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Effect of PGRs application on growth parameters in black gram (*Vigna mungo* (L.) Hepper) crop

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Abstract
An experiment conducted at Experimental farm, Eklavya University, Damoh, Madhya Pradesh during *kharif* session 2022-23. At 40 DAS maximum leaf area index (cm^2) 1.60 was received from the treatment T_3, T_5 while the minimum leaf area index (cm^2) 1.17 was recorded in treatment T_7 and 60 DAS maximum leaf area index (cm^2) 0.47 was received from the treatment T_1. At 51-60 DAS maximum net assimilation rate (g dm^{-2} day^{-1} $x10^{-3}$) 0.633 was received from the treatment T_7, absolute growth rate (g/day) 0.163 treatment T_3, relative growth rate (g g^{-1} day^{-1}) 0.203 treatment T_2.

Keywords: Leaf area index, absolute growth rate, relative growth rate and leaf area index

Introduction
Black gram is one of the important pulse crops grown throughout India. It is consumed in the form of 'dal' (whole or split, husked and un-husked) or perched. It holds ample amount of calorie contents 347 calories per 100 gm (Amruta *et al.*, 2016) [2]. Black gram is the most important legume crop and India alone produce more than two-third of the world's production (Saini and Jaiwal, 2002) [14] as food, feed and industrial raw material and ranks as the third important pulse crop in India (Selvakumar *et al.*, 2012) [15]. Total black gram production was 3280 thousand tonnes; of which percentage share in 13.48% during 2017-18 (Anonymous, 2017-18) [3]. It is 3rd important pulse crop, was cultivated over an area of 5.44 Mha (*Kharif* + *rabi*) and recorded a production of 3.56 MT at a productivity level of 655 kg/ha (Anonymous, 2018) [4]. As agriculture becomes more mechanized and science increases the possibilities for using inputs to enhance production, the role of plant growth regulators (PGRs) becomes more vital. Studies conducted in black gram and other legume crops have indicated the positive influence of some PGRs in increasing the productivity by strengthening source or sink. Application of NAA @ 30 ppm on 30 and 45 DAS and mepiquat chloride @ 120 ppm on 60 DAS recorded increased yield by 25 percent more than the control (Prakash *et al.*, 2003) [13]. Brassinolides (0.5 ppm), NAA (40 ppm), IAA (10 ppm), SA (50 ppm) and Kinetin (50 ppm) were able to improve the total chlorophyll content, nitrate reductase activity and soluble protein and thereby pod yield in soybean (Senthil, 2003) [16].

Material and Methods
Treatment details
T_1- 20 ppm NAA
T_2- 30 ppm NAA
T_3- 40 ppm NAA
T_4- 20 ppm GA_3
T_5- 30 ppm GA_3
T_6- 40 ppm GA_3
T_7- 45 ppm GA_3
T_8- Control.

Growth parameters
Leaf Area Index (LAI)
Since the crop yield is to be assessed per unit of ground area instead of per plant, the leaf area existing on unit ground area was proposed by Watson (1952) [17]. Leaf area index is the ratio of leaf area to ground area occupied by crop plant. It is calculated by using the formula given below.

$$\text{Leaf Area Index} = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Ground area per plant (cm}^2\text{)}}$$

Net assimilation rate (NAR)

Net assimilation rate is expressed as increase in dry matter per unit leaf area per unit time. It is expressed in g dm^{-2} day^{-1} $x10^{-3}$. The concept of NAR on the basis of leaf area was introduced by Gregory (1917).

$$NAR = \frac{W_2 - W_1}{t_2 - t_1} X \frac{\log e\, A_2 - \log e\, A_1}{A_2 - A_1}$$

Where,

W_1= total dry weight of plant in g at time t_1; W_2= total dry weight of plant in g at time t_2; A_1= leaf area per plant at time t_1; A_2= leaf area per plant at time t_2; t_1= initial time of observation; t_2= final time of observation.

Absolute growth rate (AGR)

Absolute growth rate is the rate of increase of growth variable (W) and the time (t). It is measured as the differential coefficient of W with respect to time (t). AGR of growth variable *viz*. total try matter per plant were worked out by formula and expressed as cm per day and g per day respectively.

$$\text{AGR for dry matter} = \frac{W_2 - W_1}{t_2 - t_1} \text{ (g day per day)}$$

Where,

W_2 and W_1 refer to height of plant (cm) and dry matter weight (g) per plant at t_2 and t_1 time, respectively.

Relative growth rate (RGR) (g^{-1} day^{-1})

The relative rate of which plant incorporate the new material into its substance is measured by relative growth rate (RGR) of dry matter accumulation. It is worked out as per the formula given by Fisher (1921).

$$RGR = \frac{\log e W_2 - \log e W_1}{t_2 - t_1} \text{ (per g per day)}$$

Where,

log e = Natural logarithm to the base (e = 2.3026)

W_1 = weight of dry matter at time tj

W_2 = weight of dry matter at time t_2

T_1 = initial time of observation

t_2 = final time of observation

Results and Discussion

Growth parameters

Leaf Area Index (cm^2)

At 30 DAS of black gram were differed significantly to each other. The significantly maximum leaf area index (cm^2) 0.57 was received from the treatment T_8 followed by 0.40 in the treatments T_2, T_7, while the minimum leaf area index (cm^2) 0.17 was recorded in treatment T_1. At 40 DAS of black gram were differed significantly to each other. The significantly maximum leaf area index (cm^2) 1.60 was received from the treatment T_3, T_5 followed by 1.57 in the treatments T_1, T_2, T_4, while the minimum leaf area index (cm^2) 1.17 was recorded in treatment T_7. At 50 DAS of black gram were differed significantly to each other. The significantly maximum leaf area index (cm^2) 1.77 was received from the treatment T_4 followed by 1.70 in the treatments T_1, T_5, while the minimum leaf area index (cm^2) 1.17 was recorded in treatment T_8. At 60 DAS of black gram were differed significantly to each other. The significantly maximum leaf area index (cm^2) 0.47 was received from the treatment T_1 followed by 0.40 in the treatments T_3, while the minimum leaf area index (cm^2) 0.20 was recorded in treatment T_4. Similar results were found in groundnut (Kaul, 1999 and Antony, 2000) [9, 5].

Net assimilation rate (g dm^{-2} day^{-1} $x10^{-3}$)

At 30-40 DAS of black gram were differed significantly to each other. The significantly maximum net assimilation rate (g dm^{-2} day^{-1} $x10^{-3}$) 0.553 was received from the treatment T_4 followed by 0.550 in the treatments T_6, while the minimum net assimilation rate (g dm^{-2} day^{-1} $x10^{-3}$) 0.410 was recorded in treatment T_3. At 41-50 DAS of black gram were differed significantly to each other. The significantly maximum net assimilation rate (g dm^{-2} day^{-1} $x10^{-3}$) 0.873 was received from the treatment T_7 followed by 0.733 in the treatments T_6, while the minimum net assimilation rate (g dm^{-2} day^{-1} $x10^{-3}$) 0.550 was recorded in treatment T_3. At 51-60 DAS of black gram were differed significantly to each other. The significantly maximum net assimilation rate (g dm^{-2} day^{-1} $x10^{-3}$) 0.633 was received from the treatment T_7 followed by 0.503 in the treatments T_6, while the minimum net assimilation rate (g dm^{-2} day^{-1} $x10^{-3}$) 0.337 was recorded in treatment T_1. Results are in confirmation with the findings made by Abraham *et al.*, (1987) [1] in green gram, Lakshmamma and Rao (1996) [10], More (1999) [11] in black gram and Senthil Kumar and Jayakumar (2004) [16] in green gram.

Absolute growth rate (g/day)

At 30-40 DAS of black gram were differed significantly to each other. The significantly maximum absolute growth rate (g/day) 0.453 was received from the treatment T_3 followed by 0.267 in the treatments T_8, while the minimum absolute growth rate (g/day) 0.023 was recorded in treatment T_6. At 41-50 DAS of black gram were differed significantly to each other. The significantly maximum absolute growth rate (g/day) 0.233 was received from the treatment T_2 followed by 0.197 in the treatments T_3, while the minimum absolute growth rate (g/day) 0.040 was recorded in treatment T_5. At 51-60 DAS of black gram were differed significantly to each other. The significantly maximum absolute growth rate (g/day) 0.163 was received from the treatment T_3 followed by 0.083 in the treatments T_4, while the minimum absolute growth rate (g/day) 0.040 was recorded in treatment T_8. Results are in confirmation with the findings made by Abraham *et al.*, (1987) [1] in green gram, Lakshmamma and Rao (1996) [10] and More (1999) [11] in black gram and Senthil Kumar and Jayakumar (2004) [16] in green gram.

Table 1: Different Growth parameters at various stages of black gram crop

Treatment	Leaf Area Index (cm^2)			Net assimilation rate (g dm^{-2} day^{-1} $x10^{-3}$)			Absolute growth rate (g/day)			Relative growth rate (g^{-1} day^{-1})		
	Days after sowing											
	30	40	50	60	41-50	51-60	30-40	41-50	51-60	30-40	41-50	51-60
T_1	0.17	1.57	1.70	0.47	0.590	0.337	0.077	0.103	0.070	0.014	0.040	0.043
T_2	0.40	1.57	1.67	0.27	0.593	0.433	0.027	0.233	0.070	0.010	0.010	0.203
T_3	0.23	1.60	1.67	0.40	0.550	0.400	0.453	0.197	0.163	0.020	0.073	0.103
T_4	0.20	1.57	1.77	0.20	0.553	0.467	0.197	0.153	0.083	0.037	0.047	0.080
T_5	0.23	1.60	1.70	0.27	0.587	0.430	0.043	0.040	0.077	0.037	0.017	0.047
T_6	0.30	1.53	1.60	0.23	0.733	0.503	0.023	0.077	0.053	0.013	0.023	0.023
T_7	0.40	1.17	1.27	0.30	0.873	0.633	0.190	0.080	0.080	0.017	0.057	0.013
T_8	0.57	1.20	1.17	0.37	0.650	0.493	0.267	0.113	0.040	0.023	0.083	0.020
SEm±	0.06	0.02	0.02	0.04	0.05	0.07	0.08	0.04	0.03	0.01	0.02	0.03
CD at 5%	0.17	0.07	0.07	0.11	0.14	0.22	0.25	0.11	0.10	0.02	0.05	0.09

Relative growth rate (g g^{-1} day^{-1})

At 30-40 DAS of black gram were differed significantly to each other. The significantly maximum relative growth rate (g g^{-1} day^{-1}) 0.037 was received from the treatment T_4, T_5 followed by 0.023 in the treatments T_8, while the minimum relative growth rate (g g^{-1} day^{-1}) 0.010 was recorded in treatment T_2. At 41-50 DAS of black gram were differed significantly to each other. The significantly maximum relative growth rate (g g^{-1} day^{-1}) 0.083 was received from the treatment T_8 followed by 0.073 in the treatments T_3, while the minimum relative growth rate (g g^{-1} day^{-1}) 0.010 was recorded in treatment T_2. At 51-60 DAS of black gram were differed significantly to each other. The significantly maximum relative growth rate (g g^{-1} day^{-1}) 0.203 was received from the treatment T_2 followed by 0.103 in the treatments T_3, while the minimum relative growth rate (g^{-1} day^{-1}) 0.013 was recorded in treatment T_7. Similarly, More (1999) [11], Jadhav (2000) [8], Patil (2000) also reported that the foliar application of NAA and GA_3 significantly increased the mean RGR in black gram.

Conclusion

Among 30 DAS recorded the maximum leaf area index (cm^2) 0.57 was received from the treatment T_8 while the minimum leaf area index (cm^2) 0.17 was recorded in treatment T_1 and 60 DAS maximum leaf area index (cm^2) 0.47 was received from the treatment T_1 while the minimum leaf area index (cm^2) 0.20 was recorded in treatment T_4. The net assimilation rate on 30-40 DAS recorded the maximum (g dm^{-2} day^{-1} $x10^{-3}$) 0.553 treatment (T_4), absolute growth rate (g/day) 0.453 treatment (T_3), relative growth rate (g^{-1} day^{-1}) 0.037 treatment (T_4 & T_5). At 51-60 DAS maximum net assimilation rate (g dm^{-2} day^{-1} $x10^{-3}$) 0.633 treatment (T_7), absolute growth rate (g/day) 0.163 treatment (T_3), relative growth rate (g^{-1} day^{-1}) 0.203 treatment (T_2).

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