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Effect of Plant Growth Regulators on Yield and Quality of Cucumber (*Cucumis sativus* L.)

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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 study investigated the effect of plant growth regulators (PGRs) on the yield and quality of cucumber (*Cucumis sativus* L.) to explore its production potential conducted during the summer season of 2020 at the College farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan. The experiment followed a randomized block design (RBD) with three replications and ten treatments which including different concentrations of gibberellic acid (GA_3), Naphthalene acetic acid (NAA) and ethrel *viz*., T_1: Control (Water spray), T_2: NAA at 50 ppm, T_3: NAA at 75 ppm, T_4: NAA at 100 ppm, T_5: GA3 at 20 ppm, T_6: GA3 at 40 ppm, T_7: GA_3 at 60 ppm, T_8: Ethrel at 100 ppm, T_9: Ethrel at 200 ppm, and T_{10}: Ethrel at 300 ppm were applied at the 2-4 true leaf stages. Treatment T_{10} (Ethrel @ 300 ppm) exhibited the highest number of fruits per vine (14.13), while T_4 (NAA @ 100 ppm) showed the maximum number of pickings (8.59). GA_3 @ 40 ppm (T_6) recorded the highest fruit yield per vine (1.87 kg), Fruit yield per plot (28.29 kg) and Fruit yield per hectare (251.50 q). Additionally, Treatment T_6 produced fruits with the longest length

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(30.34 cm) and widest diameter (3.91 cm). These findings demonstrate the potential of plant growth regulators particularly Ethrel and $GA_3$to significantly impact on cucumber yield and quality.

Keywords: GA_3; NAA; ethrel; cucumber; fruit yield.

1. INTRODUCTION

Vegetable growing is the most remunerative enterprise as it is adopted on small and marginal holding with high production in short duration. Being a source of farm income, it creates impact on the agricultural development and economy of the country. Vegetables are cheaper sources of minerals, vitamins and with high caloric values. There is an increasing demand of vegetables both for domestic and for export, which can earn valuable foreign exchange for India. Cucurbits are the largest group of summer vegetable crops and are notable for its comparatively larger number of species of cultivated plants [1].

Cucumber (*Cucumis sativus* L.) also known as '*Khira*' is a creeping vine bearing cucumiform fruits, which are used as vegetables. It is the second most widely cultivated cucurbit after watermelon, it has huge demand and consumer inclination both in domestic and export markets. Cucumbers are rich sources of conventional antioxidants and nutrients including vitamin K and C, beta carotene, manganese and pantothenic acid. They are considered to be good sources of phytonutrients like cucurbitacins, lignin and flavonoids. Cucumber (*Cucumis sativus* L.) is highly esteemed as a vegetable due to its diverse applications, superb flavor, appealing texture, and medicinal properties. Typically cultivated as a summer vegetable in open field conditions, it is also grown as a forcing crop in greenhouses during the off-season. This practice is driven by the growing demand for cucumbers across various purposes [2].

Plant growth regulators also known as phytohormones are chemical molecules that influence all aspects of plant growth and development. Auxin, cytokinins, gibberellins, abscisic acid and ethylene are the five primary classical phytohormones that include more than 20 different kinds of plant growth regulators [3]. Plant growth regulators are known to be modifying growth and sex expression improve fruit set and ultimately increases yield in a number of cucurbits. The modification and shift of sex from male in to female in monoecious cucurbits by the exogenous application of various growth regulating chemicals has been a topic of great interest to number of investigators in India and abroad. Exogenous application of plant growth regulators can alter the sequence of male and female flowers, if applied at 2^{nd} or 4^{th} leaf stages, the critical stage at which suppression or promotion of either sexes is possible. Hence, by proper manipulation the sequence of flowering with the application of exogenous plant growth regulators, the yield of cucurbits can be increased. Certain growth regulating chemicals *viz.,* NAA, GA_3 and Ethrel have been reported to influence sex suppression of male flower [4] in cucumber. The growth regulators specially, NAA and ethrel suppress the male flower and increase female flower appearance there by finally increase the yield.

2. MATERIALS AND METHODS

2.1 Location and Weather Condition

The study aimed to assess cucumber production potential. Conducted at the College farm of Sardarkrushinagar Dantiwada Agricultural University in Jagudan during the summer of 2020 in an open field, Jagudan is situated approximately 10 km from Mehsana and 60 km from Ahmedabad representing the North Gujarat Agro-Climatic Region (AES-IV).Jagudan experiences a subtropical climate with distinct seasons. The region encounters a warm and humid monsoon from mid-June to early September with most rainfall in July and August. Winters, lasting from October to February, are cool and dry, reaching minimum temperatures in December and January. The temperature gradually rises from the end of February peaking in May, which along with April constitutes the hottest period of the year. Over the past 15 years, Jagudan has received an average annual rainfall of 688 mm, concentrated in about 28 rainy days. Local variety used for investigation was brought from farmer field of Nandasan. It is land races of Mehsana, Gujarat.

2.2 Experimental Detail

The study followed a RBD with three replications. Three plant growth regulators (PGRs) were utilized such as gibberellic acid (GA_3), Naphthalene acetic acid (NAA) and ethrel.

Sprays of each PGR were administered at the 2-4 true leaf stages which resulting in a total of ten treatments for the field trial. The experiment includes treatments *viz*., T_1: Control (Water spray), T_2: NAA at 50 ppm, T_3: NAA at 75 ppm, T_4: NAA at 100 ppm, T_5: GA3 at 20 ppm, T_6: GA3 at 40 ppm, T_7: GA_3 at 60 ppm, T_8: Ethrel at 100 ppm, T_9: Ethrel at 200 ppm, and T_{10}: Ethrel at 300 ppm.

2.3 Preparation of Spray Solution

For the preparation of foliar spray solutions, the required quantity of GA_3, NAA and Ethrel were weighed separately. GA_3 and NAA were dissolved by adding the specified amounts of NAA and GA3 to a small quantity of NaOH, as they do not readily dissolve in water. The volume was then adjusted to 1 liter by incorporating distilled water, resulting in a solution containing 225 ppm of NAA and 120 ppm of GA_3. Then desired concentration of NAA (50 ppm, 75 ppm, 100 ppm) and GA_3 (20 ppm, 40 ppm, 60 ppm) were prepared by dilution method. Ethrel was dissolved in water and final volume made up to 1.0 liter by adding distilled water. Then a desired concentration of Ethrel (100 ppm, 200 ppm, 300 ppm) was prepared by dilution method. Foliar application of each treatment was given at 2nd and 4th true leaf stage during the morning. Both the surface of leaves and apical meristems were fully moistened. Spraying was done with 'Plastic hand sprayer'.

2.4 Data Analysis

The data of all yield and quality parameters are collected from five tagged plant and count average of five tagged plant, after that mean data was statistically analysis by technique as described by Panse and Sukhatme [5]. The Randomized Block Design (RBD) was used for experimental analysis of variance.

3. RESULTS AND DISCUSSION

3.1 Yield Parameters

3.1.1 Number of fruits per vine

The maximum number of fruits per vine (14.13) was recorded from the application of 300 ppm Ethrel (T_{10}). This may be due to the fact that ethrel suppressed the number of male flowers and promoted number of female flower thereby, increased number of fruits per vine. The present finding is in accordance with Mehdi et al*.* [2] and Nayak et al*.* [1] in cucumber.

3.1.2 Number of picking

In treatment T4, where NAA was applied at a concentration of 100 ppm, there were a maximum pickings (8.59), signifying a notable outcome. This aligns with the research conducted by Nayak et al*.* [1] in cucumber, emphasizing the consistency of these findings across different studies. The enhanced frequency of pickings in this treatment suggests the potential effectiveness of NAA in influencing the harvest schedule, offering valuable insights for optimizing cucumber cultivation practices.

3.1.3 Fruit yield (per vine, plot and hectare)

The application of GA_3 at 40 ppm (T_6) resulted in the highest recorded fruit yield per vine at (1.87 kg) as well as the maximum fruit yield per plot (28.29 kg) and per hectare (251.50 q). The notable increase in fruit yield in the GA_3 treatment can be attributed to the positive impact of GA_3 on various factors, including enhanced fruit set percentage, increased fruit weight, and improvements in the length and diameter of the fruits. These combined effects ultimately contributed to the highest overall yield. These outcomes closely align with the findings of Dostogir et al*.* [6] and Birdar et al*.* [7] in bitter gourd, as well as with Farhana [8], Baqi et al*.* [9] and Kadi et al. [10] in cucumber. Additionally, the consistency of these results extends to the study by Hidaytullah et al*.* [11] in bottle gourd.

3.2 Quality Parameters

3.2.1 Length of fruit (cm) and Diameter of fruit (cm)

The data indicates a significant increase in both the length (30.34 cm) and diameter (3.91 cm) of fruits, with treatment T_6 (GA_3@ 40 ppm) demonstrating the highest values. The observed enhancement in fruit dimensions in response to GA_3 aligns with the findings of Ghani et al*.* [12] and Vadigeri et al*.* [13]. These studies propose that the increase in fruit length and diameter may be attributed to the activation of cell division and elongation, coupled with an elevation in metabolic activity induced by GA_3. This outcome resonates with the results reported by Sondarva et al*.* [14] in ridge gourd and by Singh and Choudhary [15] and Pawar et al*.* [16] in cucumber, highlighting the consistent influence of GA_3 on fruit morphology across various plant species.

Table 1. Effect of plant growth regulators on yield parameters of cucumber (*Cucumis sativus* L.)

Treatments No.	Treatment	Number of fruit per vine	Number of pickings	Fruit yield per vine (kg)	Fruit yield per plot (kg)	Fruit yield per hectare (q)
T_1	Control (Water spray)	8.15	5.97	1.22	17.64	156.82
T_2	NAA @ 50 ppm	10.01	6.72	1.35	19.79	175.90
T_3	NAA @ 75 ppm	10.63	6.79	1.43	20.24	179.73
T_4	NAA @ 100 ppm	12.62	8.59	1.62	21.63	192.25
T_5	GA_3 @ 20 ppm	11.80	7.39	1.41	22.46	199.65
T_6	GA_3 @ 40 ppm	12.39	7.12	1.87	28.29	251.50
T_7	GA_3 @ 60 ppm	11.09	6.83	1.47	24.01	213.27
T_8	Ethrel @ 100 ppm	10.99	6.59	1.44	21.60	192.01
T_9	Ethrel @ 200 ppm	12.03	7.39	1.50	23.39	207.90
T_{10}	Ethrel @ 300 ppm	14.13	7.79	1.63	25.34	225.23
S.Em. ±		0.457	0.346	0.080	0.080	1.050
C.D. at 5 %		1.36	1.03	0.22	0.22	3.12
C.V. %		6.96	8.41	8.68	8.68	8.10

Table 2. Effect of plant growth regulators on quality parameters of cucumber (*Cucumis sativus* L.)

Treatments No.	Treatment	Length of fruit (cm)	Diameter of fruit (cm)	TSS (°Brix)
T_1	Control (Water spray)	23.31	2.90	5.07
T_2	NAA @ 50 ppm	26.45	3.17	5.13
T_3	NAA @ 75 ppm	26.35	3.05	5.16
T_4	NAA @ 100 ppm	27.49	3.24	5.27
T_5	GA_3 @ 20 ppm	27.66	2.92	5.23
T_6	GA_3 @ 40 ppm	30.34	3.91	5.73
T_7	GA_3 @ 60 ppm	28.25	3.41	5.44
T_8	Ethrel @ 100 ppm	24.69	3.23	5.42
T_9	Ethrel @ 200 ppm	25.81	3.38	5.44
T_{10}	Ethrel @ 300 ppm	25.55	3.42	5.44
S.Em. ±		0.679	0.113	0.172
C.D. at 5 %		2.02	0.34	ns
C.V. %		4.42	6.02	5.60

3.2.2 Total soluble solid (°Brix)

Total soluble solid in fruit affected by different treatments was found not significant among various treatments but application of GA_3 40 ppm showed maximum (5.73 °Brix) total soluble solid in fruit. The results supported by the findings of Kadi et al. [10] in cucumber.

4. CONCLUSION

In conclusion, the study reveals that different treatments significantly influenced fruit yield and quality in cucumber vines. Treatment T_{10}, utilizing Ethrel at 300 ppm, exhibited the highest number of fruits per vine (14.13) and maximum pickings (8.59) was found with 100 ppm NAA (T_4). However, Treatment T_6, applying GA3 at 40 ppm, showed remarkable results with the highest fruit yield per vine (1.87 kg), fruit yield per plot (28.29 kg), and fruit yield per hectare (251.50 q). Moreover, Treatment T_6 produced fruits with the longest length (30.34 cm) and widest diameter (3.91 cm), indicating its superiority in enhancing both yield and quality parameters.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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