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# Foliar spray of plant growth regulators in cucurbits: A review

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**Abstract**
The growth and development of plant is a complex process and is under the control of three main factors *viz*., genetics, environment and endogenous growth substances. The genetic factors determine the potentiality of a plant for growth and the fullest expression of this potential in turn is under the control of various environmental factors. As the plant growth and development is a complex process and there are two factors which influence their action and metabolism of plants and thus regulate the developmental pattern of plant. One of them is a system of endogenous chemical messengers, called hormones. The second one comprises more or less interdependent set of external environmental factors such as light, water, temperature and gravity, which play indispensable role in the development as do hereditary factors which have been transmitted from its biological parents. The enhanced productivity of crop through physiological approaches is chiefly achieved by coordinating plant processes to synthesize maximum dry matter production and partitioning major quantum of this increased dry matter into effective yield contributing factors. The effect of various growth regulators on morphological characters like plant height, number of branches, days to flower initiation and 50% flowering indicated that these parameters differed significantly due to growth regulators. These effects can also be achieved by certain growth regulators. The success in using these growth regulators depends on several factors such as, the choice of plant growth substances, the purpose for which it is being used, the appropriate concentration and the right time of application.

**Keywords:** foliar spray, plant growth regulators, yield and yield parameters, quality of cucurbits

## Introduction

### Role of foliar spray of plant growth regulators

Plant growth regulators also known as plant hormones are chemicals used to alter the growth of a plant or plant part. Hormones are substances naturally produced by plants, substances that control normal plant functions, such as root growth, fruit set and drop, growth another development processes. On other hand PGR are defined as any substance or mixture of substances intended, through physiological action, for accelerating or retarding the rate of growth or maturation or for otherwise altering the behavior of ornamental or crop plants or the produce thereof, but not including substances intended as plant nutrients, trace elements, nutritional chemicals, plant inoculants, or soil amendments. Over a century later we know that the substances in question are small molecules derived from various essential metabolic pathways. In general these compounds are present at very low concentrations and act either locally, at or near the site of synthesis, or in distant tissues. Although the physiological function of most of these compounds has been studied for decades, the last 10 to 15 years have seen dramatic progress in our understanding of the molecular mechanisms of hormone biosynthesis, transport and response.

Foliar spray of plant growth regulators have emerged as “magic chemicals” that could increase agricultural production at an unprecedented rate and help in removing and circumventing many of the barriers imposed by genetics and environment. The importance of plant growth regulators was first recognized in the 1930s. Today, specific plant growth regulators are used to modify crop growth rate and growth pattern during the different growth and development stages i.e., from germination to harvest and post-harvest. Plant growth regulators are known to have great potential to increase the productivity of vegetables. However, the response of crop or plant parts to growth regulators varies due to fluctuations in endogenous hormonal levels of the plant and the manner in which the natural growth regulators interact with the applied growth regulators.

Though the plant growth regulators have great potentialities to influence plant growth and morphogenesis, its application and actual assessments have to be judiciously planned in terms of optimal concentrations, stage of application, species specificity, seasons, etc. which constitute the major impediments in PGRs applicability. In view of their wide spectrum effectiveness on every aspect of plant growth, even a modest increase of 10-15 per cent could bring about an increment in the gross annual productivity by 10-15 million tons.

There is a great deal of experimental evidence in the literature showing that endogenous growth substances are involved in many processes which lead to growth and development. Many scientists all over the world have conducted many investigations on the effect of foliar application of plant growth regulators on plant growth and development, physiological, biochemical and yield parameters of many crop species. Many crop species have also been shown to respond to the exogenous application of plant growth regulators. Considering their role in plants, plant growth regulators have been designated as magic chemicals which bring about an unprecedented growth and help in removing and circumventing many of the barriers imposed by genetics and environmental factors. An attempt has been made to present the impact of plant growth regulators on plant growth and development *vis-à-vis* physiological, biochemical, quality and yield parameters, which are reviewed in this article and some of them are listed in the following Table.

| Sl. No. | Name of the Researchers | Crops | Growth and morphological parameters |
|---|---|---|---|
| 1 | Prasad *et al.* (2003) [28] | Cucumber | Cucumber cultivars, *viz.*, Pusa Hybrid, Tripti-19 and Local Super Green gave best result in terms of vine length, average fruit weight as well as yield |
| 2 | Shantappa *et al.* (2005) [30] | Bitter gourd | Observed that the application of $GA_3$ @ 25 ppm in bittergourd at 2 and 4 leaf stages increased the length of the vine (503.10 cm) at the final harvest and increased the number of fruits and yield per vine. |
| 3. | Kore *et al.* (2003) | Bottle gourd | Observed that increased number of leaves per vine (93.93), produced higher number of branches per vine (4.20) and higher number of inter node per vine and more numbers of fruits per vine as compared to control. |
| 4 | Murthy *et al.* (2007) [24] | Gherkin | Showed that foliar application of $GA_3$ @ 100 ppm increased the length of primary shoot, branches and internodes by promoting cell elongation; However, it reduced the number of branches as well as fresh and dry weight |
| 5 | Geeta *et al.* (2010) [12] | Bittergourd | The research findings revealed a significant difference between the treatments and varieties on vine length and number of leaves at all the growth stages. Among the treatments $GA_3$ @ 20 ppm had recorded significantly maximum vine length and number of leaves 61.1 cm and 46 cm, respectively. |
| 6 | Thappa *et al.* (2011) [32] | Cucumber | Revealed that the influence of the plant growth regulators was variable on the morphological traits of cucumber but the floral and yield traits were significantly affected by a foliar application of NAA @100 ppm was (180.2 cm and 5.75) and 100 ppm ethephon (180.24 cm and 5.75) on vine length and number of primary branches, respectively. |
| 7. | Sure *et al.* (2013) [31] | Pumpkin | Results of the study showed that, foliar spray of gibberellin @ 25, 50 and 75 mgl-1 during four leaf stage had more significantly effects on vegetative growth and increased the male flowers, so that enhanced the seed yield and oil seed per hectare than control |
| 8. | Mia *et al* (2014) [23] | Bittergourd | Foliar application of auxin like 1- naphthalene acetic acid (NAA) @ 50 and 100 ppm proved to be effective in inducing early female flowers by (41, 46 and 42, respectively) at lower node. Whereas NAA@ 50 ppm was found to be the best treatments for reducing sex ratio by increasing the female flowers. |
| 9. | Kumar *et al.* (2012) | Bittergourd | The results of the study revealed that NAA @ 50 ppm produced highest vine length (192.33 and 260.67 cm), leaf area (1.890 and 2.965 cm2/vine) at 85 and 100 days after sowing, respectively. |
| 10 | Mehdi *et al.* (2012) [21] | Cucumber | the tested concentrations of ethrel caused dwarfness and increased number of fruits plants$^{-1}$ |
| 11 | Arvindkumar *et al.* 2014 [6] | Bittergourd | Results of the study revealed that NAA @ 50mg/l produced the longest vines (192.33 and 260.67cm), maximum leaf area (1.890 and 2.965 $cm^2$ $vine^{-1}$), leaf area index (1.969 and 2.760) and leaf chlorophyll content (39.23 and 38.90 SPAD value) at 85 and 100 days after sowing, respectively. |
| 12 | Dalai *et al.* (2015) [7] | Cucumber | It was found significantly superior in terms of growth parameters i.e. vine length $plant^{-1}$ (cm), number of primary branches per plant, number of leaves per plant, as compared to control. |
| 13 | Amandeep *et al.* (2016) [3] | Cucumber | It was revealed that growth regulators which had a significant effect on leaf area, total dry weight and absolute growth rate while CCC @ 250 and 500 ppm decreased leaf area. GA3 @ 50 ppm significantly increased all the growth parameters at later stages which in turn increased the yield (1.71 kg plant-1). |
| 14 | Merentoshi *et al.* (2016) [22] | Cucumber | It was revealed that growth regulators which had a significant effect on leaf area, total dry weight and absolute growth rate while CCC @ 250 and 500 ppm decreased leaf area. GA3 @ 50 ppm significantly increased all the growth parameters at later stages which in turn increased the yield (1.71 kg plant-1). |
| 15 | Ajay *et al.* (2018) [2] | Cucumber | The results revealed that treatment $GA_3$ @ 100 ppm has recorded the maximum values for growth parameters *viz.*, vine length (139.89 cm), number of leaves (59.46), number of branches (17.00) and leaf area (293.28 cm).Whereas maximum inter-nodal distance (8.33 cm) was recorded with NAA @50 ppm. Among all GA3 @ 75 ppm recorded maximum vine length (271.76 cm), number of number of leaves (90.32), number of nodes on main stem (30.22), length of primary branches (153.25 cm) and leaf area (458.14 $cm^2$), whereas, maximum number of primary branches(18.49) was recorded in ethrel @ 300 ppm. Further, maximum inter-nodal distance (8.24 cm) was recorded with GA3 @ 250 ppm. |
| 16 | Dinesh *et al.* (2019) [10] | Cucumber | Among all GA3 @ 75 ppm recorded maximum vine length (271.76 cm), number of number of leaves (90.32), number of nodes on main stem (30.22), length of primary branches (153.25 cm) and leaf area (458.14 $cm^2$), whereas, maximum number of primary branches (18.49) was recorded in ethrel @ 300 ppm. Further, maximum inter-nodal distance (8.24 cm) was recorded with GA3 @ 250 ppm. |
| 17 | Acharya *et al.* (2020) [1] | Cucumber | Ethrel @ 400-500 ppm increased number of female flowers, enhanced maturity cycle and improve sex ratio by suppressing the male flowers. Auxin @ 50- 100 ppm has great influence on growth as well as ethrel improves the yield attributing parameters in cucurbits. |

| | | | |
|---|---|---|---|
| **Phenological parameters** | | | |
| 18 | Kooner *et al.* (2000) [17] | Bottle gourd | The earliest female flower was produced by treatment with ethrel at the highest rate. Sex ratio was narrowed due to the different growth regulator treatments. Early yield was not affected by the different treatments. |
| 19 | Cheng *et al.* (2002) [36] | Summer squash | Reported that significantly decreased the node position of the first male flower and increased the number of male flowers. |
| 20 | Patel *et al.* (2009) [37] | Sponge gourd | They reported lowest number of male flowers (230.0), the highest number of female flowers (44.0) and lowest male: female sex ratio (1:5.26) was observed in ethrel @ 300 ppm spray |
| 21 | Akter and Rahman (2010) [38] | Bittergourd | Results of the study showed a positive stimulatory effect in the increase of female flowers at $T_3$ where the male to female sex ratio was the lowest |
| 22 | Hilli *et al.* (2010) [15] | Ridgegourd | The study revealed that more number of branches with foliar spray of 200 ppm ethrel over control during summer and kharif seasons. The higher number of male (147.42 and 93.21) and female (17.19 and 12.60) flowers recorded with sex ratio of 8.58 and 7.40, respectively |
| 23 | Acharya *et al.* (2020) [1] | Cucurbits | Results of the studyshowed that the foliar spray of ethrel @ 400-500 ppm increased the number of female flowers, enhanced maturity cycle and improved sex ratio by suppress the male flowers and $GA_3$ @ 50-100 ppm increased number of male flower |
| 24 | Gosai *et al.* (2020) [14] | cucumber | Results showed that that foliar spray of ethrel @ 300-400 ppm retards the secondary development and increase femaleness, and ethrel @ 200-300 ppm make fruit surface smooth. and application of ethrel @ 300 ppm reduces the harvesting time of the fruit. |
| **Yield parameters** | | | |
| 25 | Vadigeri *et al.* (2001) | Cucumber | Results revealed that GA3 @ 10 ppm increased the number of female flowers, number of fruits per plant yield per hectare and increased the size of individual fruits and also both ascorbic acid and total sugars, while r was decreased in the reducing sugar content. |
| 26 | Devaraju *et al.* (2001) [9] | Gherkin | Observed that the application of ethrel @ 100 ppm at 2 and 4 leaf stages in gherkin resulted in highest number of female flowers (169.35) and fruits per vine (73.32), respectively. Fruit set was higher (72.72%) as compare to control under Bangalore conditions |
| 27 | Negi *et al.* (2003) [25] | Bittergourd | Results revealed that reduced the length of vine and number of branches, delayed appearance of the first male and first female flowers. However, in the appearance of first female flower at the higher nodes and reduced the total number of female flowers per plant |
| 28 | Kakroo *et al.* (2005) [16] | Bottlegourd | The results are revealed that foliar application of ethrel @ 150 ppm at 2 and 4 true leaf stage increased number of female flowers and decreased number of male flowers per plant, and showed the minimum sex ratio of 1:3.85 (female: male) and produced female flowers at the early nodes ultimately increased yield |
| 29 | Pankaj *et al.* (2005) [26] | Bottlegourd | Recorded substantial variation in the number of days for first male and female flowers over control and the application of CCC @ 200 ppm exhibited significantly lower values (50.94 days) for male flowers and 58.8 days for female flowers as against the control. |
| 30 | Dinesh *et al.* (2019) [10] | Bitter gourd | They concluded that the treatment $GA_3$ @ 150 ppm recorded minimum number of days taken to initiation of flowering (33.74 days), minimum days taken for 50 per cent flowering (44.91 days) and time taken for first harvesting (51.80 days) over other treatments and finally yield (165.17 t/ha) was recorded highest in $GA_3$ @ 75 ppm. |
| **Quality parameters** | | | |
| 31 | Das *et al.* (2001) [8] | Cucumber | The results are indicated that the application of NAA @ 30 and 100 ppm at 4-5 leaf stage of growth and flower bud appearance stage as foliar spray during rabi season revealed that highest ascorbic acid content and TSS (total soluble solid) content in fruit of cucumber was ascertained under Assam conditions |
| 32 | Ullah *et al.* (2011) [34] | Groundnut | Reported that all concentrations of ethrel (except 700 and 1750 µmol/l), gibberellic acid and maleic hydrazide significantly increased the TSS of fruit as compared to water soaked control. Maximum increase (3.23 and 3.19 Brix %) was observed with MH at 450 µ mol/l and $GA_3$ @ 60 µ mol/l. |
| 33 | Ajay *et al.* (2018) [2] | Cucumber | Concluded that quality parameters like TSS maximum were recorded in the treatment $GA_3$ @ 200 ppm (6.06). |
| 34 | Geetha *et al.* (2014) [39] | Bittergourd | The experiment consisted of foliar treatment with three plant growth regulators, GA3@ (20, 40 and 60ppm), NAA @ (50 ppm) and CCC @ (100 and 200 ppm) in two bittergourd varieties, MHBI–15 and Chaman Plus at 45 days after sowing (DAS). Foliar application of CCC @ (200ppm) recorded maximum amount of total sugars (18.03% over control), total phenol content (10.93%) as also nitrate reductase activity (16.12%). Among the treatments, application of GA3 (20 ppm) recorded maximum chlorophyll content (18.03% over control). Highest increase in mean fruit yield over control was recorded with application of GA3 @ (20 ppm) (39.88%), followed by CCC (200 ppm) (34.15%) in both the cultivars. |

## Conclusion

Plant growth regulators have profound influence on growth, development, morpho-physiological and fruit production in cucurbits. It can modify growth and flowering, improve fruit set and ultimately increase the yield of cucurbits. A good relationship between growth substances and sex expression probably exists in these plants. Plant growth regulators (Promoters, inhibitors or retardants) play a key role in contributing internal mechanisms of plant growth by interacting with key metabolic processes such as, nucleic acid metabolism and protein synthesis. Growth retardants are known to reduce inter-nodal length, thereby enhancing source-sink relationship and stimulate the translocation of photo-assimilates to the seeds. The enhanced source-sink relationship with the use of plant growth regulators stimulates the translocation of photo assimilates, ultimately improving the growth and development, thereby increasing the productivity.

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