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INFLUENCE OF PUTRESCINE AND IBA ON MORPHO-PHYSIOLOGICAL PARAMETERS AND YIELD OF BLACK GRAM

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ABSTRACT

Field experiment was undertaken at farm of Botany section College of agriculture, Nagpur, during *kharif* 2017-2018 to study the influence of two foliar sprays of 25, 50, 75 and 100 ppm putrecine and IBA alone with water spray (control)on morpho-physiological parameters and yield of black gram. Data revealed that treatments 100 ppm IBA and putrescine significantly increased plant height, number of branches plant^{-1} leaf area, dry weight, RGR, NAR, seed yield ha^{-1} and harvest index. But considering the Benefit : Cost ratio two foliar sprays of 25 ppm IBA at 25 and 40 DAS was found more effective and economical with increased yield of 30.47% having B:C ratio of 2.97 as compared to 2.54 in control.
(Key words: Black gram, IBA, foliar application, morpho-physiological parameters, yield)

INTRODUCTION

Black gram (*Vigna mungo* L. Hepper) crops play an important role in Indian agriculture.It is annual herbaceous plant attaining a height of 30 to 100 cm. Black gram belong to family *"Leguminaceae"* and sub-family *"Papilionaceae"* having chromosome number 2n=22. It also known as "Mash bean".

Black gram is grown in several parts of Asia and Africa. Bangladesh, Myanmar, Pakistan, Indonesia, Ceylon and China. In India black gram contributes 13% in total pulses area and 10% in total pulse production In India.

Black gram plays an important role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. It is a drought resistant crop and suitable for dry land farming and predominantly used as an intercrop with other crops.

Growth mainly refers to quantitative increase in the plant body whereas, the diamine putrescine occurred widely in the higher plants. It was suggested to be involved in a variety of growth and developmental processes such as cell division (Bueno and Matilla., 1992), fruit set and growth (Biasi e*t al*., 1991) and senescence (Kao, 1994). 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 development of flowers and fruit 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.

This experiment aimed to investigate the effect of foliar applications of putrescine and IBA on morpho-physiological parameters and yield of black gram.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* season of 2017-18 at experimental farm of Agricultural Botany Section, College of Agriculture, Nagpur with the object to know the influence of foliar sprays of growth regulators on morpho- physiological parameters and yield of black gram. This experiment was carried out in RBD with 3 replications(Table 1). Two foliar sprays of growth regulators individually were given as per treatments (Table 1) at 25 and 40 DAS.TAU-1 cultivar of black gram was used in the experiment. Observations on plant height and number of branches were recorded at the time of maturity. Leaf area and dry weight of plant were recorded at 25, 40 and 55 DAS RGR and NAR were also calculated at 25-40 and 40-55 DAS. Seed yield ha^{-1}were recorded. Harvest index was also calculated.The observed data were analyzed statistically using analysis of variance at 5% level of significance (Panse and Sukhamate, 1967).

RESULTS AND DISCUSSION

Plant height

Plant height is important and visible measure of plant growth. Plant height is a function of internode elongation and leaf emergence.Plant height was recorded at maturity. Leaves are born on stem, leaf area development and biomass production shows a close relationship with plant height.

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Plant height varied among the treatments. Foliar application of growth regulators significantly increased the plant height which varied a minimum height of 43.83 cm in control (T_1) to a maximum of 49.95 cm in 100 ppm IBA(T_9) treatment. Foliar application of 100 ppm IBA (T_9) registered the highest plant height followed by foliar application of 100 ppm putrescine (T_5), 75 ppm IBA (T_8), 75 ppm putrescine (T_4), 50 ppm IBA (T_7), 50 ppm putrescine (T_3), 25 ppm IBA (T_6) when compared with treatment control and 25 ppm putrescine (T_2). While, application of 25 ppm putrescine (T_2) was also increased plant height significantly over control treatment.

Pandey *et al*. (2017) cunducted field experiment to determine the effect of foliar application of growth regulators on maize. Results indicated that foliar application of 100 ppm putrescine and 100 ppm IBA significantly increased plant height over control.

Number of secondary branches plant^{-1}

Branches are the sites of the leaves, flowers, and pod formation. Hence, they are closely associated with the photosynthetic activity and yield of plant. So, more number of branches is a desirable attribute for higher biomass production and yield.

Application of growth regulators as foliar spray significantly increased number of secondary branches plant^{-1} as recorded at maturity. Minimum number of secondary branches plant^{-1} (3.63) was recorded in control and the maximum number of secondary branches plant^{-1} (5.73) was recorded in 100 ppm IBA followed by treatments T_5 (100 ppm putrescine) and T_8 (75 ppm IBA) when compared with treatment control and rest of the treatments under study. Similarly, foliar application of 75 ppm Putrescine (T_4) and 50 ppm IBA (T_7) were also increased secondary branches significantly over treatment control. But treatments T_3 (50 ppm putrescine), T_6 (25 ppm IBA) and T_2 (25 ppm putrescine) were found at par with treatment control.

Leaf area plant^{-1}

Leaf area depends upon the light, moisture, nutrients availability and photosynthetic capacity of the plant. It plays a key role in absorption of radiation in the deposition of photosynthates during the diurnal and seasonal cycles and in the path ways and rates of biochemical cycling within the canopy soil system. Development of leaf area is a decisive factor for yield of the particular crop.

Data revealed that the leaf area increased from 25 to 55 DAS. The data regarding leaf area at 25 DAS was found non significant because foliar sprays of growth regulators were given from this stage (25 DAS).

Leaf area (dm^2) increased significantly due to foliar application of growth regulators which was ranged a minimum of 6.29 in treatment control (T_1) to a maximum of 7.47 in treatment 100 ppm IBA (T_9) at 40 DAS and 10.44 in treatment control (T_1) to 12.47 in treatment 100 ppm IBA (T_9) at 55 DAS. At both the stages (40 and 55 DAS) significantly the highest leaf area was recorded in plants sprayed with 100 ppm IBA (T_9) followed by application of 100 ppm putrescine(T_5) and 75 ppm IBA (T_8) when compared with control and rest of the treatments under study. But foliar application of 75 ppm putrescine(T_4), 50 ppm IBA (T_7), 50 ppm putrescine(T_3), 25 ppm IBA (T_6) and 25 ppm putrescine(T_2) were found at par with treatment control in leaf area.

Wagh (2015) recorded that of two foliar sprays (30 and 45 DAS) of putrescine and IBA @ 100 ppm significantly increased leaf area in soybean.

Dry matter plant^{-1}

Data regarding dry matter accumulation were recorded at 25, 40, and 55 DAS. Data revealed that there was concomitant increase in dry matter accumulation till 55 DAS.

Significantly the highest accumulation of dry matter was recorded at 40 DAS in plant applied with foliar spray of growth regulators. Significantly maximum dry matter was noticed in 100 ppm IBA (T_9) followed by 100 ppm putrescine (T_5), 75 ppm IBA (T_8), 75 ppm putrescine(T_4) and 50 ppm IBA (T_7) when compared with treatment control and remaining treatments under study. But foliar application of 50 ppm putrescine (T_3), 25 ppm IBA (T_6) and 25 ppm putrescine (T_2) were found at par with treatment control in respect to total dry matter production.

At 55 DAS significantly maximum dry matter was recorded by the application of 100 ppm IBA (T_9) followed by the 100 ppm putrescine (T_5), 75 ppm IBA (T_8), 75 ppm putrescine (T_4), 50 ppm IBA (T_7), and 50 ppm putrescine (T_3) when compared with treatment control and remaining treatments under study. Application of 25 ppm IBA (T_6) and 25 ppm putrescine (T_2)were found at par with treatment control.

It was suggested that putrescine improves the photosynthetic rate and stomatal conductance and putrescine also seems to be helpful in ameliorate the negative effect of K^+ and Cl^- on photosynthesis by reducing uptake of these two and improvement in concentration of K^+ and Ca^{+2} ions. Putrescine (polyamines) application implied that they could act as a growth promoter (Mirza and Bagni, 1991). Similarly, dry matter production by the application of IBA might be due to enhancement of cell division and chlorophyll accumulation (Amin *et al*., 2007). This might be the reasons for increase in dry weight of black gram plants due to application of putrescine and IBA in the present investigation.

Shraiy and Hegazi (2009) explained the effect of acetylsalicylic acid (ASA) @ 10 and 20 ppm, indole-3-butyric 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.

Growth analysis

Growth analysis is one of the measures for accessing the seed yield of plant. The physiological basis of yield difference can measured through an evaluation of difference in growth parameters and their impact on yield. The productivity of crop may be related with the parameters such as RGR, NAR and partitioning of total photosynthates into economic and non-economic sink.

Relative Growth Rate

The highest rate of RGR indicates the ability of maximum dry matter for development. The increment in RGR might be associated with maximum leaf area expansion and growth of stem and root. Increment in NAR is related with the increase in total dry weight of plant unit^{-1} of leaf area.

Relative growth rate (RGR) at 25-40 DAS and 40-55 DAS increased with the foliar spray of most of the growth regulator treatments over control. Maximum and significant increase was recorded by 100 ppm IBA at both stages of growth, Next to this treatment the treatments were T_5 (100 ppm putrescine), T_8 (75 ppm IBA), T_4 (75 ppm putrescine), T_7 (50 ppm IBA), and T_3 (50 ppm putrescine) when compared with treatment T_1 (control) and remaining treatments under study. While treatments T_6 (25 ppm IBA) and T_2 (25 ppm putrescine) were found at par with treatment T_1 (control). At first stage i.e. 25-40 DAS range of RGR was 0.0247–0.0348 g g^{-1} day^{-1} and at second stage i.e. 40-55 DAS range of RGR was 0.0624-0.0739 g g^{-1} day^{-1}.

Net Assimilation Rate

Net assimilation rate (NAR), synonymously called as unit leaf rate expresses the rate of dry weight increase at any instant on a leaf area basis with leaf representing an estimate of the size of the assimilatory surface area (Gregory, 1926). Increase in NAR during reproductive phase might be due to increase efficiency of leaves for photosynthesis as a response to photosynthetic apparatus to increase demand for assimilates by growing seed fraction and also due to photosynthetic contribution by pod and sink demand on photosynthetic rate of leaves.

Net assimilation rate (NAR) significantly influenced by foliar application of growth regulators. The significant increase in NAR over control was observed in case of foliar spray of all the growth regulators treatments except treatments T_6 (25 ppm IBA) and T_2 (25 ppm putrescine) which were at par with control (T_1) in NAR. The highest NAR was recorded in treatment T_9 (100 ppm IBA) followed by treatments T_5 (100 ppm putrescine), T_8 (75 ppm IBA),T_4 (75 ppm putrescine), T_7 (50 ppm IBA), and T_3 (50 ppm putrescine) when compared with treatment T_1 (control). As per the observations at first stage i.e. 25-40 DAS range of NAR recorded was 0.0271-0.0348 g dm^{-2} day^{-1} and at second stage i.e. 40-55 DAS range of NAR recorded was 0.0716-0.0864 g dm^{-2} day^{-1}.

Wagh (2015) executed an experiment to study the effect of two foliar sprays (30 and 45 DAS) of putrescine and IBA on soybean. He reported that two foliar sprays of putrescine and IBA @ 100 ppm significantly increased RGR and NAR.

Seed yield ha^{-1}

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). Data regarding yield are presented in table 2 .

Seed yield is influenced by morpho-physiological parameters such as plant height, total dry matter production, leaf area, number of secondary branches plant^{-1}, number of pods plant^{-1} and 100 seed weight which are considered as yield contributing parameters. Seed yield plant^{-1}, plot^{-1} and ha^{-1} are combined effect of yield attributing characters and physiological efficiency of plant during the present investigation.

Source-sink relation contributes to the seed / grain yield. It includes phloem loading at source (leaf) and unloading at sink (seed and fruit) by which the economic part will be getting the assimilates synthesized by photosynthesis. Partitioning of the assimilate in the plant during reproductive development is important for flower, fruit and seeds. Thus, crop yield can be increased either by increasing the total dry matter production or by increasing the proportion of economic yield (harvest index) or both (Gardner *et al*., 1988).

The highest seed yield of 13.49 q ha^{-1}was obtained by the treatment T_9 (100 ppm IBA) which registered 52.25% higher seed yield over control (8.86 q ha^{-1}).Treatments T_5 (100 ppm putrescine), T_8 (75 ppm IBA),T_4 (75 ppm putrescine), T_7 (50 ppm IBA), T_3 (50 ppm putrescine), T_6 (25 ppm IBA) and T_2 (25 ppm putrescine) in a descending manner also enhanced seed yield ha^{-1}significantly over control.

Amin *et al*. (2013) explained 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 number of pods, seed yield, straw and biological yield feed^{-1} of chickpea (*Cicer arientinum*).

Harvest index

Data were found statistically significant. Significantly maximum harvest index was recorded in treatment T_9 (100 ppm IBA) and minimum in control (T_1). The range of increased harvest index was 33.09% in treatment T_9 (100 ppm IBA) when compared to control (T_1) 28.76%.

Harvest index was also significantly increased in treatment receiving 100 ppm IBA (T_9) followed by treatments T_5 (100 ppm putrescine), T_8 (75 ppm IBA) and T_4 (75 ppm putrescine) when compared with treatment T_1 (control) and remaining treatments under study. Treatments T_7 (50 ppm IBA), T_3 (50 ppm putrescine), T_6 (25 ppm IBA) and T_2 (25 ppm putrescine) were found at par with treatment T_1 (control).

Pinkey *et al.* (2016) laid out a field experiment to study the effect of putrescine on wheat. The result exhibit

Table 1.Effect of putrescine and IBA on plant height plant^{-1}, number of branches plant^{-1}, leaf area (dm^2) and dry matter plant^{-1} (g) in black gram

Treatments	Plant height (cm)	Number of secondary branches plant	Leaf area (dm^2)			Dry matter plant^{-1} (g)		
			25 DAS	40 DAS	55 DAS	25 DAS	40 DAS	55 DAS
T_1 (Control)	43.83	3.63	2.81	6.29	10.44	3.91	5.67	14.47
T_2 (25 ppm putrescine)	47.60	3.80	2.85	6.38	10.59	3.86	5.70	14.90
T_3 (50 ppm putrescine)	48.45	4.40	2.87	6.57	11.10	3.67	5.87	16.87
T_4 (75 ppm putrescine)	49.20	4.60	2.91	6.87	11.67	3.72	6.05	17.70
T_5 (100 ppm putrescine)	49.80	5.26	2.85	7.12	12.22	3.70	6.14	18.34
T_6 (25 ppm IBA)	48.10	4.10	2.82	6.48	10.98	3.89	5.83	15.53
T_7 (50 ppm IBA)	48.70	4.55	2.88	6.75	11.61	3.68	5.98	17.48
T_8 (75 ppm IBA)	49.35	4.80	2.95	6.98	11.87	3.74	6.11	17.96
T_9 (100 ppm IBA)	49.95	5.73	2.92	7.47	12.47	3.69	6.22	18.87
SE(M) ±	0.73	0.28	0.18	0.24	0.23	0.24	0.09	0.79
CD at 5%	2.18	0.83	-	0.71	0.68	-	0.26	2.36

Table 2.Effect putrescine and IBA on RGR and NAR seed yield ha^{-1}, per cent increase in yield, B:C ratio and harvest index in black gram

Treatments	RGR (g g^{-1} day^{-1})		NAR (g dm^{-2} day^{-1})		Seed yield ha^{-1} (g)	Per cent increase	B:C ratio	Harvest index
	40-25 DAS	55-40 DAS	40-25 DAS	55-40 DAS				
T_1 (Control)	0.0247	0.0624	0.0271	0.0716	8.86	-	2.54	28.76
T_2 (25 ppm putrescine)	0.0259	0.0640	0.0279	0.0738	10.89	22.91	2.37	29.12
T_3 (50 ppm putrescine)	0.0313	0.0703	0.0328	0.0848	12.06	36.11	2.11	30.37
T_4 (75 ppm putrescine)	0.0324	0.0715	0.0336	0.0857	12.63	42.50	1.85	31.84
T_5 (100 ppm putrescine)	0.0337	0.0729	0.0348	0.0861	13.43	51.58	1.69	32.96
T_6 (25 ppm IBA)	0.0269	0.0653	0.0293	0.0757	11.56	30.47	2.97	29.87
T_7 (50 ppm IBA)	0.0323	0.0715	0.0335	0.0855	12.29	38.71	2.86	31.12
T_8 (75 ppm IBA)	0.0327	0.0718	0.0337	0.0857	12.83	44.80	2.73	32.29
T_9 (100 ppm IBA)	0.0348	0.0739	0.0348	0.0864	13.49	52.25	2.64	33.09
SE(M) ±	0.0017	0.0016	0.0015	0.0019	0.56	-	-	0.87
CD at 5%	0.0050	0.0047	0.0044	0.0056	1.67	-	-	2.60

that foliar application of putrescine @ 100 ppm significantly increased grain, straw and biological yield.

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.

Considering the B:C ratio it is inferred that, spraying plants at vegetative stage (25 and 40 DAS) with 25 ppm IBA (2.97) could be considered as the most suitable time and most suitable concentration to expect promising improvement regarding the growth parameters, physiological characters and of black gram.

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