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Effect of Conjunctive Application of Rock Phosphate, Pyrites and Farm Yard Manure on Physical Properties of Alfisols and Yield of Wheat (*Triticum aestivum* L.)

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Abstract: A field experiment was conducted during 1995-96 *rabi* season on Agronomy Farm, Rajasthan College of Agriculture, Udaipur to find out the most effective combination of composted rock phosphate pyrite for improving the physical properties of soil and wheat yield. Results indicated that increase in acidulation of rock phosphate with pyrite as well as FYM improved the soil physical condition and increased grain and straw yield of wheat. The application of rock phosphate pyrite in the proportion of 1:3 was proved best for its effectiveness on water stable aggregates >0.25 mm (40.64%), WHC (56.23%) and saturated hydraulic conductivity (2.21 cm h^{-1}), as well as on physico-chemical properties and grain and straw yield of wheat. The treatment RP + pyrite in the proportion of 1:3, composted with FYM also gave highest net return (Rs. 30140.50 ha^{-1}). The highest benefit: cost ratio was observed under treatment RP + pyrite in the proportion of 1:3 without FYM.

Key words: Rock phosphate, pyrite. FYM, alfisols, physical properties, yield, wheat.

India is endowed with huge reserves of both rock phosphate and pyrite, but due to the poor quality, both are not economical for industrial uses. Therefore, it is highly desirable to explore the possibility of utilizing the minerals for direct application, or with some transformation, to improve crop yield on neutral and alkaline soils. The conjunctive application of rock phosphate, pyrite and farm yard manures (FYM) is known to significantly improve the physical properties of soil and phosphate solubilization by the dissolving action of carbon dioxide which is liberated during the decomposition of organic matter. Significant improvement in soil structural index, hydraulic conductivity, soil porosity and water holding capacity of the soil, with increasing dose of organic matter and phosphorus have been reported (Ladha *et al*., 1984). FYM with rock phosphate resulted in better growth and yield of wheat crop (Minhas and Tripathi, 1986). The present investigation is an attempt to explore the possibilities of using locally available organic and inorganic acidulating materials for increasing the availability of phosphorus from low grade rock phosphate and improving the soil fertility.

A field experiment was conducted on clay loam soil during 1995-96 in *rabi* season at agronomy farm, Rajasthan College of Agriculture, Udaipur. Studies were carried out in a factorial randomized block design comprising 12 treatment combinations (Table 1) with 3 replications and having plot

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Table 1. Relative economics of the treatments

Treatments	Net return (Rs. ha^{-1})	B:C ratio
Control (R_0F_0)	11924.00	1.91:1
FYM (10 t ha^{-1}) - R_0F^1	13719.00	1.57:1
Rock phosphate alone (60 kg P_2O_5 ha^{-1}) - R_1F_0	15315.60	2.35:1
Rock phosphate (60 kg P_2O_5 ha^{-1}) + FYM (10 t ha^{-1}) - R_1F_1	17374.60	1.93:1
Rock phosphate + Pyrite (1:05) - R_2F_0	18394.70	2.78:1
Rock phosphate + Pyrite (1:05) + FYM (10 t ha^{-1}) - R_2F_1	21153.70	2.32:1
Rock phosphate + Pyrite (1:1) - R_3F_0	21584.25	3.21:1
Rock phosphate + Pyrite (1:1) + FYM (10 t ha^{-1}) - R_3F_1	24312.75	2.64:1
Rock phosphate + Pyrite (1:2) - R_4F_0	24443.90	3.53:1
Rock phosphate + Pyrite (1:2) + FYM (10 t ha^{-1}) - R_4F_1	27502.40	2.92:1
Rock phosphate + Pyrite (1:3) - R_5F_0	27413.50	3.85:1
Rock phosphate + Pyrite (1:3) + FYM (10 t ha^{-1}) - R_5F_1	30143.50	3.13:1

size of 5.0 x 2.5 m. The soil of the experiment site had pH 8.2, EC 0.82 dS m^{-1}, organic carbon 0.66%, available N, P_2O_5 and K_2O 255.50, 18.5 and 68.6 kg ha^{-1}, respectively. Bulk density and particle density of the experimental site was 1.45 Mg m^{-3} and 2.64 Mg m^{-3}, respectively.

Before the sowing of wheat crop, P-enriched compost was prepared by digging the pits near the site of experiment. These pits were lined with polythene sheets. Required quantities of material as per treatment combinations were mixed, moistened and filled in separate polythene bags. The bags were placed in pits, covered with soil and left for composting upto a period of one month. When the field was prepared, the composted material was applied in desired amounts to all the required plots of each replication and then mixed within top 22.5 cm layer of soil by spade.

The seed and straw yields were recorded at harvest; the undisturbed soil samples from each plot were drawn with the help of core sampler from 0 to 15 cm depth at harvest and analyzed for physical (water stable aggregates and water holding capacity) and chemical (organic carbon and available N, P_2O_5 and K_2O) properties using standard procedures. The plant samples collected at harvest were ground and digested in 2:1 mixture of HNO_3 and $HClO_4$. The nitrogen in digested samples was estimated by colorimetric method (Snell and Snell, 1939), phosphorus was determined by Vanadomolybdate yellow color method (Jackson, 1973) and potassium by flame-photometric method.

The physical properties of the soil were altered significantly with the application of different treatments of acidulation and FYM (Table 2). The water stable aggregates (WSA 0.25 mm), water holding capacity (WHC) and saturated hydraulic conductivity (HC) of soil were maximum under the treatment of acidulation of RP with Pyrite in the proportion of 1:3. Similarly, incorporation of the FYM also increased the WSA, WHC and HC significantly over no FYM application. The increase in these

Table 2. Effect of RP-Pyrite and FYM on physical and chemical properties of soil and yield of wheat

Treatment	WSA >0.25 mm (%)	WHC (%)	HC (cm h^{-1})	Organic carbon (%)	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
RP-Pyrite									
R_0	26.03	35.53	1.45	0.562	224.56	15.26	189.83	35.2	54.3
R_1	29.03	40.02	1.63	0.625	244.56	18.06	206.71	42.1	61.0
R_2	31.98	44.33	1.79	0.686	264.56	20.46	223.55	48.5	67.5
R_3	34.89	48.57	1.94	0.745	284.56	22.65	240.37	54.5	73.6
R_4	37.77	51.98	2.08	0.803	304.55	24.75	257.17	60.3	79.7
R_5	40.64	56.23	2.21	0.860	324.55	26.80	273.97	65.7	85.8
CD (P=0.05)	2.85	4.18	0.14	0.057	19.99	2.04	16.80	5.5	6.1
FYM									
F_0	29.00	42.54	1.63	0.668	259.23	19.77	217.84	46.9	61.5
F_1	37.78	49.68	2.07	0.759	289.88	22.89	246.03	55.2	79.1
CD (P=0.05)	1.64	2.41	0.08	0.033	11.54	1.18	9.70	3.2	3.5

properties with acidulation of RP + Pyrite and FYM application indicated the improvement in water permeability of the soil as compared to control, which could be due to increase in degree of aggregation with increasing organic carbon content of the soil (More, 1994) and solubilization of Ca by root exudates (Tomar *et al.*, 1987). Laddha and Totawat (1998) have also reported that incorporation of FYM @ 10 t ha^{-1} increased the WHC and saturated hydraulic conductivity of the soil over no FYM application.

Application of acidulated RP with pyrite, as well as FYM, also significantly improved the organic carbon and available N, P_2O_5 and K_2O contents of the soil. The maximum improvement was with acidulated RP+Pyrite (1:3) and FYM @ 10 t ha^{-1}. Increase in availability of soil phosphorus with increase in acidulation of rock phosphate could be due to enhanced use efficiency of applied P, as well as soil P, due to decrease in soil pH by application of increasing dose of iron pyrite which might have released calcium bound P (Pannamperuma, 1972). The favourable effect of FYM in improving these soil parameters might have helped in the mineralization of soil nitrogen, leading to build-up of available N. It was an outcome of increased root proliferation and microbial activity, which in turn released the organic acids, lowering the pH of the soil (Maurya and Ghosh, 1972) and releasing the native phosphorus and potassium from the soil. There was also reduction in fixation of applied phosphorus through chelation of Ca^{2+} (Khaini and More, 1984; Reddy and Reddy, 1998).

The grain and straw yields of wheat were influenced significantly due to application of acidulated RP + Pyrite and FYM (Table 2). The highest grain yield (65.7 q ha^{-1}) and straw yield (85.8 q ha^{-1})

were recorded in the treatment of acidulation of RP with pyrite in the proportion of 1:3. This was followed by acidulation of RP with pyrite in the proportion of 1:2 and the least was with control. Similarly, incorporation of FYM @ 10 t ha^{-1} resulted in significant increase in grain and straw yields with a corresponding value of 55.2 and 79.2 q ha^{-1}, compared to 46.9 and 61.5 q ha^{-1} under control, respectively. The spectacular increase in grain and straw yields is attributed mainly to the solubilizing effect of iron pyrite and FYM on rock phosphate and release of essential plant nutrients from decomposition of organic manures (Subehia and Minhas, 1993). The higher concentration of N, P and K in plant due to these treatments justify the results of present study. The treatment of acidulation of RP with pyrite (1:3) and FYM @ 10 t ha^{-1} produced higher values of N (2.76 and 2.63%), P (0.483 and 0.47%) and K (2.47 and 2.52%), which may be attributed to higher availability of macro-nutrients in soil on account of application of acidulated rock phosphate (Subehia and Minhas, 1993) and FYM (Dahiya *et al*., 1987).

Studies on the economic feasibility of different treatments revealed that the treatment combination of acidulation of rock phosphate with pyrite (1:3) along with FYM @ 10 t ha^{-1} (R_5F_1) gave maximum net return (Rs. 30,143.50 ha^{-1}), whereas treatment combination of acidulation of RP with pyrite without FYM (R_5F_0) gave maximum benefit:cost ratio (3.85:1). The lowest net return (Rs. 11,924.00 ha^{-1}) was from control (R_0F_0) and the lowest benefit cost ratio (1.57:1) was from application of FYM @ 10 t ha^{-1} alone (R_0F_1).

It is concluded that acidulation of rock phosphate with pyrite, in the proportion of 1:3, when composting with FYM (10 t ha^{-1}), gave maximum yields of wheat and net return. Thus, it is the most economic feasible combination for growing wheat in alfisols.

References

Dahiya, S.S., Goel, S., Antil, R.S. and Karwasara, S.P.S. 1987. Effect of farm yard manure and cadmium on the dry matter yield and nutrient uptake by maize. *Journal of Indian Society of Soil Science* 35: 460-464.

Jackson, M.L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Private Ltd., New Delhi.

Khaini, K.N. and More, D.A. 1984. Long term effect of tillage operations and farmyard manure applications on soil properties and crop yield in vertisol. *Journal of Indian Society of Soil Science* 32: 392-393.

Laddha, K.C., Lavti, D.L. and Somani, L.L. 1984. Effect of organic matter addition and phosphate fertilization on physical properties of a sandy loam soil and yield of soyabean. *Transaction of Indian Society of Desert Technology* 9: 61-62.

Laddha, K.C. and Totawat, K.L. 1998. Interactive effect of tillage and phosphate fertilization in conjunction with FYM to sorghum + green gram intercropping system on physico-chemical properties of the soil. *Annals of Arid Zone* 37: 75-81.

Maurya, P.R. and Ghosh, A.B. 1972. Effect of longer term manuring and rotational cropping on fertility status of alluvial calcareous soil. *Journal of Indian Society of Soil Science* 20: 31-43.

Minhas, R.S. and Tripathi, D. 1986. Phosphorus nutrition of wheat through super phosphate and Mussoorie rock phosphate in acid soils of Himachal Pradesh. In *Rock Phosphate in Agriculture*, pp. 42-50. Tamil Nadu Agricultural University, Coimbatore.

More, S.D. 1994. Effect of farm wastes and organic manures on soil properties, nutrient availability and yield of rice-wheat grown on sodic vertisol. *Journal of Indian Society of Soil Science* 42: 253-256.

Pannamperuma, I. 1972. The chemistry of submerged soils. *Advances in Agronomy* 14: 29-96.

Reddy, G.B. and Reddy, S.M. 1998. Effect of organic manures and nitrogen levels on soil available nutrient status in maize - soyabean cropping system. *Journal of Indian Society of Soil Science* 46: 474-476.

Snell, F.D. and Snell, C.T. 1939. *Colorimetric Methods of Analysis*. Third Edition, van Nostrand Inc., New York.

Subehia, S.K. and Minhas, R.S. 1993. Phosphorus availability from URP as influenced by different organic amendments. *Journal of Indian Society of Soil Science* 41: 96-99.

Tomar, N.K., Sharma, N.K. and Gupta, P.P. 1987. Effect of pre-incubated phosphates, manures and pyrites on the phosphorus transformation in a sodic soil. *Journal of Indian Society of Soil Science* 35: 432-440.