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# Effect of plant growth regulators on vegetative growth, flowering and yield of bitter gourd cv. Priya

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## ABSTRACT

**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 charantia* Linn.) cv. Priya during the late kharif season of 2003-2004. It was observed that $GA_3$ at 200 ppm registered the maximum vine length. Whereas, MH at 400 ppm proved to be the best treatment in inducing the first pistillate flower earlier and at a lower node number, delaying the appearance of the first staminate flower to a higher node number, suppressing the number of staminate flowers and lowering the male:female sex ratio. 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, number of fruits per vine and ultimately produced the highest fruit yield.**

**Key words:** bitter gourd, plant growth regulators, growth, flowering, yield

## INTRODUCTION

Bitter gourd is monoecious in nature and exhibits a wide variation in the ratio of male to female flowers. Normally, staminate flowers are more in number than pistillate flowers. Therefore to realize higher productivity it becomes imperative to tilt this balance in favour of pistillate flowers. A shift towards femaleness in sex expression with the exogenous application of plant growth regulators has received considerable attention from the scientific community. Earlier reports have conclusively demonstrated such effects in bitter gourd (Ghosh and Basu, 4; Kabir *et al.*, 7). However, there exist very few reports in bitter gourd under South Saurashtra agroclimatic region of Gujarat. Morever, the efficacy of plant growth regulators in inducing such changes is considerably influenced by the agroclimatic factors. This necessitates the need to generate region specific information. Therefore, the present study was undertaken to evaluate the potentiality of gibberellic acid ($GA_3$), napthalene acetic acid (NAA), ethrel, maleic hydrazide (MH) and cycocel (CCC) under Saurashtra conditions of Gujarat in forcing up the number of pistillate flowers so as to improve the total yield of this crop.

## MATERIALS AND METHODS

A field experiment was conducted at the Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during the late *kharif* season of 2003-2004 with a view to study the effect of plant growth regulators on vegetative growth, flowering, sex expression and yield in "Priya" cultivar of bitter gourd. The experiment was laid out in a randomized block design with three replications and consisted of sixteen treatments; namely three concentrations each of $GA_3$ (100, 150 and 200 ppm), NAA (100, 150 and 200 ppm), MH (200, 300 and 40 ppm), Ethrel (100, 150 and 200 ppm), CCC (200, 300 and 400 ppm) and control (water spray). The seeds were dibbled on each hill at a distance of 3.0 x 0.5 m between rows and plants. All the recommended agronomic practices and crop husbandry were followed to raise a good crop. Two foliar sprays of plant growth regulators were done at 2 and 4 true leaf stages on 14$^{th}$ August 2003 and 20$^{th}$ August 2003. Five vines were selected randomly from each net plot to record the observations on growth, flowering, sex expression and yield attributes.

## RESULTS AND DISCUSSION

The influence of various plant growth regulators on growth attributes of bitter gourd are presented in Table 1. Perusal of data in Table 1 indicated significant differences in the length of main vine and number of branches per vine due to various treatments. Application of ethrel and MH decreased the length of the main vine. Whereas, application of NAA, $GA_3$ and CCC increased vine length. Significantly the maximum vine length (3.32 m) was observed in plants treated with $GA_3$ at 200 ppm and minimum (2.50 m) was obtained in plants treated

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with MH at 400 ppm. The probable reason for the maximum vine length under $GA_3$ application might be due to the promotion of cell division (Audus, 2).

**Table 1.** Effect of plant growth regulators on growth attributes of bitter gourd cv. Priya.

| Treatment | Vegetative growth attributes | |
|---|---|---|
| | Length of main axis (m) | Number of branches/vine |
| Control | 2.80 | 7.94 |
| $GA_3$ 100 ppm | 3.27 | 10.30 |
| $GA_3$ 150 ppm | 3.30 | 10.27 |
| $GA_3$ 200 ppm | 3.32 | 12.77 |
| NAA 100 ppm | 3.15 | 12.13 |
| NAA 150 ppm | 3.29 | 10.47 |
| NAA 200 ppm | 3.26 | 9.40 |
| MH 200 ppm | 2.77 | 13.20 |
| MH 300 ppm | 2.62 | 13.70 |
| MH 400 ppm | 2.50 | 15.20 |
| Ethrel 100 ppm | 2.73 | 10.40 |
| Ethrel 150 ppm | 2.67 | 10.90 |
| Ethrel 200 ppm | 2.54 | 11.20 |
| CCC 200 ppm | 3.20 | 12.80 |
| CCC 300 ppm | 2.90 | 11.07 |
| CCC 400 ppm | 2.85 | 10.20 |
| CD at 5 % | 0.40 | 1.44 |
| CV (%) | 8.23 | 7.59 |

A significant increase in the number of branches per vine was observed under the influence of the selected plant growth regulators at all the concentrations. MH at 400 ppm registered the highest number of branches (15.20/vine) followed by MH at 300 (13.70/vine). The lowest number of branches per vine (7.94/vine) were recorded in water sprayed control plants. This may be attributed to the fact that MH acts as an antimitotic suppressing the apical growth of main axis and thereby increasing the number of branches per vine. The present findings are in agreement with the results of Kabir *et al.* (7) in bitter gourd.

The data pertaining to flowering and sex ratio as affected by various treatments are presented in Table 2. The data revealed a significant effect of plant growth regulators on various flowering parameters as well as sex ratio. The first pistillate flower appeared at a significantly lower node in plants treated with NAA, MH, ethrel and CCC. Application of MH at 400 ppm induced the formation of the first pistillate flower at the lowest node number (8.20) as compared to all other treatments. First pistillate flower at the highest node number (16.02) was recorded in water sprayed control plants.

The application of NAA, MH, Ethrel and CCC induced the formation of staminate flowers at a significantly higher node number. Whereas, $GA_3$ treatments produced staminate flowers at lower nodes than water sprayed control plants. MH at 400 ppm proved superior to all other treatments in increasing the node number (13.08) for the appearance of the first staminate flower. While, $GA_3$ at 200 ppm produced staminate flowers at the lowest node number (7.68) which confirms the findings of Verma *et al.* (1984) in bitter gourd with $GA_3$.

Days to appearance of first pistillate flower were significantly shortened by the application of MH, Ethrel, CCC at all concentrations as well as $GA_3$ and NAA at 100 ppm. Earliest appearance of first pistillate flower was observed with CCC at 300 ppm (47.78) followed by CCC 200 ppm (53.67). Water sprayed control plants registered the maximum days (65.18) to first pistillate flower appearance. These results are similar to that of Kshirsagar *et al.* (1995) in cucumber.

NAA, MH, Ethrel and CCC delayed the emergence of the first staminate flower as compared to control. Whereas, application of $GA_3$ hastened the appearance of first staminate flower. Days to appearance of first staminate flower were significantly shortened by $GA_3$ at 200 ppm (39.70) followed by $GA_3$ at 150 ppm (41.39) compared to all other treatments. Ethrel at 200 ppm delayed the appearance of the first staminate flower to the maximum (53.10) followed by ethrel at 150 ppm (51.33). The present finding was in agreement with Verma *et al.* (10) in bitter gourd with $GA_3$ and Kshirsagar *et al.* (8) in cucumber with ethrel. It was reported by Ito and Saito (6) that at primordial stage, all the flowers carry both the sets of sex organs and an application of certain chemicals induce the transformation of male flower buds into female flowers. This seems to be a reasonable explanation for the early appearance of female flowers and late appearance of male flowers with respect to node number and days.

MH, Ethrel and CCC at all levels as well as NAA at 100 and 150 ppm and $GA_3$ at 100 ppm proved effective in inducing pistillate flower production. The highest (35.80/vine) numbers of pistillate flowers were recorded with the application of 400 ppm MH and the lowest (25.80) with the application of 200 ppm $GA_3$.

Suppression in the number of staminate flowers was observed with the application of NAA, MH and CCC. Whereas, application of $GA_3$ promoted the production of staminate flowers. The number of staminate flowers was maximum (340.05/vine) under $GA_3$ at 200 ppm and minimum (230.20/vine) with MH at 400 ppm.

All treatments with the exception of $GA_3$ at 150 and 200 ppm recorded a lower sex ratio than control and MH at 400 ppm (6.43) emerged as the best treatment in this regard. Thus application of 400 ppm MH resulted in

**Table 2.** Effect of plant growth regulators on flowering and sex expression of bitter gourd cv. Priya.

| Treatment | Flowering and Sex Expression | | | | | | |
|---|---|---|---|---|---|---|---|
| | Node No. of first pistillate flower appearance | Node No. of first staminate flower appearance | Days taken to first pistillate flower appearance | Days taken to first staminate flower appearance | No. of pistillate flowers/ vine | No. of staminate flowers/ vine | Sex ratio Male: Female |
| Control | 16.02 | 9.04 | 65.18 | 45.70 | 28.80 | 280.30 | 9.73 |
| $GA_3$ 100 ppm | 15.20 | 8.42 | 55.20 | 42.60 | 31.70 | 290.00 | 9.12 |
| $GA_3$ 150 ppm | 14.17 | 7.80 | 59.28 | 41.39 | 26.03 | 321.00 | 12.33 |
| $GA_3$ 200 ppm | 14.05 | 7.68 | 60.32 | 39.70 | 25.80 | 340.05 | 13.19 |
| NAA 100 ppm | 12.17 | 10.42 | 54.93 | 48.20 | 31.87 | 278.20 | 8.72 |
| NAA 150 ppm | 11.72 | 10.76 | 60.33 | 49.00 | 30.23 | 270.90 | 8.96 |
| NAA 200 ppm | 13.10 | 10.53 | 58.48 | 47.04 | 27.68 | 253.30 | 9.15 |
| MH 200 ppm | 8.90 | 12.30 | 55.70 | 46.66 | 35.20 | 255.60 | 7.26 |
| MH 300 ppm | 8.47 | 11.80 | 54.02 | 45.80 | 35.70 | 251.30 | 7.03 |
| MH 400 ppm | 8.20 | 13.08 | 56.42 | 48.40 | 35.80 | 230.20 | 6.43 |
| Ethrel 100 ppm | 13.13 | 10.40 | 57.41 | 50.20 | 31.62 | 285.02 | 9.01 |
| Ethrel 150 ppm | 11.79 | 11.20 | 55.11 | 51.33 | 32.74 | 273.30 | 8.34 |
| Ethrel 200 ppm | 11.20 | 10.70 | 53.98 | 53.10 | 32.81 | 260.90 | 7.95 |
| CCC 200 ppm | 10.50 | 11.30 | 53.67 | 47.40 | 31.53 | 240.70 | 7.68 |
| CCC 300 ppm | 9.80 | 11.05 | 47.78 | 48.30 | 33.24 | 261.80 | 7.80 |
| CCC 400 ppm | 11.43 | 11.12 | 55.04 | 49.00 | 29.64 | 275.20 | 9.28 |
| CD at 5 % | 2.02 | 1.22 | 7.19 | 3.72 | 3.21 | 49.10 | 1.31 |
| CV (%) | 10.21 | 7.01 | 7.64 | 4.74 | 6.16 | 10.79 | 19.55 |

maximum number of pistillate flowers and minimum number of staminate flowers thereby registering the lowest sex ratio. Similar findings were reported by Ghosh and Basu (4) in bitter gourd and Pandya and Dixit (9) in bottlegourd. The action of MH in increasing the number of pistillate flowers and reducing staminate flowers in bitter gourd can be explained in the light of Griesel (5) that starch digestion was retarded in plant tissues after treatment with MH and ultimately considerable starch remained for a longer period and it also reduced the transpiration as well as respiration. Thus MH reduces catabolic activities inside the plant and acts in the same way as that of low temperature and short days which also reduces transpiration and other activities and thereby increases the number of female flowers and reduces the number of male flowers.

The data presented in Table 3 revealed significant differences in fruit yield and its associated traits with the application of various growth regulators. It was observed ethrel at 100 and 200 ppm and MH at 300 and 400 ppm significantly increased fruit length than control. The maximum fruit length (16.23 cm) was recorded under 400 ppm MH followed by 100 ppm Ethrel (14.69 cm).

All the concentrations of NAA, Ethrel at 100 and 150 ppm, MH at 200 and 400 ppm and $GA_3$ at 200 ppm showed a significant increase in fruit diameter over control. The maximum increase in fruit diameter (9.30 cm) was observed with Ethrel at 150 ppm, followed by Ethrel at 100 ppm (8.90 cm).

The possible reason for increase in length and diameter of fruits after the application of growth regulators may be attributed to higher respiration and photosynthesis in treated plants as compared to control. This may be due to greater accumulation of carbohydrates, owing to photosynthesis, which resulted into increased weight and size of fruits. These results are in conformity with reports on MH by Dubey (3) in sponge gourd and Arora *et al.* (1987) in ridge gourd with ethrel.

All the treatments proved significantly superior over control in increasing the number of fruits. MH at 400 ppm recorded the maximum number of fruits (32.02/vine) followed by MH 300 ppm (30.41/vine).

Data relating to fruit yield showed the possibility of increasing yield (kg/vine) significantly by the application of MH and Ethrel as well as CCC at 300 ppm. The highest fruit yield (2.51 kg/ha) was registered under MH at 400 ppm followed by Ethrel at 100 ppm (2.11 kg/vine). MH 400 ppm recorded the maximum number of fruits per vine and the highest fruit yield (kg/vine). This may be

**Table 3.** Effect of plant growth regulators on yield attributes of bitter gourd cv. Priya.

| Treatment | Yield attributes | | | | |
|---|---|---|---|---|---|
| | Fruit length (cm) | Fruit diameter (cm) | Number of fruits /vine | Fruit yield (kg/vine) | Fruit yield (ton/ha.) |
| Control | 11.80 | 6.50 | 20.20 | 1.08 | 11.34 |
| $GA_3$ 100 ppm | 12.37 | 7.10 | 25.00 | 1.37 | 14.60 |
| $GA_3$ 150 ppm | 13.10 | 7.55 | 24.20 | 1.21 | 12.89 |
| $GA_3$ 200 ppm | 13.27 | 7.90 | 23.30 | 1.20 | 12.67 |
| NAA 100 ppm | 12.32 | 7.95 | 30.00 | 1.45 | 15.41 |
| NAA 150 ppm | 12.30 | 8.10 | 27.20 | 1.24 | 13.12 |
| NAA 200 ppm | 12.84 | 7.78 | 26.30 | 1.30 | 12.80 |
| MH 200 ppm | 13.10 | 7.90 | 29.30 | 1.49 | 15.28 |
| MH 300 ppm | 14.50 | 7.47 | 30.41 | 2.03 | 17.07 |
| MH 400 ppm | 16.23 | 8.82 | 32.02 | 2.51 | 18.04 |
| Ethrel 100 ppm | 14.69 | 8.90 | 29.90 | 2.11 | 17.00 |
| Ethrel 150 ppm | 12.63 | 9.30 | 29.00 | 1.70 | 15.07 |
| Ethrel 200 ppm | 13.80 | 7.30 | 28.60 | 1.60 | 15.51 |
| CCC 200 ppm | 12.13 | 7.70 | 24.10 | 1.33 | 16.22 |
| CCC 300 ppm | 13.10 | 7.65 | 28.70 | 1.59 | 14.04 |
| CCC 400 ppm | 12.77 | 7.20 | 28.20 | 1.41 | 15.51 |
| CD at 5 % | 1.55 | 1.26 | 2.63 | 0.38 | 1.82 |
| CV (%) | 7.04 | 9.72 | 5.79 | 15.63 | 9.25 |

due to the fact that MH and Ethrel suppressed the number of male flowers and promoted the number of female flowers thereby increasing the number of fruits and ultimately produced more yield. The above results are in consonance the findings of Verma *et al.* (10) in bitter gourd with MH and Kshirsagar *et al.* (8) in cucumber with ethrel.

A similar trend was observed when the fruit yield was expressed as tons/hectare. This was reflected by a significant increase in fruit yield under the influence of all the concentrations of MH, Ethrel and CCC as well as $GA_3$ and NAA at 100 ppm over control. . The highest fruit yield (18.04 tons/ha) was obtained with MH at 400 ppm which was 59 per cent more than the yield of control. Other effective treatments were MH at 300 ppm (17.07 tons/ha) and ethrel at 100 ppm (17.00 tons/ha.) The increase in fruit yield of treated plants may be attributed to the reason that plants remain physiologically more active to build up sufficient food stock for developing flowers and fruits ultimately leading to higher fruit yield. Similar results were reported by Pandya and Dixit (9) in bottle gourd and Arora *et al.* (1) in ridge gourd.

Thus it can be concluded that MH 400 ppm was the most effective in inducing higher number of pistillate flowers and producing more number of fruits per vine. It thus reflects on the possibility of increasing yield in bitter gourd with the foliar application of MH.

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