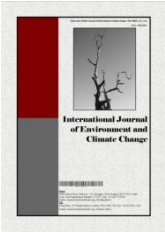

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Effect of Different Plant Growth Regulators on Growth and Phenological Parameters of Cucumber (*Cucumis sativus* L.) cv. Punjab Naveen

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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

An experiment was conducted during the season from March 2018 – June 2018 at the Horticulture farm of Lovely Professional University, Phagwara (Punjab). The three replications of the experimental trial used a randomized block design. Eleven alternative approaches were used in the trial. Based on the findings of the experimental trial, it was possible to concluded that the treatment T_8 GA_3 (100ppm) had a significant impact on the growth and phenological parameters of the cucumber, including the number of branches, leaf area, days to the first flowering, and days to 50% flowering. However, the longest vine and the greatest internodal distance were seen in treatment T_7 GA_3 (50ppm).

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1. INTRODUCTION

Cucumber (*Cucumis sativus* L.) belonging to the Cucurbitaceae family is a broadly cultivated plant. It is an annual, dioecious crawling vine that grows up trellises or other supports, covering around them vine is thin, spiral tendrils. The plant has broad size of leaves that cover hole the fruit. Cucumber fruit is generally tube shape and prolong with ends.

Generally, cucumber used in a pickle and salad but also make a vegetable because of chlorine is low. Tender leaves are also used as vegetables. Fruits help in the cure of constipation, jaundice and indigestion. Seeds have a number of ayurvedic uses. Seeds and fruit hold cooling properties, hence utilize as astringent and medicinal use.

Cucumber is widely consumed in both fresh and processed food. Based on use it may be three types salad, pickling, and cooking. Cucumber is grown mainly for its fruits both in India and abroad. Cucumber grow in many soil types like sandy, sandy loam, clay loam and silt loam. In case of higher yield in loam, silt loam and clay loam soil are in use. In case of desire the early crop then grown in sandy & sandy loam soil. It grows better in soil with having pH of 5.5-6.7. The soil should be well- drained. The role of PGR has been well known to modify various physiological processes in cucurbitaceous crops [1].

Applications of GA3 with NAA have prompted plants' metabolic activities due to enhancing vegetative growth, Hilli et al., [2]. Exogenous application of chemicals (Gibberellic acid and NAA at different doses) at 2-4 true leaf stages directly affects sex expression, and its inferred of combined application of GA3 and NAA on cucumber plant takes part in the metabolic activities. The substance of NAA slowed down the cell elongation and cell division in meristematic shoot with different tissue. It regulated the tallness of the plant without change in the physiology and morphology of the plant [2] in ridge gourd.

Growth regulators advanced the female flower initiation in the present study, which might be due to the increase the metabolization of auxin substances in plants and reduced sugar, thereby bringing a change in the membrane permeability. These results with Baruah and Sharma [3].

2. MATERIALS AND METHODS

The research experiment was carried out at the Horticulture farm of Lovely Professional University, Phagwara (Punjab). It was carried out during the season from March 2018 – June 2018. The experimental trial was conducted in Randomized Block Design with three replications. The experiment included eleven different treatments viz., T_1(NAA @50ppm), T_2 (NAA @100ppm), T_3 (NAA @150ppm), T_4 (MH @200ppm), T_5 (MH @ 250ppm), T_6 (MH @300ppm), T_7 (GA_3 @50ppm), T_8 (GA_3 @100ppm), T_9 (GA_3 @150ppm), T_{10} (NAA @100ppm + GA_3 @100ppm + MH @250ppm), T_{11} (Control). Each experimental unit was defined and the layout was drawn as per plan. Punjab Naveen was the cucumber cultivar which was planted at a spacing of 2.5 m × 0.6 m during the experimental trial.

2.1 Parameters of Study

2.1.1 Growth parameters

2.1.1.1 Vine length

Randomly selected three plants in each plot. Vine length is measured in (cm). Measure the vine length from the cotyledon node to the growing tip. Taken the observation at 15, 30 and 45 DAS.

2.1.1.2 Number of branches per plant

Randomly selected three plants in each plot and counted period- wise until the last harvesting was completed. Calculate the average value for selected plants.

2.1.1.3 Inter-nodal distance (cm)

Measure the inter-nodal distance by distance between nodes using a scale. Calculated the mean value.

2.1.1.4 Leaf area (cm^2)

Measured the leaf area on a leaf-area-meter (manufactured by Systronics Ltd.) and the average leaf area of a single leaf was worked out

and expressed in cm^2. Observations were taken at 15, 30and 45 DAS.

2.1.2 Phenological parameters

2.1.2.1 Days taken To 1st flowering

Recorded the date of inducing 1st flower in each plot, counting the no. of days from DAS.

2.1.2.2 Days taken To 50% flowering

Noted the date for 50% flowering in each plot. Counting the no. of days from DAS. Calculate the average value.

2.1.2.3 Number of male flowers per vine

Recorded the male flowers at the flowering stage. Counted the appearance of 1st flower until the last flower from selected plants.

2.1.2.4 Number of female flowers per vine

Recorded the Female flowers at the flowering stage. Counted the appearance of 1st flower until the last flower from selected plants.

2.1.2.5 Male and female ratio

Recorded the male and female flowers at the flowering stage. Counted the appearance of 1st flower until the last flower from selected plants.

3. RESULTS

The data on various growth and Phenological attributes were statistically analyzed and showed a significant result on cucumber.

3.1 Growth Parameters

Vine length (cm): The treatment significantly affected on vine length at 15, 30 and 45 days after sowing. Treatment T_9 (GA_3 @ 150ppm) recorded maximum vine length (25.69cm) at 15 DAS and treatment T_{11}(Control) exhibited minimum (15.54 cm). Vine length at 30 DAS, treatment T_7 (GA_3 @ 50ppm) recorded the maximum vine length (61.24cm) and treatment T_{11} (control) exhibited minimum (43.22). Vine length at 45 DAS, treatment T_7 (GA_3 @50ppm) recorded maximum (81.01) and minimum in treatment T_{11} (61.37).

Number of Branches Per Plant: Significantly maximum number of branches per plant (4.06) was recorded under exogenous application of the treatment T_1 (NAA @50 ppm) at 15 DAS while the minimum branches per plant were recorded in the treatments T_{11} (control) valued 2.96. Treatments T_5 (MH@250ppm) are statistically at par with NAA @50 ppm (T_1). At 30 DAS, the significantly maximum branches per plant was recorded in the treatment T_1-NAA @50 ppm valued at 6.43 while, the minimum branches per plant were recorded in the treatment T_{11}-Control (water spray) valued at 5.37. At 45 days after sowing, the maximum branches per plant were recorded in the treatments T_1-NAA @50ppm valued at 7.98 while, the minimum branches per plant was noted in treatment T_{11} - control valued 7.40.

Inter-Nodal Distance (cm): The plant growth regulators significantly affect increasing and decreasing the inter-nodal length of the vine compared to control. A significantly maximum inter-nodal distance of 5.11 cm was recorded in treatment T_7 (GA_3 @50ppm) whereas a minimum of 4.60cm was recorded in the treatment T_{11} (Control). The treatments T_3 (NAA @150ppm), T_5 (MH @250ppm) and T_1 (NAA @50ppm) were statistically at par with GA_3 @50ppm (T_7).

Leaf Area ($cm^{2)}$: The leaf area was recorded at 15 days after sowing, the significantly maximum leaf area was recorded under the treatment T_1-NAA @ 50ppm valued at 29.35cm^2 whereas minimum leaf area was recorded in the treatment T_{11} (Control) of 19.64cm^2. Treatments T_2, T_5 and T_7 were statistically at par with each other. At 30 days after sowing, the significantly maximum leaf area was recorded under the treatment T_5-MH @250ppm valued at 106.21.65cm^2 whereas minimum was recorded in the treatment T_{11} (control) valued at 88cm^2. At 45 days after sowing, the significantly maximum leaf area was recorded under the treatment T_9- GA_3 @150ppm valued at 187.46cm^2 whereas the minimum leaf area was recorded in the treatment T_{11} (control) valued at 165.76 cm^2.

3.2 Phenological Parameters

Days Taken to First Flowering: The minimum days 20.4 taken to first flowering was recorded in treatment T_8 (GA_3 @100ppm) as compared to maximum (32.44) in treatment T_{11} (control).

Days Taken To 50% Flowering: The minimum days taken to 50% flowering were recorded in the treatment T_8- GA_3 @100 ppm valued at 24.28 compared to treatment T_{11} (control) valued

37.33. However, the treatments T_7, T_9 and T_{10}were found statistically at par with T_8 (GA_3 @100 ppm).

Number of Male Flowers Per Vine: plant growth regulators play an important role in decreasing the number of male flowers per vine compared to control. The number of male flowers per vine was minimum (19.39) under the treatment T_3 (NAA @150ppm as compared to maximum T_7 (GA_3 @50ppm).

Number of Female Flowers Per Vine: The maximum number of female flowers (17.03) Was recorded under the treatment T_7 (GA_3 @50ppm) and minimum of T_{11} under control. However, the treatment $T_4$and T_8 respectively were statistically at par with treatment T_7.

Male and Female Ratio: foliar application of growth regulators has significant effect on narrowing or reducing the male and female ratio in cucumber compared to control. A narrow sex ratio of 1.92 was recorded under the treatment T_1 (NAA@50ppm) compared to the broader sex ratio of T_{11} under control. However, the T_9 and T_{10} respectively were statistically at par with the treatment T_1.

4. DISCUSSION

The vine length increased significantly with the increase in crop growth stages (15, 30 and 45 DAS). The T_7-GA_3@ 50ppm was found significantly superior compared to the rest of the treatments. Wherever the minimum was recorded in treatment T_{11} – Control. The promotion of growth either in terms of increase in the vine length or the leaf area and leaf number has been thought to be by increasing plasticity of the cell wall followed by hydrolysis of starch to sugars which lower the water potential of the cell, resulting in the entry of water into the cell causing elongation. Among treatments of 20 ppm Gibberellic acid recorded significantly maximum length of vine and no. of leaves of 61.1 cm and 46, respectively [4]. Arun et al., [5] noted that the doses of 200 ppm Gibberellic acid were shown in the highest height of the plant followed by seed soaking with @15 ppm Gibberellic acid in Brinjal cv Pusa Purple Long. The doses of 500 ppm Gibberellic acid enlarged the Vine length in muskmelon. In summer squash various doses of GA3 (25 ppm) and Naphthalene acetic acid (50 ppm) encouraged the elongation of the length of the main vine. Similarly, the doses of (25 ppm) Gibberellic acid at the 2-4 leaf stage showed the extra vine length compared to water spray in bitter-gourd [6,7]. It was observed that the doses of Naphthalene acetic acid at the 2-4 leaf stage enlarge length of crop vine in watermelon variety sugar baby [8].

In number of branches per plant, data was recorded 15,30 and 45 days after sowing the cucumber. Generally recorded maximum no. of branches in T_8- GA_3@100ppm while found the minimum no. of branches in T_{11}- (control). The variation in number of branches per vine might have been due to its PGR's effect and also due to vine length, inter-nodal length and environmental factors that confirmed to reports by Hilli et al. [2] suggested that the maximum number of branches @ GA_3 (4.60) has been recorded, Mehadi et al. [9] and Momin et al. [10].

In leaf area, data was recorded 15,30 and 45 days after sowing the cucumber. Generally recorded maximum leaf area in T_9- GA_3 @150ppm while the minimum leaf area was found in T_{11}- (control). Merentoshi [11] reported that GA3 @ 50 ppm recorded maximum leaf area at all the stages. Sure et al. [12] proved that GA_3 influences a range of developmental processing in stem elongation, germination, flowering, sex expression, enzyme induction and can improve the seedling vigor. Applications of GA3 with have prompted the metabolic activities in plants due to enhancing of vegetative growth.

Inter-nodal distance of the cucumber was recorded. Generally recorded maximum inter-nodal in T_7- GA_3 @50ppm while found the minimum in T_{11}- (control). The doses of Gibberellic acid increased the growth of the stem and the impact was more at larger concentrations. In summer squash various doses of GA_3 (25 ppm) and Naphthalene acetic acid (50 ppm) encouraged the elongation of the length of main vine. Similarly, the doses of (25 ppm) Gibberellic acid at 2-4 leaf stage showed the extra vine length compared to water spray in bitter-gourd [6,7]. It was observed that the doses of Naphthalene acetic acid at the 2-4 leaf stage enlarge the length of crop vine in watermelon variety sugar baby [8].

In treatment T_8GA_3 (@100ppm recorded minimum day taken to flowering whereas maximum day taken flowering inT_{11}- control. Due to effect of PGR reason for variation of day taken to flowering. Uses of conc. Of GA_3 @25ppm and 50ppm to give the early flowering in watermelon according to Dixit et al., (2001). In bitter gourd use of GA_3 @5ppm beneficial for total no. of flower according to Akhter and Rahman [13].

Table 1. Effect of different plant growth regulators on growth and phenological parameters of cucumber (*Cucumis sativus* L.) cv. Punjab Naveen

Sr. No.	Treatments	Vine Length (cm)			Number of Branches Per Plant			Leaf Area (cm^2)			Inter-Nodal Distance (cm)	Days Taken to First Flowering	Days Taken To 50% Flowering	Number of Male Flowers Per Vine	Number of Female Flowers Per Vine	Male Female Ratio
		15 DAS	30 DAS	45 DAS	15 DAS	30 DAS	45 DAS	15 DAS	30 DAS	45 DAS						
1.	**T_1 NAA (50ppm)**	21.34	55.29	75.27	3.50	5.72	7.65	29.15	96.99	181.05	4.87	31.00	34.83	25.75	13.44	1.92:1
2.	**T_2 NAA (100ppm)**	19.57	53.44	75.45	3.12	5.66	7.63	27.85	95.86	179.62	4.37	30.22	35.67	20.81	12.66	1.63:1
3.	**T_3 NAA (150ppm)**	20.46	53.41	73.40	3.11	5.85	7.75	26.34	93.90	171.72	4.95	29.47	35.08	19.39	12.77	1.52:1
4.	**T_4 MH (200ppm)**	22.42	50.45	71.84	3.37	6.14	7.05	27.50	100.63	183.98	4.65	25.22	32.26	32.00	15.78	1.71:1
5.	**T_5 MH (250ppm)**	22.07	50.33	69.77	3.47	5.96	7.85	26.91	106.21	182.24	4.85	25.54	32.62	29.00	16.55	1.74:1
6.	**T_6 MH (300ppm)**	19.33	49.39	70.88	3.13	6.23	7.61	25.32	95.89	178.13	4.49	23.45	31.15	25.81	14.33	1.79:1
7.	**T_7 GA_3(50ppm)**	22.48	61.24	81.01	3.63	5.72	7.59	26.61	97.46	181.35	5.11	21.36	25.46	30.00	17.03	1.76:1
8.	**T_8 GA_3(100ppm)**	24.48	59.51	79.47	4.28	6.56	8.03	24.11	96.23	186.42	4.85	20.04	24.28	26.25	15.44	1.71:1
9.	**T_9 GA_3(150ppm)**	25.69	58.54	80.83	3.75	6.33	7.95	23.19	97.11	187.46	4.76	20.32	26.92	28.36	15.44	1.82:1
10.	**T_{10} NAA (100 ppm) + GA_3(100 ppm) + MH (250 ppm)**	21.37	53.51	71.39	3.77	6.19	7.63	22.76	94.78	177.76	4.15	26.14	30.81	23.95	13.30	1.81:1
11.	**T_{11} (control)**	15.54	43.22	61.37	3.02	5.34	7.30	19.64	88.00	165.76	4.60	32.44	37.33	22.89	16.33	1.40:1
	SEm (±)	**0.553**	**0.626**	**0.617**	**0.032**	**0.024**	**0.038**	**0.527**	**2.538**	**1.437**	**0.087**	**0.352**	**0.416**	**2.096**	**1.064**	**0.009**
	C.D. at 5% of Level	**1.643**	**1.861**	**1.833**	**1.588**	**0.695**	**0.860**	**1.566**	**7.539**	**4.270**	**0.257**	**1.046**	**1.237**	**6.227**	**3.161**	**0.026**

The significantly maximum days taken to 50% flowering were recorded in treatment T_{11}- Control (37.33), while the minimum was noted in treatment T_8- GA_3@100ppm (24.28). The variation in the days taken to 50% flowering be due to effect of PGR's on different treatments. These findings agree with the results reported by Thappa et al. [14].

The significantly maximum male and female ratio were recorded in treatment T_1-NAA @50ppm (1.92:1), At the same time, the minimum was noted in T_{11}- Control (1.40:1). It is concluded that the reason for male and female ratio is the effect of PGR's on treatment. These findings agree with the results reported by the principle that sex modification in cucurbits alters the sequence of flowering and sex ratio.The smaller sex ratio by the joint application of Naphthalene acetic acid and GA_3 may be due to the fact that these substances are informed to compatibility besides reducing the embryo abortion in plants and increasing functional female organs. Banerjee and Basu [15] obtained similar results in the better gourd. Choudhary and Phatak [16] considered the effect of doses of Maleic hydrazide, 2, 4-D Naphthalene acetic acid and Indole acetic acid on the sex expression & also affect the sex ratio of cucumber.

5. CONCLUSION

Based upon the results recorded in the experimental trial it could be concluded that the treatment T_8 GA_3(100ppm) showed the significant results in terms of growth and phenological parameters of cucumber viz., number of branches, leaf area, days taken to 1st flowering and days have taken to 50% flowering. However, treatment T_7 GA_3(50ppm) showed the maximum vine length and inter-nodal distance. At the same time, the minimum results were recorded under the control treatment. So, it is advised for cucumber growers to spray GA_3(100ppm) for obtaining better growth of cucumber.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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