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Arpita Pandey
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Rajesh Singh
Assistant Professor, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Thakur Indu
Ph.D., Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Arpita Pandey
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Effect of spacing on growth and yield of varieties of black gram (*Vigna mungo* L.)

Arpita Pandey, Rajesh Singh and Thakur Indu

Abstract
A field experiment was conducted during *Zaid* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The treatments which are T_1: 25 cm x 20 cm + SHEKHAR 2, T_2: 25 cm x 20 cm + PANT U-35, T_3: 25 cm x 20 cm + T9, T_4: 30 cm x 15 cm + SHEKHAR 2, T_5: 30 cm x 15 cm + PANT U-35, T_6: 30 cm x 15 cm + T9, T_7: 45 cm x 10 cm + SHEKHAR 2, T_8: 45 cm x 10 cm + PANT U-35, T_9: 45 cm x 10 cm + T9 used. The results showed that application of 45 cm x 10 cm + SHEKHAR 2 was recorded significantly higher plant height (44.58 cm), nodules/plant (9.17), No. of Branches/plant (6.87), Plant dry weight (7.08 g/plant), pods/plant (64.64), Seeds/pod (8.20), Test weight (38.5 g) whereas maximum crop growth rate (4.36 g/m^2/day) was recorded with treatment 30 cm x 15 cm + T9. However, higher Seed yield (1062.86 kg/ha) were obtained with application of 30 cm x 15 cm + SHEKHAR 2 as compared to other treatments.

Keywords: Spacing, varieties, yield

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, black gram or curd (*Vigna mungo* L.) belonging to family Leguminosae is of immense importance as it contains, 60% carbohydrates, 25% 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) [14].

Blackgram is grown well in moisture retentive light soil, but loamy and clay loam are suitable for the cultivation of Blackgram. Loam to clay loam with neutral PH are best suited for Blackgram cultivation. It is susceptible to waterlogged conditions of the soil. It is popular because of its nutritional quality having rich protein (22-24%), carbohydrates (56.6-59.6%), fat (1.2-1.4%), Minerals (3.2%), phosphorous (385 mg/100g) and, it is rich source of calcium and Iron. Tamil Nadu leads first in productivity with an average yield of 775 kg/ha. It contained 24.7% protein, 0.6% fat, 0.9% fibre and 3.7% ash as well as sufficient quantity of calcium, phosphorus and important vitamins. Due to cheaper protein source it is designated as "poor man"s meat" (Aslam *et al.*, 2010) [2].

Plant density can have a major effect on the final yield of most of the legumes and the general response of yield to increasing population is well documented. To realize the maximum yield potential of blackgram during summer and rainy season, maintenance of optimum space made available to individual plant is of prime importance. Row and plant spacing has to be worked out to get desired spacing. The spacing requirement depends upon the growth behaviour of genotype. So it is required to maintain spacing for obtaining higher yield (P Veeramani, 2019) [15].

Introduction of suitable varieties, its cultivation is being pushed in summer season to adjust between the time left after harvesting of *Rabi* and sowing of *kharif* crops, where infestation of diseases and pests is relatively lower and also, the vacant land is efficiently utilized without affecting the seasonal crops. Improved varieties of different pulse crops hold promise to increase productivity by 20-25%, whereas latest technology comprising varieties and integrated nutrients management and pests has shown 25-42% yield advantage over the farmer % s practices in the frontline demonstrations conducted across the country (Ali and Gupta, 2012).

Materials and Methods

The present examination was carried out during *Zaid* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28ºN latitude, 81.54ºE longitude and 98 m altitude above the mean sea level. Three Varieites i.e., Shekhar 2, T9 and Pant U 35 used for sowing of Blackgram. The experiment laid out in Randomized Block Design which consisting of nine treatments with T_1: 25 cm x 20 cm + SHEKHAR 2, T_2: 25 cm x 20 cm + PANT U-35, T_3: 25 cm x 20 cm + T9, T_4: 30 cm x 15 cm + SHEKHAR 2, T_5: 30 cm x 15 cm + PANT U-35, T_6: 30 cm x 15 cm + T9, T_7: 45 cm x 10 cm + SHEKHAR 2, T_8: 45 cm x 10 cm + PANT U-35, T_9: 45 cm x 10 cm + T9 were replicated thrice.

The experimental site was uniform in topography and sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in Organic carbon (0.38%), medium available N (225 kg /ha), higher available P (19.50 kg /ha) and medium available K (213.7 kg /ha). Nutrient sources were Urea, DAP, MOP to fulfill the necessity of Nitrogen, phosphorous and potassium. The application of fertilizers was applied as basal at the time of sowing. In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters are growth parameters, plant height, branches per plant, nodules per plant and plant dry weight are recorded. The yield parameters like pods per plant, seeds per pod, test weight (1000 seeds) and seed yield (kg/ha) were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez K.A. and Gomez A.A. 1984).

Results and Discussion

Growth attributes

Plant height: Data in Table 1, tabulated that significantly highest plant height (43.91 cm) was observed in the treatment with 45 cm x 10 cm + SHEKHAR 2 over all the other treatments. However, the treatments with application of 45 cm x 10 cm + PANT U-35 (44.44 cm) and 45 cm x 10 cm + T9 (44.08 cm) which were found to be at par with treatment 45 cm x 10 cm + SHEKHAR 2 as compared to all the treatments. The spacing practices had significant effects on plant height (cm); however, an increasing trend with optimum geometry level could be noticed. This may be due to the competition between the inter and intra plants for sun light, water, nutrients and space at closer spacing, whereas optimum spacing helped in significantly highest plant height. Significant results were obtained due to the optimum spacing of 30x10 cm and similar results were obtained by Singh *et al*. (2009) [12], and the probable reason for the influence in plant height might be due to SHEKAR 2 variety proved superior over other varieties. These findings are in line with the earlier findings by Patidar and Singh (2018) [7].

Table 1: Effect of Spacing and Varieties on growth attributes of black gram

Treatments	Plamt height (cm)	Dry weight (g/plant)	Nodules/ Plant	Branches/plant
1. 25 cm x 20 cm + SHEKHAR 2	42.84	6.24	7.43	6.33
2. 25 cm x 20 cm + PANT U-35	42.41	6.08	7.20	6.10
3. 25 cm x 20 cm + T9	42.21	5.89	6.90	5.87
4. 30 cm x 15 cm + SHEKHAR 2	43.84	6.73	8.30	6.47
5. 30 cm x 15 cm + PANT U-35	43.48	6.63	7.90	6.43
6. 30 cm x 15 cm + T9	43.30	6.54	7.67	6.40
7. 45 cm x 10 cm + SHEKHAR 2	44.58	7.08	9.17	6.87
8. 45 cm x 10 cm + PANT U-35	44.44	6.94	8.80	6.70
9. 45 cm x 10 cm + T9	44.08	6.83	8.57	6.60
F- test	S	S	S	S
SEm (±)	0.19	0.09	0.21	0.12
C. D. (P = 0.05)	0.57	0.26	0.64	0.36

Table 2: Effect of Spacing on Yield attributes and Yield of varieties of Black gram

Treatments		Pods/Plant	Seeds/Pod	Test weight (g)	Seed yield (Kg/ha)
1.	25 cm x 20 cm + SHEKHAR 2	59.71	7.43	35.4	950.76
2.	25 cm x 20 cm + PANT U-35	58.43	7.22	34.6	921.66
3.	25 cm x 20 cm + T9	57.66	6.92	34.1	868.32
4.	30 cm x 15 cm + SHEKHAR 2	62.37	7.72	37.2	1062.86
5.	30 cm x 15 cm + PANT U-35	61.86	7.58	36.6	1025.61
6.	30 cm x 15 cm + T9	60.69	7.47	35.8	997.39
7.	45 cm x 10 cm + SHEKHAR 2	64.64	8.20	38.5	811.23
8.	45 cm x 10 cm + PANT U-35	64.17	8.11	38.1	733.15
9.	45 cm x 10 cm + T9	63.16	7.96	37.5	667.42
F test		**S**	**S**	**S**	**S**
S. EM (±)		0.51	0.09	0.33	22.11
CD (P = 0.05)		1.52	0.28	1.00	66.28

Nodules/Plant

The highest nodules per plant (9.17) was observed in the treatment with application of 45 cm x 10 cm + SHEKHAR 2, which was significantly higher over rest of the treatments. However, the treatments with 45 cm x 10 cm + PANT U-35 (8.80) and 45 cm x 10 cm + T9 (8.57) which were found to be statistically at par with 45 cm x 10 cm + SHEKHAR 2.

The optimum spacing resulted in increase of nodulation, root growth and growth the growth which might be due to higher number of nodules might have supplied sufficient nitrogen by fixation and the variety SHEKHAR 2 recorded higher nodules compared to the PANT U-35 and T9 varieties. The probable reason for this might be the genetical potential of the variety that has helped in producing higher number of nodules and

the results were similar to Tanya *et al*. (2015) [13] and Rajpal Bochliya *et al.* (2020) [8].

No. of Branches/Plant

The highest number of Branches per plant (6.87) was observed in the treatment with application of 45 cm x 10 cm + SHEKHAR 2, which was significantly higher over rest of the treatments. However, the treatments with 45 cm x 10 cm + PANT U-35 (6.70) and 45 x 10cm + T9 (6.60) which were found to be statistically at par with 45 cm x 10 cm + SHEKHAR 2.

The optimum (increased) plant spacing between plants resulted in enhanced space, sun-light, nutrients and soil moisture for increased photosynthesis, metabolic activities, growth and development which resulted in higher number of branches. The variety SHEKHAR 2 recorded the faster rate of increase in branches compared to other varieties. The results were in accordance with Amruta *et al*. (2015) and Jiotode *et al.* (2017) [1, 5].

Plant dry weight (g/plant)

Treatment with 45 cm x 10 cm + SHEKHAR 2 was recorded with significantly maximum dry weight (7.08 g/plant) over all the treatments. However, the treatments with 45 cm x 10 cm + PANT U-35 (6.94 g/plant) and 45 cm x 10 cm + T9 (6.83 g/plant) which were found to be statistically at par with 45 cm x 10 cm + SHEKHAR 2.

Higher dry matter production is observed in 45x10 cm spacing due to better photosynthetic activity due to greater exposure to light and increased availability of nutrients to plants have also resulted in higher dry weight, the treatment showed the increasing trend in dry weight up to harvest stage, Gadade *et al*. (2018) [4] also reported similar results. SHEKHAR 2 variety showed highest dry weight due to the higher growth and biomass accumulation compared to other varieties. Similar trends were observed by Singh *et al.* (2017)

Yield attributes and Yield

Pods/Plant

Significantly Maximum Pods/plant (64.64) was recorded with the treatment of application of 45 cm x 10 cm + SHEKHAR 2 over all the treatments. However, the treatments 45 cm x 10 cm + PANT U-35 (64.17) and 45 cm x 10 cm + T9 (63.16) which were found to be statistically at par with 45 cm x 10 cm + SHEKHAR 2.

Higher number of pods/plant might have been possible due to more vigour and strength attained by the plants as a result of better photosynthetic activities with sufficient availability of light, and supply of nutrients in balanced quantity of the plants at growing stages. Jitendra kumar *et al*. (2015) [6] observed the similar results.

Seeds/Pod

Significantly highest Seeds/Pod (8.20) was recorded with the with the treatment of application of 45 cm x 10 cm + SHEKHAR 2 over all the treatments. However, the treatments 45 cm x 10 cm + PANT U-35 (8.11) and 45 cm x 10 cm + T9 (7.96) which were found to be statistically at par with 45 cm x 10 cm + SHEKHAR 2.

Test weight (g)

Significantly highest Test weight (38.5g) was recorded with the treatment application of 45 cm x 10 cm + SHEKHAR 2 over all the treatments. However, the treatments with (38.1 g) in 45 cm x 10 cm + PANT U-35 and (37.5 g) in 45 cm x 10 cm + T9 which were found to be statistically at par with 45 cm x 10 cm + SHEKHAR 2.

The performance of SHEKHAR 2 variety as regard of pods/plant and seeds/pod was found to be superior. The probable reason for this may be the genetic make-up of the variety that has helped in improving the photosynthetic activity due to increased source capacity and efficient translocation of photosynthesis to the sink. The results were in accordance to Siddikee *et al.* (2018) [11] and Patidar and Singh (2018) [7]. Better availability of moisture and moderation of soil temperature which led to greater uptake of nutrients and reduced number of days taken to meet the required heat units for proper growth and development of plants and ultimately the yield attributes. The results were recorded similar with Anand *et al.* (2020) [12].

Seed yield (kg/ha)

Significantly highest Seed yield (1062.86 kg/ha) was recorded with the treatment application of 30 cm x 15 cm + SHEKHAR 2 over all the treatments.

However, the treatments with (1025.61 kg/ha) in 30 cm x 15 cm + PANT U-35 and (997.39 kg/ha) in 30 cm x 15 cm + T9 which were found to be statistically at par with 30 cm x 15 cm + SHEKHAR 2.

The optimum spacing 30x15 cm helped plant to receive sufficient amount of heat, water and nutrients from soil which increased number of pods/plant, seeds/pod and test weight which directly helped in increase of seed yield in lentil. The results were similar to Singh *et al*. (2009). The performance of black gram varieties in respect of seed yield was very encouraging and followed a similar trend that of yield attributes. The variety SHEKHAR 2 recorded higher seed yield over other varieties might be due to the higher production efficiency that has been reflected through improvement in different yield attributing characters. Similar findings were reported by Siddikee *et al*. (2018) [11] and Rathode and Gawande (2014). [9]

Conclusion

It is concluded that application of treatment 30 cm x 15 cm + SHEKHAR 2 was recorded significantly higher Seed yield (1062.86 kg/ha) as compared to other treatments. Since, the findings based on the research done in one season.

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