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Performance of phosphorus and molybdenum levels on growth and economics of blackgram (*Vigna mungo* L.)

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Abstract
An experiment was carried out during *kharif* season of 2020 to evaluate the performance of phosphorus and molybdenum levels on yield and economics of blackgram (*Vigna mungo* L.) done at Crop Research Farm, SHUATS, Prayagraj. The experiment contains three doses of phosphorus (20, 30, 40 kg P_2O_5 /ha) and three dose of molybdenum (Seed treatment of 8g/kg seed, Foliar spray of 0.4% at 15 DAS and 0.8% at 25 DAS) which was followed in a Randomized Block Design and total nine treatments were designed and replicated thrice. Results revealed that plant height (45.53 cm), number of branches (5.33/plant), number of nodules per plant (25.20), dry weight (3.99 g), crop growth rate (3.40 g/m^2/day) and grain yield (1369.25 kg/ha) recorded significantly higher with the application of 40 kg/ha P_2O_5 along Mo (Foliar spray 0.8% at 25 DAS). However, highest gross returns of ₹ 87,499.03/ha and net returns ₹ 63,629.03/ha and B:C ratio of 2.67 were recorded in 40 kg/ha P_2O_5 + Mo (foliar spray 0.8% at 25 DAS), respectively.

Keywords: Blackgram, economics, growth, phosphorus, molybdenum

Introduction
India is the largest producer of pulses, for nearly 25 per cent of the share globally. Apart from having an important role in nutritional security and soil ameliorative properties, pulses have a specific role in sustainable agriculture. They holds atmospheric N in the nodules of roots and maintain the soil healthy and productive. Among the pulses, blackgram or urd (*Vigna mungo* L. Hepper) belongs to the family leguminoseae which has specific importance as it contains, 60% carbohydrates, 24% proteins, 1.3% fats and is rich in phosphorus about 5-10 times among the various pulses (Tomar *et al*., 2011) [12]. It occupies an area of about more than 5.44 million ha in the country producing 3.56 million tonnes. Maharashtra, Uttar Pradesh, Andhra Pradesh, Madhya Pradesh and Tamil Nadu are the major blackgram growing states in the country. In many soils, molybdenum is found very low. Application of Mo significantly increases the vegetative growth, nodule count, protein content and yield of blackgram (Singh *et al*., 2008; Kumawat *et al*., 2009 and Kumar *et al*., 2010) [4, 7, 8]. Cereals and legumes noticed a great response comparing to other crops by application molybdenum. It helps in good growth of foliage, nitrogen fixing and assimilation of nitrogen, nitrate reductive, as a constituent of nitrogen and reduction of acid phosphates (Kathyayani *et al*., 2021) [2]. Phosphorus is an important mineral element in root development, phosphate synthesis and phosphoproteins, energy fixing and releasing process in leguminous plants. Response of legumes to phosphate supplementation has been reported by several workers (Singh and Yadav, 2008) [8]. Keeping the above facts in view, the experiment was conducted to study the response of blackgram under effect of phosphorus and application of molybdenum treatments under eastern Uttar Pradesh condition.

Material and Methods
The experiment was laid out at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during *kharif* season 2020. The soil was sandy loam in texture with a pH of 7.4, low in organic carbon (0.28%), available N (225 kg/ha), available P (21.50 kg/ha) and available K (212.8 kg /ha). The experiment consisting of three phosphorus levels such as 20 kg/ha, 30 kg/ha, 40 kg/ha and three levels of application of molybdenum such as 8 g/kg seeds (seed treatment), 0.4% at 15 DAS and 0.8% at 25 DAS (Foliar spray). Total nine treatments combinations were done and arranged in a Randomized Block Design.

The treatment combinations arranged based on the factors are T_1: 20 kg/ha P_2O_5 + Mo 8 g/kg of seeds (seed treatment), T_2: 20 kg/ha P_2O_5 + Mo 0.4% foliar spray at 15 DAS, T_3: 20 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS, T_4: 30 kg/ha P_2O_5 + Mo 8 g/kg seeds (seed treatment), T_5: 30 kg/ha P_2O_5 + Mo 0.4% foliar spray at 15 DAS, T_6: 30 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS, T_7: 40 kg/ha P_2O_5 + Mo 8 g/kg seeds (seed treatment), T_8: 40 kg/ha P_2O_5 + Mo 0.4% foliar spray at 15 DAS, T_9: 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS. Urea and MOP were supplied based on the recommendation. Phosphorus is supplied on the basis of factors considered. Ammonium molybdate were given as a source of Molybdenum. Irrigation was given at the time of sowing. Growth attributing parameters are plant height, number of branches/plant, dry weight/plant, crop growth rate and relative growth rate was considered and recorded at harvest stage. Whereas, yield attributing parameters are number of pods/plant, number of seeds/pod, test weight, grain yield, haulm yield, biological yield and harvest index were considered. Based on the yield obtained gross returns, net returns and benefit: cost ratios were done. Data was statically analysed using Analysis of variance in a Randomized Block Design (Gomez and Gomez, 1984) [1].

Results and Discussion

Growth attributes

The data presented in Table 1, crop growth and development on blackgram was measures in terms of plant height (cm), number of branches (no.), number of nodules (no.), dry weight (g/plant), crop growth rate (g/m^2/day) and relative growth rate (g/g/day). At 60 DAS, the data on plant height shows significantly increase with (45.53 cm) was with application of phosphorus and molybdenum 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS. Whereas, with phosphorus and application of molybdenum 40 kg/ha P_2O_5 + Mo 0.4% foliar spray at 15 DAS (45.13 cm) was found statistically at par to 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS compared to other treatment combination. The plant height increase in growth parameters and yield might be due to application of phosphorus increased photosynthesis activity of plants resulting in development of plant growth in blackgram. Tomar *et al.* (2013) [13]. The increase in growth attributes due to molybdenum might be due to that is structural component of nitrogenises and enzyme actively involved in nitrogen fixation by root nodule bacteria of leguminous crops. Similar findings were also reported by Kumar and Sharma (2005) [5] and Khan and Prakash (2013) [3]. Number of branches per plant significantly high number of branches (5.33) was recorded with the levels of phosphorus and application of molybdenum 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS. Whereas, with phosphorus and application of molybdenum 40 kg/ha P_2O_5 + Mo 0.4% foliar spray at 15 DAS (5.13) are found statistically at par to 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS. Significantly higher number of nodules was recorded (25.20) with levels of phosphorus and application of molybdenum 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS. Whereas, with application of 40 kg/ha P_2O_5 + Mo 8 g/kg seeds (seed treatment) (21.09) are found statistically at par to 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS compared to other treatment combination. The plant dry weight (g/plant) were influenced significantly higher (3.99 g/plant) with combination of phosphorus and application molybdenum 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS. While, with 40 kg/ha P_2O_5 + Mo 0.4% foliar spray at 15 DAS (3.87 g/plant) are found statically at par to 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS. Phosphorus tends to increase in growth and development in terms of plant height, branches, nodules and dry weight by improving nutritional environment of rhizosphere these finding corroborate the results of Tanwar *et al.*, (2003) [10]. Crop growth rate (g/m^2/day) at 45-60 DAS was recorded maximum (3.40 g/m^2/day) with the levels of phosphorus and application of molybdenum 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS. Whereas, with 40 kg/ha P_2O_5 + Mo 0.4% foliar spray at 15 DAS (3.36 g/m$_2$/day), are found statically at par to 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS and the relative growth rate (g/g/day) at 45-60 DAS showed non-significant result the highest RGR were recorded (0.03 g/g/day) was recorded with combination of 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS. Significantly higher grain yield and haulm yield 1369.25 kg/ha and 2471.98 kg/ha at harvest in which are treated with the 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS and statistically at par with 40 kg/ha P_2O_5 + Mo 0.4% foliar spray 15 DAS 1229.55 kg/ha and 2439.48 kg/ha. The significant rise in growth parameters noticed under high fertilizers levels may be attribute uptake of nutrients by the plants favouring better cell division, elongation, amino acid and protein synthesis resulting superior expression of various crop growths attributes, increase in growth parameters and thereby yield attributes and yield under higher levels was also reported by Kumar *et al.* (2004) [6].

Economics

The data on cost of cultivation, gross return, net returns and B:C ratio as influenced by different treatments as presented in Table 2, the treatment containing with the phosphorus and application of molybdenum 40 kg/ha P_2O_5 + Mo 0.8% foliar spray at 25 DAS showed highest cost of cultivation (₹ 23870/ha). The data clearly revealed that maximum gross returns (₹ 87499.03/ha), net returns (₹ 63629.03/ha) and benefit cost ratio of (2.67) was recorded with 40 kg/ha P_2O_5 + 0.8% foliar spray at 25 DAS.

Table 1: Effect of phosphorus and molybdenum levels on growth parameters of blackgram (*Vigna mungo* L.)

	Treatments	Plant height (cm)	Branches/ plant (No.)	Nodules/ plant (No.)	Dry weight (g)	45-60 DAS CGR (g/m^2/day)	45-60 DAS RGR (g/g/day)	Grain yield (kg/ha)	Haulm yield (kg/ha)
1.	20 kg P/ha + Mo 8 g/kg of seeds (seed treatment)	39.13	4.20	20.50	3.56	3.18	0.02	841.15	2069.39
2.	20 kg P/ha + Mo 0.4% foliar spray at 15 DAS	42.47	4.40	18.72	3.66	3.12	0.03	881.19	2083.13
3.	20 kg P/ha + Mo 0.8% foliar spray at 25 DAS	43.53	4.67	20.10	3.75	3.11	0.02	1032.48	2416.43
4.	30 kg P/ha + Mo 8 g/kg of seeds (seed treatment)	39.27	4.67	18.52	3.62	2.90	0.03	889.28	2110.96
5.	30 kg P/ha + Mo 0.4% foliar spray at 15 DAS	43.07	4.87	20.70	3.81	3.24	0.03	933.09	2260.88
6.	30 kg P/ha + Mo 0.8% foliar spray at 25 DAS	44.53	4.00	19.85	3.83	3.29	0.03	1231.33	2349.73
7.	40 kg P/ha + Mo 8 g/kg of seeds (seed	44.60	4.40	21.09	3.71	3.15	0.03	1167.51	2416.43

	treatment)								
8.	40 kg P/ha + Mo 0.4% foliar spray at 15 DAS	45.13	5.13	20.15	3.87	3.36	0.03	1229.55	2439.48
9.	40 kg P/ha + Mo 0.8% foliar spray at 25 DAS	45.53	5.33	25.20	3.99	3.40	0.03	1369.25	2471.98
	SEm+	1.43	0.16	1.17	0.08	0.09	0.00	64.86	69.38
	CD (P = 0.05)	4.30	0.49	3.50	0.23	0.26	-	194.44	208.01

Table 2: Effect of phosphorus and molybdenum levels on economics of blackgram (*Vigna mungo* L.)

S. No.	Treatments	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C ratio
1.	20 kg P/ha + Mo 8 g/kg of seeds (seed treatment)	21110	54026.94	32916.94	1.56
2.	20 kg P/ha + Mo 0.4% foliar spray at 15 DAS	22130	56556.76	34426.78	1.56
3.	20 kg P/ha + Mo 0.8% foliar spray at 25 DAS	23630	66733.67	43103.67	1.82
4.	30 kg P/ha + Mo 8 g/kg of seeds (seed treatment)	21230	57080.09	35850.09	1.69
5.	30 kg P/ha + Mo 0.4% foliar spray at 15 DAS	22250	59914.91	38564.91	1.81
6.	30 kg P/ha + Mo 0.8% foliar spray at 25 DAS	23750	78748.53	54998.53	2.32
7.	40 kg P/ha + Mo 8 g/kg of seeds (seed treatment)	21350	74746.25	52511.25	2.36
8.	40 kg P/ha + Mo 0.4% foliar spray at 15 DAS	22370	78681.33	56311.33	2.52
9.	40 kg P/ha + Mo 0.8% foliar spray at 25 DAS	23870	87499.03	63629.03	2.67

Conclusion

It may be concluded that 40 kg P/ha + Mo 0.8% foliar spray at 25 DAS showed higher growth characters which result in higher yield and economics. However, it is recommended for farmers for receiving higher yield and economic benefits.

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