Annals of Plant and Soil Research 26(2): 296-301 (2024)
https://doi.org/10.47815/apsr.2024.10363

Effect of levels of phosphorus and varieties on growth and yield of black gram [Vigna mungo (L.) Hepper]

ARCHANA PANI, T. GOHAINA[1] AND RINU SAKHONG

Department of Agronomy, School of Agricultural Sciences, Nagaland University, Medziphema – 797106 (Nagaland)

Received, March, 2024; Revised accepted, May, 2024

ABSTRACT

A field experiment entitled "Effect of levels of phosphorus on growth and yield of black gram [Vigna mungo (L.) Hepper]" was conducted in Agronomy research farm in School of Agricultural Sciences (SAS), Nagaland University, Medziphema, during kharif season of 2022. The experiment consisted of twelve treatments which were laid out in Randomized Block Design (RBD) with three replications. The treatment consisted of four different levels of phosphorus (P) viz., 0 (P0), 20 (P1), 40 (P2) and 60 kg P_2O_5 ha^{-1} (P3) and three different varieties (V) viz., SBC-40 (V1), SBC-51 (V2) and PU-31 (V3). The results revealed that among different levels of phosphorus, application of 60 kg P_2O_5 ha^{-1} recorded higher growth attributes, yield attributes and nutrient uptake. In case of varieties, SBC-51 variety recorded higher growth attributes, yield attributes and nutrient uptake compared to the other varieties. In case of interaction between varieties and phosphorus, variety SBC-51 along with the application of 60 kg P_2O_5 ha^{-1} recorded the maximum growth attributes and yield attributes viz., number of pods plant-1 (37.24), pod length, number of seeds pod^{-1} (6.93), seed yield (1014.66 kg ha^{-1}), stover yield (2246.54 kg ha^{-1}) over rest of the treatment. In terms of nutrient uptake, application of 60 kg P_2O_5 ha^{-1} in SBC-51 variety of black gram recorded highest N, P and K uptake by both seed and stover.

Keywords: Black gram, phosphorus, variety, growth attributes, yield attributes, nutrient uptake

INTRODUCTION

Pulses hold a significant importance in the Indian cuisine because of their affordability and accessibility and also, they are a rich source of protein. The cultivation of pulse crops offers farmers sustainable agricultural options that come with a multitude of benefits. Pulses have sustainable characteristics such as low water requirements, deep-rooted systems for soil erosion prevention, extensive ground coverage, and seamless integration into crop rotation and mixtures, enhancing productivity and farming system resilience (Singh *et al.,* 2020). Black gram, also known as urad dal, is a versatile crop that can be cultivated either as a standalone crop or as an inter-crop alongside other crops. It exhibits remarkable adaptability to various soil types, encompassing not only sandy soils but also heavy cotton soils. However, the most suitable soil for black gram cultivation is a well-drained loam soil with a pH ranging from 6.5 to 7.8. Alkaline and saline soils are not conducive to black gram growth. As a tropical crop, black gram thrives in hot and humid climates, which provide optimal conditions for its growth. It possesses characteristics of drought resistance, making it resilient during periods of water scarcity. Being a member of the Leguminosae family, black gram has the ability to fix atmospheric nitrogen, thereby enriching the soil with this essential nutrient. This makes it valuable not only as a food crop but also as a green manure crop and a source of fodder. Pulses play a vital role in India's food and nutritional security. The emphasis on enhancing food production has primarily been directed towards cereals, resulting in a notable transformation in cropping systems. Despite these concentrated efforts, pulse production in India continues to lag behind (Choudhary *et al.,* 2014).

To achieve higher yields in pulse crops, it is crucial to consider various factors that impact crop management, including phosphorus nutrition. Phosphorus plays a crucial role in promoting advantageous outcomes such as root development, nodulation, growth, and ultimately, yield. It stimulates the activity of symbiotic nitrogen-fixing bacteria by making the bacterial cells more mobile, resulting in an increase in the amount of atmospheric nitrogen that is available

[1]Corresponding author, Professor & Head, Dept. of Agronomy, SAS, Nagaland University,Email address: tankeswar1968@gmail.com

in the soil. This enhances the efficiency of pulses as soil renovators and ultimately increases the yield of both the main and succeeding crops (Choudhary *et al.,* 2017).

Sustaining appropriate phosphorus nutrition is of utmost importance in legumes as it plays a vital role in numerous plant processes. These include photosynthesis, energy transmission, signal transduction, macromolecular biosynthesis, respiration (Khan *et al.,* 2010), and nitrogen fixation. Even though phosphorus is present in soils, its accessibility to crops is frequently restricted due to the predominance of inaccessible forms of soil phosphorus. However, regular application of phosphorus fertilizers is necessary to supply crops with the required phosphorus in soluble forms. From the earliest phases of plant development, a sufficient supply of phosphorus is required (Bertrand *et al.,* 2003). In consideration of the importance of phosphorus for improving and increasing the yield of black gram, as indicated by the available information, the experiment was carried out with the intention of finding out the effect of levels of phosphorus and varieties on growth and yield of black gram.

MATERIALS AND METHODS

The field experiment was carried out in the experimental farm of School of Agricultural Sciences (SAS), Nagaland University, Medziphema during the kharif season of 2022. The soil of the experimental site was found to be well drained and sandy loam in texture. The initial fertility status of the soil was found to be acidic in pH (4.6), high in organic carbon (1.01%), low in available N (244.06 kg ha^{-1}), medium in available P_2O_5 (28.18 kg ha^{-1}) and medium in available K_2O (166.45 kg ha^{-1}). The experiment consisted of twelve treatments which were laid out in Randomized Block Design (RBD) with three replications. The treatment consisted of four different levels of phosphorus viz., 0, 20, 40 and 60 kg P_2O_5 ha^{-1} and three different varieties viz., SBC-40, SBC-51 and PU-31. The black gram seeds were sown at the seed rate of 15 kg ha^{-1} in line at 3-4 cm depth maintaining a spacing of 30 cm × 10 cm. The different levels of phosphorus i.e., 0, 20, 40 and 60 kg ha-1 along with the recommended dose of nitrogen @ 15 kg ha^{-1} and potassium @ 20 kg ha^{-1} in the form of SSP, Urea and MOP respectively were applied in the soil a day before sowing. As per the requirement, intercultural operations and plant protection measures were done time to time. The observations were recorded from randomly selected plants from each plot on different growth and yield attributes. The selected plants were also subjected to lab analysis for nutrient assessment. The recorded observations were then statistically analysed by ANOVA.

RESULTS AND DISCUSSION

Growth attributes

Effect of phosphorus level

As depicted in Table 1, the application of phosphorus @ 60 kg ha^{-1} (P3) led to significantly increased plant height at harvest, plant population, no. of branches $plant^{-1}$, no. of green leaves plant-1and Leaf Area Index (LAI) at 45 DAS, with improvements of 23.65 %, 18.31 %, 15.06 %, 16.23 % and 28.79 % respectively in comparison to the control (P0). The improved growth of plants and the reduction in mortality of plants may be ascribed to the enhanced nutritional conditions within the root zone. Phosphorus serves as an essential constituent of both adenosine diphosphate (ADP) and adenosine triphosphate (ATP), assuming a vital function in the preservation and transmission of energy throughout metabolic reactions. Furthermore, it promotes cellular division, thus making a substantial contribution to the overall increase in plant growth. Similar findings were reported in previous studies by Shroti et al. (2018), Parashar and Tripathi (2020), Pal (2021) and Gautam et al. (2022).

Effect of varieties

As indicated in Table 1, the various varieties did not yield any significant differences in terms of plant height at the time of harvest or plant population at 45 DAS. However, they did exert a noticeable influence on parameters such as the number of branches $plant^{-1}$, the number of green leaves $plant^{-1}$, and the Leaf Area Index (LAI) at 45 DAS. Variety SBC-51 displayed the most robust growth characteristics when compared to varieties SBC-40 and PU-31.

Table 1: Effect of phosphorus levels and varieties on growth attributes of black gram

Treatment	Plant height (cm)	Plant population (m^{-2})	No. of branches plant^{-1}	No. of green leaves plant^{-1}	LAI
	At harvest	45 DAS		45 DAS	45 DAS
Phosphorus levels (kg ha^{-1})					
P0 : Control	43.67	28.89	3.32	10.78	2.132
P1 : 20 kg P_2O_5 ha^{-1}	48.14	30.00	3.52	11.44	2.348
P2 : 40 kg P_2O_5 ha^{-1}	51.60	33.33	3.66	11.98	2.691
P3 : 60 kg P_2O_5 ha^{-1}	54.00	34.07	3.82	12.53	2.746
SEm+	0.10	0.82	0.01	0.05	0.002
CD (P=0.05)	0.29	2.40	0.04	0.15	0.007
Varieties					
V1 : SBC-40	49.27	30.55	3.50	11.35	2.440
V2 : SBC-51	49.45	32.77	3.67	11.88	2.513
V3 : PU-31	49.35	31.39	3.57	11.82	2.484
SEm+	0.09	0.71	0.01	0.05	0.002
CD (P=0.05)	NS	NS	0.03	0.13	0.006

Interaction effect of phosphorus and varieties

No notable variations were detected as a result of the combined influence of phosphorus and different varieties on factors such as plant height at harvest, plant population at 45 DAS whereas significant effect was observed in no. of branches plant-1, no. of green leaves plant^{-1} and Leaf Area Index (LAI) at 45 DAS as shown in Table 2. Treatment combination T8 (60 kg P_2O_5 ha^{-1} + SBC-51) exhibited the most favourable growth attributes when compared to the other treatment options.

Table 2: Interaction effect of different levels of phosphorus and varieties on growth attributes of black gram

Treatment (V × P)	Plant height (cm)	Plant population (m^{-2})	No. of branches plant^{-1}	No. of green leaves plant^{-1}	LAI
	At harvest	45 DAS		45 DAS	45 DAS
T1 (V1P0)	43.65	27.77	3.20	10.53	2.087
T2 (V1P1)	48.06	28.89	3.47	11.27	2.293
T3 (V1P2)	51.49	32.22	3.57	11.53	2.667
T4 (V1P3)	53.86	33.33	3.77	12.07	2.713
T5 (V2P0)	43.68	30.00	3.43	11.00	2.187
T6 (V2P1)	48.21	31.11	3.57	11.53	2.383
T7 (V2P2)	51.76	34.44	3.77	12.13	2.717
T8 (V2P3)	54.16	35.55	3.90	12.87	2.767
T9 (V3P0)	43.69	28.89	3.33	10.80	2.123
T10 (V3P1)	48.15	30.00	3.53	11.53	2.367
T11 (V3P2)	51.56	33.33	3.63	12.27	2.690
T12 (V3P3)	53.99	33.33	3.80	12.67	2.757
SEm +	0.17	1.42	0.02	0.09	0.004
CD (P=0.05)	NS	NS	0.06	0.27	0.012

Yield attributes and yield

Effect of phosphorus

As shown in Table 3, the application of phosphorus @ 60 kg ha^{-1} recorded significantly higher yield attributing characteristics such as no. of pods plant^{-1}, no. of seeds pod^{-1}, except for test weight, which remained unaffected by phosphorus application. The application of 60 kg P_2O_5 ha^{-1} (P3) recorded maximum seed yield and stover yield, surpassing the control (P0) by 53.14 % and 18.85 %, respectively. Phosphorus plays a vital role in improving the reproductive processes of plants. Sufficient phosphorus levels can stimulate the growth of flowers, increase pollen viability, and enhance the fertilization process, all of which have the potential to significantly impact the yield characteristics of black gram crop. These findings are consistent with previous research conducted by Das (2017), Khalid et al. (2017), Phogat *et al.* (2020) and Yadav *et al.* (2023).

Table 3: Effect of different levels of phosphorus and varieties on yield attributes of black gram

Treatment	No. of pods plant^{-1}	No. of seeds pod^{-1}	Test weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
Phosphorus levels (kg ha^{-1})					
P0 : Control	30.13	5.80	32.13	652.59	1874.34
P1 : 20 kg P_2O_5 ha^{-1}	32.79	6.13	32.92	809.70	2120.88
P2 : 40 kg P_2O_5 ha^{-1}	34.28	6.36	33.26	876.40	2199.60
P3 : 60 kg P_2O_5 ha^{-1}	36.65	6.78	34.02	999.40	2227.78
SEm+	0.21	0.05	0.98	1.66	6.56
CD (P=0.05)	0.62	0.15	NS	4.86	19.23
Varieties					
V1 : SBC-40	33.63	5.81	31.80	827.19	2084.10
V2 : SBC-51	34.92	6.59	32.06	844.05	2122.09
V3 : PU-31	31.83	6.40	35.39	832.33	2110.77
SEm+	0.18	0.04	0.85	1.43	5.68
CD (P=0.05)	0.54	0.13	2.48	4.21	16.65

Effect of varieties

The choice of black gram varieties had a notable impact on achieving elevated yields and yield-related characteristics. Variety SBC-51 exhibited the most favourable results, with the highest no. of pods plant^{-1} (34.92), no. of seeds pod^{-1} (6.59), seed yield (844.05 kg ha^{-1}) and stover yield (2122.09 kg ha^{-1}), as detailed in Table 3. However, variety PU-31 displayed the highest test weight (35.39 g).

Interaction effect of phosphorus and varieties

The combined effect of varying phosphorus levels and different varieties had significant impact on various yield attributes such as no. of pods plant^{-1}, no. of seeds pod-1, seed yield and stover yield except for test weight which was found to be non-significant. Among the treatments, T8 (60 kg P2O5 ha^{-1} + SBC-51) outperformed the other treatments by achieving the highest yield and yield attributes, as indicated in Table 4.

Table 4: Interaction effect of different levels of phosphorus and varieties on yield attributes of black gram

Treatment (V × P)	No. of pods plant^{-1}	No. of seeds pod^{-1}	Test weight (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T1 (V1P0)	29.53	5.33	31.07	647.22	1867.36
T2 (V1P1)	32.60	5.63	31.81	803.22	2067.54
T3 (V1P2)	35.13	5.73	32.00	872.23	2193.32
T4 (V1P3)	37.26	6.53	32.34	986.10	2208.19
T5 (V2P0)	32.52	6.07	31.16	660.53	1880.87
T6 (V2P1)	34.70	6.50	31.41	814.89	2153.76
T7 (V2P2)	35.23	6.87	32.14	886.10	2207.17
T8 (V2P3)	37.24	6.93	33.53	1014.66	2246.54
T9 (V3P0)	28.33	6.00	34.16	650.02	1874.78
T10 (V3P1)	31.07	6.27	35.56	811.00	2141.35
T11 (V3P2)	32.47	6.47	35.63	870.87	2198.32
T12 (V3P3)	35.43	6.87	36.20	997.43	2228.62
SEm +	0.37	0.09	1.69	2.87	11.35
CD (P=0.05)	1.08	0.26	NS	8.42	33.30

Nutrient uptake by seed and stover

Effect of phosphorus

The application of phosphorus @ 60 kg ha^{-1} resulted in the highest recorded uptake of nitrogen (34.47 and 16.17 kg ha^{-1}), phosphorus (2.418 and 3.472 kg ha^{-1}), and potassium (8.804 and 33.764 kg ha^{-1}) by both the seeds and stover of the black gram plant, as depicted in Table 5. Phosphorus plays a pivotal role in influencing the efficiency of nutrient uptake in plants. It is integral to the synthesis of energy-rich compounds like adenosine triphosphate (ATP), which are indispensable for the processes of nutrient uptake and assimilation in plants. Maintaining adequate levels of phosphorus can significantly improve the efficiency of nutrient uptake by fostering root growth and facilitating nutrient absorption. The results are in conformity with the findings of Choudhary et al. (2017), Singh et al. (2018) and Gohain and Jamir (2022).

Table 5: Effect of different levels of phosphorus and varieties on nutrient uptake by seed and stover of black gram

Treatment	N uptake (kg ha ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
	By Seed	By Stover	By Seed	By Stover	By Seed	By Stover
Phosphorus levels (kg ha^{-1})						
P0 : Control	19.53	11.15	1.437	2.224	4.170	24.643
P1 : 20 kg P_2O_5 ha^{-1}	26.05	13.44	1.853	2.688	5.980	29.184
P2 : 40 kg P_2O_5 ha^{-1}	29.69	15.03	2.111	3.101	7.002	31.732
P3 : 60 kg P_2O_5 ha^{-1}	34.47	16.17	2.418	3.472	8.084	33.764
SEm+	0.01	0.03	0.003	0.003	0.003	0.056
CD (P=0.05)	0.02	0.09	0.008	0.009	0.008	0.164
Varieties						
V1 : SBC-40	26.62	13.49	1.850	2.764	6.181	29.082
V2 : SBC-51	28.29	14.52	2.063	2.985	6.442	30.531
V3 : PU-31	27.40	13.84	1.951	2.865	6.305	29.881
SEm+	0.01	0.03	0.002	0.003	0.002	0.048
CD (P=0.05)	0.02	0.08	0.007	0.008	0.007	0.142

Effect of varieties

Different varieties exerted a significant effect on the absorption of N, P and K by both the seed and stover of black gram as depicted in Table 5. Notably, among the three varieties, SBC-51 exhibited the highest nutrient uptake.

Interaction effect of phosphorus and varieties

The interaction between different levels of phosphorus and various black gram varieties had a notable influence on the uptake of nutrients by both the seeds and stover of black gram. Treatment T8 (60 kg P_2O_5 ha^{-1} + SBC-51) significantly outperformed the other treatments in terms of nutrient uptake by both the seed and stover of black gram, as depicted in Table 6.

Table 6: Interaction effect of different levels of phosphorus and varieties on nutrient uptake by seed and stover of black gram

Treatment (V × P)	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
	By Seed	By Stover	By Seed	By Stover	By Seed	By Stover
T1 (V1P0)	18.64	10.72	1.360	2.167	4.087	24.120
T2 (V1P1)	25.57	12.76	1.693	2.503	5.797	27.960
T3 (V1P2)	28.60	14.63	2.037	3.013	6.927	31.127
T4 (V1P3)	33.66	15.85	2.310	3.373	7.913	33.120
T5 (V2P0)	20.56	11.73	1.530	2.300	4.290	25.213
T6 (V2P1)	26.70	14.15	1.973	2.857	6.143	30.323
T7 (V2P2)	30.62	15.70	2.213	3.197	7.087	32.170
T8 (V2P3)	35.28	16.49	2.537	3.587	8.247	34.417
T9 (V3P0)	19.38	10.99	1.420	2.207	4.133	24.597
T10 (V3P1)	25.89	13.42	1.893	2.703	6.000	29.270
T11 (V3P2)	29.85	14.77	2.083	3.093	6.993	31.900
T12 (V3P3)	34.47	16.18	2.407	3.457	8.093	33.757
SEm +	0.01	0.06	0.005	0.005	0.005	0.097
CD (P=0.05)	0.03	0.16	0.014	0.016	0.015	0.283

CONCLUSION

Based on the results obtained through this experiment, it can be concluded that the phosphorus dose of 60 kg P_2O_5 ha^{-1} in combination with the variety SBC-51 resulted in the most favourable outcomes in terms of growth characteristics, yield attributes, and nutrient uptake. Furthermore, this combination resulted a significant impact on the overall growth, yield, and nutrient uptake of black gram.

REFERENCES

Bertrand, I., Holloway, R. E., Armstrong, R. D., McLaughlin, M. J. (2003) Chemical characteristics of phosphorus in alkaline soils from southern Australia. *Soil Research*. **41**(1): 61-76.

Choudhary, A. K., Pooniya, V., Bana, R. S., Kumar, A., & Singh, U. (2014) Mitigating pulse productivity constraints through phosphorus fertilization – A review. *Agricultural Reviews*. **35**(4): 314-319.

Choudhary, S., Sharma, O. P., Choudhary, G. L., & Jat, L. (2017) Response of urd bean (Vigna mungo (L.) Hepper) to phosphorus fertilization and thiourea on yield, quality, nutrient content and uptake. *International Journal of Current Microbiology and Applied Science*. **6**(10): 2841-2847.

Das, S. K. (2017) Effect of phosphorus and sulphur on yield attributes, yield, nodulation and nutrient uptake of green gram (Vigna radiata (L.) Wilczek). *Legume Research*. **40**(1): 138-143.

Gautam, R., Khanna, R., Pal, K., Singh, V., Saini, A., & Gautam, M. (2022) Effect of biofertilizers and phosphorus levels on growth, yield and nodulation of black gram (Vigna mungo). *Crop Research*. **57**(4): 245-248.

Gohain, T., & Jamir, A. (2022) Response of Phosphorus and Biofertilizers on Growth, Yield Attributes and Economic Indices of Black Gram (Vigna mungo L. Hepper). *International Journal of Environment and Climate Change*. **12**(11): 3793-3801.

Khalid, N., Asif, I., Shah, F., Muhammad, J. K., Habib, A., Iqbal, H., & Akhtar, A. (2017) Response of summer pulses (mung bean vs. mash bean) to integrated use of organic carbon sources and phosphorus in dry lands. *African Jour. of Agricultural Research*. **12**(50): 3470-3490.

Pal, OM (2021).Effect of phosphorus and manganese nutrition on yield and uptake of nutrients in wheat (Triticum aestivum) in alluvial soil. *Annals of Plant and Soil Research*. **23**(1): 123-124.

Parashar, A., & Tripathi, L. (2020) Effect of phosphorus *and sulphur on the growth and yield of black gram (Vigna mungo L.). Journal* of Pharmacognosy and Phytochemistry. **9**(5): 2585-2588.

Phogat, M., Rai, A. P., & Kumar, S. (2020) Interaction effect of phosphorus and sulphur application on nutrient uptake, yield and yield attributing parameters of black gram [Vigna mungo (L.) Hepper]. *Legume Research-An International Journal*. **43**(2): 212-220.

Shroti, S. K., Pathak, A., Tiwari, A., Gupta, A., & Chauhan, S. K. (2018) Morphological, physiological, and yield analysis of black gram under different levels of FYM, PSB, and phosphorous. Int. *J. Chem. Stud*. **6**(3): 403-411.

Singh, R., Singh, V., Singh, P., & Yadav, R. A. (2018) Effect of phosphorus and PSB on yield attributes, quality and economics of summer green gram (Vigna radiata L.). *Journal of pharmacognosy and phytochemistry*. **7**(2): 404-408.

Singh, R. E., Singh, V., Tiwari, D., & Masih, A. (2020) Effect of Levels of Phosphorus and Sulphur on Growth and Yield of Black gram (Vigna mungo L.). Int. J. Curr. Microbiol. *App. Sci*. **9**(10): 2784-2791.

Yadav, V.K., Singh, D.P., Yadav, R.K. and Sharma, A. (2023) Effect of phosphorus and bio-inoculants on root nodules, nutrient uptake, quality and economics of summer mungbean [Vigna radiata (L.) Wilczek]. *Annals of Plant and Soil Research.* **25** (1): 163-168.