Environment & Ecology 35 (2D) : 1546—1550, April—June 2017
Website: environmentandecology.com ISSN 0970-0420

Effect of Plant Growth Regulators on Growth and Yield Parameters in Cape-Gooseberry (*Physalis peruviana* L.)

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Received 25 August 2016; Accepted 19 September 2016; Published online 5 October 2016

Abstract Cape-gooseberry is an important minor fruit crop but its cultivation is restricted to a limited area in our country and to a negligible area in Bihar. This is due to lack of information on production technology and required growth regulators. Present investigation was formulated to enhance morphological and yield attributing traits. For this, three plant growth-regulators namely 2, 4-D (5, 10 and 15 ppm), gibberellic acid (10, 20 and 30 ppm) and NAA (10, 20 and 30 ppm) were used. Three sprays were done with these growth regulators at fortnight intervals. It was concluded that GA_3 30 ppm was best chemical for increasing height of the plant. The yield parameters like number of fruit per plant, yield per plant, yield per hectare, weight of fruit and size of the fruit was found maximum by spraying the GA_3 30 ppm. Other vegetative characters like number of branches per plant, spread of the plant and number of leaves per plant were maximum by spraying of 2, 4-D of 15 ppm.

Keywords Cape-gooseberry, Plant growth regulators, Growth, Flowering, Fruiting.

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Introduction

India is endowed with natural wealth of climate right from tropical and subtropical in plains to temperate of higher altitude which offers great possibility of growing diverse types of fruit crops in any part of the country. Cape-gooseberry (*Physalis peruviana* L.), also known Poha, Tepari, Golden berry, Husk berry belonging to the genus *Physalis* of the family Solanaceae, believed to be native of Peru and Chile. The plant is grown by early settlers of the cape of Good Hop, New South Wales [1].

Being attractive color and flavor of ripped fruits; good source of vitamins, phosphorus and pectin, it is

used as fresh fruit, salad, flavoring agent, jam and jellies also. Small fruit size, make it convenient for packaging and transportation to the remote markets. Now, the crop is cultivated extensively, gaining popularity and it can boost-up livelihood of growers by increasing the size and ultimately yield. In this regards plant growth regulators play important role in growth, yield and quality of the crop by stimulating the biological activities.

Keeping in view of above facts and importance of this minor fruit crop the present experiment was formulated to study the effect of plant growth regulators on growth, flowering and fruiting behavior of cape-gooseberry.

Materials and Methods

The present investigation was carried out at the Agricultural research farm of Department of Horticulture (Fruit), Bihar Agricultural College, Sabour, Bhagalpur, Bihar during *rabi* season of 2005-06. The materials were sown on the raised nursery bed followed by transplanted in well prepared field. Besides, recommended dose of manures and fertilizers mixed in the soil, 25 kg/hectare BHC (5%) added in the soil. Twentyfive-thirty days old seedlings were transplanted in the randomized block design with three replications. Proper agronomical practices were adopted to have a good crop.

Treatments and their symbols

T_1-2, 4-D-5 ppm, T_2-2, 4-D- 10 ppm, T_3-2, 4-D- 15 ppm, T_4-GA_3- 10 ppm, T_5-GA_3 20 ppm, T_6-GA_3-30 ppm, T_7-NAA- 10 ppm, T_8-NAA- 20 ppm, T_9-NAA- 30 ppm, T_{10}-Control (water spray).

Preparation of solutions
and its application

Aqueous solution of 2,4-dichlorophenoxyacetic acid [2,4-D] (5 ppm, 10 ppm and 15 ppm), gibberellic acid [GA_3] (10 ppm, 20 ppm and 30 ppm) and nephthalene acetic acid [NAA] (10 ppm, 20 ppm and 30 ppm) were prepared freshly in distilled water at each spraying following standard method. Only distilled water applied in the control treatment.

Aqueous solution of plant growth substances was sprayed with the help of Ganesh Hand Sprayer. First spraying was done on after 30 days of planting. The second and third spraying was done at an interval of 15 days after first and second spraying respectively. The spraying of plant growth substances was done during the afternoon (3:00 pm) having low light intensity and medium temperature to avoid prolonged effect of sun light. Ten plants from each treatments and and replications were selected randomly for recording observations excluding border plants.

Results and Discussion

Growth parameters

Plant height

Plant height was measured from the above ground level and observed that plants of T_6 (GA_3 30 ppm) could attain maximum height of 89.75 cm followed by T_5 (GA_3 20 ppm), T_4 (GA_3 10 ppm) and T_3 (2,4-D 15 ppm) over the control T_{10} (51.7 cm). GA_3 promoted cell enlargement by stimulating the biosynthesis of α- amylase, which hydrolyse starch, thereby increasing the level of reducing sugar and hence causing increased osmotic pressure of the cell [2].

Spread of the plant

From Table 1, treatment T_3 (2, 4-D 15 ppm) was quite effective in increasing the spread of plant measured 85.64 cm which was at par with T_1 (2, 4-D 5 ppm), T_2 (2, 4-D 10 ppm), T_9 (NAA 30 ppm) and control could cover minimum spread (46.32 cm). This may be due to the fact that application of these hormones increased spread of the plants.

Number of branches

Branching is an important attributes of yield and obtained maximum significant numbers of branches in treatment T_3 (2, 4-D 15 ppm) 40.92 followed by in T_2 (2, 4-D 10 ppm) while T_{10} (water spray) could produced minimum number of branches (23.64). It was

Table 1. Effect of plant growth regulators on growth and yield parameters. NS: Non significance.

Treatments	Height (cm)	Spread (cm)	Number of branches	Number of leaves	Days to 1st flowering	Number of flowers per plant	Number of fruit per plant	Fruit weight (g)	Fruit weight per plant (g)	Fruit length (cm)	Diameter (cm)	Fruit volume	Yield per hectare (q)
T_1	72.83	83.26	35.63	126.11	53.10	66.12	23.75	9.31	221.11	22.67	2.32	6.54	61.41
T_2	77.57	81.39	37.81	127.95	53.19	69.61	24.96	9.33	332.87	22.02	2.22	5.73	92.46
T_3	83.91	85.64	40.92	130.14	52.26	73.42	26.85	9.95	267.15	24.61	2.38	7.06	74.20
T_4	86.93	69.24	31.13	119.62	52.15	75.05	26.66	10.39	276.99	23.73	2.40	7.24	76.93
T_5	86.59	69.81	36.21	123.99	52.10	75.86	28.95	11.73	339.58	22.59	2.35	6.79	94.06
T_6	89.75	72.92	39.32	128.33	50.34	76.29	29.50	13.51	398.54	25.15	2.48	7.98	110.39
T_7	52.74	71.82	27.62	114.69	54.17	63.73	21.59	9.45	203.20	20.01	2.12	4.99	56.67
T_8	56.93	75.29	32.53	123.99	53.91	61.32	21.77	9.91	233.00	19.72	2.08	4.71	59.92
T_9	58.69	79.63	37.67	127.49	51.32	61.89	20.74	9.50	197.03	20.86	2.15	5.20	54.72
T_{10}	51.70	46.32	23.64	111.73	55.65	64.05	20.51	8.70	178.43	18.71	2.03	4.38	49.56
Mean	71.764	73.532	34.248	123.404	52.82	68.734	24.528	10.178	264.79	22.007	2.253	6.052	73.032
CD at 5%	9.1839	8.2664	5.6722	NS	NS	8.6224	2.6248	1.2337	37.7785	2.9343	0.2490	0.8178	9.8061
CV %	7.47	6.55	9.65	6.38	5.19	7.31	6.24	7.07	8.37	7.77	6.44	7.86	7.83

due to presence of native and applied auxins mainly control the growth of the branches, thus it appears that foliage supplementation of 2, 4-D increased the number of branches while El-Tohamy et al. [3] observed that GA_3 was effective at higher concentration.

Number of leaves

In order to find out the effect of different treatments on the total number of leaves, it was counted at fortnightly interval. From Table 1, it is apparent that different treatments had differential effect on the emergence of leaves.treatment T_3 (2, 4-D 15 ppm) could produce maximum leaves (130.14) followed by T_2 (2, 4-D 10 ppm) throughout the observation although non-significant. This increased number of leaves may be due to activating apical meristems, enhancing the biosynthesis of proteins, carbohydrates and leads to enhancing initiation of leaves primordia at the apical growing region and consequently produce more leaves [4].

Yield parameters

Days to 1st flowering

Earliness has become desirable trait according to market value and in this respect plants of treatment T_6 (GA_3 30 ppm) were taken minimum of 50.34 days to first flower among all the treatments although it was statistically non-significant while maximum time taken by the plants of control (55.65). This earliness was stimulated the floral initiation and ultimately plants could flower earliest.

Number of flowers per plant

The number of flowers per plant was counted and found maximum in treatment T_6 (GA_3 30 ppm) with 76.29 flowers followed by T_5, T_4, T_3 and T_2. It is because of gibberellic acid which causes the production of large numbers of flowers with rapid elongation of peduncle, leading to full development of flower buds having all reproductive functional parts which increase the fruit set and number of berries per plant and same results were also found in strawberry [5].

Number of fruit per plant

From Table 1 it is apparent that significant maximum number of fruit (29.50) was observed when plants were treated with GA_3 of 30 ppm and spraying of GA_2 20 ppm resulted at par whereas, control plants could produce minimum number of fruit (20.51). This was probably because when GA_3 was applied earlier in

development, it promoted growth in term of increasing the number of branches and plant height; hence increasing the number of flowering sites and ultimately produced increased number of fruits per plant. Other workers also concluded that increased numbers of branches are site of photosynthesis, resulting more accumulation of assimilates at the site of action [6].

Fruit weight

The fresh fruits of all pickings were weighed and observed that plants sprayed with GA_3 at 30 ppm produced heaviest fruits with an average of 13.51 gram and control treatment produced lightest fruits with 8.70 grams. GA_3 application brought certain biochemical changes in the metabolism of fruits resulted more accumulation of sink in the fruit and finally increased weight. Our findings are also in conformity of Kaur et al. [7].

Fruit yield per plant (g)

Mature fruits of all pickings were weighed and treatment T_6 (GA_3 30 ppm) yielded significantly maximum of 398.54 grams per plant in contrast minimum yield of 178.43 g obtained from control. GA_3 play major role in physiological as well as biochemical activities which boosted the enzymatic pathways and ulimately the yield in tomato [8].

Fruit length (cm)

Fruit length was measured by digital callipers and observed that the application of 2, 4-D, GA_3 and NAA on an average effective in enhancing the length of fruit over control. Significant maximum fruit length was observed in the treatment T_6 (GA_3 30 ppm) with 2.51 cm while lowest value was found under control [9].

Fruit diameter (cm)

Fruit diameter of mature berry was also measured and from the data it is concluded that maximum diameter (2.48 cm) was observed in the treatment T_6 (GA_3 30 ppm) over the control. The length and diameter of fruits are making the size which can be correlated with the cell. The size could have been achieved through increment of intercellular spaces with the age of fruits. This may be due to action of GA_3, which induced cell division, cell enlargement, physiological activity and ultimately accumulation of photosynthates in the fruits. Saleem et al. [10] reported that activities of PGRs can increase the length, diameter and ultimately the size/volume of the fruit in sweet orange.

Fruit volume (cc)

Fruit volume was analyzed by water displacements method and it is apparent that the significant maximum volume (7.98 cc) was displaced by T_6 (GA_3 30 ppm) followed by T_4 (GA_3 10 ppm) and it was minimum in control (4.38 cc). This increase in the fruit volume is directly correlated with increase in weight and size with the advancement of maturity. The result of present study is in conformity of the findings of other scientists in cape gooseberry in response of GA_3 [7].

Yield per hectare (q)

From Table 1 it is quite obvious that significant maximum yield 110.39 quintal per hectare was obtained from treatment T_6 (GA_3 30 ppm) while minimum from control. It has been proven that GA_3 has definite role in cell division, cell enlargement and biological reaction which enhance physiological activities and consequently triggering the uptake of water, nutrients, and enzymatic activity. Due to above facts, there were more accumulation of food constituents in the fruits and ultimately increased fruits yield per hectare. Besides, it is quite apparent from the finding that 2, 4-D of different concentration also enhanced the photosynthetic assimilation, fruit setting and ultimately yield [2, 10].

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