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Influence of graded levels of potassium on growth, yield and quality of black gram

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Abstract
A Field experiment was conducted in *kharif* season 2016-17 at experimental farm of Department of Soil Science and Agril. Chemistry, College of Agriculture, Badnapur using black gram as a test crop to study the effect of graded levels of potassium on growth, yield and quality of black gram. The experiment was laid out on Vertisols with six treatment combination, replicated four times in randomized block design. The treatment consists of T1 Absolute control (No fertilizer application), T2 RDF (25:50:00 N, P2O5 and K2O ha-1 kg ha-1), T3 (RDF + 15 kg K2O ha-1), T4 (RDF + 30 kg K2O ha-1), T5 (RDF + 45 kg K2O ha-1), T6 (RDF+ 60 kg K2O ha-1). The results emerged out clearly indicated that various growth parameters like plant height, germination percentage, number of pods, dry matter and seed yield was increased due to application of potassium. It was inferred from the results that application of 25 kg N, 50 kg P2O5 and 30 kg K2O per hectare found superior over only N and P application i.e. RDF (25:50:00 N, P2O5 and K2O kg ha-1). The K application showed synergistic effects on other nutrients (N, P, K) uptake. Soil fertility was also found to be improved due to application of potassium to black gram.

Keywords: black gram, yield, nutrient uptake, quality, potassium

Introduction

Soil fertility and its evolution is one area which needs immediate attention since, it is now established that an arrest in the productivity of several crops is due to ever decreasing soil fertility on one hand and an imbalanced application of plant nutrients on the other. The deficiency of several major and minor plant nutrient such as K, S, Ca, Zn, Fe and B are emerging in time and space (Rao, 2010 a and b; RAO and Vital, 2007) [13].

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 its become available to plants. 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.

K 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. 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.

Potassium has been described as the "quality element" for crop production. Potassium increases the protein content of plants, the starch content in grains and tubers, Vitamin C and the solid soluble contents in fruits. The crucial importance of K in quality formation confirms its role in promoting the production of photosynthates and their transport to storage organs such as fruits, grains, and tubers and enhancing their conversion into starch, protein, vitamins, and oil (Mengel and Kirkby, 2001) [8]. With a shortage of K, many metabolic processes are affected like the rate of photosynthesis and the rate of translocation and enzyme systems (Mengel, 1997) [8].

However, fertilizer recommendation practices for pulse crops have been paid less attention. There has been a dramatic decrease in the fertilizer consumption of K compared to fertilizer N and P while K removal from the soil is generally as much as or higher than N; still its use in fertilizer is negligible. A steep rise in their price accompanied by no such increase in the price of N greatly made it imbalanced in the favour of N. As a result the N: $P2O_5$: K2O ratio which was already imbalanced at 1:1.41:0.17 in 1991 deteriorated further to 1: 0.41: 0.15 during 1999-2000 whereas the ideal ratio is 1: 0.5: 0.25. This derived nutrient imbalance in fertilizer consumption shows a distinctive pattern, increasingly in favour of N and increasing by negative for P and K. Cultivation of high yielding crop and hybrids and diversification towards P and K demanding crops such as vegetables, potatoes, oilseeds and pulses will place even more strain on K budgets of the soil. This means diminishing soil fertility and declining fertilizer use efficiency, which increases cost of production and restricts water use efficiency.

In general, response of crop to applied potassium is very low due to high potassium content of soils derived from basaltic parent material. However, available data in recent years indicate that the magnitude of crop response to potassium in these soils is increasing in areas of higher cropping intensity. Supply of pulse growing agro ecological region of India vary widely in their K supplying capacity. Light textured alluvial soils, red and lateritic soils and shallow black soils with low levels of available K and even black cotton soil needs K supplementation to enhance the productivity. Based on a number of field studies, it can be suggested that the application of 20-40 kg K2O ha-1 is beneficial for higher pulse production (Ali and Srinivasa Rao, 2001) [13]. Marathwada region of Maharashtra state is known for the kharif pulse particularly Red gram, black gram and green gram. The soils of this region are low in N, low in phosphorus and high in K and hence the agronomic recommendation includes only N, P and K application @ 25:50:00 kg ha-1 respectively. However, from last few years it was found that crops are responding for K application. The response for K application might be due to continuous mining of K, from soil by various crops and by the lowered K status of soil. It is estimated that every year nearly 2,095939 tonnes of K is removed from Maharashtra soil as against only 177,191 tones of K is added. So there is net 3,67,132 tonnes of negative balance of K every year, therefore due to continuous mining of K, K reserves are depleted and hence they respond for K application. On the other hand, if we look into the agronomic recommendation, small quantity of K is recommended and this might be the one of reasons of low yield of pulses particularly Black gram. Hence, a project was formulated to study the effect of application of graded levels of potassium on growth, yield and nutrient uptake by Black gram to achieve balance in the use of N, P and K nutrients.

Material and Methods
A field experiment was conducted during *kharif* season 2016-2017 to study the "Effect of graded levels of potassium on growth, yield & quality of Black gram" at Departmental farm of Soil Science and Agril. Chemistry, College of Agriculture, Badnapur. The details of materials used and methods adopted during the course of present investigation are explained in this chapter with appropriate heads. The experimental soil had clay structure, moderately calcareous in nature and slightly alkaline in reaction, normal in salt content. Before sowing, initial soil sample is collected randomly from 0-30 cm depth covering experimental area which was anaysed for various physio-chemical charecteristics. An experiment was laid out in Randomized Block Deign with four replicartion and six treatments. Treatments consisted of absolute control (no fertilizer application) (T1), RDF (25:50:00 N, P2O5, K2O kg ha-1) (T2), 25 kg N+50 kg P2O5+15 kg K2O (T3), 25 kg N+50 kg P2O5 +30 kg K2O (T4), 25 kg N+50 kg P2O5+45 kg K2O (T5), 25 kg N+50 kg P2O5+60 kg K2O (T6).

Black gram veriety BDU-1 was swlected for sowing. The germination test was carried out before sowing. The sowing was done at spacing 30 cm X 10 cm. Gap filling was done, wherever it is necessary to maintain the plant population in each plot. Periodical intercultural operations like thining and weeding were carried out and plots were maintain for good crop growth.

The plants from each ne4t plot was harvested and seeds were separated by threashing, after sun drying the pods seed yields obtained in in each net plot were weighted (kg) and ferther it was calculated on the hectare basis.

The total nitrogen content of grain sampls were determined by Micro- kjeldahl method. Nitrogen and crude protein (CP) contents were worked out using following formulae.

Nitrogen (%) = (Volume of acid used × 0.0014×250×100) / sample weight × 10ml Crude protein (%) = % nitrogen × 6.25

Nutrient uptake i.e. uptake of N, P, K, was calculated by considering grain and dry matter yield at harvest in particular treatment plot in relation concentration of the particular nutrient in respective treatment plot using the formula.

$$\text{Uptake (kg ha}^{-1}) = \frac{\text{Nutrient concentration \% X (dry matter yield (kg ha}^{-1})}{100}$$

a. Available Soil Potassium
It was determined by using neutral normal ammonium acetate as an extractant using flame photometer (Jackson, 1973).

b. Water soluble soil potassium
It was extracted using soil water ratio 1:5 with ½ hour shaking. It was filtered through Whatman filter paper no.42.Potassium in extract was determined by using systronic flame photometer (Jackson, 1967).

c. Exchangeable soil potassium
It was determined by deducting water soluble K from available K.

Exchangeable K= Available K – water soluble K

d. Non exchangeable soil potassium
It was determined by using 1 N HNO3 boiling method as described by Wood and Deturk (1941).

e. Total soil potassium
It was determined by decomposition of sample of HF, HClO4, digest (Jackson, 1967).

Result and Discussion
Yield
Application of RDF + 60 kg K2O ha-1 (T6) had recorded highest seed yield per plant (3.47 g plant-1) which was significant higher over control (T1; 2.14 g plant-1) and application of RDF only (T2: 2.88 g plant-1), followed by treatment receiving RDF + 45 kg K2O ha-1 (T5) (3.45 g plant-1) and RDF + 30 kg K2O ha-1 (T4) (3.42 g plant-1) also recorded higher grain yield per plant.

The data on economic yield of black gram (grain yield) under various graded levels of potassium are presented in Table 4.6 and Fig 4.2. The grain yield was lowest (712.63 kg ha-1) in absolute control (T1) while yield was improved in nutrient added plots. Potassium application showed significant increase in grain yield of black gram in all the treatments over control (T1) and RDF (T2). The highest yield was obtained by the application of RDF + 60 kg K2O ha-1 (T6) followed by RDF + 45 kg K2O ha-1 (T5) (3.45 g plant-1)and RDF + 30 kg K2O ha-1 (T4)which were at par with each other. It was observed that, the application of potassium increased the grain yield of black gram with RDF + 60 kg K2O ha-1 (T6) over control (No fertilizer) by 62.23% and grain yield was increased over RDF only (no application of K) by 20.31%. The positive effect of K on crop yield might also be due to its requirement in carbohydrate synthesis and translocation of photosynthesis and also may be due to improved yield attributing characters, shoot growth and nodulation.

Billore *et al.*, (2009) observed seed yield of soybean increase 35.6 % over control with the application of 49.8 kg K ha-1.Similar findings were observed by Thesiya *et al.*, (2013) in lentil, in green gram, Salve and Gunjal (2011) in groundnut, Balai *et al*., (2005), Asghar (1994) in black gram.

Quality

The protein content of black gram under various potassium levels are presented in Table 4.7. The data revealed that protein content showed some amount of variation among different treatments. The highest protein content 20.11 % was recorded by application of RDF + 60 kg K2O ha-1 (T6), followed by RDF + 45 kg K2O ha-1 (T5, 19.67 %) and RDF + 30 kg K2O ha-1 (T4; 19.56 %). Potassium involved in physiological and biochemical functions of plant growth i.e. enzyme activation and protein synthesis and its application in legumes might have improved the nitrogen use efficiency which leads to increase the protein content of the crop. Kurhade *et al.*, (2014) showed that seed protein content was maximum in case of RDF+ 40 Kg K2O ha-1 (22.16%). Similar findings were obtained by *Farad et al.,* (2010), Thesiya *et al.,* (2013) and Salve and Gunjal (2011) in groundnut.

N, P, K uptake

Table no.2 represent the data on uptake of N, P, K under various treatments administered. The significantly maximum enhancement in N, P, K uptake by black gram crop was recorded at of RDF + 60 kg K2O ha-1 (T6) than the application of Absolute Control (No Fertilizer Aplication) (T1). This was followed by RDF + 45 kg K2O ha-1 (T5) and RDF + 30 kg K2O ha-1 (T4). T6 treatment were at par with T5 and T4 at flowering and at harvesting stage.In presence of potassium, the increase in N uptake could be attributed to enhance vegour of crop growth with increase in utilization and translocation of N in to plant ands senergy between N and K in soil system resulting in the enhancement of yield. Similar, results was observed by Kurhade *et al.,*(2014) in black gram.

Forms of Potassium

Table no.3 represent the data on forms of K under various treatments administered. The significantly maximum enhancement in forms of K by black gram crop was recorded at of RDF + 60 kg K2O ha-1 (T6) than the application of Absolute Control (No Fertilizer Aplication)(T1). This was followed by RDF + 45 kg K2O ha-1 (T5) and RDF + 30 kg K2O ha-1 (T4). T6 treatment were at par with T5 and T4 at flowering and at harvesting stage.

Conclusion

It can be concluded that significantly highest yield, forms of potassium and uptake of NPK was delibrerated with treatment of fertilizer consisting recommended dose of fertilizer with 30 kg ha-1 of potassium application. Potassium application showed synergic effects on other nutrient uptake and soil fertility was improved due to application of potassium to the black gram. Aplication of 25 kg N, 50 kg P2O5 ha-1 and 30 kg K2O ha-1 found superior over 25:50:00 N, P2O5 and K2O

Table 1: Yield and quality of black gram as influenced by various treatments

Treatments	Seed yield (kg ha-1)	Protein (%)
T1 (Control)	712.63	14.26
T2(Only RDF)	960.86	16.31
T3 (RDF + 15 Kg MOP)	1005.01	17.29
T4 (RDF + 30 Kg MOP)	1141.68	19.56
T5 (RDF + 45 Kg MOP)	1147.89	19.67
T6 (RDF + 60 Kg MOP)	1156	20.11
SEm±	40.24	0.07
C.D. (at 5 %)	121.26	0.23

Table 2: N, P, K uptake as influenced by various treatments

Treatments	Nuptake (kg ha^{-1})				P uptake(kg ha^{-1})				K uptake(kg ha^{-1})			
T_1 (Control)	Flowering	Harvest	Seed	Total	Flowering	Harvest	Seed	Total	Flowering	Harvest	Seed	Total
T_2(Only RDF)	9.37	8.33	33.26	42.48	1.56	1.97	6.72	5.59	11.48	11.86	5.82	17.67
T_3 (RDF + 15 Kg MOP)	12.75	10.84	39.31	50.11	2.08	2.37	7.74	9.80	13.90	13.80	7.97	20.29
T_4 (RDF + 30 Kg MOP)	16.21	16.20	46.33	62.53	2.16	2.56	8.14	10.70	14.52	13.96	8.46	21.74
T_5 (RDF + 45 Kg MOP)	25.36	21.81	56.52	78.33	2.92	2.78	8.85	11.63	16.66	14.53	9.84	24.37
T_6 (RDF + 60 Kg MOP)	26.18	22.42	57.98	80.30	2.97	3.07	9.06	12.12	16.72	14.84	9.87	24.73
SEm±	26.75	22.55	61.98	84.53	3.11	3.09	9.22	12.31	16.94	14.85	9.95	24.79
C.D (at 5 %)	0.84	0.57	1.68	2.24	0.13	0.12	0.31	0.42	0.64	0.60	0.33	0.56

Table 3: forms of K as influenced by various treatments

Treatment s	Water soluble K mg kg- 1		Non exchan e k (mg			
Initial	9.0 mg kg-1		-1 761 m			
	At flowering	At harvesting	At flowering	At harvesting	At flowering	At harvesting
T1 Absolute control (No fertilizer)	8.5	7.5	370	305	504	507
T2 RDF Only(25:50: 00 N, P2O5 and K2O kg ha-1)	10.0	9.0	395	331	529	600
T3 RDF+ 15 Kg K2O ha-1	12.8	9.6	400	342	570	659

T4 RDF+ 30 Kg K2O ha-1	13.4	9.8	403	360	688	699
T5 RDF+ 45 Kg K2O ha-1	13.6	10.8	408	371	792	751
T6 RDF+ 60 Kg K2O ha-1	14.8	11.5	415	380	903	788

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