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Growth and yield attributes of black gram (*Phaseolus mungo* L.) varieties as influenced by various spacing's in *Kharif* for seed production

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Abstract
The present investigation "Performance of black gram (*Pharsalus mungo* L.) Varieties to spacings in *kharif* for seed production" was conducted on the Agronomy Farm, College of Agriculture, Pune during *Kharif*, 2018 in spilt plot design with three replications. In the present investigation, main plot treatment consists of three varieties (BDU-1, TAU-1 and AKU-10-1 (Black gold) and four spacings 30x05, 30x10, 45x05 and 45x10 cm^2 as sub plot treatments.The results revealed that the significantly higher growth characters, seed and straw yields, were obtained at variety AKU-10-1 (Black gold) sown with spacing 45 x 10 cm^2.

Keywords: Black gram, varieties, spacing, growth and yield attributes, dry matter

Introduction
Pulses play a vital role in Indian agriculture. They are important not only for maintaining fertility of soil, but also providing fearful diet to the predominantly vegetarian population of the country and nutritious fodder to the livestock. Pulse crops have special significance in India as they contribute to the income and purchasing power of the poor farmers in semi-arid regions.

It has the cheapest source of protein and the milk is becoming expensive day by day. Protein requirement for growth and development of the human being is mostly met by pulses. It contains 24.0% protein, 59.6% carbohydrate, 1.3% fat, 3.2% minerals. It also contains 154 mg calcium, 9.1 mg iron, 38 mg B-carotene per 100 g of split dal (Bakr *et al.* 2004) [1].

It is one of the most important pulse crops of rainfed areas, grown throughout the country. It accounts for about 11.92 % of India's total pulse production. India is the largest producer of pulses in the world, accounting for about 29 % global share. During 2017-18, in India black gram produce 3280.00 thousand tonnes and 13.48 % share in total production out of total pulse productions 24510.00 thousand tonnes (FAO Stat, 2017) [4].

Black gram (*Phaseolus mungo* L.) is pulse crop belonging to family Leguminoceae which is originated in India. It is also known as urd bean, mash, mung bean etc. It is grown in India, Pakistan, Sri Lanka, Burma and some countries of south-east Asia, Africa and America. In India black gram is the fourth most important pulse crop which is mostly grown in southern and eastern states of India. It is predominantly grown in Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Rajasthan, Gujarat, Madhya Pradesh, Punjab, Orissa, Bihar, Uttar Pradesh and West Bengal. Madhya Pradesh has been the major pulse producing state in the country.

Present strategies of Govt. of India are to increase the production and productivity of pulses in coming year to meet the increasing demand of pulses due to over growing population. Therefore, in the five year plan, emphasis has been laid to improve the yields of pulses and oilseeds. The cultivation of grain legumes such as black gram, green gram, pigeon pea and cowpea is adopted customarily during rainy season.

Materials and methods
The present investigation was conducted on the farm of Agronomy Farm, College of Agriculture, Pune during *Kharif*, 2018. The experiment was laid out in split plot design with three replications, three main plot and four sub plot treatments. Main plot treatment consists of three varieties V_1: BDU-1, V_2: TAU-1 and V_3: AKU-10-1(Black gold) and sub plot consist

S_1: 30 x 05 cm^2, S_2: 30 x 10 cm^2, S_3: 45 x 05 cm^2 and S_4: 45 x 10 cm^2. The gross and net plot sizes were 4.00 x 3.60 m^2 and 3.80 x 3.00 m, respectively.

The soil of experimental plot was clayey in texture, neutral to slightly alkaline in reaction (pH 7.8), medium in organic carbon (0.50 %), low in available nitrogen (165.14 kg ha^{-1}), medium in available phosphorus (21.58 kg ha^{-1}) and very high in available potassium (405.20 kg ha^{-1}). The seed treatment of *Rhizobium*, PSB and *Trichoderma* were given common to all treatments at the time of sowing and RDF (i.e. 25: 50: 00 kg NPK ha^{-1}) was applied as basal application. The sowing was carried out manually by dibbling method. The optimum plant population was maintained by thinning and gap filling and the crop was irrigated as and when required. The cultural operations were carried out mechanically in all treatments. Plant protection measures were carried out time to time during the period of experiment. Climate was favourable for growth and development of black gram crop.

The growth contributing characters *viz.*, mean plant height, number of functional leaves, leaf area, plant spread, number of branches and dry matter $plant^{-1}$ (g) were recorded periodically at an interval of 15 days after sowing. Whereas days required to 50 per cent flowering and for maturity were recorded at particular time. Yield attributes and yield *viz.*, mean number of pods $plant^{-1}$, dry weight $plant^{-1}$, number of seeds pod^{-1}, weight of seeds $plant^{-1}$, straw yield $plant^{-1}$, 1000 seed weight (g), seed and straw yields (kg ha^{-1}) and shattering per cent were recorded at harvesting of black gram.

Results and discussion

Effect of varieties and spacing's on growth attributes of black gram

The data pertaining to various growth attributes studied *viz.*, plant height, number of leaves $plant^{-1}$ and dry matter $plant^{-1}$ as influenced by various treatments are presented in Table 1.

Table 1: Growth attributes of Black gram as influenced periodically by different treatments.

Treatment	Plant height (cm)	Number of functional leaves $plant^{-1}$	No. of Branches	Leaf area $plant^{-1}$ (dm^2)	Dry matter $plant^{-1}$ (g)
	A. Varieties (V):				
V_1: BDU-1	59.68	15.18	7.97	11.46	18.62
V_2: TAU-1	55.09	14.87	6.96	11.09	17.22
V_3: AKU-10-1(Black gold)	62.52	20.71	9.16	15.77	21.40
S.Em±	0.23	0.33	0.14	0.48	0.55
C.D. at 5%	0.82	1.14	0.50	1.69	2.04
	B. Spacings (S):				
S_1: 30 x 05 cm^2	57.46	14.42	7.51	11.20	15.44
S_2: 30 x 10 cm^2	58.16	15.70	7.06	11.62	19.08
S_3: 45 x 05 cm^2	58.27	17.38	8.00	12.58	20.84
S_4: 45 x 10 cm^2	62.51	20.17	9.54	15.70	23.95
S.Em±	0.84	0.70	0.20	0.84	1.17
C.D. at 5%	2.53	2.12	0.60	2.52	3.39
	C. Interaction (A×B):				
S.Em±	1.46	1.22	0.34	1.46	1.03
C.D. at 5%	NS	3.67	1.04	NS	4.81
General Mean	59.10	16.92	8.03	12.77	19.32

Effect of varieties

Significantly maximum plant height was obtained by variety AKU-10-1(Black gold) than rest of the varieties under study. Higher plant height accounted due to more activities of meristematic tissues of plant, increasing number and size of cells, which is responsible for increased plant height.

Significantly maximum number of leaves and leaf area $plant^{-1}$ was recorded by variety AKU-10-1(Black gold) than rest of the varieties. This might be due to genetical character of the variety. Similar results was recorded by Vijayalakshmi *et al* (1993) [11].

In variety, AKU-10-1 (Black gold) significantly maximum dry matter $plant^{-1}$ (g) was recorded than rest of varieties. This might be due to higher biomass potential of the variety. Such differential dry matter production in different varieties of black gram were reported by Chaudhary *et al*. (1988) [2] and Singh and Rana (1992) [10].

Effect of spacings

Significantly maximum plant height, number of functional leaves, leaf area $plant^{-1}$ and dry matter (g) was obtained at spacing 45 x 10 cm^2 than rest of the spacings. However, it was at par with 45 x 05 cm^2. The increase in plant height was due to beneficial effect on various metabolic activities due to wider row spacing. Similar results also reported by Khan and Asif (2001) [7].

Significantly maximum leaf area $plant^{-1}$ (dm^2) is a result of cell division and expansion of cell of leaf primordial which plays role in leaf in interception of solar (energy) radiation necessary for photosynthesis and wider spacings provides more lateral space for the same, because of this reason leaf area $plant^{-1}$ (dm^2) was found higher at 45 x 10 cm^2 than other spacings.

Significantly maximum dry matter $plant^{-1}$ (g) recorded at 45 x 10 cm^2 than rest of the spacings. This might be due to more lateral space available for plant development as well as enough inter plant spacing, which may attributed to vigours growth of plant and also in other growth contributing parameters.

Effect of interaction

The interaction effect between varieties and spacings were found *viz*., number of functional leaves $plant^{-1}$, No.of branches $plant^{-1}$ and dry matter $plant^{-1}$ is depicted in Table 1(a),Table 1(b) and Table1 (c) respectively.

Table 1a: Number of functional leaves plant^{-1} of black gram at 60 DAS and at harvest as influenced by interaction between varieties and spacings

Main x Sub Interaction Leaves				
Varieties/Spacings (cm^2)	At harvest			
	V_1: BDU-1	V_2: TAU-1	V_3: Black gold	Mean
S_1: 30 X 05	15.40	13.53	14.33	14.42
S_2: 30 X 10	13.97	14.80	18.33	15.70
S_3: 45 X 05	17.41	13.00	21.73	17.38
S_4: 45 X 10	13.93	18.13	28.43	20.17
S.Em±	1.11			
C.D. at 5%	3.37			
Mean	15.18	14.87	20.71	16.92

Table 1b: Number of branches plant^{-1} of black gram at 60 DAS and at harvest as influenced by interaction between varieties and spacings

Main x Sub Interaction				
Varieties/Spacings (cm^2)	At harvest			
	V_1: BDU-1	V_2: TAU-1	V_3: Black gold	Mean
S_1: 30 X 05	15.40	13.53	14.33	14.42
S_2: 30 X 10	13.97	14.80	18.33	15.70
S_3: 45 X 05	17.41	13.00	21.73	17.38
S_4: 45 X 10	13.93	18.13	28.43	20.17
S.Em±	1.11			
C.D. at 5%	3.37			
Mean	15.18	14.87	20.71	16.92

Table 1c: Dry matter plant^{-1} (g) of black gram at 60 DAS and at harvest as influenced by interaction between varieties and spacings

Main X Sub Interaction				
Varieties/Spacings (cm^2)	At harvest			
	V_1: BDU-1	V_2: TAU-1	V_3: Black gold	Mean
S_1: 30 X 05	16.09	15.88	14.35	15.44
S_2: 30 X 10	15.91	22.26	19.07	19.08
S_3: 45 X 05	21.32	19.56	21.64	20.84
S_4: 45 X 10	21.16	4.40	30.54	23.95
S.Em±	1.03			
C.D. at 5%	4.81			

The interaction effect between varieties and spacings were found significant for major growth contributing characters *viz*., number of functional leaves plant^{-1}, number of branches plant-^{1} and dry matter plant^{-1} where black gram variety was same with wider spacing at 45 x 10 cm^2.

2. Yield attributes

The data pertaining to effect of different varieties and spacings on number of seeds pod^{-1}, weight of seeds pod^{-1} (g), seed yield (kg ha^{-1}), straw yield (kg ha^{-1}), Harvest index (%) and test weight (g) as influenced by various treatments are presented in Table 2.

Table 1: Yield attributing characters of black gram as influenced by different treatments at harvest

Treatment	No. of pods plant^{-1}	Dry wt. of pods plant^{1} (g)	No. of seeds pod^{-1}	Seed wt. plant^{-1} (g)	Straw wt. plant^{-1} (g)	1000 seed wt. (g)
A) Main plot: Varieties						
V_1 : BDU-1	28.67	8.39	7.78	8.05	10.03	38.62
V_2 : TAU-1	25.53	7.93	7.45	7.37	9.37	37.68
V_3 : AKU-10-1	29.88	8.55	8.88	8.11	11.43	39.06
S.E m±	0.57	0.09	0.19	0.04	0.53	0.20
C.D. at 5%	1.98	0.33	0.66	0.15	1.84	0.71
B) Sub plot : Spacings (cm^2)						
S_1 : 30 X 05	26.89	7.12	7.79	7.53	9.39	37.86
S_2 : 30 X 10	27.48	8.12	7.80	7.61	10.06	37.92
S_3 : 45 X 05	27.58	8.44	7.91	7.77	10.40	38.49
S_4 : 45 X 10	30.16	9.49	8.63	8.46	11.58	39.54
S.Em±	0.65	0.21	0.21	0.21	0.70	0.36
C.D. at 5%	1.97	0.63	0.65	0.64	2.12	1.10
C) Intraction (AXB)						
S.Em±	1.14	0.36	0.37	0.37	1.22	0.63
C.D. at 5%	NS	NS	NS	NS	NS	NS
General Mean	28.03	8.29	8.03	7.84	10.32	38.45

Effect of varieties

Significantly maximum number of pods plant^{-1}, number of seeds pod^{-1}, seed weight plant^{-1} (g), straw weight plant^{-1} (g), seed yield (kg ha^{-1}), straw yield (kg ha^{-1}), Harvest index (%) recorded by variety AKU-10-1 (Black gold) than other varieties. Similar results were also supported by Ihsanullah *et al.* (2002) [5] and Kandasamy and Kuppuswamy (2007) [6].

Effect of spacings

Significantly more number pods plant^{-1}, number of seeds pod^{-1}, seed weight plant^{-1} (g), straw weight plant^{-1} (g), seed yield (kg ha^{-1}), straw yield (kg ha^{-1}), Harvest index (%) were recorded at spacings 45 x 10 cm^2 except seed and straw yields (kg ha^{-1}) higher at 30 x 05 cm^2 than rest of the spacings. This might be due to yields compensated due to more plant population at 30 x 05 cm^2.

Effect of interaction

The interaction effect between varieties and spacings on maximum number of pods plant^{-1}, number of seeds pod^{-1}, seed weight plant^{-1} (g), straw weight plant^{-1} (g), seed yield (kg ha-

^{1}), straw yield (kg ha^{-1}), Harvest index (%) are non-significant.

Conclusion

Hence based on observations it is concluded that among varieties of black gram under treatments, V_3: AKU-10-1(Black gold) was found significantly superior in respect to growth contributing, yield attributing aspects of black gram followed by V_1 (BDU-1) Whereas, among spacings wider spacing (45 x 10 cm^2) growth and yield contributing characters were found significantly superior than other spacings.

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