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# Study of Influence of Plant Growth Regulators (PGRs) on Growth and Development in Cucumber

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## ABSTRACT

*Study of Horticulture Research Station, College of Agriculture Indore, to find out the effect of plant growth regulators on physiology and yield attributing characters in cucumber (Cucumis sativus L.). The experiment was laid out in randomized block design with nine treatments and three replications. The treatments consistsed of two growth promoters viz., gibberrellic acid (50 and 100 ppm), naphthalene acetic acid (50 and 100 ppm), a retardant CCC (250 and 500 ppm), tricontanol (50 and 100 ppm) and a control. Find out the application of plant growth regulators significantly increased morpho-physiological traits viz., vine length, number of leaves and number of female flowers per plant as compared to control. Growth parameters viz., leaf area, LAI, LAR etc. were also influenced by the application of plant growth regulators. Application of growth regulators increased the dry weight of leaf, reproductive parts and total dry weight significantly and the total dry weight showed a positive correlation with yield.*

***Key words:*** *Cucumber, Vegetable crops, Carbohydrates, Gibberrellic acid*

## INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important and popular vegetable crops belonging to the family Cucurbitaceae. It is grown mainly for its fruits, both in India and abroad. Worldwide, cucumbers are extensively grown for fresh market and China leads in production followed by India. In India, cucumber is cultivated extensively in the states of Madhya Pradesh, Tamil Nadu, Uttar Pradesh, Andra Pradesh, Kerala and Maharashtra. In the world during 2008, cucumber was cultivated on an area of 17.92 lakh ha with a production of 30.50 lakh tons and an average yield of 17021 kg/ha. While in India, it was cultivated on an area of 17800 ha with a production of 2.09 lakh tons and an average productivity of 11750 kg/ha. The Indian yields are 13.3 percent less than the world's average[1]. The fruits are highly nutritive and have very high-water content and very low calories.

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The fruit is used as a vegetable or salad. It is rich in minerals, thiamine, niacin and vitamin C. (0.38 g, 0.3 mg, 0.2 mg and 78 mg, respectively per 100 g of edible fruit). Fruits consist about 80 percent of edible portion which contains 95% water, 0.7% protein, 0.1% fat, 3.4% carbohydrates, 0.4% fiber and 0.4% ash[3]. Plants respond to different external factorscand adjust their physiological processes and molecular mechanisms by producing regulatory molecules to improve their growth and productivity[7]. Ethylene is one such signalling molecule that interacts with nutrients to influence physiological processes[5]. Exogenous ethylene affects ethylene biosynthesis in various plant parts through homeostasis. Since ethylene is a potent phytohormone, small changes in its production result in the re-regulation of a number of vital plant processes, such as photosynthesis, cell division, cell elongation, and the metabolism of mineral nutrients[7]. Like other nutrients, the availability of N is known to regulate the biosynthesis of ethylene[6]. For instance, Fiebig and Dodd reported that tomato (*Solanum lycopersicum*) plants reduce ethylene synthesis back to the normal level following the addition of 10 mm N. Similarly, the application of N improves photosynthesis in mustard plants through the regulation of the phytohormones proline and ethylene[4], but excess N is related to a higher production of ethylene. In contrast, aminoethoxyvinyl glycine (AVG), an inhibitor of ethylene biosynthesis, and AgNO3, an inhibitor of ethylene action, as well as gibberellins (GA) suppress the development of pistillate flowers and induce staminate fl owers[2,9,11,12,13]. Koyama[8] reported that staminate flowers induced with $AgNO_3$ at 500 mg L−1 resulted in highest seed set. Plant growth regulators are also used to control the vegetative growth of cucumber plants, thereby increasing the plant population per unit area with regard to yield[10].

## MATERIAL AND METHODS

The experiment was conducted in hi-tech area of polyhouse at Research form of Department of Horticulture, College of Agriculture, Indore (M.P.) during the summer season 2013. Indore is situated in Malwa Plateau in western part of Madhya Pradesh on latitude of 22$^o$ 43' N and longitude of 75$^o$66' E with an altitude of 555.5 meters above mean sea level, Indore region comes under sub-tropical and semi-arid region, having a temperature range from 29$^o$C – 41$^o$C as maximum and 7$^o$C – 23$^o$C as minimum in summer and winter season, respectively. The soil of the experimental field was red clay with uniform topography. The soil of the experiment field was medium black with 37% clay, 38% salt and 25% send with PH ranging 7.2. The soil was low in Available nitrogen, medium in available phosphorus and high in available potassium. The 9 treatments were replicated three times in randomized block design in 1.0 x 10.0 sqm. plots. The statistical analysis was done as per the standard procedure for analysis of variance for RCBD. Least significant difference was employed for mean comparison.

### 2.1 Leaf Area Index

The leaf area index (LAI) is the ratio of leaf area per plant to the land area occupied by the plant and was calculated by using the formula as suggested by Sestak.

$$\text{LAI} = \frac{\text{Leaf Area per Plant (cm}^2\text{)}}{\text{Land Area Occupied by a plant (cm}^2\text{)}}$$

### 2.2 Leaf Area Ratio (cm$^2$ /g)

Leaf area ratio (LAR) is the ratio of leaf area to the total dry matter which was calculated by using the formula given below and expressed as cm$^2$ /g.

$$\text{LAR (cm}^2\text{g}^{-1}\text{)} = \frac{\text{Leaf Area (cm}^2\text{)}}{\text{Total Dry Matter (g)}}$$

## RESULTS AND DISCUSSION

### 3.1. Total dry matter production per plant (g/plant)

**Table 1: Influence of plant growth regulators on total dry weight (g/plant) at different growth stages in cucumber**

| Treatments | Days after sowing (DAS) | | |
|---|---|---|---|
| | 40 (DAS) | 55 (DAS) | 70 (DAS) |
| $T_1$ - $GA_3$ (50 ppm) | 20.8 | 59.2 | 63.8 |
| $T_2$ - $GA_3$ (100 ppm) | 19.3 | 57.4 | 61.7 |
| $T_3$ - NAA (50 ppm) | 18.4 | 56.4 | 60.8 |
| $T_4$ - NAA (100 ppm) | 20.4 | 57.1 | 61.4 |
| $T_5$ - CCC (250 ppm) | 20.8 | 58.9 | 63.4 |
| $T_6$ - CCC (500 ppm) | 20.6 | 59 | 63.5 |
| $T_7$- Tricontanol (50 ppm) | 18.1 | 56.5 | 60.1 |
| $T_8$- Tricontanol (100 ppm) | 18 | 55.5 | 57.9 |
| $T_9$ – Control | 17.8 | 54.5 | 56.3 |
| Mean | 19.4 | 57.2 | 60.9 |
| S.Em± | 0.76 | 1.12 | 0.48 |
| CD (5%) | 2.28 | 3.35 | 1.45 |

The total dry weight increased from 40 to 70 DAS in all the treatments (Table 1) the maximum total dry weight was noticed at 70 DAS with all the growth regulator treatments. At 55 DAS, gibberellic acid (50 ppm) recorded significantly higher total dry weight (59.2) followed by cycocel (250 and 500 ppm) which did not differ significantly with each other. The rest of the treatments showed a significant increase in total dry weight and they were on par with each other. The minimum total dry weight was recorded in control which was significantly lower than all the treatments. A similar trend was noticed at 70 DAS with gibberellic acid (50 ppm) showing the highest total dry matter (63.8) followed by cycocel (500 and 250 ppm). The minimum total dry matter (56.3) was recorded in control which was significantly lower over all other treatments.

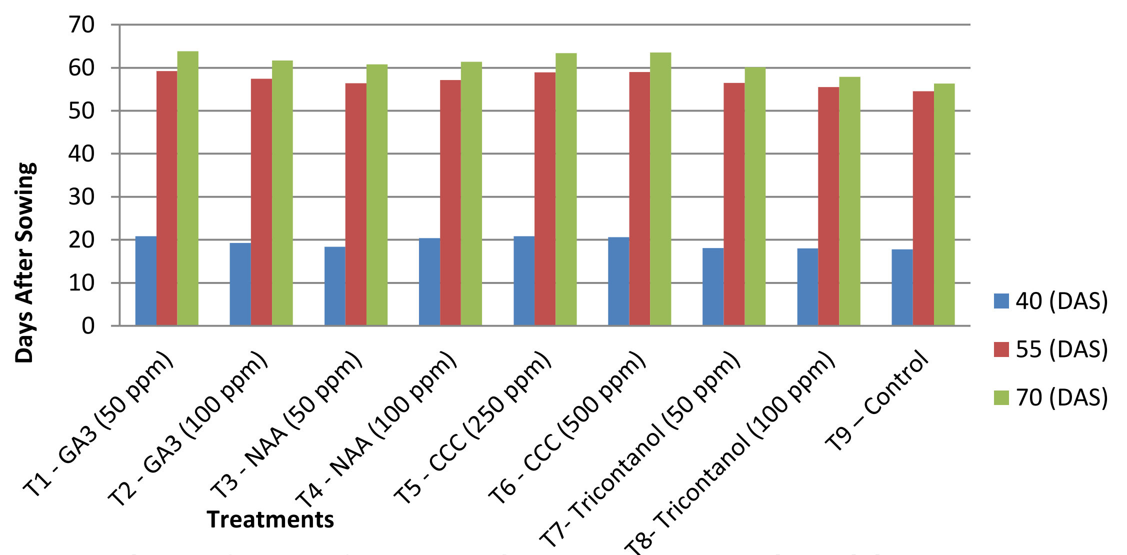


**Fig. 1: Influence of plant growth regulators on total dry weight (g/plant)at different growth stages in cucumber**

### 3.2. Leaf area ($cm^2$/plant)

**Table 2: Influence of plant growth regulators on leaf area ($cm^2$ /plant) at different growth stages in cucumber**

| Treatments | Days after sowing (DAS) | | |
|---|---|---|---|
| | **40 (DAS)** | **55 (DAS)** | **70 (DAS)** |
| $T_1$ - $GA_3$ (50 ppm) | 31.53 | 57.37 | 61.26 |
| $T_2$ - $GA_3$ (100 ppm) | 30.98 | 53.32 | 55.13 |
| $T_3$ - NAA (50 ppm) | 29.6 | 54.84 | 57.51 |
| $T_4$ - NAA (100 ppm) | 29.38 | 55.74 | 58.26 |
| $T_5$ - CCC (250 ppm) | 28.21 | 45.64 | 48.56 |
| $T_6$ - CCC (500 ppm) | 27.56 | 43.72 | 47.1 |
| $T_7$- Tricontanol (50 ppm) | 28.83 | 52.18 | 55.68 |
| $T_8$- Tricontanol (100 ppm) | 27.65 | 49.63 | 52.65 |
| $T_9$ – Control | 27.26 | 47.82 | 51.4 |
| Mean | 28.9 | 51.14 | 54.17 |
| S.Em± | 0.29 | 0.09 | 0.39 |
| CD (5%) | 0.87 | 0.06 | 1.18 |

The data on leaf area presented in Table 2 indicated significant differences between the treatments. Among the treatments, at 55 DAS, the leaf area was significantly superior (57.37) in gibberellic acid (50 ppm) over all the treatments. The treatments, gibberellic acid (100 ppm), naphthalene acetic acid (50 ppm and 100 ppm), Tricontanol (50 ppm) were on par with each other. The lowest leaf area (43.72) was recorded in cycocel (500 ppm) which was significantly lower compared to all other treatments. At 70 DAS, gibberellic acid (50 ppm) continued to produce significantly higher leaf area (61.26) compared to all other treatments. Similarly, the treatments, gibberellic acid (100 ppm), naphthalene acetic acid (50 ppm and 100 ppm) and Tricontanol were found to be on par with each other; while cycocel recorded minimum (47.10) leaf area.

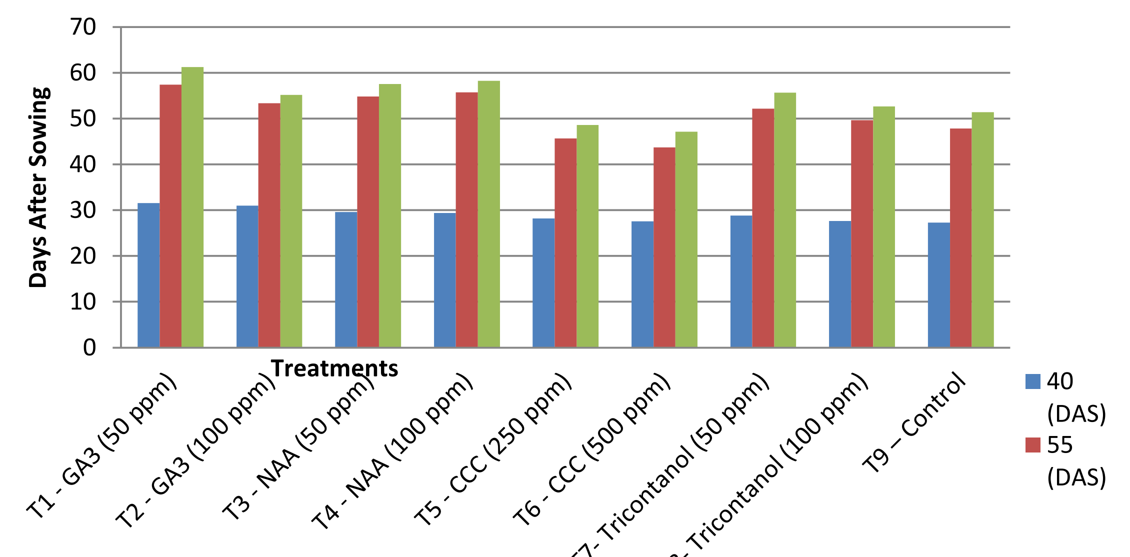


**Fig. 2: Influence of plant growth regulators on leaf area ($cm^2$/plant) at different growth stages in cucumber.**

 

### 3.3. Leaf area index (LAI)

**Table 3: Influence of plant growth regulators on leaf area index (LAI) at different growth stages in cucumber**

| Treatments | Days after sowing (DAS) | | |
|---|---|---|---|
| | 40 DAS | 55 DAS | 70 DAS |
| $T_1$ - $GA_3$ (50 ppm) | 0.21 | 0.382 | 0.408 |
| $T_2$ - $GA_3$ (100 ppm) | 0.207 | 0.356 | 0.368 |
| $T_3$ - NAA (50 ppm) | 0.197 | 0.366 | 0.383 |
| $T_4$ - NAA (100 ppm) | 0.196 | 0.372 | 0.388 |
| $T_5$ - CCC (250 ppm) | 0.188 | 0.304 | 0.324 |
| $T_6$ - CCC (500 ppm) | 0.184 | 0.292 | 0.314 |
| $T_7$- Tricontanol (50 ppm) | 0.192 | 0.348 | 0.371 |
| $T_8$- Tricontanol (100 ppm) | 0.184 | 0.331 | 0.351 |
| $T_9$ – Control | 0.182 | 0.319 | 0.343 |
| Mean | 0.193 | 0.341 | 0.361 |
| S.Em± | 0.001 | 0.002 | 0.002 |
| CD (5%) | 0.005 | 0.008 | 0.007 |

The data on LAI, presented in Table 3 indicated that it increased from 40 to 70 DAS. It followed a similar trend as that of leaf area.

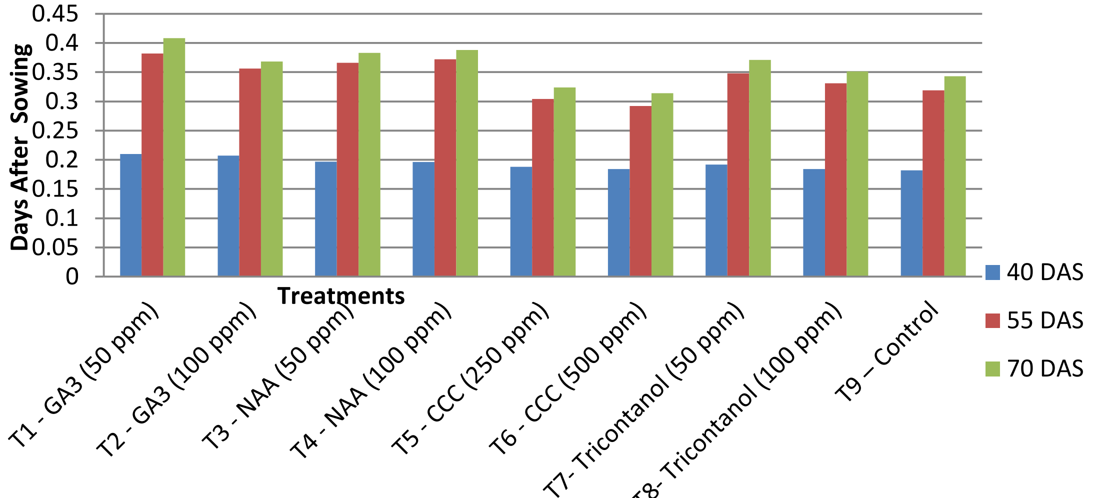


**Fig. 3. Influence of plant growth regulators on leaf area index (LAI) at different growth stages in cucumber.**

### 3.4. Leaf Area Ratio (LAR) ($cm^2/g$)

**Table 4: Influence of plant growth regulators on leaf area ratio (LAR) ($cm^2/g$) at different growth stages in cucumber**

| Treatments | Days after sowing (DAS) | | |
|---|---|---|---|
| | 40 (DAS) | 55 (DAS) | 70 (DAS) |
| $T_1$ - $GA_3$ (50 ppm) | 1.52 | 0.97 | 0.96 |
| $T_2$ - $GA_3$ (100 ppm) | 1.61 | 0.93 | 0.89 |
| $T_3$ - NAA (50 ppm) | 1.63 | 0.97 | 0.95 |
| $T_4$ - NAA (100 ppm) | 1.46 | 0.98 | 0.95 |
| $T_5$ - CCC (250 ppm) | 1.36 | 0.78 | 0.77 |
| $T_6$ - CCC (500 ppm) | 1.34 | 0.74 | 0.74 |
| $T_7$- Tricontanol (50 ppm) | 1.6 | 0.92 | 0.93 |
| $T_8$- Tricontanol (100 ppm) | 1.54 | 0.9 | 0.91 |
| $T_9$ – Control | 1.53 | 0.88 | 0.91 |
| Mean | 1.51 | 0.89 | 0.88 |
| S.Em± | 0.06 | 0.02 | 0.01 |
| CD (5%) | 0.18 | 0.05 | 0.03 |

The LAR presented in Table 4 indicated significant differences due to influence of growth regulators. In general, the LAR decreased from 40 DAS to harvest. At 40 DAS, the LAR values indicated significant differences among the treatments. The maximum LAR (1.63) was recorded in naphthalene acetic acid (50 ppm) followed by gibberellic acid (100 ppm) and they were on par with each other. The lowest LAR was recorded in cycocel (500 ppm) followed by cycocel (250 ppm) which was lower than control. At 55 DAS, naphthalene acetic acid (50 ppm) recorded maximum LAR (0.98) followed by gibberellic acid (50 ppm) and naphthalene acetic acid (50 ppm) and they were on par with each other. The minimum LAR (0.74) was recorded in cycocel which was significantly lower over all other treatments.

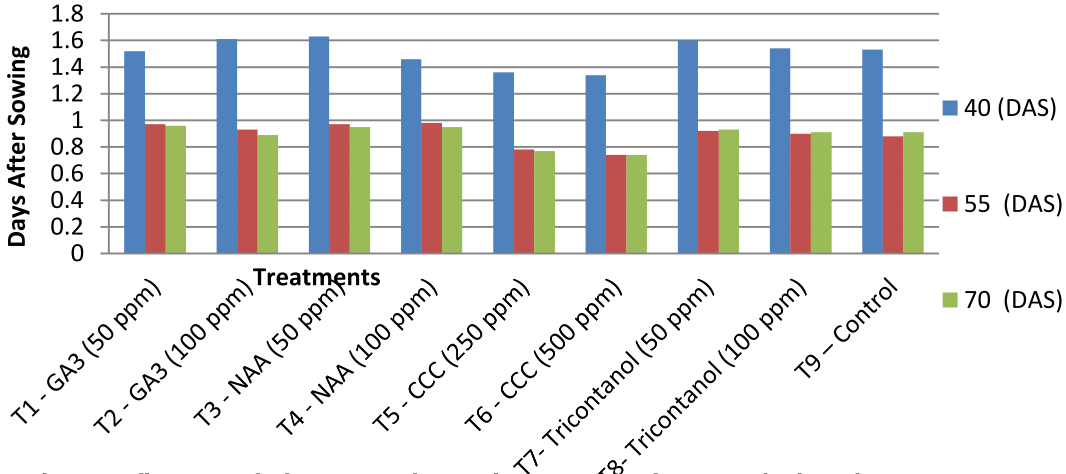


**Fig. 4: Influence of plant growth regulators on leaf area ratio (LAR) ($cm^2/g$) at different growth stages in cucumber.**

**Growth attributing characters**

The amount of total dry matter produced is an indication of the overall efficiency of utilization of resources and better interception of light. The partitioning of total dry matter in leaf, vines and reproductive parts varied significantly due to the growth regulator treatments.

The total dry matter accumulation increased from 40 to 70 DAS. $GA_3$ (50 ppm) recorded significantly higher total dry matter compared to control. The dry weight of reproductive parts also increased continuously throughout the growing period due to growth regulator treatments. The enhanced dry weight of reproductive parts is due to increased fruits per plant and also efficient translocation of assimilates from leaf and vines to reproductive parts.

Crop yield is mainly dependent on the interplay of various physiological and biochemical functions of the plant in addition to the impact of growing conditions. The cause and effect relationship is difficult to understand mainly because of complexity in understanding the interplay of several processes and functions which ultimately lead to changes not only in growth, development and physiology, but also on the yield, which is the most complex character. It is well established that the infrastructure of the plant is decided by the growth parameters like leaf area, LAI, LAR. The growth analysis technique has been adopted as one of the standard approaches in the absence of sophisticated instruments to analyze the structure of yield in several crops.

It has been observed in the present study that the application of plant growth regulators had profound influence on assimilatory surface area and its associated characters. Leaf area fairly gives a good idea of photosynthetic capacity of the plant. Significant differences were also noticed with regard to leaf area among the treatments at all the stages. The leaf area increased from 40 to

70 DAS (Figure 9). The leaf area was decreased by application of growth retardants (CCC) as compared to $GA_3$ @ 50 ppm, whereas, PGRs maintained a higher leaf area at later stage of the crop growth.

## CONCLUSION

All the yield contributing characters v*iz.* fruit length, fruit diameter, percent fruit set, number of fruits per plant and fruit yield increased significantly due to plant growth regulators. The fruit yield was significantly higher with the foliar application of $GA_3$ (50 ppm) followed by CCC (500 ppm) compared to control. The economics of using different growth regulators revealed that the B:C ratio was maximum with NAA (100 ppm) followed by $GA_3$ (50 ppm).

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