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Exogenous application of Brassinoide and salicylic acid enhances on growth, yield and nutritional quality of Indian bean (*Lablab purpureus* L. var. typicus)

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Abstract
The field experiment was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) during *kharif* season 2016-2017. The experiment consisting five bio-regulators (control, brassinoids @ 0.5 ppm, brassinoids @ 1.0 ppm, salicylic acid @ 100 ppm and salicylic acid @ 150 ppm) with three replications. The application of brassinoids 1.0 ppm to the Indian bean significantly increased the plant height (cm), number of branches per plant, dry matter accumulation, CGR at 45-60 and 60-75 days after sowing, chlorophyll content in leaves, leaf area, number of green pods per plant, average pod weight (g), green pod length (cm), number of pickings per plant, green pod yield per plant, green pod yield per plot, green pod yield (74.11 q/ha), and protein content as compared to control. Whereas, crude fibre content was found minimum with salicylic acid @ 150 ppm and found at par to brassinoids @ 1.0 ppm and 0.5 ppm. The application of brassinoids @ 1.0 ppm found significantly statistically best with net returns (₹ 67,752/ha) and highest B:C ratio (2.56).

Keywords: Brassinoids, growth, Indian bean, quality, salicylic acid and yield

Introduction
Indian bean or Dolichos bean (*Lablab purpureus* L. var. typicus) belongs to the family fabaceae (2n=22). It is a multipurpose crop grown for pulse, vegetable and forage. There are two type of cultivated species of Indian bean *viz*, *Lablab purpureus* var. typicus which is vegetable type, cultivated for its soft and edible pods and *Lablab purpureus* var. lignosus is the field bean, cultivated for dry seeds as pulse.

The pods of Indian bean are important source of protein, minerals and dietary fibre. Its mature dark coloured seeds contains trypsin inhibitor, which break down into water soluble cyanogenic. During cooking the purple coloured pods have a strong flavour, which disappears after cooking. The nutritional composition of edible green pods contain 86 percent moisture, 2 percent fibre, 4 percent protein, 7.10 percent carbohydrate, 48 Kcal energy, 68mg phosphorus, 1mg iron, 210mg Ca, 668 IU vitamin-A, 0.08mg thiamine, 0.11mg riboflavin, 0.75mg niacin and 9.3mg vitamin C (Gopalan *et al.*, 2004) [7].

The growth hormones and bio-regulators not only regulate the growth of plant species, which play an important role in root induction and growth of plants but also play important roles in DNA replication, cell division, controlling of microgenesis, senescence and resistant to environmental stresses (Kaur-Sawhney *et al*., 2003) [8].

Among the various bio-regulators, brassinolide is an important steroidal component obtained from pollen grains of *Brassica napus*. Brassinosteroids are considered as plant hormones with pleiotropic effects as they influence wide array of developmental processes such as seed germination, rhizogenesis, flowering and maturation (Sasse, 1999) [20]. Brassinosteroids improve the resistance power in the plants against environmental stresses *viz*., water stress, salinity stress, low and high temperature stress (Rao *et al*., 2002) [19] and crop productivity (Vardhini *et al*., 2006) [25].

Likewise, Salicylic acid (SA) is also an important substance which is classified as phenolic growth regulator, a non- enzymatic antioxidant, a signalling or messenger molecule to induce responses in the plants to environmental stress and plant defence against pathogens. Salicylic acid plays an important role in the regulation of some physiological processes in plants. It has also been found that SA positively affects growth and development, ion uptake, transport, photosynthesis, and membrane permeability in the plants (Simaei *et al*., 2012) [22].

Materials and Methods

The experiment was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) during *Kharif* season 2016-2017. In Rajasthan, this region falls under agro-climatic zone-IIIA (Semi-Arid Eastern Plains). The experiment was laid out in Randomized Block Design with five bio-regulators (control-B_0, brassinoids @ 0.5 ppm-B_1, brassinoids @ 1.0 ppm- B_2, salicylic acid @ 100 ppm-B_3 and salicylic acid @ 150 ppm B_4) with three replications. Bio-regulators was sprayed as foliar application at 30 and 45 DAS as per treatment combinations. Each plot measured 2.8 × 1.4 m^2 (4.32 m^2) area. The crop geometry was kept at 60 x 30 cm. All the cultural operations were followed which were necessary to raise the good crop. The observations like plant height (cm), number of branches per plant, dry matter accumulation (g/m), CGR at 45-60 and 60-75 (g/m^2/day) days after sowing, chlorophyll content in leaves (mg), leaf area (cm^2), number of green pods per plant, average pod weight (g), green pod length (cm), number of pickings per plant, green pod yield per plant (g), green pod yield per plot (kg), green pod yield per hectare (q), protein content and crude fibre content taken manually. CGR was calculated by Radford, 1967 [16] method. chlorophyll content was deterimented using the method of Arnon (1949) [3] with slight modifications. Nitrogen content in the green pods was estimated by using Nesselar's reagent by spectrophotometer method (Snell and Snell, 1949) [23], protein content in the pods was calculated by multiplying nitrogen concentration (%) by the factor 6.25 (A.O.A.C., 1960) [1]. Crude fibre content in pods was determined by the method suggested by A.O.A.C. (1960) [1].

The data obtained from the trial were subjected to statistical analysis and the results were documented, analysed and presented in tabular form.

Results and Discussion

An appraisal of data in table 1 and fig 1 reveals that growth parameters was significantly influenced by the application of different bio-regulators at different stages of Indian bean crop. The maximum plant height of (77.56 cm) at final harvesting stage, number of branches per plant **(**9.82) at 60 DAS, dry matter accumulation as 90.50 g, 161.72 g and 215 g at 45, 60 and 75 DAS, CGR (26.38) at 45 to 60 DAS and (19.73) at 60 to 75 DAS, total chlorophyll content in leaves (1.942 mg/g) and leaf area (3093 cm^2) at 60 DAS were recorded under treatment B_2 (Brassinoids @ 1.0 ppm) and minimum under control. The treatment B_2 where brassinoids @ 1.0 ppm was applied observed as significantly superior over control but remained statistically at par with treatment B_1 (Brassinoids @ 0.5 ppm), B_3 (Salicylic acid @ 100 ppm) and B_4 (Salicylic acid @ 150 ppm) in case of plant height, dry matter accumulation at 45, 60 and 75 DAS and CGR at 45 to 60 DAS and 60 to 75 DAS. However, treatment B_4 (Salicylic acid @ 150 ppm) remained statistically at par with treatment B_2 in case of leaf area.

This might be due to the stimulating effect of brassinosteroids in cell division and cell elongation. The reason can also be attributed to the synergistic effects of brassinosteroid with the available endogenous auxin as reported by Meudt *et al.,* (1983) [12]. The increase in growth attributes also supported by Vardhini and Rao (2001) [27]. Brassinolide promoted shoot growth and increased the shoot height of *Sportina patens* cultured callus (Lu *et al*., 2003) [16].

The increase in chlorophyll content by brassinoide treatment was reported in groundnut by Prakash *et al*., (2006) and by salicylic acid in soybean by Sharma and Kaur (2003) [8]. The increase in chlorophyll content was enhanced by these bio-regulators because the chlorophyllase enzyme which is responsible for chlorophyll depletion might have been inhibited leading to higher accumulation of chlorophyll (Paricha *et al.,* 1977) [14]. The increase in leaf area per plant with brassinoide treatment also revealed by Nakaseka and Yoshida (1989) [13], Prakash *et al.,* (2008) [15] and Choudhary (2017) [5]. The increase in laef area might be due to activities of meristematic tissues of plant, increase in number and size of cells, which ultimately increased photosynthetic surface area and vegetative growth of plants (Ramraj *et al.*, 1997) [18].

It is evident from data (Table 2 and Fig 1) that application of different bio-regulators significantly increased the yield and yield attributed. Total number of pods (38.63), average pod weight (3.44 g), pod length (8.35 cm), number of pickings (9.50), total green pod yield per plant (133.41g), total green pod yield per plot was recorded maximum (3.202 kg) and pod yield 74.11 q/ha were found maximum under treatment B_2 (Brassinoids @ 1.0 ppm) and minimum under control. The treatment B_1, B_3 and B_4 remained statistically at par with treatment B_2 for average pod weight, green pod length and number of pickings.

The foliar application of brassinoid increased yield and yield attributes at all levels on crop productivity and photosynthetic activity (Mona *et al*., 2011). These bio-regulators in general have to increase number of flowers as well as pods on the plants. The flower and pod drop may be reduced to same extent (Ramesh and Thirumuguran, 2001, Sangupta and Tamang, 2015 and Matwa *et al*., 2017) [17, 21, 11]. The increase in yield and yield attributes under foliar spray of brassinoids was also observed by Takemastsy *et al*., (1983) [24], Gograj Jat *et al.,* (2012) [6] and Choudhary (2017) [5].

A perusal of data presented in table 3 and fig 3 revealed that the application of bio-regulators significantly increased the protein content in green pods. The maximum protein content 3.30 per cent was recorded with the application of treatment B_2 (Brassinoids @ 1.0 ppm). The treatments B_1 (BR @ 0.5 ppm), and B_4 (SA @ 150 ppm) remained statistically at par with treatment B_2. It is evident from the data (Table 3) that the application of bio-regulators significantly reduced the crude fibre content in green pod. The minimum crude fibre content of 1.74 per cent was recorded in treatment B_4 (Salicylic acid @ 150 ppm) while maximum 1.95 per cent under control. However, treatment B4, B3 and B2 were found statistically at par to each other.

The increase in the protein content due to application of growth regulators may be attributed to their effect on biosynthetic pathways related to protein synthesis. Significant increase in protein content had been observed in the present investigation because of increased N concentration in green pods. Brassinoids were found to enhance the level of nucleic acid, soluble protein and carbohydrates (Vardhini and Rao 1998). The results were also in consonance with those of Vardhini and Rao (1998), Bera *et al*., (2006) [4], Maity and Bera (2009) and Choudhary (2017) [5].

It is also indicated that the higher net returns of green pod (₹ 67,752/ha) obtained under the treatment B_2 (Brassinoids @ 1.0 ppm) and higher B:C ratio (2.56) was obtained under treatment B_2 (Brassinoids @ 1.0 ppm).

Table 1: Effect of Bio-regulators on growth attributes of Indian bean

Treatment combinations	Characters				
	Plant height (cm) at final harvesting stage	Number of branches per plant at 60 DAS	Crop Dry Matter Accumulation (g/m row length) at 45 DAS	60 DAS	75 DAS
B_0	69.13	5.54	74.00	128.20	169.80
B_1	74.71	8.76	89.70	160.74	213.00
B_2	77.56	9.82	90.50	161.72	215.00
B_3	75.95	9.29	88.40	157.00	210.00
B_4	77.06	9.34	89.50	158.77	212.00
SEm±	1.11	0.13	1.17	2.07	2.78
CD at 0.05%	3.17	0.37	3.35	5.94	7.97

Table 2: Effect of Bio-regulators on growth of Indian bean

Treatment combinations	Characters			
	Total Chlorophyll (mg/g)	Leaf area (cm^2)	Crop Growth Rate (g/m^2/day) at	
			45 to 60 DAS	60 to 75 DAS
B_0	1.519	2483	20.07	15.41
B_1	1.859	2593	26.31	19.35
B_2	1.942	3093	26.38	19.73
B_3	1.810	2969	25.41	19.63
B_4	1.833	3056	25.66	19.71
SEm±	0.027	37	0.33	0.26
CD at 0.05%	1.519	2483	0.96	0.75

Table 3: Effect of Bio-regulators on yield attributes of Indian bean

Treatment combinations	Characters						
	Number of green pods/ plant	Average pod weight (g)	Green pod length (cm)	Number of pickings	Green Pod Yield		
					g/plant	kg/plot	q/ha
B_0	28.89	2.77	5.26	7.75	80.14	1.923	44.52
B_1	32.46	3.39	6.86	8.25	110.70	2.657	61.50
B_2	38.63	3.44	8.35	9.50	133.41	3.202	74.11
B_3	36.05	3.35	8.26	9.00	120.65	2.895	67.03
B_4	36.35	3.41	8.33	9.19	124.16	2.980	68.98
SEm±	0.74	0.07	0.07	0.17	2.31	0.055	1.28
CD at 0.05%	2.11	0.20	0.20	0.50	6.61	0.159	3.67

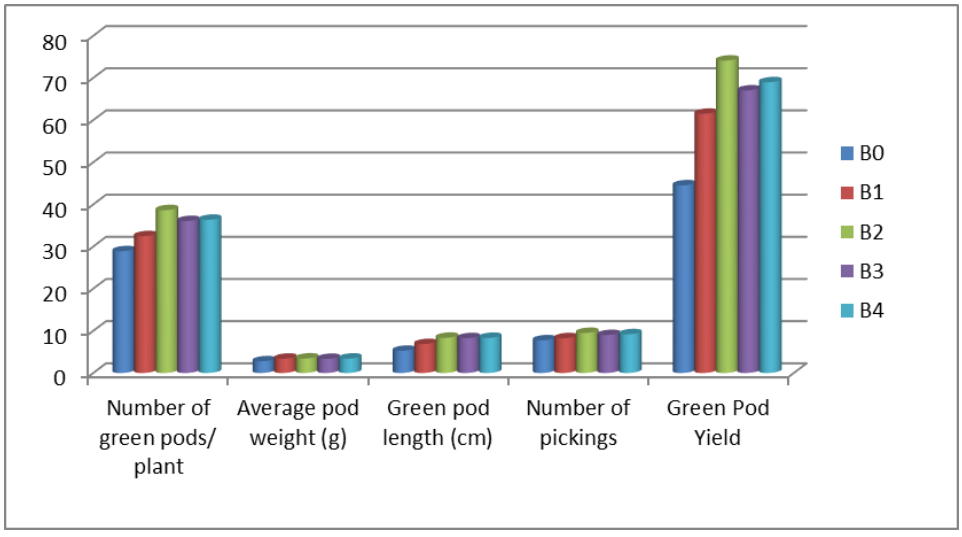

Fig 1: Effect of Bio-regulators on yield attributes of Indian bean

Table 4: Effect of Bio-regulators on quality and economic attributes of Indian bean

Treatment combinations	Characters			
	Protein content (%)	Crude fibre content (%)	Net Returns (□/ha)	B:C Ratio
B_0	2.25	1.95	23492	1.54
B_1	3.22	1.87	48892	2.13
B_2	3.30	1.84	67752	2.56
B_3	3.05	1.77	57073	2.31
B_4	3.12	1.74	59927	2.38
SEm±	0.07	0.04	1869	0.05
CD at 0.05%	0.20	0.11	5351	0.14

Conclusion

On the basis of one year experiment results, it may be concluded that the application of bio-regulator as brassinoids @ 1.0 ppm was found most suitable in terms of comparable green pod yield, Net returns and B:C ratio (74.11 q/ha, ₹ 67,752 and 2.56, respectively) being at par with brassinoids @ 0.5 ppm.

Thus, applications of brassinoids @ 0.5 ppm to Indian bean crop is recommended.

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