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Effect of plant growth regulators on growth and yield of okra [*Abelmoschus esculentus* (L.) Moench]

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Abstract
A field experiment was conducted at Horticulture cum Instructional Farm, Collage of Agriculture, Indira Gandhi Krishi Vishwavidhyalaya, Raipur (C.G.). The experiment was carried out with Randomized Block Design with nine treatments were replicated three times. At the foliar application of different concentration of GA_3, IAA, Triacontanol and Salisylic Acid, all growth and yield parameters were significantly higher as compared to control. The result showed that plant height was significantly higher (88.77cm) with T_2 (GA_3 - 50ppm). Out of nine treatments, number of leaves per plant (53.44), number of branches per plant (4.40), days to first flowering (34.67), days to first harvesting (40.93), length of reproductive phase (49.33), fruit picking period (43.06), number of fruit per plant (17.33), length of fruit (15.67 cm), percentage fruit set (96.00 %), average weight per fruit (22.20), average fruit weight per plant (407.55g) and yield (214.09 q/ha) was significantly higher with T_4 (IAA – 200ppm). It is concluded that the foliar application of IAA – 200ppm were more positively influenced the vegetative growth and yield of okra.

Keywords: Okra, plant growth regulators, GA_3, IAA, triacontanol, salicylic acid

Introduction

Okra is one of the important vegetable crop of India and Chhattisgarh. Okra (*Abelmoschus esculentus* (L.) Moench) is an annual vegetable crop of Malvaceae family. The centre of origin is tropical and sub-tropical region of the world. It grows quickly, tall, vigorous and bear a large number of fruits, which contributes to the higher yield per unit area. Its adaptability to a wide range of growing condition makes it popular among vegetable growers.

Plant growth regulators are now a days becomes an important contributor which influence the plant physiology and yield. It may applied at different stages. It stimulates or retards natural growth from germination to senescence (Das and Das, 1995) [3]. The response of growth regulators depends upon the amount of particular compound absorbed by the plant and ability of the plant to respond to the stimulus of the chemical applied (Dhage *et al*., 2011) [6]. It is however, believed that plant growth chemicals involve in cell enzymatic activities as a fundamental plant physiological process (Dhage *et al*., 2011) [6]. Generally, it improves plant growth by increases in longitudinal area, number of branches, early flower initiation, fruit set, fruit quality and subsequently contributes towards higher production (Maity *et al*., 2016) [10]. These can improve the physiological efficiency of plants including photosynthetic capacity and effective partitioning of assimilates (Solaimalai *et al*., 2001) [17]. The use of plant growth regulators has gained a separate field of study besides varietal, manurial and cultural methods for vegetable crop production.

Various PGR's were found effective in okra productivity like Gibberellins, IAA, Triacontanol and Salicylic acid etc. GA_3 is a natural plant hormone. GA_3 has many effects on plant growth such as enhance stem and internodes elongation, enzyme production during germination and fruit setting and growth. Indole acetic acid (IAA) is the most common, naturally-occurring, plant hormone of the auxin class. IAA helps in production of longer roots with increased quantity of root laterals and root hairs which are involved in nutrient uptake. It also stimulates cell elongation, inhibit or delay abscission of leaves, induce flowering and fruiting. Triacontanol is a natural plant growth regulator found in epicuticular waxes. It improves growth, yield, photosynthesis, protein synthesis, uptake of water and nutrients, nitrogen-fixation, enzymes activities.

Salicylic acid is a plant growth regulator that increases plant bioproductivity. In horticultural species, the effect reported is the increase of yield without affecting the quality of the fruits. Application of such plant growth regulators in okra their effect as increases in plant height, shoot length, fruit length, fruit diameter, fruit weight, number of leaves, number of flowers, number of fruits per plant, number of seeds per fruit, total fruit yield, fresh and dry weight of plant (Singh *et al.*, 2012; Davies, 1995; Karssen *et al.*, 1989; Meena *et al*., 2017; Usha *et al.*, 2013; Datta and Basu, 2010; Zhao, 2010; Marie *et al*., 2007; Khandaker *et al*., 2018; Ries *et al*., 1978; Acharya, 2004; Larque and Martin, 2007; Pankaj and Sharma, 2003) [16, 5, 7, 12, 18, 19, 11, 8, 14, 1, 9, 13]. Okra grower sometime suffers from recurring economic loss due to poor plant vigour, low fruit setting and uneconomical fruit quality and yield. The appropriate concentrations of plant growth regulators have great potential for plant growth and yield enhancement.

Material and Methods

The present investigation entitled "effect of plant growth regulators on growth and yield of okra [*Abelmoschus esculentus* (L.) Moench]" was carried out during the year 2018-19 at Horticulture cum Instructional Farm, Collage of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.).

The experiment with Randomized Block Design has been replicated three times with nine treatments. The field was divided into 27 experimental units of 3.6 m x 3.0 m with 60 cm irrigation channel in between two units. The allotment of treatments to various plot done by random method. Treatment consist of various levels of GA_3 (25 and 50ppm), IAA (100 and 200ppm), Triacontanol (1000 and 2000ppm) and Salicylic Acid (1.0 and 1.5 µM) along with control. The treatments consist of nine treatment viz., T_1 – GA3 (25ppm), T2 – GA3 (50ppm), T3 – IAA (100ppm), T4 – IAA (200ppm), T5 – Triacontanol (1000ppm), T6 – Triacontanol (2000ppm), T7 – Salicylic Acid (1.0 µM), T8 – Salicylic Acid (1.5 µM) and T9 – Plain water. The different concentration of plant growth regulators were foliar application at 20 and 40 days after sowing. The foliar spraying was carried out with the help of hand sprayer on both side of plant leaves were completely wet with solution of PGR's.

Result and Discussion

Plant heights

Plant heights were recorded at 30, 45 and 60 days after sowing that under different treatments is presented in Table 1. The statistical analyzed data revealed that foliar application of plant growth regulators were significantly influenced plant height.

At 30 DAS significantly maximum plant height was recorded 39.77 cm in T_2 (GA_3 - 50 ppm) followed by 39.63 cm in T_1 (GA_3 - 25 ppm) and 36.74 cm in T_4 (IAA - 200 ppm). At 45 DAS significantly maximum plant height was recorded 71.14 cm in T_2 (GA_3 - 50 ppm) followed by 68.67cm in T_1 (GA_3 - 25 ppm) and 67.44 cm in T_4 (IAA - 200 ppm). At 60 DAS significantly maximum plant height was recorded 88.77 cm in T_2 (GA_3 - 50 ppm) followed by 86.37 cm in T_1 (GA_3 - 25 ppm) and 85.95 cm in T_4 (IAA - 200 ppm). GA_3 could be involved in many aspects of plant growth and development, such as cell enlargement, internodes elongation, stimulated RNA and protein synthesis and thereby leading to enhanced growth and development Maity *et al.* (2016) [10]. The results obtained in this investigation for plant height were also similar to the findings of Chowdhury *et al.* (2014) [2] and Dhage *et al.* (2011) [6].

Number of leaves per plant

Numbers of leaves per plant were recorded at 30, 45 and 60 days after sowing under different treatments are presented in Table 1. The data revealed that application of various levels of plant growth regulators were significantly influenced the number of leaves per plant.

At 30 DAS number leaves per plant was recorded significantly highest 14.77 in T_4 (IAA - 200 ppm) followed by 13.46 in T_2 (GA_3 - 50 ppm) and 12.33 in T_3 (IAA - 100 ppm). At 45 DAS number leaves per plant was recorded significantly highest 35.42 in T_4 (IAA - 200 ppm) followed by 32.72 in T_3 (IAA - 100 ppm) and 29.16 in T_2 (GA_3 - 50 ppm). At 60 DAS number leaves per plant was recorded significantly highest 53.44 in T_4 (IAA - 200 ppm) followed by 52.12 in T_3 (IAA - 100 ppm) and 51.43 in T_2 (GA_3 - 50 ppm). The results obtained in this investigation for number of leaves per plant were also similar to the findings of Khandaker *et al*. (2018) [8] and Shittu and Karim (2014).

Number of branches per plant

Number of branches per plant were recorded under different treatments and presented in Table 1. The data revealed that various levels of plant growth regulators significantly influenced number of branches per plant. The maximum number of branches per plant recorded in 4.40 in T_4 (IAA - 200ppm) followed by 4.27 in T_3 (IAA - 100 ppm) and 3.97 in T_2 (GA_3 - 50 ppm). Application of IAA increases number of branches per plant in present investigation. Similar findings were also reported by Dhage *et al.* (2011) [6] and Khandaker *et al*. (2018) [8].

Node to first flowering

Node bear first flower was influenced by application of plant growth regulators presented in Table 1. The statistical data can revealed that foliar application of different growth regulator had significant effect on initiation of first flower bud from the node. Among all the treatments lower number of nodes for bearing first flower bud was observed from node 4.93 in T_3 (IAA - 100 ppm) followed by (5.10) in T_4 (IAA - 200 ppm) and (5.50) in T_2 (GA_3 - 50 ppm).

Days to first flowering

Days taken for initiation of first flower significantly influenced by application of different plant growth regulators showed in Table 2. It was observed that the days to first flowering was significantly differ by application of different plant growth regulators. Among the treatments with the application of IAA - 200 ppm (T_4) recorded significantly minimum days to first flowering of 34.67 days followed by 34.93 days in T_3 (IAA - 100 ppm) and 35.47 days in T_6 (Triacontanol - 2000 ppm).

Length of reproductive phase

The length of reproductive phase (from days to first flowering to final harvesting) as affected by application of plant growth regulators are shown in Table 2. The statistical data revealed that the varying levels of plant growth regulators were significantly influenced the length of reproductive phase. The longest length of reproductive phase was recorded 49.33 days in T_4 (IAA - 200 ppm) followed by 48.66 days in T_3 (IAA - 100ppm), 47.54 days in T_8 (Salisylic Acid - 1.5 µM) and 46.77 days in T_7 (Salisylic Acid - 1.0 µM).

Days to first harvest

The days to first harvest of fruit as affected by application different plant growth regulators is presented in Table 2. The effect of foliar application of plant growth regulators on this parameter were differ significantly. Significantly minimum days taken for first harvesting was recorded of 40.93 days in T_4 (IAA - 200 ppm) followed by 41.80 days in T_3 (IAA - 100 ppm) and 43.07days in T_5 (Triacontanol - 1000 ppm).

Percentage fruit set

The percentage fruit set per plant recorded under different application of plant growth regulators are shown in Table 2. It is revealed from the statistical data that there were significant difference for percentage fruit set. Significantly highest percentage fruit set per plant was recorded 96.00% in T_4 (IAA - 200 ppm) followed by 93.67% in T_3 (IAA - 100 ppm) and 93.07% in T_2 (GA_3 - 50 ppm).

9. Fruit picking period

The fruit picking period as affected by foliar application of plant growth regulators are shown in Table 2. It is revealed from the data that there were significance difference between treatments for fruit picking period under application of different plant growth regulators. It was observed that the significantly longest fruit picking period recorded was 43.06 days in T_4 (IAA - 200 ppm) followed by 41.80 days in T_3 (IAA - 100 ppm) and 40.54 days in T_8 (Salisylic Acid - 1.5 µM).

Days to 100% fruit set

The effect of foliar application of different plant growth regulators on days to 100% fruit set is presented in Table 2. The data revealed that various levels of plant growth regulators were significantly influenced days to 100% fruit set. Significantly minimum days taken for 100% fruit set was recorded 63.13 days in T_1 (GA_3 - 25 ppm) followed by 63.73 days in T_2 (GA_3 - 50 ppm) and 65.20 days in T_8 (Salisylic Acid - 1.5 µM).

Number of fruits per plant

Number of fruits per plant as affected by foliar application of different plant growth regulators are presented in table 2. The statistical data revealed that the number of fruits per plant were significantly difference under application of different plant growth regulators. Significantly higher number of fruits per plant was recorded 17.33 in T_4 (IAA - 200 ppm) followed by 16.55 in T_3 (IAA - 100 ppm) and 15.89 in T_2 (GA_3 - 50 ppm). The application of IAA increases height of the plant, and number of branches resulting in more fruit setting per plant. A similar finding was observed by Khandaker *et al*. (2018) [8].

Average fruit length

The fruit length as affected by foliar application of different plant growth regulators is shown in Table 4.3. It is revealed from the data that there were significance difference among all the treatments for fruit length under application of different plant growth regulators. Significantly higher average fruit length was recorded 15.67 cm in T_4 (IAA - 200 ppm) followed by 15.28 cm in T_3 (IAA - 100 ppm) and 14.30 cm in T_2 (GA_3 - 50 ppm). The results obtained in this investigation for average fruit length are similar to the findings of Shittu and Karim (2014).

Average fruit weight

The fruit weight as affected by foliar application of different plant growth regulators are presented in Table 3. The statistical data revealed that the average weights per fruit were significantly influenced by application of different plant growth regulators. The higher average weight per fruit was 22.20 g in T_4 (IAA - 200 ppm) followed by 21.90 g in T_3 (IAA - 100 ppm) and 21.30 g in T_2 (GA_3 - 50 ppm). A similar finding was reported by Khandaker *et al*. (2018) [8] and Shittu and Karim (2014).

Average fruit diameter

The average fruit diameter as affected by foliar application of different plant growth regulators are shown in Table 3. The data revealed that the average fruit diameters were significantly influenced by application of different plant growth regulators. Significantly maximum fruit diameter was recorded 5.49 cm in T_8 (Salisylic Acid - 1.5 µM) followed by 5.23 cm in T_5 (Triacontanol - 1000 ppm) and 5.13 cm in T_2 (GA_3 - 50 ppm).

Average fruit weight per plant (g)

The average fruit weight per plant as affected by foliar application of different plant growth regulators are presented in Table 3. The data revealed that the average fruit weight per plant were significantly influenced by various levels of plant growth regulators application. Significantly highest fruit weight per plant was recorded 407.55 g in T_4 (IAA - 200 ppm) followed by 385.23 g in T_3 (IAA - 100 ppm) and 358.31 g in T_2 (GA_3 - 50 ppm).

Average fruit weight per plot (kg)

The average fruit weight per plot as affected by foliar application of different plant growth regulators are shown in Table 3. The data revealed that the average fruit weight per plot were significantly influenced by application of various levels of plant growth regulators. Significantly highest fruit weight per plot was recorded 23.12 kg in T_4 (IAA - 200 ppm) followed by 21.80 kg in T_3 (IAA - 100 ppm) and 20.22 kg in T_2 (GA_3 - 50 ppm).

Total yield (q/ha)

Total yield (q/ha) of different treatments as influenced by application of various plant growth regulators are presented in Table 3. It is revealed from the data that there were significance difference for yield (q/ha) by application of plant growth regulators. It was observed that the significantly highest yield of 214.09 q/ha was recorded in T_4 (IAA - 200 ppm) followed by 201.85 q/ha in T_3 (IAA - 100 ppm) and 187.23 q/ha in T_2 (GA_3 - 50 ppm)

Table 1: Effect of PGR's on Plant height, Number of leaves per plant, Number of branches per plant and Node to first flowering of okra

Treatments	Plant height (cm)			Number of leaves per plant			Number of branches per plant	Node to first flowering
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS		
T1 - GA3 25 ppm	39.63	68.67	86.37	11.24	27.50	50.90	3.19	5.75
T2 - GA3 50 ppm	39.77	71.14	88.77	13.46	29.16	51.43	3.97	5.50
T3 - IAA 100 ppm	36.14	65.26	83.79	12.33	32.72	52.12	4.27	4.93
T4 - IAA 200 ppm	36.74	67.44	85.95	14.77	35.42	53.44	4.40	5.10

T5 - Triacontanol 1000 ppm	33.50	64.51	82.11	10.10	25.27	47.33	2.94	6.25
T6 - Triacontanol 2000 ppm	35.54	65.09	83.10	10.56	26.30	49.70	3.11	6.03
T7 - Salicylic acid 1.0 µM	30.83	62.53	78.80	10.36	24.70	48.86	2.85	6.10
T8 - Salicylic acid 1.5 µM	30.55	61.30	76.07	10.28	22.69	49.16	2.90	6.27
T9 - Plain Water	28.41	59.50	75.17	9.93	21.39	47.11	2.67	6.50
C.D.	1.72	2.81	3.04	1.31	2.66	2.97	1.11	0.96

Table 2: Effect of PGR's on Days to first flowering, Length of reproductive phase, Days to first harvesting, Percentage fruit set, Fruit picking period, Days to 100% fruit set and Number of fruit per plant of okra

Treatments	Days to first flowering	Length of reproductive phase	Days to first harvesting	Percentage fruit set	Fruit picking period	Days To 100% Fruit Set	Number of fruit per plant
T1 - GA3 25 ppm	37.47	45.77	43.80	92.13	40.00	63.13	15.28
T2 - GA3 50 ppm	40.47	45.67	46.27	93.07	39.87	63.73	15.89
T3 - IAA 100 ppm	34.93	48.66	41.80	93.67	41.80	66.00	16.55
T4 - IAA 200 ppm	34.67	49.33	40.93	96.00	43.06	66.20	17.33
T5 - Triacontanol 1000 ppm	36.40	46.67	43.07	89.80	40.00	66.60	14.82
T6 - Triacontanol 2000 ppm	35.47	46.33	43.33	91.00	38.46	68.20	15.33
T7 - Salicylic acid 1.0 µM	36.13	46.77	44.13	86.80	38.77	67.07	14.60
T8 - Salicylic acid 1.5 µM	38.20	47.54	45.20	90.93	40.54	65.20	14.78
T9 - Plain Water	37.13	43.33	44.67	86.67	35.80	69.87	13.02
C.D.	2.62	2.77	2.48	4.77	3.54	3.13	2.27

Table 3: Effect of PGR's on Length of fruit, Avg. weight per fruit, Fruit diameter, Avg. fruit weight per plant, Avg. yield per plot and Total yield (q/ha) of okra

Treatments	Length of fruit (cm)	Avg. weight per fruit (g)	Fruit diameter (cm)	Avg. fruit weight per plant (g)	Avg. yield per plot (kg)	Total yield (q/ha)
T1 - GA3 25 ppm	13.99	20.60	4.71	334.70	18.85	174.50
T2 - GA3 50 ppm	14.30	21.30	5.13	358.31	20.22	187.23
T3 - IAA 100 ppm	15.28	21.90	4.60	385.23	21.80	201.85
T4 - IAA 200 ppm	15.67	22.20	4.86	407.55	23.12	214.09
T5 - Triacontanol 1000 ppm	13.20	20.00	5.23	315.89	17.75	164.38
T6 - Triacontanol 2000 ppm	13.60	19.60	4.66	313.09	17.99	166.59
T7 - Salicylic acid 1.0 µM	12.69	17.40	4.76	271.80	15.26	141.34
T8 - Salicylic acid 1.5 µM	12.74	18.80	5.49	297.57	16.74	155.03
T9 - Plain Water	10.56	17.10	3.98	246.00	13.42	124.26
C.D.	2.07	2.11	0.75	56.95	3.41	31.64

Conclusion

The results obtained during the present investigation reveals that the effective concentration of undertaken plant growth regulators can be used to improve the growth and yield parameters of okra especially treatment with foliar application of IAA. So, it can be concluded that foliar application of IAA - 200 ppm and IAA - 100 ppm was most effective in enhancing the yield of okra. The highest yield (q/ha) of 214.09 q/ha was recorded in T4 (IAA - 200 ppm).

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References

1. Acharya UK. Effect of plant growth regulators on spring-summer season okra productivity under Chitwan condition of Nepal. M.Sc. (Hort.). Thesis submitted to Tribhuvan University, Institute of Agriculture and Animal Science, Rampur, Chitwan, Nepal, 2004.
2. Chowdhury MS, Hasan Z, Kabir K, Shah Jahan M, Kabir MH. Response of Okra (*Abelmoschus esculentus* L.) to Growth Regulators and Organic Manures. A Sci. J. Krishi Found. 2014; 12(2):56-63.
3. Das BC, Das TK. Efficacy of GA3, NAA and ethrel on seed expression in pumpkin (*Cucurbita moschata* Poir.) cv. guamala local. Orissa Journal of Horticulture. 1995; 23(1,2):87-91.
4. Datta C, Basu P. Indole acetic acid production by a Rhizobium species fromroot nodules of a leguminous shrub *Cajanus cajan*, J. Microbio. Res. 2000; 155:123-127.
5. Davies PJ. Plant Hormones, Physiology, Biochemistry, and Molecular Biology. Kluwer Academic Publishers, Dordrecht, 1995, 188-205.
6. Dhage AA, Nagre PK, Bhangre KK, Pappu AK. Effect of plant growth regulators on growth and yield parameters of okra. Asian J. Hort. 2011; 6(1):170-172.
7. Karssen CM, Zagorski S, Kepczynski J, Groot SPC. Key role for endogenous gibberellins in the control of seed germination. Ann. Bot. 1989; 63:71-80.
8. Khandaker MM, Azam HM, Rosnah J, Tahir D, Nashriyah M. The effects of application of exogenous IAA and GA3 on the physiological activities and quality of *Abelmoschus esculentus* (Okra) *var*. Singa 979. Pertanika J Trop. Agric. Sci. 2018; 41(1):209-224.
9. Larque-Saavedra A, Martin-Mex R. Effect of salicylic acid on the bio-productivity of plants. In: Hayat, S., Ahmad, A. (Eds). Salicylic Acid. A Plant Hormone. Springer Publishers. Dordrecht. The Netherlands, 2007, 15-23.
10. Maity U, Dutta P, Layek B. Effect of Plant Growth Regulators on Growth, Yield and Quality of Okra [*Abelmoschus esculentus* (L.) Moench]. J. Agroeco. Nat. Reso. Manage. 2016; 3(3):251-253.
11. Marie AI, Ihsan A, Salih SH. Effect of sowing date, topping and some growth regulators on growth, pod and

seeds yield of okra (*Abelmoschus esculentus* L.). Afr. Crop Sci. Soc. 2007; 8:473-478.

12. Meena RK, Dhaka RS, Meena NK, Meena S. Effect of foliar application of NAA and GA3 on growth and yield of okra [*Abelmoschus esculentus* (L.) Moench] cv. Arka Anamika. Int. J Pure App. Biosci. 2017; 5(2):1057-1062.
13. Pankaj and Sharma HK. Relative sensitivity of *Meloidogyne incognita* and *Rotylenchulus reniformis* to salicylic acid on okra. Ind. J Nematol. 2003; 33(2):120-123.
14. Ries SK, Richman TL, Wert VF. Growth and yield of crops treated with triacontanol. J American Soc. Hort. Sci. 1978; 103:361-364.
15. Sayyari M, Ghavami M, Ghanbari F, Kordi S. Assessment of salicylic acid impacts on growth rate and some physiological parameters of lettuce plants under drought stress conditions. Intl. J Agri. Crop Sci. 2013; 5(17):1951-1957.
16. Singh J, Singh BK, Singh AK, Panwar M, Singh B. Effect of foliar spray of GA3 and IBA on plant characters and yield of okra [*Abelmoschus esculentus* (L.) Moench]. Envi. and Eco. 2012; 30(4):1351-1353.
17. Solaimalai A, Sivakumar C, Anbumani S, Suresh T, Arumugam K. Role of plant growth regulators in rice production. Agricultural Reviews. 2001; 22(1):33-40.
18. Usha MR, Jyothi KU, Kumar MK. Study on the effect of growth regulators and micronutrients on yield components and nutrient uptake of okra (*Abelmoschus esculentus* L. Moench) cv. Arka Anamika. Intl. J Agric. Env. Biotech. 2013; 6(1):117-119.
19. Zhao Y. Auxin biosynthesis and its role in plant development, J Ann. Rev. Pl. Bio. 2010; 61:49-64.