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Effects of GA_3 and NAA on Growth and Yield of Brinjal (*Solanum melongena* L.) cv. Kashi Sandesh

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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 conducted to find out the Effect of two concentrations of GA_3 and NAA and their combinations on growth and yield of brinjal (*Solanum melongena* L.) cv. Kashi Sandesh. The experiment was laid out in Randomized Block Design with three replications and nine treatments. Higher growth attributing characters *viz.* maximum plant height (71.14 cm), number of leaves per plant (71.65), number of branches (12.77), Days to 50% flowering (43.12) and yield & yield attributing characters, *viz,.* number of fruit per plant (16.17), fruit length (11.66 cm), fruit weight (180.48 g), fruit diameter (9.48 cm), fruit yield (2.91 kg/plant), fruit yield (29.22 kg/plot), fruit yield (383.95 q/ha) were recorded under T_8- NAA + GA_3 (40 ppm + 50 ppm). Similarly, maximum net return (421750.86 Rs/ha) and B:C ratio (2.73) were recorded under T_8- NAA + GA_3 (40 ppm + 50 ppm) followed by treatment T_7- and T_6. T_9- Control was produced poor performance among all the treatments.

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1. INTRODUCTION

One of the most prevalent, well-liked, and important vegetable crops growing in India and other areas of the world is brinjal (*Solanum melongena* L.). In India and other Asian nations including Bangladesh, Pakistan, and the Philippines, the brinjal is widely grown. China, Turkey, Japan, Egypt, Indonesia, Iraq, Italy, Syria, and Spain are major countries that produce brinjal. Indian-origin farmed brinjal has been grown for a very long period. It is one of the most widespread and well-liked vegetable crops in India, except where there are greater altitudes. India produces 83.47 lakh tons of brinjal over an area of 5.02 lakh ha, ranking second only to China as the world's top producer. Orissa, West Bengal, Bihar, and practically all other states cultivate brinjal to the greatest extent. The production of brinjal is governed not only by the inherent genetic yield potential of the cultivars but it is greatly influenced by several environmental factors and cultivation practices.

Brinjal fruits are a reasonable supply of calcium, iron, and vitamins of the 'B' group [1]. Additionally, prized for its therapeutic benefits, brinjal has been linked to the treatment of intestinal worms, rheumatoid arthritis, leucorrhea, allergy-induced cough, and liver disease [2]. It offers nutritious fiber, vitamins, minerals, carbohydrates, and protein, just as other vegetables. Since brinjal is a warm-season crop, it needs a lengthy warm growth season. It is quite vulnerable to freezing. For effective production, a daily mean temperature of 13–21 ^{0}C is ideal. When the temperature drops below 17^{o}C, the crop's growth is negatively impacted. It can be effectively cultivated both during the rainy and summer seasons, and it can be grown up to 1200 meters above sea level. Plant growth regulators are recognized to have an impact on horticulture crops' increased yields and quality. Recently, the significance of PGRs in raising crop output has come to the attention of the entire world. GA_3 is an important growth regulator that may have many uses to modify the growth, yield and yield contributing characters of plant [3]. Plant growth regulators are used widely to improve plant performance. GA_3 is one of those growth regulators that have positive effect on plant growth through the effect on cell division and elongation [4]. It recorded dipping of brinjal seedling roots in NAA at 0.1 or 0.2 ppm for 24 hours influenced growth and development [5]. The advantage of plant growth regulators like Gibberellic (GA_3), Indole Acetic Acid (IAA), Nephthaline Acetic Acid (NAA), 2-4-Diclorophenoxy Acetic Acid (2,4-D) can be taken to increase the yield of local variety of brinjal.

2. MATERIALS AND METHODS

The field experiment was carried out in the *Rabi* season of 2020–2021 at the research farm of Department of Horticulture at Udai Pratap (Autonomous) College, Varanasi, Uttar Pradesh which is located Eastern region of the state between 25.3550° North latitude and 82.9753° East longitude. This farm has sufficient irrigation facilities accessible. The lowest temperature during the growing season is between 6 and 21.7^{0}C, while the highest temperature during that time is between 17 and 35.1^{0}C. During the growing period, relative humidity ranged from 24 to 94 percent. During the trial, average wind speeds ranged from 1.3 to 6.3 km hr^{-1}. During the testing period, the trail location got a total of 43.2 mm of rain in one wet day, providing favourable conditions for crop development. The experiment consisted of two levels of gibberellic acid (GA_3), two levels of naphthalene acetic acid (NAA) and their combinations was arranged in randomized block design with three replications and nine treatments *viz.* (T_1) - NAA (20 ppm), (T_2) - NAA (40 ppm), (T_3)- GA_3 (25 ppm), (T_4) - GA_3 (50 ppm), (T_5) – NAA + GA_3 (20 ppm + 25 ppm), (T_6) – NAA + GA_3 (20 ppm + 50 ppm), (T_7) - NAA + GA_3 (40 ppm + 25 ppm), (T_8) - NAA + GA_3 (40 ppm + 50 ppm) and (T_9) - Control. Seedling were uprooted from the nursery beds and transplanted in the main plots at a spacing of 70 cm row to row and 60 cm plant to plant. Transplanting was done in the evening hours immediately followed by irrigation for proper establishment of the seedlings. All the recommended package of practices was followed to raise a healthy crop.

The required weight of the PGRs was taken using electronic sensitive balance and solution was prepared by dissolving in 1 mg L^{-1}. The solution was poured into hand-held sprayer and was directly sprayed on the plants three times at 30, 45 and 60 days after transplanting. Spraying was performed early in the morning to avoid rapid drying of the spray solution, due to transpiration. Data were collected from randomly selected five plants in each row. The collected data includes Plant height (cm), No. of leaf/plant,

No. of branches per plant, Days to 50% flowering, No. of fruit per plant, Fruit length (cm), Weight of fruits (g), Fruit diameter (cm), Fruit Yield (Kg/plant), Yield (kg/plot) and Yield (q/ha). Recorded data was analyzed using appropriate method of 'Analysis of Variance (ANOVA)' given by Gomez and Gomez (1984).

3. RESULTS AND DISCUSSIONS

3.1 Effect of Treatments on Growth Attribute of Brinjal

Effect of plant growth regulators on growth attribute of brinjal as showed in Table 1. Significantly tallest plant was found in T_8- NAA + GA_3 (40 ppm + 50 ppm) 41.92, 61.20and 71.14 at 30, 45 and 60 DAT respectively followed by T_7 - NAA + GA_3 (40 ppm + 25 ppm) (36.18) and minimum was found in T_9 - Control (27.18). It might be due to gibberellin can promotes the activity of xyloglucan endotransglycosylase (XET) which cause loosening of cell wall and increase cell permeability [6]. Similar result was also reported by Meena and Dhaka [7]. The no. of leaves per plant increased continuously from 30 to 60 DAT in all the treatments of Kashi Sandesh. At 30 DAT. Higher no. of leaves at 30, 45 and 60 DAT (44.35, 47.12 and 71.65 leaves, respectively) were recorded under treatment (T_8) - NAA + GA_3 (40 ppm + 50 ppm) followed by T_7 - NAA + GA_3 (40 ppm + 25 ppm) and T_6 – NAA + GA_3 (20 ppm + 50 ppm).However, minimum no. of leaves was recorded in treatment (T_9) – Control at 30,45 and 60 DAT. followed by (68.59 and 67.38 leaves) in (T_7) - NAA + GA_3 (40 ppm + 25 ppm) and (T_6) – NAA + GA_3 (20 ppm + 50 ppm), whereas, minimum no. of leaves (41.63 leaves) was recorded in T_9-Control. The green leaf is the site of all physiochemical reactions, and the rise in leaf number was influenced by growth regulators combinations as a result of increased protoplasm content in plants and faster metabolic processes. As a result of the extra nitrogen encouraging vegetative development, the number of green leaves increased. Similar result was also recorded by [8] and [9]. Similarly, higher no. of branches at 30, 45 and 60 DAP (9.49, 10.07 and 12.77 plant^{-1} respectively) was found with T_8 - NAA + GA_3 (40 ppm + 50 ppm) followed by T_7- GA_3 @ 50 ppm and T_6- NAA @ 40 ppm. Whereas, lowest no. of branches was recorded in treatment T_1- NAA (20 ppm) at 30 DAT and at 45 and 60 DAT minimum branches was recorded under T_9- Control. Such effect of PGRs combination on no. of branches was also reported earlier by [10] and [11]. All the treatments were significantly influenced days taken to 50 per cent flowering. The minimum days to 50 per cent flowering (29.66) was obtained in the treatment (T_8) - NAA + GA_3 (40 ppm + 50 ppm) and it was found significantly superior over other treatments followed by (30.54) in (T_7) - NAA + GA_3 (40 ppm + 25 ppm), whereas, maximum days to 50 per cent flowering (43.12) were noted in T9- Control. Because of using the plant growth promoters in the right amount, early flowering comes in the plant [12].

3.2 Effect of Treatments on Yield and Yield Attribute of Brinjal

Increment in growth attributing characters were ultimately reflected in yield attributing characters. Among the treatments, (T_8) - NAA + GA_3 (40 ppm + 50 ppm) recorded significantly higher number of fruits plant^{-1} (16.17) followed (T_7) - NAA + GA_3 (40 ppm + 25 ppm) (15.20 fruits). While, significantly lowest number of fruits plant^{-1} was recorded with T_1-NAA (20 ppm) (8.67). The maximum fruit length (11.66 cm) was recorded in the treatment (T_8) - NAA + GA_3 (40 ppm + 50 ppm) followed by (11.29 and 10.25 cm) in (T_7) - NAA + GA_3 (40 ppm + 25 ppm) and (T_6) – NAA + GA_3 (20 ppm + 50 ppm), whereas, minimum fruit length (5.45 cm) was recorded in T_9- Control. Similarly, maximum fresh weight (180.48 g) was recorded under treatment (T_8) - NAA + GA_3 (40 ppm + 50 ppm) followed by (177.99 and 176.50 g) in (T_7) - NAA + GA_3 (40 ppm + 25 ppm) and (T_6) – NAA + GA_3 (20 ppm + 50 ppm). Whereas minimum fresh weight (163.59 g) was recorded under T_9- Control (Table 2). The maximum fruit diameter (9.48 cm) was recorded in the treatment (T_8) - NAA + GA_3 (40 ppm + 50 ppm) followed by (8.49 and 7.43 cm) in T_7- NAA + GA_3 (40 ppm + 25 ppm) and (T_6) – NAA + GA_3 (20 ppm + 50 ppm) and minimum fruit diameter (3.77 cm) was recorded under T_9- Control. Among all the treatments, (T_8) - NAA + GA_3 (40 ppm + 50 ppm) was recorded higher fruit yield plant^{-1} (2.91 kg), fruit yield per plot (29.22 kg) and fruit yield quintal per hectare (383.95) followed (T_7) - NAA + GA_3 (40 ppm + 25 ppm). In other hand least fruit yield plant^{-1}, fruit yield per plot and yield quintal per hectare was observed in T_9- Control. Which are influenced by the growth cycle during vegetative stages and mirrored during productive phases. Different growth promoter combinations improved the values of several growth and yield contributing features. Similarly reported by several researchers *viz*., [9,13,14].

Table 1. Effect of PGR on growth attribute of brinjal

Treatment	Plant height (cm)			No. of leaf/plant			No. of branches/plant			Days to 50% flowering
	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	
T_1	27.96	44.72	61.45	37.41	37.67	54.00	3.38	4.41	5.82	40.57
T_2	31.06	47.66	62.18	38.55	38.84	55.32	4.33	5.11	6.45	37.75
T_3	32.55	51.03	64.42	39.36	40.37	62.53	5.35	5.74	7.34	36.08
T_4	34.52	51.92	65.37	40.51	42.24	64.91	5.84	6.33	8.62	34.43
T_5	34.90	53.22	66.44	41.46	43.16	66.04	6.51	6.74	9.74	32.79
T_6	36.16	54.00	67.61	42.31	43.52	67.38	7.39	7.60	10.53	31.44
T_7	36.18	57.84	69.40	43.12	45.29	68.59	8.40	8.41	11.80	30.54
T_8	41.92	61.20	71.14	44.35	47.12	71.65	9.49	10.07	12.77	29.66
T_9	27.18	37.75	45.47	32.26	35.15	41.63	3.73	4.19	4.86	43.12
SE ±	**0.55**	**0.54**	**0.28**	**0.27**	**0.20**	**0.46**	**0.20**	**0.15**	**0.20**	**0.42**
CD (5%)	**1.67**	**1.63**	**0.84**	**0.81**	**0.60**	**1.38**	**0.60**	**0.47**	**0.61**	**1.28**

Table 2. Effect of PGR on yield attribute, yield and economics of brinjal

Treatment	No. of fruit per plant	Fruit length(cm)	Weight of fruits (g)	Fruit diameter(cm)	Fruit Yield (Kg/plant)	Yield (kg/plot)	Yield (q/ha)	Net return (Rs./ha)	B:C Ratio
T_1	8.67	5.56	166.51	3.94	1.44	21.90	356.61	381785.34	2.49
T_2	9.82	6.28	168.23	3.94	1.65	23.32	362.48	390577.82	2.55
T_3	11.13	7.40	170.65	4.72	1.89	24.14	366.97	397301.82	2.59
T_4	12.00	7.94	171.79	5.49	2.06	25.42	370.44	402470.82	2.62
T_5	12.93	8.88	174.34	6.50	2.25	25.84	373.57	406829.34	2.64
T_6	13.56	10.25	176.50	7.43	2.39	27.33	376.85	412073.34	2.68
T_7	15.20	11.29	177.99	8.49	2.71	28.13	379.84	416581.82	2.71
T_8	16.17	11.66	180.48	9.48	2.91	29.22	383.95	422710.86	2.75
T_9	11.63	5.45	163.59	3.77	1.90	19.91	206.69	185598.25	1.49
SE ±	**0.18**	**0.28**	**1.18**	**0.12**	**0.02**	**0.18**	**0.85**	-	-
CD (5%)	**0.56**	**0.84**	**3.54**	**0.35**	**0.07**	**0.55**	**2.56**	-	-

Table 3. Fruit colour, fruit shape and fruit size as influenced by different treatments

Symbol	Treatment	Fruit colour	Fruitshape	Fruit size
T_1	NAA (20 ppm)	Purple	Round	Medium
T_2	NAA (40 ppm)	Purple	Round	Medium
T_3	GA_3 (25 ppm)	Purple	Round	Medium
T_4	GA_3 (50 ppm)	Purple	Round	Medium
T_5	NAA + GA_3 (20 ppm + 25 ppm)	Purple	Round	Large
T_6	NAA + GA_3 (20 ppm + 50 ppm)	Purple	Round	Large
T_7	NAA + GA_3 (40 ppm + 25 ppm)	Purple	Round	Large
T_8	NAA + GA_3 (40 ppm + 50 ppm)	Purple	Round	Large
T_9	Control	Purple	Round	Small

**NAA- Nephthaline Acetic Acid, GA_3- Gibberellic Acid and ppm- Part Per Million*

3.3 Effect of Treatments on Economics of Brinjal

It was revealed that the maximum net return of Rs. 422710.86 q/ha with Benefit: Cost ratio of 2.75 was recorded in T_8 (@ 40 ppm NAA + @ 50 ppm GA_3) followed by T_7 -(@ 40 ppm NAA + 25 ppm GA_3) with net income of Rs. 416581.86 q/ha along with Benifit:Cost ratio of 2.71 and minimum net return of Rs.185598.25 q/ha with Benefit: Cost ratio of 1.49 was observed in control.). Net return and benefit cast ratio was more due to higher production fruit yield of brijal (Table. 2). The effect of PGRs on economics of brinjal was also reported by [15,16,17].

3.4 Effect of Treatments on Fruit Colour, Fruit Shape and Fruit Size of Brinjal

As for fruit sample observed and given below in Table 3 we can say that there are no any difference was found in fruit colour, Fruit shape and fruit size with the application of various doses of growth hormone, its combination and control. All the treatment including control was showed Purple colour, Round in shape and Medium size fruits. The similar result was recorded by Khaleghi et al. [9] and Ruidas et al. [14].

4. CONCLUSION

It can be concluded from the present investigation that PGRs combinations with (NAA - 40 ppm + GA_3 -25 ppm) generates maximum growth and yield attributing characters at different stages of crop. Similarly, highest fruit yield and Net return and benefit cast ratio were recorded with T_8 (@ 40 ppm NAA + @ 50 ppm GA_3.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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