Original Research Article

"Effect of phosphorus and potassium on growth and yield of black gram (*Phaseolus mungo* L)"

ABSTRACT

A field experiment was conducted during Zaid season 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India. The soil of the experimental field was sandy loam in texture, slightly alkaline in soil reaction (pH 8), low level of organic carbon (0.28%), available N (219 kg/ha), P (11.6 kg/ha) and K (217.2 kg/ha). The experiment was conducted in randomized block design consisting of 10 treatments with 3 different levels of phosphorus 40kg/ha, 50kg/ha, 60kg/ha and different levels of potassium 25, 30 and 35 with three replications and the treatments were allocated randomly in each replication. On the topic "Effect of phosphorus and potassium on growth and yield of black gram (Phaseolus mungo L)". The results showed that treatment 9 with the application of phosphorus (60kg/ha) + potassium (35kg/ha) recorded significantly higher plant height (43.81cm), higher plant nodules (40.11), higher plant dry weight (8g), maximum crop growth rate (8.5g/m^2/day), maximum number of pods/plant (36.61), higher seed yield (1115.62 t/ha) compared to other treatments. The maximum gross returns (98297.69 INR/ha), maximum net returns (64701.09 INR/ha) and benefit ratio (1.93) was recorded in treatment 9 with the application of phosphorus (60kg/ha) + potassium (35kg/ha) as compared to other treatments. Minimum parameters were recorded in treatment 10 control plot with RDF 20:40:20 kg/ha NPK.

Keywords: *Black gram, phosphorus, potassium, Growth, Yield and Economics.*

INTRODUCTION

Black gram (Phaseolus mungo) is one of the important pulse crop. The food legumes, particularly the grain or pulses are important food stuff in all tropical and subtropical countries. It is also known as urd bean, urad dal or urad. Black gram is grown well in moisture retentive light soil, but loamy and clay loam are suitable for the cultivation of Black gram. Loam to clay loam with neutral pH are best suited for Black gram 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 potassium. It defers from other pulses in its peculiarity of attaining a somewhat mucilaginous pasty character, giving additional body to the mass due to long polymer chain of polysaccharide chain of carbohydrates. Due to cheaper protein source, it is designated as "poor man's meat" (Aslam et al., 2010).

About 70% of the world's black gram production comes from India. India is the world's largest producer as well as consumer of black gram. It produces about 11.99 million tonnes of Urad annually from about 9.85 million hectares of area, Uttar Pradesh black gram production 0.84 million tonnes in an area about 0.61 million hectares. Black gram area accounts for about 19 per cent of India's total pulse acreage which contributes 23 per cent of total pulse production. Madhya Pradesh, Maharashtra and Rajasthan are major black gram growing states area wise. **(GOI 2021-22)**.

Problems facing, crop's productivity is below average due to a number of limitations. In addition to inherent limitations, the country's low production of black gram is mostly caused by an imbalance in the supply and utilization of nutrients. Improved fertilization is necessary to increase black gram's output. It can symbiotically repair atmospheric nitrogen to suit its nitrogen needs. The nutrients phosphorus requires special consideration **(Singh et al., 2020)**.

Application of phosphorus has been found very effective altogether soil types and called as vital element for increasing the yield. Aside from its essential role in growth and development of roots, phosphorus is important for growth of Rhizobium bacteria liable for biological N fixation to extend the efficiency of pulses as soil renovator and serves the twin purpose of accelerating yield of main also as succeeding crop. It also improves the standard of grain. It plays a vital role in energy storage and transfer. Phosphorus may be a constituent of nucleic acids (DNA and RNA) and majority of enzymes which are of great importance within the transformation of energy in carbohydrate metabolism and respiration of plants. Phosphorus stimulates the symbiotic organic process because in presence of phosphorus bacterial cell becomes mobile which is pre requisite for migration of

bacterial cell to plant organ for nodulation **(Charel et al., 2006)**. Phosphorus helps in proper root development which increases root nodules and consequently increases organic process. It develops anion adsorption and releases sulphate ions into the soil solution **(Tiwari et al., 2006)**. Thus, it's going to be subjected to leaching if not haunted by plant roots. Improved potassium supply also enhances biological organic process and protein content of pulse grains **(Srinivasarao et al., 2003)**. Indian soil is deficient in potassium due to deficiency of potassium crop are less gum and protein content effect Banti and Victor Debbarma (2023). Amongst all, Potassium is an alkali metal that occurs naturally in most of the soils. The total K content of the earth crust is about 2.3 to 2.5 %, but a very small proportion of it's become available to plants **(Leigh and Jones, 1984)**.

Potassium is one of the major essential plant nutrients is often required equal to or greater than other major nutrients like nitrogen, phosphorous. Even though it's not a part of any plant structure, it is found in the plant sap involved in many physiological and biochemical functions of plant growth. Plants require K in large quantities; hence, it is regarded as one of the three major food elements **(Golakiya and Patel, 1988; Leigh and Jones, 1984; Dev,1995)**. potassium application has been neglected in many countries, including India, which has resulted in soil K depletion in agricultural ecosystems and a decline in crop yields **(Regmi et al., 2002; Panaullah et al., 2006).** Higher yields and crop quality can be obtained at optimal N: K nutritional ratios. K is an essential macronutrient required for proper development of plants. In addition to activation of numerous enzymes, K plays an important role in the maintenance of electrical potential gradients across cell membranes and the generation of turgor. It is also essential for photosynthesis, protein synthesis and regulation of stomatal movement and is the major cation in the maintenance of cation-anion balances **(Marschner, 1995).** Keeping all the points in view the above fact, the experiment was conducted to find out the "Effect of Phosphorus and Potassium on Growth and Yield of black gram" is carried with following objectives.

Materials and Methods

The experiment was conducted during *Zaid* season 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, (U.P). The topic titled "Effect of phosphorus and potassium on growth and yield of black gram (Phaseolus mungo L)", to study the response of Phosphorus (40kg/ha, 50kg/ha, 60kg/ha) with combination of Potassium (25, 30 and 35kg/ha). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 8.0), low in organic carbon (0.64 %), available Nitrogen (220 kg/ha), available P (37 kg/ha) and available K (240.7 kg/ha). There were 10 treatments, and replicated thrice and laid out in Randomized Block Design (RBD). The treatment combinations are

treatment 1 [Phosphorus (40 kg/ha) + Potassium (25kg/ha)], treatment 2 [Phosphorus (40kg/ha) + Potassium (30kg/ha)], treatment 3 [Phosphorus (40kg/ha) + Potassium (35kg/ha)], treatment 4 [Phosphorus (50 kg/ha) + Potassium (25kg/ha)], treatment 5 [Phosphorus (50 kg/ha) + Potassium (30kg/ha)], treatment 6 [Phosphorus (50 kg/ha) + Potassium (35kg/ha)], treatment 7 [Phosphorus (60 kg/ha) + Potassium (25kg/ha)], treatment 8 [Phosphorus (60 kg/ha) + Potassium (30kg/ha)], treatment 9 [Phosphorus (60 kg/ha) + Potassium (35kg/ha)], treatment 10 (Control). The data recorded on different aspects of crop such as, growth parameters and yield attributes were subjected to statistical analysis by variance method **Gomez and Gomez (1976).**

RESULT AND DISCUSSION

Growth parameters

Plant height (cm)

Significant and higher plant height was with the application of phosphorus (60kg/ha) might be due to phosphorus stimulates cell division which helps in increasing plant growth it also enhances the nodulation in root zone which is responsible for nitrogen fixation which might have helped in attaining higher plant height. Similar result was also reported by **Yadav et al. (2022).** Further, significant and higher plant height was observed with potassium (35kg/ha) might be due to Potassium plays vital role in cell expansion and cell division helps in improving plant height. Similar result was also reported by **Adsure et al. (2018)**.

Nodules/plant

Significant and higher number of nodules/plant may be due to better root development as levels of phosphorus increased as phosphorus being a component of nucleic acids and various forms of proteins, which could have stimulated cell division, resulted with increased of nodules/plant. Similar result was also reported by **Niraj et al. (2013)**. Further, significant and higher root nodule/ plant was observed with potassium (35kg/ha), which may have influenced the protein formation leading to increase in number of nodules in plant. Similar results were also reported by **Abraham et al. (2021).**

Plant dry weight (g)

Significant and higher plant dry weight was with application of phosphorus (60kg/ha) might be due to

the cumulative effect of increasing in plant height and number of leaves which may have resulted in increasing the dry matter production of plant, phosphorus might enhance the activity of rhizome and increase the formation of root nodule and might be helps in fixing more of atmospheric nitrogen in root nodule. Similar result was reported by **Masih et al. (2020)** in green gram. Further potassium(35kg/ha) might be due to the production of phytohormones like cytokine, potassium is essential for meristematic growth, which aids in enhancing plant growth particularly plant dry weight. Similar result was reported by **Sahithi et al. (2023).**

Crop growth rate (g/m^2/day)

Significant and higher Crop growth rate was with the application of phosphorus (60kg/ha) might be due to the physiological and metabolic processes of the plant, enabling it to develop more quickly by assimilating the available nutrients quickly and facilitating more photosynthesis, which in turn raises the crop growth rate. Similar result was reported by **Nawhal et al. (2021).**

Relative growth rate (g/g/day)

The data found that non- significant and highest relative growth rate (0.006 g/g/day) was recorded with 9 [phosphorus (60 kg/ha) + Potassium (35kg/ha)] as compared to rest of the treatments (Table 1).

Yield attributes and Yield

Number of pods/plant

Significant and maximum number of pods/ plant was with the application of phosphorus (60 kg/ha) might be due to use of phosphorus increases symbiotic nitrogen fixation which may have increased the number of pods/plants. Similar result was also reported by **Parashar *et al.* (2020).** Further, significant and higher number of pods/plant was with application of potassium(35 kg/ha) might be due to balanced application of NPK which may have effect N and P fertilization in the presence of K, where, the crop's rate of photosynthetic and symbiotic activity might have increased, which may be stimulating stronger vegetative and reproductive growth particularly higher number of pods/ plant. Similar result was also reported by **Adsure *et al.* (2018).**

Number of seeds/pod

Significant and maximum number of seeds/pod was with the application of phosphorus (60 kg/ha) might be due to increase in vegetative development and reproductive attributes under proper phosphorus availability and improved soil physical properties. Similar result was also reported by **Singh *et al.* (2018).** Further, significant and higher number of seeds/pod was with application of

potassium (35 kg/ha) might be due to potassium supports the development of strong cell walls and the cumulative effect in improvement of number of seeds/pod. Similar result was also reported by **Sahithi *et al.* (2023).**

Seed yield (kg/ha)

Significant and higher seed yield was with phosphorus (60 kg/ha) might be due to better nodulation and efficient functioning of nodule bacteria for fixation of N to be utilized by plants during grain development stage in the synthesis of protein as reflected in N uptake which in turn led to increase in seed yield. Similar result was reported by **Singh *et al.* (2017).** Further, significantly and higher seed yield was with potassium(35kg/ha) that could be because it improves the food environment of the rhizosphere and the plant system leading to increased nutrient translocation in various plants parts, which might directly responsible for seed yield. Similar result was reported by **Jat *et al.* (2019).**

Economics

Cost of cultivation (INR/ha)

Cost of cultivation (33596.6 INR/ha) was found to be highest in treatment 9 [Phosphorus(60kg/ha) + Potassium(35kg/ha)] and minimum cost of cultivation (32098.00 INR/ha) was found to be in treatment 10 (Control) as compared to other treatments. (Table 3).

Gross return (INR/ha)

Gross returns (98297.69 INR/ha) were found to be highest in treatment 9 [Phosphorus(60kg/ha) + Potassium(35kg/ha)] and minimum gross returns (50569.20 INR/ha) was found to be in treatment 10 (Control) as compared to other treatments. (Table 3).

Net returns (INR/ha)

Net returns (64701.09 INR) were found to be highest in treatment 9 [Phosphorus(60kg/ha) + Potassium(35kg/ha)] and minimum net returns (18471.20 INR/ha) was found to be in treatment 10 (Control) as compared to other treatments. (Table 3).

Benefit cost ratio (B:C)

Benefit cost ratio (1.93) was found to be highest in treatment 9 [Phosphorus(60kg/ha) + Potassium(35kg/ha)] and minimum benefit cost ratio (0.58) was found to be in treatment 10 (Control) as compared to other treatments.

Higher benefit cost was recorded with phosphorus (60kg/ha) this could be due to the concurrent rise in the quantity of pods/ plant and seeds/ pod, which surplus assimilates may have stored

in the leaves and then translocated into seeds when the plant reached senescence, ultimately increased higher benefit cost ratio. Similar result was reported by **Nawhal et al. (2021).**

Table 1. Effect of boron and potassium on growth attributes of Black gram.

S. No.	Treatments	At 60 DAS				
		Plant height	Number of nodules/plant	Dry weight (g)	CGR $g/m^2/day$	RGR (g/g/day)
1.	Phosphorus 40kg/ha + Potassium 25kg/ha	37.30	18.56	5.23	5.14	0.04
2.	Phosphorus 40kg/ha + Potassium 30kg/ha	38.57	19.11	6.12	6.72	0.05
3.	Phosphorus 40kg/ha + Potassium 35kg/ha	39.00	19.11	6.13	6.33	0.04
4.	Phosphorus 50kg/ha+ Potassium 25kg/ha	38.58	19.33	6.46	6.98	0.04
5.	Phosphorus 50kg/ha + Potassium 30kg/ha	39.66	19.44	7.18	6.90	0.05
6.	Phosphorus 50kg/ha+ Potassium 35kg/ha	40.17	20.56	7.24	8.36	0.05
7.	Phosphorus 60kg/ha+ Potassium 25kg/ha	41.80	20.89	7.39	9.54	0.06
8.	Phosphorus 60kg/ha + Potassium 30kg/ha	41.92	22.22	7.48	7.62	0.04
9.	Phosphorus 60kg/ha + Potassium 35kg/ha	43.81	23.00	8.00	8.50	0.04
10.	Control	37.35	17.67	5.24	5.13	0.04
	SEm (±)	1.18	0.68	0.203	0.55	0.003
	CD (P=0.05)	2.02	2.04	0.61	1.66	0.01

Table 2. Effect of boron and potassium on yield attributes of Black gram.

S. No.	Treatments	No. of pods/plant	Seed/pod	Test weight (g)	Seed yield (kg/ha)	Harvest index (%)
1.	Phosphorus 40kg/ha + Potassium 25kg/ha	27.44	3.66	31.03	615.61	28.93
2.	Phosphorus 40kg/ha + Potassium 30kg/ha	28.88	4.66	33.55	690.01	31.13
3.	Phosphorus 40kg/ha + Potassium 35kg/ha	29.12	4.88	32.81	732.20	30.75
4.	Phosphorus 50kg/ha+ Potassium 25kg/ha	30.41	5.00	31.52	809.01	31.27
5.	Phosphorus 50kg/ha + Potassium 30kg/ha	31.88	5.33	34.87	870.28	32.22
6.	Phosphorus 50kg/ha+ Potassium 35kg/ha	33.44	6.55	37.26	913.64	31.90
7.	Phosphorus 60kg/ha+ Potassium 25kg/ha	34.51	5.67	35.04	974.28	35.83
8.	Phosphorus 60kg/ha + Potassium 30kg/ha	35.14	5.76	35.94	1061.75	35.80
9.	Phosphorus 60kg/ha + Potassium 35kg/ha	36.61	6.89	37.69	1115.62	35.47
10.	Control	27.44	3.66	29.30	567.35	30.45
	SEm (±)	0.57	0.38	0.59	25.93	0.83
	CD (P=0.05)	1.72	1.15	1.76	77.04	2.50

Table 3. Effect of boron and potassium on economics of Black gram.

S. No.	Treatments	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
1.	40kg/ha Phosphorus + 25kg/ha Potassium	32263.2	55294.16	23030.96	0.71
2.	40kg/ha phosphorus + 30kg/ha potassium	32430	61309.81	28879.81	0.89
3.	40kg/ha Phosphorus + 35kg/ha potassium	32596.6	65173.31	32576.71	1.00
4.	50kg/ha phosphorus + 25kg/ha Potassium	32763.2	71839.75	39076.55	1.19
5.	50kg/ha phosphorus + 30kg/ha Potassium	32930	76948.35	44018.35	1.34
6.	50kg/ha Phosphorus + 35kg/ha Potassium	33096.6	80900.53	47803.93	1.44
7.	60kg/ha Phosphorus + 25kg/ha Potassium	33263.2	84931.03	51667.83	1.55
8.	60kg/ha Phosphorus + 30kg/ha Potassium	33430	92547.68	59117.68	1.77
9.	60kg/ha Phosphorus + 35kg/ha Potassium	33596.6	98297.69	64701.09	1.93
10.	Control	32098	50569.20	18471.20	0.58

CONCLUSION

It is concluded that in black gram treatment 9 with application of Phosphorus (60kg/ha) and Potassium (35kg/ha) recorded highest yield and benefit cost ratio.

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