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Ravi Kumar
Department of Agronomy, College of Agriculture Indira Gandhi Krishi Vishwa Vidyalaya, Raipur, Chhattisgarh, India

GS Tomar
Department of Agronomy, College of Agriculture Indira Gandhi Krishi Vishwa Vidyalaya, Raipur, Chhattisgarh, India

Narendra Kumawat
AICRP Maize, Zonal Agricultural Research Station, Jhabua, M.P, India

Shishu Pal Singh
Department of Agriculture, Uttar Pradesh Government, Krishi Bhavan, Collectory Farm, Varanasi, U.P., India

Correspondence
Ravi Kumar
Department of Agronomy, College of Agriculture Indira Gandhi Krishi Vishwa Vidyalaya, Raipur, Chhattisgarh, India

Effect of varieties, plant density and molybdenum on yield and economics of blackgram under rainfed condition of Chhattisgarh

Ravi Kumar, GS Tomar, Narendra Kumawat and Shishu Pal Singh

Abstract
A field experiment was conducted to study the effects of varieties, plant density and molybdenum on production and profitability during the *kharif* season of 2011 at Instructional-cum-Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh). The experiment was laid out in a 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= 30 x 10 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%. Results revealed that significantly higher LAI (3.37), dry matter (10.21), nodules/plant (34.72), number of pods/plant (19.05), seeds/pod (7.73), 100- seed weight (4.07 g), grain yield (7.81 q/ha), straw yield (19.55 q/ha), net returns (Rs. 17943/ha) and benefit: cost ratio (1.24) were recorded in Indira Urd-1 cultivar. Similarly, maximum LAI (3.38), seeds/pod (7.35), 100-seed weight (4.02 g), grain yield (7.78 q/ha), straw yield (18.755 q/ha), net returns (Rs. 17,748/ha) and benefit: cost ratio (1.22) were noted under plant density of 30 x 10 cm. Whereas the maximum dry matter (10.44 g/plant), nodules/plant (36.03), number of pods/plant (19.17) were recorded with the plant density of 45 x 10 cm. Application of Mo @ 4 g/kg seed along with 2% spray of urea twice produced highest LAI (3.45), dry matter (11.54 g/plant), nodules/plant (36.16), number of pods/plant (20.24), seeds/pod (7.35), 100-seed weight (4.23 g), grain yield (8.10 q/ha), straw yield (18.88 q/ha), net returns (Rs. 18,570/ha) and benefit: cost ratio (1.25) which was significantly superior to seed treatment with Mo @ 4 g/kg and control (untreated). Hence, to obtain higher production, productivity and profitability of blackgram should be used cultivar of Indira Urd-1 with the plant density 30 x 10 cm and seed treated with Mo and two spray of urea.

Keywords: Economics, Growth characters, Plant density, Molybdenum, Yields, Varieties

Introduction
India is the largest producer of pulses, accounting for about 25 per cent of the global share. On account of their vital role in nutritional security and soil ameliorative properties, pulses have been integral part of sustainable agriculture since ages. They trap atmospheric N in the root nodules and keep the soil productive and healthy. Among various pulses, blackgram or urd (*Vigna mungo* L. Hepper) belonging to family leguminoseae is of immense importance as it contains, 60% carbohydrates, 24% protein, 1.3% fat and is the richest among the various pulses in phosphorus being 5-10 times richer than others (Tomar *et al*., 2011) [1]. The combination of *Daal-chawal* (pulse-rice) or *Daal-roti* (pulse-wheat bread) is an important ingredient in the average Indian diet. 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) [2]. The productivity of low mainly due to poor management practices adopted by the farmers and low yield potential of existing varieties due to short growth duration, slow rate of dry matter accumulation and non-responding to high inputs. Improved varieties of different pulse crops hold promise to increase productivity by 20-25%, whereas latest technology comprising improved varieties and integrated management of nutrients and pests has shown 25-42% yield advantage over the farmer's practices in a large number of frontline demonstrations conducted across the country (Ali and Gupta, 2012) [3]. To obtain the best yields from any crops it is important to have the correct spacing and plant population. These will vary with rainfall and soil type. It is the number of plants required to produce maximum output or biomass per unit area. Any increase beyond this stage results in either no increase or reduction in biomass. The optimum spacing favours the plants to grow in their both aerial and underground parts through efficient utilization of solar radiation and nutrients and thus

increase grain yield. 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 (Singh *et al*., 2008; Kumawat *et al*., 2009 and Kumar *et al*., 2010) [4, 5, 6]. In Chhattisgarh the yield potentiality of blackgram varieties have not been studied systematically and also not enhanced by standardizing agronomic practices. Keeping all these points in view, the present investigation entitled "to study the effects of varieties, plant density and molybdenum on production and profitability of blackgram" was undertaken.

Materials and Methods

A field experiment was conducted at the Instructional-cum-Research Farm, Indira Gandhi Krishi Vishwavidyalya, Raipur (Chhattisgarh) under rainfed conditions during *kharif* season of 2011 to study the influence of varieties, spacing and molybdenum on growth, yield and economics of blackgram. The experiment was laid out in a 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= 30 x 10 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 11th July 2011 with two spacing of 30 x 10 cm and 45 x 10 cm and seed rate of 20 kg /ha was taken. Recommended dose fertilizers (NPK) was applied as basal dose before sowing of crop. Seed treatment with molybdenum @ 4 g/kg done as per treatments. Foliar spary 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 operations such as hoeing, irrigation, insect-pest and diseases management same were done in all the treatments. In each treatment plot and replications, randomly five plants were selected and their respective branches/plant, dry matter/plant, pods/plant and seeds/pod was recorded. 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) [7].

Results and Discussion

Effect of Varieties

It was found that growth characters (LAI, dry matter/plant and nodules/plant), yield attributes (pods/plant, seeds/pod and 100-seed weight), seed yield and straw yield were significantly influenced due to varieties (Tables 1). Cultivar Indira Urd-1 produce maximum values of LAI (3.38 at 60 DAS) and which was significantly higher than those produce by other two cultivars. Significant variations in LAI due to different genotypes were also reported by Nag *et al.* (2000) [8]. Higher dry matter was recorded in Indira Urd-1 (10.21 g/plant) which was significantly superior to rest of both varieties. This might be due to owing to the fact that at optimum plant population provided favourable environment for development of individual plants. Further data showed that maximum nodules/plant (34.72) was observed in under Indira Urd-1 which was significantly superior to V_2 and V_3. Similarly, maximum pods/plant (19.05) registered in Indira Urd-1 and increases 9.44% and 11.28% over T_2 and T_3. Cultivar Indira Urd-1 produced maximum number of seeds/pod (7.43), which was significantly higher than RU-03-52 (7.15) and RU-03-16 (6.74). More number of seeds/pod in Indira Urd-1 might be due to better genetic character (Verma *et al.*, 2011) [9]. The results are in line with those reported by Khan and Asif (2001) [10] and Choudhary *et al.* (2016) [11]. Indira Urd-1 recorded significantly higher 100-seed weight (4.07 g) which was significantly superior when compared to control. Among varieties, Indira Urd-1 recorded significantly higher grain yield (7.81 q/ha) and straw yield (19.55 q/ha) which was significantly superior over V_2 and V_3. The lowest grain yield was obtained with RU-03-16 (7.18 q/ha). Among the various cultivars, maximum net returns of Rs. 17,943/ha and benefit: cost ratio of 1.24 was recorded under Indira Urd-1 followed by V_3 and V_2. The better expression of growth, yield attributes and yields by Indira Urd-1 might be responsible for raising the net returns. Similar findings were also made with Choudhary *et al.* (2016) [11].

Effect of Plant Density

Growth characters *viz*., LAI, dry matter/plant and nodules/plant, yield attributes *viz*., pods/plant, seeds/pod and 100-seed weight, seed and straw yield were significantly influenced due to plant density (Tables 1). The highest value of LAI (3.38) was recorded in the 30 x 10 cm spacing and the lowest (3.12) was found at the 45 x 10 cm. This could be ascribed due to competition among plants for solar radiation, nutrients and water in closer planting might be the reason behind greater LAI of blackgram. Kumaran *et al*. (2001) [12] stated that density of 40 plants m^{-2} recorded the highest leaf area index and net assimilation rate. Further data revealed that maximum dry matter (10.44 g/plant) was noted under density of 45 x 10 cm which proved significantly superiority over 30 x 10 cm. Due to higher plant density 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. Similarly, maximum number of nodule/plant (36.03) was observed with wider row spacing (45 x 10 cm) compare to narrower row spacing (30 x 10 cm). This was probably due to vigorous plant growth. These results are in contradiction with those obtained by Satyamoorthi *et al.* (2008) [13] in greengram. Significantly higher number of pods/plant (19.17) was recorded from 45 x 10 cm spacing as compare to 30 x 10 cm spacing. Plant density of 30 x 10 cm resulted in maximum number of seeds/pod (7.35) and 100-seed weight (4.02 g) which was significantly higher to that produced under 45 x 10 cm spacing. The highest grain yield of 7.78 q/ha and straw yield (18.75 q/ha) was obtained with 30 x 10 cm row spacing (P1) which was significantly superior over 45 x 10 cm plant density (P_2). 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 Kumar *et al*. (2013) [14]. Maximum net returns of Rs. 17,748 and benefit: cost ratio of 1.22 was observed in 30 x 10 cm plant density followed by 45 x 10 cm (Rs.15940/ha and 1.11). These results are in agreement with that reported by Kumar *et al*. (2010) [6].

Effect of Molybdenum

Application of molybdenum as seed treatment alone or in combination with 2% urea spray significantly influenced the

growth, yield attributes and yield of blackgram (Table1). Maximum leaf area index (3.45), dry matter/plant (11.54) and nodules/plant (36.16) were recorded under seed treatment with Mo followed by 2% urea spray twice (S_3) as compare to control and seed treatment with Molybdenum alone @ 4 g/kg. Further data presented in table 1 results revealed that application of Mo followed by 2% urea spray twice gave higher pods/plant (20.24), seeds/pod (7.35) and 100-seed weight (8.10 g) which was significantly superior to control and seed treatment with Mo @ 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 yield attribute and finally enhanced the yield of blackgram. Similar lines of result have also reported by Kumar *et al.* (2010) [6] and Tahir *et al.* (2014) [15].

The highest grain yield (8.10 q/ha) and straw yield (18.88 q/ha) was recorded at seed treatment with molybdenum and 2% urea spray twice (S_3), being significant over seed treatment with molybdenum only (S_2) and control (S_1). The maximum net return (Rs. 18572/ha) and benefit: cost ratio (1.25) was obtained from the application of seed treatment with molybdenum followed by 2% urea spray twice (S_3), which was followed by seed treatment with molybdenum only (S_2). Whereas lowest net return (Rs. 15271/ha) and benefit: cost ratio (1.10) was noted under the control. The superiority of this treatment combination was might be due to better performance of individual treatments with respect to grain and straw yield production. Similar lines of result have also reported by Verma *et al.* (2011) [9] and Khan and Prakash (2014) [16].

Interaction Effect

Interaction effect of varieties x plant density and varieties x seed treatments (Table 2) was found to be significant with respect to production of number of pods/plant of blackgram. At the same or different planting density, Indira Urd-1 resulted in maximum number of pods/plant (19.35), being significantly superior compared to other treatment combinations. Similarly at the same or different planting density, variety RU-03-16 produced significantly minimum number of pods/plant, lowest (14.44) being exhibited under 30 x 10 cm spacing. As regards to variety x seed treatment interaction, at same or different levels of seed treatments, Indira Urd-1 and seed treatment with molybdenum followed by 2% urea spray twice (S_3) produced the highest number of pods/plant (21.46) as compared to other treatment combinations. These results are contradiction with those obtained by Asaduzzaman *et al.* (2010) [17] and Tahir *et al.* (2014) [15].

Table 1: Effect of varieties, plant density and seed treatment with molybdenum on growth, yields and economics of blackgram.

Treatments	LAI	Dry matter/ plant (g)	Nodules/ plant at 60 Das	Pods/ plant	Seeds/ pod	100-seed weight (g)	Grain yield (q/ha)	Stover yield (q/ha)	Net returns (Rs/ha)	Benefit: Cost ratio
A.) Varieties										
V_1 (Indira Urd-1)	3.37	10.21	34.72	19.05	7.43	4.07	7.81	19.55	17943	1.24
V_2 (RU-03-16)	3.03	9.63	33.00	16.90	6.74	3.92	7.18	17.73	15365	1.07
V_3 (RU-03-52)	3.35	9.79	34.22	17.25	7.15	4.01	7.66	18.69	17223	1.19
SEm±	0.01	0.06	0.12	0.12	0.03	0.02	0.01	0.01	44	0.003
CD $_{5\%}$	0.02	0.20	0.40	0.39	0.11	0.06	0.04	0.02	139	0.009
B.) Plant density							0.00	0.00		
P_1 (30 x 10 cm)	3.38	9.32	35.25	17.29	7.35	4.02	7.78	18.75	17748	1.22
P_2 (45 x 10 cm)	3.12	10.44	36.03	19.17	7.03	3.97	7.32	18.57	15940	1.11
SEm±	0.01	0.04	0.08	0.08	0.02	0.01	0.01	0.00	29	0.020
CD $_{5\%}$	0.02	0.13	0.27	0.26	0.07	0.04	0.02	0.01	93	0.060
C.) Seed treatments							0.00	0.00		
S_1 (Control)	3.05	8.29	33.83	15.51	6.85	3.75	7.03	18.44	15271	1.10
S_2 (Mo @ 4g/ kg seed)	3.25	9.81	35.94	17.45	7.12	4.02	7.51	18.66	16688	1.15
S_3 (seed treatment with mo fb by 2% urea spray twice)	3.45	11.54	36.16	20.24	7.35	4.23	8.10	18.88	18572	1.25
SEm±	0.01	0.16	0.54	0.92	0.08	0.09	0.07	0.01	275	0.010
CD $_{5\%}$	0.04	0.49	1.57	2.68	0.23	0.27	0.20	0.02	802	0.050

Table 2: Interaction effects of varieties, plant density and seed treatments on number of pods /plant

Treatments	P_1	P_2	Treatments	V_1	V_2	V_3
V_1	19.35	18.97	S_1	16.7	15.53	14.03
V_2	14.44	19.13	S_2	19	15.33	18.03
V_3	15.31	19.2	S_3	21.46	19.83	19.43
Interactions	To compare means of			SEm±		CD (P=0.05)
VXP				0.74		2.36
VXS	2 S levels at same V			2.25		6.57
	2 V levels at same S			2.81		5.86

Conclusions

From the above study, it may be concluded that to obtain higher yields and economics of blackgram should be used cultivar of Indira Urd-1 with the plant density 30 x 10 cm and seed treated with Mo and two spray of urea.

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