



## Influence of plant growth regulators on growth, seed yield and quality of okra (*Abelmoschus esculentus* (L.) Moench)

Viraj V. Deshmukh<sup>1</sup>, Hitendrasinh J. Rajput<sup>2</sup>, Ramesh S. Bhadane<sup>3\*</sup>, Vitthal R. Patil<sup>4</sup>

<sup>1</sup>Department of Agril. Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmadnagar-413 722, Maharashtra, India.

<sup>2</sup>Associate Professor of Agril. Botany, Zonal Agricultural Research Station, MPKV, Solapur-413 001, Maharashtra, India.

<sup>3</sup>Assistant Professor of Agril. Botany, Pulse and Oilseed Crops Research and Training Centre, MPKV, Pandharpur, Dist. Solapur 413 304, Maharashtra, India.

<sup>4</sup>Assistant Professor of Agril. Botany, Agricultural Research Station, MPKV, Mohol, Dist-Solapur-413 213, Maharashtra, India.

**\*Correspondence**

Ramesh S. Bhadane  
bhadaners@rediffmail.com

Volume: 11, Issue: 3, Pages: 18-25

DOI: <https://doi.org/10.37446/jinagri/rsa/11.3.2024.18-25>

Received: 26 June 2024 / Accepted: 1 September 2024 / Published: 30 September 2024

**Background:** The use of plant growth regulators through foliar spraying proves beneficial where roots fail to supply the required nutrients. The plant growth hormones supplementation through foliar sprays enables the direct and efficient utilization of nutrients by plants, manifesting observable effects within a short period which ultimately increases seed quality and seed yield in okra.

**Methods:** The present study on “Effect of foliar application of plant growth regulators on growth, seed yield and quality of okra” was conducted at Department of Agril. Botany Farm, Agriculture College, Pune and laboratory studies was conducted in STRU, MPKV, Rahuri. The field trial was conducted in randomized block design (RBD) having nine treatments including control with three replications and lab experiment was conducted in completely randomised block design (CRD). The treatments comprise of different plant growth regulators such as GA<sub>3</sub> at 100 ppm, 200 ppm, 250 ppm, NAA at 100 ppm, 200 ppm, IBA at 100 ppm, 150 ppm, Kinetin at 200 ppm including control (No spray control). Two foliar sprays of each plant growth regulator treatment were applied at 30 and 45 days after sowing.

**Results:** The plant growth regulator GA<sub>3</sub> at 250 ppm foliar spraying was found to be the best treatment for plant growth, seed yield and quality characters of okra variety Phule Vimukha viz., days to 50% flowering (40 days), plant height (89.83 cm), number of leaves (25.50), number of branches (3.92), moisture content (16.50 %), germination (93.33 %), seedling length (24.20 cm), root length (9.23 cm), shoot length (15.27 cm), shoot root ratio (1.80), seedling dry weight (29.26 g), seed vigour index (2258), hard seeds (2.50), dead seed (3.50), electrical conductivity (1.07 dS/m), number of fruits per plant (15.00), fruit length (19.53 cm), fruit diameter (2.00 cm), number of seeds per fruit (52.00), 100 seed weight (7.87 g), seed yield per plant (58.05 g).

**Conclusion:** Application of plant growth regulator GA<sub>3</sub> at 250 ppm treatment as two foliar sprayings at 30 and 45 DAS was found more promising in increasing growth, yield and quality characters of okra variety Phule Vimukha as compared to the untreated control.

**Keywords:** GA<sub>3</sub>, NAA, okra, Phule Vimukha, quality, yield

### Introduction

Okra is a warm-season crop that can be found commercially in West Africa, India, Southeast Asia, the Southern United States, Brazil, Turkey, and Northern Australia. It is well recognized by a different regional name throughout the world, including lady's finger in England, Gumbo in America, and Bhindi in India. In tropical and subtropical regions of the world, okra is a commercially significant vegetable crop. Green okra pods are tasty and valued. Nutritionally okra

contains high levels of calcium, phosphorus, magnesium, vitamin A, B and C as well as iodine. The seeds of okra are a source of protein, oil, and can be ground up to replace aluminium salts in the process of purifying water. Okra has 1.9 g of protein, 6.4 g of carbohydrates, 0.7 g of minerals, 0.2 g of fat and 1.2 g of fibre per 100 g of edible portion (Tiwari et al., 1998). Plant growth regulators are chemicals that, when used sparingly, alter plant growth by enhancing or impairing a component of the natural growth regulatory system. The canopy structure and yield have both been proven to be altered by the growth regulators, which comprise growth promoters and retardants both (Aurovinda & Rajendra, 2003). Okra is a significant vegetable among fruits and vegetables, and its soft fruits are in high demand all year long. As the third most significant component in enhancing growth, productivity and seed quality through the use of plant growth regulators in various ways, scientists have recently given the concept of controlling plant growth and development with the attention it deserves. One of the most common techniques and a tool that many researchers have cited as being beneficial for increasing the pace and quantity of germination is the treatment of seed along with foliar sprays of plant growth regulator. Considering importance of the crop, the current study was undertaken with the objective to study the effect of growth regulators on growth, seed yield and quality of okra.

## Materials and Methods

A field trial was carried out at Botany Farm, Department of Agril. Botany, Agriculture College, Pune and Laboratory studies were conducted in Seed Technology Research Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri. The sowing of okra variety Phule Vimukha was done at the distance of 60 x 45 cm. The field research trial was conducted in randomized block design (RBD) having nine treatments including control with three replications while lab experiment was conducted in completely randomised block design (CRD). The treatments comprise of different plant growth regulators such as GA<sub>3</sub> at 100 ppm, 200 ppm, 250 ppm, NAA at 100 ppm, 200 ppm, IBA at 100 ppm, 150 ppm, Kinetin at 200 ppm including control (No spray). The Breeder Seeds of Okra *cv.* Phule Vimukha was obtained from National Agricultural Research Project, Ganeshkhind, Mahatma Phule Krishi Vidyapeeth, Pune. Phule Vimukha variety of okra is released for Western Maharashtra having high yield, excellent fruit nutritional quality, taste and resistant to yellow vein mosaic disease. The experimental plots were kept free from weeds, insect pests and diseases using proper plant protection measures. The experimental plot was given irrigation as and when required. Two foliar sprays of each plant growth regulator treatment were applied on 30 days and 45 days after sowing. The yield attributing characters data collected and analysed statistically as described by Panse & Sukhatme (1985).

## Results

### Morphological characters

The data recorded on the days taken to 50% flowering, plant height, number of leaves per plant, number of branches per plant and number of nodes per plant as influenced by plant growth regulators is reported in Table 1. From the data, significant results were recorded.

**Table 1. Influence of foliar application of plant growth regulators on morphological attributes of okra**

| Sr. No. | Treatments                 | Days to 50% flowering | Plant height (cm) | No. of leaves/pl | No. of branches/pl | No. of nodes per plant |
|---------|----------------------------|-----------------------|-------------------|------------------|--------------------|------------------------|
| 1       | GA <sub>3</sub> at 100 ppm | 42.00                 | 79.00             | 20.67            | 3.25               | 16.87                  |
| 2       | GA <sub>3</sub> at 200 ppm | 41.17                 | 85.00             | 23.25            | 3.83               | 17.17                  |
| 3       | GA <sub>3</sub> at 250 ppm | 40.00                 | 89.83             | 25.50            | 3.92               | 18.33                  |
| 4       | NAA at 100 ppm             | 43.25                 | 70.17             | 17.33            | 2.67               | 15.17                  |
| 5       | NAA at 200 ppm             | 42.08                 | 77.50             | 18.42            | 2.92               | 15.83                  |
| 6       | Kinetin at 200 ppm         | 44.17                 | 65.00             | 16.75            | 2.17               | 14.17                  |
| 7       | IBA at 100 ppm             | 45.33                 | 66.33             | 14.50            | 2.33               | 14.00                  |
| 8       | IBA at 150 ppm             | 45.00                 | 69.50             | 16.17            | 2.58               | 14.67                  |
| 9       | Control (No Spray)         | 48.00                 | 61.67             | 13.25            | 1.92               | 13.17                  |
|         | SE +                       | 2.10                  | 2.95              | 0.76             | 0.19               | 0.89                   |
|         | <b>C. D. at 5%</b>         | <b>6.50</b>           | <b>8.85</b>       | <b>2.29</b>      | <b>0.59</b>        | <b>2.67</b>            |
|         | <b>C.V. %</b>              | <b>8.50</b>           | <b>6.95</b>       | <b>7.21</b>      | <b>12</b>          | <b>9.96</b>            |

The GA<sub>3</sub> at 250 ppm recorded minimum days to 50% flowering (40.00) whereas, the control (48.00) treatment took the highest days for 50% flowering in okra. The GA<sub>3</sub> at 250 ppm treatment (T3) recorded the maximum height (89.83 cm),

number of leaves per plant (25.50), number of branches per plant (3.92) and number of nodes per plant (18.33) while minimum values for all these characters recorded in the Control.

### **Yield characters**

The results for yield characters were reported in Table 2. The significant differences were found for yield and yield attributing factors in okra. The highest number of fruits per plant (15.00), maximum fruit length (19.53 cm), fruit diameter (2.00 cm), number of seeds per fruit (52.00), 100 seeds weight (7.87 g) and seed yield per plant (58.05 g) were found in the treatment sprayed with GA<sub>3</sub> at 250 ppm. Whereas, the least number of fruits per plant (9.33), minimum fruit length (15.70 cm), fruit diameter (1.06 cm), number of seeds per fruit (34.33), 100 seeds weight (6.07 g) and seed yield per plant (26.33 g) were noticed in untreated control.

**Table 2. Influence of foliar application of plant growth regulators on yield attributing characters of okra**

| Sr. No. | Treatments                 | No. of fruits / pl | Fruit length (cm) | Fruit diameter (cm) | No. of seeds / fruit | 100 Seed weight (g) | Seed Yield / plant (g) |
|---------|----------------------------|--------------------|-------------------|---------------------|----------------------|---------------------|------------------------|
| 1       | GA <sub>3</sub> at 100 ppm | 12.33              | 18.83             | 1.57                | 49.53                | 7.30                | 44.87                  |
| 2       | GA <sub>3</sub> at 200 ppm | 14.00              | 19.13             | 1.68                | 50.00                | 7.52                | 52.00                  |
| 3       | GA <sub>3</sub> at 250 ppm | 15.00              | 19.53             | 2.00                | 52.00                | 7.87                | 58.05                  |
| 4       | NAA at 100 ppm             | 11.77              | 18.13             | 1.77                | 48.13                | 7.00                | 39.23                  |
| 5       | NAA at 200 ppm             | 12.00              | 18.50             | 1.87                | 49.00                | 7.20                | 42.33                  |
| 6       | Kinetin at 200 ppm         | 11.17              | 18.10             | 1.18                | 47.03                | 6.80                | 35.67                  |
| 7       | IBA at 100 ppm             | 11.00              | 17.80             | 1.37                | 46.00                | 6.70                | 33.90                  |
| 8       | IBA at 150 ppm             | 11.33              | 18.00             | 1.48                | 47.67                | 6.90                | 37.42                  |
| 9       | Control (No Spray)         | 9.33               | 15.70             | 1.06                | 34.33                | 6.07                | 26.33                  |
|         | SE +                       | 0.63               | 0.64              | 0.13                | 2.2                  | 0.31                | 2.29                   |
|         | <b>C. D. at 5%</b>         | <b>1.9</b>         | <b>1.94</b>       | <b>0.39</b>         | <b>6.6</b>           | <b>0.95</b>         | <b>6.88</b>            |
|         | <b>C.V. %</b>              | <b>9.12</b>        | <b>6.16</b>       | <b>11</b>           | <b>8.11</b>          | <b>7.84</b>         | <b>9.7</b>             |

### **Seed quality parameters**

The data on moisture content, germination percent, seedling dry weight, number of hard seeds and number of dead seeds of okra are given in Table 3. Non-significant differences between the treatments for moisture content were recorded. The treatment GA<sub>3</sub> at 250 ppm (T3) reported maximum moisture content (16.50%) while minimum moisture content (14.00%) was recorded in control. Among the treatments, GA<sub>3</sub> at 250 ppm (T3) showed significantly the highest seed germination percentage (93.33%) and seedling dry weight (29.26 g). In contrast, the lowest seed germination percentage (82.00%) and seedling dry weight (23.03 g) showed by the control. The lowest number of hard seeds (2.50) and dead seeds (3.50) were observed in the treatment with foliar application of GA<sub>3</sub> at 250 ppm, while the control treatment exhibited the maximum number of hard seeds (6.00) and dead seeds (7.00).

**Table 3. Influence of foliar application of plant growth regulators on seed quality of okra**

| Sr. No. | Treatments                 | Moisture content (%) | Germination (%) | Seedling dry wt. (mg) | No. of hard seeds | No. of dead seeds |
|---------|----------------------------|----------------------|-----------------|-----------------------|-------------------|-------------------|
| 1       | GA <sub>3</sub> at 100 ppm | 15.50 (23.19)        | 86.00 (68.06)   | 25.63                 | 4.20              | 5.20              |
| 2       | GA <sub>3</sub> at 200 ppm | 16.00 (23.59)        | 89.67 (71.29)   | 26.56                 | 3.40              | 4.40              |
| 3       | GA <sub>3</sub> at 250 ppm | 16.50 (23.97)        | 93.33 (75.07)   | 29.26                 | 2.50              | 3.50              |
| 4       | NAA at 100 ppm             | 15.13 (22.90)        | 85.67 (67.79)   | 23.77                 | 4.67              | 5.33              |
| 5       | NAA at 200 ppm             | 15.80 (23.43)        | 89.33 (70.97)   | 24.59                 | 3.50              | 4.50              |
| 6       | Kinetin at 200 ppm         | 14.50 (21.98)        | 83.57 (66.12)   | 23.23                 | 5.17              | 6.17              |
| 7       | IBA at 100 ppm             | 14.93 (22.74)        | 83.00 (65.68)   | 23.34                 | 4.90              | 5.90              |
| 8       | IBA at 150 ppm             | 15.00 (22.79)        | 84.00 (66.45)   | 25.24                 | 4.33              | 5.67              |
| 9       | Control (No Spray)         | 14.00 (21.98)        | 82.00 (64.92)   | 23.03                 | 6.00              | 7.00              |
|         | SE +                       | 1.23                 | 1.07            | 1.01                  | 1.01              | 1.26              |
|         | <b>C. D. at 5%</b>         | <b>N.S.</b>          | <b>3.19</b>     | <b>3.01</b>           | <b>3.01</b>       | <b>3.76</b>       |

\* The bracket values denotes arcsin transfer values

The data on root length, shoot length, shoot root ratio, vigour index, seedling length and electrical conductivity of okra seeds are given in Table 4. The maximum root length (9.23 cm), shoot length (15.27 cm), shoot root ratio (1.80), seed vigour index (2258) and seedling length (24.200) were recorded in the treatment with foliar spraying of GA<sub>3</sub> at 250 ppm, while in control treatment the minimum root length of 6.53 cm, shoot length (10.00 cm), shoot root ratio (0.77), seed vigour index (1403) and seedling length (17.533) were found.

**Table 4. Influence of foliar application of plant growth regulators on seed quality of okra**

| Sr. No. | Treatments                 | Root length (cm) | Shoot length (cm) | Shoot & root ratio | Vigour index | Seedling length (cm) | Electrical conductivity (dS/m) |
|---------|----------------------------|------------------|-------------------|--------------------|--------------|----------------------|--------------------------------|
| 1       | GA <sub>3</sub> at 100 ppm | 8.60             | 14.03             | 1.30               | 1874         | 22.333               | 1.14                           |
| 2       | GA <sub>3</sub> at 200 ppm | 8.87             | 14.47             | 1.67               | 2063         | 23.000               | 1.11                           |
| 3       | GA <sub>3</sub> at 250 ppm | 9.23             | 15.27             | 1.80               | 2258         | 24.200               | 1.07                           |
| 4       | NAA at 100 ppm             | 7.90             | 12.53             | 1.04               | 1694         | 20.667               | 1.19                           |
| 5       | NAA at 200 ppm             | 8.10             | 12.67             | 1.56               | 1879         | 21.033               | 1.17                           |
| 6       | Kinetin at 200 ppm         | 7.07             | 11.40             | 1.17               | 1573         | 18.800               | 1.28                           |
| 7       | IBA at 100 ppm             | 8.38             | 11.53             | 0.90               | 1674         | 20.500               | 1.25                           |
| 8       | IBA at 150 ppm             | 8.40             | 12.37             | 1.04               | 1760         | 21.200               | 1.21                           |
| 9       | Control (No Spray)         | 6.53             | 10.00             | 0.77               | 1403         | 17.533               | 1.31                           |
|         | SE +                       | 1.01             | 1.04              | 0.3                | 1.66         | 1.160                | 0.02                           |
|         | <b>C. D. at 5%</b>         | <b>3.01</b>      | <b>3.09</b>       | <b>0.9</b>         | <b>4.94</b>  | <b>3.400</b>         | <b>0.06</b>                    |

The minimum electrical conductivity value measuring 1.07 dS/m was reported in seeds treated with foliar application of GA<sub>3</sub> at 250 ppm and the control treatment exhibited the maximum electrical conductivity value of 1.31 dS/m.

## Discussion

### Morphological Characters

The application of growth hormones significantly decreased the 50% flowering days. It is because of accumulation of accelerated photosynthates in the plant helps in growth and development in enhancing advance flowering. [Sayed & Khan \(2000\)](#) confirm these results. The data denotes that significantly increased plant height correlates with increasing concentrations of GA<sub>3</sub> and other hormones. [Dhage et al. \(2011\); Ravat & Makani \(2015\)](#) in okra also supported these results. The enhanced growth and development resulted as Gibberellins promote stem elongation and helped in cell enlargement, internodal extension, enhance the RNA and thereby protein synthesis. The number of branches and leaves improved by increasing level of plant growth regulators. The higher leaf number per plant with GA<sub>3</sub> might be because of speedy growth. These results were also found by [Singh & Mahesh \(2005\); Patil & Patel \(2010\); Mehraj et al. \(2015\)](#) in okra and [Sharma & Lashkari \(2009\)](#) in cluster bean. As reported by [Wareing & Phillips \(1976\)](#) the per plant number of nodes increased because of more vegetative growth. The findings also reported that foliar spraying of GA<sub>3</sub> increased length of hypocotyls and two nodes. Such findings were also noted by [Mislevy et al. \(1989\)](#) and [Maity et al. \(2016\)](#).

### Yield characters

Hormones had a major role in plant mechanism, growth and development. The increase in fruit number per plant with GA<sub>3</sub> might be because of rapid and better nutrient translocation from roots to various apical plant parts. These results are parallel with [Munda et al. \(2000\); Singh et al. \(2001\); Bhosle et al. \(2002\)](#). The GA<sub>3</sub> as well as NAA application increased fruit length because of speedy cell division and cell elongation. Such findings also found by [Asghar et al. \(1997\); Kumar & Sen \(2005\); Shahid et al. \(2013\)](#) in okra. The expansion in fruit diameter by adding concentrations of GA<sub>3</sub> and NAA enhances vegetative and reproductive growth in okra. Fruit diameter is genetic character and vary among genotypes but spraying with hormones modify their growth and have great influence on seed quality. The similar results found by [Mehraj et al. \(2015\); Ravat & Makani \(2015\)](#) in okra and [Khramshaw et al. \(2022\)](#). The higher assimilation and translocation of photosynthates from source to the seeds (sink) helps to increase in number of seeds per fruit. These findings were also found by [Balraj & Kurdikeri \(2002\)](#) in chilli, [Kumari et al. \(2022\); Ambreen et al. \(2010\); Meena et al. \(2017\)](#) in okra. The increased seed weight might be due to more build-up of sufficient food reserves distributed by spraying of growth regulators towards the developing pods and seeds. This may be resulted by higher supply of photosynthates and translocation of food reserves in the seeds. The findings are in accordance with [Bhatt & Singh \(1997\)](#) in okra, and [Patil \(2005\)](#) in brinjal. The effective transfer and storage of these translocates in the

seeds, resulted in the seed size expansion. [Khramashow et al \(2022\)](#) found the same results. The  $GA_3$  application increased the yield because by entering the plant system, the plant growth regulators enhance the net photosynthetic rate with more leaf number, branches number that resulted in more fruits, length of fruit and fruit girth. This ultimately resulted in the per plant more fruit yield. These results were also supported by [Asghar et al. \(1997\)](#); [Ravat & Makani \(2015\)](#); [Mehraj et al. \(2015\)](#); [Meena et al. \(2017\)](#) in okra. The application of NAA plays important role in delaying process of senescence, root and shoot growth hastening, increased fertility rate of reproductive organs by favourable balancing of hormones and thereby setting more fruits which automatically resulted in higher yields. The findings are in conformity with the reports of [Kokare et al. \(2006\)](#) in okra.

### Seed quality parameters

The higher moisture content might be result of cell elongation and more moisture holding capacity. These results are conformity with [Kumar & Sen \(2005\)](#); [Kumar et al. \(2008\)](#) in okra. The proportionate use of growth regulators helped in better vigorous and viable seeds because of well development of embryo and endosperm. Similar findings were supported by [Chand et al. \(2013\)](#); [Sanodiya et al. \(2017\)](#) in okra. The application of  $GA_3$  and NAA increased shoot root ratio which resulted by speedy cell division and more elongation of individual cell. These results were supported by [Chand et al. \(2013\)](#) in okra. The spraying of  $GA_3$  at 250 ppm improved seed quality with more bold seeds percentage in addition to increased seeds test weight by more transport and accumulation of photosynthates from source to the sink (seeds). Such results were also noticed by [Sanodiya et al. \(2017\)](#); [Patil et al. \(2008\)](#); [Singh & Lal \(1995\)](#) in chilli, [Balraj & Kurdikeri \(2002\)](#) in chilli and [Patil \(2005\)](#) in brinjal. The percentage of dead seeds increases due to improper development of seeds during ripening and maturation stage. Heavy rains during seed maturation are also responsible for increase in seed borne infection resulting in death of seed. Further, nutrition deficiency also contributes in seed development. Deficiency in nutrients will cause underdeveloped and shrivelled seeds which fail to germinate. The results supported by [Chand et al. \(2013\)](#); [Patil et al. \(2008\)](#) in okra. In okra multiple dormancies is observed depending upon the cultivar and season. Freshly harvested seeds usually show multiple dormancies resulting in hard seeds which fail to absorb water and remain hard failing to germinate during the test period. The results also matched with the findings of [Chand et al. \(2013\)](#) in okra. Hormones has an important role in seed vigour. Seeds with high germination percentage and vigour will usually show low leachates resulting in low electrical conductivity. Fully well matured and healthy seeds remain viable for more duration. Conversely, seeds with higher conductivity measurements showed electrolyte leakage and lower quality. Lower quality seeds possess poor membrane structures that allow electrolytes and ions to leak through. The findings were supported by [Parmar et al. \(2023\)](#) in groundnut and [Kachare et al. \(2022\)](#) in green gram Harvesting and handling methods of seeds will also determinate the electrical conductivity. [Chand et al. \(2013\)](#) reported the similar results.

### Conclusion

The treatments comprised of different plant growth regulators such as  $GA_3$  at 100 ppm, 200 ppm, 250 ppm, NAA at 100 ppm, 200 ppm, IBA at 100 ppm, 150 ppm, Kinetin at 200 ppm including control (No spray) were given. Two foliar sprays of each plant growth regulator treatment were applied at 30 days and 45 days after sowing. From the data it was concluded that the two foliar sprayings of different plant growth regulators showed positive results for morphological, yield attributing and seed quality characters than control unsprayed treatment in okra. But the foliar spraying of  $GA_3$  at 250 ppm treatment at 30 and 45 days after sowing was found effective and more beneficial in increasing growth, yield contributing parameters and seed quality attributes of okra variety Phule Vimukha in comparison to the untreated control.

### Acknowledgment

The authors of the research article are very thankful to the Mahatma Phule Agricultural University, Rahuri, Dist. Ahmednagar, Maharashtra, India.

### Author contributions

Viraj V. Deshmukh conducted Research trial, collection, analysis of data, Thesis writing. Hitendrasinh J. Rajput has contribution as Research guide, guided to conduct trial, observations, analysis & thesis writing. Ramesh S. Bhadane wrote the entire manuscript of research article in addition to help in collection of data, analysis and interpretation. Vitthal R. Patil involved in collection of data, analysis, field and laboratory trial formulation.

## Funding

No financial support.

## Conflict of interest

The author declares no conflict of interest. The manuscript has not been submitted for publication in any other journal.

## Ethics approval

Not applicable.

## References

Ambreen, Nabi, Sharma, S. K. & Shukla, Y. R. (2010). Influence of plant growth regulators on seed yield and quality of okra. *Ann. Agri. Bio. Res.*, 15(1), 21-23.

Asghar, S., Hussain, S. A., & Ali, N. (1997). Effect of exogenous growth regulators on growth, flowering and yield of okra (*Abelmoschus esculentus* L.). *Sarhad Journal of Agriculture (Pakistan)*, 13(5), 449-453.

Aurovinda.D., & Rajendra, P. (2003). Effect of plant growth regulators CCC and NAA on the growth and yield of summer mung bean. *Ann. Agric. Res.*, 24(4), 874-879.

Balraj, R., & Kurdikeri, M. B. (2002). Effect of growth regulators on growth and yield of chilli (*Capsicum annuum*) at different pickings. *Indian Journal of Horticulture*, 59(1), 84-88.

Bhatt, K. L. & Singh, A. K. (1997). Effect of different level of phosphorus, GA<sub>3</sub> and picking on seed production of okra. *Vegetable Science*, 24(1), 4-6.

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

Chand, K., Channakeshava, B., & Narayananreddy, A. (2013). Effect of interaction due to plant growth regulators and fruit retention on crop growth, seed yield and quality in okra cv. *Arka Anamika*. *Indian Horticulture Journal*, 3(1-2), 10-18.

Dhage, A. A., Nagre, P. K., Bhangre, K. K., & Pappu, A. K. (2011). Effect of plant growth regulators on growth and yield parameters of okra. *Asian J. of Hort.*, 6(1), 170-172.

Kachare, P. A., Gawale, A. V., Solanke, A. P., & Pawar, G. S. (2022). Effect of micronutrients on seed quality of green gram (*Vigna radiata* L.). *Pharma Innovation*, 11(12), 843-846.

Khrmashow, D. Z., Bouras, M., & Sahuni, F. (2022). Effect of spraying with ga3 on the quality and oil content of Syrian Okra seeds *Abelmoschus esculentus* (L.). *American Journal of Plant Sciences*, 13(1), 83-90.

Kokare, R. T., Bhalerao, R. K., Prabu, T., Chavan, S. K., Bansode, A. B., & Kachare, G. S. (2006). Effect of plant growth regulators on growth, yield and quality of okra (*Abelmoschus esculentus* L. Moench). *Agricultural Science Digest*, 26(3), 178-181.

Kumar, B.P., & Gaurav, S. S. (2008). Effect of growth stimulants on seed germination and vigour index in okra (*Abelmoschus esculentus* L.). *Progressive Research*, 3(2), 195-196.

Kumar, M., & Sen, N. L. (2005). Effect of zinc, boron and gibberellic acid on yield of okra (*Abelmoschus esculentus* L. Moench). *Indian Journal of Horticulture*, 62(3), 308-309.

Kumari, S., Meena, M. L., Saini, A., & Kumar, S. (2022). Effect of foliar application of plant growth regulators on yield and yield attributes of okra in western arid region of Rajasthan. *The Pharma Innovation Journal*, 11(2), 1544-1546.

Maity, U., Dutta, P., & Layek, B. (2016). Effect of plant growth regulators on growth, yield and quality of okra (*Abelmoschus esculentus* (L.) Moench). *Journal of Agroecology and Natural Resource Management*, 3(3), 251-253.

Meena, R. K., Dhaka, R. S., Meena, N. K., & Meena, S. (2017). Effect of foliar application of NAA and GA<sub>3</sub> on growth and yield of okra [*Abelmoschus esculentus* (L.) Moench] cv. Arka Anamika. *International Journal of Pure Applied Bioscience*, 5(2), 1057-1062.

Mehraj, H., Taufique, T., Ali, M. R., Sikder, R. K., & Jamal Uddin, A. F. M. (2015). Impact of GA<sub>3</sub> and NAA on horticultural traits of *Abelmoschus esculentus*. *World Applied Sciences Journal*, 33(11), 1712-1717.

Mislevy, P., Boote, K. J., & Martin, F. G. (1989). *Soybean response to gibberellic acid treatments*. *Journal of Plant Growth Regulation*, 8(1), 11-18.

Munda, B. D. S., Singh, R. R., & Maurya, K. R. (2000). Effect of plant growth regulators on quality of seed of Okra (*Abelmoschus esculentus* L. Moench). *Journal of Applied Biology*, 10(1), 22-25.

Panse, V. G. & Sukhatme, P. V. (1985). Statistical Methods for Agricultural Workers, *ICAR, New Delhi*, pp. 167-174.

Parmar, J. N., Shelar, V. R., Bhalekar, N. B., Swami, S. R., More, S. R., & Bhingarde, M. T. (2023). Seed quality of summer groundnut (*Arachis hypogaea* L.) in response to micronutrients. *The Pharma Innovation Journal*, 12(2), 3022-3026.

Patil D. R., & Patel, M. N. (2010). Effect of seed treatment with GA<sub>3</sub> and NAA on growth and yield of okra cv. GO-2. *Asian Journal of Horticulture*, 5(2), 269-272.

Patil, C. N., Mohorkar, V. K., Dod, V. N., Peshattiwari, P. D., Kayande, N. V. & Gomase, D. G. (2008). Effect of seed treatment with gibberellic acid and maleic hydrazide on growth, seed yield and quality of okra cv. Parbhani kranti. *Asian Journal of Horticulture*, 3(1), 74-78.

Patil, S. B. (2005). *Standardization of hybrid seed production techniques in brinjal (Solanum melongena L.)* (M.Sc.(Agri.) Thesis). University of Agricultural Sciences, Dharwad, Karnataka, India.

Ravat, A. K., & Makani, N. (2015). Influence of plant growth regulators on growth, seed yield and seed quality in okra (*Abelmoschus esculentus* L. Moench) cv. GAO-5 under middle Gujarat condition. *International Journal of Agricultural Sciences*, 11(1), 151-157.

Sanodiya, K., Pandey, G., Kacholli, P., & Dubey, A. K. (2017). Effect of growth regulator on growth, yield and seed quality parameters of okra (*Abelmoschus esculentus* L.): cv. Utkal Gaurav. *International Journal of Current Microbiology and Applied Sciences*, 6(10), 3551-3556.

Sayed, A., & Khan, H. (2000). Effect of pre sowing seed treatment on yield of garden pea. *Allahabad Farmer*, 45(3), 27-30.

Shahid, M. R., Amjad, M., Ziaf, K., Jahangir, M. M., Ahmad, S., Iqbal, Q., & Nawaz, A. (2013). Growth, yield and seed production of okra as influenced by different growth regulators. *Pakistan Journal of Agricultural Sciences*, 50(3), 387-392.

Sharma, S. J., & Lashkari, C. O. (2009). Response of gibberellic acid and cycocel on growth and yield of cluster bean (*Cyamopsis tetragonoloba* L.) cv. 'Pusa Navbahar'. *Asian Journal of Horticulture*, 4(1), 89-90.

Singh R. K. & Mahesh Kumar. (2005). Response of summer season okra to plant growth regulators and foliar application of nitrogen. *Haryana Journal of Horticultural Sciences*, 34(1-2), 187-188.

Singh, B. K., Kumar, V., Singh, A. K. & Rai, V. K. (2001). Role of NAA on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill). *Environment Ecology*, 27(3), 1091- 1093.

Singh, D. K. & Lal, G. (1995). Effect of plant growth regulators on the fruit set, yield and quality of chilli (*Capsicum annuum* L.) cultivars. *Advances of Horticulture and Forestry*, 4, 133- 141.

Tiwari, K. N., Mal, P. K., Singh, R. M., & Chattopadhyay, A. (1998). Response of okra (*Abelmoschus esculentus* (L.) Moench.) to drip irrigation under mulch and non-mulch conditions. *Agricultural Water Management*, 38(2), 91-102.

Wareing, P. F., & Phillips, I. D. J. (1978). *The control of growth and differentiation in plants* (2nd ed.). Pergamon Press.