Indian Journal of Agricultural Sciences **93** (2): 214–216, February 2023/Short Communication
https://doi.org/10.56093/ijas.v93i2.119341

Phosphate Rich Organic Manure (PROM) – A novel organic fertilizer

PUSHPIKA UDAWAT[1]*

School of Agricultural Sciences, Dobok, Janardan, Rai Nagar Rajasthan Vidyapeeth (Deemed-to-be) University, Udaipur, Rajasthan 313 001, India

Received: 22 December 2021; Accepted: 16 January 2023

Keywords: Groundnut, Manure, Organic, Wheat

Phosphorous (P) is the second most essential plant nutrient after nitrogen (N) and is a constituent of several essential cellular macromolecules. It makes ~0.2% of plants dry weight. Phosphorous deficiency in plants leads to lesser amount of chlorophyll and premature death of leaves (Galatro *et al.* 2020). Globally, consumption of P fertilizer has increased from 4.6–21 million tonnes/year during 1961–2015 and significantly contributed in green revolution and food security (Mogollon *et al.* 2018). Rock phosphate is of two types, high grade (28–36% P_2O_5) and low grade (18–24% P_2O_5) (FCO 1985). Direct application of low grade rock phosphate of fine particle size to soil lowers its *p*H. High grade rock phosphate when homogenized with organic manure is very fine size. Due to this, plants are able to uptake phosphorus which is present either in water or citric acid soluble form (Basak 2019). A variety of microorganism present in soil organic matter release different type of organic acids such as citric acid and malic acid, which act upon water insoluble tricalcium phosphate to release water or citric acid (2%) soluble phosphorous into the soil (Moharana *et al.* 2018). Several researches have proven that phosphate rich organic manure (PROM) is a proficient means of applying P to soil in comparison to chemical based fertilizers. Moreover, PROM has a huge residual effect that it provides P source to the subsequent crop grown in the treated area as effectively as to the first crop (Kamal 2017).

Finely decomposed organic matter with Carbon to Nitrogen ratio of 20:1 (C:N) is an essential criteria for PROM production. As improperly decomposed organic matter fights with the crops for soil nutrients and leads to the growth of detrimental termites (Aechra *et al.* 2021). In India, significantly lower available P content is observed in soil thus leading to reduced fertility and yield. Microbes that decompose organic matter generate a diversity of beneficial molecules for example gibberlins, auxins, vitamins, fulvic and humic acids, which are important for the plant growth. Hence, chemical based fertilizers and minerals cannot substitute organic manure in crop production. Organic matter enriched with humic acid and other growth promoting molecules, improves soil fertility in multiple ways, viz. enhances soil structure, texture, aeration, and water holding capacity, etc.

A field experiment was conducted at School of Agricultural Sciences, Dobok, JRN University, Udaipur (24.6256°N, 73.8660°E), Rajasthan during 2019–2021 to study the outcome of phosphorous rich organic manure in groundnut and wheat during rainy (*kharif)* and winter (*rabi)* cropping season on clay loamy soil. The treatment consisted of C, Control; T_1, Optimal dose (OD) of NK + PROM @30 kg/ha; T_2, Optimal dose (OD) of NPK; T_3, OD of NK + PROM @60 kg/ha; T_4, OD of NK + PROM @90 kg/ha and; T_5, OD of NK + PROM @120 kg/ha.

Groundnut: Phosphorous (P) and Calcium (Ca) are the major nutrients limiting groundnut production. A huge quantity of P is needed for signalling pathways of energy transfer that occur during nodule formation in legume crops. Nodulating legumes including groundnut require more P as compared to non-nodulating crops like wheat, as it plays a significant role in nodule formation and N fixation from atmosphere (Nair 2002). Application of P to deficient soil leads to increased groundnut yield due to its significant role in physiological processes of plant. Reduced level of P leads to deficiency that ultimately causes shortened root length, meagre pod setting and lower pod productivity in groundnut.

Wheat: Phosphorous significantly influenced growth and yield in wheat and its early stages of crop required P for proper growth and good grain yield. Adequate amount of P enhances the root growth, seedling establishment and causes consistency at heading phase in wheat. Furthermore, it further enhances the water use efficiency (WUE) of plant that eventually enhances the quantity as well as quality of grain yield in wheat.

PROM production: The soil of experimental farm was clay loam to heavy loam (brown soil) with *p*H 6.4 and electrical conductivity of 3.4 dS/m in Udaipur, Rajasthan.

[1]Amity Institute of Biotechnology, Amity University Madhya Pradesh, Gwalior. *Corresponding author email: pushpikka333@gmail.com

The experiments were accompanied on plots with 20 m^2 block design with five replicates. Phosphorous was applied in the form of PROM, nitrogen in the form of urea, and potassium in the form of potassium chloride and lime in the form of calcium oxide. In an easy way, PROM is produced by mixing low grade rock phosphate (18–24% P_2O_5) in fine size (70–20 microns) with 2 kg of well decomposed organic matter and 0.6 kg of water. A total of 10 kg low grade rock phosphate was provided by Rajasthan State Mines and Minerals limited head office Udaipur (RSMML) to the School of Agricultural Sciences (SoAS), Udaipur, Rajasthan. The relative humidity (RH) was kept 70%, temperature at 60°C and oxygen (O_2) level was 10–18%. Earthworms were added to further improve the decomposition process at concentration of 2 kg/kg of organic manure or farm yard manure (FYM). The agricultural waste was intermittently mixed and then growth promoting microorganisms were added. After sporadic mixing of the decomposing waste on weekly basis, atmospheric nitrogen (N) fixing bacteria were added. The end product, i.e. PROM was analysed for *p*H, electrical conductivity, C:N ratio, moisture content, particle size, bulk density, etc. Other mineral elements present in PROM were also measured, i.e. arsenic, copper, nickel, zinc, lead, cadmium, etc. The PROM produced at the agriculture college farm (a constituent unit of Janardhan Rai Nagar Rajasthan Vidyapeeth) was applied to the field crops in a concentration ranging from 5–40.469 kg/ha.

Table 1 Effect of different concentration of PROM in addition to the optimum dose (OD) on yield of groundnut in comparison to the control

Treatment	Groundnut yield (900 kg/ha)				
	R_1	R_2	R_3	R_4	R_5
C	1.39	1.22	1.41	1.35	1.29
T_2	2.59	2.68	2.49	2.34	2.90
T_1	1.97	1.64	1.38	1.59	1.87
T_3	2.68	2.76	2.54	2.98	2.47
T_4	2.69	2.89	2.76	2.54	2.88
T_5	2.61	2.78	2.95	2.81	2.79
Mean	2.15	2.14	2.11	2.12	2.13

*R = Replicates 1–5. Refer to the methodology for treatment details.

Application of PROM at 3 kg/ha has notably improved the soil organic carbon (OC) content in comparison to the control. The highest available P (47.01 kg/ha) was observed in treatment (T_3, T_4, T_5) and it was at par with optimal dose (OD) of P (T_2). In the treatment T_1, lower PROM dose applied gave drastically poor yield as compared to the optimum dose, i.e. T_2. Besides, available P was found to be significantly higher in T_3, T_4 and T_5 in comparison to the control. This was due to more soluble phosphorous accessibility near rhizosphere of plant roots. The amount of P released from PROM did not undergo soil fixation, which might be due to phosphate solubilising bacteria (PSB) in near root zone area. This is owing to organic acids released by finely decomposed manure which has critical effect on soil structure, texture and its micro-biome.

Organic manure upon complete decomposition generates organic acids which form firm complex with Fe and Al thus averts the phenomenon of soil P fixation. After harvesting of all crops of different treatments and replicates, they were analysed for P content and have shown high potash content as compared to the control (C). Higher biomass in different farm treatments (T_3 to T_5) has revealed momentous correlation with water and organic acid soluble P. The effect of different concentration of PROM in addition to optimum dose (OD) on groundnut and wheat crops has been shown in Table 1 and 2 respectively. The residual effect of higher levels of PROM after appliance to previous crop (groundnut) extensively augmented the total N, P, and K uptake by wheat crop over control. Effect of PROM on spike length, grain number per earhead, grain yield (kg/ha) and straw yield (kg/ha) of wheat was analysed and given in Table 2. PROM has significant effect on different parameters under consideration. As observed, significant higher spike length of 8.5 cm and more was recorded from treatment T_3 to T_5 over control. Overall numbers of tillers per metre row length and their effective numbers were observed

Table 2 Effect of different concentration of PROM in addition to the optimum dose (OD) on the growth and yield parameters of wheat in comparison to control

Treatment	Wheat yield (kg/ha)		Grains/ Earhead	No. of total tillers/ meter row length	No. of effective tillers/ meter row length	Length of spike (CM)
	Grain	Straw				
C	2741	5419	39.33	70.05	55.70	5.13
T_2	3941	5419	42.45	75.59	59.94	8.65
T_1	2959	4237	40.91	73.21	57.33	6.96
T_3	3933	5921	43.99	78.82	64.76	8.74
T_4	4212	6135	44.97	79.45	65.29	8.38
T_5	4569	6579	45.05	80.76	68.91	8.36
Mean	234	287	1.92	4.13	3.09	0.40
CD (P=0.05)	621	693	5.67	9.12	8.89	0.91
CV	9.03	7.00	7.53	8.11	8.03	6.98

Refer to the methodology for treatment details.

notably maximum in treatments T_3 to T_5. Additionally, extensively maximum grain numbers were observed in T_3, T_4 and T_5 over control. This is owing to enhanced nutritional environment for wheat under treatment with PROM, which has simultaneously improved the solubility and availability of P to the plant roots. However, lower yield, tiller number and spike length was observed in treatment 1 (T_1) and control experimental field. Increase in soluble P availability in the root zone, leads to higher assimilation rate and then elevated growth, cellular development, thus leading to enhanced yield and productivity.

SUMMARY

A field experiment was conducted at School of Agricultural Sciences, Udaipur, during 2019–2021 to study the outcome of phosphorous rich organic manure in groundnut and wheat during rainy (*kharif)* and winter (*rabi)* cropping season on clay loamy soil. Four concentrations of phosphorous rich organic manure, viz. 1, 2 (optimal dose), 3, 4, and 5 kg/ha in addition to the optimum dose of nitrogen and potassium were applied in five replicates. Phosphorous rich organic manure treated and control field (without fertilizer) were considered for comparative study. Appreciably higher yield was observed for groundnut under treatment 3, 4, and 5 over control in all the five replicates. The residual effect of phosphorous rich organic manure was observed in the subsequent wheat crop, as evident with higher phosphorous uptake in comparison to the control field. All the phosphorous rich organic manure treated fields produced noticeably higher grain, tiller number, spike length and straw yield of wheat in comparison to the control field. Therefore, phosphorous rich organic manure has been a proven alternative source of organic phosphorous fertilizer in comparison to other chemical based fertilizers that has several harmful effects on soil, environment, and water resources and also to the plant itself. Hence, time has come to replace chemical based phosphorous fertilizers with organic phosphorous fertilizer which is eco-friendly with low cost fertilization and having residual effect on the subsequent crops as well.

REFERENCES

Aechra S, Yadav B L, Doodhwal K, Bhinda R and Jat L. 2021. Yield and total nutrient uptake influenced by soil salinity, phosphorus sources and biofertilizers in cowpea (*Vigna unguiculata* L.). *Journal of Experimental Agriculture International* **14**: 56–63.

Basak B B. 2019. Phosphorus release by low molecular weight organic acids from low-grade Indian rock phosphate. *Waste and Biomass Valorization* **10**(11): 3225–33.

Fertilizer Control Order (FCO). 1985. As amended up to April 2015. Department of Fertiliser, Ministry of Chemicals and Fertilizers, Government of India.

Galatro A, Ramos-Artuso F, Luquet M, Buet A and Simontacchi M. 2020. An update on nitric oxide production and role under phosphorus scarcity in plants. *Frontiers in Plant Science* **15**(11): 413.

Kamal R. 2017. Phosphate Rich Organic Manure (PROM): An emerging Biofertiliser. *Biotecharticle.com* **1**.

Mogollon J M, Beusen A H W, Van Grinsven H J M, Westhoek H and Bouwman A F. 2018. Future agricultural phosphorus demand according to the shared socioeconomic pathways. *Global Environment Change* **50**: 149–63.

Moharana P C, Meena M D and Biswas D R. 2018. Role of phosphate-solubilizing microbes in the enhancement of fertilizer value of rock phosphate through composting technology. *Role of Rhizospheric Microbes in Soil, Nutrient management and Crop Improvement*, Vol. 2, pp. 167–202. Meena V (Eds), Springer, Singapore.

Nair P K R. 2002. The nature and properties of soils. *Agroforestry Systems,* 13th edn, Vol. 54, p. 249. N C Brady and R R Weil (Eds), Kluwer Academic Publishers, Netherlands.