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Efficacy of various doses of salicylic acid, naphthalene acetic acid and gibberellic acid on vegetative growth and pod yield of broad bean (*Vicia faba* L.)

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ABSTRACT

To investigate the efficacy of various doses of plant growth regulators on vegetative growth and pod yield of broad bean (Vicia faba L.), a field experiment was accomplished at Vegetable Research Farm, B.H.U., Varanasi during the winter season of 2019-20. Ten treatments were evaluated in randomized block design with three replications. Results indicated that the growth parameters like plant height, number of branches/plant significantly increased with foliar spray of gibberellic acid followed by NAA and salicylic acid. The yield attributes like pod width, fresh pod weight, number of pods/plant as well as fresh pod yield significantly enhanced by NAA followed by gibberellic acid and salicylic acid with various concentrations, respectively. The foliar spraying of 120 ppm GA_3 tended to produce plant with maximum height (116.4 cm), number of branches/plant (6.3), pod length (7.5 cm), number of seeds/pod (4.6) as well as early 50 % flowering (57.3 days) whereas, spraying of 40 ppm NAA exhibited the maximum pod width (1.3 cm), fresh pod weight (4.6 g), number of pods/plant (87.5) as well as fresh pod yield (105.0 q ha^{-1}) as compared to other treatments. The maximum net return (Rs. 337326.5 ha^{-1}) was recorded with 40 ppm NAA with B: C ratio of 3.65 followed by 30 ppm NAA and 20 ppm NAA. The lowest net income (Rs. 162382.5 ha^{-1}) and B: C ratio (1.76) was obtained from control. The spraying of NAA was found superior in terms of yield and yield attributes as well as benefit cost ratio followed by GA_3 and salicylic acid.

Keywords: Growth, yield, SA, GA_3, NAA and broad bean

INTRODUCTION

Broad bean (*Vicia faba* L.; 2n=12) is an annual winter legume and has the potential to tolerate various agro climatic conditions. The extent of cultivating the broad bean is very less in India hence, it is considered as underutilized vegetable crop. However, its pods are used as vegetables and dry cotyledons are good source of lysine protein and levadopa (L-dopa), which is a precursor of dopamine, that is potentially utilized for treatment of Parkinson disease. In broad bean, low productivity has been associated with abscission of buds, flowers and pods and inadequate pollination (Sharief and Hamady, 2017). Plant growth regulators regulate the photosynthetic ability as well as ramp up the partitioning of biosynthesis from source to sink in crops. They play a crucial role in low concentrations and modulates the growth and yield of crop (Foyasalkabir *et al.*, 2015). Gibberellic acid (GA_3) is a phyto-hormone which was isolated from fungus *Gibberella fujikuroi*. It fosters the vegetative growth by elongation of internodes, increases pods, flowers and leaves, early flowering and pods development, breaks seed dormancy, hastens maturity and also controls fruit cracking in horticultural crops. Naphthalene Acetic Acid (NAA) is an auxin synthetic form that influences vascular differentiation, augments absorption and translocation of nutrients, maintains female : male flowers ratio, fruit setting ratio, seeds weight, protein content, yield as well as hampers fruit drop. Salicylic Acid (SA) is an endogenous signaling biomolecule which regulates physiological and biochemical activities of plants as well as mitigates various biotic and abiotic stresses. It increases germination of seeds, nodulation in legumes, regulates stomatal conductance, respiration, delays fruit ripening, prevents from senescence and enhances fruit yield (Vlot *et al.*, 2009) as well as provide resistance to heavy metals, salt, heat stress, and immunity against various diseases (Arif *et al.*, 2020).

MATERIALS AND METHODS

A field experiment was accomplished at Vegetable Research Farm, B.H.U., Varanasi (Uttar Pradesh) during the winter season of

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2019-2020. It is located at an latitude of 25° 31` North latitude, 83° 03` East longitude and at an altitude 123.23 m. The soil of the experimental field was sandy loam, well drained with a good water holding capacity. The experiment was laid out in randomized block design with three replications. The seeds were sown at a spacing of 45 × 15 cm on 20th November, 2019. Recommended dose of fertilizers as well as other standard agro-techniques was used for raising a good crop. Nitrogen, phosphorus and potassium were used @ 20, 40 and 40 kg ha^{-1} through urea, DAP and muriate of potash, respectively. Ten treatments of PGRs along with control *viz.* salicylic Acid (SA) at 100, 150 and 200 ppm, naphthalene acetic acid (NAA) at 20, 30 and 40 ppm and gibberellic acid (GA_3) at 40, 80 and 120 ppm were sprayed at 30 and 45 DAS. Randomly five plants were selected from each plot and each replication for collection of data. Observations on plant height, number of branches/plant, days to 50 % flowering, pod length, pod width, fresh pod weight, number of seeds/pod, number of pods/plant and fresh pod yield were recorded. Harvesting of pods was done manually on 16th March, 2020. The economics of various treatments was calculated on the basis of prevailing market price of inputs and produce. The data were statistically analyzed to test the significance of differences among the treatments according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth attributes

The height of plants increased significantly with increasing levels of GA_3, followed by NAA and salicylic acid. The maximum (116.4 cm) plant height was recorded with 120 ppm GA_3 which was 26.4 % higher as compared to control. The minimum (92.1 cm) plant height was reported in control (Table 1). It may be due to GA_3 which enhanced growth activities of plant, stimulated the rate of cell division, cell elongation and thus, contributed to internode and stem elongation. Increase in plant height by spraying GA_3 was also reported by Fadhil and Almasoody (2019) in broad bean and Tasnim *et al.* (2019) in mung bean. The number of branches/plant significantly increased with application of GA_3, followed by NAA and salicylic acid. The maximum (6.3) number of branches/plant was observed by spraying of 120 ppm GA_3, followed by 80 ppm GA_3 (6.1) whereas, minimum (4.9) value was reported in control. The spraying of 120 ppm GA_3 was statistically at par with 80 ppm GA_3. Nevertheless, 120 ppm GA_3 produced 28.3 % more branches as compared to control. This may be due to rapid cell division and elongation of cell and enhanced photosynthetic activity and efficient assimilation of photosynthetic product resulted in development of more number of branches/plant. Similar finding was reported by Tasnim *et al.* (2019) in mung bean. The significant impact on number of days to 50 % flowering was shown by GA_3, NAA and salicylic acid. Earliness in flowering (50 %) was recorded with 120 ppm GA_3 (57.3 days), followed by 80 ppm GA_3 (60.3 days). However, delaying in flowering (50 %) was noticed in untreated plot (69.6 days). This might be due to GA_3 which stimulated differentiation of floral buds and formation of florigen hormone that led to early commencement of flowers. This results is in conformity with the findings obtained by (Das *et al.*, 2012) in green gram.

Yield attributes and yield

The spraying of growth regulators exhibited significant impact on pod length and longest (7.51 cm) pod length was observed with spraying of 120 ppm GA_3, followed by 80 ppm GA_3 (7.34 cm) whereas, smallest (6.45 cm) pod length was recorded in control (Table 1). The application of GA_3 promotes rapid cell division and elongation of individual cell as dry matter accumulation increases it gave more sites for assimilate deposition resulted in increasing pod length. Effect of GA_3 in increasing the pod length was also reported by Tasnim *et al.* (2019) in mung bean and Fadhil and Almasoody (2019) in broad bean. The remarkable increased in pod width was reported by NAA, followed by gibberellic acid and salicylic acid. The maximum (1.55 cm) pod width was observed with 40 ppm NAA, followed by 30 ppm NAA (1.52 cm), 20 ppm NAA (1.36 cm), 120 ppm GA_3 (1.35 cm) while, the minimum (1.05 cm) was recorded in control. NAA (40 ppm) was statistically at par with 30 ppm NAA, 20 ppm NAA and 120 ppm GA_3. Foliar spray of 40 ppm NAA produced 50 % more pod width than control.

Table 1: Effect of Salicylic acid, NAA and GA_3 on various growth and yield attributes of broad bean

Treatments	Plant height (cm)	Number of branches/plant	Days to 50% flowering	Pod length (cm)	Pod width (cm)	Fresh pod weight (g)
Control	92.1	4.9	69.6	6.45	1.05	3.14
100 ppm SA	95.5	5.1	67.0	6.76	1.13	3.79
150 ppm SA	97.1	5.17	66.3	6.84	1.14	4.02
200 ppm SA	98.7	5.3	65.3	6.93	1.18	4.13
20 ppm NAA	101.0	5.37	65.0	7.02	1.36	4.97
30 ppm NAA	103.4	5.5	63.3	7.11	1.52	5.16
40 ppm NAA	106.5	5.7	62.0	7.17	1.55	5.79
40 ppm GA_3	107.3	5.8	61.6	7.23	1.22	4.57
80 ppm GA_3	111.0	6.1	60.3	7.34	1.30	4.69
120 ppm GA_3	116.4	6.3	57.3	7.51	1.35	4.65
SEm ±	1.47	0.14	0.93	0.19	0.07	0.13
CD (P = 0.05)	4.38	0.44	2.77	0.58	0.23	0.38

The spraying of NAA might promotes efficient transport of sugars from the photosynthesizing parts of the plant (Source) to the developing pod (Sinks) which substantially increased the pod width. Siddik *et al.* (2015) also reported an increase in pod width with 50 ppm NAA in sesame. Among different plant growth regulators, the maximum (5.79 g) fresh pod weight was observed in 40 ppm NAA, followed by 30 ppm NAA (5.16 g). This might be due to increased in size of photosynthetic apparatus in terms of leaf area and leaf area index which increased assimilation rate resulted higher pod weight. The lower fresh pod weight owing to spraying of GA_3 in vegetative structures might enhances the fruit abscission, either directly or by increases the vegetative mass and thereby diverting photo assimilate from the pod. However, minimum (3.14 g) fresh pod weight was recorded in control (Table 1). Similar results have also been reported by Bairva *et al.* (2014) in fenugreek. The number of pods/plant significantly increased with NAA, gibberellic acid and salicylic acid. The maximum (104.1) pods/plant was recorded at 40 ppm NAA, followed by 30 ppm NAA (98.94), 20 ppm NAA (92.5), 120 ppm GA_3 (87.5) whereas, the minimum (55.6) number of pods/plant was observed in control. However, 40 ppm NAA produced 87.1 % number of pods/plant. The spraying of NAA prevents the dropping of buds, flowers and pods as well as rapid translocation of assimilates to growing parts which might have increased the number of pods/plant. The lower pod set by spraying of GA_3 might be due to diversion of the photoassimilates from reproductive structures toward the vegetative ones. These results are in conformity with findings of Bairva *et al.* (2012) in fenugreek and Parmar *et al.* (2011) in green gram. The increase in number of seeds/pod was observed in GA_3, followed by NAA and salicylic acid. The maximum (4.6) number of seeds/pod was observed in 120 ppm GA_3, followed by 80 ppm GA_3 (4.3), 40 ppm GA_3, whereas minimum (3.0) was counted in control. GA_3 at 120 ppm was statistically at par with GA_3 80 ppm and GA_3 40 ppm. The increase in number of seeds/pod by GA_3 might be due to cell divisions which accumulate dry matter in pod therefore, more number of seeds/pod were produced as compared to NAA and salicylic acid. Tasnim *et al.* (2019) also reported that application of 200 ppm GA_3 increased the number of seeds in mungbean. The maximum fresh pod yield was observed with NAA at 40 ppm (122.71 q ha^{-1}), followed by 30 ppm NAA (113.17 q ha^{-1}) while, the minimum (72.66 q ha^{-1}) fresh pod yield was reported in control The spraying of NAA encourages cell differentiation, absorption of nutrients thereby fosters the growth and flowers development, delays senescence, hampers flowers and pods drop that results into higher pod yield as reported by Kumar *et al.* (2020). The pod yield by GA_3 might be due to increasing vegetative growth which was its major role and thus making food reserves less available for developing pods, which significantly increased the fresh pod yield but not more than the NAA. The positive effect of salicylic acid on growth and yield can be attributed due to its influence on other plant hormones it altered the auxins, gibberellin cytokinins and ABA balances and increased the growth and yield under both normal and stress conditions. The fresh pod yield was remarkably increased by NAA than gibberellic acid and salicylic acid.

Economics

Among different plant growth regulators, the maximum net return and benefit cost ratio (Rs. 337326.5 ha^{-1}, 3.65) were observed with spraying of 40 ppm NAA, followed by 30 ppm NAA (Rs. 303993.7 ha^{-1}, 3.30) whereas, the lowest (Rs. 162382.5 ha^{-1}, 1.76) was noticed in control. This might be due to low price of NAA than SA and GA_3, which are costlier than NAA. These findings are in conformity with the findings obtained by Behera and Elamathi (2007) in green gram.

Table 2: Effect of Salicylic acid, NAA and GA_3 on yield and economics of broad bean

Treatments	Number of pods/plant	Number of seeds/pod	Fresh pod yield (q ha^{-1})	Net return (Rs ha^{-1})	B: C ratio
Control	55.6	3.0	72.66	162382.5	1.76
100 ppm SA	61.1	3.4	89.45	221063.5	2.61
150 ppm SA	66.1	3.5	91.98	229863.4	2.69
200 ppm SA	72.2	3.57	94.22	237664.0	2.78
20 ppm NAA	92.5	3.6	105.70	277908.5	3.01
30 ppm NAA	98.9	3.7	113.17	303993.7	3.30
40 ppm NAA	104.1	3.9	122.71	337326.5	3.65
40 ppm GA_3	79.1	4.1	96.18	241027.5	2.58
80 ppm GA_3	83.1	4.3	100.81	253557.5	2.51
120 ppm GA_3	87.5	4.6	105.09	264862.5	2.42
SEm ±	1.00	0.19	0.97	-	-
CD (P = 0.05)	2.90	0.57	2.90	-	-

It may be concluded from the investigation that spraying of salicylic Acid, NAA and GA_3 modulates the crop growth as well as yield and yield attributing characters. Among these plant growth regulators, spraying of 120 ppm GA_3 considerably increased the vegetative growth whereas 40 ppm NAA enhanced the pod yield and benefit: cost ratio over other treatments. Therefore, 40 ppm NAA may be recommended for sustainable cultivation of broad bean.

REFERENCES

Arif, Y., Sami, F., Siddiqui, H., Bajguz, A. and Hayat, S. (2020) Salicylic acid in relation to other phyto-hormones in plant: a study towards physiology and signal transduction under challenging environment. *Environmental and Experimental Botany* **10**: 40-45.

Bairva, M., Meena, S.S. and Mehta, R.S. (2012) Effect of bio-fertilizers and plant growth regulators on growth and yield of fenugreek (*Trigonella foenum-graecum* L.). *International Journal of Seed Spices* **2**(1): 28-33.

Behera, N. and Elamathi, S. (2007) Studies on the time of nitrogen, application of foliar spray of DAP, and growth regulator on yield attributes, yield and economics of green gram (*Vigna radiata* L.). *International Journal of Agricultural Sciences* **3**(1): 168-169.

Das, P.K., Sarangi, D., Jena, M.K. and Mohanty, S. (2012) Response of green gram (*Vigna radiata* L.) to integrated application of vermicompost and chemical fertilizer in acid lateritic soils. *Indian Agriculture* **46**(1): 79-87.

Fadhil, A.H. and Almasoody, M.M.M. (2019) Effect of spraying with gibberellic acid on growth and yield of three cultivars of broad bean (*Vicia faba* L.) *Indian Journal of Ecology* **46**(8): 85-89.

Foysalkabir, A., Islam, S., Quamruzzaman, M., Rashid, S.M.M., Yeasmin, M. and Islam, N. (2015) Effect of plant growth regulator and row spacing on mungbean. *Advances in Biological Research* **10**(4): 222-229.

Gomez, K.A. and Gomez, A.A. (1984) Statistical Procedures for Agricultural Research, Second Edd. John Wiley and Sons, New York.

Kumar, D., Chahar, S.S. and Singh, A.K. (2020) Effect of naphthalene acetic acid on yield attributes of cowpea cultivars. *Plant Archives* **20**(1): 1553-1556.

Parmar, V.K., Dudhatra, M.G. and Thesiya, N.M. (2011) Effect of growth regulators on yield of summer green gram. *Legume Research-An International Journal* **34**(1): 65-67.

Sharief, A.E. and Hamady, M.M. (2017) Influence of growth regulators on shedding of broad bean, growth, yield and seed quality. *International Journal of Environment, Agriculture and Biotechnology* **2**(2): 954-959.

Siddik, M.A., Islam, M.M., Hoque, M.A., Islam, S., Parvin, S. and Rabin, M.H. (2015) Morpho physiological and yield contributing characters of sesame with NAA. *Journal of Plant Sciences* **3**(6): 329-336.

Tasnim, S., Alam, M.J., Rahman, M.M., Islam, M.S. and Sikdar, M.S.I. (2019) Response of mung bean growth and yield to GA_3 rate and time of application. *Asian Journal of Crop* **1**(2): 28-36.

Vlot, A.C., Dempsey, D.A. and Klessig, D.F. (2009) Salicylic acid, a multifaceted hormone to combat disease. *Annual Review of Phytopathology* **47**: 177-206.