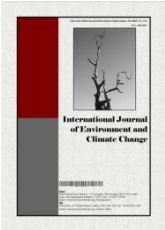

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Effect of Plant Growth Regulators on Growth Parameters of Bottle Gourd (*Lagenaria siceraria*) cv. MGH-4

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment entitled " Effect of plant growth regulators on growth, yield and fruit quality of Bottle Gourd (*Lagenaria siceraria*) cv. MGH-4" was conducted at Horticulture Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Uttar Pradesh) during 2019. Plant Growth regulators are regarded as one of the most important treatments, used nowadays in agriculture, which in most cases modify the plant growth and the subsequent fruiting. The experimental trial consisted two plant growth regulators having different concentration NAA (30, 40, 50, 60, 70 & 80 ppm) and

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GA_3(30,40, 50, 60 & 70 ppm). Water was used as a control. The application of plant growth regulators significantly affects the vegetative as well as reproductive attributes of the crop. Application of plant growth regulators at the 2-4 leaf stage was found to be the most productive in terms of growth attributes of bottle gourd. Treatment T_7 (80 ppm NAA) at 2-4 leaf stage showed the maximum vine length (8.20 m), Number of Leaves Per Plant (103.50) and took minimum Days to First Female Flower Initiation (53.33). However, the treatment T_9 (40 ppm GA_3) showed the maximum Number of Male Flowers Per Vine (54.08) and Number of Female Flowers Per vine (17.08). Plant Growth regulators are one of the most significant treatments currently used in agriculture, and they typically alter plant growth and subsequent fruiting and growth attributes.

Keywords: Bottle gourd; MGH-4; PGR; NAA; GA_3 and growth.

1. INTRODUCTION

In India, the bottle gourd [*Lagenaria siceraria* L. 2n = 2x = 22], also known as lauki, kadu, ghiya, or doodhi, is widely farmed. A good supply of carbs, vitamin A, vitamin C, and minerals may be found in this vegetable. Hilli et al. [1] the bottle gourd belongs to family Cucurbitaceae and it is a monecious climbing annual plant native to tropical Africa [2]. *Lagenaria siceraria* (Molina) Stands, which has a fleshy fruit and seeded pepo, is a popularly grown vegetable crop in tropical nations [3]. Bottle gourd has been discovered in its natural form in South Africa and India, according to De Candolle (1882). Based on the variety of seeds and fruits, Cutler and Whitaker [2] believe that it is likely native to tropical Africa. Rich and poor people both enjoy it because of its delectable, crisp, and tender fruits [4].

Bottle gourd in terms of glucose and fructose, the fruit provides an excellent provider. Ascorbic acid, a vitamin B component, is also present, and it is likewise well-known for its healing powers. Tryptophan (0.003 g), isoleucine (0.038 g), leucine (0.042 g), lysine (0.024 g), methionine (0.005 g), phenylalanine (0.017 g), valine (0.031 g), arginine (0.016 g), histidine (0.005 g), and threonine make up the fruit's amino acid makeup with one cup serving, or 116 (0.021 g). The fruit is the main source of nutrients including potassium (174 mg), calcium (30 mg), phosphorus (15 mg), magnesium (13 mg), sodium (2 mg), zinc (0.81 mg), iron (0.23 mg), manganese (0.077 mg), copper (0.03 mg), and selenium (0.2 mg), all of which are present in the same serving size of 116 g. [5]. The seed kernel contains 2.47% moisture, 30.72% protein, 52.54% oil, 8.33% carbs, 1.58% fibre, and 4.43% ash. The oil content of bottle gourd seed kernels is 52.54%. Iodine value (126.5), free fatty acids (0.54%), saponification value (301.6), and unsaponified matter (0.67%) are some of its features. Linoleic acids (64%), oleic acids (18.2%), and saturated fatty acids (17.8%) make up free fatty acids [6].

The blooming stage in cucurbits is crucial because it affects both fruiting and productivity. The staminate and pistillate blooms are found on the same plant in different configurations and individually [7]. In India, bottle gourds are typically harvested in two Seasons: the first from mid-October seeding to mid-March harvesting, and the second from early-March sowing to mid-July harvesting (harvest). It is an annual monoecious plant with a trailing or ascending vine. The stem has a hairy texture and protrudes long, forked tendrils. Flowers have stalks, with the stalks of the female flowers being shorter than the male. They are axillary, unisexual, and solitary. It produces hard-shelled fruits with a variety of morphologies, including long, oblong, and spherical.

The usage of bottle gourd juice in weight reduction treatments is common. It also aids in reducing liver and renal inflammation. Additionally, useful for curing diarrhoea is the juice of the bottle gourd. For people who are experiencing constipation, better food is available. A hair oil made from bottle gourds and sesame oil promotes restful sleep. It serves as one of the treatments for insomnia. Treatment for urinary tract infections with bottle gourd.

Currently, plant growth regulators are employed to manage a variety of physiological processes in crop production, including as blooming and fruiting (fruit set and parthenocarpy). Additionally, they are utilised in post-harvest ripening, germination, growth inhibition, and assimilate partitioning (Weaver, 1975). PGRs are used sparingly to control plant growth. Additionally, they regulate blooming, fruit set, shoot and root development, internode length, and fruit ripening. PGRs, which are commonly utilised in

horticulture, have been used to alter when certain fruits and vegetables blossom and bear fruit [8].

Gibberellic acid is a crucial growth regulator that may be used in a variety of ways to alter plant growth, yield, and yield-contributing traits [9]. Although there are four different forms of gibberellins, gibberellic acid, GA_3, is the most well-known. It stimulates cambial activity, growth, cell elongation, nucleic acid and protein synthesis, seed germination, as well as fruit set, leaf expansion, and dormancy break [10].

NAA is a crucial plant growth regulator that promotes cell division, cell elongation, and cell enlargement in the apical part of plants, which improves bottle gourd plant development [11]. NAA is utilised in chemical fruit thinning, fruit drop prevention, flower induction, larger fruit setting, and hence higher yield. Through the production of the enzymes needed for the creation of cell wall and cytoplasmic components, NAA interacts with genes. Consistent blooming is started by NAA. The biggest fruits with the highest flesh were obtained in cucumbers after NAA spraying [12].

"Use of PGR's could be a useful alternative for increasing crop production. GA_3 and NAA are important growth regulators that can modify growth, sex ratio and yield-contributing characters in a plant" [13]. Exogenous application of plant growth regulators can alter the sex ratio and sequence, if applied at 2 or 4 leaf stage which is the critical stage for suppression or promotion of either sex [14].

2. MATERIALS AND METHODS

The present investigation was conducted at Horticulture Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during mid-March to August during 2019.

2.1 Experimental Design and Treatments

MGH-4 cultivar of Bottle gourd was used for the experiment. The experiment was laid out in Randomized Block Design with three replications**.** Gibberellic acid (30, 40, 50, 60, 70 and 80 ppm) and naphthalene acetic acid (30, 40, 50, 60, and 70 ppm) treatments were applied to the bottle guard variety MGH-4 at 2-4 leaf stage of bottle gourd. It was impractical to collect observations on every plant due to the magnitude of the plant population; thus, the technique of random sampling was used to record observations of the plant's many growth metrics during the research. From each plot's representative sample of the whole population, three plants were chosen at random. Total number of 12 treatments was comprised during course of investigation including different concentration of NAA and GA_3. The treatments are as follows-

Sr. No.	Treatment notation	Treatments	Stage of treatment
1.	T_1	(Control)	At 2-4 Leaf Stage
2.	T_2	(30 ppm NAA)	At 2-4 Leaf Stage
3.	T_3	(40 ppm NAA)	At 2-4 Leaf Stage
4.	T_4	(50 ppm NAA)	At 2-4 Leaf Stage
5.	T_5	(60 ppm NAA)	At 2-4 Leaf Stage
6.	T_6	(70 ppm NAA)	At 2-4 Leaf Stage
7.	T_7	(80 ppm NAA)	At 2-4 Leaf Stage
8.	T_8	(30 ppm GA_3)	At 2-4 Leaf Stage
9.	T_9	(40 ppm GA_3)	At 2-4 Leaf Stage
10.	T_{10}	(50 ppm GA_3)	At 2-4 Leaf Stage
11.	T_{11}	(60 ppm GA_3)	At 2-4 Leaf Stage
12.	T_{12}	(70 ppm GA_3)	At 2-4 Leaf Stage

2.2 Parameters of Study

2.2.1 Vine Length (m)

Length of main vine of all the three plants of a plot was measured using ruler or measuring tape.

2.2.2 Number of leaves per plant

Total number of green leaves was estimated by counting the individual leaf from top to bottom of the plant and the mean value of three plants selected at random in each treatment was expressed as number of leaves per plant.

2.2.3 Days to first male flower initiation

The number of days taken from the date of sowing to the date of first male flower was

observed in all the three plants of a plot and average was calculated and it was recorded as number of days to first male flower.

2.2.4 Days to first female flower initiation

The number of days taken from the date sowing to the date of first female flower initiation was observed in all the three plants or a plot and average was calculated and it was recorded as number of days first female flower.

2.2.5 Number of male flowers per vine

Number at male flower opened in individual plants of a plot was recorded as number of male flower and average was calculated of the plants.

2.2.6 Number of female flowers per vine

Number at female flower opened in individual plants of a plot was recorded as number of female flower and average was calculated of the plants.

2.3 Statistical Analysis

2.3.1 Standard error of mean

The standard error (S.E.) and critical difference (C.D.) values were calculated by the following method as described below,

Formula:

$$\mathbf{SE(Mean \pm)} = \sqrt{\frac{\mathbf{2MSE}}{\mathbf{r}}}$$

Where,

MSE = Mean sum of square due to error
r = Number of replications

2.3.2 Critical difference

The critical difference at 5% at level of probability was workout to compare treatments means wherever “F” test will be significant.

The calculation of C.D. at 5% was calculated with the help of following formula:

C. D.= $SEm \pm \sqrt{2} \times tabulated\ value\ error\ d.f.\ at\ 5\%$

Where,

C. D.= Critical difference
SE (m±) = Standard error of mean

3. RESULTS

The findings of the current study on the impact of plant growth regulators on bottle gourd growth characteristics. The findings have been explained in terms of the effects of several experimental treatments. The results of the experiment have been presented separately under the following headings.

3.1 Vine Length (m)

Vine length data shows the significant results. The maximum vine length recorded in T_7 NAA 80 ppm was (8.20 m) followed by GA_3 30 ppm (7.45 m) which was found to be at par with each other and both treatments were superior to the T1 control (3.05 m).

3.2 Number of Leaves per Plant

Number of leaves per plant data shows T_7 NAA 80 ppm recorded significantly higher number of leaves per plant (103.5) as compare other treatments at full foliage stage of bottle gourd. whereas minimum number of leaves was recorded in T_1 control water spray (46.083) which was significantly lower over all the treatments.

3.3 Days to First Male Flower Initiation

Days to first male flower initiation data shows the significant result. The minimum days to appearance of first male flowering recorded in T_8 GA_3 30 ppm (42.47) followed by T_7 NAA 80 ppm (44.13) which was found to be at par with each other and both treatments were superior to the T_1 control (64.12). This might be because GA_3 speeded up male flower initiation due to actively or passively helping or boosting the floral apex development.

3.4 Days to First Female Flower Initiation

Days to first female flower initiation data shows the significant results. The minimum days to appearance of first female flower recorded in T_7 NAA 80 ppm (53.33) followed by T_6 NAA 70 ppm (55.83) which was found to be at par with each other and both treatments were observed superior to T_1 control (76.58).

Table 1. Effect of plant growth regulators on growth parameters of bottle gourd (*Lagenaria siceraria*) cv. MGH-4

Sr. No.	Treatments	Vine length (m)	Number of leaves per plant	Days to first male flower initiation	Days to first female flower initiation	Number of male flowers per vine	Number of female flowers per vine
1.	T_1 (Control)	3.05	46.08	64.13	76.58	27.75	8.00
2.	T_2 (30 ppm NAA)	3.42	63.75	61.16	58.08	30.67	11.25
3.	T_3 (40 ppm NAA)	3.18	76.67	57.78	60.00	35.50	12.75
4.	T_4 (50 ppm NAA)	4.68	82.42	47.81	56.08	31.08	10.92
5.	T_5 (60 ppm NAA)	2.54	93.92	50.31	56.58	33.92	12.00
6.	T_6 (70 ppm NAA)	6.18	98.50	46.13	55.83	37.00	10.83
7.	T_7 (80 ppm NAA)	8.20	103.50	44.13	53.33	52.33	14.50
8.	T_8 (30 ppm GA_3)	7.46	50.92	42.47	68.25	38.58	11.33
9.	T_9 (40 ppm GA_3)	6.45	94.50	45.72	74.50	54.08	17.08
10.	T_{10} (50 ppm GA_3)	6.60	91.92	55.91	65.83	40.25	11.92
11.	T_{11} (60 ppm GA_3)	5.19	90.42	52.50	72.75	38.17	10.58
12.	T_{12} (70 ppm GA_3)	4.19	68.92	55.19	70.25	35.92	9.25
SEm (±)		**0.75**	**4.28**	**0.46**	**2.51**	**2.01**	**1.07**
C.D. at 5% of Level		**1.56**	**8.93**	**0.97**	**5.23**	**4.19**	**2.25**

3.4.1 Number of male flowers per vine

Male flower per vine data shows the significant results. The maximum number of male flowers per vine recorded in T_{10} GA_3 50 ppm was 54.08 followed by T_7 NAA 80 ppm was 52.33 which was found to be at par with each other. And the minimum was found in T1 (27.75).

3.4.2 Number of female flowers per vine

Number of female flowers per vine data shows the significant results. The maximum number of female flowers per vine recorded in T_9 GA_3 40 ppm was 17.08 followed by T_7 NAA 80 ppm was 14.5 which was found to be at par with each other and both treatments were superior to control was 8.0.

4. DISCUSSION

"NAA induces cell division and cell growth and also improve synthesis and translocation of photosynthesis that enhance the vegetative growth of plant, hence vine length increased showed that application of GA_3 at 5, 10 and 15 ppm and NAA at 25, 50 and 75 ppm at 4 to 6 true leaf stage increased the main vine length with increasing concentration in muskmelon cv". Hara Madhu. Similar results were found by Kore et al. [11] reported different growth regulators showed significant effect on growth, flowering and yield. Maximum vine length (304.01 cm) was obtained with NAA at 20 ppm followed by GA_3 at 5.0 (303.61 cm) and both treatments were superior to the control (250.07 cm).

The superiority in number of leaves of different treatment over control might be due to foliar application of NAA as it has physiological effects on growth parameters of plant. The suppressive action of NAA on apical meristem might be the result in cell elongation and cell division [15,16].

The application of NAA (50 ppm) produced the first male flower earlier (43 days) and was significantly superior to all other treatments in bitter gourd and application of GA_3 at 85 ppm showed significant influence on days to first male flower (34.7) in bitter gourd. The earliest (30.63 days) was obtained in control.

This increase in number of female flowers by the foliar spray of NAA may be due to the fact that this substance is reported to increase functional female organs and compatibility besides reducing the embryo abortion in plants. NAA (50 or 100 ppm) and stages of spray on days to first male and female flowering in bitter gourd Cv. Coimbatore long (green) was studied. Among the growth regulators, NAA at 50 ppm was found to be most effective for early appearance of first female flower (53.55 days), by the application of NAA resulted in the lowest number of days to first pistilate flower appearance (37.98 and 31.59) and 50% female flowering (59.76 and 50.25) during the summer and kharif seasons by.

Number of male flowers per vine be due to well-known effects of GA_3 on early floral initiation [17] as GA_3 is mandatory for the shift from vegetative to reproductive stage, revealing florigenic effect [18]. GAs can replace the requirement of growing cells for maintenance of cellular division during early flower development.

Chovatia et al. [19] observed that "in a field experiment three concentrations each of GA_3, NAA, Ethrel, MH and CCC were applied at the 2-leaf and 4-leaf stages on bitter gourd (*Momordica Chrantia* Linn.) cv. Priya. Its application was found to be the most effective in enhancing the number of branches per vine, number of pistillate flowers, fruit length, fruit diameter and number of fruits per vine and ultimately produced the highest fruit yield".

5. CONCLUSION

Based on the results on the present investigation entitled "Effect of plant growth regulators on growth, yield and fruit quality of Bottle Gourd (*Lagenaria siceraria*) MGH-4" this was concluded that the treatment T_7 (80 ppm NAA) at 2-4 leaf stage showed the maximum vine length (8.20 m), Number of Leaves Per Plant (103.50) and took minimum Days to First Female Flower Initiation (53.33). However, the treatment T_9 (40 ppm GA_3) showed the maximum Number of Male Flowers Per Vine (54.08) and Number of Female Flowers Per vine (17.08). Therefore, it is suggested that researchers, farmers, and students use the foliar application of plant growth regulators on bottle gourd in order to improve the growth characters of bottle gourd.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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