Response of black gram [*Vigna mungo* (L.) Hepper] to spacing and fertilizer doses under rainfed conditions

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**ABSTRACT**

A field experiment was conducted during the *kharif* season of 2012 to study the response of black gram [*Vigna mungo* (L.) Hepper] to different spacing and fertilizer doses under rainfed conditions. Maintaining a wider spacing of 30×10 cm (S	extsubscript{30}) was found to increase uptake of nutrients P and K by the crop resulting in significantly higher number of leaves, branches and pods per plant respectively, thereby registering the highest grain and stover yields of 730 kg/ha and 1382 kg/ha respectively. Among the fertilizer dose, F	extsubscript{2} (N	extsubscript{20}P	extsubscript{40}K	extsubscript{20} + FYM @ 5 t/ha) was found to increase the availability of NPK by the crop resulting in significantly superior growth attributes viz., plant height, number of leaves and branches/plant and leaf area index (LAI) ultimately recording maximum number of pods/plant, test weight and grain yield of 725 kg/ha. Whereas, the fertilizer dose F	extsubscript{3} (N	extsubscript{20}P	extsubscript{50}K	extsubscript{30}) was found to record the highest stover yield of 1362 kg/ha.

**Keywords:** Black gram, Fertilizer doses, Growth and yield, Nutrient uptake, Spacing.

**INTRODUCTION**

The average productivity of black gram/urdbean continues to be low mainly due to its cultivation under poor management and without proper and adequate inputs. Inherent yield potential of black gram can be realized by adopting input intensive management practices. Suitable sowing time, variety and plant population are important non-cash inputs to achieve synchronous maturity and higher productivity of urdbean. Optimum plant density and planting geometry are important factors for optimizing grain yields in black gram. Planting density affects growth, developmental, carbohydrate production and partition and ultimately the yield of a crop. Maintaining optimum spacing and population density per unit area provides conditions such as maximum light interception, photosynthetic activity, assimilation and accumulation of more photosynthates, which facilitates luxuriant crop growth and better plant canopy area and hence they produce more seed yield with best quality traits (Mazumdar et al. 2007). Black gram is mostly cultivated on marginal lands in mono/mixed cropping system without any fertilizers under rainfed conditions with results in generally low yields compared to its yield potential. The yield potential of the crop can be realized and this yield gap can be minimized through adequate and balance supply of plant nutrients. Rathore *et al.* (2010) reported significantly superior growth characters, yield attributing traits and seed and straw yield with application of 100% recommended fertilizer doses. The use of organic manures along with synthetic fertilizers has great significance for maintenance of soil fertility, physical condition and biological activity. Soil fertility was improved significantly with farmyard manure used either alone or in combination with NPK over that of initial soil status (Singh *et al.* 2001). The integrated application of FYM with chemical fertilizer improves bulk density, water holding capacity and CEC of the soil and also increases the availability of native soil nutrients and chemical fertilizers due to release of organic acids and microbial products during their decomposition. Keeping in view the above facts the present investigation was conducted to study the response of black gram under different spacing and fertilizer dose treatments under rainfed conditions.

**MATERIALS AND METHODS**

A field experiment was conducted during the *kharif* season of 2012 in the experimental farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema Campus, Nagaland. The soil was sandy loam and well drained recording medium content of available N (313 kg/ha), P (13 kg/ha) and K (190 kg/ha) respectively with pH of 4.7 and organic carbon of 1.15%. The experiment was conducted in randomized block design (RBD) with three replications comprising of three spacings viz., S	extsubscript{1} (20×10 cm), S	extsubscript{2} (30×10 cm) and S	extsubscript{3} (45×10 cm) and four fertilizer doses viz., F	extsubscript{1}/Control (NPK), F	extsubscript{2} (N	extsubscript{20}P	extsubscript{40}K	extsubscript{20} + FYM@ 10 t/ha), F	extsubscript{3} (N	extsubscript{20}P	extsubscript{50}K	extsubscript{30} + FYM @5 t/ha) and F	extsubscript{4} (N	extsubscript{20}P	extsubscript{50}K	extsubscript{30}). Field preparation was done during the last week of June 2012. Well decomposed FYM @ 10 and 5 t/ha was uniformly broadcasted over the plots marked F	extsubscript{1} and F	extsubscript{2}.

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RESULTS AND DISCUSSION

Growth attributes: Effect of spacing on various crop growth attributes are presented in Table 1. Narrow spacing $S_1$ (20×10 cm) was found to record the highest plant height as compared to wider spacings of $S_2$ (30×10 cm) and $S_3$ (45×10 cm) at all the stages of growth. Taller plants observed under narrow spacings could be due to lack of enough space for lateral growthresulting in vertical growth (Rajput et al. 1993) or due to competition between plants for light. Number of leaves/plant and branches/plant was found to be significantly higher under wider spacing with spacing $S_3$ recording the maximum values for both the parameters and narrow spacing $S_1$ recording the lowest values for both. This may be attributed to more horizontal growth and plant canopy area under wider spacing due to less plant population density and competition compared to those in closer spacing (Bahadur and Singh, 2005). The highest leaf area index (LAI) and crop growth rate (CGR) were recorded under narrow spacing $S_1$ and the lowest LAI and CGR were recorded under $S_3$, followed by $S_2$, this could be due to higher population densities under $S_1$ as compared to comparatively lower population densities under $S_2$ and $S_3$. Biswas et al. (2002) also reported higher LAI and CGR under higher planting density. Fertilizer doses were also found to record significant variations on crop growth attributes (Table 1). Significantly higher plant height and number of leaves/plant were recorded under $F_3$ ($N_5P_2K_{20} + FYM@ 5 t/ha$) and $F_2$ ($N_5P_2K_{10} + FYM@ 5 t/ha$) at different stages of observations whereas, the lowest plant height and number of leaves/plant were constantly recorded under $F_1$ (control) which may be due to higher availability of N under treatments $F_2$ and $F_3$. The height of a plant depends on nutrient especially on nitrogen (Ferdous, 2001). Increased number of leaves/plant and plant height in forage maize due to application of nitrogen was respectively and incorporated 15 days before sowing. Nitrogen, Phosphorous and Potassium in the form of Urea, SSP and MOP were applied @ 5: 20: 10 kg/ha for treatment $F_1$, 10: 40: 20 kg/ha for treatment $F_2$ and 20:50: 30 kg/ha for treatment $F_3$. For all the treatments $F_1$, $F_2$ and $F_3$, starter dose of N and full dose of P and K were applied at the time of sowing as bas application in furrows below the seed. The crop was sown on the 30th of June 2012 wherein, black gram variety T-122 was line sown manually maintaining spacings of 20×10 cm, 30×10 cm and 45×10 cm as per treatment allocation. Inorder to increase the pH of the soil liming was done 15 days before sowing. Need based intercultural operations, pest and disease management were maintained uniformly for all the plots. Necessary biometric observations were recorded to study the response of the crop to the various treatments. The seed and stover samples were analysed for % NPK content. After harvesting the crop, soil samples were collected to determine the effect of fertilizer doses on the nutrient status of the experimental field. The data collected during the course of the investigation were analysed statistically following standard techniques.
also reported by Gasim (2001). The treatments $F_1$, $F_2$ and $F_3 (N_0P_0K_0)$ were at par with respect to number of branches/plant and recorded significantly higher values over control treatment $F_0$. Vairavan (2011) also reported that the number of branches/plant were significantly increased by the application of recommended dose of chemical fertilizers in combination with FYM. LAI was also found to be significantly higher under treatments $F_1$, $F_2$ and $F_3$, which were at par, as compared to control treatment $F_0$. Significantly higher LAI under fertilizer treatments $F_1$ and $F_3$ may be attributed to higher number of leaves and branches recorded under those treatments. The significant rise in growth parameters noticed under higher fertilizer levels may be attributed to greater uptake of nutrients by the plants favouring better cell division, elongation, amino acid and protein synthesis resulting in superior expression of various crop growth attributes compared to unfertilized treatment. Increase in growth parameters under higher fertilizer levels was also reported by Kumar et al. (2004). Significantly higher CGR was recorded under the treatment $F_1$ followed by $F_2$ and $F_3$ whereas, the lowest CGR was recorded under control treatment $F_0$ which could be attributed to the superior crop growth observed under the treatments $F_1$, $F_2$ and $F_3$.

**Yield attributes and yield:** Spacing and fertilizer doses were found to record considerable variations in the yield and yield attributes of the crop (Table-2). The different spacing treatments did not register any significant effect on the number of seeds/pod and pod length of pods however, number of pods/plant, test weight and grain and stover yield were significantly affected. Significantly higher number of pods/plant and the highest grain and stover yield of 730 kg/ha and 1382 kg/ha were recorded under $S_3(30 \times 10 \text{ cm})$ which could be due to optimum plant population resulting in reduced competition and higher availability of growth resources leading to higher growth, development and favourable crop yield. Biswas et al. (2002) also reported that a spacing of $30 \times 10 \text{ cm}$ showed optimum plant density for maximum seed yield. Kabir and Sarkar (2008) also reported that spacing of $30 \times 10 \text{ cm}$ gave the highest number of pods/plant, the highest grain yield and the highest stover yield. The spacing $S_1 (45 \times 10 \text{ cm})$ was at par with $S_3$, with respect to number of pods/plant and recorded significantly higher stover yields over $S_3$ which could be attributed to significantly higher number of branches and leaves recorded under the treatment $S_3$. The highest test weight was recorded under treatment $S_5$, which also recorded significantly higher grain yield compared to $S_3$. Higher grain yields under narrow spacing of both $F_0$ and $F_3$, the lowest number of pods/plant, test weight, grain and stover yield were recorded. Maximum number of pods/plant, test weight and grain yield of 725 kg/ha were recorded under $F_1 (N_0P_{40}K_{20} + FYM @ 5 \text{ t/ha})$. The highest stover yield of 1362 kg/ha was obtained from $F_3 (N_0P_{40}K_{20} + FYM @ 10 \text{ t/ha})$ and $F_5$ (control) whereas, $F_1$ was also found to record significantly higher grain yield over both $F_0$ and $F_3$. The lowest number of pods/plant, test weight, grain yield and stover yield were recorded under $F_0$ (control). Superior yield attributes and grain yields obtained under fertilizer doses $F_2$ and $F_3$ could be due to optimum doses of NPK under those treatments, compared to the rest of the treatments, resulting in higher nutrient availability and uptake by the crop thereby exhibiting superior yield and yield attributes, Rathore et al. (2010) also reported significantly higher growth characters, yield attributing traits (number of clusters and pods per plant) and seed and straw yield with application of 100% RDF. Inclusion of organic source i.e., FYM under the treatments $F_1$ and $F_3$ may also be attributed for superior grain yields under those treatments. Vairavan (2011) reported that application of recommended dose of NPK in combination with FYM at 5 t/ha recorded higher growth, yield attributes and yield of *rabi* black gram.

Table 2: Yield attributes and yield of black gram as affected by different spacing and fertilizer doses.

| Treatments | Number of seeds/pod | Pod length(cm) | Number of pods/plant | Test weight(g) | Grain yield(kg/ha) | Stover yield(kg/ha) | Harvest index (%) |
|------------|---------------------|---------------|-----------------------|--------------|-------------------|-------------------|------------------|
| **Spacing** |                     |               |                       |              |                   |                   |                  |
| $S_1 (20 \times 10 \text{ cm})$ | 7.52 | 4.86 | 80.87 | 36.16 | 665 | 1246 | 34.83 |
| $S_3 (30 \times 10 \text{ cm})$ | 7.78 | 4.85 | 90.17 | 34.14 | 730 | 1382 | 34.62 |
| $S_4 (45 \times 10 \text{ cm})$ | 7.63 | 4.83 | 89.58 | 35.57 | 579 | 1295 | 34.66 |
| **SEM ±** | 0.135 | 0.1 | 0.539 | 0.234 | 0.127 | 0.277 | 0.372 |
| **CD (P=0.05)** | NS | NS | 1.902 | 0.796 | 0.432 | 0.942 | NS |
| **Fertilizer doses** | | | | | | | |
| $F_1$ - Control (N$_0P_0K_0$) | 7.62 | 4.66 | 72.47 | 34.13 | 571 | 1199 | 34.34 |
| $F_2$ (N$_{20}P_{40}K_{20}$ + FYM @ 10/t ha) | 7.67 | 4.94 | 96.69 | 34.51 | 713 | 1345 | 34.68 |
| $F_3$ (N$_{30}P_{30}K_{20}$ + FYM @ 5 t/ha) | 7.76 | 4.90 | 96.02 | 36.65 | 725 | 1326 | 35.33 |
| $F_4$ (N$_{20}P_{40}K_{20}$) | 7.53 | 4.87 | 91.31 | 35.85 | 625 | 1362 | 34.46 |
| **SEM ±** | 0.156 | 0.121 | 0.646 | 0.207 | 0.147 | 0.32 | 0.429 |
| **CD (P=0.05)** | NS | NS | 2.198 | 0.918 | 0.500 | 1.088 | NS |
compared to other treatment combinations. Significantly higher number of pods/plant and test weight recorded under F₂ and F₃ could be due to increased availability of N under these treatments. Whereas, significantly higher straw yield obtained under F₁ could be due to higher doses of N and P resulting in pronounced vegetative growth. Hussain et al. (1996) also reported that N and P application had significant influence on the straw yield of mung bean cultivars. Harvest index did not register any signification variations among the different fertilizer doses.

**Seed and stover nutrient content:** Spacing treatments did not have any significant effect on the nitrogen content of both seed and stover though significant variations in phosphorus content of seed and potassium content of both seed and stover were recorded (Table 3). The phosphorus content in seed was found to be significantly higher in wider spacings S₁ and S₂, which were at par, compared to narrow spacing S₃. While, in case of potassium content both seed and stover recorded higher potassium content under wider spacings of S₁ and S₂ compared to narrow spacing S₃. Optimum/low plant densities under wider spacing S₁ and S₂ may have resulted in less competition and higher P and K uptake and dry matter accumulation whereas, higher competition for growth resources under narrow spacing S₃ may have resulted in reduced P and K content of seed and stover. Malagi (2008) also reported that wider row spacing resulted in maximum total uptake and content of NPK. The NPK content in seed and stover was significantly higher under different fertilizer levels compared to control F₀ (Table 3). Significantly higher P and K content in seed was recorded under F₁ and F₃ respectively while, with respect to N content F₀, F₂ and F₃ were at par with each other. In case of stover, the highest N and P content was recorded under F₁ while, K content was highest under F₃. Significantly higher NPK content recorded under F₁, F₂ could be due to optimum fertilizer doses along with enhanced uptake of NPK due to application of FYM. Shrikant et al. (2000) also reported increased uptake of NPK due to application of organic matter. Whereas, application of high doses of NPK under F₃ could be attributed for high uptake of nutrients under the treatment.

**Soil fertility at harvest:** Compared to the control treatment F₀, soil organic carbon and NPK were found to be significantly higher with the application of different fertilizer doses viz., F₁, F₂ and F₃ except for soil pH which did not record any significant variation across the different treatments (Table 4). The highest organic carbon was recorded under the treatment F₂ followed by F₁ while, soil available NPK was found to be significantly higher under

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**Table 3:** Effect of spacing and fertilizer doses on NPK content of seed and stover.

| Treatments | Seed | Stover |
|------------|------|--------|
|            | N (%) | P (%)  | K (%)  |
| Spacing    |       |        |        |
| S₁ (20×10 cm) | 3.35  | 0.13   | 1.24   | 1.93 | 0.18 | 2.32 |
| S₂ (30×10 cm) | 3.37  | 0.15   | 1.61   | 1.90 | 0.18 | 2.36 |
| S₃ (45×10 cm) | 3.47  | 0.15   | 1.52   | 1.96 | 0.17 | 2.73 |
| SEm ±      | 0.079 | 0.004  | 0.012  | 0.068| 0.005| 0.102|
| CD (P=0.05)| NS    | 0.013  | 0.040  | NS   | NS  | 0.347|

**Table 4:** Effect of spacing and fertilizer doses on fertility status of the soil after harvest.

| Treatments | pH | Organic Carbon (%) | Available N(kg/ha) | Available N(kg/ha) | Available N(kg/ha) |
|------------|----|--------------------|-------------------|-------------------|-------------------|
| Spacing    |    |                    |                   |                   |                   |
| S₁ (20×10 cm) | 4.82 | 1.37               | 350.19            | 14.19             | 245.96            |
| S₂ (30×10 cm) | 4.74 | 1.43               | 360.64            | 14.12             | 248.34            |
| S₃ (45×10 cm) | 4.83 | 1.40               | 350.19            | 14.64             | 244.67            |
| SEm ±      | 0.024| 0.036              | 10.172            | 0.243             | 4.126             |
| CD (P=0.05)| 0.081| NS                 | NS                | NS                | NS                |

**Fertilizer doses**

| F₀ - Control (N,P,K) | 4.79 | 1.23 | 313.60 | 13.44 | 197.44 |
| F₁ (N₃P₃K₃ + FYM@ 10/t ha) | 4.79 | 1.52 | 369.35 | 14.53 | 259.74 |
| F₂ (N₃P₃K₃ + FYM@ 5/t ha) | 4.80 | 1.61 | 369.35 | 15.24 | 263.66 |
| F₃ (N₃P₃K₃) | 4.81 | 1.24 | 362.38 | 14.64 | 264.46 |
| SEm ±      | 0.028| 0.041  | 11.746 | 0.281  | 4.764  |
| CD (P=0.05)| NS   | 0.139  | 39.966 | 0.956  | 16.209 |
the treatments $F_1$, $F_2$ and $F_3$ as compared to $F_0$ (control) however, no significant variations were recorded among the three former treatments. Significantly higher soil organic carbon and NPK recorded under $F_1$ and $F_2$ could be due to application of FYM under those treatments. The fertility of soil increases if the soil contains more organic matter, application of manures either of plant or animal origin increases organic matter in the soil and thereby the fertility of the soil is increased (Das, 2009). The unfertilized treatment $F_0$ gave the lowest pH, organic carbon and soil NPK due to exclusion of nutrient dose.

**CONCLUSION**

Based on the findings of the investigation it may be concluded that for optimum growth and seed yield performance of black gram under rainfed conditions, maintaining a wider spacing of 30×10 cm along with application of fertilizer dose of $N_{20}P_{40}K_{20} +$ FYM @5 t/ha is the best management practice to increase the availability and utilization of nutrients by the crop whereas, for stover yields a higher fertilizer dose of $N_{20}P_{50}K_{30}$ may be used along with a wider spacing of 30×10 cm.

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