

Low-grade Rock Phosphate with Zeolite can be a Valuable P Fertilizer for Crops

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ABSTRACT

In India, most of the indigenous deposits of rock phosphate are low grade. While high-grade quality rock phosphate is used to produce phosphatic fertilizers which are found to be costly. If the low-grade indigenous deposits of rock phosphate are utilized at full extent, it can reduce the cost of P fertilizers and also meet the crop P demand however, technologies by which P from indigenous low grade rock phosphate can be solubilized and utilized as a source of P fertilizer are required that are feasible to be adopted by farmers. They include composting with farm manure, green manuring, partial acidulation of rock phosphate, use of phosphorus solubilizing organisms, etc. Recent technology is the use of naturally occurring zeolites.

INTRODUCTION

Phosphorus (P) is major essential nutrient after nitrogen which is indispensable for crop production. It is the 11th most abundant element in the earth's crust. However, its availability is very limited to plants. Only 1/10th of the total P in the soil is available for plant uptake due to several

factors leading to its fixation thereby hindering its availability. About 49.3 % districts in India are reported to have low available P content based on 9.6 million soil test values (Hasan, 1996). Thus, there is a need to maintain soil P fertility and sustain crop productivity. Rock phosphate is a raw material in producing P

soluble fertilizers which is non-renewable and lasts for only 50-400 years. Moreover, only high-grade RP is only used in producing P soluble fertilizers while low grade rock phosphate is left unutilised. Increased prices of RP as well as diammonium phosphate (DAP) (Fig 1) is a big problem in India. According to the recent statistics of FAI, DAP costs Rs 1,350 per 50 kg bag. Therefore, government is welcoming strategies that utilise alternative sources of P-fertilizers such as low-grade RP. About 260 million tonnes (Mt) of rock phosphate (RP) deposits are available in India (Pathak et al., 2017). Most reserves are found in Madhya Pradesh, Jharkhand and West Bengal (mainly from Purulia) and Udaipur (Rajasthan). The low-grade P can be directly used to meet P demand in acid soil and it fails to supply P in normal and alkaline soils due to poor solubility and release rate.

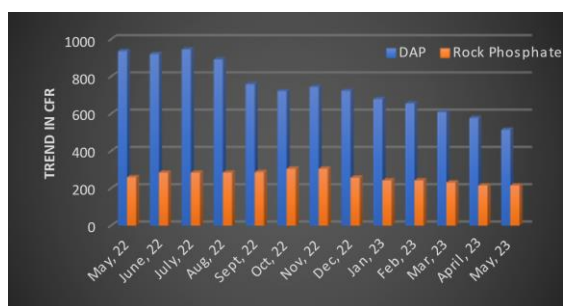


Fig:1 Trend in international price of DAP and RP (Source: <https://fertiliserindia.com/>)

Enhancing P availability from rock phosphate

There are different technologies to improve P availability from RP (fig 2). However, recent technology which is cheaper and environmentally friendly is use of zeolite to enhance the RP solubility. Zeolites are naturally occurring crystalline, hydrated aluminosilicates and alkaline earth cations. They possess three-dimensional crystal structures with voids and channel that represent a honey comb structure that possess high cation exchange capacity (nearly ten times higher than soil); large amount of free

water storage in the structural channels; and high rate of adsorption (with surface area of about 1150.5 m² /g). Zeolites have been classified based on their morphological features, crystalline structure, chemical composition, effective pore diameter, natural occurrence, and other criteria. However, the Si/Al ratio is considered as important characteristic of zeolites which is inversely proportional to the cation content. The charge imbalance resulting from the presence of Al³⁺ in the zeolite structure determines the ion exchange characteristics. The high affinity of zeolite for cations is taken advantage in the preparation of slow-release chemical fertilizers to enhance the fertilizer use efficiency.

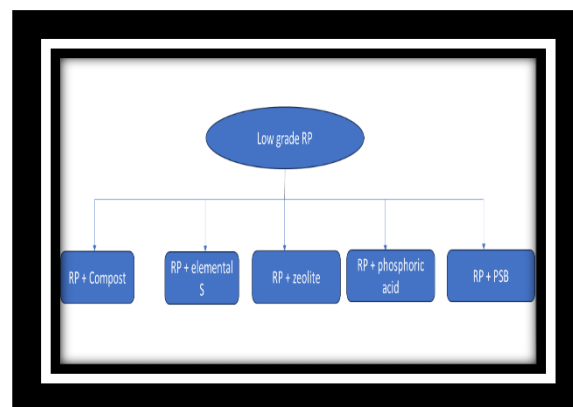
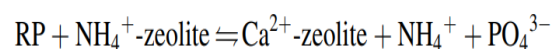


Fig:2 Different technologies that improve P solubility and availability from RP

Teles *et al* (2020) found that with 50% acidification + zeolite addition increased diffusion in Bayovar rock phosphate (BRP) and Morocco rock phosphate (MRP). Also, RAE >74% and percolated P was more pronounced due acidification and zeolite addition. The exchange-induced dissolution model of P release proposed (Allen *et al.*, 1993) can be summarised for a NH₄-saturated zeolite as:



Ca²⁺, K⁺ and NH₄⁺-saturated forms at ratios of 3.5:1 and 7:1 with RP could improve P availability from RP and also P uptake in Sunflower (Pickering *et al.*, 2002). Similar

study was carried at CRIDA, Hyderabad with mordenite zeolite and found increase in soil available P in Alfisols (Girijaveni *et al.*, 2023). However, this type of experiment needs to be evaluated for long term.

CONCLUSION

Zeolite is naturally occurring alumino-silicate mineral that can be best utilized with low grade rock phosphate. Zeolite with rock phosphate undergoes chemical reaction that makes the P available which can be utilised by plants.

REFERENCE

- Girijaveni, V., Sammi Reddy, K., Srinivas, K., Manjunath, M., Sumanta Kundu, and Singh, V.K. (2023) An Incubation study with zeolite and rock phosphate on P availability in rainfed Alfisols. In: 87th Annual Convention on National Seminar on Developments in Soil science: 2023, 03–06 October 2023, ICAR-IISS, Bhopal
- Hasan R (1996) Phosphorus status of soils in India. *Better Crops Int* 10:4–5
- Pathak, H., Purakayastha, T.J., Barkataky, S., Yadav, R.K. and Pande, P. (2017). Management of Phosphorus for Sustainable Crop Productivity and Environmental Quality. *Indian Journal of Fertilisers*, 13(7), pp.14-23.
- Pickering, H.W., Menzies, N.W. and Hunter, M.N. (2002) Zeolite/rock phosphate—a novel slow-release phosphorus fertiliser for potted plant production. *Scientia Horticulturae*, 94(3-4), pp.333-343.
- Teles, A.P.B., Rodrigues, M. and Pavinato, P.S., 2020. Solubility and efficiency of rock phosphate fertilizers partially acidulated with zeolite and pillared clay as additives. *Agronomy*, 10(7), p.918.
- Allen, E.R., Hossner, L.R., Ming, D.W. and Henninger, D.L. (1993) Solubility and cation exchange in phosphate rock and saturated clinoptilolite mixtures. *Soil Science Society of America Journal*, 57(5), pp.1368-1374.