adras Agric. J. 91 (1-3) : 113-116 January-March 2004

https://doi.org/10.29321/MAJ.10.A00079

Response of rainfed black gram to phosphorus and potassium nutrition with composted coirpith

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Abstract : To study the effect of phosphorus and potassium levels along with composed coirpith (CCP) on growth, yield and uptake of rainfed black gram, field experiments were conducted in TNAU farm during *rabi* season of 2001 with the following treatment combinations T_1 = 12.5:25:0 NPK Kg ha^{-1}; T_2 = 12.5:25:12.5 NPK Kg ha^{-1}; T_3 = 12.5:25:25 NPK Kg ha^{-1}; T_4 = 12.5:25:25 NPK kg ha^{-1} + Composted Coir Pith (CCP) @ 12.5 t ha^{-1}; T_5 = 0:25:0 NPK kg ha^{-1} + CCP @ 12.5 t ha^{-1}. Organic nitrogen, $KMnO_4$-N and Olsen's phosphorus content in the post harvest soil samples were more in 12.5:25:25 NPK + CCP @ 12.5 t ha^{-1} treated plots whereas NH_4OAc extractable potassium content was more in 12.5:25:12.5 NPK treated plots. Phosphorus and potassium application along with CCP did not show any significant effect on root and shoot length, but their application showed significant effect on yield attributing characters like number of pods, number of grains / pod, filled grain and 100 seed weight. Application of 25 kg ha^{-1} potassium and 12.5 t ha^{-1} CCP along with normal recommended dose of nitrogen and phosphorus recorded maximum nutrient uptake in black gram grains.

Keywords: Black gram, Yield, Phosphorus, Potassium.

Introduction

Pulses occupy a very significant place in Indian farming as well as in predominantly vegetarian diet. In India, pulse crops are grown on an area of 23-24 m ha accounting for nearly 33 per cent of world acreage and consumed by 22 per cent of world's population (Singhal, 1999). Among the pulses, black gram occupies 10.64 lakh ha area (4.5% of total) in *rabi* season. In this, more than 85 per cent of black gram area is under rainfed condition.

Among the plant nutrients, phosphorus and potassium play a significant role in the production of pulses through higher nodulation and nitrogen fixation. Black gram responds favorably to phosphate (Nandal *et al.* 1987). Therefore an experiment was undertaken to study the effect of phosphorus and potassium combined with CCP on growth, yield and nutrient uptake of black gram under rainfed condition.

Materials and Methods

The field experiment was conducted during *rabi* season of 2001 at Tamil Nadu Agricultural University farm, Coimbatore. The initial soil samples were analyzed for the estimation of pH, EC, bulk density, particle density, pore space, organic carbon, available nitrogen, available phosphorus and available potassium by standard methods (Table 1). The soil was clay loam having pH of 8.0; EC 0.16 dSm^{-1}; bulk density 1.25 mg m^{-3}; particle density 2.5 mg m^{-3}; pore space 50 per cent; organic carbon 4.08 g kg^{-1}; available nitrogen 159.9 kg ha^{-1}; available phosphorus 10.42 kg ha^{-1} and available potassium 423.14 kg ha^{-1}. The experiment was laid out in randomized block design with four replications. The plot size was 20 m^2. The treatment comprised five different combinations of phosphorus and potassium in the form of single super phosphate and murate of potash, respectively. Urea was the source of applied nitrogen. Treatment combinations were T_1 = 12.5:25:0 NPK kg ha^{-1}; T_2 = 12.5:25:12.5 NPK kg ha^{-1}; T_3 = 12.5:25:25 NPK kg ha^{-1}; T_4 = 12.5:25:25 NPK kg ha^{-1} + Composted Coir Pith (CCP) @ 12.5 t ha^{-1}; T_5 = 0:25:0 NPK kg ha^{-1} + CCP @ 12.5 t ha^{-1}. Black gram (*Vigna mungo* var. CO 5) was sown at a spacing of 30 cm x 10 cm and 470 mm rainfall was received during crop period.

Table 1. Details of analytical methods employed in the soil analysis

S.No.	Determination	Reference
1.	Soil reaction pH (1:2.5 soil:water suspension)	Jackson (1973)
2.	Electrical conductivity (EC) (1:2.5 soil:water suspension)	Jackson (1973)
3.	Bulk density	Piper (1966)
4.	Particle density	Piper (1966)
5.	Pore space	Piper (1966)
6.	Organic carbon	Walkey and Black (1934)
7.	Available nitrogen	Subbiah and Asija (1956)
8.	Available phosphorus	Olsen (1954)
9.	Available potassium	Stanford and English (1949)

Table 2. Available nutrient contents in post harvest soil samples

Treatments	Organic carbon (g kg^{-1})	$KMno_4$-N (kg ha^{-1})	Olsen's-P (kg ha^{-1})	NH_4OAc-K (kg ha^{-1})
12.5 : 25 : 0 NPK kg ha^{-1}	5.93	359.77	22.58	401.40
12.5 : 25 : 12.5 NPK kg ha^{-1}	6.83	361.27	33.11	471.50
12.5 : 25 : 25 NPK kg ha^{-1}	4.87	392.78	27.60	403.65
12.5 : 25 : 25 NPK + CCP @ 12.5 t ha^{-1}	7.70	413.46	38.64	455.84
0 : 25 : 0 NPK + CCP @ 12.5 t ha^{-1}	7.00	394.89	33.11	460.99
CD (P=0.05)	1.45	8.48	6.52	12.02

Table 3. Biometric observations on black gram after harvest

Treatments	Root length (cm)	Shoot length (cm)	No. bran-ches	No. leaves/ plant	No. pods/ plant	Grain/ pod	Filled grain	100 seed wt.(g)
12.5:25:0 NPK kg ha^{-1}	13.0	23.6	2.8	16.0	44.75	5.00	3.00	0.38
12.5:25:12.5 NPK kg ha^{-1}	13.5	23.8	2.6	16.0	52.08	6.65	4.50	0.2
12.5:25:25 NPK kg ha^{-1}	15.1	24.8	3.3	16.5	55.00	6.80	5.00	0.95
12.5:25:25 NPK+CCP @ 12.5 t ha^{-1}	12.9	27.7	4.0	21.0	60.50	7.75	5.75	1.70
0:25:0 NPK + CCP @ 12.5 t ha^{-1}	16.7	27.4	3.3	19.7	47.00	5.75	4.50	0.47
CD (P=0.05)	NS	NS	1.3	10.9	9.1	1.9	1.1	0.24

Table 4. Phosphorus and potassium uptake (kg ha^{-1}) in black gram

Treatments	Phosphorus		Potassium	
	Haulm	Grain	Haulm	Grain
12.5 : 25 : 0 NPK kg ha^{-1}	2.33	0.18	85.5	3.95
12.5 : 25 : 12.5 NPK kg ha^{-1}	4.31	0.21	171.1	4.21
12.5 : 25 : 25 NPK kg ha^{-1}	2.86	0.14	153.2	2.64
12.5 : 25 : 25 NPK + CCP @ 12.5 t ha^{-1}	4.17	0.33	167.1	6.71
0 : 25 : 0 NPK + CCP @ 12.5 t ha^{-1}	4.19	0.21	163.2	3.88
CD (P=0.05)	0.01	0.01	7.53	0.03

Soil samples were collected after harvest (90 days) of the plant and were analyzed for organic carbon, $KMnO_4$-N, Olsen's phosphorus and available potassium. Observation on root length, shoot length, number of branches, leaves, pods, grain/pod, filled grain and 100 seed weight was taken from five randomly selected plants in central rows of each plot. The yield of haulm and grain was computed on plot basis. Nitrogen, phosphorus and potassium content of plant samples and CCP was also analyzed by microkjeldahl method (Humphries, 1956), vanadomolybdate yellow colour method (Jackson, 1973) and Flame photometer method (Piper, 1966) respectively.

Results and Discussion

Germination percentage

It could be seen from the data that the CCP treated plot recorded significantly lower germination percentage (59-62%). It might be due to the roughness of CCP that inhibit the emergence of plumule. But it was not reflected in later stages due to high WHC and nutrient content (N=1.45 %, P=0.96 % and K=1.50%) of CCP utilized in this experiment and also influences the mineralization of native soil nutrients by priming effect.

Phosphorus

It is the second most critical plant nutrient and for pulses and it assumes primary importance owing to its important role in root development, number of active nodules per plant (Ssali and Keya, 1986; Chaudhary and Das, 1996) and higher nitrogen fixation.

The residual Olsen's phosphorus content of post harvest soil sample was 17.25 kg ha^{-1} in NPK application with CCP treatment (T_4), it was 71 per cent higher than that of normal recommended dose (T_1) and it was significantly different from other treatments (Table 2). It might be due to the presence of phosphorus content in CCP and its influence on the mineralization of nutrients.

Application of phosphorus and potassium each 25 kg ha^{-1} along with CCP @ 12.5 t ha^{-1} (T_4) increased the shoot length and recorded more number of branches, leaves, pods, grain/pod and filled grain (Table 3). The reasons are i) Phosphorus is the main constituent of ADP and ATP that might be important for growth parameters. ii) Application of potassium along with CCP and generally potassium fertilizer regulates the utilization of other nutrient (Phosphorus) in the plant system (Ghonsikar and Shinde, 1997). iii) Phosphorus is the constituent of nucleic acid and proteins that might have stimulated cell division resulting in increased growth of plants (Chaudhary and Das, 1996).

Grain yield and 100 seed weight was high in T_4 treatment. This was mainly due to increasing values of yield attributes particularly pods/plant and filled grain. This is in line with the findings of Thakur and Negi (1985) and Ramamoorthy *et al.* (1997). Application of NPK at the rate of 12.5:25:12.5 kg ha^{-1} (T_2) significantly increased the uptake of phosphorus in haulm whereas the application of NPK with CCP (T_4) significantly recorded higher amount of phosphorus uptake in grain (Table 4).

Potassium

Residual NH_4OAc extractable potassium content in the post harvest soil sample was significantly high in T_2 treatment and it was followed by T_4 and T_5 treatments (Table 2). Higher biometric observations such as shoot length, number of branches, leaves, pods, grains and filled grain were recorded with the application of potassium 25 kg ha^{-1} and CCP @ 12.5 t ha^{-1} along with recommended dose of nitrogen and phosphorus (T_4) (Table 3).

Yield of haulm, grain and 100 seed weight was high in T_4. It might be due to increase in the value of biometric attributes. The treatments without potassium application recorded low yield. Potassium uptake was high in haulm under T_2 treatment due to the presence of 1:1 N:K ratio that favours the maximum uptake (Gill *et al.* 2000). Whereas in grain, addition of CCP influenced the potassium uptake and it was high under T_4 treatment (Table 4).

It can be inferred from the experiment that maximum grain yield and nutrient uptake of grain could be obtained with the application of NPK at the rate of 12.5:25:25 kg ha^{-1} along with CCP @ 12.5 t ha^{-1}.

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(Received: January 2003; Revised: December 2003)