

Effect of plant growth regulators on yield and quality of cucumber (*Cucumis sativus* L.)

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, SardarkrushinagarDantiwada Agricultural University, Jagudan. The experiment followed a randomized block design (RBD) with three replications and ten treatments which including different concentrations of gibberellic acid (GA₃), Naphthalene acetic acid (NAA) and ethrelviz., T₁: Control (Water spray), T₂: NAA at 50 ppm, T₃: NAA at 75 ppm, T₄: NAA at 100 ppm, T₅: GA₃ at 20 ppm, T₆: GA₃ at 40 ppm, T₇: GA₃ at 60 ppm, T₈: Ethrel at 100 ppm, T₉: Ethrel at 200 ppm, and T₁₀: Ethrel at 300 ppm were applied at the 2-4 true leaf stages. Treatment T₁₀ (Ethrel @ 300 ppm) exhibited the highest number of fruits per vine (14.13), while T₄ (NAA @ 100 ppm) showed the maximum number of pickings (8.59). GA₃ @ 40 ppm (T₆) 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 T₆ produced fruits with the longest length (30.34 cm) and widest diameter (3.91 cm). These findings demonstrate the potential of plant growth regulators particularly Ethrel and GA₃ to significantly impact on cucumber yield and quality.

Key words: GA₃, 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 (Nayak *et al.*, 2017).

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. (Mehdi *et al.*, 2012).

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 (Gosai *et al.*, 2020). 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 2nd or 4th 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, GA₃ and Ethrel have been reported to influence sex suppression of male flower (Rafeekharet *al.*, 2001) 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. Material and Methods

2.1 Location and weather condition

The study aimed to assess cucumber production potential. Conducted at the College farm of SardarkrushinagarDantiwada 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 (GA₃), 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.*, T₁: Control (Water spray), T₂: NAA at 50 ppm, T₃: NAA at 75 ppm, T₄: NAA at 100 ppm, T₅: GA₃ at 20 ppm, T₆: GA₃ at 40 ppm, T₇: GA₃ at 60 ppm, T₈: Ethrel at 100 ppm, T₉: Ethrel at 200 ppm, and T₁₀: Ethrel at 300 ppm.

2.3 Preparation of spray solution

For the preparation of foliar spray solutions, the required quantity of GA₃, NAA and Ethrel were weighed separately. GA₃ 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 GA₃. Then desired concentration of NAA (50 ppm, 75 ppm, 100 ppm) and GA₃ (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 (1985). 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 (T₁₀). 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.* (2012) and Nayak *et al.* (2017) 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.* (2017) 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 GA₃ at 40 ppm (T₆) 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 GA₃ treatment can be attributed to the positive impact of GA₃ 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 Dostogiret *et al.* (2006) and Birdaret *et al.* (2014) in bitter gourd, as well as with Farhana (2015), Baqi *et al.* (2018) and Kadi *et al.* (2018) in cucumber. Additionally, the consistency of these results extends to the study by Hidaytullahet *et al.* (2012) 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 T₆ (GA₃@ 40 ppm) demonstrating the highest values. The observed enhancement in fruit dimensions in response to GA₃ aligns with the findings of Ghani *et al.* (2013) and Vadigeriet *al.* (2001). 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 GA₃. This outcome resonates with the results reported by Sondarvaet *al.* (2016) in ridge gourd and by Singh and Choudhary (1989) and Pawar *et al.* (2019) in cucumber, highlighting the consistent influence of GA₃ on fruit morphology across various plant species.

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 GA₃ 40 ppm showed maximum (5.73 °Brix) total soluble solid in fruit. The results supported by the findings of Kadi *et al.* (2018) in cucumber.

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

Conclusion

In conclusion, the study reveals that different treatments significantly influenced fruit yield and quality in cucumber vines. Treatment T₁₀, 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 (T₄). However, Treatment T₆, 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 T₆ 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.

Reference

- Baqi A, Manohar R, Krishna and Sankar AG. Effect of GA₃ and NAA with pruning levels on growth, sex expression and yield attributes of cucumber (*Cucumis sativus* L. Malini F₁) under protected condition. *International Journal of Chemical Studies*. 2018;6(4): 1991-1996.
- Batlang U, Emongor VE and Pule-Meulenburg F. Effect of benzyladenine plus gibberellins and gibberellic Acid on yield and yield component of cucumber (*Cucumis sativus* L. cv. 'tempo'). *Journal of Agronomy*. 2008; 5(3): 418-423.
- Biradar G, Chetti MB and Navalgatti CM. Effect of plant growth regulators on leaf biochemical characters and fruit yield components of bitter melon (*Momordica charantia* L.) cvs. MHBI-15 and Chaman Plus. *Journal of Horticulture Science*. 2014;9(1): 43-47.
- Dostogir H, AbdulKM, Habibur R, Pramanik M and Syedur Rahman AAM Effect of gibberellic acid (GA₃) on flowering and fruit development of bitter melon (*Momordica charantia* L.). *International Journal of Botany*. 2006;2(3): 329-332.

- Farhana U. Effect of plant growth regulators on flowering behavior and yield of cucumber. M.sc. (Agri. Botany), Thesis (unpublished). Department of Agricultural Botany Sher – Bangla Agricultural University, Dhaka, 2015.
- Ghani MA, Amjad M, Iqbal Q, Nawaz K, Ahmad T, Hafeez OB and Abbas M. Efficacy of plant growth regulators on sex expression, earliness and yield components in bitter gourd (*Momordica charantia* L.). *Pakistan Journal of Soil Science*. 2013;**10**(10): 1-7.
- Gosai S, Adhikari S, Khanal S and Poudel PB. Effects of plant growth regulators on growth, flowering, fruiting and fruit yield of cucumber (*Cucumis sativus* L.): A review. *Archives of Agriculture and Environmental Science*. 2020;**5**(3): 268-274.
- Hidaytullah T, Mahmood M, Farooq MA and Hussain SI. Plant growth regulators effecting sex expression of bottle gourd (*Lagenaria siceraria* Molina) plants. *Pakistan Journal of Agricultural Research*. 2012;**25**(1): 50.
- Kadi AS, Asati KP, Barche S and Tilasigeri RG. Effect of different plant growth regulators on growth, yield and quality parameters in cucumber (*Cucumis sativus* L.) under polyhouse condition. *International Journal of Current Microbiology and Applied Sciences*. 2018; **7**(4): 3339-3352.
- Mehdi M, Ahmed N, Jabeen N and Afroza B. Effect of different concentration of ethrel on growth, fruiting behavior and yield of cucumber (*Cucumis sativus* L.) under green house condition. *Asian Journal of Horticulture*. 2012;**7**(2): 579-581.
- Nayak SR, Parmar VK, Patel AN, Suchismita J, Lathiya JB and Tandel YN. Efficacy of pinching and plant growth regulators in enhancing yield characters of cucumber (*Cucumis sativus* L.). *International Journal of Chemical Studies*. 2017;**6**(1): 1804-1807.
- Panse VG and Sukhatme PV. Statistical Methods for Agricultural Workers. ICAR, New Delhi. 1985; pp. 97- 151.
- Pawar V, Meena MK, Jadia M and Basediya SS. Study of influence of plant growth regulators on yield attributing characters in cucumber. *International Journal of Pure and Applied Bioscience*. 2019;**7**(3): 318-324.
- Rafeekher M, Gondane SU, Gormnagar HB, Murkute AA, Chaudhari DU and Patil RR. Hormonal regulation of growth, sex expression and yield of cucumber in kharif crops. *Journal of Soils and Crops*. 2001; **11**(10): 95-98.
- Singh RK and Choudhary B. Differential response of three generation of cucurbits to boron and plant growth regulators. *Indian Journal of Horticulture*. 1989;**46**(2): 215-221.
- Sondarva J, Patel NB and Patel JV. Effect of plant growth regulators and stages of spray on seed yield and seed quality parameters of ridge gourd [*Luffa acutangula* (Roxb) L.]. *Journal of Applied and Natural Science*. 2016;**8**(3): 1551-1555.
- Vadigeri BG, Madalgeri BB, Sheelavantar MN. Effect of ethrel and gibberellic acid on yield and quality of cucumber varieties. *Karnataka Journal of Agricultural Science*. 2001;**14**(3): 727-30.