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ROCK PHOSPHATE FERTILIZERS WITH SPECIAL REFERENCE TO EPPAWALA

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The nutrient phosphorus

Life in any form cannot exist without phosphorus. Its function cannot be performed by any other nutrient. No plant can produce a normal growth or give a good yield if it suffers from P deficiency. No soil can sustain high yields if it is deficient in P and this deficiency is not corrected. Phosphorus is a fascinating plant nutrient. It is involved in a wide range of plant processes and needed most by young, fast growing tissues and performs a number of functions related to growth, development, photosynthesis and utilization of carbohydrate. P makes up about 0.12% of the earth's crust. It is present in all soils and rocks, in water, and in plant and animal remains; and it forms complex compounds with a wide variety of elements. About 150 minerals are known that they contain at least 0.44% P (1% P_2O_5). The worlds supply of P comes from mineral deposits, a nonrenewable natural resource. The phosphate of almost all mineral deposits is one of the minerals of the apatite group.

Rock Phosphates

Many soils in tropical and subtropical regions are phosphate deficient, which severely limits their potential for crop production. The deficiency can be corrected by application of phosphatic fertilizers. But, for developing countries cheaper alternatives have always been considered and therefore direct application of rock phosphates to soils as a source of fertilizer P is a popular practice with varying degrees of success.

In the mining industry, the term phosphate rock or simply, rock is used in two senses. If an apatite - bearing rock is high enough in P content to be used directly to make fertilizer or elemental P, it is called phosphate rock. The term is also used to designate a beneficiated apatite concentrate phosphate. Phosphate rock is therefore a trade name that covers a wide variety of rock types with different textures and mineral compositions.

Phosphate bearing minerals occur in all geological settings; sedimentary, metamorphic and igneous deposits. Deposits from all three classes are mined and beneficiated to obtain phosphate rock fertilizers. Economically, the sedimentary deposits are the most important of the three, with nearly 85% of the phosphate rock mined world wide coming from such deposits. The physical and chemical characteristics of igneous and metamorphic rock render them quite unreactive and nearly inert for direct application. The igneous rocks are acidulated for manufacturing superphosphates since they have higher P contents, white the sedimentary rocks are used for direct application.

Phosphate rocks are also classified according to their mineralogical compositions into three types. In the order of increasing economic importance they are; Fe-Al Phosphates, Ca-Fe-Al phosphates and Ca- phosphates. The most common and economically significant deposits of the first class are found in Senegal. Liberia, Brazil and Utah. The deposits of the second class are found in Florida and Christmas Island. The third class which is known as the most economical mineral phosphates are found in the extensive deposits in Togo, Morocco, Algeria, Tunisia, Australia and United States.

Eppawala rock phosphate deposit

The apatite reserve at Eppawala in Sri Lanka is a large deposit with and estimated phosphate materials of more than 60 million tones. The rock phosphate deposit is exposed in the form of six hills rising to a maximum elevation of about 200 meters from mean sea level and covering a surface area of almost 150 ha. The average thickness of this zone is about 75 m from the crest of the hill. In the Eppawala phosphate deposit, several compositional zones based on colour, texture, structure and phosphate minerals were identified. Laboratory analyzes suggest variable P2O5 composition ranging from 12-42%.

Mining operations at Eppawala and different P fertilizers

During the current mining operations at Eppawala, small charges of explosives are used and the phosphate material is not differentiated and selected on any scientific and systematic basis although a wide range of P_2O_5 variations has been observed. As a result phosphate materials of different compositions are mixed and final product contains high amount of iron and aluminium as impurities. This finely ground phosphate is then used as a source of P in fertilizer mixtures for long term crops i.e. Tea, Rubber and Coconut. The final product marketed as a fertilizer (Commercially available Eppawala rock phosphate - CERP) consists of at least 30% P_2O_5 which is guaranteed by the Lanka Phosphate Limited.

According to the information available at Eppawala, a phosphate high fertilizer around 35-38% P_2O_5 (HERP), also manufactured by minimizing the soil and clay particles already mixed with apatite particles. But, production of phosphate fertilizer in this nature at Eppawala is limited mainly due to the high cost of production involved than in making 30% P_2O_5. Therefore, priority is given in operational processes to make phosphate fertilizer with 30% P_2O_5 to reach the annual production of 35,000 metric tones using semi-modern machinery.

In addition, primary apatite crystals which are relatively unweathered and fresh are distributed in the deposit at different sizes and they can be handpicked. These primary apatite crystals are reported to be rich in phosphate around 35 to 42% and very low in combined iron and aluminium content. Selectively mined and finely ground these apatite crystals (SERP) are reported be superior for annual crops than randomly mined, finely ground Eppawala rock phosphate.

Although, the direct use of phosphate rock as a fertilizer is not a new concept sometimes their usage is limited due to low solubility of different rock P fertilizers. It is reported that the solubility of ERP is very low and hence the agronomic effectiveness is highly affected especially with short term crops. This is one of the main concern of some scientists in Sri Lanka and therefore attempts were made to increase the solubility of Eppawala using different techniques. Mixing with acidic compounds gained high interest in this respect. As this is a costly process, acidulation is done partially with inorganic acids such as sulphuric and the product (PAERP) is still under investigation as a source of P for rice.

Important characteristics of different P fertilizers from Eppawala

Selectively mined Eppawala rock phosphate is contained the highest amount of phosphorus among P fertilizers from Eppawala. The total P content of the commercially available product is nearly 1.5 times lesser than that of SERP. Except the SERP, all the other P fertilizers from Eppawala are contaminated with high amount of impurities such as Fe and Al. Therefore, it is possible to categorized SERP as a quality product from Eppawala (Table 1).

The citric acid solubility of SERP is more than 2 times higher than that of other P fertilizers from Eppawala. Although, the citric acid solubility of CERP is low it increased after acidulation for making PAERP. It is even higher than that of imported rock phosphate (IRP) (Table 2).

Table 1. *Total phosphorus, calcium, iron and aluminium contents of rock phosphates*

P Fertilizer	P%	Ca%	Fe%	Al%
CERP	13.30	39.46	4.55	0.222
HERP	14.50	58.26	2.02	0.096
SERP	19.50	61.98	0.35	0.035
PAERP	13.43	40.49	4.30	0.094
IRP	12.55	56.23	0.88	0.014

Table 2. *Citric acid solubility of rock phosphate fertilizers*

Fertilizer	Citric acid solubility ($\%P_2O_5$)
CERP	3.84
HERP	4.66
SERP	5.11
PAERP	4.50
IRP	6.51

Rock P dissolution and P availability

The availability of the phosphorus in phosphate rock is influenced by the inherent differences among phosphate rock sources, soil and plant factors. In addition to the chemical composition, solubility and particle size of the phosphate rock and acidity, phosphorus, calcium status of the soil and P demand by the crop are important parameters which governed the dissolution of the rock phosphates. Several scientists of various disciplines have conducted more research on chemical, geological, engineering and agronomical aspects on Eppawala and these studies have yielded more valuable results.

Research carried out on rubber shown that commercially available Eppawala rock phosphate is equally effective as imported rock phosphate and therefore recommended as the only source of P for mature rubber. The efficiency of Eppawala rock phosphate in relation to young plants was similar to imported rock phosphate when used in soils with a P status less than 37.00 kg of soils. It is therefore possible

to used commercially available ERP (30% P_2O_5) as a source of P for immature rubber plants growing in areas which are considered low in P for rubber. Also, fast growing clones such as RRIC 110 and 121 were gained prominence as effective users of Eppawala rock phosphate and this is under investigation in the field scale. Electron microscopic studies revealed that two main minerals present in the material reacted in different ways indicating their preference to dissolve at different pH levels which makes the overall effect of soil acidity complicated. However, positive influence of increase time factor on dissolution of both type of minerals indicated the suitability of the material for long term crops. In addition, rubber factory effluent seems to be more valuable in increasing the dissolution of ERP in the rubber soils also reported.

The forecast made on phosphate consumption by the year 2000 clearly shown that the Asia region is going to be dominated and hence demand for P is increased. As a result the price for phosphate fertilizers also expected to be increased and more money has to be spend to meet the increasing demand of P fertilizers in the agricultural sector of Sri Lanka. The significance and importance of our locally available ERP deposit is therefore ever increasing.

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