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## Analysis of Sulphur and Phosphorus on the Growth and Yield of Black Gram (*Phaseolus mungo* L.)

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### Abstract

The experimental work was conducted in randomized block design with three replications. The treatment comprises of three levels of phosphorus (0, 20 and 40 kg  $P_2O_5$  ha<sup>-1</sup>) and three levels of Sulphur. Growth parameters viz. plant height, number of branches, number of leaves plant<sup>-1</sup> and dry matter yield plant<sup>-1</sup> appreciably improved with the application of phosphorus up to 40 kg  $P_2O_5$  ha<sup>-1</sup>. More values of these parameters were appreciably higher with the application of 15 and 30 kg S ha<sup>-1</sup> over the control. The root length, total and effective number of nodules plant<sup>-1</sup> and fresh and dry weight of root nodules were significantly higher with the application of 40 kg  $P_2O_5$  ha<sup>-1</sup> while sulphur had no significant impact on these parameters. All the yield attributes, biological yield and grain yield appreciably increased with increasing rates of phosphorus as well as sulphur application. Economics revealed that, highest net return (Rs.70302) and benefit cost ratio (3.34) was observed with I<sub>2</sub> while, highest net return (Rs.462053 ha<sup>-1</sup>) and B:C ratio (3.03) were observed with application of 40 kg  $P_2O_5$  and 30 Kg S ha<sup>-1</sup>. Field experiment was conducted in the department of crop physiology at Vindhya Science & Agricultural Research Institute, Raushar, Rewa (M.P.) during 2019 to 2020.

**Keywords:** Black gram, Phosphorus, Sulphur, Yield, Economics

### Introductions

The black gram (*Phaseolus mungo* L.) is under cultivation since prehistoric time in India. It is also known as green gram and serve are a major source of dietary protein for the vast majority of people. In India these crops are cultivated in three different seasons, viz., Kharif, Rabi and summer. It is an important pulse crop in South and East Asia Keatinge *et al.* (2011) [5]. India is the world's largest producer as well as consumer of black gram. It produces about 1.5 to 1.9 mt of urad annually from about 3.5 m ha of area, with an average productivity of 500 kg ha<sup>-1</sup>. Black gram output accounts for about 10% of India's total pulse production. Black gram production in the country remained stable more than a decade through the 2000s at around 12 to 14 lakh tons. But a sudden jump in output was noted in 2010-11 to 17.5 lakh tonnes primarily on account of rise in production from Madhya Pradesh, Rajasthan and Tamil Nadu. As per the latest available estimates, UP and Maharashtra occupy the first two positions, contributing over 32%. Individually, Madhya Pradesh and Andhra Pradesh contribute 14% each to total production in the country.

Agricultural feasibility and economic viability of black gram (*Phaseolus mungo* L.) as sole as well as intercrop in different crop sequence have been established due to its unique property of maintaining and restoring soil fertility through biological nitrogen fixation as well as conserving and improving physical properties of soil by virtue of its deep root system and leaf fall. Phosphorus is essential constituent of every living cell. It is concerned with structural compounds, nucleic acids for reproductive purpose, and the conservation and transfer of energy in the metabolic reactions taking place. Phosphorus stimulates the symbiotic nitrogen fixation because in presence of phosphorus bacterial cell becomes mobile which is pre-requisite for migration of bacterial cell to root hair for nodulation (Charel 2006) [2]. It also plays an important role in the process of photosynthesis, energy conservation and transportation, cell division and meristematic growth in living tissues, grain quality and most of physico-biochemical activities. Sulphur is another essential nutrient which is usually required by leguminous crops in amounts comparable to Phosphorus. Sulphur is known to help in chlorophyll formation, stimulating growth, seed formation and Nitrogen fixation by enhancing nodule formation. Unlike Nitrogen, Sulphur deficiency symptoms appear first on the younger leaves, and will persist even after Nitrogen application. Plants deficient in Sulphur are small and spindly with short and slender stalks, growth is retarded, maturity in

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cereals is delayed, Plants deficient in Sulphur are small and spindly with short and slender stalks, growth is retarded, maturity in cereals is delayed, nodulation in legumes may be poor and Nitrogen fixation reduced. Sulphur application also has marked effect on soil properties and is used as soil amendment to improve the availability of other nutrients in soil as gypsum and pyrite (Nad & Goswami, 2010) [9].

Black gram (*Phaseolus mungo*) is an important food legume widely consumed in India. It also plays an important role in sustainable agriculture enriching the soil through biological nitrogen fixation. It is mostly grown in Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, Rajasthan and Gujarat during rainy season, where as in Andhra Pradesh and West Bengal in winter (rabi) season (Ram *et al.*, 2010) [13]. Keeping the above facts in view the present study was conducted in Kharif season of 2019-2020 at department of crop physiology at Vindhya Science & Agricultural Research Institute, Raushar, Rewa (M.P.) during 2019 to 2020. To study the effect of P and S, on growth, yield and economics of black gram.

### Materials and Methods

Field experiment was conducted in the department of crop physiology at Vindhya Science & Agricultural Research Institute, Raushar, Rewa (M.P.) during 2019 to 2020. The experiment comprising of three levels of phosphorus (0, 20 and 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and three levels of Sulphur (0, 15 and 30 kg S ha<sup>-1</sup>) in Black gram. Thus, in all 9 treatment combinations were compared in a 'Randomized Block design' having with three replications. The soil was deficient in available nitrogen (183.50 kg ha<sup>-1</sup>) and medium in available phosphorus (14.4 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and available potash (243.00 kg K<sub>2</sub>O ha<sup>-1</sup>). Black gram variety Awasthi was sown with seed rate of 20 kg ha<sup>-1</sup> in furrows at the depth of approximately 3-4 cm by hand and covered with soil immediately. The recommended quantities of fertilizer (20 kg N and 20 kg K<sub>2</sub>O ha<sup>-1</sup>) and levels of P and S as per treatment were applied through Urea, Single Super Phosphate, Muriate of potash (MOP) and Sulphur (Cossavet), respectively. Entire required quantity of nitrogen, phosphorus, potash and sulphur were applied at the time of sowing, as basal application. The irrigation was applied as per requirement of the crop on different growth stages and other management practices were adopted as per recommendations.

### Results and Discussion

The plant growth attributes i.e. plant height, number of branches and number of leaves plant<sup>-1</sup> appreciably improved with the application of phosphorus up to 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The application of phosphorus significantly increased dry matter accumulation in plant at all the stages of crop growth and differences were well marked up to 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The magnitude of increase in dry matter yield plant<sup>-1</sup> with 20 and 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was to the tune of 13.66 and 21.16 per cent, respectively over the control. The favourable effect of phosphorus on growth might be due to the fact that phosphorus is chief constituent of the lipoids and nucleoproteins, an abundance of phosphorus in the meristematic region might have helped in cell division and multiplication, it is also concerned the carbohydrate transformation, respiration and nitrogen fixation and hence boosted plant growth. The response of phosphorus application in terms of dry matter accumulation in plant up to 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> have also been reported by Niraj and Ved Prakash (2014) [10]. Application of 15 and 30 kg S ha<sup>-1</sup> resulted in appreciably

higher dry matter plant<sup>-1</sup> than the control at all the stages of crop growth. At harvest, the increase in dry matter accumulation plant<sup>-1</sup> with the application of 15 and 30 kg S ha<sup>-1</sup> was 13.23 and 21.05 per cent, respectively over the control. Dry matter accumulation is the resultant of better plant growth. In this study, plant height, number of branches plant<sup>-1</sup> and number of leaves plant<sup>-1</sup> also exhibit similar trend to that of recorded in dry matter accumulation in plant. Niraj and Ved Prakash (2014) [10] also reported significant increment plant height, number of branches plant<sup>-1</sup> and dry matter accumulation in plant of black with the application of 30 or 40 kg S ha<sup>-1</sup> over the control. The plant with 20 and 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> took about 49 and 47 days for 75 per cent flowering and about 85 and 82 days for maturity, respectively. However, application of sulphur extended about one day to 75 per cent flowering and maturity. The root length, total and effective number of nodules plant<sup>-1</sup> and fresh and dry weight of root nodules were significantly increased with every increase in the rate of phosphorus application up to 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. However, Application of sulphur had no significant impact on these parameters. The beneficial effect of phosphorus on root development and nodulation were also reported by Kumar and Singh (2008). Biological yield ha<sup>-1</sup> appreciably increased with increasing rates of phosphorus application up to 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The magnitude of increase in biological yield with 20 and 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was to the tune of 86.46 and 134.65 per cent, respectively over the control. Which may be ascribed to the favourable effect of phosphorus application in case of plant height, number of branches and leaves plant<sup>-1</sup>. These results are in closed conformity with those of Kumawat, *et al.* (2013) [8] and Niraj and Ved Prakash (2014) [10]. Grain yield consequently increases with every increase in the rate of phosphorus application up to 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The magnitude of increase in grain yield with 20 and 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was to the tune of 104.56 and 176.6 per cent, respectively over the control. The application of phosphorus increases the symbiotic nitrogen fixation power and in turn, increased number of pods plant<sup>-1</sup>, Length of pod, number of grain pod<sup>-1</sup> and 1000 grain weight and ultimately grain yield. Biological yield of black gram appreciably increased with increasing rates of sulphur application. The increase in biological yield with 15 and 30 kg S ha<sup>-1</sup> was to the tune of 59.81 and 101.45 per cent, respectively over the control. Grain yield significantly increased with every increase in the rate of sulphur application up to 30 kg S ha<sup>-1</sup>. The increase in grain yield with 15 and 30 kg S ha<sup>-1</sup> was to the tune of 69.96 and 110.35 per cent, respectively over the control. Black gram crop responded well to the application of sulphur up to 30 or 40 kg S ha<sup>-1</sup> have also been reported by Niraj and Ved Prakash (2014) [10]. The interaction effect of phosphorus and sulphur levels was found to be significant on grain yield of black gram. Black gram crop fertilized with phosphorus at 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> along with 30 kg S ha<sup>-1</sup> was the best combination for higher grain production in Raushar, Rewa conditions. Harvest index significantly increased up to 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, because it is the function of seed yield and biological yield and these two yields were increased up to 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. 30 kg S ha<sup>-1</sup> appreciably improved harvest index over other levels of sulphur application and control. Nita Chand *et al.* (2002) [11] and Kumawat *et al.* (2013) [8] have also reported likewise. In this experiment the highest net profit of and B:C ratio was recorded with the application of 40 kg P<sub>2</sub>O<sub>5</sub> and 30 Kg S ha<sup>-1</sup> followed by 20 kg P<sub>2</sub>O<sub>5</sub> and 30 Kg S ha<sup>-1</sup>. Similar findings were observed by Niraj and Prakash (2014) [10].

Enhanced monetary returns as well as IBCR through improved farm technology have also been reported by

various workers (Kumari *et al.*, 2007; Choudhry *et al.* 2009; Choudhary *et al.* 2013) [7, 3, 4].

**Table 1:** Growth and development parameters of Black gram as influenced by levels of phosphorus and sulphur

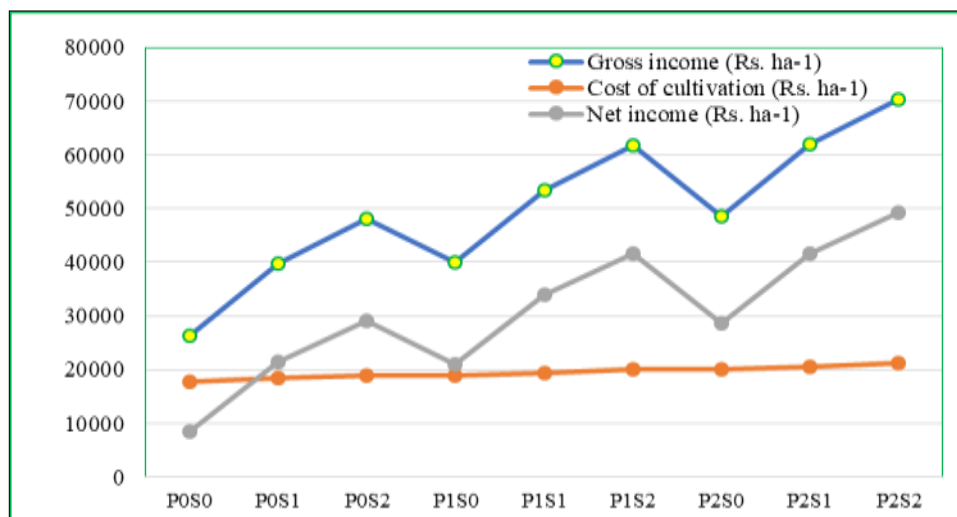
Treatments	Plant height (cm)	Number of branches plant <sup>-1</sup>	Number of leaves plant <sup>-1</sup>	Dry matter accumulation in plant (g)	Days to 75% flowering	Days to maturity
Phosphorus (kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> )						
0	11.94	6.04	7.68	22.48	51.13	88.25
20	13.22	6.72	9.46	25.55	48.87	84.52
40	14.44	7.15	10.45	27.26	47.04	82.16
Sem±	0.56	0.14	0.23	1.02	0.65	1.04
CD (P=0.05)	1.14	0.26	0.61	2.14	1.35	2.24
Sulphur (kg S ha <sup>-1</sup> )						
0	11.96	6.05	7.66	22.53	48.55	84.25
15	13.18	6.68	9.44	25.51	49.07	85.26
30	14.36	6.69	10.52	27.27	49.43	85.47
Sem±	0.57	0.13	0.29	1.02	0.62	1.04
CD (P=0.05)	1.14	0.26	0.61	2.14	NS	NS

**Table 2:** Yield and Yield attributes of Black gram as influenced by levels of phosphorus and sulphur

Treatments	Number of pods plant <sup>-1</sup>	Number of grains pod <sup>-1</sup>	1000- Grain weight (g)	Biological yield (kg ha <sup>-1</sup> )	Grain yield (kg ha <sup>-1</sup> )	Straw yield (kg ha <sup>-1</sup> )	Harvest index (%)
Phosphorus (kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup> )							
0	22.46	1.84	31.57	1635	421	1213	25.84
20	24.82	2.16	33.06	3047	875	2172	30.43
40	26.67	2.45	34.18	3835	1166	2665	30.45
Sem±	0.35	0.03	0.34	142	22	76	0.56
CD (P=0.05)	1.56	0.06	0.76	307	52	161	1.21
Sulphur (kg S ha <sup>-1</sup> )							
0	22.52	1.87	32.66	1635	424	1214	25.84
15	24.91	2.16	32.96	3046	875	2171	30.45
30	26.51	2.40	33.14	3835	1168	2668	30.44
Sem±	0.32	0.03	0.36	144	23	77	0.56
CD (P=0.05)	1.56	0.05	NS	306	50	162	1.20

**Table 3:** Economics of Black gram crop (Rs. ha<sup>-1</sup>) as influenced by levels of phosphorus and sulphur

Treatment	Gross income (Rs. ha <sup>-1</sup> )	Cost of cultivation (Rs. ha <sup>-1</sup> )	Net income (Rs. ha <sup>-1</sup> )	B:C ratio
P <sub>0</sub> S <sub>0</sub>	26220	17738	8512	1.46
P <sub>0</sub> S <sub>1</sub>	39748	18322	21435	2.16
P <sub>0</sub> S <sub>2</sub>	47985	18896	29086	2.55
P <sub>1</sub> S <sub>0</sub>	39901	18853	21046	2.14
P <sub>1</sub> S <sub>1</sub>	53408	19436	33972	2.76
P <sub>1</sub> S <sub>2</sub>	61657	20023	41634	3.08
P <sub>2</sub> S <sub>0</sub>	48544	19976	28557	2.46
P <sub>2</sub> S <sub>1</sub>	62053	20563	41490	3.03
P <sub>2</sub> S <sub>2</sub>	70302	21146	49154	3.34



**Fig 1:** Economics of Black gram crop (Rs. ha<sup>-1</sup>) as influenced by levels of phosphorus and sulphur

## Conclusion

On the basis of the results summarized above, it is concluded that Plant and root growth and yield and yield attributes can be obtained appreciably higher with the application of 40 kg  $P_2O_5$  ha<sup>-1</sup> and 30 Kg S ha<sup>-1</sup>. On the basis of maximum net return and B: C ratio black gram crop with the application of 40 kg  $P_2O_5$  ha<sup>-1</sup> along with 30 kg S ha<sup>-1</sup> may be recommended for the farmers of Rewa region in M.P.

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