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Effect of variety and spacing on growth and yield of Blackgram (*Vigna mungo* L.) under *Vertisol* of Chhattisgarh

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Abstract
The present investigation entitled "Effect of variety and spacing on growth and yield of Black gram (*Vigna mungo* L.) under *Vertisol* of Chhattishgarh'' was carried out at Instructional cum Research Farm, DKS College of Agriculture and Research Station, Bhatapara during *Kharif* season of 2019-20, with the objective to study the effect of different spacing and variety on growth and yield of blackgram. The soil of the experimental field was medium texture with low, medium and high in N, P and K, respectively. The climate of the region is sub-humid to semi-arid.

Experiment was laid out in Split Plot Design (SPD) with three replications and twelve treatment combination. Blackgram was sown on 13th July,2019 in a split plot design with crop geometry as main plot and variety in sub plot. There were six levels of crop geometry (cm) *viz.* S1-30×10 S2-30×5 S3-20×10 S4-20×5, S5-45×10 and S6-45×5 row to row and plant to plant and two level of varieties V1-Indira Urd-1 and V2-Pratap Urd-1. The crop was harvested on 5th October, 2019. Result indicated that the S4-20×5 cm at 20 DAS and at harvest was found effective in plant population and plant height, S5-45×10 cm at 20, 40 and 60 DAS was found effective in enhancing growth of branches and S1-30×10 at harvest was found effective in dry matter production of blackgram showed at par with S5-45×10 cm. The findings revealed that crop geometry (cm) 30×10 recorded significantly yield attributing characters, yield, gross return and net return. Variety Indira Urd-1 produced to significant higher growth parameters, yield attributing characters and net return and return per rupee invested as compared to Pratap Urd-1. The interaction between spacing and variety revealed that crop geometry 30×10 with variety Indira Urd-1 was produce significant higher seed yield as compared to other treatment combinations.

Keywords: Variety, Pratap urd-1, Indira urd-1, spacing, *Vertisol* of Chhattisgarh

Introduction
Blackgram (*Vigna mungo* L) is one of the main *kharif* pulse crop grown throughout the India, next to greengram. It is eaten in form of "dal" (wholly or split, husked or unhusked) or parched. It is the chief constituent of both "papad" and "bari" (spiced balls) making a delicious curry. The husked dal is ground in a fine paste in the south and allowed to ferment and is combine with same amount of rice flour to make "dosa" and "idli" serving as a savory dish is fried too. Urd dal is also used for the "halwa" and "imarti" preparation (Singh *et al*., 2010). Blackgram seed contain 55-60% carbohydrate, 22-24% protein and 1.0-1.3% of fat besides, phosphoric acid (H3PO4), being 5-10 times more than other pulses (Ali *et al*., 2002) [2] and sulphur containing amino acid (methionine and cysteine). However, blackgram, especially contains a higher percentage of methionine compared to other food legume (Tosu and Hsu, 1978) [29]. In India, Blackgram (*Vigna mungo* L.) is highly valued in vegetarian diets. It can be boiled or eaten whole, and used to make porridge or baked into bread and biscuits are ground into flour. The green pods are edible too. Dried blackgram contain about 9.7% water, 23.4% protein, 1.0% fat, 57.3% carbohydrate and 3.8% fibre along with 154 mg Calcium, 9.1 mg Iron, 0.37 g riboflavin and 0.42 g Thiamin in each gram of blackgram (Verma *et al*., 2011) [30] It is rich in vitamin A, B1, B3 and has small amounts of thiamine, riboflavin, niacin and vitamin C. This contains 78 to 80 percent nitrogen in the form of albumin and globulin. The dry seeds are good source of phosphorus. It also contains very high calorie content. India is the largest producer of pulses, producing about 25% of the world‟s production. Because of their vital role in nutritional protection and soil development, pulses have been an integral part of

sustainable agriculture since ancient times. (Tomar *et al*., 2011) [27] Total blackgram grown area in Chhattisgarh is 85.88 thousand hactares which contributes 27.80 tonnes production with a typical productivity of 324 kg/ha reported (Ministery of Agriculture Government of Chhattissgarh. 2017-18) Blackgram is short duration pulse crop which is grown in India area of 50.31 lakh hactor having the production of 32.84 lakh tons with productivity 652 kg/ha.(Ministry of Agriculture and Farmer Welfare, 2017-18) Low productivity mainly due to poor management practices of farmers and low potential yield of existing species due to short growth time, slow accumulation of dry matter and non-responding to high inputs. Improved varieties of different pulse crops hold promise to increase productivity by 20-25%, where as latest technology, which includes improved varieties and integrated nutrient and pest management, showed 25-42% advantage over the farmer‟s practices in a large number of frontline demonstrations conducted across the country (Ali and Gupta, 2012) [3]. It is important to have the correct spacing and plant population to get the best yields from any crop. These will differ with type of soil and the rainfall. It is the number of plants per unit area required to produce maximum output or biomass any rise beyond this stage would result in no increase or decrease in biomass either. The optimum spacing encourages plants to grow in their both aerial and underground parts by using solar radiation and nutrients efficently and thus increasing grain yield. (Singh *et al*., 2008; Kumawat *et al*., 2009 and Kumar *et al*., 2010) [25, 15, 12] It is prime necessity to maintain optimum plant population by maintaining inter and intra row spacing properly. Maximum or minimum plant density may minimize yield of blackgram causing physiological change in plant. Hence appropriate fertilizer dose with adequate plant population may increase crop yield of blackgram. Similar results were noted by (Choudhary *et al*. 2017) It is prime necessity to maintain optimum plant population by maintaining inter and intra row spacing properly. Maximum or minimum plant density may minimize yield of blackgram causing physiological change in plant. Hence appropriate fertilizer dose with adequate plant population may increase crop yield of blackgram.

Method and Material

A field experiment was conducted at Research cum Instructional Farm, Dau Kalyan Singh College of Agriculture and Research Station Bhatapara, during rainy season of 2019-20. The experimental soil was clay in texture with pH 7.47 EC 0.30 dsm-1, organic carbon 0.30%, low in available nitrogen (112.8 kg ha-1), medium in phosphorus (12.74 kg ha-1) and high in
available potassium (385 kg ha-1). The experiment was laid out in split plot design with three replication. The treatments was consisted six spacing(cm) 30×10, 30×5, 20×10 20× 5, 45×10 and 45× 5 and two varieties Indira Urd-1and Pratap Urd-1. Spacing in main plot and varieties in sub plot are adopted. Crop was sown in second week of July. Recommand dose of fertilizer applied 20 kg ha-1 of nitrogen, 50 kg ha-1 phosphorus and 20 kg ha-1 potassium. Crop harvest in first week of October. Five plants were taken for recording growth parameters. The seed yield was taken plot wise and converted into kg ha-1. Optimum plant population and spacing are important factor for obtaining high seed yields of blackgram. The aim of the present study was to find out optimum seed yield and economics pattern for farmer economy in planted different spacing and variety.

Economic analysis Harvest Index (%)

The harvest index was determined by using the formula given by Donald (1962).

$$\text{Harvest index \%} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Where

Economic yield = Seed yield
Biological yield = Seed yield + Straw yield

Cost of cultivation

The cost of cultivation (Rs ha-1) of each treatment was worked out by considering the price of inputs, charges for cultivation, labour and other charges.

Gross returns

The gross returns (Rs ha-1) occurred due to different treatments in the present study were worked out by considering market prices of economic product, by product and crop residues during the experimental year.

Net returns

The net returns (Rs ha-1) of each treatment were worked out by deducting the mean cost of cultivation of each treatment from the gross monetary returns gained from the respective treatments.

B:C ratio

The B:C ratio of each treatment was calculated by dividing the net returns by the mean cost of cultivation.

Table 1: Response of growth parameters of Blackgram as influenced by Spacing and variety on of Blackgram

Treatment	Plant hight(cm)	No. of branches/plant	Dry matter accumulation g/plant	Leaf area index
Spacing (cm)				
30×10	28.893	5.482	9.427	3.176
30×5	31.400	5.400	8.022	5.548
20×10	30.128	5.387	8.378	4.286
20×5	34.805	5.070	7.390	8.213
45×10	26.892	6.010	8.977	2.011
45×5	28.773	5.878	8.697	3.924
S.Em ±	1.071	0.164	0.216	0.124
CD 5%	3.374	0.518	0.681	0.389
Varieties				
Indira Urd-1	31.133	5.808	8.818	4.935
Pratap Urd-1	29.164	5.267	8.146	4.117
S.Em ±	0.622	0.162	0.215	0.071
CD 5%	1.916	0.499	0.664	0.217

Result and Discussion

Effect of varieties and spacing in growth parameters of Blackgram Plant height (cm)

The data pertaining to plant height of blackgram as influenced by spacing (cm) and varieties were presented in Table 1. Result revealved that the plant population increased with the passage of time interval but sharp increase in height was recorded in 20 to 40 DAS. In between 60 DAS to at harvest increased in slow pace. At 60 DAS, spacing (cm) was recorded significant taller plant in 20×5 cm, However, it was found at par to spacing of 30×5 cm and followed by 20×10 cm and 30×10 cm. and smallest plant in 45×10 cm. In case of varieties,, Indira Urd-1‟ was recorded significantly taller plant in variety as compared to „Pratap Urd- 1‟. At harvest, similar trend was recorded as in 60 DAS. Taller plants observed under narrow spacings could be due to lack of enough space for lateral growth resulting in vertical growth.

A.K.K. *et al.* (2007), also conclude that moderate row spacing *viz*., 30 and 35 cm numerically produced the highest plant height i.e. 49.89 and 49.22 cm respectively. Hamid *et al.* (2002) the increase in plant height at closer spacing might have been caused due to increased plant population density.

Number of branches/plant

The data on number of branches/plant of blackgram as influenced by spacing (cm) and varieties were presented in Table 1. The data was recorded at 20, 40 60 DAS and at harvest. Data revealed that the number of branches/plant was affected significantly at all the stages due to different spacing (cm) and different variety**.** At 20 DAS, number of branches/plant was recorded significant maximum in 45×10 cm spacing, However, it was found at par to spacing of 45×5 cm and followed by 30×10 cm and lowest in 20×5 cm. In case of varities,,, Indira Urd-1‟ was recorded significantly maximum number of branches/plant and lowest in „Pratap Urd-1‟. At 40 DAS, Spacing (cm) was recorded significant maximum number of branches/plant in 45×10 cm followed by 45×5 cm and 30×10 cm and lowest in 20×5 cm. In case of variety, significantly maximum number of branches/plant was recorded is „Indira Urd-1‟ and lowest in „Pratap Urd-1‟. At 60 DAS, spacing (cm) was recorded significant maximum number of branches/plant in 45×10 cm However, it was found at par to spacing of 45×5 cm and followed by 30×10 cm and lowest in 20×5 cm. In case of varieties, significant maximum number of branches/plant recorded in variety „Indira Urd-1‟ and lowest in „Pratap Urd-1‟ and at harvest was same trend as 60 DAS for both spacing and variety. Increase of plant density, decreased the number of branches/plant due to plants at higher densities accumulate less carbon which is not sufficient to support more branching. Similar observations have been reported by Gama *et al.* (2007).

Dry matter accumulation (g/plant)

Dry matter accumulation of blackgram was recorded at 20, 40, 60 DAS and at harvest and presented in the Table 1. Dry matter accumulation (g/plant) was significantly affected by different treatment and it was found significant at 40, 60 DAS and at harvest. Data showed increasing dry matter accumulation at 20 DAS, to at harvest in different treatments. At 20 DAS all the treatment for dry matter accumulation was found no significantly. At 40 DAS, spacing (cm) was recorded significant maximum dry matter accumulation (g/plant) in 30×10 cm However, it was found at par to spacing of 45×10 cm, and followed by 45×5 cm and lowest in 20×5 cm. In case of varieties, significantly maximum dry matter accumulation (g/plant) recorded in variety „Indira Urd-1‟ and lowest in „Pratap Urd-1‟. At 60 DAS and at harvest were same trend as 40 DAS for both spacing and variety. Higher dry matter accumulation was directly related to the higher value of LAI at different crop growth stage which gives an indication of higher photosynthesis and better plant growth rate. Similar results were also noted Satyamoorthi *et al*. (2008) stated that due to higher plant density crop growth and development was suppressed due to intra-specific competition in particular for moisture, light and nutrients which could result in less number of branches and thus decreased accumulation of dry matter/plant. Nag *et al*. (2000) found that growth characters (dry matter/plant), were significantly influenced due to varieties. Verma *et al*. (2011) [30] stated that higher dry matter was recorded in Indira Urd-1 (10.21 g/plant) which was significantly superior to both varieties remaining. This could be because to the fact that at optimum plant population provided favourable environment for development of individual plants.

Leaf area index (LAI)

Leaf area index (LAI) of blackgram was computed at 20, 40 and 60 DAS, and presented in Table 1. LAI is a measure of proportionate canopy coverage over ground. In general, leaf area index increased from 20 to 60 DAS. Leaf area index increasing in 20 to 40 DAS are fast and 40 to 60 DAS are at slow pace. At 20 DAS, spacing (cm) was computed significant maximum leaf area index in 20×5 cm followed by 30×5 cm and 20×10 cm and minimum in 45×10 cm. In case of varieties, significant maximum leaf area index computed in variety „Indira Urd-1‟ and lowest in „Pratap Urd-1‟. At 40 DAS, spacing (cm) was computed significantly maximum leaf area index in 20×5 cm followed by 30×5 cm and 20×10 cm and minimum in 45×10 cm. In case of varieties, significant maximum leaf area index was computed in variety „Indira Urd-1‟ and lowest in „Pratap Urd-1‟. At 60 DAS, spacing was showed significantly maximum leaf area index in 20×5 cm followed by 30×5 cm and 20×10 cm and minimum in 45×10 cm. In case of varieties, significant maximum leaf area index computed in variety „Indira Urd-1‟ and lowest in „Pratap Urd-1‟. Kumaran *et al*. (2001) recorded that the highest value of LAI (3.38) was recorded in the 30x10 cm spacing and the lowest (3.12) was found at the 45x10 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. Nag *et al*. (2000) found that growth characters (LAI) were significantly influenced due to varieties. 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.

Effect of varieties and spacing in yield attributes and yield of blackgram Plant population (No./m2)

Plant population of blackgram observed at 20 DAS and harvest, were presented in Table 2 The data revealed that the plant populations of blackgram at 20 DAS and harvest have the variation due to spacing (cm) and varieties. At 20 DAS maximum plant population was recorded in spacing 20×5 cm followed by 30×5 cm and 20×10 cm and lowest in 45×10 cm. Significantly maximum plant population was recorded in variety „Indira Urd-1‟ and lowest in „Pratap Urd-1‟. At harvest, spacing (cm) was recorded significantly maximum plant population in 20×5 cm followed by 30×5 cm and 20×10

cm and lowest in 45×10 cm. Significantly maximum plant population was recorded in variety „Indira Urd-1‟ and lowest in „Pratap Urd-1‟. The plant population of blackgram was influenced significantly due to different land configurations. Shibles, RM and Weber, CR (1966) stated that maximum (20) Plant density was obtained by 25 cm row spacing. Whereas the minimum (12) Plant density was produced by 40 cm row spacing. Seed yield and yield components of mungbean are significantly influenced by the density of the plants.

Number of pods/plant

The number of pods/plant as influenced by spacing and varieties have been shown in Table 2. Data showed that both spacing and varieties had significant effects on number of pods/plant of blackgram. The data revealed that Spacing (cm) was recorded significant higher number of pods/plant in 30×10 cm, However, it was found at par with the 45×10 and followed by 45×5 cm and lowest in 20×5 cm In case of variety, significantly higher pods/plant was recorded in variety „Indira Urd-1‟ and lowest in „Pratap Urd-1‟.

Plant population increased number of pods/plant due to more competition amongst plants for nutrients, moisture, sunlight and space. Narrow row and plant spacing ensured early canopy coverage and maximum light interception, crop growth rate and crop biomass, resulting in increased number of pod and yield potential per unit area. Similar results have been reported by Boydak *et al*. (2004) and Malek *et al*. (2012). Nag *et al*. (2000) found that yield attributes (pods/plant), Significant variations in yield attribute different genotypes were also reported. Interaction effects of spacing and varieties on number of pods / plant was found significant (Table 3). It might be due to greater number of plants per unit row length, which might have adversely affected the pod development, hence, pods formation were comparatively less than that of low seeding rate which resulted in greater competition for light, space and nutrients.

Number of seed/pod

The number of seeds/pod are presented in Table 2 The data revealed that spacing (cm) was recorded significant higher no. of seeds/pod in 30×10 cm followed by 45×10 cm and 45×5 cm and lowest in 20×5 cm. In case of variety, significantly maximum number of seed/pod was recorded in variety „Indira Urd-1‟ and lowest in „Pratap Urd-1‟. Nag *et al*. (2000) and Amanullah *et al.* (2016) also noted similar findings.

100 seed weight (g)

The weight of hundred seeds is also an important attribute to yield and data are presented in Table 2. The findings revealed that 100-seed weight has significant at spacing (cm) and varieties. The data showed that spacing and varieties have significant effect on 100-seed weight. Significantly the highest 100-seed weight was obtained spacing 30×10 cm while, it was at par with 45×10 cm and followed by 45×5 cm. The lowest was recorded under 20×5 cm. In case of variety, maximum 100-seed weight was recorded in variety „Indira Urd-1‟ and lowest in „Pratap Urd-1‟. Ihsanullah *et al*. (2002) also noted similar findings.

Table 2: Response of blackgram as influenced by spacing and variety on yield attributing parameters.

Treatment	Plant population (No. m-1)	No. of pods plant-1	No of seed pod-1	100 Seed weight
Spacing (cm)				
30×10	30.938	31.507	6.608	4.303
30×5	60.045	22.545	3.622	3.723
20×10	44.143	25.027	4.520	3.852
20×5	92.130	20.133	2.888	2.982
45×10	17.105	29.492	5.668	4.103
45×5	37.388	27.782	5.255	3.930
S.Em ±	0.615	1.029	0.219	0.095
CD 5%	1.938	3.241	0.690	0.300
Varieties				
Indira Urd-1	47.691	27.929	5.198	3.998
Pratap Urd-1	46.226	24.232	4.323	3.633
S.Em ±	0.433	0.323	0.098	0.074
CD 5%	1.335	0.995	0.301	0.227

Table 3: Interaction effect of different spacing and varieties on number of pods of blackgram

Treatment Varieties	Spacing (cm)						
	30×10	**30×5**	**20×10**	**20×5**	**45×10**	**45×5**	**Mean**
Indira urd- 1	103.47	71.25	78.78	62.50	98.15	88.58	27.93
Pratap urd- 1	85.57	64.02	71.38	58.30	78.80	78.11	24.23
Mean	31.51	22.55	25.03	20.13	29.49	27.78	
	SEm±	CD (P=0.05%)					
Spacing (cm)	1.029	3.241					
Varieties	0.323	0.995					
Spacing× Varieties	0.79	2.44					

Seed yield (kg/ha)

The data pertaining to seed yield has been presented in Table 3.1. The data revealved that there was significant difference recorded in seed yield due to varietal and spacing (cm) arrangement and variety. Significant higher seed yield recorded in spacing (cm) 30×10 cm while, it was at par with 45×10 cm and followed by 45×5 cm and minimum in 20×5 cm. Significantly maximum seed yield was recorded in variety „Indira Urd-1‟ and minimum in „Pratap Urd-1‟. Sabbaghpur H (2002) reported that grain yield kg/ha responded in significant in response to effect of row spacing however, numerically a maximum (709) grain yield kg/ha were obtained from 35 cm row spacing while the minimum 429 grain yield kg/ha were observed in 25 cm row spacing.

Kumar *et al*. (2013) reported that plant density of 30x10 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 45x10 cm spacing. The highest grain yield of 7.78 q/ha and straw yield (18.75 q/ha) it was obtained with 30x10 cm row spacing which was significantly greater than the plant density of 45x10 cm. This might be due to improved expression of growth characters and yield attributes as discussed above also be the possible reasons for the production of higher yields.

Choudhary *et al*.(2017) [19] stated that optimum row spacing plays an important role in contributing to the high yield because thick plant population won‟t get sufficient light for photosynthesis and can be easily attacked by diseases. Sharma *et al*. (2000) [22] and Sing and Sing (2000) [22] supported production potential variations for different varieties.

The interaction effect between spacing (cm) and varieties presented in Table 5. Data revealed that the intraction effect observed significantly in seed yield. Intraction show combination of treatment spacing (cm) and variety was highest seed yield obtained in spacing 30×10 cm with „Indira Urd-1‟ and lowest in spacing 20×5 cm with „Indira Urd-1‟. Asaduzzaman *et al*. (2010) [7] and Tahir *et al*. (2014) reported that interaction effect of varieties x plant density was found to be significant. Indira Urd-1 being significantly superior compared to other treatment combinations. Similarly at the same or different planting density. Choudhary *et al*. (2017) [19] reported that Indira Urd-1 recorded significantly higher 100-seed weight, which was significantly superior when compared to among varieties, Indira Urd-1 recorded significantly higher grain yield and straw yield which was significantly superior over RU-0352 (736 kg/ha) and RU-03-16 (870 kg/ha).

Tiwari and Tomar (1991) [26] observed that the maximum plant density of 50 plants per square meter decreased the yield of grain in green gram and black gram, might be due to more vegetative growth and low yield attributes due to severe plant competition.

Straw yield (kg/ha)

The data pertaining to straw yield has been presented in Table 4. Data on straw yield as affected by spacing (cm) and varieties. Significantly maximum straw yield was observed in spacing (cm) in 30×10 cm However, it was at par with 45×10 cm and followed by 45×5 cm and minimum in 20×5 cm. In case of variety, significantly maximum straw yield was observed in variety „Indira Urd-1‟ and minimum in „Pratap Urd-1‟. The more biomass produced at narrow plant spacing was due to more plant population contributing to the final biomass production. Similar results have been reported by Yadav (2003) [31].

Choudhary *et al*. (2017) [19] reported that Indira Urd-1 recorded significantly higher 100- seed weight, which was significantly superior when compared to among varieties, Indira Urd- 1 recorded significantly higher grain yield and straw yield which was significantly superior over RU-0352 and RU-03-16.

Harvest index (%)

The data on harvest index for different spacing (cm) and varieties have been presented in Table 4 Data on harvest index as affected by spacing (cm) and varieties. Maximum harvest index was recorded significant in spacing (cm) 30×10 However, it was at par with 45×10 cm and followed by 45×5 cm and minimum in 20×5 cm. significant maximum harvest index was recorded in variety „Indira Urd-1‟ and minimum in „Pratap Urd-1‟.Shrivastav *et al*. (1996) [24] also concluded that increased level of row spacing generally increases the harvest index in blackgram.

Table 4: Response of blackgram as influenced by spacing and variety on seed yield straw yield and harvest index

Treatment	Seed yield (kg ha-1)	Straw yield (kg ha-1)	Harvest index
Spacing (cm)			
30×10	1185.233	1741.202	40.656
30×5	700.647	1235.185	36.221
20×10	809.235	1285.648	38.732
20×5	637.592	1099.845	36.690
45×10	1122.218	1719.652	39.542
45×5	978.673	1536.243	38.869
S.Em ±	24.209	36.710	0.419
CD 5%	76.286	115.675	1.319
Varieties			
Indira Urd-1	964.693	1549.039	38.119
Pratap Urd-1	846.507	1323.552	38.784
S.Em ±	15.932	24.651	0.361
CD 5%	49.092	75.959	1.112

Table 5: Interaction effect of different spacing and varieties on seed yield of Blackgram

Treatment Varieties	Spacing (cm)						
	30×10	**30×5**	**20×10**	**20×5**	**45×10**	**45×5**	**Mean**
Indira urd- 1	3976.54	2244.89	2499.96	1889.34	3582.12	3171.62	964.69
Pratap urd- 1	3134.86	1958.99	2355.45	1936.21	3151.19	2700.42	846.51
Mean	1185.23	700.65	809.24	637.59	1122.22	978.67	
	SEm±	CD (P=0.05%)					
Spacing (cm)	24.21	76.286					
Varieties	15.932	49.092					
Spacing× Varieties	39.03	120.25					

Economics fesibilities

To examine the economic feasibility and viability of different treatment under investigation, economics of blackgram production in terms of gross return, net return and B:C ratio were calculated for different treatments of blackgram and the outcome is presented in Table 5.

Cost of cultivation

The data on cost of cultivation for different spacing (cm) and varieties have been presented in Table 5. The maximum cost of cultivation was computed under spacing 20×5 cm followed by 30×5 cm and 20×5 cm and minimum under 45×10 cm but same as both varieties.

Gross return

The data on gross return for different spacing (cm) and varieties have been presented in Table 5. The data revealed that spacing (cm) was recorded significant highest gross return in 30×10 cm, However, it was at par with 45×10 cm and followed by 45×5 cm and lowest in 20×5 cm. Significantly highest gross return in variety „Indira Urd-1" and lowest in variety „Pratap Urd-1".

The interaction effect was presented in between spacing (cm) and varieties presented in Table 6. Data reveled that significant maximum gross return was computed under spacing 30×10 cm with variety in Indira Urd-1 and followed by spacing 45×10 cm with variety in Indira Urd-1 and spacing 45×5 cm with variety in Indira Urd-1. Kumar, R. *et al.* (2018) [5, 6]. concluded that to obtain higher yields and economics of blackgram should be used cultivar of Indira Urd-1 with the plant density 30x10 cm. A.k.k. *et al.* (2007) [1] also similar findgings

Net return

The data on net return for different spacing (cm) and varieties have been presented in Table 5. Spacing (cm) was recorded significant highest gross return in 30×10 cm, However, it was at par with 45×10 cm and followed by 45×5 cm and lowest in 20×5 cm. The significant highest net return recorded in variety „Indira Urd-1" and lowest in variety „Pratap Urd-1". The interaction effect was presented in between spacing (cm) and varieties presented in Table 9. Data reveled that significant maximum net return was computed under spacing 30×10 cm with variety in Indira Urd-1 and followed by spacing 45×10 cm with variety in Indira Urd-1 and spacing 45×10 cm with variety in Pratap Urd-1 and lowest under spacing 20×5 cm with variety in Indira Urd-1. Kumar *et al.* (2010) [12] recorded that maximum net returns of Rs. 17,748 and benefit:cost ratio of 1.22 was observed in 30x10 cm plant density followed by 45x10 cm (Rs.15940/ha and 1.11). Choudhary *et al.* (2017) [19] found that 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 RU-0352 and RU-03-16. The better expression of growth, yield attributes and yields by Indira Urd-1 might be responsible for raising the net returns.

B:C ratio

The data on B:C ratio for different spacing (cm) and varieties have been presented in Table 5. Spacing (cm) was recorded significant highest B:C ratio in 30×10 cm, However, it was at par with 45×10 cm and followed by 45×5 cm and lowest in 20×5 cm. The significant highest B:C ratio recorded in variety „Indira Urd-1" and lowest in variety „Pratap Urd-1". The interaction effect was presented in between spacing and varieties presented in Table 7. Data reveled that significant maximum B:C ratio was computed under spacing 30×10 cm with variety in Indira Urd-1 and followed by spacing 45×10 cm with variety in Indira Urd-1 and spacing 45×10 cm with variety in Pratap Urd-1 and lowest under spacing 20×5 cm with variety in Indira Urd-1. Lone *et al.* (2010) [16] reported that the highest Benefit Cost ratio of 3:20 and highest net return of Rs.37351 thousands/ ha were recorded with treatment combination of 60 kg seed rate/ha at 45 cm row to row spacing.

Table 6: Economics of cultivation assessment

Treatments	Cost of cultivation (Rs. ha-1)	Gross return (Rs. ha-1)	Net return (Rs. ha-1)	B:C ratio (Rs. ha-1)
Spacing (cm)				
30×10	21505	69299	47794	2.22
30×5	22653	41172	18519	0.82
20×10	22079	47412	25333	1.15
20×5	23800	37443	13642	0.57
45×10	21103	65686	44582	2.12
45×5	21849	57321	35471	1.62
S.Em ±		1408.35	1408.35	0.07
CD 5%		4437.83	4437.83	0.21
Varieties				
Indira Urd-1	22165	56537	34371	1.58
Pratap Urd-1	22165	49574	27409	1.26
S.Em ±	0.622	922.05	922.05	0.05
CD 5%	1.916	2841.14	2841.14	0.13

Table 7: Interaction effect of different spacing and varieties on gross return of blackgram

Treatment				Spacing (cm)			
	30×10	30×5	20×10	20×5	45×10	45×5	Mean
Varieties							
Indira urd- 1	232752.24	131893.05	146715.46	110921.02	209745.65	185630.08	56536.53
Pratap urd- 1	183044.77	115139.22	137756.80	113734.40	184370.93	158293.66	49574.43
Mean	69299.50	41172.05	47412.04	37442.57	65686.10	57320.62	
	SEm±	CD (P=0.05)					
Spacing (cm)	1408.359	4437.830					
Varieties	922.058	2841.144					
Spacing× Varieties	2258.57	6959.35					

Table 8: Interaction effect of different spacing and varieties on net return of Blackgram

Treatment	Spacing (cm)						
	30×10	30×5	20×10	20×5	45×10	45×5	Mean
Varieties							
Indira urd- 1	168235.74	63934.05	80477.71	39519.52	146434.03	120080.83	34371.22
Pratap urd- 1	118528.27	47180.22	71519.05	42332.90	121059.31	92744.41	27409.12
Mean	47794.00	18519.05	25332.79	13642.07	44582.22	35470.87	
	SEm±	CD (P=0.05)					
Spacing (cm)	1408.359	4437.830					
Varieties	922.058	2841.144					
Spacing× Varieties	2258.57	6959.35					

Table 9: Interaction effect of different spacing and varieties on B:C ratio of blackgram

Treatment	Spacing (cm)						
	30×10	30×5	20×10	20×5	45×10	45×5	Mean
Varieties							
Indira urd- 1	7.82	2.82	3.64	1.66	6.94	5.50	1.58
Pratap urd- 1	5.51	2.08	3.24	1.78	5.74	4.24	1.26
Mean	2.22	0.82	1.15	0.57	2.11	1.62	
	SEm±	CD (P=0.05)					
Spacing (cm)	0.065	0.206					
Varieties	0.041	0.126					
Spacing× Varieties	0.10	0.31					

Conclusion

There research programme was recorded variety Indira Urd-1best performance as compared to Pratap Urd-1 in terms of growth parameters, yield attributes and yield. Spacing was performance recorded in 30×10 higher in terms of growth parameter, yield attributes and yield as compared to all other spacing. Interaction effect in seed yield variety Indira Urd-1 and spacing (cm) 30×10 was recorded significant higher seed yield as compared to all combination treatments. Relationship between plant population and seed yield (kg ha-1) was linear with performance maximum in variety Indira Urd-1 and spacing (cm) 30×10. Result shows best economics fesibilies was recorded in variety Indira Urd-1 and lowest in Pratap Urd-1. Spacing was recorded in economics fesibility highest in 30×10 and lowest in 20×5. All over things economics are greater perform to variety Indira Urd-1 and spacing 30×10.

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