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# INCREASED MOBILITY OF PHOSPHATE IN LATERITE SOIL WITH THE ADDITION OF ORGANIC MATTER*

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ABSTRACT

In laterite soils, applied water soluble P compounds get converted to sparingly soluble compounds. Application of organic matter and increasing soil organic matter reduce this type of conversion or make these compounds more soluble, thus facilitating deeper movement of phosphorus in soil.

## INTRODUCTION

With increasing time lapse from application of fertilizer P to the soil, compounds that are formed in the soil become usually less available because of their sparingly soluble nature. The plant roots absorb P from soil solution, and to meet their requirements, the P concentration in soil solution should be adequately replinished. With the sparingly soluble nature of the reaction products formed, this does not become possible. The roots found in the lower layers of soil do not get adequate P supply for the above reason. In perennial crops like arecanut, coconut, and cacao, now extensively grown in laterite soils under irrigation in summer, adequate supply of P to the entire root region throughout the year is very important. All these crops have fairly deep root systems extending to one meter or more both laterally and vertically. The usual practice is to apply fertilizers and manures to the surface soil, usually within the top 20 cm. Any convenient method which will increase the movement of applied P nutrient to lower soil regions, where roots of these trees are found, will be of agronomic value. Prasad et al. (1971) reported maximum solubility of phosphate under farm yard manure treatment. Othieno (1973) reported that mulching with organic matter increased the downward movement of P and decreased the amount of P fixed by the soil. Mandal and Mandal (1973) found that organic matter maintained higher amounts of P in soluble form and reduced fixation as iron phosphate. Sharif et al. (1974) claimed higher P uptake from super phosphate when it was mixed with farm yard manure.

## MATERIALS AND METHODS

The following investigations were taken up to investigate the role of organic matter in the movement of P fertilizers in soil.

A. Study in the field plots of some selected treatments of the NPK experiment running at the CPCRI Regional Station, Vittal. The available $P_2O_5$ was estimated (Bray 1 method) in soil samples drawn at 10 cm intervals from top to 100 cm depth in the basins of palms under three treatments. This experiment was planted in 1961. N

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was supplied as ammonium sulphate, P as super phosphate, K as muriate of potash, and organic matter as green manure every year. The samples were drawn in 1976 and analysed. For each treatment, soil samples from two palm basins were collected and separately analysed.

B. Column leaching study in two laterite soils, one rich and the other poor in organic matter. Two soil profile samples were collected, one from a virgin forest near the CPCRI Kidu Farm, and other from an uncultivated hill side of CPCRI Regional Station, Vittal. Polyethylene tubings of 5 cm diameter and one meter length were used for preparing soil columns. These columns were filled with air dried and sieved soil samples profile-wise with gentle tapping. Bottom ends of the tubes were fitted with a tight fitting glass funnel packed with acid washed glass wool to hold the soil in position. Acid washed sand was spread above the soil columns to about 0.5 cm thickness for adding the phosphate compound ($KH_2PO_4$) above this. Two such columns were prepared for each soil type. For each type of soil in columns, P was added at one P-fixing capacity to one column and at 1.5 P-fixing capacity to the other. The quantity of P to be added was calculated on the basis of the P-fixing capacity of the soil and the weight of soil in each column. P was added as $KH_2PO_4$ over the sand layer kept above the soil column. Water was allowed to trickle down over this. The water flow was so adjusted that it flowed through the column without either any stagnation at the top or drying of soil column. The leaching was continued for 95 days. The columns were then allowed to drain, they were segmented to 5 cm lengths, the soils were air dried, and the available $P_2O_5$ and pH in water were determined for each section.

## Results and Discussion

The pH, organic C, and P-fixing capacity of soils used for erecting soil columns are presented in Table I.

**Table I.** *The pH, organic C, and P-fixing capacity of soils used for soil columns*

| Location of soil | Profile depth (cm) | pH | Organic carbon (%) | P-fixing capacity ppm | P-fixing capacity % |
|---|---|---|---|---|---|
| Kidu Forest soil | 0–8 | 5.50 | 3.80 | | |
| -do- | 8–100 | 5.15 | 1.78 | 650 | 0.065 |
| Vittal soil | 0–20 | 5.70 | 0.98 | | |
| -do- | 20–100 | 5.70 | 0.42 | 600 | 0.060 |

The available $P_2O_5$ contents from the soil samples drawn from the selected three treatments of NPK experiment are presented in Table II.

**Table II.** *Available $P_2O_5$ (ppm) in soil samples from the NPK experiment Vittal (Mean of two palm basins)*

| Profile depth (cm) | Treatment $N_3P_3K_3G_3$ | $N_3P_3K_3G_1$ | $N_2P_2K_2G_2$ |
|---|---|---|---|
| 0–10 | 2535 | 1101 | 232 |
| 10–20 | 759 | 561 | 142 |
| 20–30 | 432 | 82 | 160 |
| 30–40 | 103 | 23 | 132 |
| 40–50 | 96 | 5 | 28 |
| 50–60 | 75 | 3 | 11 |
| 60–70 | 87 | 4 | 6 |
| 70–80 | 105 | 4 | 6 |
| 80–90 | 66 | 5 | 5 |
| 90–100 | 51 | 7 | 8 |

*Note:*

$N_3$—200gm N/palm/year as ammonium sulphate
$N_2$—100gm N/palm/year as ammonium sulphate
$P_3$—160gm $P_2O_5$/palm/year as superphosphate
$P_2$—80gm $P_2O_5$/palm/year as superphosphate
$G_3$—21kg green leaf/palm/year
$G_1$—7kg green leaf/palm/year
$G_0$—No green leaf
$K_3$—280gm $K_2O$/palm/year as muriate of potash

The data show that addition of green leaf, a bulky organic manure, along with superphosphate has facilitated the downward movement of P.

The data on pH and available $P_2O_5$ content of soils from leached soil column sections in study B are presented in Table III.

**Table III.** *Changes in soil pH and available $P_2O_5$ in soil columns leached with water soluble phosphorus*

| Depth of soil column | Kidu Soil | | | | Vittal Soil | | | |
|---|---|---|---|---|---|---|---|---|
| | One PFC | | 1.5 PFC | | One PFC | | 1.5 PFC | |
| | pH | Available $P_2O_5$ | pH | Available $P_2O_5$ | pH | Available $P_2O_5$ | pH | Available $P_2O_5$ |
| 0–5 | 6.10 | 1088 | 6.33 | 2233 | 6.70 | 1174 | .660 | 1388 |
| 5–10 | 6.50 | 873 | 6.30 | 2127 | 6.85 | 1002 | 6.90 | 1275 |
| 10–15 | 6.10 | 859 | 6.70 | 1689 | 6.85 | 773 | 6·95 | 1188 |
| 15–20 | 6.55 | 693 | 6.30 | 1589 | 6.95 | 759 | 7.05 | 1073 |
| 20–25 | 6.55 | 567 | 6.70 | 1302 | 7.10 | 644 | 6.90 | 816 |
| 25–30 | 6.45 | 464 | 6.65 | 1260 | 7.10 | 401 | 7.20 | 673 |
| 30–35 | 6.20 | 338 | 6.55 | 653 | 6.90 | 63 | 7.10 | 286 |
| 35–40 | 5.70 | 286 | 6.00 | 498 | 7.20 | Trace | 7.40 | 37 |
| 40–45 | 5.70 | 143 | 5.95 | 452 | 5.90 | Trace | 7.45 | 6 |
| 45–50 | 5.55 | 120 | 6.10 | 487 | 5.30 | Trace | 6.25 | 3 |
| 50–55 | 5.45 | 103 | 6.10 | 235 | 5.15 | 1 | 5.20 | Trace |
| 55–60 | 5.50 | 83 | 5.50 | 238 | 5.10 | 1 | 5.55 | Trace |
| 60–65 | 5.55 | 83 | 5.50 | 238 | 5.10 | 1 | 5.55 | Trace |
| 65–70 | 5.40 | 9 | 5.55 | 74 | 5.25 | Trace | 5.50 | Trace |
| 70–75 | 5.30 | 6 | 5.50 | 43 | 5.35 | Trace | 5.45 | Trace |
| 75–80 | 5.30 | 5 | 4.45 | 9 | 5.35 | Trace | 5.45 | Trace |
| 80–85 | 5.20 | 2 | 5.40 | 6 | 5.15 | Trace | 5.30 | Trace |
| 85–90 | 5.15 | 2 | 5.55 | 24 | 5.40 | Trace | 5.45 | Trace |
| 90–95 | 5.30 | 6 | 5.50 | 23 | 5.30 | Trace | 5.50 | Trace |
| 95–100 | 5.30 | 5 | 5.70 | 5 | 5.50 | Trace | 5.55 | Trace |

From the data it can be seen that at both levels of P added (i.e., one P-fixing capacity and 1.5 P-fixing capacity), P has moved to a greater depth in Kidu soil than in Vittal soil. An interesting change in soil pH was also noticed. As the available P increases there is an increase in soil pH. Increase in soil pH or correction of soil acidity was more in Vittal soil than in Kidu soil at each soil level. The P-fixing capacity of both the soils was almost the same. The P-fixing capacity was estimated after equilibrating the soil with P solution for 4 days. In this column leaching study, the soil was under leaching for 95 days. It can be ssafely assumed that the organic matter in the soil during this period undergoes changes, both chemical and microbial, which release substances having solubilising effect on P compounds formed in the soil. Sinha (1972) has observed greater release of phosphates under anerobic incubation of straw. Stanford and Pierre (1953) have quoted works where compounds resulting from organic matter decomposition are also active in making soil-P more available. They opine that certain organic anions react with Fe and Al to form complexes. These reactions not only reduce fixation of added phosphate ions, but also bring about dissolution of native Fe- and Al- phosphates. Laterite soils (oxisols) contain ferric and iron oxides which contribute to soil acidity. The organic matter in the soil has acid functional groups like carboxyls, phenols, and some other alcoholic hydroxyls. At acidic pH, these have positive charges. Anions like $H_2PO_4$ will be held at these sites. As the aluminium and ferric oxides react with phosphate, there is a pH increase. The soil rich in organic matter will have some phosphate held by organic complex which do not react with aluminium and ferric oxide. So, pH increase may be slow in soil rich with organic matter.

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