

CURRENT AND RESIDUAL EFFECTS OF REACTIVE AND UNREACTIVE NATURAL PHOSPHATE ROCKS ON OIL PALMS SEEDLINGS GROWN ON AN ACID SOIL

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Introduction

Phosphorus is known to be limiting in acid soils of the humid and sub-humid tropics. Application of soluble P fertilisers is uneconomical due to high production costs and low utilisation efficiencies. The latter is thought to arise from high P fixing capacities of these soils (Juo and Fox, 1977). Direct use of phosphate rocks (PR) has shown tremendous potential in improving crop yields in acid soils (Chien et al. 1980). Based on this knowledge, Malaysia has been importing PR from various sources in the world as a P source for plantation crops. But naturally occurring PR has varied mineralogical properties that affect their solubilities in the soil. The fate of these PR applied to our soils has not been studied in detail. Thus to evaluate the agronomic effectiveness of these PR, greenhouse and laboratory involving conventional chemical extractants and isotopic techniques were carried out. The effects of ameliorating the soil with several types of green manure on PR solubility and plant P uptake was also evaluated.

Materials and Methods

Six sources of PR from North Carolina (NCPR), Tunisia (TPR), Jordan (JPR), Morocco (MPR), Christmas Island (CIPR) and China (CPR) and triple super-phosphate (TSP) were evaluated using a Rengam series soil (Typic Paleudult) with oil palm seedlings as the test crop using P-32 isotopic dilution technique (Zapata and Axmann, 1995). Plant growth and P uptake by the oil palm seedlings were monitored over a one-year period. P dissolution from these PR were assessed using 0.5M NaOH, 2% citric acid, 2% formic acid, 0.5M ammonium citrate, L value and E-value methods. Correlations between P dissolved and P uptake by the plants was made. The effects of 4 green leaves from *Acacia mangium*, *Leucaena leucocephala*, *Gliricidia sepium*, and *Senna siamea* used as green manure on PR solubility and P uptake by short term crop was evaluated in a pot experiment in the green house using the P-32 isotope dilution technique.

Results and Discussion

PR reactivity ranked according to CaO:P₂O₅ molar ratio and the magnitude of PR solubility in 2% citric acid and 2% formic acid and neutral ammonium citrate as percentage of rock and total P₂O₅ content are in the order of NCPR > TPR > MPR > JPR > CIPR > CPR. This is due to the mineralogical constituents of the original rock obtained. NCPR with its high carbonate substitution in the crystals are more reactive and are more soluble in all the reactants used (McClellan and van Kauwenbergh, 1992). Correlation coefficients of P extracted with the total P taken up by the oil palm seedlings showed that neutral ammonium citrate gave the highest r₂ value as compared to 2% citric acid and 2% formic acid.

The r² values also improved when the solubility of the PR was expressed as percentage of the rock rather than total P₂O₅ content. This finding is similar to what has been stated by Chien and Hammond, (1980) when working with soils from the USA. The P uptake by oil palm seedlings in the first three months of growth showed no significant difference between the PR sources, but TSP gave the highest P uptake. This is due to TSP being highly water-soluble; the roots easily take it up. PR being slowly solubilised needed longer time to interact with the acid in the soil for it to be dissolved and made available to the plants. The P uptake increased with increasing growing time. North Carolina and Tunisia PR showed higher P uptake as compared to Christmas Island and China PR. The percent P derived from fertilisers (% PdfF) in 3, 6, 9 and 12 months of oil palm seedlings growth ranged from 81 – 99 %, indicating the poor P supplying power of the soil used. The total amount of P taken up during 12 months growing period was equivalent to 15% of the added P as TSP, 5.2% from NCPR, 4.2% from JPR, 4.1% from MPR, 3.2% from TPR 4% from CIPR and 2.2% from CPR. Addition of green manure as fresh green leaves of *Gliricidia sepium*, *Acacia mangium*, *Leucaena leucocephala* and *Senna siamea* generally increased the solubility of the less reactive PRs and depressed that of the more reactive ones. This was believed to be through nutrient supply and release of P and indirectly by decreasing or increasing P fixing capacity. The extent of this influence was observed to be dependent on green manure quality, especially C:P ratio.

Conclusion

The dry matter yields obtained due to high P application did not indicate the effectiveness of a particular P fertiliser source on oil palm seedlings. The use of P-32 isotope dilution technique has made it possible to differentiate the P made available from the original soil and the P fertiliser sources. The order of effectiveness of these P sources were NCPR > TPR ≥ JPR ≥ MPR ≥ CIPR > CPR. P extracted by neutral ammonium citrate correlated better to plant uptake than formic acid or citric acid. Addition of green manure increased the solubility of the less reactive PRs and depressed or did not affect the more reactive PRs. The extent of this influence was observed to be dependent on the green manure quality, especially C:P ratio.

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