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Effect of Gibberellic Acid (GA_3) on Vegetative and Reproductive Growth and Yield Characters of Cucumber (*Cucumis sativus*) under Costal Region of West Bengal, India

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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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ABSTRACT

The field experiment was conducted on cucumber during spring-summer (March to June) season of 2022 and 2023 at Instructional Farm of The Neotia University, Sarisha, Diamond Harbour, West Bengal, India. Entirety six numbers of gibberellic acid treatments were comprises with five levels of GA_3 *viz.,* GA_3@100ppm, GA_3@200ppm, GA_3@300ppm, GA_3@400ppm and GA_3@500ppm along with control treatment were assessed in randomized block design with three numbers of replications.The cucumber plant height was recorded for three sowing date intervals *viz.,* 30 DAS, 60 DAS and 90 DAS, among these three sowing dates GA_3@200 ppm was recorded highest plant height within the other treatments and the plant heights are 88.75cm, 234.30 cm and 272.18cm respectively for different sowing date intervals and lowest plant height was recorded in control treatment. It was also recorded from this experiment that is the number of male flower was recorded highest in GA_3@400 ppm and highest number of female flower recoded in GA_3@200 ppm (22.91).The most important and conclusion marking data was recorded in case of GA_3@200 ppm treatment, because two parameters likely yield per plant (2348.84 g) and yield per hectare (281.86 qt/ha), collectively recorded highest in this treatment, on the other hand control treatment recorded least yield per plant (816.26 g) and yield per hectare (107.62 qt/ha).

Keywords: Cucumber; flower; gibberellic acid (GA_3); days after sowing (DAS); yield.

1. INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important vegetables belonging to family Cucurbitaceae comprising 117 genera and 825 species endemics in warmer parts of the world [1]. It has a diploid chromosome number of 14 (2n= 14) [2]. Cucumber exhibits a fascinating range of floral morphology, including staminate, pistillate and hermaphrodite flowers occurring in various arrangements and sowing several types of sexual expression [3]. The stems of cucumber are found scabrous or hirsute with acute and shallow sinuses and have a creeping vines bears cucumiform fruits [4]. The seed are extremely enriched with nutritive compound like protein (33.8%), fat (45.2%), carbohydrate (10.3%), crude fibers (2.0%) and the seed oil consist of four chief fatty acids linoleic acid (61.6%), oleic acid (15.7%), stearic acid (11.1%) and palmitic acid (10.7%) [5] Along with other several nutrient compounds, it also very rich in antioxidant and vitamin K and C [6]. They are considered to be good sources of phytonutrients like cucurbitacins, lignans and flavonoids. (Nayak et al [7].

Cucumber is considered to be native of India. It is an important salad vegetable cultivated both in north and south region and as well as lower and higher hills in India. It is good for people suffering from constipation, jaundice and indigestion. In India, it has been cultivated on 0.028 million ha area with 0.175 MT production and productivity of 6.3 t ha^{-1} [8].

The concept of plant growth regulators are refer to artificially produced substances which in very low quantities normally act at sites other than the place of production and control different physiological processes that modulate plant growth and development [9] It also control vegetative growth of plant and helps to increase the plant population in a specific area [10]. Exogenous use of plant growth regulators improved the germination of the vegetable seeds, increased total yield, protect the plant from pests and sometimes also used to avoid the loss of yield due to the unfavorable condition [11]. For improving crop quality and regulate the uptake and accumulation of mineral nutrients in plants the plants growth regulators play a major role, along with other activities it also helps in the transport of water and nutrients through the xylem, influencing various biochemical and physiological parameters like photosynthesis, respiration, protein synthesis, cell extension, and wall thickness and stability [12]. The exogenous application of plant growth regulator can alter the sex ratio and sequence, if applied at the two to four leaf stages, which is the critical stage for cucurbits by suppressing or promoting any one sex forms with the different concentration as per objective of application [13].The coastal region of South 24-pargans have immense climacteric and soil characteristics for better production of several numbers of cucurbits, among those cucurbits cucumber is one of the profitable one. The farmers of coastal region of South 24-pargans every year planted cucumber several hectares of land, but the production and productivity not up to the marks, it may be due to

several factor and lack of external application of several plant growth regulators is one of the most important. The plant growth regulator promotes number of female flower production and several growth factors to the plants, which results in the enrichment of yield potential. Keeping above views of the crops and the lack of application different plant growth regulator, this study was carried out with main objective to understand the role of plant growth regulators on growth and yield of cucumber with different concentration, which may be helps to the farmers to application of PGR's with appropriate concentrations.

2. MATERIALS AND METHODS

The present field trial was conducted during spring-summer (March to June) season of 2022 and 2023 at Instructional Farm of The Neotia University, Sarisha, Diamond Harbour, West Bengal, India, located at $22^0$48' N latitude and $88^0$31' E longitudes with an average altitude of 8 m above the mean sea level (MSL) and soil pH 6-7 throughout summer season of 2022 and 2023. Total six number of treatments were comprises with five levels of GA_3 *viz.,* GA_3@100ppm, GA_3@200ppm, GA_3@300ppm, GA_3@400ppm and GA_3@500ppm along with control treatment were assessed in randomized block design with four number of replications. The hybrid cucumber variety Rajani seeds were sown on February 15th, 2022 and February 20th, 2023 in a well prepared bed with the size of 1m X 10m and a spacing of 1m X 1m. Two numbers of seeds were sown in a hill. To execute the present study the recommended dose of N, P_2O_5 and K_2O (150 kg, 75 kg and 75 kg ha^{-1}, respectively) were abounding through Urea, Single Superphosphate and Muriate of potash, respectively on main field. The different concentrations of plant growth regulator was applied 25 days after sowing, when the plants were three to four leaves stage. Suitableintercultural operations were adopted to raise the crop. Randomly ten numbers of plant were selected from each plot tagged them and observations were recorded on assorted growth and yield parameters for instance Plant Height (at 30, 60 and 90 DAS), Number of Primary Branches (at 30, 60 and 90 DAS), Number of leaves per plant (at 30, 60 and 90 DAS), Internodal distance, Days taken to initiation of flowering, Days Taken first female flower, Node number first female flower, Total Male Flower, Total Female Flower, Sex Ratio (Male: Female), Fruit Per Plant, Fruit Setting Percentage (%), Fruit Diameter (cm), Fruit Length (cm), Average fruit weight (g), Yield per plant (g), and Yield/ha (qt). Collected data were statistically analyzed with the help of SPSS 22.0.

3. RESULTS AND DISCUSSION

The present study was recorded significant responses for all the characters under this present experiment of growth regulator treatments. The plant height was recorded for three sowing date intervals *viz.,* 30 DAS, 60 DAS and 90 DAS, among these three sowing dates GA_3@200 ppm was recorded highest plant height within the other treatments and the plant heights are 88.75cm, 234.30 cm and 272.18cm respectively for different sowing date intervals. Rahaman et al., [14,15] were recorded highest vine length through better increased rate of photosynthesis activity and accelerated translocation via application of GA_3@300ppm and GA_3@150ppm respectively on cucumber and bottle gourd. Kadi et al [2] and [16] both found a beneficial effect of GA3 on cucumber and squash vine length, which supports our current findings. Again the same treatment GA_3@200ppm showed significant maximum positive effect on the number of primary branches at 30, 60 and 90 days after sowing with number of 3.79, 9.94 and 15.84 respectively. The current study's findings are consistent with prior research of Dalai et al. 2016 and Kadi et al. 2018, which found that foliar treatment of GA3 enhances shoot number in cucumber plants. On the other hand the maximum number of leaves at 30 DAS was recorded against the treatment GA_3@300ppm (17.12), but in case of 60 DAS and 90 DAS leaves number observations the treatment GA_3@200ppm was found superior among the other treatments (63.51 and 93.31) Sahil [17] and Pal et al. [12] reported significant impact on growth attributes of vegetative part of cucumbers through exogenous applications of gibberellic acid. On behalf of the above discussed three plant growth characters the treatment GA_3@200ppm might be very effective to up regulate the other natural plant growth regulators at desired amount to promote the better growth. The main reason for GA_3's positive effect on these growth parameters was may be due to the cell division by mitosis and cell elongation influenced by GA_3 treatment, which increased cell length and size and these effects collectively results the response of different growth parameters. Similar findings also reported by Dinest et al., [18] in cucumber, [19] in bottle gourd, [16] in squash and Chaurasiya et al.[20] in musk melon.

Data represented in Table-2 clearly indicated relationship between internodal distance and days taken to flower initiation. Both this two observation was recorded maximum result in case of control treatment (14.67 cm and 32.86, respectively), in contrast the treatment of GA_3@200ppm was recorded minimum results against internodal distance and days taken to flower initiation (23.98).Rahaman et al., [14]and Kadi et al. [2] were recorded similar type of finding in terms to internodal length in cucumber. Along with this the findings of Farhana ,[21] who concluded that applying different growth regulators, such as maleic hydrazide, silver nitrate, ethophon, and GA_3 at varying rates, impacted the flowering behavior of cucumber plants.On the other hand GA_3@200ppm again reported favorable results in terms of days taken to first female flower induction (30.00) and node number of first female flower (7.28), in these cases the same treatment reported minimum values, which encourage the yield. The current study's findings are consistent with the findings of Dalai et al.,[4] who indicated that foliar application of GA_3 impacted female flower induction in cucumber. From the data enlisted in Table-2, it was clearly found that the number of male flower was recorded highest in GA_3@400 ppm and highest number of female flower recoded in GA_3@200 ppm (22.91). Rahaman et al.,[14] Kadi et al. [2] Hossain [22] and Shafeek et al. [16] also recorded similar type of finding when they were conducted study on cucumber and date taken for 50% flower inductiotime. Further GA_3@400 ppm was recorded highest in sex ratio observations (3.46) and the lowest sex ratio was reported in GA_3@200 ppm, which solely depends on the number of male and female flower influenced by the concentration of gibberellic acid.[23]*et. al*., (2020) andFarhana (2015) both were recorded previously the effect of GA_3@300ppm increased the femaleness in cucumber. Among all the treatments GA_3@200 ppm was recorded maximum number of fruit per plant (13.43) and the minimum number of fruit per plant was collectively recorded in GA_3@500 ppm (5.63) and control treatment (4.64) combined,z both treatments were at par with each other. Beside this the fruit setting percentage was collected higher in GA_3@200 ppm (82.44), this result observed may be due to the accumulation of higher percentage of photosynthates due to the application of GA_3.Sapkota *et. al*., (2020) was previously recorded GA_3@300ppm gives maximum length of cucumber against control, when he was conducted a study at Nepal region [24,25].

Table 1. Different growth parameters of cucumber

Treatments	Plant Height			Number of Primary Branches		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Control	60.12^{c}	193.09^{bc}	238.12^{b}	2.39^{b}	5.71^{c}	8.64^{d}
GA_3 100 ppm	79.01^{ab}	200.92^{b}	232.47b^{c}	3.56^{a}	8.01^{b}	12.53^{b}
GA_3 200 ppm	88.75^{a}	234.30^{a}	272.18^{a}	3.79^{a}	9.94^{a}	15.84^{a}
GA_3 300 ppm	76.08b	182.83^{c}	228.34^{bc}	3.22^{ab}	7.37^{b}	11.42^{bc}
GA_3 400 ppm	88.42^{a}	182.07^{c}	211.70^{cd}	3.56^{a}	7.59^{b}	10.77^{c}
GA_3 500 ppm	80.66^{ab}	153.78^{d}	197.16^{d}	2.25^{b}	5.47^{c}	7.94^{d}
C.D.	11.49	16.79	22.69	1.10	0.97	1.23
SE(m)	3.60	5.26	7.11	0.35	0.31	0.39

Table 2. Different growth and flowering parameters of cucumber

Treatments	Number of Leaves per Plant			Internodal Distance	Days Taken to Initiation of flowering
	30 DAS	60 DAS	90 DAS		
Control	10.86c	50.84bc	80.71bc	14.67a	32.86a
GA_3 100 ppm	11.74bc	48.64c	81.53bc	11.03b	33.34a
GA_3 200 ppm	12.01bc	63.51a	93.31a	11.25b	23.98b
GA_3 300 ppm	17.12a	55.40b	84.75b	11.54b	23.64b
GA_3 400 ppm	13.48bc	53.40bc	77.77c	10.26b	33.87a
GA_3 500 ppm	14.79ab	54.31b	84.23b	11.44b	30.11ab
C.D.	3.37	5.03	3.86	2.18	7.17
SE(m)	1.06	1.58	1.21	0.68	2.25

Table 3. Different flowering and yield parameters of cucumber

Treatments	Days Taken First Female Flower	Node Number First Female Flower	Total Male Flower	Total Female Flower	Sex Ratio (Male: Female)	Fruit Per Plant
Control	42.24a	9.36a-c	28.92b	11.70c	2.48b	4.64e
GA_3 100 ppm	39.87a	8.52bc	25.43bc	13.63bc	1.88cd	11.23b
GA_3 200 ppm	30.00b	7.28c	27.30bc	22.91a	1.20e	13.43a
GA_3 300 ppm	30.70b	11.89a	23.56c	16.67b	1.42de	7.22c
GA_3 400 ppm	40.60a	10.83ab	41.25a	12.09c	3.46a	6.24cd
GA_3 500 ppm	37.83a	9.82ab	25.15bc	11.94c	2.13bc	5.63e
C.D.	6.87	2.39	4.15	3.57	0.54	1.51
SE(m)	2.15	0.75	1.30	1.12	0.17	0.47

Table 4. Different flowering yield parameters of cucumber

Treatments	Fruit Setting Percentage (%)	Fruit Diameter (cm)	Fruit Length (cm)	Average Fruit Weight (g)	Yield per Plant (g)	Yield/ha (qt)
Control	39.54e	3.45c	7.01b	103.67c	816.26d	107.62c
GA_3 100 ppm	82.44a	5.03bc	9.38b	153.43b	1724.33b	206.92b
GA_3 200 ppm	61.78b	5.59b	12.08a	174.77a	2348.84a	281.86a
GA_3 300 ppm	43.27de	4.36bc	8.70b	154.77ab	1113.41	133.61c
GA_3 400 ppm	51.71c	3.89bc	8.75b	171.33ab	1063.24cd	127.59c
GA_3 500 ppm	47.61cd	8.19a	8.85b	159.00ab	893.61cd	107.23c
C.D.	5.13	1.87	2.74	19.28	272.73	32.08
SE(m)	1.61	0.59	0.86	6.04	85.45	10.05

Considering the fruit yield related observation first data was collected for the fruit diameter and it was recorded utmost data found in GA_3@500 ppm (8.19 cm) and least fruit diameter found in control treatment (3.45 cm). But, in case of fruit length observations, it was evidently recorded highest in GA_3@200 ppm (12.08 cm) and the lowest length of cucumber was recorded in control treatment (7.01 cm). Further GA_3@200 ppm was recorded maximum average fruit weight (174.77 g) and the control treatment (103.67 g) recorded minimum. Rahaman *et. al*., [14] Kadi et al. [2] Shafeek et al. [16] and [21] all reported on the promotion of individual fruit weight by the use of GA_3. The most important and conclusion marking data was recorded in case of GA_3@200 ppm treatment, because two parameters likely yield per plant (2348.84 g) and yield per hectare (281.86 qt/ha), collectively recorded highest in this treatment, on the other hand control treatment recorded least yield per plant (816.26 g) and yield per hectare (107.62 qt/ha).Sapkota et. al., (2020), Rahaman et. al., [14] and Dalai et al. [4] also reported similar type of yield findings when they conducted experiment on cucumber with the influence of GA_3 [26-28].

4. CONCLUSION

Considering all the results reviled from this study it was concluded that different GA_3 treatment have significant effect on different growth, flowering and yielding parameters of cucumber under costal region West Bengal. Among the different treatment GA_3@200ppm was recorded superior affect on growth, flowering a yielding parameters and this treatments may be effective also for the farmers of this coastal region of West Bengal.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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