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Research Article

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Study of Influence of Plant Growth Regulators (PGRs) on Physiological Parameters 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. Results revealed that 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, Reductase enzymes, Fruits, Brassica juncea*

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is an important vegetable crop that is cultivated all over the world for its economic and nutritional benefits. Mature cucumber fruits are used in salads while the immature fruits are used to produce pickles. The growth and development of cucumber are adversely affected in stressful environments, including under nutrient deficient conditions[16]. Nitrogen (N) is an important phytonutrient that is usually required in large amounts, with its deficiency generally limiting plant growth and development[3]. Plants assimilate N by reducing nitrate to nitrite and then ammonium through the action of respective reductase enzymes. Thus, N functions as a signalling element that sustains plant growth and development, particularly in stressful conditions[8,7].

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It has previously been shown that both deficient and excessive amounts of N have a significant negative impact on mustard *Brassica juncea*[3], demonstrating that the amount of N needs to match the optimum requirements of a particular crop. The role of plant growth regulators has been well known to modify various physiological processes in cucurbitaceous crops[15], among them sex modification is well studied under the influence of growth regulators[6]. The ealier studies reveal production of female flowers in low temperature and short days[11]. Lal and Jaiswal[6], which suggest the synthesis of phytohormones in plant body. Keeping in view the fact exogenous application of growth regulators has been extensively studied to modified sex expression in favors of feminism under the influence of growth regulators i.e. ethephon and maleic hydrazide when applied at two and four leaf stage[2].

Ethylene is a gaseous plant hormone involved in regulation of various morphological and physiological processes throughout life cycle of plant including root hair formation, seed dormancy, fruit ripening and numerous abiotic stresses[9,5]. stem elongation[12]. Ethylene is also involved in shoot, root growth and differentiation[1,10] and adventitious root formation[13]. Ethylene emission from all plant organs has been reported depending on environmental factors and plant species. Moreover, sensitivity and production of ethylene plays essential role regarding sex expression in cucurbits by transition of male buds into female buds and also affect the number of male and female flowers per plant. There is large body of literature regarding the role of foliar-applied source of ethylene (Ethephon) in enhancing femaleness and fruit number of cucumber[18,17,14], leaf area of mustards[4]. However, there is a little research regarding the role of biologically substrate-dependent ethylene for cucumber production.

MATERIAL AND METHODS

The experiment was conducted in hi-tech area of playhouse 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 Fruit set (%)

Fruit set percent was calculated from the number of fruits to the number of female flowers produced per plant as follows:

$$\text{Fruit set (\%)} = \frac{\text{No. of fruits per plant}}{\text{No. of female flowers per plant}} \times 100$$

RESULTS AND DISCUSSION

3.1 Vine length (cm)

Table 1: Influence of plant growth regulators on vine length (cm) at different growth stages in cucumber

Treatments	Days after sowing (DAS)		
	40	55	70
T_1 - GA_3 (50 ppm)	80	139	220
T_2 - GA_3 (100 ppm)	78	133	208
T_3 - NAA (50 ppm)	73	132	209
T_4 - NAA (100 ppm)	77	133	211
T_5 - CCC (250 ppm)	72	127	200
T_6 - CCC (500 ppm)	70	126	197
T_7 -Tricontanol (50 ppm)	74	131	207
T_8-Tricontanol(100 ppm)	75	131	207
T_9 - Control	73	129	204
Mean	75	131	208
S. Em±	3.6	2.34	3.74
CD (5%)	NS	7.03	11.2

The data on vine length presented in Table 1 indicated significant differences between the treatments at all the stages except 40 DAS. The vine length almost doubled between 40 and 55 DAS and increased progressively thereafter. At 55 DAS, the vine length was significantly higher (139.3) with the treatment of gibberellic acid (50 ppm) followed by gibberellic acid (100 ppm). The lowest vine length (126.0 cm) was recorded in cycocel (500 ppm) followed by CCC (250 ppm) which did not differ significantly among themselves. Among the treatments, gibberellic acid (50 ppm) recorded significantly higher vine length (220.4 cm) over all the treatments even at 70 DAS. Significantly lower vine length (197.4) was recorded in cycocel (500 ppm) as compared to control.

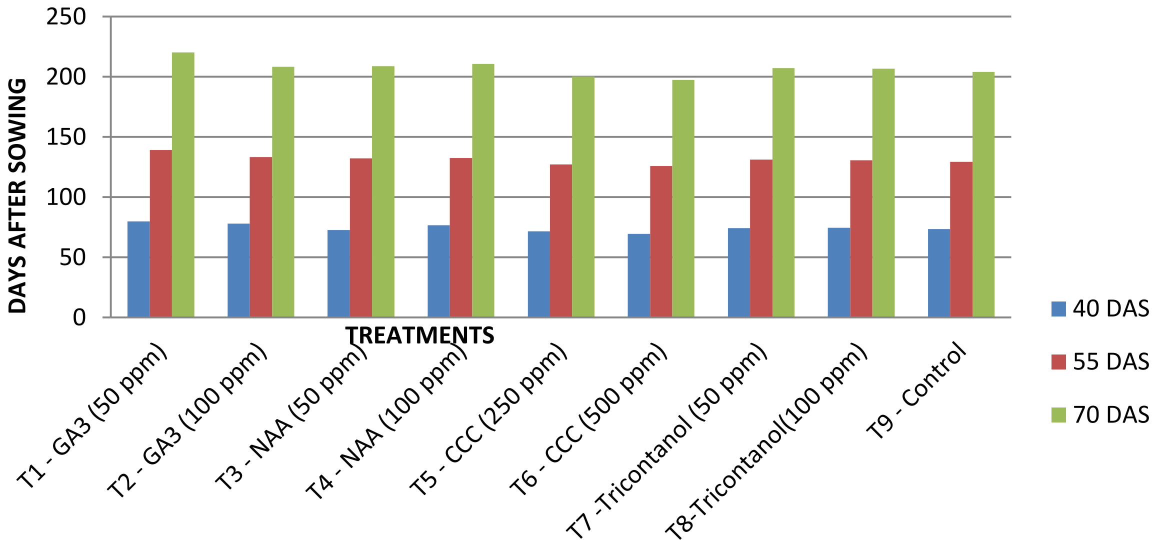

Fig. 1: Influence of plant growth regulators on vine length (cm) at different growth stages in cucumber

3.2 Number of leaves/plant

Table 2: Influence of plant growth regulators on number of leaves/plant at different growth stages in cucumber

Treatments	Days after sowing (DAS)		
	40 DAS	55 DAS	70 DAS
T_1 - GA_3 (50 ppm)	42.7	63	155.8
T_2 - GA_3 (100 ppm)	42.9	59.7	152.3
T_3 - NAA (50 ppm)	42.4	61.4	148.1
T_4 - NAA (100 ppm)	42.8	58.3	151.7
T_5 - CCC (250 ppm)	41.8	57.6	143.6
T_6 - CCC (500 ppm)	42.3	57.2	142.2
T_7- Tricontanol (50ppm)	40.8	58	147.8
T_8- Tricontanol (100ppm)	41.6	60.6	145.5
T_9 – Control	40.7	57	141.3
Mean	42	59.4	147.7
S. Em±	1.23	2.14	1.52
CD (5%)	NS	6.42	4.58

In general, the number of leaves increased from 40 to 55 DAS, irrespective of the treatments, it differed significantly between the treatments at all the stages except 40 DAS (Table 2). At 55 DAS, the number of leaves was maximum (63.0) in gibberellic acid (50 ppm) followed by gibberellic acid (100 ppm) and naphthalene acetic acid (50 ppm) and was significantly superior over control. Significantly lower number of leaves was recorded in control (57.0) compared to all other treatments. At 70 DAS, gibberellic acid (50 ppm) recorded significantly higher number of leaves (155.8) over all the treatments. Significantly lower number of leaves was recorded in control. However, the treatments gibberellic acid (100 ppm), naphthalene acetic acid (50 ppm and 100 ppm) was at par with each other.

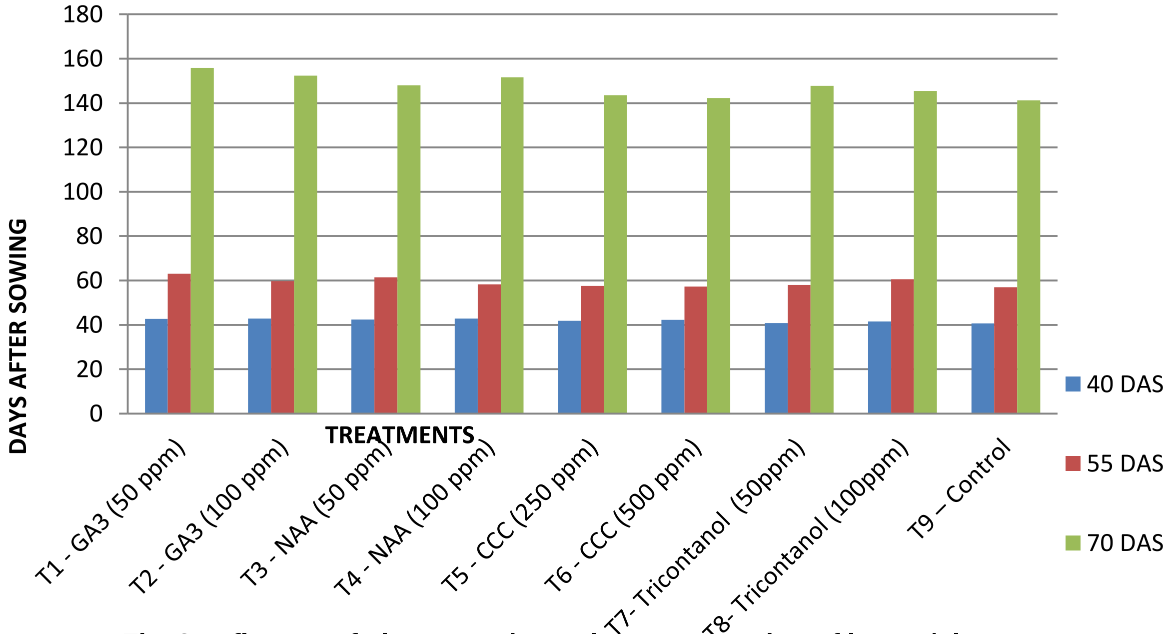

Fig. 2: Influence of plant growth regulators on number of leaves/plant at different growth stages in cucumber.

3.3 Days to flower initiation

Table 3: Influence of plant growth regulators on days to first male flower initiation, female flower initiation and fruit set in cucumber

Treatments	Days to		
	First male flower	First female flower	Fruit set
T_1 - GA_3 (50 ppm)	27.4	34.6	41.6
T_2 - GA_3 (100 ppm)	25.7	35.7	42.5
T_3 - NAA (50 ppm)	29.7	32.8	43.2
T_4 - NAA (100 ppm)	29.8	33.4	42.5
T_5 - CCC (250 ppm)	30	33.5	41.8
T_6 - CCC (500 ppm)	30.1	33.3	40.8
T_7-Tricontanol (50 ppm)	30	34.6	44.2
T_8- Tricontanol (100 ppm)	30.1	34.8	44.6
T_9 – Control	30.3	36.3	44.7
Mean	29.2	34.4	42.9
S. Em±	0.05	0.34	0.64
CD (5%)	1.5	1.03	1.94

The data with respect to days to flower initiation indicated significant differences between the treatments (Table 3). Days to first male and female flower initiation was found to be influenced significantly due to different growth regulators. CCC (500 ppm) delayed the appearance of male flowers (30.1) whereas GA3 (100 ppm) produced first male flowers as early as 25.7 DAS. However, less number of days (40.8) was required to initiate first female flower with CCC (500 ppm) followed by GA3 (50 ppm). The maximum number of days for first female flower initiation (44.7) was recorded in control.

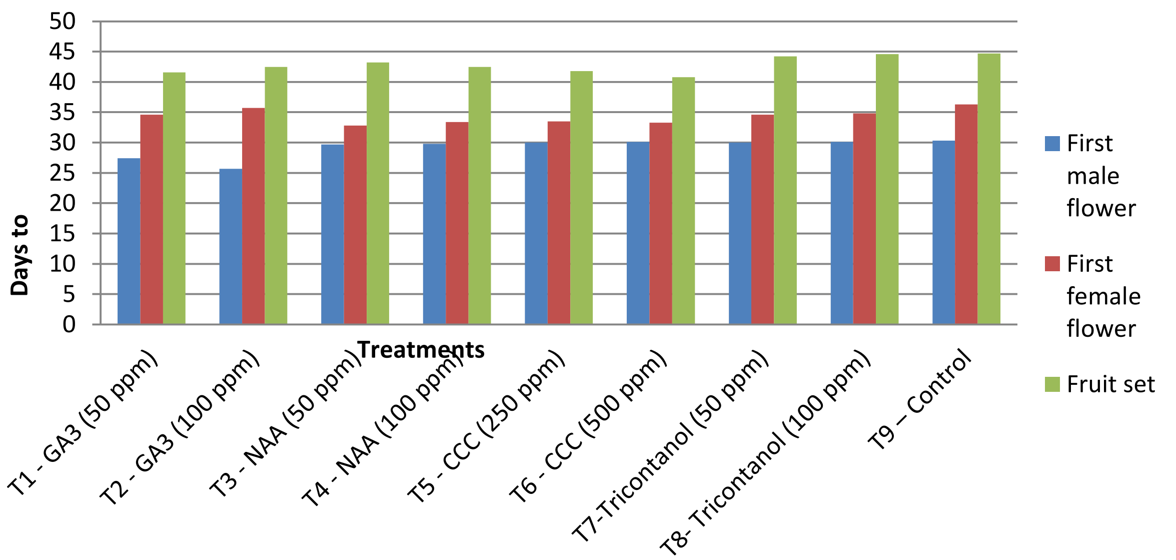

Fig. 3: Influence of plant growth regulators on days to first male flower initiation, female flower initiation and fruit set in cucumber

3.4 Number of female flowers/plant

Table 4: Influence of plant growth regulators on number of female flowers per plant and percent fruit set at 55 DAS in cucumber

Treatments	Number of female flowers	Fruit set (%)
T_1 - GA_3 (50 ppm)	10.5	82.9
T_2 - GA_3 (100 ppm)	10.4	76
T_3 - NAA (50 ppm)	10.5	73.3
T_4 - NAA (100 ppm)	10.7	78.5
T_5 - CCC (250 ppm)	10.6	79.2
T_6 - CCC (500 ppm)	10.8	79.6
T_7- Tricontanol (50 ppm)	10.2	74.5
T_8- Tricontanol (100 ppm)	10.2	73.5
T_9 – Control	10	71
Mean	10.4	76.5
S.Em±	0.12	1.59
CD (5%)	0.36	4.78

The data on number of female flowers per plant presented in Table 4 indicated significant differences between the treatments. Among the treatments, the number of female flowers was found to be maximum (10.8) with CCC (500 ppm) followed by naphthalene acetic acid (100 ppm) which were on par with each other. The minimum number of female flowers (10.2) was recorded in Tricontanol (100 ppm) compared to all other treatments. However, the number of female flowers in control (10.0) was lower than Tricontanol (100 ppm).

3.5 Fruit set (%)

The data on percent fruit set presented in Table 4 indicated significant differences between the treatments.

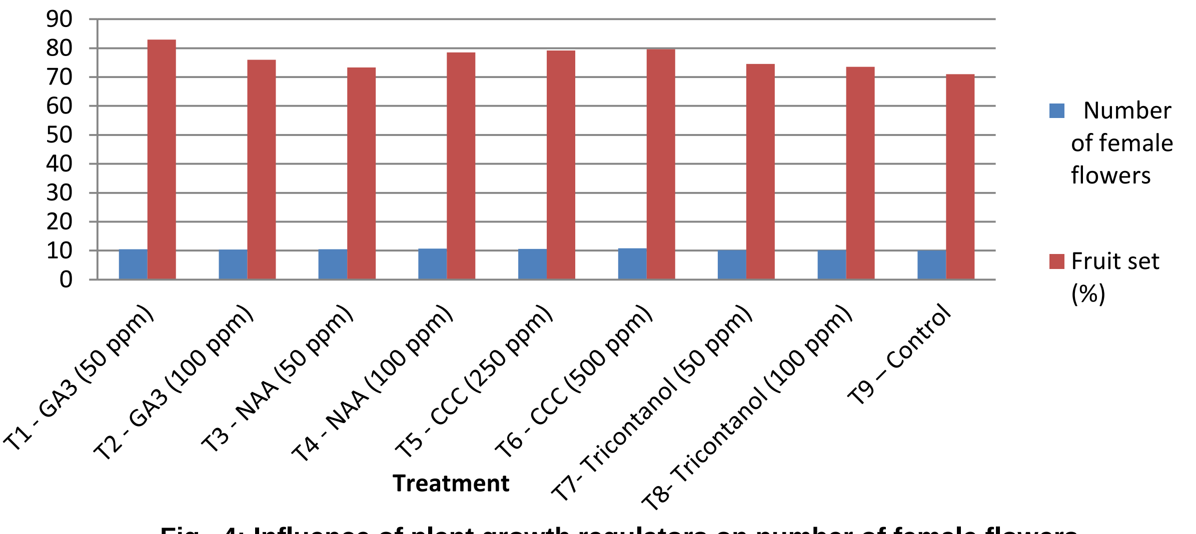

Fig. 4: Influence of plant growth regulators on number of female flowers per plant and percent fruit set at 55 DAS in cucumber.

Among the treatments, the percent fruit set was maximum (82.9) with gibberellic acid (50 ppm) and it was significantly superior over rest of the treatments. The minimum percent fruit set (71.0) was recorded control which was significantly lower than rest of the treatments.

Morphological characters

Application of plant growth regulators had significant influence on morphological characters like vine length, number of leaves in cucumber. Remarkable increase in vine length was observed with GA_3 (50 ppm) and the minimum was recorded in cycocel (500 ppm). There are numerous reports showing that gibberellins promote growth of intact plants. The promotion of growth either in terms of increase in the vine length or the leaf area and leaf number has been thought to be by 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. These results are in conformity with the findings of Singh and Choudhary in watermelon and summer squash. The simulative effect of GA_3 at 25 ppm on vine length was also noticed in watermelon by Arora. A similar increase in vine length in cucumber was also observed by Vadigeri.

The number of leaves per plant differed significantly among the treatments and increased due to the application of plant growth regulators. Among the treatments, GA_3 @ 50 ppm (155.8) followed by GA_3 @ 100 ppm (152.3) and NAA @ 100 ppm (151.7) recorded maximum number of leaves. Increase in the number of leaves might be due to its additional availability of gibberellins in seed which might have increased the level of amylase in the aleurone tissues of seed for better conversion of complex starch into simple sugars for providing energy to growth. The decrease in both the vine length as well as number of leaves with CCC could be due to the nature of onium compounds to which CCC belongs and it is known to interfere in the GA_3 biosynthetic pathway before the cyclisation of gernayl pyrophosphate.

3.6 Phenological characters

CCC @ 500 ppm produced maximum number of female flowers (10.8) per plant and the minimum number of female flowers (10.0) was produced in control. It has been observed in the present study that the application of plant growth regulators has profound influence on assimilatory surface area and its associated characters. The maximum increase in leaf area was observed with GA_3 @ 50 ppm followed by NAA @ 100 ppm. This could be attributed to the stimulatory effect of the plant growth regulators on cell division and cell enlargement, which lead to enhanced leaf area and hence influenced the growth and development. The increase in both leaf number and leaf area could be due to the effect of GA's on cell division and cell enlargement.

The percent fruit set differed significantly among the treatments and increased due the application of PGRs. Among these, the maximum percentage of fruit set per plant was obtained with GA_3 (50 ppm), while the minimum percentage of fruit set per plant was obtained in control.

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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