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Impact of plant growth regulators and emasculation on insect-pest incidence and fruit cracking in cape gooseberry (*Physalis peruviana* L.)

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Abstract
The effect of plant growth regulators (PGRs) on insect- pest incidence and fruit cracking is not widely studied. The PGRs have potential to regulate all aspects of plant growth and development that can improve yield and quality of fruits through reduced incidence of insect-pest and minimized cracking of fruit. In the present study an attempt was made to reduce the insect-pest incidence and fruit cracking in Cape gooseberry using plant growth regulators and emasculation with objective of avoiding the loss and ultimately increase the income to the farmers. The concentrations of plant growth regulators were taken as GA_3 @ 50 ppm, 100 ppm, 200 ppm, 2, 4-D @ 5 ppm, 10 ppm, 15 ppm, NAA @ 50 ppm, 100 ppm, 150 ppm, IAA @ 15 ppm, 30 ppm, 45 ppm and Control (water spray). The plants growth regulators with varying concentrations were sprayed on emasculated as well as un-emasculated flower buds (30 in each case) except control during both the years 2017-18 and 2018-19. On the basis of findings, the application of GA_3 @ 200 ppm effectively minimized the lower percentage of insect- pest incidence (1.67%) whereas; the spray of GA_3 @ 100 ppm on flower buds was showed the minimum fruit cracking percentage (1.67%) over the rest of the treatments in the fruit of Cape gooseberry.

Keywords: Cape gooseberry, PGR, insect-pest incidence, fruit cracking

Introduction

Cape gooseberry (*Physalis peruviana* L.) is a minor and a quick growing fruit which belongs to the family *Solanaceae* is catching the imagination of farmers for improved income during the recent years [1]. Cape gooseberry is famous for its flavour and having good blend of acid-sugar. The fruits are very attractive in colour at maturity time and if properly packed, it can easily be sent to distant markets. The fruit is small, roundish in shape and before maturity it is green and at maturity turn into bright orange in colour, fruit weight varies from 4 to 10 g with the diameter around 12.5 to 25.0 millimeters, a matured fruit bears about 100 to 300 seeds. Cape gooseberry fruits is an important source of ascorbic acid (36mg $100g^{-1}$ pulp), rich in Vitamin A (1730 IU. $100g^{-1}$ of pulp), iron (38mg $100g^{-1}$ of pulp) and phosphorus (1.2 mg $100g^{-1}$ of pulp) [2]. The matured and ripen fruits are used for preparation of jams. Some species of *Physalis* are an important source of vitamin A, C and B complex, minerals and are beneficial for medicinal properties such as antioxidants including anti-bacterial, anti-inflammatory and anti-cancer etc.

Cape gooseberry plants are cultivated in Rabi season during October to March. The fruit maturity starts in February-March and the same crop continue to produce fruit until last of April, yielding about 200- 500 g of fruit per plant. An important problem in Cape gooseberry is insect- pest incidence and fruit cracking during the fruit growth, development and fruit maturity. The major pest is fruit borer which damage the calyx during the early stage of fruit growth and enters into the fruit and destroy it, resulting lower down the fruit yield with less market value. In some treatment it was found calyx without complete fruit. The damaged calyx were unable to maintain the micro climate inside the calyx and ultimately more fruit cracking was observed resulting in lower production of quality fruits. This problem makes it difficult for growers to produce the quality fruits. This type of situation is more or less the same for all the growers; it results at the time of harvesting with poor quality of fruits to market with low price.

For improving the quality of the fruits, today, specific PGRs are used to modify crop growth rate and growth pattern during the various stages of development from germination through harvest and post-harvest life. The tree fruits are considered high value crops and even small modifications in production efficiency, product quality or enhanced cosmetic appeal have the potential to significantly increase product value [3].

Hence, avoiding the loss to the growers by insect-pest incidence and fruit cracking the present investigation was made to use of plant growth regulators for minimizing the insect pest incidence and fruit cracking in Cape gooseberry.

Materials and methods

The present investigation was carried out in the experimental area of the Department of Horticulture, Birsa Agricultural University, Kanke, Ranchi during two successive seasons (2017-18 and 2018-19). The experimental site comes under VIIth Agro-Climatic Region i.e., Eastern Plateau and Hills. It is situated between 23^{0}17' North latitude and 85^{0}19' East longitude and the height from the mean sea level is 625m. The soil of the experimental plot was Sandy loam in texture with average fertility and thus considered suitable for cultivation of Cape gooseberry. The factorial randomized block design was adopted for the trial. The numbers of treatment combination was 26 with three replications during both the years.

Field Preparation

The field was prepared thoroughly. The required area was marked for experiment and land was again prepared thoroughly by spading to bring a fine tilth suitable for Cape gooseberry cultivation. A basal dressing of well rotten farm yard manure at the rate of two tractor trolley full load per ha was applied and was thoroughly incorporated in the soil. The sub-plots were then divided into different blocks according to the layout plan.

Nursery Bed

Seeds were sown on the raised bed with suitable mixture of garden soil and well rotten farm yard manure. Germination started visible after nine days of sowing. The seedlings were ready for transplanting after a month of germination. Seedlings attained a height of 5-6 centimeter at the time of transplanting.

Seedling Transplanting

Seedlings were transplanted in the field in the afternoon which was done manually in each sub-plot according to the layout plan with a planting distance of 50 cm × 50 cm i.e. row to row and plant to plant respectively. The plot size was maintained 2m in both sides with accommodation of 16 plants per plot. To overcome the shock of transplanting, the transplanted seedlings were irrigated immediately with the help of a watering rose can. This practice was continued up to seven days in both morning and evening hours.

Treatment Details

In this investigation plants growth regulators (PGRs) with different concentrations were sprayed on emasculated (E_1) as well as un-emasculated (E_2) flower buds (30 in each case) except control. For emasculating the buds, a few petals were removed for exposing the anther as well as style. Anthers were taken out carefully with the help of forceps. Emasculation was done in the morning on each day and 24 hours before spraying of PGRs. After spraying emasculated buds (E_1) was bagged with perforated parchment paper. The concentrations of plant growth regulators were taken as GA_3 @ 50ppm (C_1), 100ppm (C_2) and 200 (C_3), 2,4-D @ 5ppm (C_4), 10ppm (C_5) and 15ppm (C_6), NAA @ 50ppm (C_7), 100ppm (C_8) and 150ppm (C_9), IAA @ 15ppm (C_{10}), 30ppm (C_{11}) and 45ppm (C_{12}), Control, water spray (C_{13}).

Observations Recorded

1. Insect-pest incidence (%)

The insect-pest incidence percentage was recorded by counting the number of infected fruits per treatment among twenty randomly selected fruits and the average value was taken and calculated in percentage.

2. Fruit cracking (%)

The fruit cracking percentage was recorded by counting the number of cracked fruits per treatment among twenty randomly selected fruits and the average value was taken and calculated in percentage.

Results

Insect pest incidence (%)

The insect- pest incidence percentage is presented in Table-1. The critical examination of the data for the year 2017-18 clearly indicated that the insect- pest incidence appreciably decreased by the spray of various growth substances at different concentrations. The significantly minimum insect-pest incidence of 1.67 per cent was recorded by the effect of the treatments E_1C_3 (Emasculated flower buds with spray of GA_3 @ 200 ppm), E_1C_9 (Emasculated flower buds with spray of NAA @ 150 ppm), E_2C_3 (Un-emasculated flower buds with spray of GA_3 @ 200 ppm), E_2C_8 (Un-emasculated flower buds with spray of NAA @ 100 ppm), E_2C_9 (Un-emasculated flower buds with spray of NAA @ 150 ppm) and E_2C_{12} (Un-emasculated flower buds with spray of IAA @ 45 ppm), whereas, the treatment E_2C_6 (Un-emasculated flower buds with spray of 2,4-D @ 15 ppm) showed the statistically at par value of 3.33 per cent and treatment E_2C_{13} (Un-emasculated flower buds with spray of water) exhibited maximum incidence of 8.33 per cent. In the next year 2018-19 of investigation more or less similar trends were recorded as the result of previous year. The minimum insect-pest incidence was obtained by the effect of the treatments E_1C_3 (Emasculated flower buds with spray of GA_3 @ 200 p, E_1C_6 (Emasculated flower buds with spray of 2,4-D @ 15 ppm), E_1C_{12} (Emasculated flower buds with spray of IAA @ 45 ppm), E_2C_3(Un-emasculated flower buds with spray of GA_3 @ 200 ppm) and E_2C_9 (Un-emasculated flower buds with spray of NAA @ 150 ppm) with the same footing value of 1.67 per cent whereas; the maximum insect-pest incidence was noted under the treatment E_1C_{13} and E_2C_{13} (Emasculated and un-emasculated flower buds with spray of water) along with same footing value of 6.67 per cent. Pooled data for both the years indicated almost same trend as it was recorded in individual years. The combined analysis of the two years data (2017-18 & 2018-19) also disclosed that all the treatments applied had minimized the insect-pest incidence during fruiting of Cape gooseberry. The minimum insect- pest incidence 1.67 per cent was recorded in the treatments E_1C_3 (Emasculated flower buds with spray of GA_3 @ 200 ppm), E_2C_3 (Un-emasculated flower buds with spray of GA_3 @ 200 ppm) and E_2C_9 (Un-emasculated flower buds with spray of NAA @ 150 ppm) whereas; the maximum insect-pest incidence 7.50 per cent was noticed in the fruits of Cape gooseberry under the control E_2C_{13} (Un-emasculated flower buds with spray of water).

In the year 2017-18 emasculated (E_1) and un-emasculated (E_2) flower buds process in fruit of Cape gooseberry was significantly differed among each other in respect of reduced the incidence of insect-pest (5.38 % and 4.62 % respectively). In the next year (2018-19) it was observed non-significant. The pooled data of the combined year (2017-18 and 2018-19) when it was statistically analyzed, it was cleared that the un-emasculated (E_2) flower buds significantly minimized the incidence of insect- pest with showing value of 4.42 per cent in comparison to emasculated (E_1) flower buds of 4.94per cent.

The effect of different treatments of plant growth regulators were registered significance result in respect to minimize the incidence of insect-pest. During the first year 2017-18 the significant effect of the treatment GA_3 @ 200 ppm (C_3) was recorded for lower incidence of insect pest (1.67%) whereas; the significantly more incidence of 7.50 per cent was noticed under the treatment control (C_{13}). In the next year 2018-19 more or less similar trends was observed, treatment GA_3 @ 200 ppm (C_3) registered the significantly lower value i.e. 1.67 per cent of insect-pest incidence. The next best promising results were noted under the treatments 2,4-D @ 15 ppm (C_6), NAA @15 ppm (C_9) and IAA @ 45 ppm(C_{12}) with same footing value of 2.50 per cent of insect- pest incidence in the fruit. The higher occurrence of 6.67 percent insect-pest incidence was found under the treatment control (C_{13}). The combined data of two years 2017-18 and 2018-19 clearly indicated the trend of previous two years. Among the different treatments of plant growth substances, the effect of GA_3 @ 200 ppm (C_3) significantly minimized the incidence of insect-pest i.e. in terms of value it was recorded as 1.67 per cent, which was statistically at par by the treatment NAA @ 150 ppm (C_9) with having value 2.08 per cent whereas; maximum incidence percentage was observed as 7.08 per cent in the treatment control ($C_{13)}$).

Table 1: Insect-pest incidence (%).

Treatments		2017-18			2018-19			Pooled over the year		
		Emasculation (E_1) (AB)	Un-emasculation (E_2)	Treatments Effect (B)	Emasculation (E_1) (AB)	Un-emasculation (E_2)	Treatments Effect (B	Emasculation (E_1) AB	Un-emasculation (E_2)	Treatments Effect (B
GA_3 50 ppm	(C_1)	6.67	6.67	6.67	5.00	6.67	5.83	5.83	6.67	6.25
GA_3 100 ppm	(C_2)	5.00	5.00	5.00	3.33	3.33	3.33	4.17	4.17	4.17
$GA_3$200 ppm	(C_3)	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
2,4-D 5 ppm	(C_4)	6.67	6.67	6.67	6.67	5.00	5.83	6.67	5.83	6.25
2,4-D 10 ppm	(C_5)	6.67	6.67	6.67	5.00	5.00	5.00	5.83	5.83	5.83
2,4-D 15 ppm	(C_6)	5.00	3.33	4.17	1.67	3.33	2.50	3.33	3.33	3.33
NAA 50 ppm	(C_7)	6.67	6.67	6.67	6.67	5.00	5.83	6.67	5.83	6.25
NAA 100 ppm	(C_8)	5.00	1.67	3.33	5.00	5.00	5.00	5.00	3.33	4.17
NAA 150 ppm	(C_9)	1.67	1.67	1.67	3.33	1.67	2.50	2.50	1.67	2.08
IAA 15ppm	(C_{10})	6.67	5.00	5.83	6.67	5.00	5.83	6.67	5.00	5.83
IAA 30ppm	(C_{11})	6.67	5.00	5.83	5.00	3.33	4.17	5.83	4.17	5.00
IAA 45ppm	(C_{12})	5.00	1.67	3.33	1.67	3.33	2.50	3.33	2.50	2.92
Control	(C_{13})	6.67	8.33	7.50	6.67	6.67	6.67	6.67	7.50	7.08
Emasculation Effect (A)		5.38	4.62	-	4.49	4.23	-	4.94	4.42	-
		A	B	AB	A	B	AB	A	B	AB
SEm±		0.23	0.57	0.81	0.17	0.44	0.62	0.16	0.40	0.57
CD (P=0.05)		0.64	1.63	2.30	0.49	1.25	1.77	0.44	1.12	1.59
CV%		28.11	-	-	24.71	-	-	29.68	-	-

2. Fruit Cracking (%)

Fruit cracking of Cape gooseberry under different treatments were analyzed and recorded data in this respect are presented in Table-2.The critical examination of the data for the year (2017-18) clearly indicated that the fruit cracking appreciably decreased by the application of different treatments of plant growth retardants. The minimum of 1.67 per cent fruit cracking was recorded under the treatments E_1C_2 (Emasculated flower buds with spray of GA_3 @ 100 ppm), E_2C_2 (Un-emasculated flower buds with spray of GA_3 @ 100 ppm) and E_2C_5 (Un-emasculated flower buds with spray of 2,4-D @ 10 ppm), which was found statistically at par with the treatments E_1C_1 (Emasculated flower buds with spray of GA_3 @ 50 ppm), E_1C_4 & E_1C_5 (Emasculated flower buds with spray of 2,4-D @ 5 & 10 ppm), E_2C_1 (Un-emasculated flower buds with spray of GA_3 @ 50 ppm), E_2C_7 (Un-emasculated flower buds with spray of NAA @ 50 ppm) and E_2C_{10} (Un-emasculated flower buds with spray of IAA @ 15 ppm) with same footing value of 3.33 per cent. The maximum of 10.00 per cent fruit cracking was recorded under the treatment E_1C_{13}

(Emasculated flower buds with spray of water). In the next year 2018-19 of trial more or less similar trend was observed as the previous year. The minimum fruit cracking of 1.67 per cent was found by the effect of the treatments E_1C_2 (Emasculation of flower buds with spray of GA_3 @ 100ppm) and E_2C_2 (Un-emasculation of flower buds with spray of GA_3 @ 100 ppm) whereas; the maximum fruit cracking of 8.33 per cent was noted in the treatment E_1C_{13} (Emasculated flower buds with spray of water). The pooled analysis of the data of the combined two years (2017-18 & 2018-19) also disclosed that all the treatments applied had minimized the fruit cracking percentage. The significantly minimum fruit cracking percentage was recorded by the effect of the treatments E_1C_2 (Emasculated flower buds with spray of GA_3 @ 100 ppm) and E_2C_2 (Un-emasculated flower buds with spray of GA_3 @ 100 ppm) with having the same footing value of 1.67 per cent and it was found statistically at par with the treatment E_2C_5 (Un-emasculated flower buds with spray of 2,4-D @ 10 ppm). The next best treatments were observed as E_1C_1 (Emasculated flower buds with spray of GA_3 @ 50 ppm), E_1C_4 & E_1C_5 (Emasculated flower buds with spray of 2,4-D @ 5 &10 ppm), E_2C_1(Un-emasculated flower buds with spray of GA_3 @ 50 ppm), E_2C_7(Un-emasculated flower buds with spray of NAA @ 50 ppm) and E_2C_{10} (Un-emasculated flower buds with spray of IAA @ 15 ppm) with the same footing value 3.33 per cent of fruit cracking whereas; maximum fruit cracking of 9.17 per cent was observed under the treatment control E_1C_{13} (Emasculated flower buds with spray of water).

In between the emasculated (E_1) and un-emasculated (E_2) flower buds, during the first year (2017-18) the un-emasculated (E_2) flower buds significantly minimized the lower percentage of fruit cracking of 4.23 per cent, whereas, the emasculated (E_1) flower buds exhibited the more percentage (5.00 %) of fruit cracking. And in the next year (2018-19) of investigation the effect of emasculation process was found non-significant. Pooled data of combined two years (2017-18 and 2018-19) also exhibited the non-significant effect of emasculation.

The effect of plant growth retardants on lower down the fruit cracking was significantly differed among the different treatments. In the first year (2017-18) of experimentation the significantly minimum fruit cracking of 1.67 per cent was obtained with the effect of the treatment GA_3 @ 100 ppm (C_2) and it was found statistically at par with the treatments GA_3 @ 50 ppm (C_1) and 2,4-D @ 10 ppm (C_5) with same footing value of 3.33 per cent. The significantly more fruit cracking of 8.33 per cent was noted under the treatment control (C_{13}). During the second year (2018-19) of trial the treatment GA_3 @ 100 ppm (C_2) again performed better with highly significance effect of minimum fruit cracking (1.67%). The next best promising results were noted under the treatments GA_3 @ 50 and 200 ppm (C_1 & C_3), 2,4-D @ 5 and 10 ppm (C_4 & C_5) with the same footing value of 3.33 per cent of fruit cracking. The higher fruit cracking of 7.50 per cent was noted under the treatment control (C_{13}). The combined data of two years (2017-18 and 2018-19) clearly indicated that the significantly lower value of fruit cracking of 1.67 per cent was observed by the effect of the GA_3 @ 100 ppm (C_2) and maximum of 7.92 per cent in the treatment control (C_{13}).

Table 2: Fruit Cracking (%).

Treatments		2017-18			2018-19			Pooled over the year		
		Emasculation (E_1)	Un-emasculation (E_2)	Mean (B)	Emasculation (E_1)	Un-emasculation (E_2)	Mean (B)	Emasculation (E_1)	Un-emasculation (E_2)	Mean (B)
		(AB)			(AB)			AB		
GA_3 50 ppm	(C_1)	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
GA_3 100 ppm	(C_2)	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
$GA_3$200 ppm	(C_3)	5.00	5.00	5.00	3.33	3.33	3.33	4.17	4.17	4.17
2,4-D 5 ppm	(C_4)	3.33	5.00	4.17	3.33	3.33	3.33	3.33	4.17	3.75
2,4-D 10 ppm	(C_5)	3.33	1.67	2.50	3.33	3.33	3.33	3.33	2.50	2.92
2,4-D 15 ppm	(C_6)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
NAA 50 ppm	(C_7)	5.00	3.33	4.17	5.00	3.33	4.17	5.00	3.33	4.17
NAA 100 ppm	(C_8)	5.00	5.00	5.00	3.33	5.00	4.17	4.17	5.00	4.58
NAA 150 ppm	(C_9)	6.67	5.00	5.83	5.00	5.00	5.00	5.83	5.00	5.42
IAA 15ppm	(C_{10})	5.00	3.33	4.17	5.00	3.33	4.17	5.00	3.33	4.17
IAA 30ppm	(C_{11})	5.00	5.00	5.00	3.33	5.00	4.17	4.17	5.00	4.58
IAA 45ppm	(C_{12})	6.67	5.00	5.83	5.00	5.00	5.00	5.83	5.00	5.42
Control	(C_{13})	10.00	6.67	8.33	8.33	6.67	7.50	9.17	6.67	7.92
Emasculation Effect (A)		5.00	4.23		4.23	4.10		4.62	4.17	
		A	B	AB	A	B	AB	A	B	AB
SEm±		0.19	0.49	0.70	0.15	0.39	0.55	0.13	0.32	0.45
CD (P=0.05)		0.55	1.40	1.98	0.43	1.11	1.57	0.35	0.89	1.27
CV%		26.18	-	-	22.95	-	-	25.20	-	-

Discussion

In the last four decades, many authors suggested that the PGRs can be used as alternative to the conventional insecticides for controlling the economically dangerous insect pests [4]. The obtained results of above findings, plant growth substances GA_3 @ 200 ppm (C_3), NAA @ 150 ppm (C_9), IAA @ 45 ppm (C_{12}) and 2,4-D @ 15 ppm (C_6) significantly minimized the incidence of insect-pest i.e. 1.67 per cent, 2.08 per cent, 2.92 per cent and 3.33 per cent respectively in comparison to 7.08 per cent of control (C_{13})) are consistent with the results obtained by researchers [5]. They stated that NAA significantly (P<0.05) reduced development of white mold lesions on bean and cucumber detached leaves pretreated concentrations up to 600 μg/ml. Also, it has reduced white mold disease severity on bean and cucumber plants at concentrations up to 500 μg/ml. The PGRs like

Prohaxadione calcium, an inhibitor of gibberellin biosynthesis, altered plant metabolism to impart resistance to insects and diseases [3]. The parthenocarpic fruits which were treated with plant growth regulators were only 1% of fruits being affected by blossom-end rot compared to 31% in the control [6]. The natural and synthetic auxin and gibberellin spraying in tomato helped farmer to cultivate in adverse climatic condition [7]. The application of Auxin/ IAA genes functions as hubs that integrate genetic and environmental information to achieve the appropriate developmental or physiological outcome [8]. The disruptive effects of PGRs on various insect pests leading directly to death or through impairment of their reproductive potential and other physiological processes [9]. Thus, the use of PGRs may be an effective tactic in IPM programs, since they induce the plant defenses resulting in decreased herbivore fitness [10, 11]. However, the available literature has been enriched with many reported works indicating the stimulatory effects of PGRs on some plants to resist herbivorous insects through various defense strategies to minimize their damage [12, 13].

In the view of present findings, the medium and lower dose of GA_3 and 2,4-D had potentiality to minimize the fruit cracking in the Cape gooseberry. However, the spray of GA_3 @ 100 ppm was most effective treatment to reduce the fruit cracking and 2,4-D @ 10 ppm was also observed as the next best treatment in this regards. It might be due to Gibberellic acid treated fruits had up taken more water, which makes flexible of epidermis of treated fruits. Due to flexible or elasticity of cell, GA_3 could reduce the fruit cracking [14]. Some researcher reported foliar spray of $CaCl_2$ and Borax is able to enhanced fruit weight, fruit size, TSS, ascorbic acid and also minimized acidity, fruit drop and reduced fruit cracking [15]. Cline and Trought observed that the foliar spray of GA_3 and 2,4-D have performed better response on fruit development, reduced fruit drop, fruit cracking and improved the fruit quality in apple under field conditions [16]. Further, application of GA_3 reduces fruit cracking by effect of permeability or elasticity of the fruit cells. The cell wall elasticity may be due to use of GA_3 and presence of Ca in cell wall known as cementing agent which plays an important role in maintaining firmness of cell wall which minimize loss of moisture during evaporation and ultimately reduces fruit cracking. Thus, response of GA_3 and 2,4-D in the present investigation was also confirmed by the similar observations of Cline and Trought [17] in sweet cherry and Kumar [18] in pomegranate.

Conclusion

In the light of above findings it may be concluded that among the different treatments the higher and medium dose of PGRs effectively minimize the insect- pest incidence in the Cape gooseberry. The treatment GA_3 @ 200 ppm effectively minimized the lower percentage of insect- pest incidence in the fruit of Cape gooseberry.

In the view of aforesaid observations, it can be derived that among the different treatments the medium and lower dose of GA_3 and 2,4-D had potentiality to minimize the fruit cracking in the Cape gooseberry. However, the spray of GA_3 @ 100 ppm was most effective treatment to reduce the fruit cracking and 2,4-D @ 10 ppm was also observed the next best treatment in this regard.

References

1. Kumar R, Jha KK, Sengupta S, Misra S, Mahto CS, Narayan SC. Effect of colchicine treatment on survival of seedlings and morphology in Cape gooseberry (*Physalis peruviana* L.). Journal of Pharmacognosy and Phytochemistry. 2019; 5:184-189.
2. Fischer G. Production, post-harvest and export of Cape gooseberry (*Physalis peruviana* L.). National University of Colombia, 2000, 175.
3. Bisht TS, Rawat L, Chakraborty B, Yadav V. A Recent Advances in Use of Plant Growth Regulators (PGRs) in Fruit Crops - A Review. International Journal of Current Microbiology and Applied Sciences. 2018; 7(5):1307-1336.
4. Silva MTB, Costa EC, Boss A. Control of *Anticarsia gemmatalis* Hubner (Lepidoptera: Noctuidae) larvae with insect growth regulators. Ciencia Rural. 2003; 33(4):601-605.
5. Al-Masri MI, Barakat R. Role of the auxin, Naphthalene Acetic Acid (NAA) in the pathogenicity of *Sclerotinia sclerotiorum*, causative organism of white mold disease. Hebron University Research Journal. 2003; 1(2):4-15.
6. Heuvelink E, Rner OK. Parthenocarpic Fruit Growth Reduces Yield Fluctuation and Blossom-end Rot in Sweet Pepper. Annals of Botany. 2001; 88:69-74.
7. Pramanik K, Pradhan J, Sahoo SK. Role of auxin and gibberellins growth, yield and quality of tomato: A review. The Pharma Innovation Journal. 2018; 7(9):301-305.
8. Shani E, Salehin M, Zhang Y, Sanchez SE, Doherty C, Wang R *et al*. Plant Stress Tolerance Requires Auxin-Sensitive Aux/IAA Transcriptional Repressors. Current Biology. 2016; 27:437-444.
9. Honeim K. Role of Plant Growth Regulators in the Insect Pest Control: A Quick Outlook. Environment Analysis and Ecological Studies. 2018; 4(1):1-2.
10. Stout MJ, Zehnder GW, Baur ME. Potential for the use of elicitors of plant resistance in arthropod management programs. Archives of Insect Biochemistry and Physiology. 2002; 51(4):222-235.
11. Lyon GD. Agents that can elicit induced resistance. In: Walters D, Newton A, Lyon G (Eds.), Induced resistance for plant defense: A sustainable approach to crop protection, 2nd edn, John Wiley and Sons, New York, USA, 2014, 11-40.
12. Herbert DA, Abaye AO, Dugger P, Richer D. Compensation from systematic square removal by Virginia cotton. Proceedings Beltwie Cotton Conferences, Orlando, Florida, USA. 1999; 2:968-971.
13. Reglinski T, Dann E, Deverall B. Implementation of induced resistance for crop protection. In: Walters D, Newton A, Lyon G (Eds.), Induced resistance for plant defence: A sustainable approach to crop protection, 2nd edn, John Wiley and Sons, New York, USA, 2014, 249-299.
14. Sebastian K, Arya MS, Reshma UR, Anaswara SJ, Syama S, Thampi SS. Impact of Plant Growth Regulators on Fruit Production. International Journal of Current Microbiology and Applied Science. 2019; 8(2):800-814.
15. Singh SP, Lal RL, Mishra KK, Singh M, Mishra DS. Improving fruit set, yield and fruit quality of Litchi (*Litchi chinensis* Sonn. cv. Rose Scented) through foliar spray of different concentrations of macro and micro nutrients. International journal of Chemical Studies. 2018; 6(1):2146-2150.
16. Tuan NM, Ruey YC. Effect of Gibberellic Acid and 2,4-Dichlorophenoxyacetic Acid on Fruit Development and

Fruit Quality of Wax Apple. International Journal of Agricultural and Biosystems Engineering. 2013; 7(5):299-305.

17. Cline JA, Trought M. Effect of gibberellic acid on fruit cracking and quality of Bing and Sam sweet cherries. Canadian Journal of plant Science. 2007; 87:545-550.
18. Kumar K, Pinder R, Jitender STK, Dabas S, Yadav B, Rana S. Effect of growth regulators and micronutrients on fruit cracking and fruit yield in pomegranate. Indian Journal of Agricultural Research. 2017; 51(3):272-276.