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Effect of Integrated Nutrient Management on Soil Available Nutrient Status and Yield in Blackgram

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ABSTRACT

A field experiment was conducted at the Agricultural College Farm, Bapatla, during *kharif* 2017 to study the integrated phosphorus management in blackgram.The experiment was laid out in Random Block Design with eight treatments replicated thrice. The results revealed that application of 75% RDP along with FYM and seed inoculated PSB to blackgram crop significantly recorded highest yield *viz.,* seed and haulm yield at harvest. Among the various treatments of phosphorus with or without FYM and PSB the available nutrient status of N, K, Fe, Zn, Cu, Mn recorded highest with T_4 (RDNK + 75% RDP + FYM @ 5 t ha^{-1}).

Key words: *Blackgram, phosphorus levels, Farm yard manure, phosphorus solubilising bacteria.*

Among the pulses, blackgram (*Phaseolus mungo*) is the third important crop which is cultivated over wide range of agro-climatic zones of the country.It occupies about 3.25 million ha area in the country producing 1.5 million tonnes of seed with an average productivity of 462 kg ha^{-1} (AICRP, 2013). Blackgram seed is rich in protein and phosphoric acid content. Blackgram is generally grown in soil with low fertility status or with use of low quantity of organic and inorganic sources. However, imbalance use of chemical fertilizers not only lowers productivity but also adversely affects soil health by decreasing soil organic carbon, micro flora and hardening of soil. Hence, the integrated nutrient management increases productivity, minimizes expenditure on costly fertilizer inputs, improves physical properties of the soil, increases efficiency of added nutrients and at the same time ensures good soil health and is also an environmental-friendly approach. Among the major nutrients, phosphorus is a key element in legume nutrition favours healthy root growth by helping translocation of carbohydrates and promotes seed setting and seed yield. Hence, Seed inoculation with such phosphorus solubilizing bacteria may be beneficial to the crop in utilizing the phosphorus and hence increasing crop production. The activity of phosphorus solubilizing bacteria can be improved by the addition of farmyard manure to the soil, since it acts as a source of carbon and also contributes some amount of nutrients to soil through mineralization process. Hence, the use of phosphorus, PSB and farmyard manure in blackgram has to be studied to obtain the maximum seed yield.

MATERIAL AND METHODS

Available Nitrogen was determined by modified alkaline potassium permanganate method (Subbaiah and Asija, 1956). Available phosphorus in soil was extracted with 0.5N $NaHco_3$ of pH 8.5 and measured in Spectrophotometer (Olsen *et al.,* 1954). The available zinc, copper, iron and manganese in soils were exreacted by DTPa and measured by using atomic absorption spectrophotometr (Lindsay and Norvell, 1978).

The field experiment was conducted at the Agricultural College Farm, Bapatla during *kharif,* 2017. The soil was sandy clay loam in texture, non-saline (0.22 EC), slightly alkaline (7.4 pH), low in organic carbon (0.3 %), low in available nitrogen (115 kg ha^{-1}) and available phosphorus (20.82 kg ha^{-1}), medium in potassium (210 kg ha^{-1}) and the micronutrients Fe(5.89 ppm), Zn (1.84 ppm), Cu (1.55 ppm) and Mn (2.87 ppm) are high in soil. The experiment was laid out in Random Block Design with eight treatments replicated thrice. The treatments comprised of T_1- Control, T_2- RDF, T_3 – RDNK + 75% RDP + PSB, T_4 - RDNK + 75% RDP + FYM @ 5 t ha^{-1}, T_5- RDNK + 75% RDP + PSB + FYM @ 5 t ha^{-1}, T_6- RDNK + 50% RDP + PSB, T_7- RDNK + 50% RDP + FYM @ 5 t ha^{-1}, T_8- RDNK + 50% RDP + PSB + FYM @ 5 t ha^{-1}.

Well decomposed farmyard manure @ 5 t ha^{-1}was applied to the field one week before sowing. The inorganic nitrogen through urea was applied in 2 splits (at basal and at flowering) equally to all treatments *i.e.*T_2 to T_8 except control (T_1). Entire quantity of Phosphorus in the form of Single Super Phosphate was divided into 75% and 50% based on treatments and applied accordingly as basal application the day before sowing. Potassium was applied in the form of Murate of Potash was applied to all the treatments as basal dose at the time of sowing. (Recommended dose of fertilizers was 25-50-25 kg N- P_2O_5 - K_2O kg ha^{-1}).The crop was sown with a spacing of 30 × 10 cm. With a plot size of 6 m × 4 m. Observations regarding the available nutrients in soil and yield were recorded. The data was analysed statistically by adopting the standard procedures described by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Soil available nutrient status:

The available nitrogen content in soil was ranged between 120 to 170 kg ha^{-1} (Table 1). The available nitrogen content in soil was maximum (170 kg ha^{-1}) in treatment supplied with RDNK + 75% RDP + FYM @ 5 t ha^{-1} (T_4) and it was on par with the treatments RDNK + 75% RDP + PSB + FYM @ 5 t ha^{-1} (T_5), RDNK + 50% RDP + FYM @ 5 t ha^{-1} (T_7) and RDNK + 50 % RDP + PSB + FYM @ 5 t ha^{-1} (T_8) while, the lowest was found in control (120 kg ha^{-1}).

The increase in available N due to application of organics could also be attributed to the greater multiplication of soil microbes, which could convert organically bound N to inorganic form and might have helped in the mineralization of soil N leading to the build-up of higher available N (Prasad *et al*., 2010). Similar increase in available N in soil due to addition of organics was observed in wheat by Yadavindersingh *et al*. (2004).

The available P in soil was ranged between 37.2 to 17 kg ha^{-1}. The highest available P (37.2 kg ha^{-1}) in soil was observed with T_5 (RDNK + 75% + PSB + FYM), whereas the lowest (17 kg ha^{-1}) was observed in the control plot (T_1) at harvest. The increase in the available P content of soil significantly increased due to the combined application of Phosphorus, FYM and PSB. Application of P resulted in lesser fixation of P thus resulted in an increase in available P and also enhanced P absorption by the plants.FYM solubilises the insoluble form of P in the soil through release of various organic acids and also due to reduced P fixation by organic acids through chelation of metal ions, which forms insoluble P compounds with applied P. (Tolanur and Badanur, 2003).On other hand PSB also increases the P content in the soil, which might be due to production of organic acids and inorganic acids which convert the 'insoluble phosphates to available forms. Same results were reported by Chesti and Ali (2012).

The available potassium content in soil was maximum (264 kg ha^{-1}) in treatment supplied with RDNK + 75% RDP + FYM @ 5 t ha^{-1} (T_4) and it was on par with the treatments T5 (RDNK + 75% RDP + PSB + FYM @ 5 t ha^{-1}), T7 (RDNK + 50% RDP + FYM @ 5 t ha^{-1}) and T8 (RDNK + 50% RDP + PSB + FYM @ 5 t ha^{-1}) while, the lowest was found in control (218 kg ha^{-1}) at harvest.

The available potassium content was maximum value (264.0 kg ha^{-1}) at flowering while, decreased value (218.0 kg ha^{-1}) at harvest. This could be due to the high root activity and production of large quantities of root exudates during peak growth stage which encourages solubilization and release of native potassium.

The application of organic matter might have caused reduction in K fixation and consequentially increased K content due to interaction of organic matter with clay besides the direct addition to the available K pools and release of K due to interaction of organic matter with clay.

The higher buildup of available potassium in the soil treated with organic manures compared to sole inorganic nitrogen treated soil might be due to addition of potassium to available pool of the soil from organic sources. In addition, the organic acids released during decomposition of manures mobilize the native or nonexchangeable forms of potassium and charge the soil solution with potassium ions, so that it will be readily available. Similar findings were reported by Chesti and Ali (2012), Elayaraja and Singaravel (2011).

Available Micronutrients

Available zinc

At harvest stage, the highest available zinc (2.76 mg kg^{-1}) was recorded in the treatment, RDNK + 75% RDP + FYM @5 t ha^{-1} (T_4) while, the lowest value (1.51 mg kg^{-1}) was observed in control. The treatment (T_4) RDNK + 75% RDP + FYM @ 5 t ha^{-1} was statistically comparable with RDNK + 75% RDP + PSB + FYM @ 5 t ha^{-1} (T_5), RDNK + 50% RDP + FYM @ 5 t ha^{-1} (T_7) and RDNK + 50 % RDP + PSB + FYM @ 5 t ha^{-1} (T_8) at harvest (Tabl;e 1).

The perusal of the data indicated that addition of organic matter exhibited a favourable influence on available micronutrient content of soils. Organic matter was found to be superior in enriching micronutrient status than raw residues. The micronutrient content increased up to flowering stage and then decreased at harvest in all the treatments (Prasuna, 2006).

Available iron

Data regarding available iron content influenced by integrated use of phosphorus was found in Table 2.

At harvesting stage, significantly highest available iron content (6.69 mg g^{-1}) was observed in treatment supplied with application of RDNK + 75% RDP + FYM @ 5 t ha^{-1} (T_4) and it was on par with

Table 1. Effect of integrated phosphorus management on soil available macronutrient status at harvesting stage of blackgram.

Treatments	Soil Available nitrogen (kg ha^{-1})	Soil Available phosphorus (kg ha^{-1})	Soil Available potassium (kg ha^{-1})
T_1 : CONTROL	120.0	17.0	218.0
T_2 : RDF	143.0	35.2	231.0
T_3 : RDNK + 75% RDP + PSB	134.0	26.8	220.0
T_4 : RDNK + 75% RDP + FYM @ 5 t ha^{-1}	170.0	27.4	264.0
T_5 : RDNK + 75% RDP + PSB + FYM @ 5 t ha^{-1}	157.0	37.2	245.0
T_6 : RDNK + 50% RDP + PSB	140.0	24.8	226.0
T_7 : RDNK + 50% RDP + FYM @ 5 t ha^{-1}	160.0	25.1	252.0
T_8 : RDNK + 50% RDP + PSB + FYM @ 5 t ha^{-1}	154.0	30.3	240.0
CD (p=0.05)	26.0	6.4	29.0
CV%	10.0	12.1	7.0
SEm±	9.0	2.1	9.0

Table1. Effect of integrated phosphorus management on soil available micronutrient status at harvesting stage of blackgram.

Treatments	Soil available zinc (mg $kg^{?1}$)	Soil available iron (mg $kg^{?1}$)	Soil available copper (mg $kg^{?1}$)	Soil available manganese (mg $kg^{?1}$)
T_1 : CONTROL	1.51	5.14	1.38	2.35
T_2 : RDF	1.85	5.58	1.41	2.38
T_3 : RDNK + 75% RDP + PSB	1.77	5.33	1.38	2.36
T_4 : RDNK + 75% RDP + FYM @ 5 t ha^{-1}	2.76	6.69	1.47	2.44
T_5 : RDNK + 75% RDP + PSB + FYM @ 5 t ha^{-1}	2.52	6.12	1.45	2.4
T_6 : RDNK + 50% RDP + PSB	1.64	5.37	1.39	2.37
T_7 : RDNK + 50% RDP + FYM @ 5 t ha^{-1}	2.64	6.39	1.46	2.43
T_8 : RDNK + 50% RDP + PSB + FYM @ 5 t ha^{-1}	2.45	5.92	1.45	2.39
CD (p=0.05)	0.27	0.77	NS	NS
CV%	7.45	7.62	12.3	7.39
SEm±	0.09	0.25	0.101	0.102

RDNK + 75% RDP + PSB + FYM @ 5 t ha^{-1} (T_5), RDNK + 50% RDP + FYM @ 5 t ha^{-1} (T_7) and RDNK + 50 % RDP + PSB + FYM @ 5 t ha^{-1} (T_8). The lowest (5.14 mg g^{-1}) was observed in control (T_1).

Application of organic manures increased concentration of iron and zinc by the crop. Due to the chelation of Fe and Zn by organic compounds formed during decomposition of organic manures making them more available. Similar results were also observed by Karache *et al.* (2013). The increase in micronutrients in soils with addition of organics was due to enhanced microbial activity and consequent release of complex organic substances like chelating agents and which prevent the micronutrients from precipitation, fixation, oxidation and leaching in addition to build up of these nutrients through organic sources.

Table 3. Effect of integrated phosphorus management on yield (kg ha^{-1}) of blackgram

Treatments	Yield (kg ha^{-1})	
	Seed yield	Haulm yield
T_1 : CONTROL	577	1082
T_2 : RDF	879	1750
T_3 : RDNK + 75% RDP + PSB	895	1680
T_4 : RDNK + 75% RDP + FYM @ 5 t ha	970	1900
T_5 : RDNK + 75% RDP + PSB + FYM @ 5 t ha^{-1}	1120	2100
T_6 : RDNK + 50% RDP + PSB	850	1420
T_7 : RDNK + 50% RDP + FYM @ 5 t ha^{-1}	864	1600
T_8 : RDNK + 50% RDP + PSB + FYM @ 5 t ha^{-1}	1010	1980
CD (p=0.05)	176.67	237.49
CV%	11.26	8.02

Available manganese

The data presented in Table 2 indicated that the available manganese content was not significantly influenced by the treatments of different phosphorus levels, PSB and FYM. The highest available manganese content was recorded highest (2.44 mg g^{-1}) at harvest stage in treatment supplied with RDNK +50 % P_2O_5 + FYM @ 5 t ha^{-1} (T_4) and the lowest content of 2.35 mg g^{-1} was recorded in control (T_1).

Available copper

The results are presented in Table 2 indicated that available copper content was not significantly influenced by imposed treatments at all stages of crop growth. The maximum (1.47 mg g^{-1}) available copper content of was observed in T_4 (RDNK +50 % P_2O_5 + FYM @ 5 t ha^{-1}) while, control (T_1) recorded the lowest (1.38 mg g^{-1}) available copper content.

Yield

The results pertaining to seed yield are presented in Table 3, was found to be significantly influenced by application of phosphorus levels along with FYM and PSB.

The application of 75% RDP along with PSB and FYM resulted in a significant increase in grain yield over the treatments, which received 100% RDF and 50% RDP. Grain yield ranged from 577 to 1120 kg ha^{-1}. The highest seed yield (1120 kg ha^{-1}) was recorded with application of RDNK + 75% RDP + PSB +FYM @ 5 t ha^{-1} (T_5) and the lowest seed yield (577 kg ha^{-1}) was obtained in control (T_1) treatment. Among all, the treatment supplied with RDNK + 75% RDP + PSB +FYM @ 5 t ha^{-1} (T_5) was found significantly superior to all other treatments. However, it was on par with RDNK + 75% RDP +FYM @ 5 t ha^{-1} (T_4) and RDNK + 75% RDP + PSB +FYM @ 5 t ha^{-1} (T_8).

The results of the haulm yield are presented in Table 3. The highest haulm yield (2100 kg ha^{-1}) was recorded with application of RDNK + 75% RDP + PSB +FYM @ 5 t ha^{-1} (T_5) and the lowest haulm yield (1082 kg ha^{-1}) was obtained in T_1 (control). The treatment supplied with RDNK + 75% P_2O_5 + PSB +FYM @ 5 t ha^{-1} (T_5) was on par with treatments received RDNK + 75% P_2O_5 +FYM @ 5 t ha^{-1} (T_4) and RDNK + 75% P_2O_5 + PSB +FYM @ 5 t ha^{-1} (T_8).

The production of organic acids and growth promoting substances during decomposition of organic manures might have facilitated easy availability of macro as well as micronutrients. Adequate supply of nutrients to the crop helps in the synthesis of carbohydrates, which are required for the formation of protoplasm, thus resulting in higher cell division and cell elongation. Thus, an increase in seed yield might have been an account of overall improvement in the vegetative growth of the plant due to the application of organic manures in combination with inorganic fertilizer. The increased yield with combined application of phosphorus, FYM, PSB might be due to increased availability of phosphorus through its effect on Rhizobium and proliferation of root system. Through mineralisation the applied FYM supplied nutrients required for the plant and improved the physical and biological properties of soil. And applied PSB solubilises the native as well as applied P in soil, thus making it available for plant use. The results are in conformity with Tanwar *et al.*, 2002, Velayutham and Kalpana (2004).

CONCLUSION

The treatments which received PSB performed better when compared to complete inorganic treatments. The highest seed yield (1120 kg ha^{-1}), Haulm yield (2100 kg ha^{-1}) and soil available phosphorus (37.2 kg ha^{-1}) where recorede with treatment receiving RDNK +75% RDP + PSB + FYM @ 5t ha^{-1}. Where as significantly highest available Nitrogen (170.0 kg ha^{-1}), available Potossium (264.0 kg ha^{-1}), available iron (6.69 mg kg^{-1}) and available Zinc (2.76 mg kg^{-1}) were recorded in the treatment receiving RDNK + 75% RDP + FYM @ 5t ha^{-1}.

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