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Performance of blackgram (*Phaseolus mungo* L.) cultivars as influenced by row spacings and molybdenum

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ABSTRACT
A field trial was conducted to assess the performance of blackgram cultivars to row spacings and molybdenum doses at the Instructional-cum-Research Farm, Indira Gandhi Krishi Vishwavidyalya, Raipur (Chhattisgarh), under rainfed conditions during *kharif* season of 2011. The treatments comprised of three varieties *viz.*, Indra urd-1, RU-03-16 and RU-03-52; two row spacings *viz.*, 30x10 cm and 45 x 10 cm and three treatments of molybdenum *viz.*, control, 4 g/kg seed and 4 g/kg seed + two spray of urea @ 2%. The experiment was laid out in factorial randomized block design (FRBD) with three replications. Results revealed that all the growth and yield attibutes such as number of branches/plant, number of leaves/plant, seeds/plant, seed yield (781 kg/ha), biological yield (2736 kg/ha) and harvest index (29.71%) noticed significantly higher under cultivar Indra urd-1. Similarly, maximum production efficiency (9.52 kg/ha/day), economic efficiency (Rs. 218.82/ha/day) and gross returns (Rs. 32,335/ha) were also recorded in Indra urd-1 as compared to rest of the cultivars. Further results showed that all the growth and yield attributes *viz.*, number of branches/plant, number of leaves/plant, seeds/plant, seed yield (778 kg/ha), biological yield (2653 kg/ha) and harvest index (29.10%) recorded significantly higher in row spacing of 30 x 10 cm as compared to 45 x 10 cm. Maximum production efficiency (9.49 kg/ha/day), economic efficiency (Rs. 216.44/ha/day) and gross returns (Rs. 32,107/ha) were also recorded in 30 x 10 cm. Application of molybdenum @ 4 g/kg seed along with 2% urea spray twice gave highest seed yield (810 kg/ha), biological yield (2698 kg/ha) and harvest index (29.25%) over control and seed treatment with molybdenum @ 4 g/kg. Similarly, application of molybdenum + 2% urea spray twice gave maximum production efficiency (9.88 kg/ha/day), economic efficiency (Rs. 226.49/ha/day) and gross returns (Rs. 33,293/ha).

Keywords: Blackgram, Cultivars, Economic efficiency, Molybdenum, Row spacings, Yields

INTRODUCTION

Pulses have occupied immense significance in recent years as an important component of Indian economy. Pulses are seeds of leguminous plants and belong to the family *Fabaceae*. Pulses are rich source of protein and thus form an important part of vegetarian diet supplying the major portion of the protein requirements to human nourishment. About 88 per cent of protein consumed in India is of vegetable origin. Pulses have 2-6% fats and can meet the essential fatty acids (Kumar *et al*. 2018 and Mahilane and Singh, 2018). Blackgram is a widely grown grain legume and assumes considerable importance from the point of food and nutritional security in the world. Blackgram is favorable short duration pulse crop as it thrives better in all seasons either as sole or as intercrop or fallow crop. India is the world's largest producer as well as consumer of blackgram. In India, it is cultivated in an area of 1.38 Mha with an annual production of 1.46 MT but the productivity of the crop is only 459 kg/ha (Singh *et al*. 2015). Selection of suitable cultivars for the location of a crop so, specific high yielding cultivars for the location should be shown for a particular place. Similarly appropriate spacing is also neces-

sary for interception of sunlight to each stratum of plant leaves which enhances the rate of phosynthesis consequently dry matter production (Joshi and Rahevar, 2015). Row planting facilitates easy intercultural operations resulting in higher yields. Row planting with appropriate planting density can help ensure optimum plant population/unit area thereby increasing the yield.

Micronutrients play an important role in increasing legume yield through their effect on the plant itself, nitrogen fixing symbiotic process and effective use of major and secondary nutrients. Among micronutrients, cobalt and molybdenum are essential for the growth of *Rhizobium* and nitrogen fixation (Singh *et al*., 2017). Molybdenum is very low in many soils. Application of molybdenum significantly increased the vegetative growth, nodule numbers, grain protein content and yield of blackgram as compared to control (Kumar *et al*., 2010). The essential role is played by trace elements in nutrition and metabolism of plant. Molybdenum, one of the important member of this group is of special significance due to its contribution in activation of several enzyme systems and physiological activities encountered

inside the plant body. Molybdenum is a constituent part of the enzyme nitrate reductase concerned with the reduction of nitrate to nitrite in both micro organism and higher plants. It is also known to be specific inhibitor for acid phosphatase. Deficiency of molybdenum has also been shown to decrease the concentration of sugars, particularly reducing sugars, suggesting an involvement of molybdenum in carbohydrate metabolism (Malik *et al*., 2015). The reasons for low yield are manifold: some are plant geometry, varietals and some are agronomic management practices. Keeping these facts, a field experiment was conducted to investigate the performance of blackgram (*Phaseolus mungo* L.) as affected by row spacings, cultivars and seed treatment with molybdenum.

MATERIALS AND METHODS

A field experiment was planned to assess the effect of row spacings, cultivars and seed treatment with molybdenum on growth, yields and profitability of blackgram conducted at the Instructional-cum-Research Farm, Indira Gandhi Krishi Vishwavidyalya, Raipur (Chhattisgarh), under rainfed conditions during *kharif* season of 2011. The experiment was laid out in factorial randomized block design with three replications. The treatments comprised of three varieties *viz*., V_1=Indra urd-1, V_2=RU-03-16 and V_3=RU-03-52; two plant density *viz*., P_1= 30x10 cm and P_2= 45 x 10 cm and three treatments of molybdenum *viz*., S_1= control, S_2= 4 g/kg seed and S_3= 4 g/kg seed along with two spray of 2 urea @ 2%. The soil of the experiment field was black clay soil (sand 52.46, silt 22.28 and clay 25.26%) in texture, neutral in soil reaction (pH 7.05), low in organic carbon (0.43%), available N (193.2 kg/ha), available P (9.87 kg/ha) and high in available K (310.2 kg/ha). Seeds of blackgram were sown on 07th July 2011 with two spacing of 30 x 10 cm and 45 x 10 cm. Crop was sown on well prepared seedbed in lines with single row hand drill. Recommended dose of fertilizers (NPK) was applied as basal dose before sowing of crop. Seed treatment with molybdenum @ 4 g/kg done as per treatments. Foliar spray of 2% DAS was given twice at flower initiation and 15 days later as per treatments. For reduce weed infestation, one hand weeding was done at 25 days after sowing (DAS) and second on 45 DAS. All other cultural practices such as hoeing, irrigation, insect- pest control were kept normal for all the treatments. In each treatment plot and replications, randomly five plants were selected and their respective branches/plant, leaves/plant and seeds/plant was recorded. After threshing and winnowing the weight of seeds for each net plot area was recorded in kg/plot and then converted to kg/ha. Harvest index was calculated as per suggested formula by Kumar *et al*. (2014). Production efficiency and economic efficiency was calculated as following formula suggested by Kumawat *et al.* (2015). The data collected on various parameters was analyzed statistically by using Fisher's analysis of variances techniques and differences among treatment means were compared by using LSD at 5% probability level (Ranganathan, 1990).

RESULTS AND DISCUSSION

Effect of cultivars on yields and economics: The results revealed that growth characters (number of branches/plant and number of leaves/plant), yield attributes (seeds/plant), seed yield, biological yield and economics were significantly influenced due to cultivars (Table 1). Among the different cultivars, significantly higher values of number of branches/plant (3.07, 4.92 and 5.38 at 40, 60 DAS and harvest stage, respectively) was noted by the cultivar Indira Urd-1 which was superior to RU-03-16 and RU-03-52. Similarly, cultivar Indira Urd-1 produced maximum number of leaves/plant (8.65, 14.79 and 13.67 at 40, 60 DAS and harvest stage, respectively) which was shown superiority over rest of cultivars. Significantly higher number of seeds/plant (141.54) was recorded by Indira Urd-1 cultivar as compared to RU-03-52 (125.29) and RU-03-16 (117.02). This might be due to genetically variability of cultivar. The results are in line with those reported by Kabir and Sarkar (2008), Panotra *et al*. (2016) and Kumar *et al*. (2018).

Among the various cultivars, Indira Urd-1 produced significantly highest seed yield (781 kg/ha) and biological yield (2736 kg/ha) as compared to

Table 1. Branches/plant, leaves/plant and seeds/plant of blackgram as influenced by cultivars, row spacings and seed treatment with molybdenum.

Treatments	Number of branches/plant			Number of leaves /plant			Seeds/ plant
	40 DAS	60 DAS	At harvest	40 DAS	60 DAS	At harvest	
Cultivars							
Indira Urd-1	3.07	4.92	5.38	8.65	14.79	17.86	141.54
RU-03-16	2.65	4.11	4.87	8.17	13.65	16.08	117.02
RU-03-52	2.87	4.61	4.95	7.97	12.11	15.63	125.29
SEm±	0.01	0.02	0.02	0.02	0.05	0.05	1.11
CD (P=0.05)	NS	0.07	0.07	NS	0.16	0.15	3.50
Row spacings							
30 x 10 cm	2.68	4.14	4.48	8.13	13.01	16.16	127.00
45 x 10 cm	3.05	4.95	5.65	8.40	14.05	16.89	134.00
SEm±	0.01	0.02	0.04	0.01	0.03	0.03	0.74
CD (P=0.05)	NS	0.06	0.12	NS	0.10	0.10	2.33
Seed treatments							
Control	2.46	3.95	4.44	7.99	12.53	15.40	106.23
Mo @ 4g/ kg seed	2.84	4.63	5.11	8.37	13.8	16.6	122.55
Seed treatment with Mo + 2% urea spray twice	3.30	5.05	5.65	8.43	14.25	17.58	153.30
SEm±	0.03	0.06	0.05	0.06	0.10	0.10	5.78
CD (P=0.05)	NS	0.20	0.16	NS	0.30	0.30	16.86

Table 2. Yields and economics of blackgram as influenced by cultivars, row spacings and seed treatments with molybdenum.

Treatments	Grain yield (kg/ha)	Biological yield (kg/ha)	Harvest Index (%)	Production efficiency (kg/ha/day)	Cost incurred (Rs./ha)	Gross returns (Rs./ha)	Economic efficiency (Rs./ha/day)
Cultivars							
Indira Urd-1	781	2736	29.71	9.52	14392	32335	218.82
RU-03-16	718	2491	27.50	8.76	14202	29566	187.38
RU-03-52	766	2635	28.68	9.34	14297	31519	210.04
SEm±	1.0	2.0	0.05	0.01	-	44	0.54
CD (P=0.05)	4.0	6.0	0.17	0.05	-	139	1.70
Row spacings							
30 x 10 cm	778	2653	29.10	9.49	14360	32107	216.44
45 x 10 cm	732	2589	28.18	8.93	14233	30173	194.39
SEm±	1.0	1.0	0.38	0.01	-	29	0.35
CD (P=0.05)	2.0	3.0	0.12	0.02	0	93	1.13
Seed treatments							
Control	703	2547	28.02	8.57	13818	29089	186.23
Mo @ 4g/ kg seed	751	2617	28.62	9.16	14350	31038	203.51
Seed treatment Mo + 2% urea spray twice	810	2698	29.25	9.88	14722	33293	226.49
SEm±	7.0	8.0	0.11	0.09	-	273	3.35
CD (P=0.05)	20.0	22.0	0.33	0.24	-	797	10.45

RU-03-52 and RU-03-16 (Table 2). While lowest seed yield was recorded in RU-03-16 (718 kg/ha). The increase in grain yield and biological yield was 8.77 and 9.70 per cent by the Indira Urd-1 as compared to RU-03-16. Similar trend was also followed in harvest index. Significantly higher harvest index (29.71%) was observed in cultivar Indira Urd-1 as compared to RU-03-16. This could be ascribed due to variation occurred due to the contribution of different yield traits. Harvest index is an important physiological character that reflects dry matter partitioning of a given genotype to the economic part. Higher harvest index results higher crop yield probably due to more partitioning of dry matter to reproductive sink. Similar results have been reported by Singh *et al*. (2011) in mungbean, Panotra *et al*. (2016) in blackgram and Kumar *et al*. (2018) in blackgram.

Further date presented in table 2 showed that maximum cost of cultivation Rs. 14,392/ ha and gross returns of Rs. 32,335/ha was observed in Indira Urd-1 followed by RU-03-52 and RU-03-16 (Table 2). The better yield attributes and yields produced by Indira Urd-1 which might be responsible for higher the economics of blackgram. The maximum production efficiency (9.52 kg/ha/day) and economic efficiency (Rs. 218.82/ha/day) was also recorded with Indira Urd-1 cultivar which was proven superiority among the cultivars. Similar findings were also made by Joshi Rahevar (2015)

Table 3. Interaction effects of cultivars, row spacings and seed treatments with molybdenum on grain yield (kg/ha)

Treatments	P_1	P_2	Treatments	V_1	V_2	V_3
V_1	814.16	747.13	S_1	718.43	682.01	708.96
V_2	729.77	705.75	S_2	776.41	720.76	757.18
V_3	789.02	742.9	S_3	847.09	750.51	831.73
Interactions	To compare means of			SEm±		CD (P=0.05)
VxP				6.84		21.56
VxS	2 S levels at same V			16.44		47.99
	2 V levels at same S			14.20		42.62

in Indian bean and Kumar *et al*. (2018) in blackgram.

Effect of row spacings on yield and economics: Row spacings significantly influences on growth characters *viz*., number of branches/plant and number of leaves/plant, yield attributes *viz*., seeds/plant, seed yield, biological yield, harvest index, gross returns, production efficiency and economic efficiency of blackgram (Tables 1). Significantly the maximum number of branches/plant (3.05, 4.75 and 5.65 at 40, 60 DAS and harvest stage, respectively) was recorded at 45 x 10 cm plant spacing as compared to 30 x 10 plant spacing. Further data revealed that maximum number of leaves/plant (8.40, 14.05 and 16.89 at 40, 60 DAS and harvest stage, respectively) was noted under density 45 x 10 cm which was significantly superior over 30 x 10 cm. Due to wider spacing might attributed to crop growth and development was suppressed due to intra-specific competition particularly for moisture, light and nutrients which might be resulted in less number of branches and thereby reduced dry matter accumulation plant. These results are in agreement with that reported by Singh *et al*. (2011) in mungbean. Similarly, significantly higher number of seeds/plant (134.0) was recorded under wider row spacing of 45 x 10 cm as compared to 30 x 10 cm. This was probably due to more space per plant ultimately enhanced availability of nutrients, moisture and light consequently better development of yield attributes. These results are in contradiction with those obtained by Satyamoorthi *et al.* (2008) in greengram Panotra *et al*. (2016) in blackgram.

The highest seed yield of 778 kg/ha and biological yield of 2653 kg/ha was obtained with 30 x 10 cm row spacing which was significantly superior over 45 x 10 cm plant spacing (Table 2). Similarly, significantly higher harvest index was observed in spacing of 30 x 10. The increase in seed yield and biological yield was sown 30 x 10 cm plant spacing was 6.88 and 2.47 per cent, respectively as compared to 45 x 10 cm. This might be due to better expression of growth characters and yield attributes as discussed earlier may also be the possible reasons for the production of higher yields. These results are in agreement with that reported by Kabir and Sarkar (2008) in mungbean, Kumar *et al*. (2013) in blackgram and Panotra *et al*. (2016) in blackgram.

Higher gross returns of Rs. 32,107 was fetched in 30 x 10 cm spacing and lowest in 45 x 10 cm (Rs.30173/ha). The highest production efficiency (9.49 kg/ha/day) and economic efficiency (Rs. 244.16/ha/day) was recorded with 30 x 10 cm row spacing followed by in 45 x 10 cm. Similar results were also reported by Kumar *et al*. (2010), Kumar and Kumawat (2014) and Kumar *et al*. (2018).

Effect of molybdenum on yield and economics: Application of molybdenum significantly influenced the number of branches/plant, number of leaves/plant and seeds/plant of blackgram (Table1). The maximum number of branches/plant (3.30, 5.05 and 5.65 at 40, 60 DAS and harvest stage, respectively), number of leaves/plant (8.43, 14.25 and 13.9340, 60 DAS and harvest stage, respectively) and seeds/plant (153.30) were recorded under seed treatment with Mo followed by 2% urea spray twice as compare to control and seed treatment with Molybdenum alone @ 4 g/kg. Due to presence of adequate amount of major nutrients and availability of Mo in the soil, might have enabled the plant to fix nitrogen from the atmosphere in nodules which improved the plant growth and its development and was probably responsible for increased growth attribute and finally enhanced the yield of blackgram. Similar results have also been reported by Kumaran and Subramanian (2002) in blackgram and Malik *et al.* (2015) in mungbean.

The highest seed yield (810 kg/ha) and straw yield (26.98 kg/ha) was recorded in seed treatment with Mo + 2% urea spray twice, being significant over seed treatment with Mo @ 4 g/kg and control (Table 2). The increase in seed yield and biological yield was 15.22 and 5.92 per cent, respectively over control. This might be due to phenomenal increase was attributed apparently to increased availability of nitrogen in the soil which helped the plants to produce abundance of effective nodules which in turn led to produce huge bio-mass, pod and seed yield. These results are contradiction with those obtained by Karpagam and Rajesh (2014) in mungbean and Kumar *et al*. (2018) in blackgram.

Maximum gross returns (Rs. 33,293/ha) was obtained from the application of seed treatment with molybdenum followed by 2% urea spray twice

followed by seed treatment with molybdenum only. Whereas, lowest net return (Rs. 29,089/ha) was recorded in control. Similarly, seed treatment with molybdenum and 2% urea spray twice gave maximum production efficiency (9.88 kg/ha/day) and economic efficiency (Rs. 226.49/ha/day) which was significantly superior over control and seed treatment alone. The superiority of this treatment combination was might be due to better performance of individual treatments with respect to grain and straw yield production. Kumaran and Subramanian (2002) reported that the treatments as spray 2 per cent DAP + 25 ppm ammonium molybdenum + 100 ppm $ZnSO_4$ + 100 ppm $FeSO_4$ + 0.5 per cent urea resulted in a higher grain yield. Similar lines of result have also reported by Verma *et al.* (2011) in greengram and Karpagam and Rajesh (2014) in greengram.

Interaction effect: Seed yield of blackgram was significantly influenced by the interaction effects of row spacings and cultivars (Table 3). Indira Urd-1 sown on 30 x 10 cm spacing resulted in maximum grain yield (814.16 kg/ha). Thus it can be inferred that at the same or different levels of row spacing of 30 x 10 cm row spacing maintained its superiority over that of 45 x 10 cm spacing. The higher grain yield might be attributed to the higher amount of cumulative solar radiation activating the photosynthesis and favouring accumulation of more synthates in the sink. As regard to cultivars and seed treatment interaction effects data showed that Indira Urd-1 recorded maximum grain yield at all the levels of seed treatments. Significantly highest seed yield of blackgram (847.09 kg/ha) was recorded when crop were treated with molybdenum @ 4 g/kg seed followed by 2% urea spray twice and it excelled over all other treatment combinations. In an earlier study also linear increase in seed yield was recorded by Kabir and Sarkar (2008) in mungbean, Rajavel and Vincent (2009) in blackgram and Tahir *et al*. (2014) in blackgram.

Conclusion

From the above research findings it may be concluded that cultivars Indira Urd-1 grown with spacing of 30 x 10 cm along with seed treatment with Mo @ 4 g/kg + 2% urea spray twice was better for higher seed yield (781 kg/ha), and gross returns (Rs. 32,335/ha), production efficiency (9.52 kg/ha/day) and economic efficiency (218.82 Rs./ha/day) of blackgram under rainfed conditions of Chhattisgarh.

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