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FOLIAR APPLICATION OF CHITOSAN AND IBA IMPROVED MORPHO-PHYSIOLOGICAL ATTRIBUTES AND YIELD IN PIGEONPEA

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ABSTRACT

A study was planned to investigate the effect of foliar application of chitosan and IBA on morpho-physiological parameters and yield in pigeonpea at farm of Botany section, College of Agriculture, Nagpur during the *kharif* season of 2017-2018. The experiment was laid out in randomized block design with eleven treatments and three replications. The experiment comprised six levels of chitosan and IBA viz., 0 (control), 25, 50, 75,100 and 125 ppm.Spraying of chitosan and IBA applied at 45 and 65 DAS. Foliar sprays of 25 ppm IBA followed by 50 ppm chitosan significantly enhanced plant height, leaf area, dry matter, yield ha^{-1}and harvest index when compared with control and rest of the treatments under study. Considering the Benefit:Cost ratio 25 ppm IBA was found more economical having B:C ratio of 3.37 as compared to 2.72 in control.

(Key words: Pigeonpea, chitosan, IBA, foliar application, morpho-physiological parameters, yield)

INTRODUCTION

Pigeonpea (*Cajanus cajan* L.) is one of the most common tropical and subtropical legumes cultivated for its edible seeds. Pigeonpea is fast growing, hardy, widely adaptable, and drought resistant. Because of its drought resistance it can be considered of the utmost importance for food security in regions where rainfall is unreliable and droughts are prone to occur. The pod of *Cajanus cajan* is a flat, straight, pubescent pod, 5-9 cm long x 12-13 mm wide. It contains 2-9 seeds that are brown, red or black in colour, small and sometimes hard-coated.

The origin of pigeonpea (*Cajanus cajan*) is either North-Eastern Africa or India. Its cultivation dates back at least 3000 years .It is now a pantropical and subtropical species particularly suited for rainfed agriculture in semi-arid areas because of its deep tap root, heat tolerance and fast growing habit. Plant growth regulators are shown to change leaf resistance by altering stomatal aperture, the rate of photosynthesis could be manipulated through this technology. Chitosan and IBA are reported to increase and stimulate the rate of photosynthesis.In agriculture, chitosan is typically used as a natural seed treatment and plant growth enhancer. It is one of the most abundant biodegradable (Gooday, 1990) material in the world.

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IBA is a plant growth regulator, used to promote and accelerate root formation of plant clippings and to reduce transplant shock of non-food ornamental nursery stock. IBA is also used on fruit and vegetable crops, field crops and ornamental turf to promote growth and development of flowers and fruits and to increase crop yields. IBA has been classified as a biochemical pesticide because it is similar in structure and function to the naturally-occurring plant growth hormone indole-3-acetic acid.Considering the above fact present work was undertaken to study the response of chitosan and IBA on morpho-physiological parameters and yield of pigeonpea.

MATERIALS AND METHODS

Experiment was laid out in randomized block design with eleven treatments and three replications. Plot size of individual treatment was gross 4.20 m x 4.40 m and net 3.0 m x 4.0 m. Seeds were sown at the rate of 20 kg ha^{-1} by dibbling method at spacing of 60 cm x 20 cm on 1st July 2017. Treatments comprised of control (T_1), 25 ppm chitosan (T_2), 50 ppm chitosan (T_3), 75 ppm chitosan (T_4), 100 ppm chitosan (T_5), 125 ppm chitosan (T_6), 25 ppm IBA (T_7), 50 ppm IBA (T_8), 75 ppm IBA(T_9), 100 ppm IBA(T_{10}), 125 ppm IBA (T_{11}). The foliar application of chitosan and IBA was given at two stages i.e. at 45 and 65 DAS on pigeonpea. Observations on plant height, number of branches, leaf area plant^{-1}, total dry weight of plant were recorded at 45 , 65, 85 and 105 DAS and seed yield ha^{-1} were also recorded after harvesting. Per

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cent increase and B:C ratio were also calculated. The crop was kept free from disease and pest during the growth period. Harvesting was undertaken after the crop attained maturity. Data were analysed by statistical method suggested by Panse and Sukhatme (1954).

RESULTS AND DISCUSSION

Plant height

Data clearly indicate that at the time of harvesting significantly maximum plant height (228.15 cm) was recorded in treatment 25 ppm IBA (T_7) and minimum in control (T_1) . Considering eleven treatments under study it was noted that the treatments 50 ppm chitosan (T_3) , 50 ppm IBA (T_8) , 75 ppm chitosan (T_4), 75 ppm IBA (T_9) , 100 ppm chitosan (T_5) , 125 ppm chitosan (T_6), 125 ppm IBA (T_{10}) , 25 ppm chitosan (T_2) , 125 ppm IBA (T_{11}) were also found next to superior in a descending manner and significantly increased plant height over control (T_1) .

Chitosan increased the growth character viz; plant height. It might be due to increased number of internode or length of internode because of increased cell number (Hong Yan and Shu, 2001).Chibu *et al.* (2002) in rice reported that application of chitosan at early stages increased plant height.

IBA stimulate dry mass production through enhancement of cell division and chlorophyll accumulation and in turn reflected on the increase in vegetative growth (Amin *et al.*, 2007). This might be the reason for increase in plant height in the present investigation.

Number of branches plant^{-1}

Branches of a plant provide more area for the leaves to develop and capture more sunlight for photosynthesis. These branches then bear more flowers and pods. So, more number of branches is a desirable attribute for higher biomass production and yield.

The results revealed significant influence of different treatments. The number of branches varied from 11.16 to 17.82.The best results were obtained in treatments 25 ppm IBA (T_7) and 50 ppm chitosan (T_3). These treatments were found significantly superior in increasing number of branches over control and rest of the treatments, whereas treatments 50 ppm IBA (T_8) , 75 ppm chitosan (T_4) , 75 ppm IBA (T_9) , 100 ppm chitosan (T_5), 125 ppm chitosan (T_6) were next to these two superior treatments. But treatments 100 ppm IBA (T_{10}), 25 ppm chitosan (T_2), 125 ppm IBA (T_{11}) were found at par with control (T_1) in number of the branches plant^{-1}.

It is clear from above data that foliar application of growth promoters chitosan and IBA increased number of branches plant^{-1}. Similar results were obtained by many scientists.

Mondal *et al.* (2011) carried out the field experiment to study the effect of plant growth promoter on growth parameters and yield of Indian spinach. The results impacted that higher number of branches was registered due to foliar application of chitosan @ 75 ppm.

Amin *et al.* (2013) revealed the response of chickpea (*Cicerarietinum* L.) to treatment with two plant growth regulators putrescine and Indole-3-butyric acid (IBA) @ 25, 50 and 100 mg l^{-1} applied either alone or in combinations. Spraying of putrescine and IBA @ 100 mg l^{-1} significantly increased number of branches over control.

Leaf area plant^{-1}

Leaf area depends upon the number and size of leaves. Leaves play an important role in the absorption of light radiations and using it in photosynthetic process. Leaf size is influenced by light, moisture and nutrients. Hence, yield is depends on leaf area.

Data regarding leaf area were recorded at four growth stages viz., 45, 65, 85, and 105 DAS. Significant variation with gradual increase (45, 65, 85 and 105 DAS) was noticed regarding leaf area at all the stages of observations.

At 45 DAS leaf area plant^{-1} was significantly influenced by different treatments. The leaf area varied from 4.50-6.85 dm^2. At this stage the significantly best result was obtained in treatments 25 ppm IBA (T_7) and 50 ppm chitosan (T_3) . Next best treatments were 50 ppm IBA (T_8) , 75 ppm chitosan (T_4) , 75 ppm IBA (T_9) , 100 ppm chitosan (T_5), 125 ppm chitosan (T_6) , 100 ppm IBA (T_{10}), 25 ppm chitosan (T_2). But treatments 125 ppm IBA (T_{11}) was found at par with control (T_1) in leaf area at this stage of observation.

At 65 DAS leaf area plant^{-1} was significantly influenced by different treatments. The leaf area varied from 19.4-27.58 dm^2. At this stage the significantly best result were obtained in treatments 25 ppm IBA (T_7) and 50 ppm chitosan (T_3) . Treatments 50 ppm IBA (T_8) , 75 ppm chitosan (T_4) , 75 ppm IBA (T_9) , 100 ppm chitosan (T_5), and 125 ppm chitosan (T_6) were also enhanced leaf area significantly. But treatments 100 ppm IBA (T_{10}) , 25 ppm chitosan (T_2), 125 ppm IBA (T_{11}) were found at par with control (T_1) in leaf area plant^{-1}.

At 85 DAS three treatments viz., 25 ppm IBA (T_7) , 50 ppm chitosan (T_3) , 50 ppm IBA (T_8) were exerted hightest and had positive influence on leaf area which significantly surpassed over control and remaining treatments under study. Whereas treatments 75 ppm chitosan (T_4) , 75 ppm IBA (T_9) , 100 ppm chitosan (T_5), 125 ppm chitosan (T_6) , 100 ppm IBA (T_{10}) were found next to these three superiror treatments. But treatments 25 ppm chitosan (T_2) and 125 ppm IBA (T_{11}), were found at par with control (T_1) in leaf area plant^{-1}.

Observations recorded at 105 DAS indicated significant variations. Treatments 25 ppm IBA (T_7) ,50 ppm chitosan (T_3) , 50 ppm IBA (T_8) , 75 ppm chitosan (T_4) and 75 ppm IBA (T_9) were showed their superiority in leaf area over the control (T_1) and rest of the treatments under study. Next to these treatments significantly more leaf area was also recored in treatments 100 ppm chitosan (T_5), 125 ppm chitosan (T_6) and 100 ppm IBA (T_{10}). Treatments 25 ppm chitosan (T_2) and 125 ppm IBA (T_{11}) were found at par with control (T_1) in leaf area.

Hence, it can be inferred that when hormones applied through foliar spray, might have accelerated the metabolic and physiological activities of plant and put up more growth by assimilating more amount of major nutrients and ultimately increased leaf area of plant. This might be the reason for increase in leaf area by the application of chitosan and IBA.

Bideshki *et al*. (2013) conducted a field experiment to study the impact of 0 and 100 ppm indole-3-butyric acid (IBA) and 0, 0.1 and 0.5mM salicylic acid (SA) on garlic and reported that 0.5 mM salicylic acid and 100 ppm IBA significantly enhanced leaf area.

Rabbi *et al*. (2016) examined different concentrations of chitosan viz., 0 (control), 25, 50, 75 and 100 ppm at 30 and 40 DAS on mung bean plant. Results showed that foliar application of chitosan @ 50 ppm significantly enhanced plant leaf area over control.

Dry weight plant^{-1}

Total dry matter accumulation is one of the factor that determines economic yield in crop species. Leaf is the major organ where most of photosynthates are produced. The number of leaves, their arrangement on the main stem and side branches determine the structure of crop canopy which ultimately decides the dry matter production at each growth stage and its partitioning to reproductive organs during pre-flowering to maturity period has immense importance in determining the final productivity. The dry matter accumulation of individual plant was studied at each sampling i.e. 45, 65, 85, and 105 DAS.

At 45 DAS significantly hightest dry weight was obtained in treatments 25 ppm IBA (T_7), 50 ppm chitosan (T_3) and 50 ppm IBA (T_8). Similarly treatments 75 ppm chitosan (T_4) , 75 ppm IBA (T_9) , 100 ppm chitosan (T_5), 125 ppm chitosan (T_6), 100 ppm IBA (T_{10}) , 25 ppm chitosan (T_2) and 125 ppm IBA (T_{11}) were also significantly surpassed treatment control significantly in dry weight.

At 65 DAS significantly hightest dry matter was accumulated in treatments 25 ppm IBA (T_7) and 50 ppm chitosan (T_3), whereas treatments 50 ppm IBA (T_8) ,75 ppm chitosan (T_4) , 75 ppm IBA (T_9), 100 ppm chitosan (T_5) , 125 ppm chitosan (T_6) , 100 ppm IBA (T_{10}), 25 ppm chitosan (T_2), 125 ppm IBA (T_{11}) also registered significantly more dry matter over control (T_1) .

Data clearly indicate that at 85 DAS the range of dry matter production was 167.09 – 310.02 g . The highest dry matter production was noticed in treatment 25 ppm IBA (T_7), the next best treatments were 50 ppm chitosan (T_3), 50 ppm IBA (T_8) , 75 ppm chitosan (T_4) and 75 ppm IBA (T_9),100 ppm chitosan (T_5), 125 ppm chitosan (T_6) , 100 ppm IBA (T_{10}) and 25 ppm chitosan (T_2) . These treatments were also increased dry matter significantly over control (T_1).

At 105 DAS it may be seen that foliar application of 25 ppm IBA (T_7) , 50 ppm chitosan (T_3) , 50 ppm IBA (T_8) and 75 ppm chitosan (T_4) exhibited significantly higher dry matter . Similarly treatments 75 ppm IBA (T_9), 100 ppm chitosan (T_5) , 125 ppm chitosan (T_6), 100 ppm IBA (T_{10}) and 25 ppm chitosan (T_2) were found next to above three superiror treatments. These five treatments also significantly enhanced dry matter. But treatment 125 ppm IBA (T_{11}) was found at par with control (T_1) .

Shraiy and Hegazi (2009) studied the effect of acetyl salicylic acid (ASA) @ 10 and 20 ppm, indole-3-bytric acid (IBA) @ 50 and 100 ppm and gibberellic acid (GA) @ 50 and 100 ppm on pea (*Pisum sativum* L.). Application of ASA and IBA at 25 and 35 DAS significantly enhanced dry weight.

Mondal *et al.* (2013) carried out field experiment to investigate the effect of chitosan on mungbean plant. Five concentrations of chitosan viz., 0, 25, 50, 75 and 100 ppm were applied twice at 25 and 35 DAS. Results showed that 50 ppm chitosan enhanced dry weight of plant.

Seed yield

Seed yield is the economic yield which is final result of physiological activities of plant. Economic yield is the part of biomass that is converted into economic product. (Nichiporovic, 1960).

Seed yield is influenced by morphophysiological parameters such as plant height, total dry matter production, leaf area, number of pods plant^{-1} and test weight which are considered as yield contributing parameters. Seed yield ha^{-1} is combined effect of yield attributing characters and physiological efficiency of plant during the present investigation.

Seed yield and its related parameters were influenced by the application of different growth regulators in pigeonpea which indicated that these chemicals have differential influence on the allocation of assimilates between vegetative and reproductive organs. In general, crop yield depends on the accumulation of photo-assimilates during the growing period and the way they are partitioned between desired storage organs of plant.

The significantly maximum seed yield hectare^{-1}was recorded in treatment 25 ppm IBA (T_7) followed by treatments 50 ppm chitosan (T_3) , 50 ppm IBA (T_8) , 75 ppm chitosan (T_4), 75 ppm IBA (T_9) and 100 ppm chitosan (T_5) . Remaining treatments 125 ppm chitosan (T_6) , 100 ppm IBA (T_{10}) , 25 ppm chitosan (T_2) and 125 ppm IBA (T_{11}) were found at par with control (T_1) .

Plant growth regulators are known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates thereby helping in effective flower formation, fruit and seed development and ultimately enhance productivity of the crops. Growth regulators can improve the physiological efficiency including photosynthetic ability and enhance the effective partitioning of accumulates from source and sink in the field crops (Solamani *et al*., 2001).

Table 1. Effect of chitosan and IBA on growth and yield of pigeonpea

Treatments	Plant height (cm)	Number of branches plant^{-1}	Leaf area plant^{-1} (dm^2)				Total dry weight plant^{-1} (g)				Seed yield ha^{-1}	Harvest index	B:C ratio
			45 DAS	65 DAS	85 DAS	105 DAS	45 DAS	65 DAS	85 DAS	105 DAS			
T_1 (Control)	178.52	11.16	4.50	19.40	32.19	57.36	4.58	20.71	167.09	203.94	10.70	20.77	2.72
T_2 (25 ppm Chitosan)	189.58	11.90	5.25	20.17	39.56	63.60	5.59	28.38	207.41	263.99	11.57	25.16	2.73
T_3 (50 ppm Chitosan)	217.91	17.06	6.68	26.60	45.11	78.20	6.49	46.61	291.79	379.12	14.58	29.09	3.21
T_4 (75 ppm Chitosan)	205.64	14.44	5.90	25.04	43.14	75.15	6.25	38.93	247.62	365.43	12.82	27.23	2.64
T_5 (100 ppm Chitosan)	199.92	12.53	5.49	23.71	41.92	69.03	6.16	36.78	229.62	332.17	12.37	25.67	2.39
T_6 (125 ppm Chitosan)	198.74	12.46	5.44	22.70	41.83	67.15	5.84	34.32	227.03	271.95	12.22	25.16	2.24
T_7 (25 ppm IBA)	228.15	17.82	6.85	27.58	46.19	78.55	6.71	47.47	310.02	384.02	14.90	32.95	3.37
T_8 (50 ppm IBA)	215.63	14.63	6.25	25.22	43.94	75.90	6.36	41.40	248.29	375.55	13.47	28.99	2.74
T_9 (75 ppm IBA)	202.50	14.11	5.74	24.12	42.62	72.93	6.18	38.56	231.91	352.78	12.65	27.17	2.34
T_{10} (100 ppm IBA)	197.50	12.06	5.42	20.44	40.93	66.73	5.66	31.46	224.97	264.74	11.81	23.19	2.00
T_{11} (125 ppm IBA)	188.61	11.24	4.51	20.12	38.90	61.17	5.41	28.33	177.58	230.19	10.85	21.90	1.70
SE (m) ±	1.614	0.317	0.178	0.442	0.801	2.078	0.137	1.611	4.655	9.065	0.544	0.706	-
CD at 5%	4.761	0.937	0.528	1.306	2.365	6.130	0.404	4.752	13.732	26.742	1.558	2.084	-

Amin *et al*. (2013) studied the effect of two plant growth regulators putrescine and Indole-3-butyric acid (IBA) @ 25, 50 and 100 mg l^{-1} applied either alone or in combinations. Spraying of putrescine and IBA @ 100 mg l^{-1} significantly increased seed yield of chickpea (*Cicer arientinum* L.).

Rabbi *et al*. (2016) formulated an experiment to study the effect of chitosan (0, 25, 50, 75 and 100 ppm) on mungbean sprayed at 30 and 40 DAS. Results showed that application of chitosan @ 50 ppm significantly enhanced seed yield.

Harvest index (HI)

The highest harvest index was recorded in treatment 25 ppm IBA (T_7) followed by treatments 50 ppm chitosan (T_3) , 50 ppm IBA (T_8), 75 ppm chitosan (T_4), 75 ppm IBA (T_9), 100 ppm chitosan (T_5) , 125 ppm chitosan (T_6) and 100 ppm IBA (T_{10}) . Rest of the treatments viz., treatments 25 ppm chitosan (T_2) and 125 ppm IBA (T_{11}) were found at par with control (T_1) in harvest index.

Harvest index is the proportion of biological yield represented by economic yield. It is the coefficient of effectiveness or migration coefficient. Harvest index reflects the proportion of assimilate distribution between the economic and total biomass (Donald and Hamblin, 1976). Increase in harvest index might be the result of co-ordinated interplay of growth and development characters.

The analysis of B:C ratio due to expenditure incurred under different treatments of chitosan and IBA revealed that highest benefit : cost ratio was calculated in treatment (T_7) 25 ppm IBA (3.37) followed by treatment (T_3) 50 ppm chitosan (3.21) as compared to control (2.72).

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