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RESEARCH ARTICLE

Evaluation of Phosphorus Availability in a Lateritic Gravelly, Coconut Grown and Long Term Phosphate Fertilizer Applied Soil in Sri Lanka with an Indicator Plant

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ABSTRACT

The residual phosphorus availability and response of Ginger (*Zinigiber officinale*) to residual available phosphorus in (lateritic gravelly) Red Yellow Podzolic soil (RYP - Rhodustults) of *Andigama* soil series from Rathmalagara estate, Madampe was evaluated after 10 years of continuous application of 03 sources of phosphates to young coconut palms. A pot experiment was established using Andigama soil series which was collected from field experimental site where coconut palms were treated with 03 levels of phosphate with 03 different phosphate sources i.e., Eppawela Rock Phosphate (ERP, 30 % P_2O_5), Imported Rock Phosphate (IRP, 27.5% P_2O_5) and Triple Super Phosphate (TSP, 46 % P_2O_5) from the seedling stage up to the age of 10 years. The initial rates of phosphate applications were P_2O_5 equivalent of 50, 100 and 200 g $palm^{-1}year^{-1}$ respectively which were annually increased by 5, 10 and 20 g respectively. Ginger was used as an indicator plant as the growth parameters, yield and the total P content in the ginger can be taken as an indication of the response to different treatments. Ginger rhizomes were planted in pots filled with 5 kg of phosphate treated soil and all the plants were treated with a basal dose of nitrogen (N) and potassium (K) at every 1 ½ month intervals for 6 months. Number of tillers per bush, height of the plants and number of leaves in bush in each pot were recorded. Six months after planting, ginger plants were uprooted and fresh and dry weight of shoots of the plants, roots and rhizomes were recorded. All the plant parts were analysed for total P. Soil samples were collected before planting the ginger and analyzed for available P by 2.5 % acetic acid method, Olsen's bicarbonate and Bray and Kurtz 1 method.

The overall result showed that the extractable P in soil treated with all 03 levels of ERP, IRP and TSP by 2.5 % HAc-P, Olsen – P and Bray – P values were above the sufficiency soil P values of 7.8 mg kg^{-1}, 8.5 mg kg^{-1} and 5.8 mg kg^{-1} respectively. The highest level of TSP, IRP and ERP treatments were significantly effective in increasing the dry weight of rhizomes and the shoots of ginger. It indicated that residual phosphorus availability of TSP, IRP and ERP was high and its effectiveness on response to ginger was more or less similar. This might be

due to low dissolution of ERP and fixation of TSP in lateritic gravel soil. According to the findings of this experiment, P fertilizers can be taken out from the coconut fertilizer recommendation for a period of time by monitoring the effectiveness of the residual P status in soil and coconut leaf. Findings of this experiment can be included into site specific fertilizer recommendation programmes of the other perennial crops. By monitoring the availability of P in soil, intercrops can be grown in coconut plantations without application of P fertilizers.

Key words : Phosphate sources, residual phosphorus availability, critical soil P, response, Red Yellow Podzolic

INTRODUCTION

In Sri Lanka, Eppawela Rock Phosphate (ERP) is used as a direct application fertilizer for tea, rubber and coconut grown on acid soils (Appleton, 1994). It is used for other crops too in varying proportions together with Imported Rock Phosphates (IRP). Phosphorus in rock phosphates is available to plants grown on acidic soils, more than on neutral and alkaline soils. Rock phosphates are often recommended for slow growing crops such as tea, rubber and coconut on neutral and acidic soils (Amarasinghe and Wijewardana, 1989). The Coconut Research Institute has recommended 100% of the phosphorus requirement of adult coconut palms in Wet and Intermediate zone be supplied with ERP. The comparison of the effect of ERP with that of IRP and Triple Super Phosphates (TSP) on performance of young coconut palms showed no significant difference in leaf P concentration of the palms among treatments at the 10^{th} year of the experiment. It implies that ERP can be equally good as IRP for young coconut palms. Rock phosphates may provide a higher residual effectiveness than super phosphate which may be of advantage for some management regimes (Khasawneh and Doll, 1978). However, long term residual effect of North Carolina and Queensland rock phosphates compared with TSP showed that rock phosphates are unlikely to be economic alternatives to super phosphate in the short or long term on most lateritic soils in South-Western Australia (Bolland and Gilkes, 1995). The objective of the present study was to evaluate the residual P availability and plant response to residual phosphorus in *Andigama* series soil after 10 years of continuous application of ERP, IRP and TSP.

MATERIALS AND METHODS

Andigama series soils used in this study was Red Yellow Podzolic soils (RYP-Rhodustults) dominant in interior part of the country (mantled plain), well drain, moderately deep lateritic gravelly soil. A pot experiment was established with surface soil (0 – 25 cm) samples collected from a field experiment where coconut palms were treated with 03 levels of phosphate with 03 different phosphate sources namely ERP (28.5 % P_2O_5), IRP (27.5% P_2O_5) and TSP (46% P_2O_5) from the seedling stage up to the age of 10 years. The initial rates of applications were P_2O_5 equivalent of 50, 100 and 200 g $palm^{-1}$ $year^{-1}$ respectively which were annually increased by 5, 10 and 20 g respectively. The sources of P and the levels of treatments applied in the 10^{th} year are given in (Table 1).

Cumulative weights of phosphate fertilizer received by soil through different phosphate sources during 10 years are given in Table 2. Soil samples were collected at 0-25 cm depth from the manure circle compassing 1 m distance from base of the coconut palm of each treated plot. The soils were passed through 6 mm mesh to remove medium and coarse gravel (Davias and Jokiniemi, 2011) at field moist state and 5 kg soil were filled into plastic pots. Calculated amounts of phosphorus fertilizer added to 5 kg soil used for the pot experiment which were considered as treatments are given in the Table 3.

Collected soil samples were analyzed before planting the ginger for available P by 2.5 % acetic acid (Wijebandara, 2004), Olsen's bicarbonate (Olsen *et al.,* 1954) and Bray and Kurtz P -1 method (Bray and Kurtz, 1945). Ginger used as an indicator plant as the growth parameters, yield and the total P content in the ginger can be taken as an indication of the response to different treatments. Ginger rhizomes were planted in pots and all the plants were treated with a basal dose of nitrogen at the rate of 10 g of urea and potassium at the rate of 20 g of muriate of potash at every 1 ½ month intervals for 6 months. Treatment pots were arranged in a Completely Randomized Design with 3 replicates. Six months after planting, ginger plants were uprooted and fresh and dry weight of vegetative parts of the plants, roots and rhizomes were recorded. All the plant parts were analysed for total P through wet digestion with HNO_3 : $HClO_4$ ratio of 1 : 4 followed by colorimetric analysis with UV visible spectrophotometer. Data were analysed statistically using GLM procedure.

RESULTS AND DISCUSSION

As shown in Table 4 the residual available P contents in different treatments extracted by different extractants were significantly higher than the control. The residual available P values were above the critical soil P levels for 2.5 % Acetic acid (7.8 mg kg^{-1}), Olsen's bicarbonate (8.5 mg kg^{-1}) and Bray and Kurtz (5.8 mg kg^{-1}) (Wijebandara, 2004).

It has been noted that significantly different Bray – P, Olsen-P and 2.5 % HAc – P were observed between phosphate sources. The IRP and ERP treatments had significantly higher P values for 2.5 % acetic acid extraction than that of TSP. It is therefore evident that IRP and ERP treated soils contained significantly higher quantities of basic Ca-P fraction (apatite-P) than both TSP treated soil and control. According to Olsen-P and Bray – P values, only TSP treatments showed significantly high values compared to IRP and ERP. It indicated that a considerable amount of soluble Ca-P and Al – P were present in TSP treatment than the other two treatments. Evaluating ERP and TSP with rice, Ratnayake *et al.,* (1994) also reported that the highest Olsen – P values for TSP in RYP soil. Significantly different Bray – P and Olsen – P values between TSP levels and 2.5 % HAc values between both ERP and IRP were also observed.