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Impact of plant growth regulators on the growth and flowering of cucumber (*Cucumis sativus* L.)

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Abstract
This research aimed to evaluate the impact of plant growth regulators on the growth and flowering of cucumber (*Cucumis sativus* L.) at the Department of Vegetable Science, COH, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, during the 2019-2020 period. The field experiment results demonstrated that GA_3 at 40 ppm had a significant positive effect on the length of the main vine at 60 and 90 days after sowing (DAS), as well as minimum days required for the first male flower to appear and for the fruit to reach edible maturity. Additionally, the application of Ethrel at 300 ppm resulted in a substantial increase female flowers and an elevated number of male flowers, thereby influencing the sex ratio.

Keywords: PGR, Cucumber GA, Ethrel, NAA

Introduction
As most vegetables are good suppliers of vitamins and minerals, they have a significant potential to enhance consumer nutrition and consequently, their physical well-beings. According Nayak *et al.*, 2017 [10], the cucurbitaceae family, which includes the majority of summer vegetable crops is notable for its farmed plant species' high levels of stiffness and rarity of woodiness or arborescence. One of the precious plants among this group is cucumber (*Cucumis sativus* L.) a largely significant cross pollinated and most popular vegetable. Cucumber is an indigenous vegetable to India. Annual, monoecious climbing or running vine with hirsute or scabrous stems and ovate triangular leaflets sprouting shallow and acute sinuses. Cucumber's sex expression is deliberated by genetics as well as environment factors such as photoperiod and temperature. The PGRs may have an impact on the complicated process that occurs as vegetation moves from vegetative development to the generative stages (Ansari and chowdhary, 2018) [1].

Cucumber is widely consumed both fresh and as a processed food. It can be categorized into three types based on its use; salad, pickling and cooking. The primary focus of cultivation is on its young tender fruits, commonly used in salads. However, mature fruits can also be cooked or pickled. The plant exhibits early flowering, yielding marketable fruits within two or three months, influenced by factors like the cultivar, region, soil and climate. Flowering is critical developmental phase in cucurbits as fruiting and yield depend on this process. Typically, *Cucumis sativus* is a monoecious plant, and the first flower to appear near the base of a cucumber plant is male. About 7-8 days later, female flowers emerge with small ovaries at the base (Farhana, 2015) [5].

PGRs play a significant role in production of fruit in cucurbits. They can alter growth and blossoming, maximizing fruit set and eventually raising the yields of crops. In these plant seems to be a strong connection between growth factors and sex expression. PGRs influence on different physiological and biochemical processes in plants is well established. They affect the production of the earliest flowers, yield, the ratio of male to female flowers, number of fruits and the fruit weight. Physiological processes control flower bud initiation, flower development and fruit development. Proper application of PGRs can be utilized to alter these processes in many agricultural plants. For cucurbits, application of PGRs has shown to change the sex expression of cucurbits toward maximum female flowers production while reducing that of male flowers. Etheral has been particularly efficient in inducing early female flowers, even at lower concentrations (Farhana, 2015) [5].

Cucumbers are highly sensitive to environmental conditions, and the use of PGRs can significantly influence their growth and flowering. Understanding the specific roles of PGRs in

cucumber production enable farmers and horticulturists to optimize cultivation practices and achieve desired outcomes.

Materials and Methods

The research was carried in the summer season of 2020 at the College farm, COH, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Dist. Mehsana, Gujarat, India. The study followed a RBD with three replications. Three plant growth regulators (PGRs) were utilized: gibberellic acid (GA_3), Naphthalene acetic acid (NAA), and ethrel. Sprays of each PGR were administered at the 2-4 true leaf stages, resulting in a total of ten treatments for the field trial. The following treatments were assessed: 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.

Results and Discussions

Growth parameters

The treatment T_6 (GA3 40 ppm) showed the highest length of the main vine at 60 DAS (days after sowing), measuring 150.90 cm. Similarly, at 90 DAS, the main vine length was also highest with the application of GA_3 40 ppm (T_6), reaching 249.20 cm. The observed increase in main vine length can be attributed to the mechanism of GA_3, which stimulates cell division, elongation, and expansion in cucumber vines. These findings align with earliest studies conducted by Ansari and Chowdhary *et al.* (2018) [1] and Kumari *et al.* (2019) [9] in bottle gourd, as well as Baqi *et al.* (2018) [2] and Kadi *et al.* (2018) [7] in cucumber. Furthermore, the treatment T_6 (GA_3 40 ppm) resulted in the shortest duration (7.77 days) from fruit set to edible maturity.

Flowering parameters

The minimum days (33.92) taken for appearance of first male flower was recorded with treatment T_7 (GA_3 60 ppm). The result occurs in findings of Dostogir *et al*. (2006) [4] in the case of bitter gourd and Farahana (2015) in the case of cucumber. Application of Ethrel 300 ppm (T_{10}) recorded lowest number of male flowers (124.12) per vine, maximum female flowers (17.43) and lowest male to female flower sex ratio (7.12). The findings of the current study are consistent with those of Patel *et al.* (2017) who found that ethrel decrease the sex ratio and male flowers with increased the amount of female flowers per plant in bottle gourd. The findings of Hiyadtullah *et al.* (2012) [6], Kumari *et al.* (2019) [9], Chaudhary *et al.* (2016) [3] and Khatoon *et al.* (2019) [8] in the fields of bottle gourd, watermelon and bitter gourds complement these results.

Table 1: Impact of plant growth regulators on growth parameters of cucumber

Treatments No.	Treatment	Length of main vine (cm)		Days taken from fruit set to edible maturity
		60 DAS	90 DAS	
T_1	Control (Water spray)	113.82	200.53	12.13
T_2	NAA @ 50 ppm	131.35	231.04	10.79
T_3	NAA @ 75 ppm	122.39	217.47	10.12
T_4	NAA @ 100 ppm	122.75	223.73	10.79
T_5	GA_3 @ 20 ppm	129.28	233.65	11.12
T_6	GA_3 @ 40 ppm	150.90	249.20	7.77
T_7	GA_3 @ 60 ppm	143.37	234.07	8.64
T_8	Ethrel @ 100 ppm	122.91	214.90	9.93
T_9	Ethrel @ 200 ppm	129.71	236.81	9.39
T_{10}	Ethrel @ 300 ppm	131.30	238.23	9.86
S.Em. ±		5.374	8.874	0.413
C.D. at 5%		15.97	26.36	1.23
C.V. %		7.17	6.74	7.11

Table 2: Impact of plant growth regulators on flowering parameters of cucumber

Treatments No.	Treatment	Days taken for appearance of first male flower	Number of male flowers	Number of female flowers	Sex ratio
T_1	Control (Water spray)	41.56	136.80	11.71	11.68
T_2	NAA @ 50 ppm	39.02	131.19	12.72	10.31
T_3	NAA @ 75 ppm	39.71	133.01	13.15	10.11
T_4	NAA @ 100 ppm	40.50	146.19	15.00	9.75
T_5	GA_3 @ 20 ppm	39.22	148.06	14.48	10.23
T_6	GA_3 @ 40 ppm	35.19	183.40	14.54	12.61
T_7	GA_3 @ 60 ppm	33.92	168.74	13.31	12.68
T_8	Ethrel @ 100 ppm	39.12	145.01	13.97	10.38
T_9	Ethrel @ 200 ppm	38.12	138.53	15.15	9.14
T_{10}	Ethrel @ 300 ppm	37.52	124.12	17.43	7.12
S.Em. ±		1.245	5.305	0.545	0.566
C.D. at 5%		3.70	15.76	1.62	1.68
C.V. %		5.62	6.31	6.67	9.43

Conclusion

It can be concluded from the result obtained from the experiment that the use of GA_3 at 40 ppm in cucumber plants enhanced growth parameters, including increased main vine length and reduced time to edible maturity. Additionally, GA_3 at 60 ppm promoted early male flower appearance. Ethrel at 300 ppm influenced flowering parameters by increasing the proportion of female flowers and changing the sex ratio.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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