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PHOSPHATASE ENZYME ACTIVITIES AND PHOSPHORUS CONTENT IN RICE RHIZOSPHERE SOIL

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ABSTRACT

A pot culture experiment was conducted to study phosphatase enzyme activities of soil as influenced by root system of rice cultivars in acid and alkali soil. In unplanted soil, acid phosphatase and alkaline phosphatase enzyme activities were 0.06 and 0.09 mg/ min of incubation/g of soil respectively and it was higher than that of root-zone soil which recorded the value of 0.03 and 0.04 mg/ min of incubation/g of soil, respectively. The increase in unplanted soil was positively correlated with nitrogen content. In root-zone soil, acid phosphatase and alkaline phosphatase enzyme activities were higher at post harvest stage than maximum tillering stage and it was increased by 26.1 and 19%, respectively. There was no relationship between phosphatase enzyme activity and phosphorus content. The soluble phosphorus content was increased by 19 times in root-zone acid soil and 28 times in root-zone alkali soil when compared to corresponding unplanted soil. It was due to organic acids exudation from roots, formation of soluble complexes between phosphate and metabolites of microbial and plant orgin.

Key words : Rice rhizosphere soil, Phosphatase, Phosphorus

INTRODUCTION

The organic phosphorus in soil exists essentially as esters of phosphoric acid, inositol phosphate, nucleic acids, phospholipids and other simple esters. Mineralization of these organic compounds to inorganic phosphate is brought about by a group of enzymes. Among the various enzymes, phosphatases viz., phosphomonoesterases (acid phosphatase & alkaline phosphatase), phosphodiesterase and phosphotriesterase (Eivazi & Tabatabai (1977) produced by microorganisms and plant roots play a major role in the hydrolysis of soil organic phosphorus, thereby releasing inorganic phosphorus for availability and plant uptake.

The number of organisms in the rhizosphere region is 100 times greater than that of unplanted soil and it is highly influenced the nutrient use efficiency, reduce the loss of nutrients and chemical inputs. Very few studies had been carried out in the root-zone soil. Hence, this research was undertaken to study the relationship between phosphatase enzymes and phosphorus content and also other reasons for increasing phosphorus availability.

MATERIALS AND METHODS

A pot culture experiment was conducted at Agricultural college and Research institute, Killikulam (TNAU). Bulk samples of acid soil was collected from Rice Research Station, Ambasamudram and alkali soil was collected from the Agricultural College and Research Institute, Killikulam and these soils were classified as Typic Ustropepts and Typic Rhodustalfs, respectively.

The soil samples were processed and analyzed for pH and electrical conductivity (Jackson 1973), CEC, ammoniacal nitrogen and total nitrogen (Piper 1966), nitrate nitrogen (Bremner & Keeney 1966), available nitrogen (Subbiah & Asija 1956), organic carbon (Walkley & Black 1934), available-P (Bray & Kurtz 1945), available-K (Stanford & English 1949) and phosphatase enzyme activities by Tabatabai and Bremner (1969) method.

The initial acid soil had a pH of 5.21, EC of 0.10 dS m^{-1}, CEC of 4.20 cmol (p^+) kg^{-1}, organic carbon of 0.94%, organic-N of 513 mg l^{-1} NH_4-N of 28 mg l^{-1}, NO_3-N of 128 mg l^{-1}, available-N of 280.5 mg l^{-1}, total-N of 570 mg l^{-1}, available-P of 26.5 mg l^{-1} and available-K of 111 mg l^{-1}. And the alkali soil had a pH of 8.82, EC of 0.18 dSm^{-1}, CEC of 8.20 cmol (p^+) kg^{-1}, organic carbon of 0.87%, organic-N of 672 mg l^{-1}, NH_4-N of 9.8 mg l^{-1}, NO_3-N of 74 mg l^{-1}, available-N of 214.5 mg l^{-1}, total-N of 540 mg l^{-1}, available-P of 8.5 mg l^{-1} and available-K of 155 mg l^{-1}.

Five kg of processed soil was transferred to specially designed tubular pots of 30 cm height and 20 cm diameter. The soil was hand puddled and the water level was maintained at 5 cm level throughout the experiment period. Twenty-three days old seedlings of the rice varieties ASD-18 and IET-1444 were planted in pots at two population levels equivalent to 66 hills m^{-2} and 115 hills m^{-2}. Ten pots were maintained without any plant (unplanted soil) under above said similar conditions. In other pots, gap filling was done after a week of transplanting to ensure uniform population levels. Fertilizer was applied at the rate of 100-50-50 NPK kg ha^{-1}. Half of the nitrogen, entire phosphorus and potassium were applied as basal. The other half of the nitrogen was applied in two splits; one at the maximum tillering and the other at flowering stage. Adequate plant protection measures were given. At the time of collecting the soil samples from pot, the flood water in the pots were drained, and the pots were gently turned upside down and the soil core was allowed to slide down on a polythene sheet spread on the table. The soil volume permeated by the root system (Rhizosphere soil) was collected and analyzed for phosphatase enzyme activities and various forms of nitrogen. The bulk soil (unplanted soil) was also collected and analyzed for enzyme activities. The data collected were analyzed in FRBD following the procedure given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Phosphatase enzyme activities were more in unplanted soil than that of root zone soil (Figs 1 & 2) due to water logging and high nitrogen content (Table 1). According to Domsch *et al* (1979), the acid and alkaline phosphatase enzyme activities were found to be significantly and positively correlated with microbial biomass. But in this study the root zone environment of rice under puddled condition was not favourable for the microorganisms synthesizing acid and alkaline phosphatases. It was also supported by Halstead (1964), Ross *et al* (1975) and Spiers and McGill (1979).

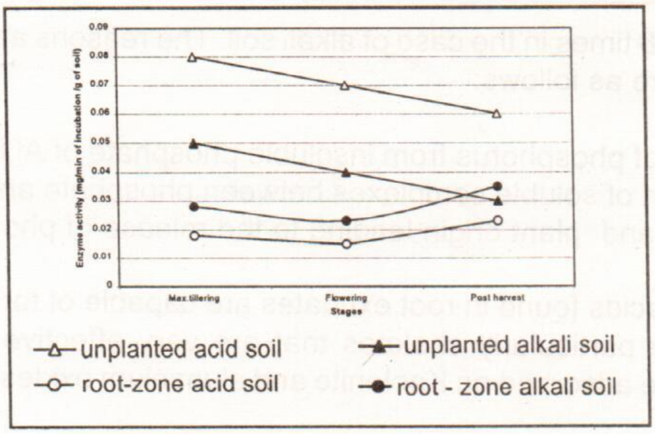

Fig. 1 Changes in acid phosphatase enzyme activity of soil

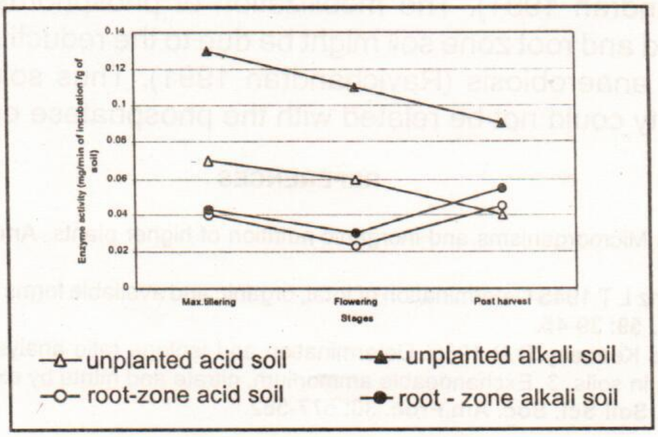

Fig. 2 Changes in alkaline phosphatase enzyme activity of soil

In both acid and alkali soils, the soluble phosphorus content was low under unplanted condition. The acid soil had 0.01 ppm of phosphorus whereas alkali soil had 0.005 ppm. However, under planted condition due to root zone-effect solubilisation of phosphorus increased 19 times in the case of acid soil and 28 times in the case of alkali soil. The reasons attributed for such mobilization are as follows:

Table 1 Changes in available nitrogen, organic nitrogen and total nitrogen in unplanted and root-zone soil

	Unplanted soil		Root-zone soil	
Available-N	388.47	382.43	283.15	224.57
Organic-N	993.33	854.00	953.75	823.81
Total-N	1106.75	995.33	1067.47	977.33

i. Release of phosphorus from insoluble phosphate of Al,Fe,Ca etc.,
ii. Formation of soluble complexes between phosphate and metabolites of microbial and plant origin leading to the release of phosphorus (Barber 1968)
iii. Organic acids found in root exudates are capable of forming complexes and more particularly chelates that are very effective competitors for phosphate adsorbed on Kaolenite and aluminium oxides (Nagarajan *et al* 1970).
iv. Colonization of organic acids and higher concentration of carbon di oxide (Ravichandran 1991). The mobilization of phosphorus under both the unplanted and root zone soil might be due to the reductive process under complex anaerobiosis (Ravichandran 1991). Thus soluble phosphorus availability could not be related with the phosphatase enzyme activity.

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