Evaluation of Eppawela Rock Phosphate as a phosphate fertilizer for *Panicum maximum*

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ABSTRACT

The effect of Eppawela rock phosphate, fused Eppawela rock phosphate, saphos phosphate, fused magnesium phosphate, Rhenania phosphate and concentrated supperphosphate at 20 ppm P and 40 ppm P on the supply of phosphorus to *Pai ic ım maximum* was studied in the greenhouse on a soil of pH 4.5. At the first cut concentrated superphosphate and Rhenania phosphate fared best while Eppawela rock phosphate fared worst, being not even better than the control. Eppawela rockphosphate improved in its effectiveness at the second cut but still fared poorly compared to the other phosphates. In comparison fused Eppawela rock phosphate fared better, especially at the higher level of P.

INTRODUCTION

An apatite deposit was discovered at Eppawela, Sri Lanka in 1971. The total phosphorus content of the crushed ore ranges from 11-15% and the citric acid soluble phosphorus content from 1 to 2.5 % P. While the total phosphorus content compares favourably with other phosphate deposits in the world, the citric acid soluble P content is much lower in the Eppawela rock phosphate. However, the conversion of Eppawela rock phosphate by fusion with soda ash and silica to a product with a citric acid solubility of about 5.5-7.5% P has been reported (2). Sri Lanka imports about 40,000 tonnes of rock phosphate annually from the Middle East, the citric acid content of which is about 4.0 to 4.5%P.

While several field experiments have been conducted with flooded rice which have shown that Eppawela rock phosphate does not fare well as a source of phosphate fertilizer (7), information on its performance on upland crops is very scarce. In this study *Panicum maximum* was used as the test crop to compare Eppawela rock phosphate and its fused product with other phosphates.

MATERIALS AND METHODS

A soil of pH 4.5 and sodium bicarbonate soluble P of 5 ppm was used in the greenhouse experiment. Each pot contained 4.5 kg air dried soil passing through a 2 mm sieve. Six forms of phosphorus fertilizer namely, Eppawela, rock phosphate (ERP), saphos phosphate (SaP), Rhenania phosphate (RhP.) fused Eppawela rock phosphate (FERP), fused magnesium phosphate (FMP) and concentrated superphosphate (CSP) at 20 ppm P and 40 ppm P were used. In one treatment phosphorous was not added. The thirteen treatments were replicated four times. Rhenania phosphate is a fertilizer product from West Germany manufactured by fusing phospahte rock with soda ash and quartz at 1100^0 C, while fused Eppawela rock phospahte was prepared similarly using Eppawela rock phosphate (2). The anyalyses of the two phosphates are given in Table 1. Total phosphorus was determined by digestion with concentrated hydrochloric acid and the available phosphorus determined by treatment with 2% citric acid (1). The phosphate fertilizers were mixed thoroughly with the soil which was then brought to field capacity. Ten seeds of *Panicum maximum* were sown to each pot. After establishment the seedlings were thinned to one plant per pot. The soils were maintained at field capacity throughout the experiment.

Two weeks after sowing 20 ppm N and 20 ppm K were added to all plots including the control. Six weeks after sowing a further 20 ppm N was added. Ten weeks after sowing the grass was cut 5 cm above ground level. The regrowth was fertilized in an identical manner to the primary growth except that no phosphorus was added. All additions of N and K were made in the form of ammonium sulphate and muriate of potash respectively. The grass was cut again 10 weeks after the first harvest. The plant material collected was dried to constant weight in an oven at 65^0 C digested in a mixture of hydrochloric, sulphuric and perchloric acids, and the phosphorus content determined by the vanado molybdate method (3).

For purposes of facilitating the comparison of a given phosphate source with concentrated superphosphate, the parameter Relative Phosphorus Supplying Index (RPSI) is used. This is calculated from the equation below for a specific level of phosphorus added, where Po, Pps, and Pcsp are the amounts of P uptake by the grass to which no phosphorus was added, to which the phosphate source under comparison was added, and to which CSP was added respectively.

$$RPSI = \frac{Pps - P_0}{Pcsp - P_0} \times 100$$

RESULTS AND DISCUSSION

The effect of the phosphates on % P, and P uptake are given in Table 2. The % P values were low compared to those of many other plants, and did not change significantly with type or amount of phosphate added, or with time of cutting, while the dry matter content varied widely, Perhaps a value of 0.06-0.10% P is on the higher side as far as this particular grass is concerned. In fact it has been reported that different grasses can have very variable P contents at their maximum yields (4).

At the first cut the lowest P uptake was from the control pot and ERP treated pots, while the highest P uptake was from the CSP and RhP pots. ERP was inferior to all other phosphates. CSP at second level had higher P uptake than SaP, FERP and FMP. There were no marked differences between SaP, FERP and FMP. The second level of FERP was inferior only to the second level of CSP. Of the six forms of phosphate only FERP and CSP showed a significant increase in P uptake on doubling the rate.

At the second cut the highest uptake was from CSP and the lowest from no phosphate pots. However, unlike at the first cut ERP had higher uptake than the control. There were no marked differences between the other phosphates. P uptake was significantly higher at the second level than the at first level in FERP, FMP and CSP. Here again the second level of FERP was inferior only to the second level of CSP.

All treatments showed a greater growth and a higher P uptake at the second cut than at the first cut, the mean values of P uptake for the first and second cuts for all treatments being 3.72 and 8.91 mg P/pot respectively. The effect of doubling the quantity of phosphorus on the sum total of phosphorus supplied to the plant during the first and the second cut are shown in Figure 1 From the slope of the ERP line it appears that even adding higher doses cannot expect to make it as.effective as the other phosphates. Similar results have been reported (6) where, after incubating five soils of pH ranging from 4.8 to 5.5 with two levels of ERP, SaP and CSP for a period of one year, the highest available P content ($NaHCO_3$ method) was observed for soil mixed with CSP and lowest for soil mixed with ERP. For some of these soils ERP did not lead to any increase in the amount of available P in soil. Yet it is noteworthy that in the present study ERP increased the Relative Phosphorus Supplying Index from 12 to 62 at level 1, and from 17 to 37 at level 2, from the 70 day harvest to the 140 day harvest, although it fared poorly amongst the six phosphates (Table 3).

In the soil incubation method referred to above a chemical extractant was used to evaluate phosphates, while in this study phosphorus uptake by the plant is used for the same purpose. While the two methods of assessment are different, there is perhaps also a real difference in the factors which cause the solubilization of the rock phosphate in the two systems. The difference is basically due to the influence of the root system. Further, different plants may solubilize phosphates differentially owing to the influence of the varying rhizosphere biologies generated by each of them.

It has been suggested (5) that uptake of calcium ions by the roots can lead to a greater P solubilization of say, fluorapatite, by driving the equilibrium of the reaction below to the right. In addition roots may directly dissolve rock phosphate by its exudates.

$$Ca_{10}(PO_4)_6F_2 \rightleftharpoons 10Ca^{2+} + 6PO_4^{3-} + 2F^-$$

They may also indirectly do so by promoting the growth of certain microorganisms which could themselves cause solubilization of the phosphate. It has been reported (6) that the isolates from the rhizosphere of plants had more apatite solubilizing fungi and bacteria than from nearby soil. All of the above seem to illustrate the importance of including the plant in a comparison of the effectiveness of different phosphates.

Of the phosphates tested CSP is water soluble, while the others are very sparingly soluble in water. From the excellent peformance of Rhenania phosphate which had a Relative Phosphorus Supplying Index ranging from 75 to 105 it is clear that water solubility is not a satisfactory criterion to evaluate phosphate fertilizers.

While Eppawela rock phosphate fared poorly, fused Eppawela rock phosphate fared better, especially at the higher level where it was inferior only to CSP. If the citric acid solubility of FERP can be further increased it is likely that a better fertilizer will result.

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Table 1: Total, citric acid soluble and water soluble phosphate contents of the different phosphorus fertilizers

Fertilizer	*Total phosphate* % P	*Citric soluble phosphate* % P	*Water soluble phosphate* % P
Eppawela rock phosphate	12.7	1.5	0.01
Saphos	12.9	4.1	0.01
Fused Eppawela rock phosphate ...	10.5	7.5	0.24
Rhenania phosphate	11.9	11.4	0.93
Fused magnesium phosphate	8.7	6.6	0.07
Concentrated superphosphate ...	18.8	18.8	18.45

Table 2: Effect of phosphates on % P and P Uptake by *Panicum maximum*

Fertilizer	*Amount ppm P*	*First Cut* *% P*	*First Cut* *P Uptake mg P/pot**	*Second Cut* *% P*	*Second Cut* *P Uptake mg P/pot**
No P	0	0.06	0.06 f	0.11	2.86 e
ERP	20	0.10	0.63 f	0.08	7.27 d
ERP	40	0.09	1.32 f	0.07	7.08 d
SaP	20	.008	3.80 cde	0.08	9.09 bc
SaP	40	0.09	5.06 bc	0.08	9.84 b
FERP	20	0.08	2.84 e	0.07	7.41 d
FERP	40	0.08	4.47 bed	0.08	9·88 b
FMP	20	0.11	3.25 de	0.08	7.60cd
FMP	40	0.09	3.89 cde	0.07	10.44 b
RhP	20	0.08	5.10 bc	0.09	9.33 b
RhP	40	0.08	5.86 ab	0.09	11.35 b
CSP	20	0.08	4.84 bed	0.09	9.95 b
CSP	40	0.09	7.27a	0.11	14.14 a
CV %		18.5	20.6	21.8	9.4

* Duncans Multiple Range Test at 1% level of significance. Means followed by the same letters within the column are not significantly different.

Table 3: Relative Phosphorus Supplying Index of the different phosphates

Fertilizer	*Amount ppm P*	*Relative Phosphorus Supplying Index*	
		First cut	*Second cut*
ERP	20	12	62
SaP	20	78	88
FERP	20	58	64
FMP	20	67	70
RhP	20	105	91
CSP	20	100	100
ERP	40	17	37
SaP	40	69	62
FERP	40	61	62
FMP	40	53	67
Rhp	40	80	75
CSP	40	100	100

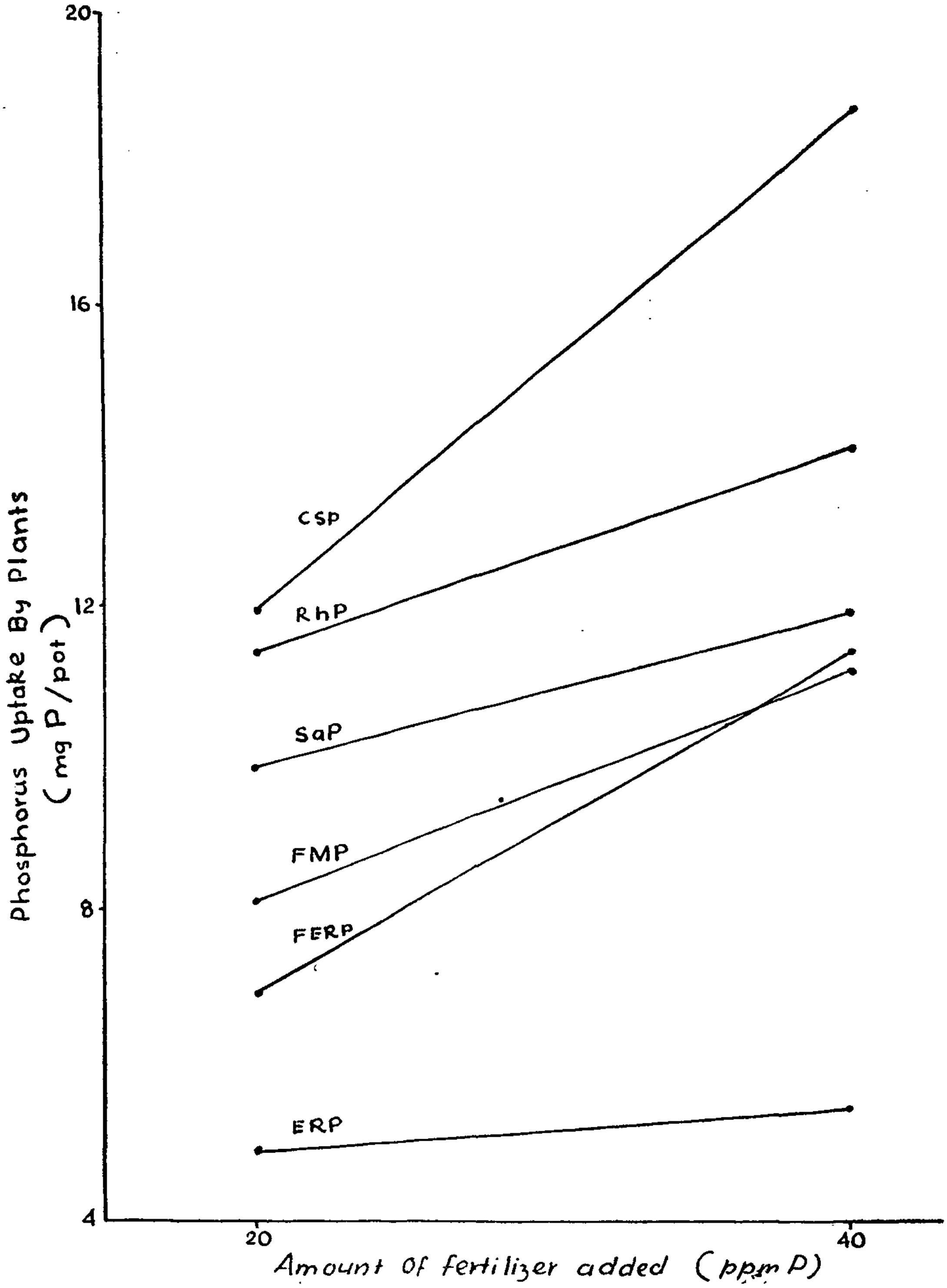

Figure I. Effect of doubling the amount of fertilizer phosphorus on P uptake by the plants.