

Original Research Article

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

ABSTRACT

An experiment conducted to investigate the effect of plant growth regulators on growth, yield and quality of cucumber. It 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 replicated thrice. The growth regulator was sprayed at two true leaf 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 GA₃ 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 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 °Brix), Vitamin C (2.05mg/100g). This resulted in its application being recommended for use by the farming community.

Key words: 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 grown 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-Masri (1999) 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 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 (**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 (Reference).

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 the maximum 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, GA₃, Ethrel & MH) on growth, yield and quality of cucumber.

2. MATERIALS AND METHOD

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 replications three times. The experiment materials consisted of cucumber hybrid TMCU-1107 from Trimurti Plant Sciences Pvt. Ltd. and Hyderabad. The treatments were as follows: T₀: Control (Water Spray), T₁: NAA@75ppm, T₂: NAA@125ppm, T₃: NAA@175ppm, T₄: GA₃@75ppm, T₅: GA₃@125ppm, T₆: GA₃@175ppm, T₇: Ethrel@75ppm, T₈: Ethrel@125ppm, T₉: Ethrel@175ppm, T₁₀: MH@75ppm, T₁₁: MH@125ppm, T₁₂: 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 (°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 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. Long vine length 131.28 cm at 60 days after sowing was recorded in T₆ (GA₃ @175 ppm) followed by 130.51cm in T₉ (Ethrel @ 175ppm) whereas short vine length 119.56 cm was recorded in T₀ control. GA₃ 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.

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	39.00	43.69	46.69
NAA @75ppm	122.25	37.00	43.00	46.00
NAA @ 125ppm	121.68	37.50	43.17	46.17
NAA @175ppm	120.79	38.00	43.28	46.28
GA3 @75ppm	127.26	35.00	40.47	43.47
GA3@125ppm	129.30	34.00	40.10	43.10
GA3@175ppm	131.28	32.16	38.20	41.20
Ethrel @75ppm	126.21	35.50	41.26	44.26
Ethrel @125ppm	128.62	34.50	40.64	43.64
Ethrel @175ppm	130.51	33.00	40.23	43.23
MH @75ppm	123.26	36.50	42.63	45.63
MH @125ppm	124.69	36.50	42.28	45.28
MH @175ppm	125.49	36.00	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

3.2 Earliness Parameters

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

Results in Table 1 showed significant differences in days to first appearance of male and female flowers. The minimum days to appearance of first male flowering was recorded in T₆ GA₃ 175 ppm (32.16) followed by T₉ Ethrel@ 175ppm (33) where as maximum days to appearance of first male flowers T₀ control (39). This is attributed due to GA₃ which cause 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). The minimum days to appearance of first female flowering was recorded in T₆ GA₃ 175 ppm (38.2) followed by T₉ Ethrel@ 175ppm (40.23) where as maximum days to appearance of first female flowers T₀ control (43.69). This is attributed due to GA₃ which cause cell differentiation and rapid growth of flower. Similar findings were reported by Dalai *et al.* (2016).

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

Results in Table 1 showed significant differences in days to 50% pistillate flower. The minimum days to days to 50% pistillate flowering was recorded in T₆ GA₃ 175 ppm (41.2) followed by T₉ Ethrel@ 175ppm (43.23) where as maximum days to days to 50% pistillate

flowers T₀ control (46.69). This is attributed to GA₃ which cause cell differentiation and rapid growth of flowers. 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 number of fruits per plant and days to first harvest

Results in Table 2 showed significant differences in number of fruits per plant and days to first harvest. Maximum length of the fruit was recorded in T₆ GA₃ @175 ppm (12.16) followed by T₉ Ethrel@ 175ppm (11.39) where as minimum number of fruits per plant in T₀ control (8.55). This is attributed to GA₃ concentration could have suppressed the male flowers and promotes the female flowers resulting in increased number of fruit set thereby increasing number of fruits. Similar findings were reported by **Batlang et al. (2016) and Choudhury and Phatak (1959)**. The minimum days to days to first harvest were recorded in T₆ GA₃ @175 ppm (52.41) followed by T₉ Ethrel @175ppm (54.45) where as maximum days to first harvest T₀ control (57.91). This could be due to GA₃ contributing to the growth of young leaves and roots extending to all directions and in all tissues including xylem and phloem leading to increases 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)**.

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	3.50	1471.80	13.08
NAA @75ppm	57.21	9.15	184.83	12.75	3.86	1698.71	15.10
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	4.70	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	4.00	1849.59	16.44
MH @175ppm	56.43	9.63	210.63	13.41	4.50	2033.26	18.10
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

3.3.2 Effect of Plant growth regulators on fruit length and weight

Results in Table 2 showed significant differences in length and weight of the fruit. The maximum length of the fruit was recorded in T₆ GA₃ @175 ppm (17.27) followed by T₉ Ethrel@ 175ppm (16.65) where as minimum length of the fruit in T₀ control (11.78). This could be due to GA₃ which contributed to the 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 as reported by **Kadi et al.(2018)**, **Shafeek et al. (2016)** and **Farhana(2015)**. The maximum fruit weight was recorded in T₆ GA₃ @175 ppm (255.87) followed by T₉ Ethrel @175ppm (245.03) where as minimum fruit weight in T₀ control (171.55). GA₃ increased rate of photosynthesis activity and similarly reported by **Kadi et al.(2018)**, **Shafeek et al. (2016)** and **Farhana(2015)** that parallel to our findings.

3.3.3 Fruit diameter, average yield per plant

Results in Table 2 showed significant differences in fruit diameter and average yield per plant. Maximum fruit diameter was recorded in T₆ GA₃ @175 ppm (4.82) followed by T₉ Ethrel@ 175ppm (4.7) where as minimum fruit diameter in T₀ control (3.5). This is attributed to GA₃ which increases the rate of photosynthesis activity leading to, accelerated translocation and efficiency of utilization of photosynthates, ~~thus~~ resulting in the cell elongation and rapid cell division in the growing portion also reported by **Kadi et al. (2018)**, **Shafeek et al. (2016)** and **Farhana(2015)**. Average yield per plant was recorded in T₆ GA₃ @175 ppm (3117.11) followed by T₉ Ethrel@ 175ppm (2796.12) where as minimum average yield per plant in T₀ control (1471.8). Similar findings were reported by **Kadi et al.(2018)**, **Shafeek et al. (2016)** and **Farhana(2015)**.

3.4. Quality Parameters

Effect of Plant growth regulators on Total Soluble Solids and Vitamin C

Results in Table 3 showed significant differences in total soluble solids and vitamin C such that maximum total soluble solids was recorded in T₆ GA₃ @175ppm (4.24) followed by T₉ Ethrel @ 175ppm (4.16) where as minimum in T₀ control (2.47). This could be due to concentration GA₃ contribute to quick metabolic transformation of starch. Similar findings were reported by **Kameswari et al. (2011)**. Maximum vitamin C (mg/100g) was recorded in

T₆ GA₃ @ 175ppm (2.05) followed by T₉ Ethrel @ 175ppm (2) where as minimum Vitamin C (mg/100g) in T₀ control (1.14) similarly reported by **Meenakshi et al. (2007)**.

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

<u>Treatments</u>	<u>TSS(⁰Brix)</u>	<u>Vitamin C</u>
<u>Control (Water spray)</u>	<u>2.47</u>	<u>1.14</u>
<u>NAA @75ppm</u>	<u>3.42</u>	<u>1.43</u>
<u>NAA @ 125ppm</u>	<u>3.22</u>	<u>1.18</u>
<u>NAA @175ppm</u>	<u>2.89</u>	<u>1.16</u>
<u>GA3 @75ppm</u>	<u>3.69</u>	<u>1.73</u>
<u>GA3@125ppm</u>	<u>4.13</u>	<u>1.82</u>
<u>GA3@175ppm</u>	<u>4.24</u>	<u>2.05</u>
<u>Ethrel @75ppm</u>	<u>3.85</u>	<u>1.65</u>
<u>Ethrel @125ppm</u>	<u>4.03</u>	<u>1.82</u>
<u>Ethrel @175ppm</u>	<u>4.16</u>	<u>2.00</u>
<u>MH @75ppm</u>	<u>3.45</u>	<u>1.49</u>
<u>MH @125ppm</u>	<u>3.49</u>	<u>1.60</u>
<u>MH @175ppm</u>	<u>3.67</u>	<u>1.63</u>
<u>F-TEST</u>	<u>S</u>	<u>S</u>
<u>SE(d)±</u>	<u>0.20</u>	<u>0.03</u>
<u>CD_{0.05}</u>	<u>0.42</u>	<u>0.07</u>

4. CONCLUSION

In conclusion treatment T₆ i.e. application of GA₃ 175 ppm at 2, 4 leaf stage was superior in vine length, days to first appearance of female flowers, days to first appearance of male flowers, days to first harvest, fruit weight, length of the fruit, fruit diameter, number of fruits per plant, average yield per plant, yield per hectare, TSS and vitamin C therefore its application was recommended.

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