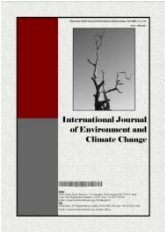

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Effect of Plant Growth Regulators on Vegetative Growth and Flowering of Okra [*Abelmoschus esculentus* (L.) Moench.]

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

A field experiment was carried out to evaluate the effects of BAP, GA_3, and NAA on flowering and growth attributes of okra (*Abelmoschus esculentus* L. Moench) cv. Arka Anamika at the Instructional farm, Agricultural Research Station, Jodhpur Rajasthan during *Kharif*, 2020. Three treatments each of BAP@ T_1-25, T_2-50, andT_3-75(ppm), GA_3 @T_4-25, T_5-50, andT_6-75 (ppm), and NAA @ T_7-25, T_8-50, and T_9-75 (ppm)were used besides controls i.e. T_0 with water spray. These three growth regulators were found to enhance early flowering. Other parameters of growth were also found to be increased by treatments with plant growth regulators in okra. Among the growth parameters, the highest inter-nodal length (6.68 cm), plant height (156.4 cm), and leaf area index (3.1) aswas recorded with GA_3 @ 75 ppm treatment, whereas maximum stem diameter (43.88 mm), number of branches per plant (5.10) and number of nodes on the main stem (25.05) were recorded with NAA @ 75 ppm. The minimum number of days to the appearance of first flowering (35.50), 50% flowering (41.80), and node on which the first flower appeared (3.82) were also recorded with NAA @ 75 ppm.

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Keywords: BAP; GA3; NAA; okra; vegetative; growth; and flowering.

1. INTRODUCTION

Wheat Okra [*Abelmoschus esculentus* (L.) Moench] popularly known as lady's finger, is believed to be a native of Ethiopia. It is an herbaceous plant belongs to family Malvacae. Okra is growing in warm season and also in rainy season of both tropical and subtropical areas of the world. It is considerably grown in India for its tender non-fibrous nutritive fruit. It is prevalent among the farmers due to its easy growing and has wide range adaptability. It has indeterminate growth and flowering habit depending on the nutrient supply and environmental factors [1]. In countries like West Africa, other parts of okra plant like flowers, leaves and buds are also consumed. Besides being a vegetable, it also has medicinal and industrial importance. The powder of okra roots and stems is used in purification of sugarcane juice, to make gur or jiggery [2]. It has good nutritional value. India is the largest producer of okra. The finding of plant growth regulators has been believed as a revolution in the history of agriculture as it has paid attention to the concept of controlling plant growth as an important factor for improving flowering and growth in plants. Plant growth regulators are designated as new generation agrochemicals having the potential of altering the phenotype of the plant by affecting the physiological efficiency of plants including growth, photosynthesis, and accretion of assimilates. They stimulate or retard the natural growth regulatory systems from germination to senescence of plants [3]. Ascribed to their significant role in numerous physiological phenomena, plant growth regulators involve the activities of the cell and the enzyme concerned in the physiological process. Plant growth regulators promote growth along the longitudinal area, stem diameter, number of nodes, increase the number of branches, and early flower initiation when applied at various concentrations.

Among the several growth substances, BAP (6 amino aminopurine benzyl amino purine), gibberellic acid (GA_3), and NAA are found very promising and these are being used in fruit and vegetable crops. Gibberellin causes cell lengthening and the formation of follicles which resulted in increasing the plant height.GA3 also enhances flowering in many vegetables. NAA and BAP reduce the internodal length and also induce the formation of lateral branches. NAA application has been reported to control flowering, improve growth, and increase productivity (Bhai and Singh, 1998). However, there is a dearth of literature available on the effect of plant growth regulators on the flowering and growth of okra in western arid Rajasthan. So, the present experiment was plotted to interpret the effect of BAP, $GA_{3,}$ and NAA on flowering and vegetative growth parameters of okra and to find out their optimum concentration. Keeping in view the above facts, a field investigation entitled planned during, *Kharif* season 2020 at the Instructional farm, Agricultural Research Station, Jodhpur Rajasthan.

2. MATERIALS AND METHODS

This experiment was carried out at the Instructional farm, Agricultural Research Station, Jodhpur Rajasthan during *Kharif,* 2020. The experiment was laid out in R.B.D. with three replications having ten treatments including controls ($T_0$with water spray). Three treatments each of BAP @ T_1-25, T_2-50, andT_3-75 (ppm), GA_3 @T_4-25, T_5-50, andT_6-75 (ppm) and NAA @ T_7-25, T_8-50, and T_9-75 (ppm) were used besides controls i.e. T_0. Seeds of okra cv. 'Arka Anamika were sown at the spacing of 60 cm x 45 cm with a net plot size of 3.0 m × 4.5 m. The crop was fertilized with2.5 kg/m^2 FYM along with NPK@ 120:60:50 kg/ha. The observations of various vegetative growth and flowering parameters were recorded on five randomly selected and labeled plants in each treatment plot. The data on growth parameters like Internodal length (cm), plant height (cm) Number of nodes on the main stem, Number of branches per plant, leaf area index, Stem diameter (mm), and flowering parameters like Days to the appearance of the first flower, Node on which the first flower appeared, Days have took to 50% flowering were recorded. The observed data for different studied characters were statistically analyzed using the Analysis of Variance technique for Randomized Block Design (RBD), as defined by Fisher [4] for interpretation of results and comparison of the treatments. Based on based on based onthe null hypothesis, the treatment variations were investigated using the F-test at a 5% level of significance. In each case, the acceptable standard error of the mean (S.E. m±) was determined and the Critical Difference (C.D.) at a 5% level of likelihood was calculated to compare the treatment means, where the treatment results were significant under the F-test.

3. RESULTS AND DISCUSSION

In the present investigation, the effect of growth regulators i.e. BAP, GA3, and NAA on several growths and flowering attributes presented in Table-1 and 2 revealed that foliar application of GA3 significantly increased internodal length, plant height, and leaf area index as compared to control treatment, BAP and NAA. NAA and BAP growth regulators significantly decreased the days to first flower appearance, 50% flowering, and the mean nodal position at which 1^{st} flower appeared as compared to control treatment T_0 with water spray (Table-1). It is also found that the number of nodes per plant, number of branches per plant at harvest, and stem diameter have been significantly increased with the application of both plant growth regulators over control. The maximum internodal length (6.68 cm) was recorded in GA_3 @ 75 ppm (T_6), whereas the minimum internodal length (4.90 cm) was recorded in the control (T_0). The maximum number of nodes per plant (25.05) was recorded in NAA @ 75 ppm (T_9), whereas the minimum number of nodes per plant (22.10) was in the control (T_0). The maximum plant height (156.4 cm) and highest leaf area index (3.11)were recorded in GA_3 @ 75 ppm (T_6), whereas the minimum plant height (114.30 cm) and lowest leaf area index (2.29) were observed in control (T_0). The highest number of branches per plant (5.10) and thickest stem diameter (43.88 mm)were recorded in NAA @ 75 ppm(T_9), while the minimum number of branches per plant (3.80) and stem diameter (41.6 mm)were recorded in control (T_0).

It could be owing to the role of GA_3 in various physiological aspects of plant growth and development, including cell elongation and expansion leading to internodal elongation along with accelerated RNA and protein synthesis, all of which might have led to increased internodal length. The longer internodes noted with the application of GA_3 as compared to NAA and BAP could be ascribed to the more profound effect of GA_3 on cell elongation leading to higher elongation of internodes as compared to NAA and BAP. The research outcomes comply comply comply with earlier findings reported by [5,6]. The increase in plant height due to GA_3 could be due to its effect on stem elongation by rapid cell elongation and multiplication in the sub-apical meristem. The rapid longitudinal growth might be the result of both the greater number of cells formed and the elongation of individual cells. The results are corroborated by the earlier findings reported by [7,8]. The comparatively higher leaf area index recorded with GA_3 foliar spraying could be due to its ability to promote plant growth and development as a result of higher photosynthetic rate and efficient use of photosynthates The results are supported by Baraskar *et al.*,[5].NAA is a potent auxin known to stimulate cell division, enhance photosynthetic activity, and accumulates of metabolites in the cell which might have reflected in more augmentation of several s nodes on the main stem as compared to GA_3 and BAP [9,10]. NAA is a well-known auxin that increases cell division and cell enlargement which might have increased the number of nodes and number of branches on the main stem and improved mobilization of photosynthates in the plant leading to the production of thicker stems. Similar results have been reported by Nisar *et al.,[*11]. Early appearance flowers on the plant might be ascribed to increased accumulation of photosynthates and their enhanced mobilization towards the sink with the application of NAA. This could have helped in the early transformation from the vegetative phase to the reproductive phase and the induction of early flower bud initiation. The results are supported by the earlier findings reported by [12,13]. The comparatively more influence of NAA as compared to BAP and GA_3 on early 50% flowering could be ascribed to its more efficacy in the regulation of flowering. The results lend support from the findings of [14,13]. The most profound effect of NAA as compared to other growth regulators in the development of flowers at lower nodes could be ascribed to comparatively enhanced flow of metabolites towards flower buds for initiation of flowering. Similar results were also reported by [15,16].

Table: 1 Effect of Plant Growth Regulators on Vegetative Growth and Flowering of Okra

Treatment	Internodal length (cm)	Number of nodes on main stem	Plant height (cm)	Stem diameter (mm)	Number of branches per plant	Leaf area index	Days to appearance of first flower	Days to 50 % flowering	Node on which first flower appeared
Control (T_0)	4.90	22.10	114.3	41.60	3.80	2.29	44.20	48.77	6.60
BAP @ 25 ppm (T_1)	5.14	22.86	120.6	42.14	3.92	2.34	44.10	47.40	6.40
BAP @ 50 ppm (T_2)	5.60	23.60	129.4	42.68	4.24	2.45	43.30	46.88	6.11
BAP @ 75 ppm (T_3)	5.98	24.83	138.2	43.34	4.75	2.62	42.60	45.60	5.88
GA_3 @ 25 ppm (T_4)	5.42	22.44	123.6	41.90	3.90	2.41	43.50	46.80	6.10
GA_3 @ 50 ppm (T_5)	5.96	23.68	140.5	43.18	4.16	2.81	42.80	45.70	5.77
GA_3 @ 75 ppm (T_6)	6.68	23.19	156.4	42.40	3.98	3.11	41.52	44.90	5.10
NAA @ 25 ppm (T_7)	5.28	23.05	121.9	42.20	3.97	2.39	43.10	45.80	5.80
NAA @ 50 ppm (T_8)	5.88	24.31	134.6	43.10	4.42	2.69	41.38	43.28	4.90
NAA @ 75 ppm (T_9)	6.08	25.05	150.2	43.88	5.10	2.97	38.50	41.80	3.82
S.E.m ±	0.30	0.62	8.08	0.37	0.11	0.16	1.09	1.28	0.33
CD (*p=0.05*)	0.89	1.85	24.02	1.10	0.34	0.47	3.25	3.79	0.98

4. CONCLUSION

From the above results, it may be concluded that plant growth regulators i.e. BAP, gibberellic acid, and NAA have a significant effect in increasing the growth and flowering of okra However, gibberellic acid GA_3 significantly increased internodal length, leaf area index, and plant height. It might be due to that GA_3 stimulated RNA and protein synthesis and induced cell enlargement, thereby leading to enhanced growth and development. NAA increased the number of nodes and branches on the main stem, ultimately increasing stem diameter. NAA was also more efficient than BAP and GA_3 to regulate the flowering habit.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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