Yield Response of Black Gram to Nitrogen, Phosphorous and Potassium Combinations Grown in Khulna District of Southwestern Coastal Bangladesh

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Abstract
Nitrogen, phosphorous and potassium have significant influence on physiological growth and yield of black gram. There is no specific nutrient recommendation for black gram in the southwestern coastal region. Nutrient requirement of black gram needed to be assessed in this area. Therefore, the field experiment was conducted at the Field Laboratory of Agrotechnology Discipline, Khulna University during *Kharif-I* season (March-July) to evaluate the effect of different rates of NPK on growth, yield and yield attributes of black gram (BARI Mash-3). The experiment comprised of four treatments *viz*. F_0 = Control (no nutrient added), F_1 = NPK-12:15:18 kg ha^{-1}, F_2 = NPK-16:20:24 kg ha^{-1} and F_3 = NPK-20:25:30 kg ha^{-1}. The experiment was laid out in randomized complete block design with four replications. NPK rates had substantial influence on growth, yield and yield attributes of black gram. Growth, yield and yield attributes were increased with the increment of NPK rates. The highest plant height (62.62 cm), number of branch plant^{-1} (11.00), number of pod plant^{-1} (27.44), number of seed pod^{-1} (7.89), 1000 seed weight (43.78 g), seed yield (1.72 t ha^{-1}), stover yield (4.22 t ha^{-1}) and harvest index (29.13%) were obtained from 20:25:30 kg NPK ha^{-1} while lowest value of all the parameters were obtained from no NPK added plot. Results of this experiment revealed that NPK @ 20:25:30 kg ha^{-1} could be the best for the cultivation of black gram (BARI Mash-3) in Khulna region of southwestern coastal Bangladesh.

Key words: Black gram, NPK, Southwestern Bangladesh, Growth and Yield.

Introduction

Black gram is a cultivated legume belongs to the family fabaceae grown in the South Asian Countries. In Bangladesh various types of pulse crops are grown, among them black gram (Mashkalai in Bangla) (*Vigna mungo* L.) is one of the major edible pulse crop in Bangladesh. It ranks third among the pulses with an area of about 98006 acres with production of 35151 MT (BBS, 2016). The crop is potentially useful in improving cropping pattern and being a short duration crop it fits well into the intensive cropping system. The percentage area under black gram in Bangladesh is 10.67% (BBS, 2016). The average yield of black gram is 0.9 ton/hectare (BBS, 2016) in Bangladesh but in case of BARI-mash 3, the average yield is 1.5-1.6 t ha^{-1}. The national production of the pulses is not adequate to meet our national demand. There are many reasons of lower yield of black gram among them fertilizer management is very crucial regarding growth and yield. Depending on the fertility status of the soil addition of adequate and balanced nutrient greatly influence the growth, development and yield of this crop. Yet the nutrient requirement is relatively very low in pulse crop for its successive growth, development and production but their deficiency greatly affect the physiological and metabolic processes involved in the plant that causes drastic yield loss (Meena et al., 2013).

Pulses although fix nitrogen from the atmosphere, it is evident that application of nitrogenous (N) fertilizers at flowering stage becomes helpful in increasing the yield (Rahman et al., 2015). Phosphorus (P) fertilizer and potash (K) fertilizer have a great effect on growth and yield of black gram. P fertilizers stimulate better root growth, disease resistance and improve the water and nutrient absorption in the seedling stage. K plays a vital role in the activation of enzymes and boost up biological N fixation and protein content of pulse seeds (Bukhsh et al., 2011; Srinivasarao et al., 2003)

Khulna is situated in southwestern coastal region of Bangladesh. T. aman is the main crop in this region. After harvest of aman rice, most of the land in this region remains fallow. There is a scope of utilizing these fallow lands by cultivation of black gram and thus it may enhance cropping intensity and also improve the existing cropping pattern. Most of the farmers in this region are less concerned about the cultivation and management practices of pulse crop specially fertilizer management. The fertility status of the soil in this region is low to very low specially nitrogen and organic matter content. In the coastal region of southwestern Bangladesh there is no nutrient recommendation for black gram. Prudent nutrient management immensely influence the yield, improve the soil health and reduce the cost of production. Therefore, the present research work was designed and carried out to investigate the effect of NPK on growth and yield of black gram (BARI mash-3) and explore the optimum rate in the southwestern coastal region of Bangladesh.

Materials and methods

Experimental site and planting material

The research experiment was conducted at the experimental field of Agrotechnology Discipline, Khulna University, Khulna during the *kharif-I* season, 2017 (March-June). The area is located in the Agro-ecological Zones (AEZ) 13 (Gangetic Tidal Floodplain). The experimental field was medium highland and well drained having clay loam type soil. Black gram (BARI Mash-3) was used as planting material in this experiment and the seeds were collected from Regional Agricultural Research Station (RARS), Jessore.

Experimental treatment and design

The experiment consisted of four treatments as nutrient (NPK) levels *viz.* F_0 = Control (no nutrient added); F_1 = NPK-12:15:18 kg ha^{-1}, F_2 = NPK-16:20:24 kg ha^{-1} and F_3 = NPK-20:25:30 kg ha^{-1}. The experiment was laid out in a randomized complete design (RCBD) with four replications. Each replication was divided into four unit plots thus total plots were sixteen maintaining a spacing of 1.5 m between replication to replication and 1.0 m between plot to plot. The plot size was 4.0 m × 2.5 m. The treatment was assigned randomly in each replication.

Experiment conduction

The land was prepared by ploughing and cross ploughing followed by laddering. Before sowing the seeds were treated with fungicide Provax-200 at the rate of 3g kg^{-1} of seed. Urea, TSP and MoP fertilizers were used as the source of N, P and K respectively. As per the treatments the fertilizers were applied at the time of final land preparation and properly mixed with the soil except urea. Two-third urea was applied as basal dose and rest one-third was used as top-dressed at 25 days after sowing (DAS) followed by irrigation. Seeds were sown in line at the rate of 40 kg ha^{-1} in 30 cm apart maintaining 25 cm spacing between seed to seed. Intercultural operations such as thinning, weeding, irrigation, plant protection measures were taken in the field as and when necessary and kept uniform for all the treatments.

Data collection

Data on first flowering, duration of flowering, first pod formation and duration of pod formation, plant height (cm), number of branch plant^{-1}, number of pods plant^{-1}, number of seed pod^{-1}, 1000 seed weight (g), grain yield (t ha^{-1}), stover yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest index (%) were collected, calculated and recoded. For the collection of growth parameters five plants were randomly selected from each plot avoiding the border line. For the measurement of yield an area of 1.0 m x 1.0 m were harvested and tagged appropriately. Then the seeds from the pods were separated manually and sundried properly (~10% moisture content). Stover also sundried correctly. Finally seed weight and stover weight were taken and converted to t ha^{-1}.

Statistical analysis

The recorded data were on growth, yield and yield contributing components were accumulated and tabulated for statistical analysis. The data were analyzed following the analysis of variance technique (one-way ANOVA) using Statistical Tool for Agricultural Research (STAR) computer package program and the means among the treatments were compared by Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984)

Results and discussion

Effect of NPK on phenological parameters

The data recorded and analyzed for phonological parameters. NPK rates had no significant effect on the recorded phonological parameters (Fig. 1 and Fig. 2). However, the earliest first flowering (30.4 days) and first pod formation (32.8 days) were recorded from control treatment (no NPK added) while the first flowering (30.9 days) and first pod formation (34.0 days) were delayed in NPK-20:25:30 kg ha^{-1}. In case of length of flowering and pod formation numerically maximum duration (6.8 days and 12.2 days respectively) were found in NPK-20:25:30 kg ha^{-1} whereas minimum (5.7 days and 10.7 days respectively) was recorded from NPK-12:15:18 kg ha^{-1}.

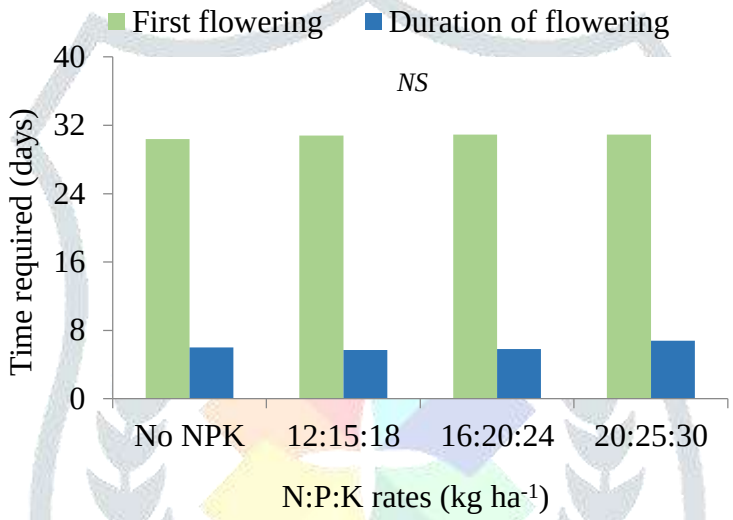

Figure 1. Effect of fertilizers NPK on first flowering and duration of flowering of black gram (BARI Mash-3) grown in the southwestern coastal Bangladesh

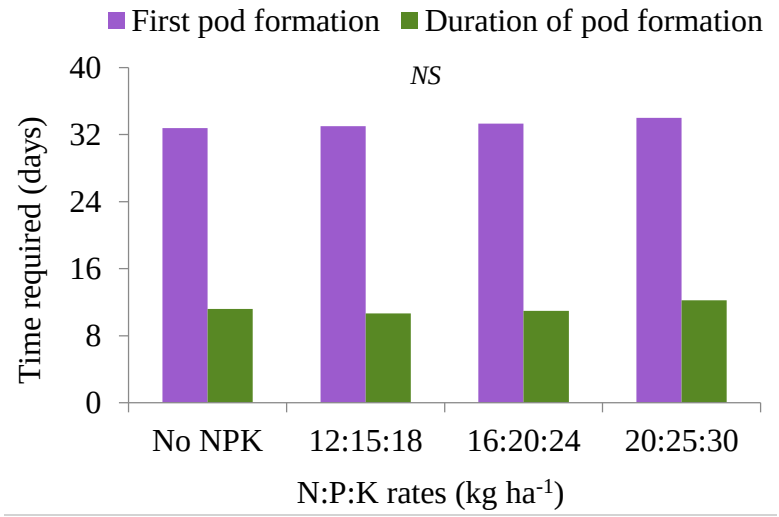

Figure 2. Effect of NPK on first pod formation and duration of pod formation of black gram (BARI Mash-3) grown in the southwestern coastal Bangladesh

Effect of NPK rates on growth parameters

Effect of NPK rates on different growth parameters has been presented in table 1. Plant height influenced significantly with the variation of NPK rates at different days after sowing and at harvest. At harvest tallest plant (62.62 cm) was recorded from NPK-20:25:30 kg ha^{-1} (F_3) whereas the shortest (40.53 cm) was obtained from control treatment (F_0). NPK levels had significant effect on branch $plant^{-1}$ at different days after sowing and at harvest. The maximum number of branch $plant^{-1}$ (11.0) at harvest was obtained from NPK-20:25:30 kg ha^{-1} (F_3) while the minimum (6.78) was found in control treatment (F_0). The result of the study indicated that with the increased of fertilizers rates the plant height and number of branch $plant^{-1}$ gradually increased. N fertilizer stimulates rapid growth and healthy developments of foliage and better establishment of seedlings in the soil. Phosphorous stimulates root growth and better uptake of nutrient and water from the soil. The results of this study supported by Kumar and Tomar (2015) who observed that plant height of black gram increased with the increased of N rates. Biswas et al. (2014) reported that branch $plant^{-1}$ steadily raised with the increased of K rates. Similar types of observation were also reported by Sharma and Abraham (2010) all the growth parameters were highest at 20 kg N ha^{-1} over the control.

Table 1. Effect of NPK rates on plant height (cm) and number of branch $plant^{-1}$ of black gram (BARI Mash-3) grown in the southwestern coastal Bangladesh

NPK rates (kg ha^{-1})	Plant height (cm)			Number of branch $plant^{-1}$		
	30 DAS	45 DAS	At harvest	30 DAS	45 DAS	At harvest
No NPK added (F_0)	23.82c	32.18d	40.53d	2.33c	4.89d	6.78c
12:15:18 (F_1)	24.01c	34.63c	44.92c	2.67bc	5.33c	8.00bc
16:20:24 (F_2)	26.38b	41.62b	52.93b	3.00ab	6.22b	9.22b
20:25:30 (F_3)	27.76a	46.39a	62.62a	2.33a	6.67a	11.00a
CV (%)	3.93	3.28	2.28	10.47	6.63	6.16
Significance level	**	**	**	**	**	**

CV = Co-efficient of variation, ** = Significant at 1% level of significance

Effect of NPK rates on yield and yield components

Experimental results in table 2 showed the effect of NPK rates on yield and yield components of black gram variety of BARI Mash-3. NPK rates had significant impacts on number of pods $plant^{-1}$. The maximum number of pods $plant^{-1}$ (27.44) was obtained from NPK-20:25:30 kg ha^{-1} (F_3) while the minimum (18.56) was found in control treatment (F_0). Number of seeds pod^{-1} affect significantly with the variation of NPK rates. Among the treatments, NPK-20:25:30 kg ha^{-1} (F_3) produced the maximum number of seeds pod^{-1} (7.89), and the minimum (6.0) was recorded from control treatment (F_0). Maximum number of pod plants attributed to higher number of branch $plant^{-1}$.

NPK rates had significance influence on seed weight $plant^{-1}$ (Table 2). The utmost seed weight $plant^{-1}$ (14.89 g) was obtained from NPK-20:25:30 kg ha^{-1} (F_3). On the other hand the lowest seed weight $plant^{-1}$ (9.22 g) was found in control treatment (F_0). 1000 seed weight substantially increased with the increment of NPK rates. The maximum weight (43.78 g) of 1000 seed was found in NPK-20:25:30 kg ha^{-1} (F_3) whereas the minimum (38.0 g) was obtained from control treatment (F_0).

Analysis of variance indicated that seed yield and stover yield of black gram varied significantly with the variation of NPK rates (Fig. 3 and Table 2). The highest seed yield (1.72 t ha^{-1}) and stover yield (4.22 t ha^{-1}) were obtained from NPK-20:25:30 kg ha^{-1} (F_3) while the lowest (1.26 t ha^{-1} and 3.45 t ha^{-1} respectively) were recorded respectively from control treatment (F_0). Seed yield of black gram increased with the increment rate of NPK. Seed yield of black gram was increased ~37% with the application of NPK-20:25:30 kg ha^{-1} over control treatment (no NPK added). Harvest index of black gram significantly influence with the NPK rates (Table 2). The highest harvest index (29.13%) was obtained from NPK-20:25:30 kg ha^{-1} (F_3) whereas the lowest (26.62) was obtained from control treatment (F_0).

Table 2. Effect of NPK rates on yield attributes and yield of black gram (BARI Mash-3) grown in the southwestern coastal Bangladesh

NPK rates (kg ha^{-1})	No. of pod plant^{-1}	No of seed pod^{-1}	Seed weight plant^{-1}	1000 seed weight (g)	Stover yield (t ha^{-1})	Harvest index (%)
No NPK added (F_0)	18.56c	6.00c	9.22c	38.00c	3.45d	26.62c
12:15:18 (F_1)	19.22c	6.11c	10.67c	38.89c	3.79c	27.08bc
16:20:24 (F_2)	22.89b	7.11b	12.78b	41.33b	4.07 b	28.09ab
20:25:30 (F_3)	27.44a	7.89a	14.89a	43.78a	4.22a	29.13a
CV (%)	9.54	10.41	15.35	4.40	4.53	5.42
Sign. level	**	**	**	**	**	**

CV = Co-efficient of variation, ** = Significant at 1% level of significance

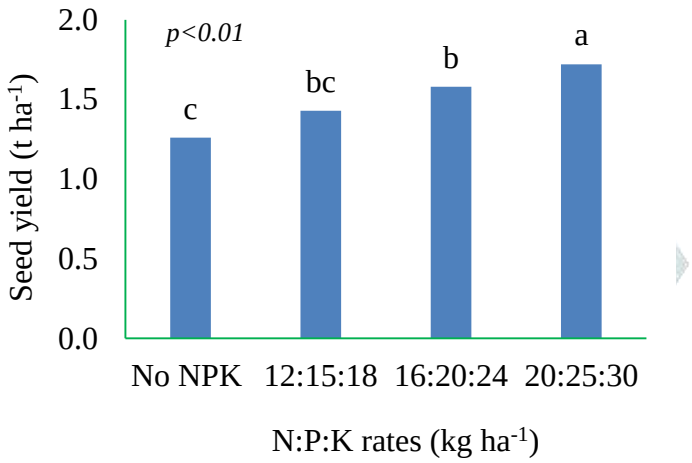

Figure 3. Effect of NPK on seed yield of black gram (BARI Mash-3) grown in the southwestern coastal Bangladesh

Adequate supply of N improved the pod bearing branch. The results of this experiment are in agreement with Hossen et al. (2015) who reported that N fertilization had significant effect on pod plant^{-1}. Higher seed yield was due to the adequate supply of P attributed to more branching, pod formation, increased seed number pod^{-1} and seed size. Previous study reported that increase of P fertilizer enhanced the vegetative growth and branch plant^{-1} (Mohammad et al., 2017 and Rathour et al., 2015). Karim et al. (2014) found that P fertilizer substantially influence the seed pod^{-1}. Seed yield is attributed to pod plant^{-1}, seed weight pod^{-1} and 1000 seed weight. NPK-20:25:30 kg ha^{-1} produced the highest value of all the yield attributes which leads to better seed yield. This may be due to the better partitioning of dry matter from source to sink. The results of this study supported by Rathore et al. (2011) as with the increase of phosphorus level, the seed yield and stover yield of black gram increase. Similar finding also found by Kulsum et al. (2007) as the yield and yield attributes of black gram increased with the increment of nitrogen up to 60 kg ha^{-1} next decline. The results corroborated with the finding of Kurhade et al. (2015) who found that the seed and stover yield increased with the addition of potassium up to 40 kg ha^{-1} with recommended dose of other fertilizer.

Conclusion

NPK rates substantially influenced the growth, yield and yield attributes of black gram. Additional rate of NPK had positive response on growth, yield and yield attributes of black gram. Form the results of the experiments it is concluded that application of NPK @ 20:25:30 kg ha^{-1} optimum for black gram (BARI Mash-3) in Khulna district of southwestern coastal Bangladesh.

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