Original Research Article

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

Comment [NSN1]: Corrected

ABSTRACT

Comment [NSN2]: Corrected

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 having thirteen treatments replicated thrice. The growth regulators were sprayed at two true leaf stage and four true leaf stages. Application of GA_3 175 ppm was sprayed at 2 and 4 true leaf stage of cucumber hybrid TMCU-1107 was found superior in terms of vine length (119.56cm), days to first appearance of male flowers (32.16), days to first appearance of female 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).

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Key words: Cucumber, GA_3, Growth, yield, Quality.

Comment [NSN4]: Corrected

1. INTRODUCTION

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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 **Al-Masoum and Al-Masri1999** without imposing any deleterious effect on the environment and human health. 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 promote 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 **Dalai*et al.*, 2015** 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.

Comment [NSN6]: Corrected

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 conducted 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@75ppm,T_2:NAA@125ppm,T_3:NAA@175ppm,T_4:GA3@75ppm,T_5:GA3@125ppm,T_6:GA3@175ppm,T_7:Ethrel@75ppm,T_8:Ethrel@125ppm,T_9:Ethrel@175ppm,T_{10}:MH@75ppm, T_{11}:MH@125ppm,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 recorded for the following 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 by adopting appropriate method of analysis of variance as described by Fisher (1950).

3.RESULTS AND DISCUSSION

Comment [NSN7]: Corrected

3.1 Effect of Plant growth regulators on vine length

Vine length shows the significant result. 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 no.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.* (2018) and Shafeek*et al.* (2016)** 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_9Ethrel@ 175ppm (33)whereas maximum days to appearance of first male flowers T_0 control (39) in Table no.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 (2015)**

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_9Ethrel@ 175ppm (40.23)whereas maximum days to appearance of first female flowers T_0 control (43.69) Table no.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_9Ethrel@ 175ppm (43.23)where as maximum days to days to 50% pistillateflowers T_0control (46.69) Table no.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 (2014) and Shafeek*et al.* (2016)**

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_9Ethrel @175ppm (54.45)where as maximum days to days to first harvest T_0 control(57.91) Table no.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.* (2012)**

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_9Ethrel@ 175ppm (11.39)where as minimum Number of fruits per plant in T_0 control (8.55)Table no.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 *etal.* (2016) and Choudhury and Phatak (1959)**

3.3.3Effect 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 no.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.*(2018), Shafeek*et al*. (2016) and Farhana(2015)**

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_9Ethrel @175ppm (245.03)where as minimum fruit weight in T_0 control (171.55) Table no.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.*(2018), Shafeek*et al*. (2016) and Farhana(2015)** 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_9Ethrel@ 175ppm (4.7)where as minimum fruit diameter in T_0 control (3.5) Table no.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.*(2018), Shafeek*et al*. (2016) and Farhana(2015)**

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_9Ethrel@ 175ppm (2796.12)where as minimum average yield per plant in T_0 control (1471.8) Table no.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.*(2018), Shafeek*et al*. (2016) and Farhana(2015)**

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_9Ethrel @ 175ppm (24.85)where as minimum length of the fruit in T_0 control (13.08) Table no.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.*(2018), Shafeek*et al.* (2016), Farhana(2015) 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_9Ethrel @ 175ppm (4.16)where as minimum Total soluble solids (^{0}Brix) in T_0 control (2.47) Table no.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**Kameswari*et al.* (2011)**

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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 no.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.* (2007)**

4.CONCLUSION

Based on the results on the present investigation entitled "Effect of plant growth regulators on growth, yield and quality of Cucumber (*Cucumis sativus* L.)" it was 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.

COMPETING INTERESTS

Comment [NSN9]: Added section name

Authors have declared that no competing interests exist

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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