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Enhancing the Productivity and Quality of Blackgram (*Vigna mungo* L.) with Potassium Fertilization

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ABSTRACT

Background: Pulses are commonly known as food legumes, next to cereals in production and consumption in India. India is the leading producer of pulses in the world. In spite of being a leading producer, India is still importing pulses to meet consumer demand, due to low productivity of pulses due to various reasons. Hence, there is a need to improve the productivity in pulses. Potassium application in pulse crops have been paid less attention, among different nutrients.

Methods: A field experiment was conducted in a randomized block design with factorial concept (FRBD) during *Rabi*, 2021-22 to enhance the productivity and quality of blackgram with potassium fertilization.

Result: The present study revealed that among different potassium levels, soil application of 40 kg K_2O ha^{-1} improved the growth parameters, yield attributes, seed and haulm yields and economic returns of blackgram, which was statistically at par with soil application of 30 kg K_2O ha^{-1}. With regard to different foliar sprays tried, foliar application of 1% KH_2PO_4 at flowering and pod development stages recorded higher growth parameters, yield attributes, seed and haulm yields, protein content and economic returns of blackgram, which was statistically on par with foliar application of 1% KCl or 0.5% KNO_3 at flowering and pod development stages. The interaction effect between soil application of potassium and foliar fertilization of potassium could not exert any significant influence on any of the parameters studied in the present investigation.

Key words: Blackgram, Economics, Growth, Potassium fertilization, Productivity, Quality.

INTRODUCTION

Pulses are important source of dietary protein, energy, minerals and vitamins for mankind and they play a significant role in food production in India, occupying an area of 28.34 Mha, production of 25.03 Mt and with a productivity of 668 kg ha^{-1} during 2020-21 (www.indiastat.com). Even though India has largest area under pulses in the world, the average productivity is very low and the production is insufficient to meet the population requirement. Therefore, it is very much necessary to increase the pulse production for meeting the protein requirement of expanding population (Subbulakshmi *et al*., 2009).In India, blackgram is mostly grown 'on marginal and sub marginal lands' without proper inputs and management practices. Imbalanced nutrition is one of the 'major cause for lower productivity of blackgram. Potassium is not recommended or applied to this crop, despite of its requirement in large quantities because of continuous mining of soil potassium reserves.

Potassium removal from the soil is as much as or higher than nitrogen, still its use in fertilizer is negligible for blackgram (Chaudhari *et al*., 2018). However, because of field level potassium responses and awareness'of soil K depletion under intensive cereal-pulse cropping systems, the importance of potassium fertilization has recently gained importance. Foliar nutrition provides an excellent way for absorption of nutrients as it can be applied directly to the site of metabolism through translocation of nutrients from leaves to all parts there by helps in synchronizing flowering as well as pod setting. It increases yield from 12 to 25% and on other side more than 90% of the fertilizer applied is utilized by the plant (Pooja and Meena, 2020). Foliar feeding of nutrients minimizes environmental pollution by reducing the amount of fertilizers added to 'the soil and also enhances the yield and quality of products (Nasri *et al*., 2011).

Light textured alluvial, red, shallow black and lateritic soils are low to medium in potassium status and hence need immediate attention. Improved potassium nutrition is associated with improved protein content, N fixation and water use efficiency. Optimum potassium application reduces 'the pest and disease infestation with improvement of yield and quality of produce. In the presence of potassium, the increase in N uptake could be attributed to enhanced vigour of crop growth with increase in utilization and translocation of N into the plant and synergy between N and K in soil resulting in the enhancement of yield.

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Significance of potassium fertilization on pulses is well known, but there was no potassium recommendation in pulses. In this context, the present experiment was planned to find out optimum dose of potassium through soil and foliar application to enhance the productivity and quality of blackgram in *alfisols*.

MATERIALS AND METHODS

The experiment was conducted during rabi, 2021-22, in Field No. 46-C at Wetland Farm of S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh, which is geographically situated at 13.5°N latitude and 79.5°E longitude and at an altitude of 182.9 m above the mean sea level in the Southern Agro-Climatic Zone of Andhra Pradesh. The soil of the experimental site was sandy loam in texture, neutral in soil reaction, low in organic carbon (0.21%) and available nitrogen (172 kg ha^{-1}), medium in available phosphorus (29 kg ha^{-1}) and potassium (193 kg ha^{-1}). The present experiment was laid out in a randomized block design with factorial concept and replicated thrice. The treatments comprised of three levels of potassium *viz*., 20 kg K_2O ha^{-1}, 30 kg K_2O ha^{-1} and 40 kg K_2O ha^{-1} as first factor and five foliar sprays *viz*., no foliar spray, water spray at flowering and pod development stages, 0.5% KNO_3 at flowering and pod development stages, 1% KCl at flowering and pod development stages and 1% KH_2PO_4 at flowering and pod development stages as second factor. Pre-emergence application of Pendimethalin 30% + Imazethpyr 2% (Valor 32) @ 2 g l^{-1} of water was done within 24 hours after sowing and hand weeding was carried out at 30 DAS to keep the crop free from weeds. Healthy seeds of blackgram (TBG-104) were sown manually at 25 kg ha^{-1} on 23.10.2021 at a spacing of 30 cm × 10 cm and at a depth of 3-4 cm. The gross plot size is 5.4 × 4. 0 m. The recommended dose of nutrients *i.e*. 20 kg N, 50 kg P_2O_5 ha^{-1} was applied in the form of urea and single super phosphate to all the plots. Potassium was applied at 3 levels *i.e*. 20, 30, 40 kg K_2O ha^{-1} in the respective treatments in the form of muriate of potash. Entire dose of nitrogen, phosphorus and potassium was applied basally at the time of sowing. The spray solutions of 0.5% (5 g l^{-1} of water) potassium nitrate, 1% (10 g l^{-1} of water) potassium chloride and 1% (10 g l^{-1} of water) potassium dihydrogen phosphate were applied as foliar sprays at flowering and pod development stages as per the treatments. All other recommended management practices were followed to raise the crop.

During the crop growth period, a total of 795.6 mm rainfall was received in 32 rainy days, as against the decennial average of 296.6 mm received in 13 rainy days for the corresponding period. The data recorded on various parameters of blackgram was analyzed statistically by following the analysis of variance for Randomized block design with factorial concept as suggested by Panse and Sukhatme (1985). Statistical significance was tested with 'F' test at 5 per cent level of probability and the treatment means were compared with critical difference. The treatmental differences those were non-significant were denoted as NS.

RESULTS AND DISCUSSION

The results obtained from the experiment is presented and discussed below:

Growth parameters

At harvest of blackgram the tallest plants with higher leaf area index, maximum SPAD reading and drymatter production (Table 1) were produced with soil application of 40 kg K_2O ha^{-1}, which was however statistically comparable with 30 kg K_2O ha^{-1}, while the shortest plants were produced with soil application of 20 kg K_2O ha^{-1}. Foliar application of 1% KH_2PO_4 at flowering and pod development stages produced improved growth stature, which was however comparable with 1% KCl at flowering and pod development stages and 0.5% KNO_3 at flowering and pod development stages. The deflated growth stature of crop was noticed with no foliar spray, which was on par with water spray at flowering and pod development stages. This might be due to increased availability of nutrients to plants in the presence of potassium leading to maximum plant growth in terms of plant height and leaf area which in turn contributed higher dry matter production (Hussain *et al*., 2011). Soil application of potassium along with foliar sprays might have increased the chlorophyll content due to increased nutrient availability which might resulted in higher SPAD reading (Kaloji, 1995).

Yield attributes and yield

Among different potassium levels tested, yield attributes *viz*., the highest number of filled pods $plant^{-1}$ and number of seeds pod^{-1} (Table 1 and 2) were obtained with soil application of 40 kg K_2O ha^{-1}, which was in parity with soil application of 30 kg K_2O ha^{-1}, while the lowest number of filled pods $plant^{-1}$ and number of seeds pod^{-1} were recorded with soil application of 20 kg K_2O ha^{-1}. Among the foliar sprays, application of 1% KH_2PO_4 at flowering and pod development stages recorded maximum number of filled pods $plant^{-1}$ and number of seeds pod^{-1}, which was however comparable with 1% KCl at flowering and pod development stages and 0.5% KNO_3 at flowering and pod development stages, while all the yield attributes were lowest with no foliar spray, which was on par with water spray at flowering and pod development stages. However, test weight was not significantly influenced by soil and foliar potassium fertilization. This might be due to reason that soil potassium application may enhanced the availability of other nutrients and adequate supply of potassium at flowering and pod development stages of crop growth due to foliar fertilization might have helped for efficient translocation of photosynthates from source to sink, as reflected in the form of higher number of filled pods $plant^{-1}$ and number of seeds pod^{-1} as reported by Sakpal (2015) and Shashikumar *et al*. (2013) in greengram. The test weight of blackgram was not significantly influenced by soil and foliar potassium fertilization.

The highest seed and haulm yields and harvest index (Table 2) were produced with soil application of 40 kg K_2O ha^{-1}, which was however comparable with 30 kg K_2O ha^{-1}, while the lowest seed and haulm yields were recorded with 20 kg K_2O ha^{-1}. Foliar application of 1% KH_2PO_4 at flowering and pod development stages recorded maximum seed and haulm yields, which was however comparable with 1% KCl at flowering and pod development stages and 0.5% KNO_3

Table 1: Growth parameters and yield attributes of blackgram as influenced by soil and foliar potassium fertilization.

Treatments	Plant height (cm)	Leaf area index	SPAD reading	Dry matter production (kg ha^{-1})	Number of filled pods plant^{-1}	Number of seeds pod^{-1}	Test weight
Potassium levels (K)							
K_1: 20 kg K_2O ha^{-1}	40.5	1.58	36.3	3616	36.4	5.75	57.3
K_2: 30 kg K_2O ha^{-1}	43.3	1.94	40.6	3978	44.2	6.26	59.6
K_3: 40 kg K_2O ha^{-1}	45.0	2.03	41.2	4130	46.9	6.48	59.9
SEm±	0.93	0.043	1.04	115.2	0.97	0.141	5.89
CD (P=0.05)	2.6	0.11	3.0	334	2.8	0.42	NS
Foliar nutrition (F)							
F_1: No foliar spray	39.6	1.50	36.2	3492	35.7	5.69	56.5
F_2: Water spray at flowering and pod development stages	40.1	1.53	36.3	3562	37.4	5.78	57.1
F_3: KNO_3 @ 0.5% at flowering and pod development stages	44.0	1.99	40.6	4016	45.1	6.40	59.9
F_4: KCl @ 1% at flowering and pod development stages	45.1	2.06	41.2	4174	46.2	6.45	60.9
F_5: KH_2PO_4 @ 1% at flowering and pod development stages	45.9	2.13	42.0	4295	48.4	6.50	61.3
SEm±	1.20	0.054	1.34	148.7	1.25	0.193	9.85
CD (P=0.05)	3.5	0.14	3.8	431	3.6	0.54	NS
Interaction (K × F)							
SEm±	2.08	0.094	3.29	257.5	2.17	0.322	0.301
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

Table 2: Yield, protein content and economics of blackgram as influenced by soil and foliar potassium fertilization.

Treatments	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)	Protein content (%)	Gross returns (` ha^{-1})	Net returns (` ha^{-1})	B:C ratio
K_1: 20 kg K_2O ha^{-1}	1572	1682	45.47	21.2	86789	53267	2.59
K_2: 30 kg K_2O ha^{-1}	1702	1856	48.20	24.7	93963	60250	2.79
K_3: 40 kg K_2O ha^{-1}	1724	1884	48.23	25.6	95175	61273	2.81
SEm±	34.6	41.3	0.92	0.52	2161	1503	0.06
CD (P=0.05)	100	120	2.67	1.5	6261	4354	0.16
F_1: No foliar spray	1514	1695	44.31	20.8	83608	50753	2.54
F_2: Water spray at flowering and pod development stages	1557	1705	44.74	21.7	85982	52565	2.55
F_3: KNO_3 @ 0.5% at flowering and pod development stages	1707	1871	48.89	24.9	94290	60123	2.80
F_4: KCl @ 1% at flowering and pod development stages	1770	1876	49.17	25.5	97737	63131	2.91
F_5: KH_2PO_4 @ 1% at flowering and pod development stages	1780	1891	49.38	26.2	98259	63743	2.85
SEm±	44.7	53.3	1.19	0.67	2790	1940	0.07
CD (P=0.05)	150	154	3.44	1.9	8082	5621	0.21
SEm±	77.4	92.3	2.06	1.17	4832	3361	0.13
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

at flowering and pod development stages. The lowest seed yield and haulm yields were produced with no foliar spray, which was statistically on par with water spray at flowering and pod development stages. This might be attributed to availability of more potassium ions, which might have enhanced the photosynthesis process by activating ATPase enzyme, which plays a major role in photosynthesis and facilitated better partitioning of photosynthates, that led to increased growth and yield attributes and finally seed and haulm yields and harvest index. These results were corroborated with the findings of Goud *et al*. (2020).

Protein content

Protein content of blackgram seed (Table 2) was higher with soil application of 40 kg K_2O ha^{-1}, which was on par with 30 kg K_2O ha^{-1}, while the lowest protein content was recorded with soil application of 20 kg K_2O ha^{-1}. Foliar application of 1% KH_2PO_4 at flowering and pod development stages recorded highest protein content, which was on par with 1% KCl at flowering and pod development stages and 0.5% KNO_3 at flowering and pod development stages. The lowest protein content of blackgram was recorded with no foliar spray, which was however comparable with water spray at flowering and pod development stages. Potassium has synergistic effect on nitrogen uptake which facilitates protein synthesis. The enzyme nitrate reductase catalyzes the formation of proteins and potassium is likely responsible for its activation and synthesis, therefore, protein content increased significantly with increased potassium levels as also reported by Chauhan *et al*. (2013).

Economics

The highest gross returns, net returns and benefit-cost ratio (Table 2) were realized with soil application of 40 kg K_2O ha^{-1}, which was on par with 30 kg K_2O ha^{-1}, while the lowest gross returns, net returns and benefit-cost ratio were recorded with the soil application of 20 kg K_2O ha^{-1}. Among foliar sprays, application of 1% KH_2PO_4 at flowering and pod development stages recorded highest gross returns and net returns, which was on par with 1% KCl at flowering and pod development stages and 0.5% KNO_3 at flowering and pod development stages, whereas, B:C ratio was recorded highest with foliar application of 1% KCl at flowering and pod development stages, followed by 1% KH_2PO_4 and 0.5% KNO_3 at flowering and pod development stages. The lowest gross returns, net returns and benefit-cost ratio were recorded with no foliar spray, followed by water spray at flowering and pod development stages. Gross and net returns increased with increased K levels which might be due to increased seed and haulm yields with increased potassium levels as reported by Yadav *et al*. (2020).

Nutrient uptake

Nutrient uptake *i.e*., nitrogen, phosphorus and potassium uptake by blackgram at harvest was significantly influenced by soil and foliar potassium fertilization, while their interaction effect was not statistically traceable (Fig 1). Nutrient uptake was highest with soil application of 40 kg K_2O ha^{-1}, which was however on par with soil application of 30 kg K_2O ha^{-1}. Significantly lowest nutrient uptake was recorded with soil application of 20 kg K_2O ha^{-1}. Among the different foliar sprays higher uptake of nutrients was observed with foliar application of 1% KH_2PO_4 at flowering and pod development stages, which was statistically on par with foliar spray of 1% KCl at flowering and pod development stages and 0.5% KNO_3 at flowering and pod development stages and the above treatments were significantly superior over no foliar spray and water spray at flowering and pod development stages, which were comparable with each other. In the presence of potassium, the increase in nutrient uptake could be due to the fact that potash regulates

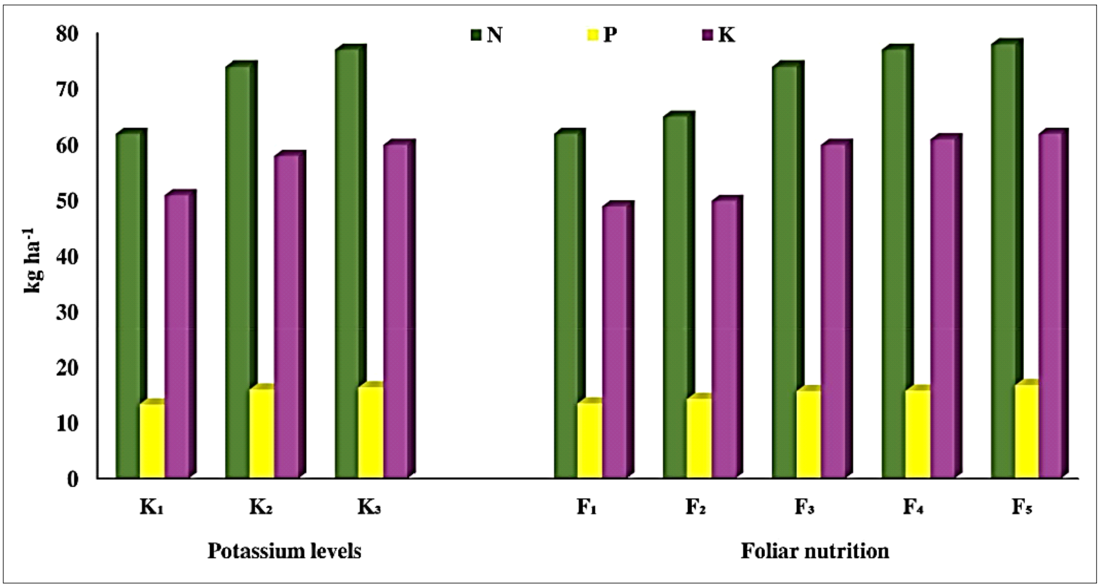

Fig 1: Nutrient uptake (kg ha^{-1}) at harvest by blackgram as influenced by soil and foliar potassium fertilization.

the uptake and utilization of other nutrients in the plant system and resulted in enhanced vigour of crop growth with that in turn led to increased uptake of nutrients by plant. Similar results were also reported by Kurhade *et al*. (2015).

CONCLUSION

It can be inferred from the above study that higher growth parameters, yield and returns of blackgram could be obtained with application of RDF (20: 50 kg N and P_2O_5 ha^{-1}) + soil application of 40 kg K_2O ha^{-1} or 30 kg K_2O ha^{-1} along with foliar spray of 1% KCl or 1% KH_2PO_4 or 0.5% KNO_3 at flowering and pod development stages. The above combinations also resulted in higher monetary returns.

Conflict of interest: None.

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