

Original Research Article

Growth and Yield of Bitter gourd as Influenced by Gibberellic acid and Naphthalene acidic acid (*Momordica charantia* L.)

Comment [V1]: This plants belongs to the cucurbitaceae family and the flower sex changes using PGR. There are some articles in this plant. Read and use them to complete this article.

Comment [V2]: The manuscript requires extensive improvements both in terms of language and scientific content

ABSTRACT

An experiment entitled "Growth and yield of bitter gourd as influenced by gibberellic acid and naphthalene acidic acid (*Momordica charantia* L.)" was conducted at Horticulture Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during year 2021 on bitter gourd with two growth regulators having concentration GA₃ (15, 20, 25 & 30 ppm) and NAA (75, 100, 125, 150 ppm). Water was used as a control. All the treatments were replicated three times in a randomized block design. The application of plant growth regulators significant affects the vegetative as well as reproductive attributes of the crop. The growth regulators were sprayed at four leaf stage. Application of 25 ppm GA₃ at 4 leaf stage was found most effective in terms of vine length at 20,40,60 and at harvest, whereas days to harvest (57.267), fruit weight (134.933), fruit length (14.107), fruit diameter (4.453), No. of fruits per plant (11.867), average yield per plant (1,609.100), yield tonne per hectare (10.725) shows maximum in NAA 150ppm

Keywords: *Bitter gourd*, *PGR*, *growth and yield*

Comment [V3]: In order to publish an article in an international journal, it is better to follow the standards of writing an abstract of the article.

- 1- Removing the name of the project site from abstract "at Horticulture Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj" and the year.
- 2- Removing the experimental design from abstract but in one sentence write the material and method (including treatment).
- 3- Adding a sentence at the end of the abstract to summarize the study.
- 4- Rewriting the abstract

Comment [V4]: 1-Replace with the GA and NAA
2-2- femal and male flower

1. INTRODUCTION

Bitter gourd [*Momordica charantia* L., 2n= 2x =22] is one of the most important cucurbitaceous vegetables widely cultivated in India. It is also known as balsam pear, bitter melon, bitter cucumber, and African cucumber. Like other cucurbits, maleness is one of the major obstacles in bitter gourd which significantly reduces the fruit and seed yields. The importance of bitter gourd has long been recognized due to its high nutritive value and medicinal properties. It is a luscious, climbing vine with slightly fuzzy stems clothed with dark green, deeply lobed leaves and yellow, monocious flowers. The fruit has a distinct warty exterior and an oblong shape. It is hollow in cross-section, with a relatively thin layer of flesh surrounding a central seed cavity filled with large, flat seeds and pith. The fruit is most often eaten green, or as it is beginning to turn yellow. Gibberellins are one of the longest-known classes of plant hormone. Gibberellins are involved in the natural process of breaking dormancy and other aspects of germination. Before the photosynthetic apparatus develops sufficiently in the early stages of germination, the stored energy reserves of starch nourish the seedling. Usually in germination, the breakdown of starch to glucose in the endosperm begins shortly after the seed is exposed to water. Gibberellins in the seed embryo are believed to signal starch hydrolysis through inducing the synthesis of the enzyme α -amylase in the aleurone cells. α -Amylase then hydrolyses starch, which is abundant in many seeds, into glucose that can be used in cellular respiration to produce energy for the seed embryo. Studies of this

process have indicated gibberellins cause higher levels of transcription of the gene coding for the α -amylase enzyme, to stimulate the synthesis of α -amylase.

Gibberellins are produced in greater mass when the plant is exposed to cold temperatures. They stimulate cell elongation, breaking and budding, seedless fruits, and seed germination. Gibberellins cause seed germination by breaking the seed's dormancy and acting as a chemical messenger. Highly significant variation in respect of number of fruits per plant was recorded due to different level of GA_3 concentration. It promotes growth, cell elongation, cambial activity, stimulate nucleic acid and protein synthesis, seed germination and help in breaking dormancy, fruit set and leaf expansion. Gibberellins are the most powerful growth promoters because they increase internodes spacing, induce and promote flowering in many plants and modify the flower sex expression in some plants.

The application of NAA at certain level improves the maximum number of fruits per plant, and increase in yield of crop. It induces root formation on cuttings and transplants. Inhibits fruit drops. It is effective against storage diseases. NAA was famed to catalyse cell division, cell elongation, elongation of shoot, photosynthesis, RNA synthesis membrane permeability etc.

NAA is an important plant growth regulator, which stimulates cell division, cell elongation and cell enlargement in apical region of plant resulted in better plant growth of bottle gourd. NAA is used in chemical thinning and prevention of fruit drop or induction of flowering, increase fruit setting, size and thus increasing yield. NAA interacts at the gene level by synthesizing enzymes required for the synthesis of cell wall and cytoplasmic components. NAA initiates uniform flowering. In cucumber the application of NAA produced the largest fruits the highest flesh. The physiological activity of vegetable crops regulates and after the application of growth regulator finally enhances the vegetable production. The present study was planned with use of different plant growth regulators and their application.

Comment [V5]: The purpose of the work should be well explained here.

2. MATERIAL AND METHODS

The experiment was carried out at the department of research field, department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (UP) during February-May 2021, which is situated in the agro climatic zone (sub-tropical belt) of Uttar Pradesh. Prayagraj is located in the south-east part of Uttar Pradesh India. Prayagraj falls under agro-climate zone IV which is named as "middle Gangetic plains" the site of experiment is located at 98 meters from sea level at 25.57° N latitude 81.51° E longitude has a typical subtropical climate with extremes of summer and winter. The maximum temperature of the location reaches up to 46°C - 48°C and seldom falls down as low as 4°C-5°C during winter the average rainfall in this area is around 1027 mm annually with maximum concentration during July to September with few showers and drizzles in winter also The treatment involving plant growth regulators viz. gibberellic acid (15, 20, 25 and 30 ppm) and naphthalene acetic acid (75, 100, 125 and 150 ppm) were imposed at 4 leaf stage in genotype TMBI-1304 of bitter melon. The salient features of plant growth regulators used in the experiment. The experiment was laid out in Randomized block design with three replications. The experiment consists of nine treatments. Seeds are sown at spacing of 1.5 m x 1 m each plot with 6 plants. The results and data were subjected to statistical analysis separately by using analysis of variance technique (ANOVA). The difference among treatments means was compared by using least significant difference test at 5% probability levels.

3. RESULTS AND DISCUSSION

3.1 GROWTH ATTRIBUTES

3.1.1 VINE LENGTH

GA₃ had significant effect on vine length of 221.04 cm was recorded in T₄ (GA₃ 25 ppm) followed by 208.673 cm in T₇ (NAA100 ppm), which was at par with each other, whereas shortest vine length 188.04 cm was recorded in T₁ control. The phenomenon of increase in vine length might be due to increasing plasticity of the cell wall followed by hydrolysis of starch to sugars which lowers the water potential of cell, resulting in the entry of water into the cell causing elongation. These osmotic driven responses under the influence of gibberellins might have attributed to increase in photosynthetic activity, accelerated translocation and efficiency of utilizing photosynthetic products thus resulting in increased cell elongation and rapid cell division in the growing portion. **Mangal *et al.*, (1981)**

3.1.2 DAYS TO APPEARANCE OF FEMALE FLOWERS IN 50% PLANTS

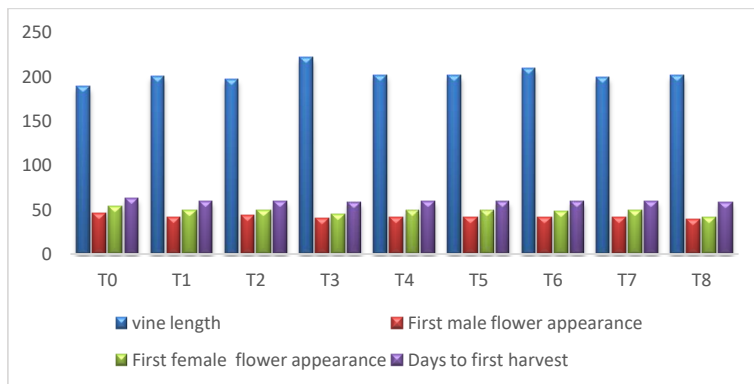
The NAA showed minimum days to appearance of first female flowering and recorded in T₉ NAA 150 ppm (40.60) followed by T₄ GA₃ 25 ppm (44.93) which was at par with each other and both treatments were superior to the T₁ control (53.06) showed significant result. Application of NAA which is attributed to the suppression of male flowers and promoted more number of female flowers and increase the metabolization of auxin substances in plants and also reduce sugar thereby bringing a change in the membrane permeability. **Choudhary and Singh (1970) and Dixit *et al.*, (2001)**.

3.1.3 DAYS TO APPEARANCE OF MALE FLOWERS IN 50% PLANTS

Days to first appearance of male flower shows the significant result. The minimum days to appearance of first male flowering recorded in T₉ NAA 150 ppm (38.933) followed by T₄ GA₃ 25 ppm (39.667) which was at par with each other and both treatments were superior to the T₁ control (45.533). The increase in male flowers might be due to fact that spraying NAA is possibly that the substance is reported to increase functional male organs and compatibility besides the embryo abortion in plants and actively or passively helping or boosting the floral apex development. **(Gill *et al.*,2012)**.

3.1.4 DAYS TO FIRST HARVEST

The minimum days to appearance of first harvest recorded in T₉ NAA 150 ppm (57.267) followed by T₄ GA₃ 25 ppm (58.00) which was at par with each other and both treatments were superior to the T₁ control (62.80) shows the significant result. NAA increases appearance of female flowers, increase fruit setting and promotes early fruit maturity and reported that the number of days required to pick the mature fruits from flowering significantly influenced by growth regulator treatments. It was also noticed that number of days was reduced with NAA treatment. **Marbhal *et al.*, (2005)**.



Comment [V6]: The measurement unit of length and day are different, so these four items cannot be presented in the same form and fig.

Fig. 1. Effect of Gibberellic acid and Naphthalene acetic acid on growth of Bitter gourd (*Momardica charantia* L.)

Table No1: Effect of GA₃ and NAA on growth parameters of Bitter gourd (*Momardica charantia* L.)

Treatments	Vine length (cm)	Days to first appearance of female flowers	Days to first appearance of male flowers	Days to first harvest
T ₀ CONTOL	188.707	53.067	45.533	62.80
T ₁ GA ₃ 15PPM	199.613	49.133	41.533	59.333
T ₂ GA ₃ 20PPM	196.527	49.600	43.067	59.400
T ₃ GA ₃ 25PPM	221.040	44.933	39.667	58
T ₄ GA ₃ 30PPM	200.687	49.067	41.067	58.933
T ₅ NAA 75PPM	200.427	49.067	41.133	59
T ₆ NAA 100PPM	208.673	47.800	40.800	58.667
T ₇ NAA 125PPM	199.013	49.133	41.200	59.133
T ₈ NAA 150PPM	200.780	40.600	38.933	57.267

Comment [V7]: A table or a figure should be used to present the results. There is no need to repeat the same results in the table and figure.

Comment [V8]: Data should be presented with standard error or standard deviation.

3.2 QUALITY ATTRIBUTES

3.2.1 FRUIT WEIGHT

The maximum fruit weight recorded in T₉ NAA 150 ppm (134.93) followed by T₄ GA₃ 25 ppm (126.947) which was at par with each other and both treatments were superior to the T₁ control (107.02). Fruit weight is maximum may be due to the application of NAA and GA₃ which activating cell division and cell elongation along with increasing the metabolic activity which stimulates the cell and heavy fruits might be due to more carbohydrate's accumulation due to increased photosynthesis. **Gedam et al., (1998).**

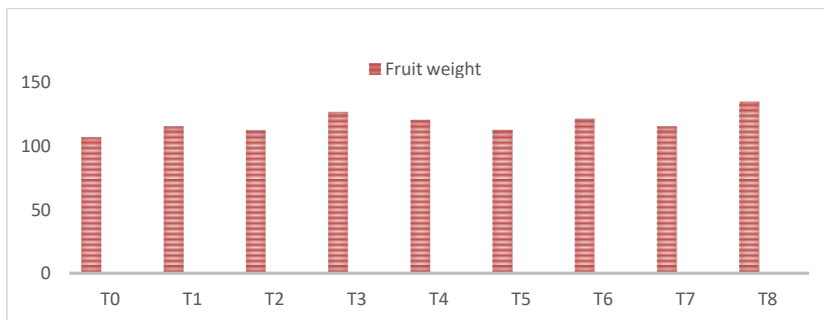


Fig. 2. Effect of GA₃ and NAA on Fruit weight of Bitter gourd (*Momardica charantia* L.)

Comment [V9]: These figures are not standard. They should identify the Vertical and horizontal axis and their units. In all figures, they must change

3.2.2 LENGTH OF THE FRUIT

Analysis of Length of fruit data shows the significant result. The maximum length of the fruit recorded in T₉ NAA 150 ppm (14.107) followed by T₄ GA₃ 25 ppm (13.773) which was at par with each other and both treatments were superior to the T₁ control (12.847). Fruit length is maximum may be due to the application of plant growth regulators NAA which activating cell division and cell elongation along with increasing the metabolic activity which promotes the length of fruit.

3.2.3 FRUIT DIAMETER

Analysis of Fruit diameter data shows the significant result. The maximum fruit diameter recorded in T₉ NAA 150 ppm (4.453) followed by T₄ GA₃ 25 ppm (4.333) which was at par with each other and both treatments were superior to the T₁ control (3.960). The larger size of fruit might be due to the application of plant growth regulators which increase in cell division and cell elongation and can change the morphology of plants and enhancing the metabolic activity lead to higher accumulation of food reserves in the fruit. NAA significantly increased fruit diameter in bitter gourd. **Gedam et al., (1998) and Dostogir et al., (2006).**

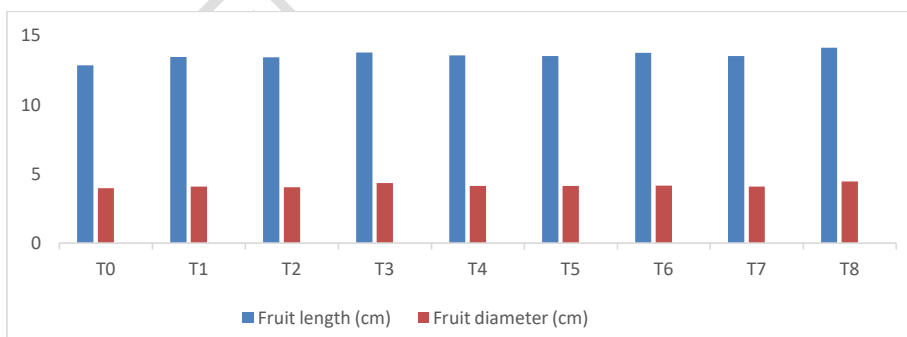


Fig. 3. Effect of GA₃ and NAA on Fruit Length, Fruit diameter of Bitter gourd (*Momardica charantia* L.)

3.2.4 NUMBER OF FRUITS

Analysis of Number of fruits data shows the significant result. The maximum No. of fruits per plant recorded in T₉ NAA 150 ppm (11.867) followed by T₄ GA₃ 25 ppm (11.200) which was at par with each other and both treatments were superior to the T₁ control (8.467). The increase in number of fruits per plant may be due to application of NAA by which number of female flowers produced per plant increased which resulted in higher fruit set percentage. **Nagamani et al., (2015) and Ghani et al., (2013).**

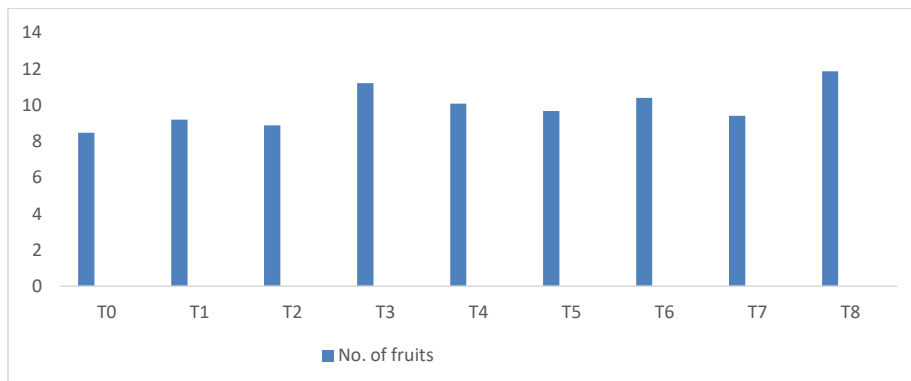


Fig. 4. Effect of GA₃ and NAA on No. of fruits of Bitter gourd (*Momardica charantia* L.)

3.2.5 AVERAGE YIELD PER PLANT

Analysis of Average yield per plant shows the significant result. The maximum Average yield per plot recorded in T₉ NAA 150 ppm (1,609.100) followed by T₄ GA₃ 25 ppm (1,421.693) which was at par with each other and both treatments were superior to the T₁ control (905.487). The phenomenon to increase fruit yield might be due to application of plant growth regulators attributed that the plants remain physiologically more active to build by sufficient assimilates for the developing flowers and fruits which leads to higher yield and effect of auxins to cause physiological modifications in the plants mainly on sex ratio, increased fruit set, fruit weight and higher photosynthetic activity, synthesis and translocation of metabolites from source to sink points (**Hilli et al., 2010**). Maximum fruit yield was recorded with the application of NAA@150 ppm. **KHATOON. R., MONIRUZZAMAN. M. et al., (2019).**

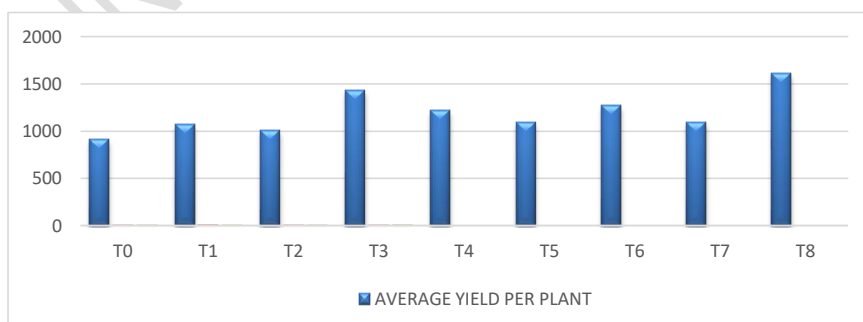


Fig. 5. Effect of GA₃ and NAA on average yield per plant of Bitter gourd (*Momardica charantia* L.)

3.2.6 YIELD TONNE PER HECTARE

Analysis of Yield tonnes per hectare shows the significant result. The Yield tonnes per hectare recorded maximum in T₈ NAA 150 ppm (10.725) followed by T₄ GA₃ 25 ppm (9.476) which was at par with each other and the minimum yield tonnes per hectare recorded in T₁ control (6.036). The maximum yield tonnes per hectare might be due to application of plant growth regulators which increase the number of fruits and average fruit yield per plant by which yield tonnes per hectare increases. External application of NAA in bitter gourd also increased the yield of the crop. (Melisa and Nina, 2005; Biradar *et al.*, 2010).

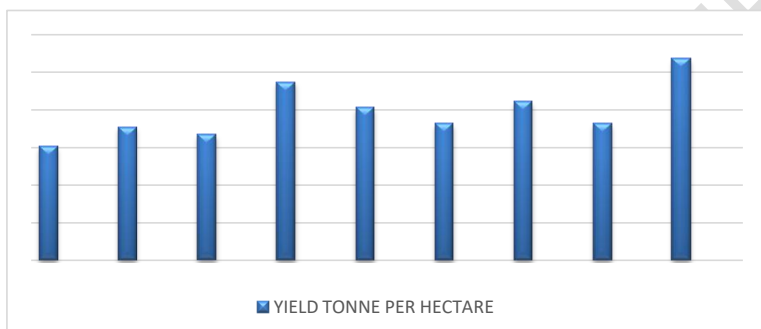


Fig. 6. Effect of GA₃ and NAA on yield tonne per hectare of Bitter gourd (*Momardica charantia* L.)

Treatments	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	No. of fruits	Average yield per plant (g)	Average tonne per hectare (t)
T ₀ CONTOL	107.020	12.847	3.960	8.467	905.487	6.036
T ₁ GA ₃ 15PPM	115.427	13.447	4.067	9.200	1062.573	7.083
T ₂ GA ₃ 20PPM	112.567	13.407	4.027	8.867	998.380	6.655
T ₃ GA ₃ 25PPM	126.947	13.773	4.333	11.200	1421.693	9.476
T ₄ GA ₃ 30PPM	120.573	13.547	4.120	10.067	1216.227	8.107
T ₅ NAA 75PPM	112.820	13.513	4.120	9.667	1088.740	7.257
T ₆ NAA 100PPM	121.487	13.747	4.153	10.400	1263.920	8.424
T ₇ NAA 125PPM	115.527	13.513	4.073	9.400	1086.940	7.245
T ₈ NAA 150PPM	134.933	14.107	4.453	11.867	1609.100	10.725

4. CONCLUSION

From the present investigation, it was concluded that the plant growth regulators treatments rendered their significant effect on the better germination, growth and development of the bitter gourd crop. The treatment T₃ consisted of GA₃ 25ppm at 4 leaf stage recorded best in vine length at harvest. The treatment, T₈ consisted of NAA (150 ppm) at 4 leaf stage recorded best performance with respect to growth parameters like days to first appearance of female flowers in 50% plants, days to first appearance of male flowers in 50% plants, days to first picking of fruits and yield parameters like average fruit length (cm), average fruit weight (g), fruit diameter (cm), fruit yield per plant (g), yield per hectare.

Comment [V10]: In this experiment, the treatments were used at the time of four leaves. How can it be effective on germination?

Comment [V11]: In this section should use the code of treatments.

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