DEGREE OF PHOSPHORUS SATURATION IN SOME SOILS OF SRI LANKA

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Introduction

Phosphorus (P) makes up about 0.12 % of the earth's crust and it is an essential nutrient which leads to optimum crop growth and production (He *et al.*, 2004). Long-term continuous application of P fertilizers and other P sources may cause P accumulation in the surface horizon (Zhang *et al.*, 2004). Loss of accumulated P from agricultural soils is one of the major causes of eutrophication in surface waters (Pote *et al.*, 1996). The degree of P saturation (DPS) which relates the extractable P of a soil to its P adsorption capacity is a good indicator of the potential of the soils to release P to cause environmental problems (Ige *et al.*, 2005; Nair *et al.*, 2004). Studies of P saturation in Sri Lankan soils are rare to find or do not exist. The degree of phosphorus saturation is the percent ratio of P retained by soil to the total capacity of soil to retain P (ES_{Max}). Main limitation of using ES_{Max} is the time consuming steps involved in the determination. P sorption index (P_{150}), which is the measurement of P adsorption at 150 mg L^{-1} of added P, is used as an alternative for ES_{Max} for many soils (Ige *et al.*, 2005). Therefore, the objectives of this study were to develop relationships between ES_{Max} and P_{150}, and between P_{150} and exchangeable cations in soils, and to calculate DPS for major Sri Lankan soils and relate DPS to available P in soils.

Materials and Methods

Twenty seven surface soil samples were collected from different locations of the country representing the major soil orders in Sri Lanka. Air dried and sieved (< 2 mm) soils were analyzed for pH, Mehlich 3 extractable P, Ca, Mg and Fe and Oxalate extractable Fe. Single point P adsorption capacity (P_{150}) and estimated adsorption capacity (ES_{max}) using Langmuir adsorption maxima were also determined. DPS was calculated using ES_{max} and P_{150} as the numerator and Mehlich 3 extractable P (P_{M3}) as the denominator. Relationships were developed between calculated DPS and water extractable P (P_{H2O}) which could be used as an index of P in runoff losses.

$$DPS\ (P_{150}) = P_{M3} / P_{150} \times 100 \quad \ldots\ldots(1)$$

$$DPS\ (ES_{Max}) = P_{M3} / ES_{Max} \times 100 \quad \ldots(2)$$

Results

Phosphorus sorption index (P_{150}) varied from 192 to 1454 mg kg^{-1} while ES_{max} was varying between 625 to 5000 mg kg^{-1} among the soils. Single point adsorption capacity is a good indicator to represent estimated adsorption capacity (ES_{max}) of soil due to the good relationship between both parameters (Figure 1). Significant relationships were observed (Table 1) between P_{150} and Mehlich extractable Ca ($r^2 = 0.562$), Mg ($r^2 = 0.698$) and oxalate extractable Fe ($r^2 = 0.624$) for soils.

Degree of P sorption values obtained using P_{M3} with P_{150} (Equation 1) ranged from 0.014 to 7.805 % while DPS calculated using the Es_{Max} as the denominator (Equation 2) ranged from 0.007 % to 2.66 %. DPS calculated using equation 1 and 2 significantly correlated with $r^2=0.91$. Water extractable P positively correlates with DPS calculated by both equations.

Table 1. Correlation between single point P adsorption isotherm (P_{150}) and exchangeable cations

Correlation	r^2
$Ca_{M3} * P_{150}$	0.562 ($p<0.01$)
$Mg_{M3} * P_{150}$	0.698 ($p<0.001$)
$Fe_{ox} * P_{150}$	0.624 ($p<0.001$)

Discussion

Mehlich extractable Ca and Mg, and oxalate extractable Fe correlate well with P sorption index confirming the formation of these metals with for P retention in soils. Degree of P saturation of the tested soils was less than 10 %, indicating the low environmental risk due to P losses.

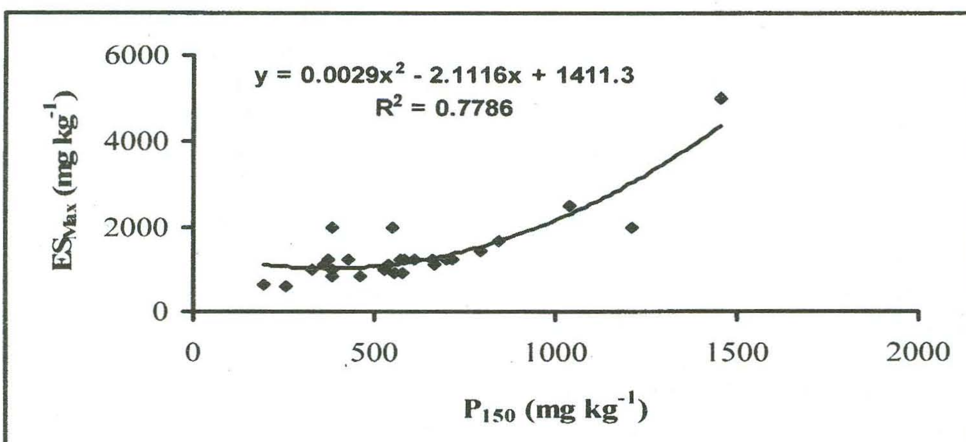

Figure 1. Relationship between calculated P adsorption at 150 ppm concentration (P_{150}) and estimated adsorption maximum using linear form of Langmuir isotherm (ES_{max})

Studied soils showed considerable lower extractable P with higher adsorption values. Low DPS values of the studied soils indicate the low susceptibility of P runoff loss of these soils. DPS evaluated, were correlated with P_{H2O}, indicating the validity of calculated DPS for P loss assessments.

Conclusions

Phosphorus sorption index can be used to evaluate P adsorption capacity in tested Sri Lankan soils. Mehlich extractable Ca and Mg and oxalate extractable Fe provide a convenient tool for P management in the country. Therefore, these exchangeable cations are good indicators for predicting P losses from Sri Lankan soils. According to the results, studied soils are not at a risk of P loss from soil to water based on the calculated DPS.

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