

Phosphate Rock

Phosphorus (P) additions are needed in most areas of the world to improve soil fertility and crop production. Direct application of unprocessed phosphate rock (PR) to soil may provide a valuable source of plant nutrients in specific conditions, but there are several factors and limitations to consider.

Production

Phosphate rock is obtained from geologic deposits located around the world. Apatite, a calcium phosphate mineral, is the primary constituent of PR. It is primarily extracted from sedimentary marine deposits, with a small amount obtained from igneous sources. Most PR is recovered through surface mining, although some is extracted from underground mines.

The ore is first screened and some of the impurities removed near the mine site. Most PR is used to produce soluble phosphate (P) fertilizers, but some is used for direct application to soil. While PR can be a valuable source of P for plants, it is not always appropriate for direct application. Its suitability depends partly on naturally occurring mineral impurities, such as clay, carbonate, iron, and aluminum (Al). The effectiveness of PR for direct application is estimated in the laboratory by dissolving rock in a solution containing a dilute acid to simulate soil conditions. Sources classified as “highly reactive” are the most suitable for direct soil application.

Direct use of PR avoids the extra processing associated with converting apatite to a soluble form. The minimal processing may result in a lower-cost nutrient source and make it acceptable for organic crop production systems.



Agricultural Use

When a water-soluble P fertilizer is added to soil, it quickly dissolves and reacts to form low solubility compounds. When PR is added to soil, it slowly dissolves to gradually release nutrients, but the rate of dissolution may be too slow to support healthy plant growth in some soils. To optimize the effectiveness of PR, these factors should be considered:

- **Soil pH:** PR requires acid soil conditions to be an effective nutrient source. Use of PR is not usually recommended when the soil pH exceeds 5.5. Adding lime to raise soil pH and decrease Al toxicity may slow PR dissolution.
- **Soil P-fixing capacity:** The dissolution of PR increases with a greater P-fixing capacity of soil (such as high clay content).
- **Soil properties:** Low calcium and high organic matter in the soil tend to speed PR dissolution.
- **Placement:** Broadcasting PR and incorporation with tillage speeds the reaction with the soil.
- **Species:** Some plant species can better utilize PR due to their excretion of organic acids from the roots into the surrounding soil.
- **Timing:** The time required for the dissolution of PR necessitates its application in advance of the plant demand.

Management Practices

Not all sources of unprocessed PR are suitable for direct application to soil. Additionally, many soils are not suitable for PR use. The total P content of a material is not a good predictor of the potential reactivity in the soil. For example, many igneous PR sources are high in total P, but are of low reactivity and provide minimal plant nutrition because they dissolve so slowly. However, mycorrhizal fungi may aid in the acquisition of P from low-solubility materials in some environments.

Over 90% of PR is converted into soluble P fertilizer through reaction with acid. This is similar to the chemical reaction that PR undergoes when it reacts with soil acidity. The agronomic and economic effectiveness of PR can be equivalent to water-soluble P fertilizers in some circumstances, but the specific conditions should be considered when making this choice.

