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Pratyksh Pandey
Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

IN Shukla
Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Ashutosh Upadhyay
Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Corresponding Author:
Pratyksh Pandey
Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India

Effect of different plant growth regulators on growth, yield and quality parameters of cucumber (*Cucumis sativus* L.) *cv.* Kalyanpur green

Pratyksh Pandey, IN Shukla and Ashutosh Upadhyay

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Abstract
An investigation was carried out at the Vegetable Research farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during *Kharif* season of 2018. The soil of the experimental field was sandy-loam with uniform topography. The experiment was laid out in a randomized block design replicated thrice with nine treatments i.e. T_1 - foliar application of GA3 (100ppm) at 15 days after sowing, T_2 - foliar application of GA3 (150ppm) at 30days after sowing, T_3 - foliar application of GA3 (200ppm) at 45days after sowing, T_4 - foliar application of NAA (100ppm) at 15days after sowing, T_5 - foliar application of NAA (150ppm) at 30days after sowing, T_6 - foliar application of NAA (200ppm) at 45 days after sowing, T_7 - foliar application of Ethrel (200ppm) at 2-4 leaf stage, T_8 - foliar application of Ethrel (300ppm) at pre flowering and T_9 - Control (Water Spray). The result shows that an application of Ethrel 200ppm was found most effective in reducing the number of male flowers (90.75) in comparison to female flowers (52.08). GA_3 200ppm reduce the number of days required for appearance of first flower (36.58 days) of cucumber plant, increased the production of female flowers (50.25), lowered the male and female sex ratio (1.70: 1), increased number of fruits per plant (11.67), increased yield per plant (3.89 kg) and per hectare (180.69 q). The next best treatment was GA_3 100 ppm which increased the yield of fruits per plant (3.42 kg) and yield per hectare. From the results of this investigation, it could be inferred that Ethrel 200 ppm treatment was found most effective in improving femaleness with increased fruit yield of cucumber cv. Kalyanpur Green'. Results revealed that the application of plant growth regulators significantly increased growth. GA_3 (100ppm) play an important role in increasing yield characters followed by NAA (100 ppm) and male and female flower ratio can be lowered by the application Ethrel (300 ppm). The fruit set and fruit retention percentage was improved through the application GA_3 (150ppm) followed by GA_3 (200ppm).

Keywords: cucumber, growth regulators (GA_3, NAA, Ethrel), yield and quality

Introduction
Vegetables are protective food. They are rich in vitamins and minerals which are most essential for maintaining good health of human. Among the vitamins, vitamin A, B, C, D and E are important. All vitamins are found in small or large quantities in the common vegetable crops. According to recommendation made by the ICMR (Indian Council of Medical Research), an average man with vegetarian or non-vegetarian food habit should consume 300 g of vegetables in his daily diet. It recommended that 125 g of these should be green leafy vegetables, 100 g of roots and tubers vegetables and the remaining 75 g of other vegetables. But our present consumption of vegetables is 184 g per day per capita. This means that we need to produce and consume vegetables than we do as present. Cucumber *(Cucumissativus* L.) is one of the oldest cultivated vegetable crops having its origin probably in India. It belongs to family "Cucurbitaceae" genus Cucumis. The fruit of cucumber is said to have cooling effect, prevent constipation, checks jaundice and indigestion. Fruit is also used as astringent and antipyretic. Nutritively 100 g edible portion of cucumber contains 96.3 g moisture, *2.5* g carbohydrates, 0.4 g protein, 0.1 g fat, 0.3 g minerals, 10 mg calcium, 1.5 mg of iron 0.4 g fibre and traces of vitamin C and iron.

On the basis of flowering habit cucumber has three types of varieties (i) gynoecious, which produces only female flowers (ii) pre-dominantly gynoecious, which also bears some male flowers, and (iii) the monoecious, which produces both male and female flowers. At the early stages of development, flower buds contain primordia of both stamen and pistil, and sex determination occurs due to the selective arrest of development of either the staminate or pistillate primordia just after the bisexual stage. Cucurbits exhibit different constraints in increasing the production out of these, sex expression is most important one.

Cucurbitaceous plants have variable range of male and female flowers. The production of male flowers is greater than that of female flowers and ultimately only the female flowers contribute towards yields. Increase in number of female flowers per vine would obviously result into more production of fruits. The expression of different sex forms is influenced by genetic factors, the manifestation of which is influenced by environmental conditions. Besides, exogenous applications of plant harmones play an important role in changing sex tendency in these plants. Subsequently, growth regulating chemicals became important tools in this respect. The suppression of male flowers and increasing the number of female flowers by application of plant growth regulators in cucumber was found in series of reports from USA, Japan, Israel and also from India (Bhandary *et al*, 1974) [1], The chemicals mostly used were MH, NAA, IAA, TIBA and GA on cucumber, watermelon and bottle gourd.

Growth regulators have tremendous effects on sex expression and flowering in cucumber crop leading to either suppression of male flowers or an increase in the number of female flowers (Al-Masoum and Al-Masri, 1999) [2] without imposing any deleterious effect on the environment and human health. 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 (Latimer, 1991) [3].

Materials and Methods

The Experiment was conducted at Department of vegetable science, College of Horticulture, Kanpur (U.P.) during the year 2017-2019. It comes under sub-tropical region, having a temperature range from 29^{0}C to 41^{0}C as maximum and 7^{0}C to 23 ^{0}C as minimum in summer and winter season, respectively. The soil of the experimental field was sandy-loam with uniform topography. The experiment was laid out in a randomized complete block design replicated thrice with nine different growth regulators as treatments i.e. T_1 - foliar application of GA3 (100ppm) at 15 days after sowing, T_2 - foliar application of GA3 (150ppm) at 30days after sowing, T_3 - foliar application of GA3 (200ppm) at 45days after sowing, T_4 - foliar application of NAA (100ppm) at 15days after sowing, T_5 - foliar application of NAA (150ppm) at 30days after sowing, T_6 - foliar application of NAA (200ppm) at 45days after sowing, T_7 - foliar application of Ethrel (200ppm) at 2-4 leaf stage, T_8 - foliar application of Ethrel (300ppm) at pre flowering and T_9 - Control (Water Spray). Sowing was done in the month of June on ridges after preparation of well levelled and fine seed bed. Well rotten Farm Yard Manure was applied @ 20 tons/ha before preparing of the plot. Nitrogen, Phosphorus and potash were applied @ 80:50:40 kg/ha in the form of urea, single super phosphate and muriate of potash, respectively. First hoeing and weeding was done after twenty days of sowing and second weeding was repeated after twenty days of first weeding in all the treatments to keep plots weed free. Light irrigation was applied for establishment of seed. After sowing subsequent irrigations were provided as and when required for growth and development of plants. Plant protectants chemicals were also used for keep the plant safe from insect pest and diseases.

Results and Discussion

Effect of Different Plant Growth Regulators on Yield Attributes

In the present study it was observed that GA_3 is most effective in increasing the fruit set per cent and fruit retention per cent (Table 1). Among all the treatments, GA_3@150 ppm, 200 ppm and 100 ppm recorded maximum fruit set (88, 85.08 and 84.33, respectively) whereas the fruit set was minimum in control (75.25). This might be due to the physiological process in treated plants, remains higher than the checks, this indicates that there may be lesser chances of female flower drop which resulted into increased fruit set. Similar findings were reported by Dubey (1983) [4] in bitter gourd and Patel (1992) [5] in bottle-gourd. All the growth regulator treatments were significantly superior in recording more length (cm) of fruit as compared to the water spray control as well as absolute control (Table 1). It was observed that among all the treatments GA3@100 and 150 ppm produced the longest marketable fruit (25.23 cm and 24.6 cm, respectively). These results are in consonance with those of Choudhury (1988) [6] in cucumber, Singh and Choudhury (1989) [7] in bottle gourd and Singh and Arora *et al*. (1982) [8] in sponge gourd. These may be probably due to cell enlargement as well as activate the metabolic activity in fruit. Similar results were also obtained by Arora *et al*. (1987) [9] in ridge gourd. It was observed that among all the treatments, GA3@100ppm and 150ppm recorded the maximum diameter of marketable fruit (8.41cm and 8.2cm, respectively). The increased in diameter of marketable fruit is in agreement with the results of Arora *et al*. (1988) [10], Singh and Choudhury (1989) [7], Patel (1992) [5] and Singh and Choudhury (1989) [7] in cucumber. The present studies indicated that the response of different treatments to male and female sex ratio differed significantly. All the treatments significantly lowered the male and female sex ratio over control (Table 1). Among all the treatments, GA3@100 ppm and NAA@100 ppm was found to be most effective in lowering the male and female flower ratio (1.54: 1 and 1.66: 1, respectively). Probably, it could be attributed to the suppression in number of staminate flowers and promoted in more number of pistillate flowers. Similar results were obtained Sharma *et al*. (1988) [11] and Patel (1992) [5] in bottle-gourd, and Kshirsagar *et al*. (1995) [12] in cucumber.

Table 1: Influence of plant growth regulators on yield attributes in cucumber

TREATMENTS	Length Of Fruit (cm.)	Diameter Of Fruit (cm.)	Fruit set%	Fruit retention%	Sex ratio
GA_3 100ppm(T_1)	25.23	8.41	81.92	84.83	1.54:1
GA_3 150ppm(T_2)	24.60	8.20	86.08	88.00	1.70:1
GA_3 200ppm(T_3)	24.07	8.02	82.08	85.08	1.68:1
NAA 100ppm(T_4)	24.47	8.16	81.08	82.25	1.66:1
NAA 150ppm(T_5)	24.13	8.04	77.00	83.00	1.87:1
NAA 200 ppm(T_6)	23.53	7.84	77.58	81.25	1.73:1
Ethrel 200ppm(T_7)	20.17	6.72	77.17	80.92	1.73:1
Ethrel 300ppm(T_8)	22.30	7.43	80.33	81.42	1.93:1
Control/Water spray(T_9)	18.60	6.20	75.25	78.33	1.41:1
S.Em±	0.033	0.004	0.422	0.203	0.00
CD at 5% Level	0.313	0.104	1.124	0.780	0.032

Effect of Different Plant Growth Regulators on Yield

The results of the present investigation revealed that all the GA_3@ 200ppm and NAA @100ppm concentrations were found significantly superior in recording more yield in Kg per plant as well as quintal per hectare as compared to control (Table 2). Further, it was observed that among all these treatments GA_3@200 ppm produced the maximum yield 3.89Kg per plant and 180.69 quintal per ha; while control produced the lowest yield 2.64Kg per plant and 163.89 quintal per ha. An increase in fruit yield in treated plants may further be attributed to the reason that plant remained physiologically more active to build up sufficient food stock for the developing flowers and fruits, ultimately leading to higher yield. Increased fruit yield is also due to the increase in pistillate flowers production and ultimately harvested more number of fruits per plant. These findings are in consonance with those of Mangal *et al*. (1981) [13], and Zeng *et al*. (1998) [14] in bitter gourd, Sharma *et al*. (1988) [11] and Patel (1992) [5] in bottle-gourd and Kshirsagar *et al*. (1995) [12] in cucumber.

Influence of Growth Substances On Quality Characters

Total soluble solids (obrix)

The present studies showed that the response of different growth regulator treatments on total soluble solids content in bitter gourd (Table 2) differed significantly. It was observed that all the treatments were effective in recording more T.S.S. (obrix) as compared to the control. The treatment GA3@ 200ppm produced the significantly highest T.S.S. (5.1 obrix) followed by GA3@150ppm (4.53 obrix). The increase in T.S.S. in the fruits seems probably due to accumulation of metabolites which stimulated functioning of a number of enzymes in physiological process. Which turns, hydrolized starch and helped in the metabolic activity during the change of available starch into sugar and T.S.S. These results agree with the reports of Randhawa (1974) [22] in muskmelon.

Table 2: Influence of plant growth regulators on yield and quality parameters in cucumber

Treatments	Number of fruit/plant	Fruit yield kg/plant	Fruit yield q/ha	T.S.S.
GA_3 100ppm(T_1)	10.25	3.42	180.46	3.83
GA_3 150ppm(T_2)	9.75	3.25	177.19	4.53
GA_3 200ppm(T_3)	11.67	3.89	180.69	5.10
NAA 100ppm(T_4)	10.75	3.58	174.82	4.10
NAA 150ppm(T_5)	10.25	3.42	168.59	4.33
NAA 200 ppm(T_6)	9.25	3.08	170.54	3.93
Ethrel 200ppm(T_7)	11.08	3.69	171.98	3.03
Ethrel 300ppm(T_8)	9.08	3.03	170.14	3.67
Control(T_9)	7.92	2.64	163.89	4.27
S.Em±	0.172	0.014	0.538	0.005
CD at 5% Level	0.718	0.207	1.269	0.126

Conclusion

It can be concluded from the above findings of investigation, that GA_3@ 150 ppm to 100 ppm recorded significantly higher yield attributes i.e. Length of Fruit, Diameter of Fruit, Fruit set%, Fruit retention% and Sex ratio where as GA_3 @ 200 ppm recorded maximum yield and quality parameters i.e. T.S.S. (brix) in Kalyanpur green cultivar of cucumber *(Cucumis sativus* L.).

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