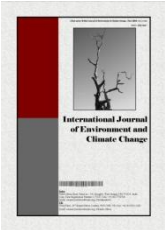

International Journal of Environment and Climate Change

12(11): 2448-2453, 2022; Article no.IJECC.91638
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Effect of Plant Growth Regulators on Yield Contributing Traits and Quality Attributes of Bottle Gourd (*Lagenaria siceraria*) cv. MGH-4

Mohd Wamiq [a*ω], Deepak Kumar [aω], Vishal Gangwar [bω], Navdeep Singh [cω], Veersain [bω], Manish Gaur [aω] and V. M. Prasad [d#]

[a] Department of Vegetable Science, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, (U.P.), India.
[b] Department of Fruit Science, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, (U.P.), India.
[c] Department of Vegetable Science, Punjab Agricultural University, Ludhiana, Punjab, India.
[d] Department of Horticulture, SHUATS, Prayagraj, (U.P.), India.

Authors' contributions

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

Article Information

DOI: 10.9734/IJECC/2022/v12i1131239

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/91638

Original Research Article

Received 04 July 2022
Accepted 08 September 2022
Published 13 September 2022

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 yield contributing traits and quality attributes. The experimental trial consisted two plant growth regulators having different concentration NAA (30, 40, 50, 60, 70 and 80 ppm) and GA_3 (30,40, 50, 60 and 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

[ω] Research Scholar;
[#] Professor;
**Corresponding author: E-mail: mohdwamiq0704@gmail.com;*

productive in terms of growth attributes of bottle gourd. The application of plant growth regulators has a major influence on both the reproductive and vegetative traits of the crop. The fruit yield per hectare (58.45 t/h), fruit diameter (23.89 cm), weight (1.273 kg), TSS (17.89 °Brix), vitamin C content (10.77 mg/100gm), and seed pulp ratio (9.16) were all determined to be best when 40 ppm GA_3 was applied at the 2-4 leaf stage.

Keywords: Bottle gourd; PGR; NAA; GA_3; yield and quality.

1. INTRODUCTION

The bottle gourd, also referred to as lauki, kadu, ghiya, or doodhi in India (*Lagenaria siceraria* L. 2n = 2x = 22), is a popular crop. It could have originated in tropical Africa. This vegetable provides an excellent source of carbohydrates, vitamin A, vitamin C, and minerals Hilli et al*.* [1]. The bottle gourd is a plant that belongs to the kingdom Plantae, division Magnoliophyta, class Magnoliopsida, order Cucurbitales, and family Cucurbitaceae. The name "lagena," which translates to "the bottle," is where the genus Lagenaria of bottle gourds got its start Minocha [2]. In tropical countries, Lagenaria siceraria (Molina) Stands, a vegetable crop with a fleshy fruit and seeded pepo, is widely cultivated [3]. Bottle gourd has been discovered in its natural state in South Africa and India Cutler and Whitaker (1961) hypothesised that it is probably native to tropical Africa based on the diversity of seeds and fruits. It's delicious, crisp, and soft fruits are enjoyed by both rich and poor people [4].

Cucurbit flowering is important because it influences fruiting and production. On the same plant, staminate and pistillate flowers can be found in various arrangements and separately [5]. Bottle gourds are normally harvested in India in two different crops: the first from mid-October seeding to mid-March harvesting, and the second from early-March sowing to mid-July harvesting (harvest). It is a monoecious annual plant with an ascending or trailing vine. Long, forked tendrils extend from the stem's hairy texture. Flowers have stalks, and the female flowers' stalks are shorter than the male flowers. They are axillary, solitary, and unisexual. It produces a wide range of morphologies of hard-shelled fruits, including long, oblong, and spherical ones.

The host of physiological processes involved in crop development, such as blooming and fruiting, are controlled by plant growth regulators (fruit set and parthenocarpy). Additionally, they are employed in the germination, inhibition of growth, and post-harvest ripening of assimilates. PGRs are employed in very tiny amounts to control plant development. Additionally, they regulate the length of the internode, blooming, fruit setting, and fruit ripening. They also govern the development of the shoot and the root. PGRs, which are frequently employed in horticulture, have been utilised to alter the timings of blooming and fruiting in a variety of fruits and vegetables [6].

NAA is an essential regulator of plant growth that enhances the development of bottle gourd plants by encouraging cell division, cell elongation, and cell enlargement in the apical region of plants [7]. NAA is used to chemically thin fruit, reduce fruit drops, induce flowering, increase fruit size, and hence increase production. NAA interacts with genes via producing the enzymes required for the synthesis of cell wall and cytoplasmic components. NAA initiates continuous flowering. After NAA spraying, cucumbers produced the largest fruits with the thickest flesh [8].

Gibberellic acid is a vital growth regulator that may be applied in a number of ways to change plant growth, yield, and features that affect production [9]. Gibberellic acid, often known as GA3, is the most well-known of the four main types of gibberellins. It promotes seed germination, cambial activity, growth, cell elongation, nucleic acid synthesis, protein synthesis, fruit set, leaf expansion, and dormancy break [10].

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 (Uttar Pradesh) during mid- March to 2- August during 2019.

2.1 Experimental Design and Treatments

For the experiment, a bottle gourd cultivar called MGH-4 was employed. Three replications were

used in the Randomized Block Design experiment. The bottle guard variety MGH-4 was treated with gibberellic acid (30, 40, 50, 60, 70, and 80 ppm) and naphthalene acetic acid (30, 40, 50, 60, and 70 ppm) at 2-4 leaf stage of bottle gourd. The important aspects of the plant growth regulators used in the experiment. Due to the size of the plant population, it was difficult to observe every plant, thus the technique of random sampling was employed to document observations of the numerous attributes of the plants during the investigation. Three plants were randomly selected from a representative sampling of the entire population from each plot. Throughout the course of the experiment, a total of 12 treatments including various concentrations of NAA and GA_3 were used.

2.2 Parameters of Study

2.2.1 Yield parameters

Fruit length (cm): A random sample ten fruit was taken from each plot to record fruit characteristics viz., fruit length and fruit circumference, fruit length was measured from the peduncle end of fruit up to the blossom scar point with the help of measuring tape. Total length of ten fruit was divided ten to obtain average length of the fruit variety.

Fruit diameter (cm): The same fruits used for measuring the length of fruit were taken for measuring the diameter. Diameter of fruit was measured with the help of Vernier callipers and the average fruit diameter was calculated.

Fruit weight (kg): The total yield of plot was recorded in kg and divided by the number of fruits of that plot to obtain average weight of edible green fruit or a variety in a particular replication.

Fruit yield per hectare (t/ha): Fruit yield at physiological maturity was recorded from the harvested fruits of net plot in each replication and the average of three replications was expressed as t/ha.

2.2.2 Quality parameters

T.S.S. (°Brix): T.S.S. (Total Soluble Solids) content of a solution is determined by the index of refraction. This is measured using a hand refractometer and is referred to as the ^{0}Brix. Brix is the term used when a refractometer equipped with a scale, based on the relationship between refractive indices at 20°C and percentage by mass of total soluble solids of a pure aqueous sucrose. This tests the solids concentration of a sucrose containing solution.

Ascorbic Acid (Vitamin C) (mg / 100gm): Ascorbic acid content of fruit was determined by diluting the known volume of juice with 3 percent meta-phosphoric acid and titrating with 2,6-diclorophenol-indophenol solution till the faint pink colour was obtained.

Seed-Pulp Ratio: Seed pulp ratio at physiological maturity was recorded by weight of fruit pulp (flesh) to weight of seed.

Table 1. A total of 12 treatments including various concentrations of NAA and GA3

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

2.3 Statistical Analysis

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

Where,

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

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 AND DISCUSSION

The findings of the current study on the impact of plant growth regulators on bottle gourd for yield contributing traits and quality parameters. 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.

Fruit length (cm): Fruit length data shows the significant result. The maximum length of fruit recorded in T_7 80 ppm NAA was 48.00 cm followed by T_{10} 50 ppm GA_3 (45.50 cm) which was found to be at par with each other and both treatments were superior to the T1 control (32.33).

Mandal and Maity [11], observed that bottle gourd cv. Pusa Summer Prolific Long treated with the growth regulators NAA (100 or 200 ppm), GA_3 (25 or 50 ppm), Ethrel (ethephon) (10 or 20 ppm), MH (100 or 200 ppm) or morphactin (25 or 50 ppm). Highest fruit length (61.6 cm) was obtained with 100 ppm NAA.

Fruit diameter (cm): Fruit diameter data shows the significant result. The maximum diameter of fruit recorded in T_9 40 ppm GA_3 (23.89 cm) followed by T_7 80 ppm NAA (22.94 cm) which was found to be at par with each other. Minimum was found in treatment T1 control (13.44 cm).

Chovatia et al*.* [12] and Mandal and Maity [11] observed that bottle gourd cv. Pusa Summer Prolific Long treated with the growth regulators NAA (100 or 200 ppm.), GA3 (25 or 50 ppm) Ethrel (ethephon) (10 or 20 ppm.), MH (100 or 200 ppm) or morphactin (25 or 50 ppm.). Highest fruit girth (22.5 cm) was obtained with 50 ppm GA_3.

Fruit weight (kg): Fruit weight data shows the significant results. The maximum weight of fruit recorded in T_9 40 ppm GA_3 (1.27 kg) followed by T_7 80 ppm NAA (0.96 kg) which was found to be at par with each other and both treatments were observed superior to the T1 control (0.69 kg).

Dixit and Mishra (2006) reported that application of growth regulators like GA_3 (25 or 50 ppm), ethrel (ethephon) (250 or 500 ppm) and NAA (50 or 100 ppm) in bitter gourd cv. Coimbatore long (green). Among the growth regulators, GA_3 at 50 ppm was found to be the most effective for higher fruit weight (1.74 kg).

Fruit yield per hectare (t/ha): Total fruit yield per hectare varies from 16.85 t/ha to 58.45 t/ha. Analysis of total yields per hectare data shows the significant results. Maximum fruit yield recorded in T_9 40 ppm GA_3 (58.45 t/ha) followed by T_7 80 ppm (42.49 t/ha) NAA which was found to be at par with each other. Minimum fruit yield per hectare was recorded in treatment T1 control (16.85 t/ha).

Sharma et al*.* (1998) found in his studies with the cultivar Pusa summer Prolific Long the plants were treated with several growth regulators, some were applied at the 2-4 true leaf stages and some 35 and 45 days after sowing. Data are tabulated on growth, flowering and yields. The highest average yields were obtained with GA_3 at 50 ppm (316.8 q/ha) and with Atonik [Nitrophenolate-sodium+nitroguaincol-sodium] at 0.1% (316.2 q/ha). The control yield was 116.7 q/h.

T.S.S. (°Brix): total soluble solid data shows the significant result. The maximum T.S.S was recorded in T_9 40 ppm GA_3 (17.89 °Brix) followed by T_7 80 ppm NAA (16.17 °Brix) was found to be at par with each other. The minimum was recorded in treatment T_1 (5.36 °Brix).

Ascorbic acid (vitamin C) (mg/100gm): Ascorbic acid varies from 10.77 mg/100gm to 6.83 mg/100gm. Analysis of ascorbic acid data shows the significant result. Maximum ascorbic acid recorded in T_9 40 ppm GA_3 (10.77 mg/100gm) followed by T_7 80 ppm NAA

Table 2. Effect of plant growth regulators on yield contributing traits and quality parameters of bottle gourd (*Lagenaria siceraria*) cv. MGH-4

Sr. No.	Treatments	Fruit yield per hectare (t/ha)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (kg)	T.S.S. (°Brix)	Ascorbic acid (vitamin C) (mg/100gm)	Seed-pulp ratio
1.	T_1 (Control) 2-4 leaf stage	16.85	32.33	13.44	0.69	5.36	6.83	5.05
2.	T_2 (30 ppm NAA) 2-4 leaf stage	27.63	34.83	18.03	0.76	9.67	7.61	5.70
3.	T_3 (40 ppm NAA) 2-4 leaf stage	34.69	39.67	19.25	0.87	11.63	8.14	6.68
4.	T_4 (50 ppm NAA) 2-4 leaf stage	22.14	39.17	20.03	0.67	12.61	7.80	7.83
5.	T_5 (60 ppm NAA) 2-4 leaf stage	30.87	42.25	18.97	0.80	13.56	8.55	8.28
6.	T_6 (70 ppm NAA) 2-4 leaf stage	20.43	43.92	17.25	0.82	15.64	9.22	8.01
7.	T_7 (80 ppm NAA) 2-4 leaf stage	42.49	48.00	22.94	0.96	16.17	9.60	8.68
8.	T_8 (30 ppm GA_3) 2-4 leaf stage	21.73	41.33	19.22	0.89	15.35	8.59	6.58
9.	T_9 (40 ppm GA_3)	58.45	39.25	23.89	1.27	17.89	10.77	9.16
10.	T_{10} (50 ppm GA_3) 2-4 leaf stage	23.60	45.50	20.81	0.94	14.54	8.66	7.00
11.	T_{11} (60 ppm GA_3) 2-4 leaf stage	29.22	41.17	18.97	0.86	13.34	7.90	7.04
12.	T_{12} (70 ppm GA_3) 2-4 leaf stage	26.43	41.42	18.28	0.85	14.00	7.78	6.18
	SEm (±)	3.15	0.89	0.73	0.03	0.18	0.24	0.19
	C.D. at 5% of Level	6.56	1.87	1.53	0.07	0.37	0.51	0.41

(9.60 mg/l00gm) which was found to be at par with each other and minimum in T_1 control (6.83 mg/100gm of fruit pulp) [13].

Seed-pulp ratio: Seed-Pulp Ratio data shows the significant result. The maximum seed-pulp ratio was recorded in T_9 40 ppm (9.16) GA_3 followed by T_7 80 ppm (8.68) NAA which was found to be at par with each other as compare to control T_1 (5.05).

4. CONCLUSION

According to the findings of the current study, "Effect of Plant Growth Regulators on Yield contributing traits and Fruit Quality of Bottle Gourd (*Lagenaria siceraria*) cv MGH-4," among all the treatment T_9 (40 ppm GA_3) which involved applying at the 2-4 leaf stages, was found to be superior in terms of bottle gourd fruit yield and quality parameters. 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 yield and quality characters of bottle gourd.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/91638