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Yellamati Lawrence Abraham
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Umesha C
Assistant professor, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Lalit Kumar Sanodiya
Ph.D. Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Yellamati Lawrence Abraham
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Effect of levels of phosphorus and potassium on growth, yield and economics of black gram

Yellamati Lawrence Abraham, Umesha C and Lalit Kumar Sanodiya

Abstract
The aim of this research was to determine the effect of levels of Phosphorus and Potassium on growth, yield and economics of blackgram (*Vigna mungo* L.). A field experiment was conducted during *kharif* 2020, at prakasam Krishi Vigyan Kendra (KVK), Jayaprakashnagar, Jammikunta mandal, Karimnagar, Telangana. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.83), medium organic carbon (0.62%), available low N (197.12 Kg/ha), available medium P (31.21 Kg/ha) and available medium K (198.71 Kg/ha). The Observations of Ten treatments were replicated thrice in a Randomized Complete Block Design the finding shows that growth and yield attributes *viz.* The result showed that higher plant height (38.17 cm), maximum number of branches per plant (5.93), highest number of nodules per plant (15.73), maximum dry weight (8.63), maximum number of pods per plant (20.13), highest number of seeds per pod (6.20), test weight (33.60), seed yield (1456.67 kg/ha), Stover yield (3086.67 kg/ha), harvest index (32.06) and relative growth rate (0.013) were recorded significantly with the application of 40 kg/ha phosphorous + 30 kg/ha potassium. However Highest crop growth rate (7.90) was recorded with 40 phosphorous kg/ha + 30 potassium kg/ha. However highest gross return (80,191 INR/ha), net return (56391 INR/ha), and Benefit: cost ratio (2.36) was recorded with the application of 40 kg phosphorous per hectare + 30 kg of potassium per hectare.

Keywords: Black gram, phosphorous, potassium, growth, economics

Introduction
Black gram (*Vigna mungo* L.) is also known as Urd in India. It is one of the important pulse crops grown throughout the country. It is a self-pollinated and short duration leguminous crop. Pulses are "Marvel of Nature" because of their drought resistance and ability to soil erosion due to deep root structure and good ground covering (Solaiman *et al.*, 1997). Which contains 24 % protein, 60 % carbohydrate, 1.3 % fat, 3.2 % minerals, 0.9 % fibre, 154 mg Ca, 385 mg P, 9.1 mg Fe and small amount of vitamin-B complex. It is rich source of vitamins like A, B1, B3 and has small amount of thiamine, riboflavin, niacin and vitamin C. It contains 78% to 80% nitrogen in the form of albumin and globulin. Black gram contributes about 13 per cent of total area under pulses and 10 per cent of their total production in our country. This crop is extensively grown in the states of Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu, Uttar Pradesh and Rajasthan. But, it does well on heavier soils like black cotton soils which retain moisture better. The dry seeds which are good source of phosphorus. In India, 44.93 lakh hectares cultivated with a total production of 29.26 lakh tonnes. (Directorate of Pulse development, Annual report 2016-17). As per annual report 2016-17 the department of agriculture, cooperation and farmers welfare declared in India pulses crop is about 252.59 lakh ha area and production 16.47 million tonnes with a yield of 652 kg/ha.

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, 2006) [4]. 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 and Gupta, 2006) [14]. Thus, it's going to be subjected to leaching if not haunted by plant roots.

Potassium has been described because the "quality element" for crop production. Potassium increases the protein content of plants, the starch content in grains and tubers, Vitamin-C and therefore the solid soluble contents in fruits. The crucial importance of K in quality formation confirms its role in promoting the assembly of photosynthetic and their transport to storage organs like fruits, grains, and tubers and improve their conversion into starch, protein, vitamins, and oil. Potassium (K), as a plant nutrient features a good crop response and is being reported from many parts of the country. By potassium application pulses showed yield benefits. Improved potassium supply also enhances biological organic process and protein content of pulse grains (Srinivasa rao *et al.,* 2003) [11]. The availability of potassium to leguminous crops is major role at the flowering and pod setting stages (Zahran *et al.,* 1998) [15]. K also plays an important role as macronutrient in plant growth and sustainable crop production. It maintains turgor pressure of cell which is important for cell expansion. It helps in osmo-regulation of plant cell, assists in opening and shutting of stomata. It plays a key role in activation of quite 60 enzymes (Tisdale *et al.,* 1990; Bukhsh *et al.,* 2011) [13, 2].

Materials And Methods

This experiment was carried during the *Kharif* season 2020, at Prakasam Krishi Vigyan Kendra (KVK), Jayaprakashnagar, Jammikunta mandal, Karimnagar District, Telengana - 505122. The site is geographically situated in altitude of 243.4m above mean sea level on 18'49'40" N latitude and 78'5'45" E longitude. Soil having pH (6.83), OC (0.62 %), available N (197.12 kg/ha),available P_2O_5 (31.21 kg/ha), available K_2O (198.71 kg/ha).Treatment combinations of T_1 – 20 P kg/ha + 15 K kg/ha, T_2 – 40 P kg/ha + 15 K kg/ha, T_3 – 60 P kg/ha + 15 K kg/ha, T_4 – 20 P kg/ha + 25 K kg/ha, T_5 – 40 P kg/ha + 25 K kg/ha, T_6 – 60 P kg/ha + 25 K kg/ha, T_7 – 20 P kg/ha + 30 K kg/ha, T_8 – 40 P kg/ha + 30 K kg/ha, T_9 – 60 P kg/ha + 30 K kg/ha, T_{10} – RDF. The Urea, SSP, and MOP to fulfil the requirements of nitrogen, phosphorus and potassium. The RDF of NPK was 20: 40: 20 kg/ha we applied. The Observations *viz.* plant height, no. of branches/plant, no. of nodules/plant, plant dry weight, CGR, RGR, no. of pods/plant, no. of seeds/plant, test weight, seed yield, straw yield, harvest index and economics of crop were recorded with standard process of observations. The data was statistically process in Randomized Block Design, analysis of variance (ANOVA) is used.

Result and Discussion

A. Growth attributes

(i) Plant height

The data regarding plant height shows that at harvest Significantly higher plant height (38.17cm) was recorded with treatment 40 P kg/ha + 30 K kg/ha, Whereas treatments 30 P kg/ha + 30 K kg K/ha, 40 P kg/ha + 25 K kg K/ha and 30 P kg/ha + 25 K kg/ha was found to be statistically on par with 40 P kg/ha + 30 K kg/ha. Plant height of blackgram was influenced by the application of both phosphorus and potassium. A. H. Mir *et al.,* (2013) [9] reported that among different phosphorus levels, phosphorus @ 60 kg ha^{-1} recorded comparatively higher growth and yield. An increase of about 59.61, 19.71, 19.49 and 12.78% in plant height, number of leaves, grain yield and haulm yield, respectively was observed as compared to control. As reported Potassium plays vital role in meristematic growth through synthesis of Phyto hormone like Cytokine, which helps in plant growth yield attributes by Brar *et al*., (2004) [1].

(ii) Number of branches/plant

The result regarding the branches, at harvest the statistically significant the higher number of branches/plant (5.93cm) was recorded with treatment 40 P kg/ha + 30 K kg/ha, whereas treatments 30 P kg/ha + 30 K kg /ha, 20 P kg/ha + 30 K kg/ha and 40 P kg/ha + 25 K kg/ha were found to be statistically on par with treatment 40 P kg/ha + 30 K kg/ha. The result was supported by number of branches/plant of blackgram was influenced by the application of both phosphorus and potassium. A. H. Mir *et al.,* (2013) [9] reported that among different phosphorus levels, phosphorus @ 60 kg/ha recorded comparatively higher growth and yield. An increase of about 59.61, 19.71, 19.49 and 12.78% in plant height, number of leaves, grain yield and haulm yield, respectively was observed as compared to control. The result of this experiment which grew vigorously by application of Potassium was more relevant to Teggelli *et al.,* (2016) [12].

(iii) Number of nodules/plant

At harvest the significantly higher number of nodules per plant (15.73) was recorded with treatment 40 P kg/ha + 30 K kg/ha. However, 30 P kg/ha + 30 K kg/ha was found to be statistically on par with treatment 40 P kg/ha + 30 K kg/ha. Number of nodules/plant of blackgram was influenced by the application of both phosphorus and potassium Kachave *et al.,* (2018) [6] observed that with the application of phosphorus produced significantly higher root length (cm), number of nodules per plant of black gram. Phosphorus influenced the protein formation leads to increase number of nodules by the intraction of Phosphorus and potassium.

(iv) Plant dry weight

The result regarding dry weight, at harvest the significantly higher plant dry weight (8.63 g/plant) was recorded with treatment 40 P kg/ha + 30 K kg/ha. However, no other treatment was found to be statistical on par with 40 P kg/ha + 30 K kg/ha. Plant dry weight of blackgram was influenced by the application of both phosphorus and potassium. A. H. Mir *et al.,* (2013) [9] reported that among different phosphorus levels, phosphorus @ 60 kg/ha recorded comparatively higher growth and yield. An gradual increase of plant height, plant dry weight, grain yield respectively was observed as compared to control. Phosphorus @ 60 kg/ha produced significantly maximum grain and haulm yield of 8.02, 8.06 and 8.04 q/ha 28.90, 28.96 and 28.93 q/ha during 2004, 2005 and pooled data respectively. Laltlanmawia *et al.,* (2004) [7] reported that the plant dry weight of black gram influenced significantly due to different levels of potash. Application of 20 kg K_2O/ha and 40 kg K_2O/ha did not differ significantly but these levels of K_2O recorded significantly higher plant dry weight over 60 kg K_2O/ha and control.

(v) Crop growth rate

The result regarding CGR, at 45-60 DAS interval the significantly higher crop growth rate value (7.90 g/m^2/day) was observed in 40 P kg/ha + 30 K kg/ha. However, 30 P kg/ha + 30 K kg/ha achieved statistical on par with 40 P kg/ha + 30 K kg/ha.

B. Yield attributes and yield

(i) Number of pods/plant

The result regarding yield attributes of treatment 40 P kg/ha + 30 K kg/ha resulted in significantly higher number of pods/plant (20.13). However, no other treatment was found to be statistically at par with 40 P kg/ha + 30 K kg/ha. The reason that Maya Yadav *et al.,* (2017) [8] observed that the successive increase in phosphorus levels significantly increased number of pods/plant up to 40 kg/ha. This could be attributed because of better root proliferation, higher root development, increased availability and uptake of nutrients, energy transformation and metabolic processes in plant. Hussain *et al.,* (2011) [5] reported that different potassium levels significantly influenced the number of pods/plant, number of seeds/pod, seed yield and yield contributing parameters. Maximum seed yield (753 Kg/ha) was obtained with the appliance of 90 Kg potash per hectare.

(ii) Number of seeds/pod

Significant effect was observed by the statistical analysis of number of seeds/pod. Treatment 40 P kg/ha + 30 K kg/ha recorded significantly higher number of seeds/pod (6.20). However, 30 P kg/ha + 30 K kg/ha recorded statistical at par with 40 P kg/ha + 30 K kg/ha. Maya Yadav *et al.*,(2017) [8] observed that the successive increase in phosphorus levels significantly increased number of pods/plant up to 40 kg/ha, which was comparable with application of highest level of 60 kg/ha and no significant effect was observed on harvest index. This could be attributed due to better root proliferation, higher root development, increased availability and uptake of nutrients, energy transformation and metabolic processes in plant.

(iii) Test weight

The statistical analysis on test weight was found to be non-significant. However, highest test weight (33.60 g) was recorded with treatment 40 P kg/ha + 30 K kg/ha and lowest test weight (31.93 g) was recorded with control. Test weight was not influenced by the application of phosphorus and potassium which might be due to characters highly influenced by its genetic makeup.

(iv) Seed yield

The seed yield showed increasing trend with the application of phosphorus and potassium in blackgram. It rose from 14.56 q/ha under control to 8.5 q/ha with the application of 40 P kg/ha + 30 K kg/ha. Significant and highest grain yield (14.56 q/ha) was observed under 40 P kg/ha + 30 K kg/ha. However, no other treatment was found to be statistically at par with 40 P kg/ha + 30 K kg/ha. As reported by Negi *et al.* (1985) [10] Phosphorus plays important role in root proliferation leads to Nitrogen fixation for better crop production. The effect of Potassium increase carbohydrates synthesis and translocation of photosynthesis leads to attributes the better yield reported by Chaudhari *et al*., (2018) [3].

(v) Straw yield

The straw yield of blackgram was also influenced by the application of phosphorus and potassium, it varied from 13.86 q/ha under control to 19.00 q/ha with the application of 40 P kg/ha + 30 K kg/ha. Highest straw yield (13.86 q/ha) was recorded with 40 P kg/ha + 30 K kg/ha, however, no other treatment was found to be statistically at par with 40 P kg/ha + 30 K kg/ha.

(vi) Harvest index

The data showed non-significant difference in harvest index, however, 40 P kg/ha + 30 K kg/ha recorded highest value of (32.06%) and lowest value (30.51%) was recorded with control. Observed that the successive increase in phosphorus levels significantly increased number of pods/plant, number of grains/pod, test weight, grain yield, straw yield and biological yield is close to 40 kg per hactare, which was comparable application of highest level of 60 kg/ha and no significant effect was observed on harvest index Maya Yadav *et al.,* (2017) [8]. The rise in grain yield with 60 kg/ha was 13.9 and 51.2% over 20 kg/ha and control, respectively. This could be trait to raised root proliferation, higher root development, increased availability and uptake of nutrients, energy transformation and metabolic processes in plant. Hussain *et al.,* (2011) [5] reported that different potassium levels significantly influenced the number of pods/plant, number of seeds/pod, seed yield and yield contributing parameters. Maximum seed yield (753 Kg/ha) was obtained with the appliance of 90 Kg potash per hectare.

C. Effect of phosphorus and potassium on economics of production of blackgram

Table 3 represents the significantly higher Gross return (80.19 x 10^3INR/ha), Net return and Benefit: cost ratio (56.39 x 10^3INR/ha and 2.36 respectively) was recorded under treatments 40 P kg/ha + 30 K kg/ha.

Table 1: Effect of levels of phosphorus and potassium on growth attributes of blackgram

S. No.	Treatments	Plant height (cm)	No. of Branches /plant	No. of Nodules /plant	Dry weight (g/plant)	CGR (g/m²/day) (45-60 DAS)
1.	20 kg P/ha + 15 kg K/ha	32.30	5.27	12.60	7.24	5.79
2.	30 kg P/ha + 15 kg K/ha	32.67	5.20	13.10	7.35	5.79
3.	40 kg P/ha + 15 kg K/ha	35.40	5.60	13.97	7.81	6.83
4.	20 kg P/ha + 25 kg K/ha	34.10	5.47	13.37	7.54	6.28
5.	30 kg P/ha + 25 kg K/ha	36.50	5.60	14.50	8.09	7.53
6.	40 kg P/ha + 25 kg K/ha	36.73	5.73	14.97	8.17	6.97
7.	20 kg P/ha + 30 kg K/ha	34.70	5.67	13.63	7.58	6.38
8.	30 kg P/ha + 30 kg K/ha	37.37	5.80	15.30	8.40	7.88
9.	40 kg P/ha + 30 kg K/ha	38.17	5.93	15.73	8.63	7.90
10.	RDF	31.40	5.60	12.20	6.87	5.16
	S.Em±	0.52	0.09	0.17	0.06	0.34
	CD (P=0.05)	1.54	0.28	0.50	0.19	1.00

Table 2: Effect of levels of phosphorus and potassium on yield attributes and yield of blackgram at harvest

S. No.	Treatments	Pods/plant	Seeds/pod	Test weight(g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
1.	20 kg P/ha + 15 kg K/ha	16.37	5.13	32.70	903.33	2030.00	30.79
2.	30 kg P/ha + 15 kg K/ha	16.80	5.20	32.90	923.33	2096.67	30.57
3.	40 kg P/ha + 15 kg K/ha	17.87	5.37	32.83	1046.67	2343.33	30.87
4.	20 kg P/ha + 25 kg K/ha	17.03	5.17	32.27	926.67	2110.00	30.51
5.	30 kg P/ha + 25 kg K/ha	18.57	5.40	33.13	1096.67	2420.00	31.17
6.	40 kg P/ha + 25 kg K/ha	18.77	5.60	33.10	1173.33	2566.67	31.37
7.	20 kg P/ha + 30 kg K/ha	17.10	5.07	33.37	940.00	2133.23	30.58
8.	30 kg P/ha + 30 kg K/ha	19.37	5.97	32.93	1293.33	2790.00	31.67
9.	40 kg P/ha + 30 kg K/ha	20.13	6.20	33.60	1456.67	3086.67	32.06
10.	RDF	15.50	5.20	31.93	850.00	1900.00	30.35
	S.Em±	0.20	0.13	0.42	38.82	99.22	0.57
	CD (P=0.05)	0.60	0.38	-	115.35	294.80	-

Table 3: Effect of levels of phosphorus and potassium on economics of blackgram

S. No.	Treatments	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C Ratio
1.	20 kg P/ha + 15 kg K/ha	21600	49941	28341	1.31
2.	30 kg P/ha + 15 kg K/ha	22600	51129	28529	1.26
3.	40 kg P/ha + 15 kg K/ha	23600	57856	34256	1.45
4.	20 kg P/ha + 25 kg K/ha	21736	51111	29375	1.35
5.	30 kg P/ha + 25 kg K/ha	22736	60639	37903	1.66
6.	40 kg P/ha + 25 kg K/ha	22800	64824	41088	1.73
7.	20 kg P/ha + 30 kg K/ha	21800	52000	30200	1.38
8.	30 kg P/ha + 30 kg K/ha	23736	71501	48701	2.13
9.	40 kg P/ha + 30 kg K/ha	23800	80191	56391	2.36
10.	RDF	22664	49941	28341	1.31

Conclusion

It can be concluded that the application of phosphorous 40 kg/ha and potassium 30 kg/ha has recorded significantly higher growth and yield parameters and also higher gross and returns which may be preferable for farmers since it is economically more profitable. The conclusion drawn based on one season data only which requires further confirmation for recommendation.

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