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Research Communication

Effect of different organic amendments on phosphorus dynamics of blackgram (*Vigna mungo*)

NALLAGATLA VINOD KUMAR[1] AND PATIL M.B.[2]

College of Agriculture (University of Agricultural Sciences, Dharwad), Vijayapur, Karnataka 586 101

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ABSTARCT

Legumes play a significant role in sustainable agriculture through their ability to improve soil fertility and health. With a mutual symbiotic relationship with some bacteria in soil, they can improve nitrogen (N) amount through biological N-fixation (BNF). But to maximize such functions, legumes need more phosphorus (P) as it is required for energy transformation in nodules. Besides, P also plays a significant role in root development, nutrient uptake and growth of legume crops. A field experiment was conducted during rainy (*kharif*) season of 2019 at IFS unit, College of Agriculture, (University of Agricultural Sciences, Dharwad), Vijayapur, Karnataka to study the effect of different combination of organic sources on phosphorus dynamics of blackgram [*Vigna mungo* (L.) Hepper]. Among different treatments, the application of vermicompost + ghanajeevamrutha @ 100% RDP + *Rhizobium* + PSB recorded significantly higher soil available phosphorus (36.30 kg/ha) and uptake by blackgram (16.08 kg/ha). This study has demonstrated the dynamics of phosphorus through different organic sources in blackgram.

***Key words*:** Blackgram, Farmyard manure, Ghanajeevamrutha, Nutrient uptake, *Rhizobium*, Vermicompost

Pulses play an important role in Indian agriculture for sustainable production, improvement in soil health and environment safety. Legumes serve as a cost-effective protein source to address malnutrition among vegetarians, offering a high percentage of quality protein, nearly three times greater than that found in cereals. While legumes respond well to organic manures, the indiscriminate and continuous use of chemical fertilizers has detrimental effects on soil physical, chemical, and biological properties. This not only impacts the sustainability of crop production but also contributes to environmental pollution. There is a scope to improve the crop productivity by enhancing the soil fertility and productivity through increasing soil organic carbon, soil moisture storage capacity and adopting integrated nutrient management practices. The crop productivity under organic production system can be enhanced through optimizing the nutrient requirement of crop at different stages.

Blackgram [*Vigna mungo* (L.) Hepper] is one of the most important pulse crops of India, with an annual production of 2.1 MT from 3.51 Mha with the average productivity of 655 kg/ha (Anonymous, 2018). Though blackgram has spread across the country with significant area, its overall production is very poor owing to its poor productivity. Even among the different pulses, productivity of blackgram is very poor. Among other factors the main cause of its low production is cultivation on marginal lands with low nutrient quality. Blackgram being a member of Leguminosae family has the capacity to meet its nitrogen requirements while, focus need to be diverted towards other important nutrients.

As the demand for agricultural products rises and the world's production peaks in the coming decades, phosphorus (P) is receiving more attention as a non-renewable resource (Cordell *et al*., 2009). One unique characteristic of P is its low availability due to slow diffusion and high fixation in soils. Maintaining a proper P-supplying level at the root zone can maximize the efficiency of plant roots to mobilize and acquire P from the rhizosphere by an integration of root morphological and physiological adaptive strategies. Furthermore, P uptake and utilization by plants plays a vital role in the determination of final crop yield. A holistic understanding of P dynamics from soil to plant is necessary for optimizing P management and improving P-use efficiency, aiming at reducing consumption of chemical P fertilizer, maximizing exploitation of the

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[2]**Corresponding author's Email:** vinodnallagatla@gmail.com
[1]M.Sc. Student; [2]Professor and Head, Department of Agronomy, College of Agriculture, (University of Agricultural Sciences, Dharwad), Vijayapur, Karnataka 586 101

biological potential of root/rhizosphere processes for efficient mobilization, and acquisition of soil P by plants as well as recycling P from manure and waste. Taken together, overall P dynamics in the soil-plant system is a function of the integrative effects of P transformation, availability, and utilization caused by soil, rhizosphere, and plant processes. In view of this, the present study was carried out to know the effect of different organic sources on dynamics of phosphorus in blackgram.

A field experiment was conducted during rainy (*kharif*) season of 2019 at College of Agriculture, (University of Agricultural Sciences, Dharwad), Vijayapur, Karnataka. The soil of experimental site was clayey having *p*H about 7.82 with medium organic carbon (0.57%), low N (262 kg/ha), high P_2O_5 (32.5 kg/ha) and K_2O (390 kg/ha) content. Experimental site falls under semi-arid climatic with rainfall of 576.8 mm. Other weather parameters such as maximum (35.1°C) and minimum (21.6°C) temperature, relative humidity (%) were also recorded during the experimental year (*kharif*, 2019). The experiment was laid out in a randomized complete block design (RCBD) with three replications. Treatment included were: T_1, Application of FYM (Farmyard manure) + vermicompost based on 100% RDP (Recommended dose of phosphorus); T_2, Application of vermicompost + ghanajeevamrutha based on 100% RDP; T_3, Application of FYM + ghanajeevamrutha based on 100% RDP; T_4, Application of FYM + vermicompost based on 50% RDP; T_5, Application of vermicompost + ghanajeevamrutha based on 50% RDP; T_6, Application of FYM + ghanajeevamrutha based on 50% RDP; T_7, Application of FYM + vermicompost based on 100% RDP + *Rhizobium* + PSB (Phosphorus solubilizing bacteria); T_8, Application of vermicompost + ghanajeevamrutha based on 100% RDP + *Rhizobium* + PSB; T_9, Application of FYM + ghanajeevamrutha based on 100% RDP + *Rhizobium* + PSB; T_{10}, Application of FYM + vermicompost based on 50% RDP + *Rhizobium* + PSB; T_{11}, Application of vermicompost + ghanajeevamrutha based on 50% RDP + *Rhizobium* + PSB; T_{12}, Application of FYM + ghanajeevamrutha based on 50% RDP + *Rhizobium* + PSB. The blackgram variety TAU-1 was sown with a spacing of 45 cm × 10 cm. The recommended dose of phosphorus for blackgram was supplemented with different combinations of soil organic manures with equal proportions based on their P content. The required quantity of organic manures, viz. FYM, Vermicompost, Ghanajeevamrutha was applied uniformly as per the treatments and incorporated into the soil three weeks before sowing. The quantity of organic manures was worked out equivalent to the recommended dose of fertilizers (RDF 20 kg/ha N + 50 kg/ha P_2O_5 + 0 kg/ha K_2O).

The numbers of pods removed at the time of harvest were counted. Finally, the mean was computed by dividing the total value by five. The samples were drawn from the harvested produce of each plot to work out the mean number of seeds per pod. Seed sample from the produce of each net plot was taken and hundred from these samples were counted, weighed and expressed in grams. Seed yield was recorded from each net plot after the harvest of crop and was expressed in kg/ha. The haulm yields per plot were determined by subtracting the seed yield (economical yield) of each plot from the biological yield (bundle weight) of the same plot. The haulm yield per hectare was computed and expressed in kg/ha.

Plant samples were collected treatment wise from all the replications. Sample were cleaned and dried in oven at 60–70°C till constant weight was attained and ground to fine powder in Willey mill with stainless steel blades. Powdered plant samples were used for nutrient analysis. Phosphorus content in the digested plant samples was determined by vanadomolybdo-phosphoric acid yellow colour method using spectrophotometer at 470 nm wave length (Olsen, 1954). The representative soil samples from each replication were collected randomly after harvest with the help of auger. The samples were mixed homogenously and composite sample was prepared, air dried, and then dried in the hot air oven at 105°C for 24 h. Samples were passed through 2 mm sieve. Available phosphorus was determined by Olsen's (1954) method by Jackson (1973) using spectrophotometer and expressed in kg/ha.

Among the organic manures, application of P as vermicompost + ghanajeevamrutha based on 100% RDP + *Rhizobium* + PSB resulted in higher seed yield and yield attributing characters. Also the similar treatment recorded a higher number of pods per plant (19.33), number of seeds per pod (6.33), haulm yield (2038.67 kg/ha) and seed yield (701.33 kg/ha) compared to other treatments. The increased seed yield and yield attributing characters of blackgram by application of organic manures might be owing to prolonged and steady availability of major nutrients during the crop growth period, by inclusion of nutrient rich organics viz. FYM, vermicompost, Ghanajeevamrutha. Pivotal role of *Rhizobium* in fixation of atmospheric nitrogen might have enhanced the supply and translocation of N which influences the development of photosynthetic organs; and inoculation of PSB, solubilizes the insoluble P through the production of organic acids and have some augmenting effect on the native population of *Rhizobium* besides playing a vital role in nodule formation in blackgram. These results are in accordance with the findings of Sailaja and Usha (2002) and Wagadre *et al.,* (2010).

In each treatment, a specific amount of phosphorus was applied per hectare. In the first scenario, referred to as

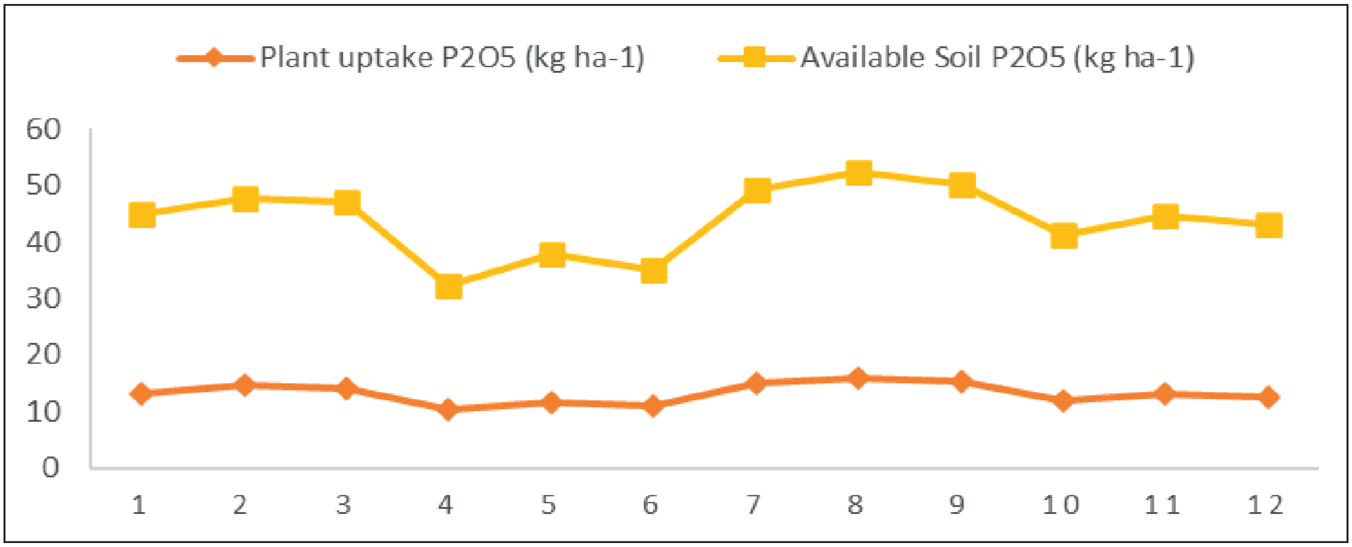

Fig. 1. Effect of different organic amendments on phosphorus dynamics of blackgram

100% RDP, each hectare received an application of 50 kg of phosphorus. This indicates that the recommended dietary phosphorus for the crops was fully met at this rate. In the second scenario, known as 50% RDP, the application of phosphorus was reduced. In this case, each hectare received 25 kilograms of phosphorus, representing only half of the recommended dose phosphorus. This reduction in phosphorus application may have been implemented for various reasons, such as cost-effectiveness, environmental considerations, or specific crop requirements. These treatments with different phosphorus application rates provide a basis for studying and comparing the effects of varying phosphorus levels on crop growth, yield, and overall agricultural outcomes

Available phosphorus in soil after the harvest of the crop differed among the treatments. The treatment (T_8) with the application of vermicompost + ghanajeevamrutha based on 100% RDP + *Rhizobium* + PSB registered significantly higher available phosphorus (36.30 kg/ha) i.e. 72.60% with an uptake of 16.08 kg/ha i.e. 32.16% due to better interaction of rhizosphere with solubilizing bacteria resulting in conversion of unavailable phosphorus to available phosphorus. Manure can be applied to soil to increase P fertility. In manure, inorganic P accounts for 50 to 90% (Dou *et al.,* 2000). Manure also contains large amounts of organic P, such as phospholipids and nucleic acids (Turner and Leytem, 2004), which can be released to increase soil inorganic P concentrations by mineralization. Phosphorus

Table 1. Effect of different organic amendments on pods per plant, seeds per pod, haulm yield and seed yield in blackgram

Treatment	Pods/ plant	Seeds/ pod	Haulm yield (kg/ha)	Seed yield (kg/ha)	Applied P_2O_5 (kg/ha)	Available soil P_2O_5 (kg/ha)	Plant uptake or P uptake (kg/ha)
T_1	14.67	5.33	1,707.33	610.00	50	31.79	13.27
T_2	15.67	5.67	1,807.33	634.00	50	33.33	14.56
T_3	15.00	5.33	1,728.00	622.00	50	32.97	14.04
T_4	7.33	4.67	1,390.33	408.33	25	21.82	10.43
T_5	9.00	5.00	1,432.33	491.33	25	26.48	11.47
T_6	8.33	4.00	1,426.00	411.00	25	23.98	10.96
T_7	17.00	6.00	1,838.00	659.33	50	34.17	15.02
T_8	19.33	6.67	2,038.67	701.33	50	36.30	16.08
T_9	18.00	6.33	1,890.00	680.00	50	35.09	15.17
T_{10}	10.33	4.67	1,480.33	537.00	25	29.40	12.01
T_{11}	13.00	5.00	1,631.67	592.67	25	31.46	13.08
T_{12}	11.67	5.00	1,532.33	573.00	25	30.80	12.43
SEm±	0.61	0.40	60.81	30.54			
CD (P=0.05)	1.79	1.17	178.37	89.60			

Refer to the methodology for treatment details.

adsorption to soil particles can be greatly reduced through applying organic substances. The humic acids contain large numbers of negative charges, carboxyl and hydroxyl groups, which strongly compete for the adsorption sites with inorganic P.

It is concluded that integration of P dynamics from soil to plant via the rhizosphere provides a comprehensive picture of available P behaviour and efficient acquisition in association with plant adaptive strategies. Given the importance of P to plants and as a strategic resource, a better understanding of P dynamics in the soil/rhizosphere-plant continuum is necessary to guide establishment of integrated P-management strategies involving manipulation of soil and rhizosphere processes, development of P-efficient crops, and improving P-recycling efficiency in the future.

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