14.90 | 1.56 | 84.56 | 13.94 | 12.26 |
| SE m ± | 0.35 | 0.24 | 0.80 | 0.09 | 6.08 | 1.53 | 0.81 |
| CD @ 5% | 1.03 | 0.70 | 2.34 | 0.27 | 17.72 | 4.47 | 2.37 |

**11. Fruit yield per plot (kg)**

The data presented in table 2 showed that significantly maximum green okra fruit yield was recorded in the treatment $T_5$ ($GA_3$ at 150 ppm) 13.86 kg followed by $T_3$ (NAA at 200 ppm) 13.60 kg whereas, the minimum okra fruit yield 9.58 kg was recorded in treatment $T_{13}$ (Control). Similar results were also reported by Singh *et al. et al.* A (2012) [17, 18] and Singh *et al.* B (2012) [17, 18] in okra.

**Conclusion**

It is concluded that foliar application of plant growth regulators at vegetative stage enhances the growth and development, result in Increase yield in okra. Among all the concentrations, $GA_3$ at 150 ppm showed desirable result in all the growth parameters followed by NAA 200 ppm, chitosan 1000 ppm and salicylic acid 100 ppm over other plant growth regulators concentration. Therefore, application of $GA_3$ at the rate of 150 ppm or NAA at 200 ppm may be recommended for okra cultivation.

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