Jl. Rubb. Res. Inst. Sri Lanka (1987) **67**, 19 — 25

EFFECT OF LEAF LITTER ON DIRECT AND INDIRECT MOBILIZATION OF P FROM APATITE

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SUMMARY

Leaf litter as direct and indirect means of improving P availability from apatite was tested. Application of leaf litter improved the P uptake by indicator crops but did not influence the availability of P from applied apatite.

INTRODUCTION

It has been well established that mulches and organic residues supply considerable amounts of P to plants (Nye, 1952). Mulches sometimes are more efficient than mineral phosphates in supplying P to plants, and they also increased available P in soil (Kim *et al*, 1965). The availability of P from phosphate fertilizers is also improved by litter and mulches (Othieno, 1973). This was found to be partly due to improvement of soil physical properties leading to improved root growth (Othieno, 1973), and partly due to prevention of fixation of released P (Mandal and Mandal, 1973).

Some of these phenomena were tested using Eppawala apatite (Anon, 1980). In one experiment, the effect of the first crop treated with apatite and application of its tops as mulch or incorporation into soil, on uptake of P by a second crop was tested. Mixing leaf litter with soil on availability of P from added apatite to a test crop and attendent microbial type and biomass changes were monitered in the second experiment.

MATERIALS AND METHODS

Apatite

Ground apatite passing through a 212 μm mesh and consisting of Chloroapatite and Francolite was used. It contained 12% total P and 1·59% citric acid soluble P.

Soil

Surface soil, an ultisol (red yellow podzolic) upto a depth of 20 cm with and available P content (NH_4F/HCL) of 5·6 — 5·9 ppm was collected from Dartonfield Estate. The pH of this soil in water (1 : 2·5) was 4·8.

Total P content in plant material was estimated after digesting the oven dried and ground material in Se/H_2SO_4. The Vanado Molybdate method was followed.

Phosphate dissolving bacteria (PDB) and fungi (PDF) was estimated according to the methods of Katznelson *et al.*, (1962) and Angihotri (1970) respectively. Total microbial biomass in soil was estimated by measuring the substrate induced respiration using glucose as substrate (Anderson and Domsch, 1973).

Experimental

Experiment 1 was carried out in two stages. In the first crop of *Panicum maximum* var. Guinea B and *Stylosanthus guyanensis* were grown with (250 g/kg soil) or without apatite. The first crop was harvested at the end of 90 days and dry matter yield and P content were estimated. This material was applied (as the source of P) to the indicator crop (*Pueraria phaseoloids*) which was grown subsequently in the same pots. Each main (previous) treatment was now split into three subtreatments *viz.*

(a) Plant material not returned
(b) Plant material added as surface mulch
(c) Plant material incorporated into soil

thus giving twelve treatments each replicated three times. After addition of this litter the pots were covered with black polythene and incubated for one month. Pots were watered with 250 ml of water every week to keep them moist. At the end of this incubation period seeds of *Pueraria* was planted. The total microbial biomass (TMB) was measured at the end of 1, 3 and 5 months after addition of litter. Shoots of the indicator crop were harvested every two months after planting.

In the second experiment, apatite was applied with leaf litter collected from a mature *Hevea* plantation. Leaf litter was dried, ground to pass a 1·0 mm seive and was incorporated at the rate of 13·0 g/pot (approx. 4000 kg/ha) in the first three inches of soil to give a concentration of approximately 1·0% of litter in this layer. Apatite was added at the rates of 200 and 400 mg/kg soil. Pots were then covered with black polythene and incubated for one month. At the end of 15 days, soil fungi and bacteria and the P-solubilizers among them were estimated. The indicator crop, *Pueraria phaseoloids* was planted at the end of the incubation period, and shoot harvested after 60 and 120 days of planting.

RESULTS

Dry matter and P contents were higher in both *Stylosanthus* and *Panicum* treated with apatite than in the untreated. The differences were strikingly greater in the case of *Panicum* (Table 1), and only the difference in P content was significant in the case of *Stylosanthus.*

Table 1. *Dry matter (DM) yield and P yield of Stylosanthus and Panicum*

		Mean DM yield (g/pot)	Mean P yield (g/pot)
Stylosanthus	Without apatite	33·47	35·50
	With apatite	41·01	52·34
Panicum	Without apatite	46·05	38·21
	With apatite	66·37	63·09
LSD (P = ·05)		12·73	10·89

Statistical analysis revealed that differences in amount of plant material returned to pots after harvest of first crop did not influence shoot P yield of the indicator crops. There was also no significant interaction between apatite and addition of litter.

Nature of the first crop and apatite influenced the cumulative shoot P yield of the subsequent indicator crop (Table 2). In apatite applied soil it was significantly more when the first crop was *Panicum* than when it was *Stylosanthus*. On the other hand in the absence of apatite the reverse situation obtained. There was a significant increase in P yield of *Panicum* as a result of apatite but not in that of *Stylosanthus*.

Table 2. *Effect of the first crop and apatite on the cumulative shoot P yield of the indicator crop (Pueraria)*

First crop	Shoot P yield (mg/pot)	
	With apatite (A_1)	Without apatite (A_0)
Stylosanthus	45·41	39·07
Panicum	54·25	25·69
LSD (P = 0·5)	8·89	

As there were no significant interactions of the added leaf litter with other factors the main effects are summarized in Table 3. There was no influence of the litter on the shoot P yield of the indicator crop in the first harvest. But both surface application or incorporation of litter significantly increased the total shoot P yield as well as in the 2nd and 3rd harvests.

Table 3. *Effect of litter on the shoot P yield of the indicator crop*

Litter	Shoot P yield (mg/pot) Harvests			Cumulative
	First (60 dap*)	Second (120 dap)	Third (180 dap)	
Surface application	13·21	14·96	19·10	47·27
Incorporation	11·68	14·19	19·96	45·71
Without	9·44	7·55	13·34	30·33
LSD (P = ·05)	NS	3·19	3·34	7·70

*dap — days after planting
NS — Not Significant

Fig. 1 shows that the total microbial biomass (TMB) at intervals of 30, 90 and 150 days. It was not affected by the type of biomass, *Stylo* or *Panicum* and hence the data for two types of material were combined. Litter greatly increased TMB at 30 days after addition compared to the untreated control. With time it decreased in the treated pots but still remained higher than in the untreated control even at 150 days after addition. At 30 days surface application of litter appeared to increase the TMB more than with incorporation into the soil, but this difference disappeared with time.

Table 4. *Effect of apatite on shoot P yield*

Apatite	Shoot P yield (mg/pot) First harvest	Second harvest
Nil	3·22	8·66
200 ppm	6·22	15·72
400 ppm	10·56	19·02
LSD (P = ·05)	1·83	3·52

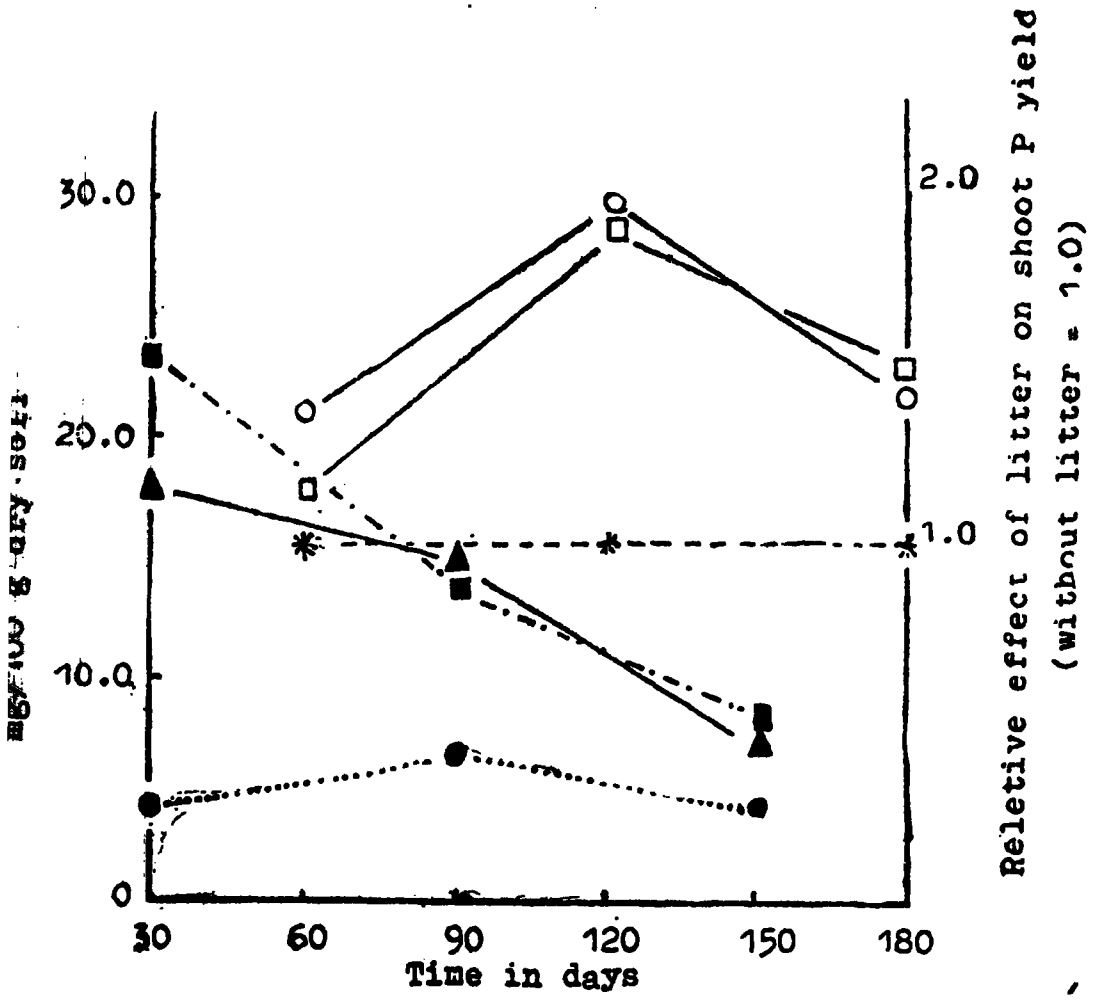
In experiment 2, with increase in the amount of apatite at each step there has been a significant increase in the shoot P yield at both harvests (Table 4). Incorporation of litter significantly increased shoot P yield in the second (final) harvest but not in the first harvest. There was also a striking increase in root growth as a result of litter incorporation (Table 5).

Table 5. *Effect of leaf litter on shoot P yield and root weight*

	Shoot P yield First harvest (60 dap)	Second harvest (120 dap)	Root weight g/pot
With leaf litter	8·26 ns	23·06*	6·2*
Without leaf litter	6·38	11·68	2·9

*Significant at P = ·01
NS — Not significant
dap — days after planting

Colonies of P dissolving bacteria (PDB) and fungi (PDF) were estimated (Table 6) in experiment 2, 15 days after incorporation of phosphate to soil and prior to planting seeds. The results show that number of P solubilizing types is too low to produce any appreciable effect, but incorporation of litter increased the total microbial numbers.



1. Effect of litter on total microbial biomass and reletive shoot P yield. of the indicator crop

- litter surface applied; ▲ - litter incorporated;
- without litter; ○ - litter surface applied;
- litter incorporated; ✱ - without litter

Table 6. *Numbers of PDB and PDF as affected by addition of litter and 15 days of incubation*

	Fungi		Bacteria		Total
	Non - PDF	PDF	Non - PDB	PDB	
With litter	66·5	0·9	84·4	1·6	153·3
Without litter	3·0	0·2	24·2	2·2	29·6

DISCUSSION

Low (1·6%) citric acid solubility of Eppawela apatite has discouraged its use in fast growing (arable) crops. But results here (Tables 1 & 4) reveal large differences between apatite treated and untreated crops within 60 — 120 days suggesting its possible use even with arable crops. Clearly apatite could be used as a source of phosphatic fertilizer for perenial pasture grasses and legumes such as *Panicum maximum, Stylosanthus guyanensis* and *Pueraria phaseoloids.*

Indicator crop took up more P from soil initially with *Panicum* than from soil first with *Stylosanthus.* This may be explained not merely in terms of greater P in the returning shoot material but in terms of greater total organic matter (root biomass included) in the case of *Panicum than Stylosanthus,* and its effect on soil physical and chemical properties that should lead to enhanced root growth and P uptake. This contention is consistent with the data in Tables 3 and 5 and discussed below. Moreover, greater solubilization of apatite by *Panicum* through greater secretion of organic acids as compared to *Stylosanthus* may also be a further factor.

Leaf litter application as mulch or incorporation into soil enhanced availability of P (Tables 3 & 5). Leaf litter is known to be a good source of P to plants. Effects of litter (organic matter) and soil properties and root growth have already been mentioned. Litter effect on root development is clearly indicated in Table 5 and has been reported by others (*e.g.* Othieno, 1973).

It is to be noted in both Tables 3 & 5 that P from added litter becomes available following a long lag phase of more than 60 days. This clearly is due to absorption of P by the litter decomposing microbes. With depletion of energy sources in the litter, microbial breakdown should have (Fig. 1) released P which then become available to plants (see also Birch, 1961).

It is to be noted that although there was improved P uptake due to litter addition, there was no notable influence of litter on P availability from apatite. Such effects, if at all, are reported to be only marginal (Khasewnech and Doll, 1978).

ACKNOWLEDGEMENTS

The authors wish to thank Dr N. Yogaratnam and the staff of the department of Soils and Plant Nutrition for helping in analysis of plant material and Mr W. N. Wickremasinghe and his staff for statistical analysis.

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