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Effect of homobrassinolide on biochemical, yield and yield contributing parameters of black gram

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Abstract
A field experiment was conducted during the *kharif* seasons of 2021 at farm of Botany section, College of Agriculture, Nagpur. The experiment was laid out in randomized block design and replicated thrice consisting eleven treatments i. e. Homobrassinolide (0.10 ppm, 0.20 ppm, 0.30 ppm, 0.40 ppm, 0.50 ppm, 0.60 ppm, 0.70 ppm, 0.80 ppm, 0.90 ppm and 1.00 ppm) Results revealed that foliar application of homobrassinolide sprayed at two stages i. e. 20 and 40 DAS significantly improved biochemical parameters like nitrogen content in leaves, protein content in seed, total chlorophyll content in leaves, and yield parameters like number of pods plant-1, test weight, seed yield plant^{-1}, plot^{-1} and hectare^{-1}, harvest index and B:C ratio. Treatment T_{11} (Homobrassinolide @ 1.00 ppm) gave significantly higher results in all parameters under study.

Keywords: Black gram, homobrassinolide, biochemical parameters, yield contributing parameters

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 has originated from Indian sub-continent.

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. Higher yield and crop quality of black gram may be obtained through physiological manipulation such as foliar application of homobrassinolide

The grain of black gram is superior in nutritive value, black gram contain about 24% proteins, 60% carbohydrate, 1.4% fat, 347 Kcal energy, 3.2% minerals, 385 mg 100 g-1 phosphoric acid and 16.2% total dietory fibre. Black gram rich in minerals like zinc, cadmium and also rich in vitamins like thiamine, riboflavin and niacin. High values of lysine make black gram an excellent complement to rice in terms of balanced human nutrition (Anonymous, 2020) [1].

Brassinosteroid can induce plant tolerance to abiotic stresses such as high temperature, low temperature, drought, salinity and heavy metals. It has a positive contribution to the cellular, biochemical, physiological and morphological processes of higher plants, especially affecting cell division, antioxidant metabolism, gas exchange and the plant growth rate.

Homobrassinolide imparts stress resistance by increased proline production under adverse environmental conditions inducing flowering and increasing fruit set and fruit growth and so on, over other commonly available brassinosteroids (Bajguz, 2000) [3]. Brassinosteriods improve the resistance power in the plants against environmental stresses such as water stress, salinity stress, low and high temperature stress and crop productivity (Rao *et al*., 2002) [13] whereas, (Fariduddin *et al*. 2014) [4] also reported that the potential application of brassinosteroid BRs in agriculture to improve growth and yield under various stress conditions including drought, salinity, extreme temperatures, and heavy metal (Cd, Cu, Al and Ni) toxicity, is of immense significance as these stresses severly hamper the normal metabolism of plant. BR regulate antioxidant enzyme activities, chlorophyll contents, photosynthetic capacity, and carbohydrate metabolism to increase plant growth under stress. Mutants with BR defects have shortened root and shoot developments. Exogenous BR application increases the biosynthesis of endogenous hormones such as indole-3-acetic acid, abscisic acid, jasmonic acid, zeatin riboside, brassinosteroids (BR), and isopentenyl adenosine, and gibberellin (GA) and regulates signal transduction pathways to stimulate stress tolerance (Anwar *et al*., 2018) [2].

Materials and Methods

A field experiment was conducted during the kharif seasons of 2021 at farm of Botany section, College of Agriculture, Nagpur asses the effect of foliar sprays of homobrassinolide on growth and yield of black gram. The experiment was laid out in randomized block design and replicated thrice consisting eleven treatments i. e. T_1 (control), T_2 (Homobrassinolide @ 0.10 ppm), T_3 (Homobrassinolide @ 0.20 ppm), T_4 (Homobrassinolide 0.30 @ ppm), T_5 (Homobrassinolide @ 0.40 ppm), T_6 (Homobrassinolide 0.50 @ ppm), T_7 (Homobrassinolide @ 0.60 ppm), T8 (Homobrassinolide @ 0.70 ppm), T_9 (Homobrassinolide @ 0.80 ppm), T_{10} (Homobrassinolide @ 0.90 ppm) and T_{11} (Homobrassinolide @ 1.00 ppm). The foliar application of homobrassinolide was given at two stages i. e. at 20 and 40 DAS on black gram. The observation nitrogen content in leaves, protein content in seed, total chlorophyll content in leaves were recorded at 30, 50 and 70 DAS. Also, yield and yield contributing attributes viz., number of pod plant^{-1}, seed yield ha^{-1}, test weight, harvest index and B:C ratio were recorded at harvest. Data were analysed by statistical method suggested by Panse and Sukhatme (1954) [12].

Results and Discussion

Nitrogen content in leaves

It is observed from the data that there was significant variation in leaf nitrogen due to foliar sprays at various concentrations of homobrassinolide at 30, 50 and 70 DAS. (Table 1)

At 30 DAS leaf nitrogen was recorded from 3.96-5.01%. Significantly highest N content was found in T_{11} (Homobrassinolide @ 1.00 ppm). However, it was at par with treatments T_{10} (Homobrassinolide @ 0.90 ppm), T_9 (Homobrassinolide @ 0.80 ppm), T_8 (Homobrassinolide @ 0.70 ppm) and T_7 (Homobrassinolide @ 0.60 ppm). These treatments of homobrassinolide was found superior to N content when compared with treatment T_1 (control) and rest of the treatments.

At 50 and 70 DAS leaf nitrogen was ranged from 4.69-7.16% and 3.61- 5.16% respectively. At these stages significantly highest N content was found in T_{11} (Homobrassinolide @ 1.00 ppm). However, it was at par with treatments T_{10} (Homobrassinolide @ 0.90 ppm), T_9 (Homobrassinolide @ 0.80 ppm), T_8 (Homobrassinolide @ 0.70 ppm) and T_7 (Homobrassinolide @ 0.60 ppm). These treatments of homobrassinolide was found superior to N content when compared with treatment T_1 (control) and rest of the treatments.

The inferences drawn from the data that leaf N content was increased from 30 DAS to 50 DAS and it decreased thereafter at 70 DAS. The decrease in N content might be due to fact that younger leaves and developing organs, such as grains act as strong sink demand and may draw heavily nitrogen from older leaves and leaves in general respectively (Gardner *et al*., 1988) [5]. The above findings are consonance with the findings of Jeyakumar *et al*. (2008) [8] observed that the maximum photosynthetic efficiency was observed in brassinolide @ 0.1 ppm treated plants as evidenced by the higher nitrate reductase activity in black gram. Assessing nitrate reductase (NR) activity also saw the influence of brassinolides on nutrient uptake.

Protein content in seeds

Protein content in seeds differed significantly among different treatments. However, treatment T_{11} (Homobrassinolide @ 1.00 ppm) recorded the highest protein content i.e. 27.18%, while control (T_1) treatment recorded minimum i.e. 24.25% protein content. Significantly highest protein content was found in T_{11} (Homobrassinolide @ 1.00 ppm). However, it was at par with treatments T_{10} (Homobrassinolide @ 0.90 ppm), T_9 (Homobrassinolide @ 0.80 ppm), T8 (Homobrassinolide @ 0.70 ppm) and T_7 (Homobrassinolide @ 0.60 ppm). These treatments of homobrassinolide was found superior to protein content when compared with treatment T_1 (control) and rest of the treatments. (Table 1)

It is observed from the result that homobrassinolide more effective in seed protein content. These might be due to enhancement of enzymatic activity and translocation of metabolites to the black gram seeds.

These results are comparable with Jeyakumar *et al*. (2008) [8] reported that brassinolide @ 0.1 ppm treated plants as evidenced by the higher soluble protein. Seed protein content was also found improved due to brassinolide application. Sana *et al*. (2014) [14] the foliar application of brassinolide study the effect of the foliar and root application of brassinolide on growth and metabolism of (*Vigna radiata* L.). Content of proteins significantly increased by 1 ppm foliar spray of brassinolide. Netwal *et al*. (2018) the experiment consisting carried consisting brassinoids @ 0.5 ppm and brassinoids @ 1.0 ppm. The application of brassinoids 1.0 ppm to the Indian bean significantly increased the protein content as compared to control. The increase in the protein content due to application of brassinoids 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 carbohydrate.

Total chlorophyll content in leaves

Chlorophyll content in leaves was increased up to 50 DAS but thereafter, it decreased at 70 DAS. At 30 DAS chlorophyll content in leaves ranged from 1.21-1.38 mg g^{-1}. Significantly highest chlorophyll content was found in T_{11} (Homobrassinolide @ 1.00 ppm). However, it was at par with treatments T_{10} (Homobrassinolide @ 0.90 ppm), T_9 (Homobrassinolide @ 0.80 ppm), T_8 (Homobrassinolide @ 0.70 ppm), T_7 (Homobrassinolide @ 0.60 ppm) and T_6 (Homobrassinolide @ 0.50 ppm). These treatments of homobrassinolide was found superior when compared with treatment T_1 (control) and rest of the treatments.

At 50 DAS chlorophyll content in leaves ranged from 1.27-1.96 mg g -1. Significantly highest chlorophyll content was found in treatment T_{11} ((Homobrassinolide @ 1.00 ppm). However, it was at par with treatments T10 (Homobrassinolide @ 0.90 ppm) T_9 (Homobrassinolide @ 0.80 ppm), T_8 (Homobrassinolide @ 0.70 ppm), T_7 (Homobrassinolide @ 0.60 ppm) and T_6 (Homobrassinolide @ 0.50 ppm). These treatments of homobrassinolide was found superior when compared with treatment T_1 (control) and rest of the treatments.

At 70 DAS chlorophyll content in leaves ranged from 1.18-

1.48 mg g-1. Significantly maximum chlorophyll was observed in treatment T_{11} (Homobrassinolide @ 1.00 ppm). However, it was at par with treatments T_{10} (Homobrassinolide @ 0.90 ppm), T_9 (Homobrassinolide @ 0.80 ppm), T_8 (Homobrassinolide @ 0.70 ppm), T_7 (Homobrassinolide @ 0.60 ppm) and T_6 (Homobrassinolide @ 0.50 ppm). These treatments of homobrassinolide was found superior in chlorophyll content in leaves when compared with treatment T_1 (control) and rest of the treatments. The above findings are consonance with the findings of Jeyakumar *et al*. (2008) [8] observed that brassinolide @ 0.1 ppm treated plants as evidenced by the higher chlorophyll content. The chlorophyll content was enhanced as the chlorophyllase enzyme which is responsible for chlorophyll degradation, might have been inhibited by growth regulators.

The result further verified by Sana *et al*. (2014) [14] study the effect of the foliar and root application of brassinolide on growth and metabolism of (*Vigna radiata* L.). Content of chlorophyll significantly increased by 1 ppm foliar spray of brassinolide.

These results are in accordance with the findings of Netwal *et al*. (2022) [10] reported that application of brassinoids 1.0 ppm to the Indian bean significantly increased the chlorophyll content in leaves.

Number of pod plant^{-1}

At harvest the range of number of pod plant^{-1} was observed in the range of 28.04-39.87. Significantly highest number of pod was found in T_{11} (Homobrassinolide @ 1.00 ppm). (Table 2)

Similar findings were enlightened by Jeyakumar *et al*. (2008) [8] reported that among the treatments, brassinolide @ 0.1 ppm resulted in more number of pods per plant in black gram. The increased number of pods and seeds could be due to better translocation of nutrients and assimilates to the reproductive regions.

Seed yield plant^{-1} (g), plot^{-1} (kg) and ha^{-1} (q)

Seed yield is the economic yield which is final results of physiological activities of plant. Economic yield is the part of biomass that is converted into economic product (Nichiporovic, 1960) [11].

Significantly maximum seed yield plant^{-1}, plot^{-1} and hectare^{-1} were produced in treatment T_{11} (Homobrassinolide @ 1.00 ppm). The range of increase in seed yield plant^{-1}, plot^{-1} and hectare^{-1} was 4.71 g, 0.51 kg and 11.26 q in treatment T_1 (control) and 10.26 g, 0.80 kg and 17.77 q in treatment T_{11} (Homobrassinolide @ 1.00 ppm) respectively. (Table 2)

According to results of Gograj *et al*. (2012) [6] the use of brassinolide up to 1.0 ppm was observed to increase significantly grain yield and biological yield of clusterbean.

Similarly, Hamed and Abdullah (2022) [7] reported that plant sprayed with 1.5 mg L^{-1} concentration of brassinolide achieved highest weight of total seed yield of sunflower.

Test weight

The range of test weight recorded after harvest was 4.07-5.02 g. Significantly highest test weight content was found in T_{11} (Homobrassinolide @ 1.00 ppm). (Table 2)

Application of homobrassinolide as foliar spray increased the seed weight due to better mobilization of nutrients to seed.

Gograj *et al.* (2012) [6] reported that the use of brassinolide up to 1.0 ppm was observed to increase significantly test weight of clusterbean.

Harvest Index

The range of harvest index obtained was 30.44 in control to 38.11 in treatment receiving Homobrassinolide @ 1.00 ppm. Among all treatments under study significantly more harvest index was exhibited in treatment T_{11} (Homobrassinolide @ 1.00 ppm). (Table 2)

The significant effect of homobrassinolide on harvest index was confirmed by Gograj *et al*. (2012) [6] the use of brassinolide up to 1.0 ppm was observed to increase significantly harvest index of clusterbean.

Our findings about harvest index are in accordance with that of obtained by Matwa *et al*. (2017) [9] spraying brassinolide 0.25 ppm at 50% flowering and 15 days later showed significant increase on harvest index in green gram.

The B:C ratio was calculated for one hectare. The highest B:C ratio was found in treatment T_{11} (Homobrassinolide @ 1.00 ppm) i.e. 3.06. Next to this treatment T_{10} (Homobrassinolide @ 0.90 ppm) also found more B:C ratio over control i.e. 2.98. The lowest B:C ratio was observed in treatment T_1 (control) i.e. 1.98. (Table 2)

Table 1: Effect of homobrassinolide on Leaf nitrogen content, Leaf chlorophyll content, protein content in seeds of black gram

Treatments	Leaf nitrogen content (%)			Leaf chlorophyll content (mg g^{-1})			Seed protein content (%)
	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS	
T_1 (Control)	3.96	4.69	3.61	1.21	1.27	1.18	24.25
T_2 (Homobrassinolide @ 0.10 ppm)	4.19	5.07	3.97	1.25	1.38	1.23	24.64
T_3 (Homobrassinolide @ 0.20 ppm)	4.28	5.47	4.00	1.27	1.42	1.25	24.79
T_4 (Homobrassinolide @ 0.30 ppm)	4.41	5.93	4.07	1.28	1.47	1.27	25.66
T_5 (Homobrassinolide @ 0.40 ppm)	4.46	6.01	4.14	1.30	1.52	1.29	25.84
T_6 (Homobrassinolide @ 0.50 ppm)	4.64	6.31	4.30	1.31	1.58	1.36	26.00
T_7 (Homobrassinolide @ 0.60 ppm)	4.77	6.41	4.65	1.33	1.66	1.42	26.47
T_8 (Homobrassinolide @ 0.70 ppm)	4.83	6.58	4.82	1.35	1.71	1.44	26.63
T_9 (Homobrassinolide @ 0.80 ppm)	4.94	6.77	4.90	1.36	1.76	1.46	26.98
T_{10} (Homobrassinolide @ 0.90 ppm)	4.98	7.01	4.96	1.37	1.84	1.47	27.08
T_{11} (Homobrassinolide @ 1.00 ppm)	5.01	7.16	5.16	1.38	1.96	1.48	27.18
SE (m) ±	0.08	0.20	0.12	0.01	0.05	0.03	0.33
CD at 5%	0.24	0.59	0.35	0.05	0.17	0.09	0.98

Table 2: Effect of homobrassinolide on seed yield plant^{-1}, plot^{-1}, ha^{-1}, harvest index and B:C ratio in black gram

Treatments	Number of pod plant^{-1}	Test Weight (g)	Seed yield plant^{-1} (g)	Seed yield plot^{-1} (kg)	Seed yield ha^{-1} (q)	Harvest index (%)	B:C ratio
T_1 (Control)	28.60	4.07	4.71	0.51	11.26	30.44	1.98
T_2 (Homobrassinolide @ 0.10 ppm)	33.71	4.22	8.01	0.60	13.40	32.06	2.31
T_3 (Homobrassinolide @ 0.20 ppm)	33.77	4.35	8.18	0.61	13.55	32.62	2.33
T_4 (Homobrassinolide @ 0.30 ppm)	34.17	4.52	8.37	0.63	13.99	32.96	2.41
T_5 (Homobrassinolide @ 0.40 ppm)	34.58	4.58	8.41	0.65	14.44	33.21	2.49
T_6 (Homobrassinolide @ 0.50 ppm)	34.79	4.64	8.73	0.69	15.33	33.37	2.64
T_7 (Homobrassinolide @ 0.60 ppm)	38.30	4.74	9.69	0.72	16.07	35.44	2.77
T_8 (Homobrassinolide @ 0.70 ppm)	38.45	4.86	9.75	0.75	16.59	37.22	2.86
T_9 (Homobrassinolide @ 0.80 ppm)	39.15	4.91	9.98	0.77	17.03	37.63	2.93
T_{10} (Homobrassinolide @ 0.90 ppm	39.24	4.96	10.07	0.78	17.33	38.04	2.98
T_{11} (Homobrassinolide @ 1.00 ppm	39.87	5.02	10.26	0.80	17.77	38.11	3.06
SE (m) ±	1.67	0.11	0.58	0.04	1.07	1.26	
CD at 5%	4.95	0.33	1.71	0.14	3.17	3.74	

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