International Journal of Environment and Climate Change

Volume 13, Issue 9, Page 3583-3590, 2023; Article no.IJECC.104288
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

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

Deepika Katta [a++*] and Deepanshu [a#]

[a] Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj – 211007,Uttar Pradesh, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2023/v13i92610

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/104288

Original Research Article

Received: 01/06/2023
Accepted: 04/08/2023
Published: 12/08/2023

ABSTRACT

An experiment entitled Effect of plant growth regulators on growth, yield and quality of cucumber (*Cucumis sativus* L.) was conducted at Horticulture Research Field, Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj during July-October, 2022. The experiment was laid out in Randomized Block Design with thirteen treatments and replicated thrice. The growth regulators were sprayed at two true leaf stage and four true leaf stages. Data was collected from vine length, days to first appearance of male flowers, days to first appearance of female flowers, days to 50% pistillate flowers, days to first harvest, length of fruit, fruit weight, fruit diameter, number of fruits per plant, average yield per plant, yield per hectare, Total Soluble Solids, and vitamin C and analyzed using analysis of variance. Results showed that GA_3 175 ppm sprayed at 2 and 4 true leaf stage of cucumber hybrid TMCU-1107 was superior in terms of vine length (119.56cm), days to first appearance of male flowers (32.16), days to first appearance of female

---

[++] *M. Sc. Scholar;*
[#] *Assistant Professor;*
**Corresponding author: E-mail: kattadeepika9@gmail.com;*

flowers (38.2), days to 50% pistillate flowers (41.2), days to first harvest (52.41), fruit weight (255.86g), length of the fruit (17.27cm), fruit diameter (4.82cm), number of fruits per plant (12.16), average yield per plant (3117.11g), yield per hectare (27.7t/ha), TSS (4.23 ^{0}Brix), Vitamin C (2.05mg/100g).

Keywords: Cucumber; GA3; growth; yield; quality.

1. INTRODUCTION

Cucumber (*Cucumis sativus* L.)is a warm season annual crop with climbing and trailing habit. Cucumber is cross pollinated crop and propagated by seed. It is primarily grow for processing (pickling) or for fresh market (slicing). Bitter principle present in the cucumber is cucurbitacin i.e. tetracyclic triterpenes. The staminate flowers are normally much more than pistillate flowers in cucumber. The application of plant growth regulators such as auxin and gibberellin when applied at proper stage and concentrations plays an important role in modifying sex expression, plant growth, development and yield. Application of plant growth regulators can alter the sequence of male and female flowers when applied at 2 and 4 leaf stages. Hence by proper manipulation the sequence of flowering with the application of exogenous plant growth regulators, the yield of cucurbits can be increased. "Growth regulators have tremendous effects on sex expression and flowering in cucumber crop leading to either suppression of male flowers or an increase in the number of female flowers without imposing any deleterious effect on the environment and human health" [1]. "NAA is a synthetic form of Auxin that have great impact on sex modification, cell division, vascular tissue differentiation, root initiation, apical dominance, leaf senescence, leaf and fruit abscission, fruit setting ratio, prevent fruit dropping, promote flower sex ratio and flowering. Gibberellic acid (GA_3) is an important growth regulator which promotes growth, cell elongation, cambial activity, stimulate nucleic acid and protein synthesis, seed germination and help in breaking dormancy, fruit set and leaf expansion. They are used in low concentrations to change the plant growth usually by stimulating part of the natural growth regulatory system" [2]. Maleic Hydrazide is a growth retardant that reduces growth through preventing cell division but not cell enlargement. Generally, it is used for enhancing flowering especially increasing female and male flower sex proportion, ultimately escalating the yield by better fruit setting. Ethylene is regarded as a multifunctional phytohormone that regulates both growth, and senescence. It promotes or inhibits growth and senescence processes depending on its concentration, timing of application, and the plant species.

The effect of foliar application of NAA, GA_3, Ethrel, MH has been shown to change the physiological and developmental processes including plant vegetative growth, sex expression (male, female, hermaphrodite) yield components in cucumber. The PGR's (NAA, GA_3, Ethrel, MH) are used to improve themaximum number of fruits per plant i.e., yield of the crop and increases the female flowers in the crop and also used to control the vegetative growth of the cucumber. Therefore, the present investigation was executed to find out the most suitable concentration of different PGR's (NAA, GA_3, Ethrel & MH) on growth, yield and quality of cucumber.

2. MATERIALS AND METHODS

The experiment was carried out at the Horticulture Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P.) during July-October, 2022.The experiment was laid in Randomized Block Design with 13 treatments including control in three replications. The experiment materials consist of cucumber hybrid TMCU-1107 from Trimurti Plant Sciences Pvt. Ltd. Hyderabad and thirteen treatments were tried and replicated thrice *viz.* T_0: Control (Water Spray), T_1:NAA@75 ppm, T_2:NAA@125 ppm, T_3:NAA@175 ppm, T_4:GA3@75 ppm, T_5:GA3@125 ppm, T_6:GA3@175 ppm, T_7:Ethrel@75 ppm, T_8:Ethrel@125 ppm, T_9:Ethrel@175 ppm, T_{10}:MH@75 ppm, T_{11}:MH@125 ppm, T_{12}:MH@175ppm with the spacing of 150×75 cm were applied at 2 and 4 true leaf stage in Cucumber. The data was collected from parameters *viz.* vine length (cm), days to first appearance of male flowers, days to first appearance of female flowers, days to 50% pistillate flowers, days to first harvest, length of

fruit (cm), fruit weight (g), fruit diameter(cm), number of fruits per plant, average yield per plant(g), yield per hectare (t/ha), TSS (^{o}Brix), Vitamin C(mg/100g). Five plants were randomly selected for recording observations for growth, yield and quality parameters. The data collected during course of investigation were subjected to statistical analysis of variance (ANOVA) as described by Fisher (1950).

3. RESULTS AND DISCUSSION

3.1 Effect of Plant Growth Regulators on Vine Length

Results in Table 1 showed significant difference in vine length. Longer vine length 131.28 cm at 60 days after sowing was recorded in T_6 (GA_3 @175 ppm) followed by 130.51cm in T_9 (Ethrel @ 175ppm) whereas shorter vine length 119.56 cm was recorded in T_0 control in Table 1. GA_3 is synthesized in young leaves, root and immature shoots and move in all directions and in all tissues including xylem and phloem which might have caused increase in cell elongation which leads to increase the internodal length of the vine, thereby increase in vine length. Similar findings were reported by Kadi et al. [3] and Shafeek et al. [4] in Cucumber.

3.2 Earliness Parameters

3.2.1 Effect of Plant growth regulators on days to first appearance of male flowers

Days to first appearance of male flower data shows the significant result. The minimum days to appearance of first male flowering recorded in T_6 GA_3 175 ppm (32.16) followed by T_9 Ethrel@ 175ppm (33) where as maximum days to appearance of first male flowers T_0 control (39) in Table 1. GA_3 causes rapid growth of flower primordia, high temperature during growth period and expansion of first true leaf stage which might causes the early appearance of male flower. Similar findings were reported by Farhana [5].

3.2.2 Effect of Plant growth regulators on days to first appearance of female flowers

Days to first appearance of female flower data shows the significant result. The minimum days to appearance of first female flowering recorded in T_6 GA_3 175 ppm (38.2) followed by T_9 Ethrel@ 175ppm (40.23)whereas maximum days to appearance of first female flowers T_0 control (43.69) Table 1. GA_3 causes cell differentiation and rapid growth of flower which enhances flowering in day neutral plants growing under inducive conditions which might be the cause of early appearance of female flower. Similar findings were reported by Dalai et al. (2016).

3.2.3 Effect of Plant growth regulators on days to 50% pistillate flowers

Days to 50% pistillate flower data shows the significant result. The minimum days to days to 50% pistillateflowering recorded in T_6 GA_3 175 ppm (41.2) followed by T_9 Ethrel@ 175ppm (43.23) where as maximum days to days to 50% pistillateflowers T_0 control (46.69) Table 1. GA_3 causes cell differentiation and rapid growth of flower which enhances flowering in day neutral plants growing under inducive conditions which might be the cause 50% pistillateflower. Similar findings were reported by Kadi et al. (2018), Hossain [6] and Shafeek et al. [4].

3.3 Yield Parameters

3.3.1 Effect of Plant growth regulators on days to first harvest

Days to first harvest data shows the significant result. The minimum days to days to first harvest recorded in T_6 GA_3 @175 ppm (52.41) followed by T_9 Ethrel @175ppm (54.45)where as maximum days to days to first harvest T_0 control(57.91) Table 2. GA_3 is synthesized in young leaves and roots and move in all directions and in all tissues including xylem and phloem which might have caused increase in metabolic activity leading to active translocation of nutrients to develop fruits which result in early maturity of fruits.Similar findings were reported by Anjanappa et al. [7].

3.3.2 Effect of Plant growth regulators on No of fruits per plant

Number of fruits per plant data shows the significant result. The maximum length of the fruit recorded in T_6 GA_3 @175 ppm (12.16) followed by T_9 Ethrel@ 175ppm (11.39) where as minimum Number of fruits per plant in T_0 control (8.55) Table 2. GA_3 concentration might have suppressed the male flowers and promotes the female flowers which results in more number of fruit set there by increasing the number of fruits. Similar findings were reported by Batlang et al. [8] and Choudhury and Phatak [9].

3.3.3 Effect of Plant growth regulators on Fruit length (cm)

Length of the fruit data shows the significant result. The maximum length of the fruit recorded

in T_6 GA_3 @175 ppm (17.27) followed by T_9Ethrel@ 175ppm (16.65) where as minimum length of the fruit in T_0 control (11.78) Table 2. GA_3 increased rate of photosynthesis activity, accelerated translocation and efficiency of utilization of photosynthates, thus resulting in the cell elongation and rapid cell division in the growing portion which increase fruit length. Similar findings were reported by Kadi et al. [3], Shafeek et al. [4] and Farhana [5].

3.3.4 Effect of Plant growth regulators on Fruit weight (g)

Fruit weight data shows the significant result. The maximum fruit weight recorded in T_6 GA_3 @175 ppm (255.87) followed by T_9 Ethrel @175ppm (245.03)where as minimum fruit weight in T_0 control (171.55) Table 2. GA_3 increased rate of photosynthesis activity, accelerated translocation and efficiency of utilization of photosynthates, thus resulting in the cell elongation and rapid cell division in the growing portion which increase fruit weight. Promotion of individual fruit weight by application of GA_3 were also reported by Kadi et al. [3], Shafeek et al. [4] and Farhana [5] that parallel to our findings.

3.3.5 Effect of Plant growth regulators on Fruit diameter (cm)

Fruit diameter data shows the significant result. The maximum fruit diameter recorded in T_6 GA_3 @175 ppm (4.82) followed by T_9 Ethrel@ 175ppm (4.7) where as minimum fruit diameter in T_0 control (3.5) Table 2. GA_3 increased rate of photosynthesis activity, accelerated translocation and efficiency of utilization of photosynthates, thus resulting in the cell elongation and rapid cell division in the growing portion which increase fruit diameter. Similar findings were reported by Kadi et al. [3], Shafeek et al. [4] and Farhana [5].

3.3.6 Effect of Plant growth regulators on Average yield per plant (g)

Average yield per plant data shows the significant result. The maximum average yield per plant recorded in T_6 GA_3 @175 ppm (3117.11) followed by T_9 Ethrel@ 175ppm (2796.12)where as minimum average yield per plant in T_0 control (1471.8) Table 2. Optimum GA_3 concentration might have suppressed the male flowers and promoted the female flowers which results in more number of fruits, increased rate of photosynthesis, accelerated translocation and efficiency of utilization of photosynthates, thus resulting in increased average weight which is directly proportional to increased yield per plant. Similar findings were reported by Kadi et al. [3], Shafeek et al. [4] and Farhana [5].

3.3.7 Effect of Plant growth regulators on Yield tonnes per hectare

Length of the fruit data shows the significant result. The maximum length of the fruit recorded in T_6 GA_3 @175ppm (27.71) followed by T_9 Ethrel @ 175ppm (24.85)where as minimum length of the fruit in T_0 control (13.08) Table 2. Optimum GA_3 concentration might have suppressed the male flowers and promoted the female flowers which results in more number of fruits, increased rate of photosynthesis, accelerated translocation and efficiency of utilization of photosynthates, thus resulting in increased average weight which is directly proportional to increased yield tonnes per hectare. Similar findings were reported by Kadi et al. [3], Shafeek et al. [4], Farhana [5] and Dalai et al. (2016).

3.4 Quality Parameters

3.4.1 Effect of Plant growth regulators on TSS (^{0}Brix)

Total soluble solids (^{0}Brix) show the significant result. The maximum Total soluble solids (^{0}Brix) recorded in T_6 GA_3 @175ppm (4.24) followed by T_9 Ethrel @ 175ppm (4.16)where as minimum Total soluble solids (^{0}Brix) in T_0 control (2.47) Table 3. "GA_3 concentration might be due to quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to developing fruits" Kameswari et al. [10].

3.4.2 Effect of Plant growth regulators on Vitamin C (mg/100g)

Vitamin C (mg/100g) shows the significant result. The maximum Vitamin C (mg/100g) recorded in T_6 GA_3 @175ppm (2.05) followed by T_9Ethrel @ 175ppm (2)where as minimum Vitamin C (mg/100g) in T_0 control (1.14) Table 3. GA_3 concentration might be due to quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to developing fruits. Similar findings were reported by Meenakshi et al. [11].

Table 1. Effect of PGR's on growth and earliness parameters of Cucumber

Treatments	Vine length (cm)	Days to first appearance of male flowers	Days to first appearance of female flowers	Days to 50% pistillate flowers
Control (Water spray)	119.56	39	43.69	46.69
NAA @75ppm	122.25	37	43	46
NAA @ 125ppm	121.68	37.5	43.17	46.17
NAA @175ppm	120.79	38	43.28	46.28
GA3 @75ppm	127.26	35	40.47	43.47
GA3@125ppm	129.30	34	40.1	43.1
GA3@175ppm	131.28	32.16	38.2	41.2
Ethrel @75ppm	126.21	35.5	41.26	44.26
Ethrel @125ppm	128.62	34.5	40.64	43.64
Ethrel @175ppm	130.51	33	40.23	43.23
MH @75ppm	123.26	36.5	42.63	45.63
MH @125ppm	124.69	36.5	42.28	45.28
MH @175ppm	125.49	36	42.22	45.22
F-TEST	**S**	**S**	**S**	**S**
SE(d)±	0.14	0.07	0.13	0.13
$CD_{0.05}$	0.30	0.13	0.26	0.26

Table 2. Effect of PGR's on yield parameters of Cucumber

Treatments	Days to first harvest	No. of fruits per plant	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Average yield per plant (g)	Total Yield (t/ha)
Control (Water spray)	**57.91**	**8.55**	**171.55**	**11.78**	**3.5**	**1471.8**	**13.08**
NAA @75ppm	57.21	9.15	184.83	12.75	3.86	1698.71	15.1
NAA @ 125ppm	57.38	9.04	174.17	12.67	3.81	1577.12	14.02
NAA @175ppm	57.49	8.82	173.16	12.66	3.82	1533.77	13.63
GA3 @75ppm	54.68	10.61	217.13	14.17	4.55	2310.58	20.54
GA3@125ppm	54.31	11.41	233.8	16.27	4.54	2664.32	23.68
GA3@175ppm	52.41	12.16	255.87	17.27	4.82	3117.11	27.71
Ethrel @75ppm	55.47	10.41	214.16	13.71	4.44	2236.88	19.88
Ethrel @125ppm	54.85	11.11	225.27	15.32	4.48	2507.95	22.29
Ethrel @175ppm	54.45	11.39	245.03	16.65	4.7	2796.12	24.85
MH @75ppm	56.85	9.21	193.46	13.23	4.09	1787.08	15.88
MH @125ppm	56.49	9.26	198.27	13.36	4	1849.59	16.44
MH @175ppm	56.43	9.63	210.63	13.41	4.5	2033.26	18.1
F-TEST	**S**	**S**	**S**	**S**	**S**	**S**	**S**
SE(d)±	0.13	0.23	4.25	0.09	0.08	68.02	0.60
$CD_{0.05}$	026	0.48	8.77	0.19	0.16	140.38	1.25

Table 3. Effect of PGR's on quality parameters of Cucumber

Treatments	TSS(^{0}Brix)	Vitamin C
Control (Water spray)	2.47	1.14
NAA @75ppm	3.42	1.43
NAA @ 125ppm	3.22	1.18
NAA @175ppm	2.89	1.16
GA3 @75ppm	3.69	1.73
GA3@125ppm	4.13	1.82
GA3@175ppm	4.24	2.05
Ethrel @75ppm	3.85	1.65
Ethrel @125ppm	4.03	1.82
Ethrel @175ppm	4.16	2
MH @75ppm	3.45	1.49
MH @125ppm	3.49	1.6
MH @175ppm	3.67	1.63
F-TEST	**S**	**S**
SE(d)±	0.20	0.03
$CD_{0.05}$	0.42	0.07

4. CONCLUSION

The study concluded that the treatment T_6 i.e. application of GA_3 175 ppm at 2, 4 leaf stage was found superior in terms of vine length, days to first appearance of female flowers, days to first appearance of male flowers, days to first harvest, fruit weight in grams(g), length of the fruit(cm), fruit diameter(cm), number of fruits per plant, average yield per plant(g), Yield per hectare, TSS(^{0}Brix), Vitamin C(mg/100g. Hence spraying of GA_3 @175 ppm at 2, 4 leaf stages was recommended.

ACKNOWLEDGEMENT

The author is thankful to the Advisor and Department of Horticulture, Naini Agricultural Institute,Sam Higginbottom University of Agriculture Technology And sciences, Prayagraj(U.P.) India for providing necessary facilities to undertaken this research. This manuscript has not received any grant from any sources.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Al-Masoum AA, Al-Masri AA. Effect of ethephon on flowering and yield of monoecious cucumber. Egyptian Journal of Horticulture. 1999;26:229-236.
2. Dalai S, Singh MK, Kumar M, Singh KV and Kumar V. Growth, flowering and yield of cucumber (*Cucumis sativus* L.) as influenced by different levels of NAA and GA3. Journal of Plant Development Sciences. 2015;8(9):445-450.
3. Kadi AS, Asati KP, Barche S, Tulasiger 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.
4. Shafeek MR, Helmy YI, Ahmed AA, Ghoname AA. Effect of foliar application of growth regulators (GA3 and Ethereal) on growth, sex expression and yield of summer squash plants (*Cucurbita pepo* L.) under plastic house condition. International Journal of Chem Tech Research. 2016;9(6):70-76.
5. Farhana U. Effects of plant growth regulators on flowering behaviour and yield of cucumber. M.Sc. (Ag.) Thesis, Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh; 2015.
6. Hossain D, Karim MA, Pramanik MHR and Rahman AAMS. Effect of gibberellic acid (GA3) on flowering and fruit development of bitter gourd. International Journal of Botany. 2006;2:329-332.
7. Anjanappa M, Venkatesh J, Kumara SB. Growth, yield and quality attributes of cucumber (cv. Hassan local) as influenced by integrated nutrient management grown under protected condition. Vegetable Science. 2012;39:47-50.

8. Batlang U, Emongor VE and Pule-Meulenburg F. Effect of benzyladenine plus gibberellins and gibberellic acid on yield and yield components of cucumber (*Cucumis sativus* L. cv. tempo). Journal of Agronomy. 2006;5(3): 418-423.
9. Choudhury B, Phatak SC. Sex expression and sex ratio in cucumber (Cucumis sativus L.) as affected by plant regulator sprays. Indian Journal of Horticulture. 1959;16:162-169.
10. Kameswari PL, Narayanamma M. Influence of integrated nutrient management in ridge gourd (*Luffa acutangula* L.). Journal of Research ANGRAU. 2011;39:16-20.
11. Meenakshi N, Vadivel E, Kavtha M. Response of bitter gourd on fruit yield and quality traits as influenced by fertigation levels. Asian Journal of Horticulture. 2007; 2:126-130.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/104288