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Short Communication

Effect of plant growth regulators and fertilizers on the growth and yield of black gram (*Vigna mungo* L.)

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ABSTRACT

A field experiment was carried out to assess the effect of foliar application of plant growth regulators and fertilizers on the growth, yield attributes and grain yield of black gram. The results revealed that the application of RDF + DAP 2% + NAA 60 ppm recorded significantly higher growth attributes *viz*., plant height (47.87 cm), number of leaves plant^{-1} (34.22), number of primary branches plant^{-1} (7.06) and number of secondary branches plant^{-1} (19.63), as well as yield and yield attributes including number of pods plant^{-1} (34.39), pod length (6.82 cm), number of grains pod^{-1} (6.61), test weight (38.67g), grain yield (1234.19 kg ha^{-1}) and straw yield (3640 kg ha^{-1}). The net returns and benefit-cost ratio (Rs. 75667.66 and 2.17, respectively) were also recorded substantially higher with the application of RDF + DAP 2% + NAA 60 ppm over the rest of the treatments. Based on the present findings it was concluded that the application of RDF + DAP 2% + NAA 60 ppm in black gram crop is profitable.

***Key words**:* Black gram, DAP, NAA, Plant growth regulators, Salicylic acid.

Black gram (*Vigna mungo* L.) is also known as urd bean, kalai, and mash. It originated in India and belongs to the family Fabaceae. It is an annual and short-duration crop grown throughout the country due to its wider adaptability and grown in various cropping systems such as sole crop, sequential crop, catch crop, and mixed crop. Black gram is rich in carbohydrates (59.99 g), protein (24.9 g), and fat (1.49 g) 100 g^{-1}. After red gram and chickpea, the black gram is the third most important pulse crop grown in India, covering an area of about 4.49 million hectares with a production of 29.2 million tons. The top five pulse-growing states in India are Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh and Karnataka. Production of *Kharif* pulses in India was 80.46 lakh tons (Srivastava *et al.* 2010).

Application of plant growth substances in varying minute concentrations at critical stages of crop growth accelerates crop growth from seed germination to senescence. Naphthalene acetic acid (NAA) is a synthetic plant growth regulator in the auxin family. Foliar application of NAA improves cell elongation as well as apical dominance and significantly increases the number of pods plant^{-1}, number of seeds plant^{-1}, pod length, pod weight, pod dry weight and grain yield of black gram (Prabhu 2000). Salicylic acid is a phenolic phytohormone found in plants and has an impact on the physiological processes and growth of the plant. The important role of salicylic acid is to tolerate some environmental stresses, viz., drought stress, heat stress, and salt stress (El-Tayed 2005). Diammonium phosphate is the most widely used fertilizer and it is a good source of nitrogen as well as phosphorous for legumes. The foliar application of 2% DAP at the flowering and pod-filling stages increased the growth and yield attributes of the crop (Kunjammal and Sukumar 2019). The application of P_2O_5, along with sulfur (Sarda Devi *et al.* 2022), PSB inoculation (Pallavi *et al.* 2023), and growth regulators (Usha *et al.* 2023), has been reported to be beneficial in legume crops. The objective of this experimental research was to study the effect of plant growth regulators and fertilizers on the growth and yield of black gram.

The field experiment was conducted at the Crop Research Centre, Department of Agronomy, School of Agriculture, ITM University, Gwalior (M.P.) during the *Kharif* season of 2022. The experiment was laid out in a randomized block design (RBD) with ten treatments and three replications. In the experiment, two plant growth regulators, such as naphthalene acetic acid (NAA) and salicylic acid with different concentrations, and 2% DAP along with plant growth regulators, were used. The treatments comprised RDF 20:40:40 NPK (kg ha^{-1}),

RDF (recommended dose of fertilizer) + Salicylic Acid (150 ppm), RDF + Salicylic Acid (200 ppm), RDF + NAA (40 ppm), RDF + NAA (60 ppm), RDF + DAP 2%, RDF + DAP 2% + Salicylic Acid (150 ppm), RDF + DAP 2% + Salicylic Acid (200 ppm), RDF + DAP 2% + NAA (40 ppm), RDF + DAP 2% + NAA (60 ppm). The gross plot size was 3.6m × 4.5m**.** The crop was sown in lines with a seed rate of 20 kg ha^{-1} and a spacing of 30cm x 10 cm. The recommended dose of fertilizer (20:40:40 NPK kg ha^{-1}) was applied at the time of sowing as a basal dose. Foliar application of plant growth regulators and fertilizer treatments was applied as $treatments^{-1}$ at 50 DAS with the help of a knapsack sprayer by using 500 liters of water $hectare^{-1}$. The cultural operations, such as gap filling, thinning, and weeding, were done as per the requirement. The statistical analysis of the data was done using the analysis of variance (Panse and Sukhatme,1967).

Significantly higher plant height was recorded with the treatment RDF + DAP 2% + NAA 60 ppm (46.34 cm) among all the treatments and it was at par with RDF + DAP 2% + NAA 40 ppm (45.20 cm) as compared to the rest of the treatments. Significantly lower plant height was recorded with RDF 20:40:40 NPK kg ha^{-1} (27.10 cm) as compared to the rest of the treatments. Similar observations were recorded At the 60-DAS stage and the harvest stage of the crop growth, (Table 1). The significantly higher number of leaves $plant^{-1}$ was recorded with the treatment RDF + DAP 2% + NAA 60 ppm (37.22) and found to be at par with the treatment RDF + DAP 2% + NAA 40 ppm (36.72) as compared to the rest of the treatments. A significantly lesser number of leaves $plant^{-1}$ was recorded with RDF 20:40:40 NPK kg ha^{-1} (22.40) as compared to the rest of the treatments. Similar observations were recorded at the 60-DAS and the harvesting stages. A significantly higher number of primary branches $plant^{-1}$ was recorded with treatment RDF + DAP 2% + NAA 60 ppm (6.90) and found at par with RDF + DAP 2% + NAA 40 ppm (6.31) as compared to the rest of the treatments. A significantly lower number of primary branches $plant^{-1}$ was recorded with RDF 20:40:40 NPK kg ha^{-1} (3.48) as compared to the rest of the treatments. Similar observations were recorded at the 60-DAS and the harvesting stages. The significantly higher number of secondary branches $plant^{-1}$ was recorded with the treatment RDF + DAP 2% + NAA 60 ppm (18.11) and found to be at par with RDF + DAP 2% + NAA 40 ppm (17.91) as compared to the rest of the treatments. A significantly lower number of secondary branches $plant^{-1}$ was recorded with RDF 20:40:40 NPK kg ha^{-1} (10) as compared to the rest of the treatments. Similar observations were recorded at the 60-DAS and the harvesting stages. The increase in the growth characteristics of plants with the basal application of the recommended dose of fertilizers (RDF) and the foliar application of DAP improved the photosynthetic activity of plants. It was followed by the foliar application of NAA, which promoted cell elongation, apical dominance, and shoot development in the plants. Similar findings were reported by Dixit and Elamathi (2007), Shashikumar *et al.* (2013) and Singh and Jambukiya (2020).

The yield attributes such as number of pods $plant^{-1}$ (34.39), pod length (6.82 cm), number of grains pod^{-1} (6.61), grain yield (1234.19 kg ha^{-1}) and straw yield (3640 kg ha^{-1}) were recorded significantly higher with treatment RDF + DAP 2% + NAA 60 ppm and found at par with RDF + DAP 2% + NAA 40 ppm (33.25, 6.11, 6.50 cm, 1213.83 kg ha^{-1}, 3616 kg ha^{-1}, respectively) and significantly lower yield attributes were recorded with treatment RDF 20:40:40 NPK kg ha^{-1} (Table 2). The test weight of 1000 seeds were found to be non-significant, but numerically higher values were recorded with treatment RDF + DAP 2% + NAA 60 ppm (38.67 g) and a lower test weight was recorded with treatment RDF 20:40:40 NPK kg ha^{-1} (37.04g). The increase in yield attributes may be due to the foliar application of nutrients at critical crop growth stages because they were easily translocated in the plants. The foliar spraying of DAP at critical crop growth stages improved the photosynthetic activity of the plant. Foliar application of NAA stimulated apical dominance, cell elongation, and shoot development. It also increases the number of flowers as well as the fruit setting of the crop. The foliar application of fertilizer along with plant growth regulators may enhance the photosynthetic activity of the plant, reduce the flower drop percentage, increase the fruit-to-pod ratio of the plant, and ultimately increase yield. These results followed the findings of Chandrasekar and Bangarusamy (2003), Dixit and Elamathi (2007), Shashikumar *et al.* (2013), Marimthu and Surendran (2015), and Mahesh *et al.* (2022).

Among all the treatments, the higher net return (Rs. 75667.66) and benefit-cost ratio (Rs. 2.17) were recorded with treatment RDF + DAP 2% + NAA 60 ppm over the other treatments, and found at par with treatment RDF + DAP 2% + NAA 40 ppm (74132.05 and 2.12, respectively). A much lower net return and benefit-cost ratio were recorded with treatment

Table 1. Effect of plant growth regulators and fertilizers on growth attributes of black gram

Treatment	Plant height (cm)		No. of leaves plant^{-1}		No. of primary branches plant^{-1}		No. of secondary branches plant^{-1}	
	60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest
T_0- RDF 20:40:40 NPK (kg ha^{-1})	27.10	27.40	22.40	19.62	3.48	3.72	10.00	10.93
T_1- RDF + Salicylic acid (150 ppm)	33.38	34.02	27.13	25.29	4.34	4.50	13.12	14.27
T_2- RDF + Salicylic acid (200 ppm)	33.51	34.12	27.18	25.45	4.41	4.61	13.24	14.42
T_3- RDF + NAA (40 ppm)	39.36	40.33	32.20	29.71	5.40	5.63	15.69	16.95
T_4- RDF + NAA (60 ppm)	39.50	40.50	32.37	29.92	5.47	5.71	15.86	17.02
T_5- RDF + DAP 2%	32.72	33.20	26.75	23.45	4.32	4.45	12.05	13.10
T_6- RDF + DAP 2% + Salicylic acid (150 ppm)	33.69	34.33	27.65	25.70	4.50	4.72	13.46	14.61
T_7- RDF + DAP 2% + Salicylic acid (200 ppm)	33.72	34.53	27.85	25.90	4.57	4.80	13.63	14.77
T_8- RDF + DAP 2% + NAA (40 ppm)	45.20	46.29	36.72	33.72	6.31	6.43	17.91	19.18
T_9- RDF + DAP 2% + NAA (60 ppm)	46.34	47.87	37.22	34.22	6.90	7.06	18.11	19.63
S.Em ±	1.88	1.94	1.46	1.28	0.28	0.23	0.69	0.72
C.D (P=0.05)	5.57	5.77	4.33	3.79	0.82	0.70	2.04	2.15

Table 2. Effect of plant growth regulators and fertilizers on yield attributes, grain yield and economics of black gram

Treatment	Number of pods plant^{-1}	Pod length (cm)	Number of grains pod^{-1}	Test Weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net Return (Rs ha^{-1})	B:C (Rs Re^{-1} invested)
T_0- RDF 20:40:40 NPK (kg ha^{-1})	19.75	3.31	3.80	37.04	700.33	2536.66	32853.61	0.98
T_1- RDF + Salicylic acid (150 ppm)	24.30	4.16	4.63	37.41	843.28	2903.52	44422.91	1.29
T_2- RDF + Salicylic acid (200 ppm)	24.58	4.19	4.67	37.62	868.20	2927.23	46257.21	1.34
T_3- RDF + NAA (40 ppm)	29.10	5.19	5.55	38.26	1053.20	3295.04	61409.79	1.78
T_4- RDF + NAA (60 ppm)	29.49	5.34	5.60	38.34	1075.80	3319.44	63096.44	1.83
T_5- RDF + DAP 2%	23.50	4.09	4.59	37.24	835.93	2889.20	43376.53	1.24
T_6- RDF + DAP 2% + Salicylic acid (150 ppm)	25.19	4.29	4.72	37.77	899.90	2941.97	48020.43	1.38
T_7- RDF + DAP 2% + Salicylic acid (200 ppm)	25.34	4.41	4.80	37.93	917.61	2991.98	49589.27	1.42
T_8- RDF + DAP 2% + NAA (40 ppm)	33.25	6.11	6.50	38.55	1213.83	3616.00	74132.05	2.12
T_9- RDF + DAP 2% + NAA (60 ppm)	34.39	6.82	6.61	38.67	1234.19	3640.00	75667.66	2.17
S. Em ±	1.26	0.26	0.25	1.88	45.10	99.45	-	-
C.D (P=0.05)	3.74	0.76	0.74	NS	134.00	295.49	-	-

RDF 20:40:40 NPK kg ha^{-1} (Rs. 32853.61 and 0.98, respectively). The appreciably higher net returns and benefit-cost ratio were due to the maximum productivity in terms of yield of black gram. Similar results were reported by Dixit and Elamathi (2007), Shashikumar *et al.* (2013), and Jadhav *et al.* (2020). Thus present study has revealed that the application of RDF + 2% DAP + 60 ppm NAA significantly increased the plant growth parameters, *viz*., plant height, number of leaves $plant^{-1}$, primary branches $plant^{-1}$, and secondary branches $plant^{-1}$ as compared to the application of RDF. The highest yield and yield attributes including number of pods $plant^{-1}$, pod length, number of grains pod^{-1}, test weight, grain yield, and straw yield, were recorded with the application of RDF + DAP 2% + 60 ppm NAA. While lower yield and yield attributing characters were recorded by the application of RDF 20:40:40 NPK (kg ha^{-1}). Appreciably higher values of net return and benefit-cost ratios (B:C) were found with the application of RDF + 2% DAP + 60 ppm NAA and lower values of net return and benefit-cost ratio were recorded with the application of RDF 20:40:40 NPK (kg ha^{-1}).

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