Growth Regulators and Cucumber Yield: A Study on Vegetative development and Yield Dynamics (*Cucumis sativus* L.)

**Abstract:** Bioregulators, commonly known as plant hormones, play a pivotal role in the development and productivity of crops. This study investigates the impact of various growth regulators on the vegetative and yield dynamics of cucumber (*Cucumis sativus* L.), a vital horticultural crop with significant economic and nutritional value. By examining the effects of specific growth regulators on cucumber plants, the research aims to enhance our understanding of how these substances influence growth patterns, flowering, fruit set and ultimately, yield. The findings have the potential to inform agricultural practices and optimize cucumber production, contributing to improved food security and sustainable farming practices. The experiment was carried out during summer season 2021 at Vegetable Research Farm, Institute of Agricultural Sciences, Banaras Hindu University. The trial was accomplished in a randomized block design with three replications and 13 treatments. Plant growth hormones viz., GA3 (50, 100 and 150 ppm), NAA (25, 50 and75 ppm), AgNO3 (125, 250 and 350 ppm) and ethrel (100, 200 and 300 ppm) were applied as foliar spray at two true leaf stage. The findings of the effects of plant growth regulators on cucumber growth, presented in this abstract serve as a valuable resource for researchers, agronomists and farmers seeking to optimize cucumber cultivation practices and meet the increasing demand for this popular vegetable crop. **Keywords:** Plant hormones, Vegetative growth, Yield dynamics, Crop production.

# Introduction

Cucumber is an annual climbing vegetable crop native to India and commonly grown in temperate and tropical climates all over the world. Botanically, it is known as *Cucumis sativus*, belonging to the family Cucurbitaceae having chromosome number 2n = 14 (Jia and Wang, 2021). The fruits are generally utilized in salads and pickles for culinary, medicinal and are high in vitamins and minerals and they can be used to treat skin illnesses, kidney and heart problems, as well as functioning as an alkalizer and antipyretic (Pal *et al*., 2020). Sex expression in cucurbits is influenced by environmental factors as well as hormone levels in plant, modification in environmental conditions as well as hormonal balance within the plant can readily alter the sex expression in cucurbits. Therefore, these two aspects have a large impact on sex manipulation (Manjunathagowda and Bommesh, 2017).

Exogenous treatment of plant hormones plays a key role in modifying the sex ratio of these plants hence growth regulating chemicals became significant tools in this regard (Dalai *et al*., 2016). The chemicals most commonly used on cucumber, watermelon and bottle gourd are gibberellic acid, naphthalene acetic acid, silver nitrate and maleic hydrazide. Gibberellic acid is a tetracyclic di-terpenoid molecule that promotes plant growth and development by promoting seed germination, initiate change from meristem to shoot growth, juvenile to adult leaf stage, vegetative to flowering and regulate the sex expression and fruit development (Gupta and Chakrabarty, 2013). NAA is a synthetic plant hormone from the auxin family and application of it improves vegetative growth parameters such as height of plant, leaves per vine, regulation of flowering, control fruits drops and development of parthenocarpic fruits (Arvindkumar *et al*., 2014). The role of silver nitrate (AgNO3) in micropropagation, somatic embryogenesis, in vitro flowering, growth stimulation, fruit ripening and sex expression in plants and very effective for ethylene inhibition and stimulation of staminate flower development in cucurbits (Zhang *et al*., 2017). Ethylene is a gaseous plant hormone which is commonly thought to be a growth inhibitor, it can also stimulate growth in certain tissues and cells at low quantities (Xin *et al*., 2019). In some plants like cucurbits, it is responsible for growth of leaves, flowers and fruits.

# Materials and methods

The experiment was conducted at Vegetable Research Farm, Institute of Agricultural Sciences, Banaras Hindu University during summer season of 2021. Trial was accomplished in a randomized block design with three replications and 13 treatments including control. The

sowing of seeds was done in well prepared plot at a spacing of 120×60 cm during year 2021. Treatments includes 50, 100 and 150 ppm of GA3; 25, 50 and 75 ppm of naphthalene acetic

acid; 125, 250 and 375 ppm of silver nitrate and 100, 200 and 300 ppm of ethrel applied as foliar spray at 15, 30 and 45 days after seed sowing. Observations like vine length, number of leaves, number of primary branches, internode length, days for maturity of fruits, total fruits per vine, length and diameter of fruits and total fruit yield/vine were taken from five randomly tagged plants of each replication. Observations recorded for various parameters analysed by statistical tools to compare the means among the treatments.

# Results and Discussion Growth parameters

The findings related to vegetative growth attributes indicated that vegetative growth of plant influenced significantly by spray of different PGRs at varied concentrations (**Table-1**). At 45 and 60 DAS, the longest main vine was (39.07 cm) and (103.77 cm) recorded from plants sprayed with AgNO3 375 ppm respectively while plants with shortest vine were found in untreated plot, it may be due to increased cell elongation and rapid cell division at growing parts promoted by both the chemicals (gibberellic acid and silver nitrate), the enhanced vine length by spray of plant growth regulators was also reported by (Nejatzadeh-Barandozi *et al*., 2016 and Rahman *et al*., 2020). Data pertaining to number of primary branches/vines showed that ethrel (300 ppm) produced more branches/vine (3.57). This could be related to presence of ethylene in ethrel which inhibit the gibberellin actions and ability to suppress the apical growth and divert plant’s energy towards lateral growth which results in more primary branches the results of present study are similar as reported by Thappa *et al*. (2011), Kaur *et al*. (2016), Chaurasiya *et al*. (2016), Dhakal *et al*. (2019) and Rahman *et al*. (2020). Another growth parameter i.e., leaves/vine was observed that plants treated with ethrel (300 ppm) remarkably produced more leaves/vine (14.88) and (36.83) at 45 and 60 DAS, respectively. More leaves/vine was due to more branches/vine resulted more leaves as compared to other treatments, findings with similar results were also observed by Hilli *et al*. (2010), Murthy *et al*. (2007), Shafeek *et al.* (2016) and Sabri *et al*. (2021). On the basis of findings, it was noted that highest (11.32 cm) internodal length was recorded from treatment with GA3 (150 ppm) was measured in which might be due to cell enlargement and elongation effect of gibberellic acid

on main vine as it increases internodal distance in plants, Dinesh *et al*. (2019) also recorded the similar findings on cucumber.

# Table: 1 Effect of GA3, NAA, AgNO3 and ethrel on growth parameters.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Vine length (cm)** | | **Number of leaves/vines** | | **No. of Primary**  **branches/vine** | **Internodal**  **distance (cm)** |
| **45 DAS** | **60 DAS** | **30 DAS** | **45 DAS** | **45 DAS** | **45 DAS** |
| T1 (GA3 50 ppm) | 33.03 | 99.03 | 11.47 | 25.07 | 2.50 | 10.17 |
| T2 (GA3 100 ppm) | 34.24 | 98.77 | 11.13 | 25.52 | 2.62 | 11.00 |
| T3 (GA3 150 ppm) | 34.51 | 100.07 | 12.27 | 26.13 | 2.50 | 11.32 |
| T4 (NAA 25 ppm) | 35.15 | 97.00 | 11.87 | 25.47 | 2.67 | 8.54 |
| T5 (NAA 50 ppm) | 35.51 | 96.17 | 11.73 | 25.15 | 3.00 | 8.70 |
| T6 (NAA 75 ppm) | 36.54 | 95.15 | 11.33 | 26.50 | 3.40 | 8.02 |
| T7 (AgNO3 125 ppm) | 37.79 | 98.09 | 12.67 | 34.13 | 3.00 | 9.87 |
| T8 (AgNO3 250 ppm) | 38.27 | 102.34 | 13.27 | 35.15 | 3.50 | 9.15 |
| T9 (AgNO3 375 ppm) | 39.07 | 103.77 | 12.40 | 34.02 | 3.00 | 9.45 |
| T10 (Ethrel 100 ppm) | 30.05 | 78.50 | 13.83 | 36.07 | 3.33 | 7.09 |
| T11 (Ethrel 200 ppm) | 30.58 | 79.20 | 14.50 | 36.37 | 3.53 | 6.97 |
| T12 (Ethrel 300 ppm) | 30.00 | 79.80 | 14.88 | 36.83 | 3.57 | 6.82 |
| T13 Control | 27.43 | 75.84 | 10.13 | 24.20 | 2.27 | 8.20 |
| Treatments mean | 34.01 | 92.59 | 12.42 | 30.05 | 2.99 | 8.87 |
| CD(p=.05) | 3.49 | 12.86 | 2.12 | 4.74 | 0.79 | 1.00 |
| SEm ± | 1.19 | 4.38 | 0.72 | 1.61 | 0.27 | 0.34 |

**Yield parameters**

Growth regulators applied as foliar spray significantly affected the yield and yield related traits of cucumber (**Table-2**). Treatment with ethrel (100 ppm) resulted in maximum fruits per (11.75) vine as compared to control. This was due to ethrel spray resulted in a higher number of female flowers, which exhibited higher fruits per vine. The similar results were also observed by Hossain *et al*. (2006) in bottle gourd, Hilli *et al*. (2010) in bitter gourd, Akter and Rehaman (2010) in bitter gourd, Mahala *et al*. (2014) in ridge gourd and Dhakal *et al*. (2019) in cucumber, all recorded more fruits per vine. The earliest maturity of fruits was recorded with NAA (25 ppm) which indicates that naphthalene acetic acid promoted cell division and thus enhanced the early growth and maturity of cucumber fruits (Hu *et al*., 2019). Among all the treatments, the fruit length was comparatively more (16.75 cm) in treatment with GA3 (150 ppm) than control which was due impact of gibberellins on greater photosynthetic activity, quicker translocation and efficiency of utilizing photosynthetic products leading in increased cell elongation and rapid cell division in the growing section. Similar results were obtained by Prabhu *et al*. (2006), Akter and Rehaman (2010), Jyoti *et al*. (2016), Kadi *et al*. (2018) and Pawar *et al*. (2019). The maximum (4.83 cm) fruit girth was recorded with ethrel (300 ppm), while it was noticed that control produced fruits with minimum girth. Growth regulators boosted photosynthetic activity, faster translocation and improved photosynthate use efficiency, leading in cell elongation and rapid cell division in the growing section, resulting in increased girth. Dhakal *et al*. (2019) also found that fruit girth was remarkably increased with application of 300 ppm of ethrel in cucumber. Ethrel substantially boosted yield when compared to GA3, NAA, AgNO3 and control. Because of improvements in fruit yield contributing parameters such as number of fruits per vine and fruit diameter, treatment with ethrel 100 ppm produced maximum fruit yield per vine (2.35 kg). Increased the fruit yield per vine may also be due to the fact that plants remain physiologically "more active" in order to accumulate sufficient assimilates for producing flowers and fruits, resulting in higher yield. The current findings are consistent with those reported by Thomas (2008), Akter and Rehaman (2010), Jadav *et al*. (2010), Thappa et *al*. (2011) Kaur *et al*. (2016), Shafeek *et al*. (2016), Pandey *et al*. (2018) and Dhakal *et al*. (2019).

# Table: 2 Effect of GA3, NAA, AgNO3 and ethrel on yield related traits.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | **Days taken for maturity of fruits from flowering** | **Total number of fruits per vine** | **Fruit length (cm)** | **Fruit girth (cm)** | **Fruit yield/vine (kg)** |
| T1 (GA3 50 ppm) | 7.93 | 6.88 | 15.60 | 4.50 | 1.37 |
| T2 (GA3 100 ppm) | 8.27 | 7.10 | 16.27 | 4.37 | 1.41 |
| T3 (GA3 150 ppm) | 7.45 | 7.40 | 16.75 | 4.47 | 1.50 |
| T4 (NAA 25 ppm) | 6.67 | 7.07 | 15.37 | 4.40 | 1.42 |
| T5 (NAA 50 ppm) | 6.80 | 7.47 | 16.20 | 4.60 | 1.51 |
| T6 (NAA 75 ppm) | 7.27 | 7.41 | 16.40 | 4.38 | 1.51 |
| T7 (AgNO3 125 ppm) | 7.60 | 7.97 | 14.33 | 4.37 | 1.57 |
| T8 (AgNO3 250 ppm) | 8.02 | 8.43 | 14.40 | 4.43 | 1.69 |
| T9 (AgNO3 375 ppm) | 7.13 | 8.29 | 14.20 | 4.60 | 1.66 |
| T10 (Ethrel 100 ppm) | 7.24 | 11.75 | 14.68 | 4.77 | 2.35 |
| T11 (Ethrel 200 ppm) | 7.65 | 11.36 | 14.90 | 4.69 | 2.27 |
| T12 (Ethrel 300 ppm) | 7.65 | 11.52 | 15.14 | 4.83 | 2.34 |
| T13 Control | 8.68 | 5.93 | 13.32 | 3.66 | 1.10 |
| Treatments mean | 7.57 | 8.35 | 15.20 | 4.47 | 1.67 |
| CD(p=0.05) | 0.66 | 1.27 | 1.13 | 0.49 | 0.04 |
| SEm ± | 0.23 | 0.43 | 0.39 | 0.17 | 0.01 |

**Conclusion**

The application of phytohormones, such as auxins, cytokinins, gibberellins and ethylene, various aspects of cucumber development can be regulated and enhanced. It is always

crucial to consider optimal application methods and concentrations of PGRs, as they vary based on cultivar, growth stage and environmental conditions. Understanding the interactions between PGRs and other growth factors, such as light, temperature and nutrient availability, is also vital for maximizing their beneficial effects on cucumber growth. However, findings of this study it was observed that various concentrations of GA3, NAA, AgNO3 and ethrel were found to be significantly effective over vegetative growth, period of flowering, sex modification and yield related attributes in cucumber. The outcome obtained with this investigation concluded that application of GA3 150 ppm resulted in increased internodal distance of vine and AgNO3 at 375 ppm exhibited a greater number of male flowers than control. Results revealed that plants treated with ethrel at 100 ppm demonstrated significantly increased femaleness and early flowering as a result of higher number of pistillate flower which increased the total fruit yield. Overall, plant growth regulators provide valuable tools for cucumber growers to optimize growth, enhance flowering and maximize fruit yield. With proper understanding and application, these regulators can contribute to the successful cultivation of high-quality cucumbers, meeting market demands and ensuring profitability for farmers.

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