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Effect of Phosphate Rich Organic Manure on Yield, Available Nutrient Status and Nutrient Uptake Of Soybean in Calcareous Soil

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Abstract

A field investigation entitled "Effect of phosphate rich organic manure on yield, available nutrient status and nutrient uptake of soybean in calcareous soil." was conducted in kharif season of 2023 at AICRP on Irrigation Water Management Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri. The experiment was laid out in randomized block design (RBD) with three replications. The experiment consists of eighttreatments *viz*. The treatments comprised of T_1 - Absolute control, T_2 - GRDF (50:75:45 kg $N:P_2O_5:K_2O$ ha^{-1} + 10 t FYM ha^{-1}), T_3 - RDF (50:75:45 kg $N:P_2O_5:K_2O$ ha^{-1}) , T_4 - RDP @ 100% through DAP , T_5 - RDP @ 25% through PROM + 75% RDP through DAP , T_6 - RDP @ 50% through PROM + 50 % RDP through DAP , T_7 - RDP @ 75% through PROM + 25% RDP through DAP, T_8 - RDP @ 100% through PROM. Recommended N and K @ 50 and 45 kg ha^{-1} respectively were applied to treatments T_4 to T_8 the by considering the compensation of N through DAP application.Organic manures were applied as per treatments 10daysbeforesowing.The application of general recommended dose of fertilizer to soybean in calcareous soil was found beneficial for increase in yield contributing characters, yield of soybean, total nutrient uptake, nutrient availability in soil, soil microbial count and enzyme activities. It also improved phosphorus use efficiency. However, the treatment of an application 25% phosphorus and 50% phosphorus through PROM and remaining through diammonium phosphate were at par with aforesaid treatment. Application of PROM along with chemical fertilizers enhances the soil's properties and improves the phosphorus use efficiency. Which indicates that, we can substitute 25 to 50 % phosphorus by using phosphate rich organic manure (PROM).

Key words : PROM, Soybean, Phosphorus, Yield, Available Macronutrients,Nutrient uptake.

Soybean (*Glycine max*) is a vital crop, originating in China around 2838 B.C., valued for both its oil and protein content. Introduced to India in the 1960's to address edible oil shortage, soybeans are versatile, used in products like soya milk, oil, and baked goods. They are rich in protein (39-44%), oil (21%), carbohydrates (26%), and essential amino acids, making them crucial for nutrition and economic development in rural areas. The soybean produces 2-3 times higher good quality protein on per hectare basis and cholesterol free oil than other pulses (Kumar *et al*., 2004).

Soybean has significantly improved the economic status of farmers in various regions of the country. The primary soybean-producing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, and Gujarat (Soybean outlook- January 2024). In India, the area under soybean cultivation in 2023-24 was 12.56 million hectares, slightly increased from 12.47 million hectares in 2022-23. (ICAR Indian institute of soybean research). Madhya Pradesh led with 55.84 lakh hectares, followed by Maharashtra with 46.01 lakh hectares (Reddy *et al*., 2022). Soybean's ability to fix atmospheric nitrogen enhances soil fertility, influencing root development and nodulation.

Phosphorus is essential for energy transfer and metabolic processes. It is a crucial nutrient component that has a direct impact on crop productivity because it encourages roots to grow

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and develop healthy and increases rhizobial activity, which increases nodulation and nitrogen fixation. Phosphorus fertilizer is typically added to increase the P concentration in the soil solution. However, once added, phosphorus undergoes various reactions in the soil, forming products with different solubilities. It is estimated that about 80% of the applied phosphorus becomes unavailable to plants due to its immobility and its tendency to form complexes with other nutrients such as aluminium (Al) and iron (Fe) (Rana *et al*., 2020; Teng *et al*., 2020). Phosphorus fixation is prevalent in both acidic and alkaline soils, leading to low recovery rates of applied phosphorus fertilizer. Therefore, more efficient management of phosphorus fertilizer is needed.

While macronutrients are essential for meeting crop nutrient needs, ongoing nutrient depletion threatens sustainable agriculture. Consequently, it's critical to decrease the reliance on NPK chemical fertilizers and increase the use of organic alternatives. Applying organic manure alone or alongside chemical fertilizers enhances the soil's physical and chemical properties and improves the efficiency of fertilizer use, leading to higher seed yields and quality. Legumes can release more phosphorus from rock phosphate through rhizosphere acidification during nitrogen fixation, making it available in the soil and incorporating it into biomass (Vanlauwe *et al*., 2000).

PROM offers an efficient method to blend rock phosphate with different organic nitrogen sources, enhancing soil quality in the process. One significant benefit of composting rock phosphate is the conversion of insoluble phosphorus forms into more usable forms through organic acids. Using phosphorus-rich organic fertilizer could be a more effective method of adding phosphorus to soil compared to sole application of using chemical phosphorus fertilizers. The movement of phosphorus from the fertilizer may depend on its chemical composition, as organic phosphorus tends to be more mobile than inorganic phosphorus. However, the type of phosphorus in the fertilizer might not be the single factor influencing its movement in soil. Another advantage of using phosphorus rich organic fertilizer is they supply phosphorus to subsequent crops as effectively as to the initial crop. Chemical phosphorus fertilizers are costly and cannot provide multiple nutrients to crops simultaneously

Materials and Methods

The field experiment was conducted during kharif season of 2023 at AICRP on Irrigation Water Management farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra (India). Before laying out the experiment, soil samples were collected from 0-20 cm depth of experimental plot to evaluate physical and chemical properties of soil. The soil texture of the experimental site was found to be clayey soil. The soil pH was moderately alkaline (8.31), normal in electrical conductivity (0.42 dSm^{-1}), medium in organic carbon (0.53%) and high in calcium carbonate (12.50% $CaCO_3$). The soil was low in available N (152 kg ha^{-1}), moderate in available P (16.51 kg ha^{-1}) and very high in available K(370 kg ha^{-1}) content. The micronutrient Fe and Zn were deficient however, Mn and Cu were sufficient.This area falls in the semi-arid tropics region with an annual rainfall ranging from 307 to 619 mm. The seeds of good quality of variety PhuleDurva (KDS- 992) was used for present investigation. Seed are treated with PSB and Rhizobium @ 25 g kg^{-1} given to all the treatments. Phosphate Rich Organic manure and FYM were applied as per treatments 10 days before sowing. Then seeds were dibbled manually with spacing of 45 cm x 5 cm. The inorganic nutrients were applied as per treatments in gross plot.

The experiment was conducted in

Randomized Block Design with three replications. The treatments comprised of T_1 : Absolute control, T_2 : GRDF (50:75:45 kg $N:P_2O_5:K_2O$ ha^{-1} + 10 t FYM ha^{-1}), T_3 : RDF (50:75:45 kg $N:P_2O_5:K_2O$ ha^{-1}), T_4 : RDP @ 100% through DAP , T_5 : RDP @ 25% through PROM +75% RDP through DAP , T_6 : RDP@ 50% through PROM + 50% RDP through DAP, T_7 : RDP @ 75% through PROM + 25% RDP through DAP, T_8 : RDP @ 100% through PROM. Recommended N and K @ 50 and 45 kg ha^{-1} respectively were applied to treatments T_4 to T_8 the by considering the compensation of N through DAP application.

Results and Discussion

Growth and Yield Attributing Characters : Data regarding to growth and yield contributing charactersof soybean *viz.*, plant height (cm), number of pods $plant^{-1}$, number of seeds pod^{-1}, Nodules count $plant^{-1}$, Total chlorophyll contentas influenced by different treatments are presented in Table 1. Amongst them number of seeds per pod were not influenced significantly.

Plant height : Impact of phosphate rich organic manure alone or in combination with different chemical fertilizers on plant height was found significant. However among all the treatments the maximum plant height (82.93 cm) was observed in treatment T_2 - GRDF (50:75:45 N, P_2O_5, K_2O kg ha^{-1}, FYM 10 t ha^{-1}) over all the treatments except treatment T_5 (RDP @ 25% P_2O_5 through PROM and 75% P_2O_5 through DAP) (82.80 cm) which was at par with treatment T_2. The minimum plant height (58.80 cm) was observed in treatment T_1 (Absolute control). The results from table1 showed that incorporating FYM along with chemical fertilizers led to a significant increase in plant height. Treatments T_2, T_5 and T_6 which involved organic manure applications, resulted in increase in plant height of 9.40%, 9.23% and 1.89% respectively, compared to the application of only recommended dose of fertilizer (RDF) in T_3. The enhanced plant height with organic manure treatments may be attributed to improved nutrient availability, better soil physical conditions, and potential stimulation of growth through phytohormones. It was indicated that phosphorus plays an essential role to improve the height of plants. However Phosphate rich organic manure helps to promote plant height. These results were supported by Noor *et al*. (2021). In same way Zafar *et al*. (2011) said that the combined use of phosphatic fertilizers and organic manures resulted in max. plant height.

Table 1. Growth and yield contributing characters of soybean as influenced by phosphate rich organic manure.

Treatments	Plant height (cm)	No. of pods $plant^{-1}$	No. of seeds pod^{-1}	Root nodules count $plant^{-1}$	Total chlorophyll (mg g^{-1})
T_1 - Absolute control	58.80	34.33	2.80	30.83	0.78
T_2 - GRDF (50:75:45 N, P_2O_5, K_2O kg ha^{-1} + FYM 10 t ha-1)	82.93	56.33	2.93	58.83	0.90
T_3 - RDF (50:75:45 N, P_2O_5, K_2O kg ha^{-1})	75.80	53.13	2.87	44.17	0.81
T_4 - RDP @100 % through DAP	72.89	48.87	2.93	39.17	0.81
T_5 - RDP @25% through PROM +75% RDP through DAP	82.80	55.87	2.93	54.83	0.88
T_6 - RDP @ 50% through PROM + 50% RDP through DAP	77.24	53.80	3.00	42.67	0.84
T_7 - RDP @ 75 % through PROM + 25% RDP through DAP	76.62	53.60	3.00	54.00	0.82
T_8 - RDP @ 100% through PROM	71.65	44.27	2.93	47.67	0.80
S.Em (±)	0.99	1.35	0.08	2.78	0.02
C. D. at 5%	3.00	4.10	NS	8.42	0.07

Number of pods plant^{-1} : Treatment T_2 (GRDF 50:75:45 N, P_2O_5, K_2O kg ha^{-1} + FYM 10 t ha^{-1}) exhibited the highest number of pods per plant (56.33), which was significant over all the treatments except T_5 by the application of (RDP @ 25% through PROM + 75% RDP through DAP), T_6 (RDP @ 50% P_2O_5 through PROM and 50% P_2O_5 through DAP), T_7 (RDP @ 75% through PROM + 25% RDP through DAP) and T_3 RDF (50:75:45 N, P_2O_5, and K_2O kg ha^{-1} which were at par with treatment T_2 having 55.87, 53.80, 53.60 and 53.13 pods per plant respectively. This improvement can be attributed to the provision of sufficient moisture and optimal temperatures facilitated by the addition of phosphate enriched organic manure. These amendments enhance the physical, chemical, and biological conditions of the soil, promoting increased total uptake of NPK nutrients. This, in turn, boosts plant metabolism and leads to an increase in pod formation. Similar results were also reported by Koireng *et al*. (2018) on green gram.

Nodules count plant^{-1} : Application of phosphate rich organic manure positively impacts soybean nodulation by enhancing nutrient availability, which improves root health and supports better rhizobium activity. Adequate phosphorus levels promote the development of an extensive root system and efficient symbiotic relationships, leading to increased nodule formation. Additionally, organic manure improves soil structure and water-holding capacity, further benefiting nodulation. However, it's important to balance phosphorus with other nutrients to avoid potential imbalances that could inhibit rhizobium growth. The results revealed that treatment T_2 GRDF (50:75:45 N, P_2O_5, K_2O kg ha^{-1} + FYM 10 t ha^{-1}) significantly recorded the highest number of nodules count per plant (58.83) which was followed by the treatment T_5, (54.83) i.e., RDP @ 25% through PROM + 75% RDP through DAPand treatment T_7 (54.00) (RDP @ 75% through PROM + 25% RDP through DAP) which were at par with treatment T_2. The lowestnodules count (30.83) was noted under absolute control treatment.

The increase in thenutrient pool and the positive role of organic manure on nutrientavailability to crop, which was influenced by better physical condition and might haveproduced phytohormones, which stimulates the growth and development of roots nodulesand better assimilation of nutrients. These results are in agreement with the findings ofDitta Allah *et al*. (2018).

Total chlorophyll content : The total chlorophyll content (mg g^{-1}) was significantly highest (0.90 mg g^{-1}) in treatment T_2 - (GRDF 50:75:45 N, P_2O_5, K_2O kg ha^{-1}, FYM 10 t ha^{-1}) which was at par with treatments T_5 - (RDP @ 25% P_2O_5 through PROM and 75% P_2O_5 through DAP (0.88 mg g^{-1}) and T6 (50% P_2O_5 through PROM and 50% P_2O_5 through DAP) (0.84 mg g^{-1}) Lowest chlorophyll content i.e. 0.78 mg g^{-1} was found in treatment T_1 (Absolute control).

Grain and stover yield : Grain and stover yield of soybean as influenced by phosphate rich organic manure are presented in Table 2. Phosphate enriched organic manure application realized spectacular improvements in grain and stoveryield of soybean. The significantly maximum grain yield (22.39 q ha^{-1}) was recorded in treatment T_2 - (GRDF 50:75:45 N, P_2O_5, K_2O kg ha^{-1}, FYM 10 t ha^{-1}) over all the treatments except treatment T_5 (25% P_2O_5 through PROM and 75% P_2O_5 through DAP) with yield of 22.17 q ha^{-1} was at par with treatment T_2. The lowest grain yield (13.42 q ha^{-1}) was observed in treatment T_1 (absolute control). Further treatments T_2 and T_5 recorded the 15.29% and 14.16% grain yield of soybean over T_3. Treatment T_6 (RDP @ 50% through PROM + 50% RDP through DAP), T_7 (RDP @

75% through PROM + 25% RDP through DAP) and T_3 (RDF (50:75:45 N, P_2O_5, K_2O kg ha^{-1}) showed yield of 19.89,19.80 and 19.42 q ha^{-1} respectively.

In respect of stover yield of soybean significantly highest yield (29.39 q ha^{-1}) was recorded in treatment T_2 - (GRDF 50:75:45 N, P_2O_5, K_2O kg ha^{-1}, FYM 10 t ha^{-1}) which was at par with treatment T5 (25 % P_2O_5 through PROM and 75% P_2O_5 through DAP) (29.26 q ha^{-1}). The lowest stover yield (17.72 q ha^{-1}) was observed in treatment T_1 i.e. absolute control. It was noticed that inclusion of biological phosphate rich organic manure significantly increased the stover yield of soybean when compared with only RDF (25.24 q ha^{-1}).

In present study, the result of significant 58% increase in yield of soybean over control due to addition of organic manure with phosphatic fertilizer confirmed with the earlier reports of Meena R. (2017) Khan *et al*. (2021) who reported that inclusion of phosphate enriched organic manure enhances favourablephysio-chemical condition, biological status which is responsible for availability of nutrients, root growth, direct impact on moisture retention and reduction in P fixation phenomenon, beneficial effects on soil microbial population which leads to the solubilization of nutrients. The C: N ratio of manure had the favourable effects on the process of mineralization of nutrients in soil and their effects in increasing yields of crops. The results are in line with Nishanthand Biswas (2007).

Soil Available Micronutrients Content after Harvest of Soybean : The data presented in Table 3 showed the soil available nutrients content at harvest of soybean as influenced by phosphate rich organic manure. With the application of different nutrients available potassium was not influenced significantly.

Available nitrogen : At harvest, the available nitrogen content in the soil was significantly higher (165.16 kg ha^{-1}) in treatment T_2 - which involved general recommended dose of fertilizer i.e. 50:75:45 N, P_2O_5, K_2O kg ha^{-1}, FYM 10 t ha^{-1}. This treatment was at par with treatments T_6 (155.75 kg ha^{-1}) i.e. 50% P_2O_5 through PROM and 50% P_2O_5 through DAP and T_7 (159.04 kg h^{-1}) i.e. RDP @ 75 % through PROM + 25% RDP through DAP. In contrast absolute control treatment showed lower nitrogen levels (140.07 kg ha^{-1}). The study found that using phosphate-rich organic manures, FYM in treatments T_2,

Table 2. Soybean yieldas influenced by phosphate rich organic manure

Treatments	Yield (q ha^{-1})	
	Grain	Straw
T_1 - Absolute control	13.42	17.72
T_2 - GRDF (50:75:45 N, P_2O_5, K_2O kg ha^{-1} + FYM 10 t ha^{-1})	22.39	29.39
T_3 - RDF (50:75:45 N, P_2O_5, K_2O kg ha^{-1})	19.42	25.24
T_4 - RDP @100 % through DAP	18.90	24.76
T_5 - RDP @25% through PROM +75% RDP through DAP	22.17	29.26
T_6 - RDP @ 50% through PROM + 50% RDP through DAP	19.89	26.05
T_7 - RDP @ 75 % through PROM + 25% RDP through DAP	19.80	25.94
T_8 - RDP @ 100% through PROM	17.08	22.38
S.Em (±)	0.11	0.14
C. D. at 5%	0.33	0.43

T_7, T_6 and T_8, increased the available nitrogen by 17.91%, 13.54%, 11.19% and 7.46% respectively, compared to the absolute treatment. The increased nitrogen availability is likely due to application of 100% RDF along with higher amount of organic manure and release of nitrogen from decomposed organic matter and the additional nitrogen from FYM and biological phosphate-rich organic manure. This finding aligns with observations made Meena (2017) and Billah *et al*. (2020).

Available phosphorus : The data indicated that applying fertilizer materials significantly increased the available phosphorus at all stages of crop growth compared to the control, likely due to the initially low phosphorus levels in the soil. Fertilizer treatments with chemical fertilizers showed better growth at the early stages because of its high water-soluble phosphorus content. However, enriched compost demonstrated a significantly greater increase in available phosphorus at later stages. Among all treatments, T_2 GRDF (50:75:45 N, P_2O_5, K_2O Kg ha^{-1}, FYM 10 t ha^{-1}) achieved the significantly highest phosphorus levels in the soil, which was at par with treatments T_8 (100% phosphorus from phosphate-rich organic manure and N and K_2O as per recommendation) and T_6 (50% P_2O_5 from PROM and 50% P_2O_5 from DAP). The use of phosphate-rich organic manure notably increased the available phosphorus (P) content in the soil compared to both the recommended dose of fertilizers (RDF) and the control group. Specifically, the available P content was higher by 11.87%, 22.80% and 23.24%, in treatments T_7, T_6 and T_8 respectively, compared to absolute control.

The same results are were obtained by Nishanth and Biswas (2007). The increased availability of P is likely due to the mineralization and decomposition of the organic materials, which may have enhanced the population of P-solubilizing microbes in the soil, reduced phosphorus fixation by soil components, and released various weak acids that improved the soil's phosphorus status. Moreover during decomposition of organic matter CO_2 is evolved and results in the formation of weak carbonic acid, which further dissolves P from RP, thus increasing the availability of P in the enriched compost. These findings are consistent with the studies of Biswas and Narayanasamy (2006).

Total Nutrient Uptake of Soybean : The data on nutrient uptake by soybean crop as influenced by PROM was incorporated in Table 4.

Table 3. Effect of phosphate rich organic manure on soil available macronutrients after harvest of soybean

Treatment	Soil available nutrients (kg ha^{-1})		
	N	P	K
T_1 - Absolute control	140.07	16.09	350.93
T_2 - GRDF (50:75:45 N, P_2O_5, K_2O Kg ha^{-1} + FYM 10 t ha^{-1})	165.16	19.92	380.80
T_3 - RDF (50:75:45 N, P_2O_5, K_2O Kg ha^{-1})	147.39	16.66	373.33
T_4 - RDP @100 % through DAP	140.07	18.17	399.47
T_5 - RDP @25% through PROM +75% RDP through DAP	148.43	17.60	395.73
T_6 - RDP @ 50% through PROM + 50% RDP through DAP	155.75	19.76	380.80
T_7 - RDP @ 75 % through PROM + 25% RDP through DAP	159.04	18.00	395.73
T_8 - RDP @ 100% through PROM	150.52	19.83	392.00
SEm (±)	3.81	0.49	19.28
CD at 5%	11.54	1.49	NS
Initial	152	16.51	370

Total nitrogen uptake : The application of phosphate enriched organic manure or ordinary compost and chemical fertilizers applied either alone or in combination significantly increased total N uptake of soybean. (Table 4) over the control, while lowest N uptake was observed under unfertilzed plot i.e. absolute control. Total nitrogen uptake by soybean was significantly higher (138.64 kg ha^{-1}) in treatment T_2 (GRDF 50:75:45 N, P_2O_5, K_2O Kg ha^{-1}, FYM 10 t ha^{-1}) over treatments T_1 and T_8. However rest of treatments were at par with T_2. The increase in nitrogen uptake by the soybean crop could be attributed to the higher availability of NPK in the soil. This greater nutrient availability led to an increase in root mass and plant biomass, positively impacting soybean yield and ultimately resulting in higher nitrogen uptake. Similar findings were reported by Khan *et al*. (2021) and Meena*et al*. (2021).

Total phosphorus uptake : Incorporation of FYM and phosphate enriched organic manure resulted (Table 4) in significantly higher total P uptake by soybean (22.20 kg ha $^{-1}$) in treatment T_2 i.e. GRDF 50:75:45 N, P_2O_5, K_2O Kg ha^{-1}, FYM 10 t ha^{-1} over treatment T_1, T_4 and T_8. However the rest of the treatments T_3 (RDF (50:75:45 N, P_2O_5, K_2O Kg ha^{-1}), T_5 (RDP @ 25% through PROM + 75% RDP through DAP), T_6 (RDP @ 50% through PROM + 50% RDP through DAP) and T_7 (RDP @ 75% through PROM + 25% RDP through DAPwere at par with T2. (With total P uptake of 18.15, 21.43, 20.20 and 19.83 kg ha^{-1} respectively.)

More availability of phosphorus is responsible for increase in photosynthesis activity of leguminous crop which may enhance the phosphorus uptake by soybean crop. Similar trend was noted by Sharif *et al*. (2013). Ramphisa *et al*. (2020) suggested that efficient phosphorus (P) utilization from organic wastes is crucial for alternative P sources to be adopted as fertilizers. There must be predictable plant responses in terms of P uptake and plant growth.

Total potassium uptake : Results in Table 4 showed that the significantly highest total uptake of potassium (55.31 kg ha^{-1}) was recorded in treatment T_5 (25% RDP from PROM and 75% RDP from DAP) over treatments T_1 and T_8. However rest of treatments T_2, T_3, T_4, T_6 and T_7 were at par with T5 with total K uptake of 55.05, 46.93, 46.08, 49.51 and 49.87 kg ha^{-1} respectively. The increase in potassium uptake can be linked to the application of organic matter, which improved the soil's physical, chemical, and

Table 4. Effect of phosphate rich organic manure on total nutrient uptake of soybean

Treatment	Total Nutrient uptake (kg ha^{-1})		
	N	P	K
T_1 - Absolute control	66.35	11.38	27.18
T_2 - GRDF (50:75:45 N, P_2O_5, K_2O Kg ha^{-1}, FYM 10 t ha^{-1})	138.64	22.20	55.05
T_3 - RDF (50:75:45 N, P_2O_5, K_2O Kg ha^{-1})	119.44	18.15	46.93
T_4 - RDP @100 % through DAP	117.00	17.47	46.08
T_5 - RDP @25% through PROM +75% RDP through DAP	137.11	21.43	55.31
T_6 - RDP @ 50% through PROM + 50% RDP through DAP	122.72	20.20	49.51
T_7 - RDP @ 75 % through PROM + 25% RDP through DAP	122.81	19.83	49.87
T_8 - RDP @ 100% through PROM	105.02	17.76	41.65
SEm (±)	7.70	1.12	2.09
CD at 5 %	23.36	3.42	6.33

biological properties. This led to higher concentrations of potassium in the soil solution and in the exchangeable potassium complex, facilitating potassium ion uptake by the plants. These findings are consistent with those reported by Singh and Singh (2012).

Conclusion

Based on the findings of above experiment it can be concluded that, the application of general recommended dose of fertilizer i.e., 50 kg N ha^{-1}, 75 kg P_2O_5 ha^{-1} (through SSP) and 45 kg K_2O ha^{-1} through chemical fertilizers + 10 t FYM ha^{-1} to soybean in calcareous soil was found beneficial for increase in yield contributing characters, yield of soybean, total nutrient uptake, nutrient availability in soil, soil microbial count and enzyme activities. It also improved phosphorus use efficiency. However, the treatment of 25% phosphorus and 50% phosphorus through PROM and remaining through diammonium phosphate were at par with aforesaid treatment. Application of PROM along with chemical fertilizers enhances the soil's properties and improves the phosphorus use efficiency. Which indicates that, we can substitute 25 to 50% phosphorus by using phosphate rich organic manure (PROM).

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