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Influence of Plant Growth Regulators on Growth, Yield and Yield Components in Garden Pea

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ABSTRACT

Background: Garden pea is one of the most important legume crop which require proper crop management practices. Crop regulation is an important practices which enhancing the productivity of garden pea with higher economic return. This can be done by adopting proper application of PGRs. Therefore, the present study was designed to assess the effect of PGRs on growth and yield of garden pea.

Methods: The present study was laid out on garden pea (*Pisum sativum* subsp. hortense) cv. Azad Pea-3 in a randomized block design with three replications and ten treatments comprising different levels NAA, GA_3 and Salicylic acid at various stages. The data on growth and yield were recorded and analyzed statistically applying the analysis of variance technique.

Result: Results revealed that the plants treated with 120 ppm gibberellic acid showed 45.39% 38.55%, 40.60% and 32.84% increment in plant height, length of pod, width of pod and number of seeds per pod and taken lowest number of days to 50% flowering over control, respectively. The use of 40 ppm NAA exhibited maximal enhancement in number of pods per plant (57.43-68.02%), seed weight per pod and Pod yield per hectare (50.62-60.26%) over remaining treatments. Conclusively, the results suggest that foliar application of PGRs favors the growth and yield of garden pea.

Key words: Garden pea, NAA, PGR, Plant growth regulators, Salicylic acid.

INTRODUCTION

Garden pea (*Pisum sativum* L.) (2n=14) belongs to the Leguminosae family is widely cultivated as a vegetable crop in various temperate and subtropical region of the world. Green pods of garden pea have unique flavor, sweetness and freshness due to this ability its local consumption and exportation increases day by day. It is an important winter vegetable in plains of north, north western and as a summer crop in high part of hills in India (Pandey *et al*., 2006). The major garden pea growing states are Uttar Pradesh, West Bengal, Madhya Pradesh, Bihar and Gujarat. Garden pea is considered as one of the most important sources of nutrition throughout the world which contains high amount of digestible protein and carbohydrates (Hussein *et al.,* 2006). Nutritionally, garden pea contains approximately protein (5.4/100 g) carbohydrates (14.5 /100 g), fiber (5.1/100 g), sugar (6/100 g), sodium (5/100 m), potassium (244/100 g), iron (1.5 mg/ 100 g), vitamin A (38 ug/100 g), vitamin C (40 mg/100 g), zinc (1.2 mg/100 g) and some little amount of other minerals (Bhat *et al.,* 2013 and Dhall, 2017). Beside these, it has a unique ability of biological nitrogen fixation, mobilization of insoluble soil nutrients which brings the qualitative changes in soil property. There are a number of factors which are responsible for lower growth, development and productivity of garden pea such as crop regulation, planting method, water and fertilizer managements. Among these, crop regulation is an important practices which enhancing the productivity of garden pea with higher profitability. This can be done by adopting proper application of PGRs.

The plant growth regulators (PGRs) play an important role in the cultivation of garden pea because their small amount promote or inhibits or quantitatively modifies the growth and development of crop. Gibberellic acid has proved to be very effective in manipulating the growth, flowering and yield of garden pea (Shraiy and Hegazi, 2009). Beside these, it play an important role in stem elongation, fruit development and regulation of gene expression in various crops. Similarly, NAA enhance the cell elongation and division by promoting the DNA synthesis in the cell. It reduced the juvenile phase due to increase in

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photosynthesis and respiration with enhanced CO_2 fixation in the plant (Murugan *et al.,* 2020). The another plant growth regulator is salicylic acid (SA) which is considered as a phenolic antioxidant compound, messenger, or signaling molecule and growth regulator which support the plant growth and performance under different stressors. It helps plants to withstand various stressors by raising the plant's antioxidant capacity and suppressing ROS overproduction by playing important roles in regulating some processes related to plant physiology and biochemistry.

The selection of right hormones with appropriate concentration, time and method of application are most essential in effective crop production as because the same growth regulator in different concentrations brings about different results (Mukhtar and Singh, 2006). Therefore, the present study was conducted to assess the growth and yield of garden pea under different levels of PGRs.

MATERIALS AND METHODS

The present research was carried out at Vegetable Research Farm, Institute of Agricultural Sciences, B.H.U., Varanasi (Uttar Pradesh), during the winter season 2017- 2018. The geographical reference of the study area is 25°31′N latitude and 83°03′E longitude, with a height of 123.23 meters above mean sea level. The climate of experimental field is humid subtropical with large variation in the summer and winter temperature *i.e.,* extreme of hot weather in summer and cold in winter. Soil of experimental area was light sandy loam having pH value of 6.5, available nitrogen (282.4 kg ha^{-1}), available phosphorus (20.16 kg ha^{-1}) and potassium (168 kg ha^{-1}). The experiment was laid out in a randomized block design (RBD) with three replications and 10 treatments combination, comprising three different plant growth regulators (PGRs), *viz.* T_1 - distilled water, T_2 - Salicylic acid @ 100 ppm, T_3 - Salicylic acid @ 150, T_4 - Salicylic acid @ 200 ppm, T_5 - NAA @ 20 ppm, T_6 - NAA @ 30 ppm, T_7 - NAA @ 40 ppm, T_8 - GA_3 @ 40 ppm, T_9 - GA_3 @ 80 ppm and T_{10}- GA_3 @ 120 ppm at 30, 45 and 90 days after sowing. The healthy and disease free seed of garden pea cultivar Azad pea-3 was collected from Indian Institute of Vegetable Research, Varanasi (ICAR-IIVR). Prior to sowing, the experimental field was ploughed and fairly leveled and the recommended dose of fertilizer was supplied to each plot. Sowing of garden pea seed done by dibbling method on well prepared raised beds (4-3 m) at 4 cm depth with 30 and 10 cm row to row and plant to plant distance, respectively. Seedlings emergence were observed on a daily basis and sowing was done again in case of any dead or week seedlings.

The observations on plant height, days taken for 50% flowering were recorded manually on ten randomly selected representative plants from each treatment of each replication. The length of pod (cm), width of pod (cm) was measured using measuring scale and seed weight per pod and weight of pod was weighed using digital weighing balance. Yield attributes were also recorded at physiological maturity stage. The data obtained from various parameters during experiment were analyzed by the method of analysis of variance.

RESULTS AND DISCUSSION

Growth and flowering attributes

The plant height and flowering of garden pea was significantly affected by foliar application of plant growth regulators (Table 1). Among the different treatments, the maximum plant height was observed in the treatment T_{10} which was 45.39 per cent higher over control. Similarly, the treatment T_{10} take lowest days to 50 per cent flowering as compared to other treatment which was 1.41- fold lower than the control plot. Similar finding was reported by Singh *et al.* (2015) in pea. Emongor (2007) reported that the foliar application of GA_3 improved the growth and flowering in vegetable cowpea as compared to control. Vadeo (2018) observed that application of GA_3 @ 20 ppm produced maximum plant height and earliest 50 per cent flowering in pea. Foliar application of GA_3 increased the growth of garden pea as compared to other treatments might be due to enhanced cell division, cell enlargement, increased plasticity of cell, promotion of protein synthesis and apical dominance which increased the auxin level of the tissue and the conversion of tryptophan to IAA (Emongor, 2007). The earliest days taken to 50 per cent flowering with GA_3 application might be due to increased translocation of food materials, photosynthesis, respiration and synthesis of florigen hormone which stimulate flowering (Datta and Nanda, 1985).

Yield attributes

The yield attributes of garden pea was increased with increasing level of GA_3 NAA and SA (Table 2, 3). The foliar application of GA_3 @ 120 exhibited 38.55% increase in pod length of garden pea as compared to control plot, respectively. Maximum width of garden pea (1.87 cm) was recorded with spraying of NAA @ 40 ppm as compared to other treatments. The plants of garden pea treated with NAA @ 40 ppm enhanced the seed weight per pod by 1.40-

Table 1: Effect of plant growth regulators on plant height and days taken to 50 per cent flowering.

Treatments	Plant height	Days taken to 50% flowering
T_1	55.47	45.67
T_2	58.54	42.00
T_3	60.29	41.00
T_4	61.09	40.00
T_5	64.28	40.33
T_6	67.11	38.33
T_7	69.6	37.00
T_8	70.17	36.67
T_9	75.41	35.33
T_{10}	80.65	32.33
Grand mean	66.26	38.87
S.E.M.	1.25	1.23
C.D.	3.83	3.66

Table 2: Effect of plant growth regulators length of pod, width of pod, seed weight per pod, weight of per pod and shelling.

Treatments	Length of pod (cm)	Width of pod (cm)	Seed weight per pod (g)	Weight of per pod (g)	Shelling (%)
T_1	2.49	1.33	2.49	7.11	35.00
T_2	2.76	1.40	2.76	7.76	35.50
T_3	2.84	1.43	2.84	7.99	35.60
T_4	2.93	1.47	2.93	8.10	36.23
T_5	3.02	1.67	3.21	8.94	35.90
T_6	3.11	1.83	3.30	9.13	36.15
T_7	3.17	1.87	3.45	9.76	35.41
T_8	3.21	1.50	3.02	8.54	35.21
T_9	3.30	1.60	3.11	8.66	35.97
T_{10}	3.45	1.63	3.17	8.62	36.82
Grand mean	3.03	1.57	3.03	8.46	35.8
S.E.M.	0.14	0.11	0.14	0.26	1.56
C.D.	0.42	0.33	0.42	0.89	NS

Table 3: Effect of plant growth regulators on number of seeds per pod, number of pods per plant and yield per hectare.

Treatment	Number of pods per plant	Number of seeds per pod	Yield (q/ha)
T_1	7.40	15.67	98.04
T_2	8.43	19.00	123.35
T_3	8.47	20.33	125.61
T_4	8.53	22.67	128.12
T_5	8.63	24.67	139.99
T_6	8.80	25.33	147.74
T_7	9.00	26.33	157.19
T_8	9.17	23.00	130.07
T_9	9.39	23.67	134.86
T_{10}	9.83	24.33	139.17
Grand mean	8.77	22.50	132.42
S.E.M.	0.12	0.83	3.95
C.D.	0.36	2.46	11.74

fold comparing to untreated plants. Similarly, plants receiving foliar application of GA_3 @ 120 ppm and SA @ 200 ppm exhibited up to a 27.30 and 17.67 per cent increase in seed weight per pod of garden pea as compared to control but 8.83 and 17.74 per cent lower than the NAA @ 40 ppm, respectively. The maximum pod weight of garden pea was observed with the application of NAA @ 40 ppm as compared to other treatments and closely followed by NAA @ 30 and 20 ppm. The maximum shelling percentage of garden pea was observed with GA_3 @ 120 ppm as compared to remaining treatments and closely followed by SA @ 200 ppm. The application of GA_3 @ 120 ppm gave 32.84 per cent higher number of seeds per pod as compared to control plot. Maximum number of pods per plant (26.33) was observed under NAA @ 40 ppm as compared to other treatments.

These results could be attributed mainly to the stimulatory effect of GA_3 on plant growth, which resulted in higher rates of biosynthesis and therefore higher amounts of assimilates available for distribution to the pods (Shraiy and Hegazi, 2009). Enhanced photosynthetic activity, efficient translocation and the use of photosynthesis, resulting in rapid cell division, cell elongation and cell differentiation at the leaf growth region of the plant, which stimulated growth. Results are in conformity with earlier reports of Zewail *et al.* (2011) and Singh *et al.* (2015) in pea. Mohandoss and Rajesh (2003) observed that spraying of GA_3 increased length of pod, shelling percentage and numberof seeds per pod in cowpea. Improved yield attributing due to foliar application of NAA could be attributed to increase in the rate of respiration resulting in production of metabolic energy which would have been utilized by plants for cellular expansion and tissue growth (Chattopadhyay and Sen, 1974). The application of NAA could be attributed to more efficient use of plant growth regulators for reproductive growth, better source and sink relationship, plant growth, transpiration and respiration, increased translocation and accumulation of sugar and other metabolites (Balraj *et al.,* 2002). The maximum yield of green gram was recorded with foliar application at NAA (Medhi *et al.,* 2014). Ayanle and Ahmed (2019) observed that application of NAA improved the yield attributes of garden pea. Kumar *et al.* (2020) reported foliar spraying of NAA improved number of seeds per pod and number of pods per plant of cowpea. Similar results were also reported by Kokare *et al.* (2006) in okra and Netam and Sharma (2014) in brinjal.

Yield

The highest pod yield per hectare (157.19 q/ha) of garden pea was observed with NAA @ 40 ppm over other treatments and closely followed by NAA @ 30 ppm while, minimum value (98.04 q/ha) was found in untreated plot. The increment in pod yield of garden pea with NAA @ 40 ppm over control was 60.33 per cent and 59.15 q/ha (Table 3). Similar findings were reported by Ayyub *et al.* (2013) in okra and Singh *et al.* (2015) in garden pea var. Arkal. Kumar *et al.* (2020) observed that the application of NAA increased yield per hectare in cowpea.

The increase in the yield of garden due to foliar application of NAA might be due to the reduction in flower

and fruit drop, increase in vegetative growth, fruit length and fruit thickness (Choudhary *et al.,* 2002). Similar results have also been reported by Rathod *et al.* (2015) in French bean, Tripathi and Kumar (2006) and Singh *et al.* (2015) in pea.

CONCLUSION

The results obtained during the present investigation revealed that use of various levels of PGRs improved the growth, yield and yield attributes of garden pea. The foliar spray of GA_3 @ 120 ppm substantially increased vegetative growth and flowering. In case of yield and yield attributes spraying of NAA @ 40 ppm was found effective. Therefore, the application of GA_3 @ 120 ppm and NAA @ 40 ppm can be recommended for garden pea cultivation after further investigation.

Conflict of interest: None.

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