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Standardization of different plant growth regulators on growth parameters of cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) under protected condition

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Abstract
The present investigation was carried out at instructional cum research farm, Department of Horticulture, College of Agriculture, Osmanabad during kharif season 2021 to find out the effects of different plant growth regulators on growth parameters of cherry tomato cultivar 'Nagmoti' under protected conditions. The experiment was laid out in Randomized Blocked Design having ten treatments and three replications. 9 Treatments consist of different levels of GA3 (10, 30 and 50 ppm), NAA (10, 30 and 50 ppm) and Kinetin (30, 50 and 70 ppm) along with control. These different concentrations of GA3, NAA, Ki were sprayed on cherry tomato plants at 15, 30, 45 and 60 days after transplanting to study the growth behavior of cherry tomato. All growth parameter was found to be significantly superior at different concentration of GA3, NAA and Ki as compare to control treatment. The maximum plant height (220.26 cm), maximum number of leaves per plant (364), maximum number of clusters per plant (7.33), maximum number of flowers per plant (59.83), minimum days required for 50 percent flowering (27.20 days), maximum number of branches per plant (17.06), minimum days required for the fruit set (32.53 days), minimum days required for first harvesting (65.26 days) was reported in treatment T4 where plant has been sprayed with 50 ppm GA3. Among the various plant growth regulators, GA3 @ 50 ppm performed best on most of the growth parameters of cherry tomato.

Keywords: Cherry tomato, plant growth regulators, growth parameters, NAA, GA3, kinetin

Introduction
Cherry tomatoes (*Solanum lycopersicum var. cerasiforme*) are small, round, cherry- sized fruits of the Solanaceae family with chromosome number 2n = 24 it is multi-seeded berry and considered a native of the Mexican region. This species is characterized by its relatively high contents of lycopene, vitamin-A, vitamin-B, folic acid, fructose, and minerals such as phosphorus, potassium, calcium, and magnesium. Cherry tomatoes are also an excellent source of antioxidant compounds such as polyphenols and carotenoids. According to the USDA nutritional information, one cup of cherry tomatoes (150 g) provides 26.8 calories, 1.3 g protein, 4.5 mg omega-3 fatty acids, 119 mg omega-6 fattyacids, 1241 IU of vitamin A, 18.9 mg vitamin C, 22.3 mcg folic acid, 11.8 mcg vitamin C, 353mg potassium, 35.8 mg phosphorus and 14.9 mg calcium. Whole cherry tomatoes are sold fresh as well preserved in brine. The fruit shape ranges from spherical to oblong to pear and the colours include red, pink, yellow, grape green and brown. Cherry tomato can be grown in open or protection in poly or glass or shade houses. However, yield and fruit quality is higher when cultivated under protection.

Plant Growth Regulators are organic compounds which are either synthesized in laboratories or produced naturally within the plants. They profoundly control and modify the physiological processes like the growth, development and movement of plants. They are efficient and profit-making to the farmers. However, the improvement of the crop differs greatly depending on the type of growth regulator used, concentration, time and application. Their effect is entirely different although, they have a beneficial effect on growth, quality and yield of cherry tomato. Keeping the above circumstance in view, the present study was under taken to evaluate the performance of GA3, NAA and Kinetin on growth parameters and to determine the optimum concentration of these Plant Growth Regulators in order to maximize the yield of cherry tomato.

Material and Methods

This experiment was conducted at instructional cum research farm, Department of Horticulture, College of Agriculture, Osmanabad during kharif season 2021 to find out the suitable growth regulator and its concentration for the growth parameters of cherry tomato. The experiment consisting ten treatments in Randomized Block Design with three replications with 2.74 m2 plot size and spacing of plant is 70 cm×45 cm (R×P). Treatment consists of different levels of GA3 (10, 30 and 50 ppm), NAA (10, 30 and 50 ppm) and Kinetin (30, 50 and 70 ppm) along with control. The treatment consisted of ten treatments *viz* T1 (Control), T2 (GA3 10 ppm), T3 (GA3 30 ppm), T4 (GA3 50 ppm), T5 (NAA 10 ppm), T6 (NAA 30 ppm), T7 (NAA 50 ppm), T8 (Ki 30 ppm), T9 (Ki 50 ppm), T10 (Ki 70 ppm). The important characters encompassed in the research study are divided in three categories like A) Plant architecture **-** Plant height (cm), Number of branches per plant, Number of leaves per plant, B) Flower characters - Number of clusters per plant, Number of flowers per plant, Days required for 50% flowering, C) Fruit characters - Days required for fruit set, Days required for first harvest.

Observations recorded for the growth parameters, five plants from each plot of all the replications were selected randomly. Plants were selected from each plot and stakes were fixed near each of the selected plants, and labelled the selected plants. The procedure for recording the data was mentioned with the convenient headings.

A) Plant architecture -

Plant height (cm): The height of plant was measured from ground level to the top of the plant in the intervals of 30, 60, 90 and 120 days after transplanting. The mean of five plants in each treatment from the three replications was calculated to work out for further calculations. It was measured in centimeters (cm).

Number of branches per plant: The total number of primary branches produced by each selected plant during its life cycle was recorded.

Number of leaves per plant: The numbers of leaves of five selected plants in each treatment were recorded at the time of 30, 60, 90 and 120 DAT of the crop.

B) Flower characters

Number of clusters per plant: The total number of clusters produced by each selected plant during its life cycle was recorded.

Number of flowers per plant: The total number of flowers produced by each selected plant during its life cycle was recorded.

Days required for 50% flowering: It was recorded as number of days counted from date of transplanting to the date when first flower emerged (pre-anthesis stage) in 50 percent of the plants in a plot per treatment.

C) Fruit characters

Days required for fruit set: The number of days counted from the date of transplanting to the first fruit set of selected plant.

Days required for first harvest: The number of days counted from the date of transplanting to the first fully matured red fruits harvest of selected plants.

Statistical analysis of data

Data obtained on various variables were analyzed by analysis of variance of Randomized Block Design as suggested by Panse and Sukhatme, 1987. The data in which the treatment effects were significant, the appropriate standard errors (S. E.) and critical difference (C. D.) at 5 percent level of significance (C. D. at 5%) were calculated.

Result and Discussion

A) Plant architecture Plant height (cm)

Plant height was recorded at the interval of 30, 60, 90 and 120 days after transplanting (DAT). The data is presented in Table 1. The plant height was ranged from 161.53 cm to 220.26 cm after 120 DAT. The highest plant height (220.26 cm) was observed in T4. Which may be due to cell elongation and rapid cell division in growing portion, stimulated RNA and there by leading to enhanced growth and development. The above results are in conformity with Baby *et al.* (2018) [2] who reported that the plant height of cherry tomato was increased significantly by the application of GA3 75 ppm.

Number of branches per plant

The total number of branches per plant was recorded in the range from 12.26 to 17.06 and result presented in Table 2. The maximum number of branches per plant (17.06) was recorded in T4 and minimum number of branches per plant (12.26) was recorded in T1. It may be due to the role of GA3 in increasing cell division and cell elongation which is responsible for vegetative growth of plant. The above results are in conformity with Prasad *et al*. (2018) [2] who reported that the total number of branches per plant in tomato was increased significantly by the application of GA3.

Number of leaves per plant

The result regarding total number of leaves per plant of cherry tomato under different concentrations of plant growth regulators was influenced significantly at 30, 60, 90 and 120 DAT and result is presented in Table 3. The total number of leaves per plant was recorded in the range from 271.13 to 364. The maximum number of leaves per plant (364) was recorded in T4 and minimum number of leaves per plant (271.13) was recorded in T1. This may be due to the role of GA3 in increasing cell division and cell elongation. The above results are similar with Halim *et al.* (2015) [6] who reported that total number of leaves per plant in tomato was increased significantly by the application of GA3.

B) Flower characters

Number of clusters per plant

The result regarding total number of clusters per plant of cherry tomato under different concentrations of plant growth regulators was influenced significantly at 30, 60, 90 and 120 DAT and result is presented in Table 4. The total number of clusters per plant was recorded in the range from 4.60 to 7.33 at 120 days. The maximum number of clusters per plant (7.33) was recorded in treatment T4 and the minimum number of clusters per plant (4.60) was recorded in treatment T1 at 120 days. This may be due to the role of GA3 in promoting vegetative growth characters conductive to food manufacturing mechanism. Hence, the treated plants have comparatively more food stock which is responsible for more number of clusters. The above results are similar with Hossain *et al.* (2018) [9] who reported that total number of clusters per plant in tomato was increased significantly by the application of GA3 and NAA.

Number of flowers per plant

The result regarding total number of flowers per plant of cherry tomato under different concentrations of plant growth regulators was influenced significantly at 30, 60, 90 and 120 DAT and result is presented in Table 5. The total number of flowers per plant was recorded in the range from 48.03 T1 to 59.83 T4. The maximum number of flowers per plant (59.83) was observed in treatment T4 and the minimum number of flowers per plant (48.03) was recorded in treatment T1. The above results are similar with Verma *et al.* (2016) [10] who reported that total number of flowers per plant in tomato was increased significantly by the application of GA3 and NAA.

Days to 50% flowering (After transplanting)

The data pertaining on days required for 50% flowering after transplanting is presented in Table 6. Days required for 50 percent flowering after transplanting was recorded in the range from 27.20 to 32.80 days. However, the minimum days required for 50 percent flowering after transplanting (27.20 days) were recorded in T4 and maximum days required for 50 percent flowering after transplanting (32.80 days) were recorded in T1. Early flowering promotes the early fruit formation. The major reason for early flowering might be due to the role of GA3 which stimulate photosynthesis activity and rapidly translocation of photosynthates to the opening of flower buds which are resulting on earliness of flowering. The above findings are similar with Jhakar *et al.* (2018) [7] who reported that the days required for 50% flowering after transplanting of tomato was increased significantly by the application of GA3 50 ppm.

C) Fruit characters

Days to first harvesting (After transplanting)

The data pertaining on days to first harvesting after transplanting is presented in Table 6. The effect of different plant growth regulators on days to first harvesting after transplanting was observed in the range from 65.26 to 76.80 days. However, the minimum days required for first harvesting after transplanting (65.26 days) was recorded in T4 and the maximum days required for first harvesting after transplanting (76.80 days) was recorded in T1. The application of plant growth regulators may have attributed to the faster enhancement of vegetative growth and storing sufficient reserved food materials for differentiation of buds into flower buds and consequently fruit growth and development ultimately resulted in early harvest. The above results are similar with Gurjar *et al.* (2018) [5] and Verma *et al.* (2016) [10] in tomato.

Days to fruit set (After transplanting)

The data pertaining on days to fruit set after transplanting is presented in Table 6. The effect of different plant growth regulators on days to fruit set after transplanting was observed in the range from 32.53 to 39.26 days. However, the minimum days required for fruit set after transplanting (32.53 days) was recorded in T4 and maximum days required for fruit set after transplanting (39.26 days) was recorded in T1. It is due to the fact that application of GA3 and NAA check the flowers and fruit drop and ultimately increase the percent of fruit set. The above results are in conformity with Kumar *et al.* (2018) [8] and Prasad *et al.* (2013) [2] in tomato.

Table 1: Effect of different plant growth regulators on plant height (cm) in cherry tomato

Sr. No.	Treatment details	30 Days	60 Days	90 Days	120 Days
T1	Control	40	121.66	148.20	161.53
T2	GA3 10 ppm	54.93	159.60	190.53	196.40
T3	GA3 30 ppm	60	169.86	197.60	206.40
T4	GA3 50 ppm	68.93	183.80	214.20	220.26
T5	NAA 10 ppm	45	163.66	192.93	203.46
T6	NAA 30 ppm	46	165	192.33	204.06
T7	NAA 50 ppm	48.40	166.93	195.8	207.26
T8	Kinetin 30 ppm	48.67	165.86	196.80	206.13
T9	Kinetin 50 ppm	50.13	167.86	197.20	207.60
T10	Kinetin 70 ppm	55.33	173	205.13	210.93
S.E.(m) ±		0.95	0.74	0.71	1.12
C.D at 5%		2.85	2.22	2.13	3.32

Table 2: Effect of different plant growth regulators on number of branches per plant in cherry tomato

Sr. No.	Treatment details	Number of Branches per plant			
		30 Days	60 Days	90 Days	120 Days
T1	Control	4.26	7.73	10.46	12.26
T2	GA3 10 ppm	5.66	11.26	13	13.46
T3	GA3 30 ppm	6.20	12.26	13.73	14.40
T4	GA3 50 ppm	7.20	14.46	16.76	17.06
T5	NAA 10 ppm	5	11.43	13	13.26
T6	NAA 30 ppm	5.20	12.50	13.46	13.73
T7	NAA 50 ppm	5.30	13.46	14.30	14.66
T8	Kinetin 30 ppm	5.13	11.26	12.20	12.80
T9	Kinetin 50 ppm	5.46	11.66	12.63	13.13
T10	Kinetin 70 ppm	6	12.46	14.60	14.53
S.E.(m) ±		0.11	0.27	0.21	0.57
C.D at 5%		0.33	0.83	0.62	1.71

Table 3: Effect of different plant growth regulators on number of leaves per plant in cherry tomato

Sr. No.	Treatment details	Number of Leaves per plant			
		30 Days	60 Days	90 Days	120 Days
T1	Control	61.43	131.23	231.60	271.13
T2	GA3 10 ppm	84.93	183.53	300.80	314.13
T3	GA3 30 ppm	91.76	193.21	310.66	325.20
T4	GA3 50 ppm	110.66	222.13	354.86	364
T5	NAA 10 ppm	82.20	186.21	294.60	310.46
T6	NAA 30 ppm	85.43	193.81	303.60	316.33
T7	NAA 50 ppm	86.46	207	314.13	325.86
T8	Kinetin 30 ppm	80.50	180.26	291.80	310.53
T9	Kinetin 50 ppm	81.80	186.46	295.80	313.93
T10	Kinetin 70 ppm	85.20	195.53	306.80	318.86
S.E.(m) ±		0.33	0.60	1.27	10.34
C.D at 5%		0.98	1.79	3.77	30.73

Table 4: Effect of different plant growth regulators on number of clusters per plant in cherry tomato

Sr. No.	Treatment details	Number of Clusters per plant			
		30 Days	60 Days	90 Days	120 Days
T1	Control	1.36	8.86	7.73	4.60
T2	GA3 10ppm	1.66	12.53	12.73	6.26
T3	GA3 30ppm	1.75	13.40	13.66	6.73
T4	GA3 50ppm	1.93	15.46	15.46	7.33
T5	NAA 10ppm	1.60	12.13	12.20	6.20
T6	NAA 30 ppm	1.73	12.93	11.93	6.53
T7	NAA 50 ppm	1.80	14.40	14	6.73
T8	Kinetin 30 ppm	1.40	12.06	12.23	6.13
T9	Kinetin 50 ppm	1.53	12.86	12.53	6.46
T10	Kinetin 70 ppm	1.76	14.23	13.53	6.60
S.E.(m) ±		0.13	0.21	0.42	0.17
C.D at 5%		0.40	0.64	1.26	0.51

Table 5: Effect of different plant growth regulators on number of flowers per plant in cherry tomato

Sr. No.	Treatment details	Number of Flowers per plant			
		30 Days	60 Days	90 Days	120 Days
T1	Control	12.56	65.46	67.26	48.03
T2	GA3 10ppm	16	79.20	75.73	51.46
T3	GA3 30ppm	13.96	83.06	86.26	51.73
T4	GA3 50ppm	17.76	93.46	98.70	59.83
T5	NAA 10ppm	14.53	83.20	84.80	49.86
T6	NAA 30 ppm	16.26	85.93	86.66	50.43
T7	NAA 50 ppm	17.86	90.26	89.13	53.06
T8	Kinetin 30 ppm	15.26	78.26	74.06	46.40
T9	Kinetin 50 ppm	13.60	80.80	82	48.40
T10	Kinetin 70 ppm	17.53	85.03	84.53	49.40
S.E.(m) ±		0.96	0.48	5.08	1.11
C.D at 5%		2.87	1.45	15.11	3.31

Table 6: Effect of different plant growth regulators on days to 50% flowering, Days to fruit set, Days to first harvesting in cherry tomato

Sr. No.	Treatment details	Days to 50% flowering	Days to fruit set	Days to first harvesting
T1	Control	32.80	39.26	76.80
T2	GA3 10 ppm	28.33	33.46	67.46
T3	GA3 30 ppm	28.13	33.06	66.86
T4	GA3 50 ppm	27.20	32.53	65.26
T5	NAA 10 ppm	27.86	34	68.50
T6	NAA 30 ppm	28.46	34.46	68
T7	NAA 50 ppm	28.60	34.86	67.46
T8	Kinetin 30 ppm	28.86	34.53	69.06
T9	Kinetin 50 ppm	28.66	34.46	69.26
T10	Kinetin 70 ppm	28.76	33.60	68
S.E.(m) ±		0.15	0.18	0.40
CD at 5%		0.45	0.54	1.21

Conclusion

The application of plant growth regulators are effective response in growth parameter of cherry tomato. The findings revealed that treatment T4 at (GA3 50 ppm) recorded the maximum plant height (cm), number of leaves per plant, number of clusters per plant, number of flowers per plant, days to 50% flowering after transplanting, number of branches per plant, days to fruit set after transplanting, days to first harvest after transplanting.

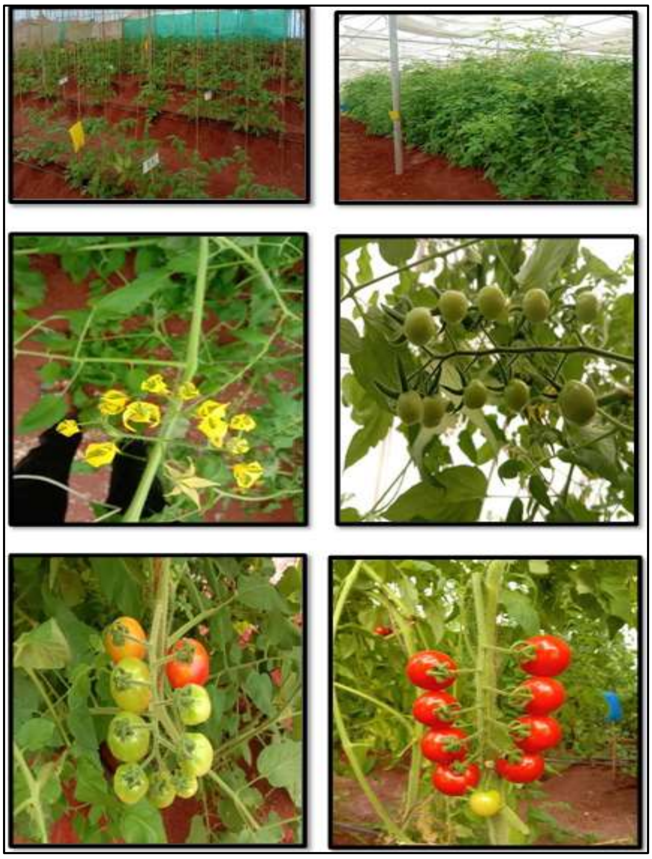

Plate 1: Visual of different growth stages of cherry tomato

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