



## Phosphatase activity and microbial population in pineapple (*Ananas comosus* L.) orchard soils

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### Abstract

The study compares monthly variation in microbial population and acid phosphatase activity (EC 3.1.3.2) in soils of 1 year, 5 year and 10 year old pineapple plantations. Higher phosphatase activity was noted from the 10 year old plantation. Phosphatase activity was maximum during spring period. Bacterial population of soils followed a trend analogous to that of the phosphatase activity. Phosphatase activity correlated positively with soil temperature, organic carbon and bacterial population. Soil moisture, pH and fungal population correlated negatively with phosphatase activity. Variations in phosphatase activity with time as well as due to plantation age were statistically significant.

### Introduction

In mineral soils, ester-bound phosphate represents a potentially valuable source of phosphate required for plant nutrition (Cosgrove, 1967). Soil phosphatases hydrolyse phosphate esters to inorganic phosphate and make them available to higher plants. Thus, phosphatase activity measurements provide an index of potential availability of phosphate in soil (Skujins, 1976). The size of microbial populations in soil can determine the levels of phosphatase activity as microorganisms are the major source of the phosphatases in soils (Greaves and Webley, 1965). Vegetation type (Neal, 1974) cropping system (Khan, 1970) and soil organic matter content (Malcolm and Vaughan, 1979) are some of the important factors affecting phosphatase activity in soil.

Studies on soil phosphatase activity have been generally confined to grasslands forest and agricultural soils (Holford and Cullis, 1985; Harrison, 1983). The orchard soils have not received due attention. The pineapple growers of this region routinely maintain the crop for a decade after planting. The present study was performed to assess seasonal variations in phosphatase activity in the orchard soils and to determine whether the age of pineapple (*Ananas comosus* L.) plantations has any effect on the soil phosphatase activity. With this objective pineapple plantations of three

ages; one year, five year and ten year were selected for the study. The study also examined the relation among various physico-chemical characteristics of soil and microbial populations and phosphatase activity.

### Material and Methods

The study was conducted at the Pineapple Research Station, Nayabunglow (altitude 800m, latitude 25°44'N, longitude 91°53'E). Soils were collected at monthly intervals from the vicinity of the actively growing plant roots. Soil temperature was recorded with the help of soil thermometer. Moisture content of the soil was estimated on w/w basis by drying the soil at 105°C for 24 hours. Soil pH was determined potentiometrically in 1 : 5 (w/w) soil water suspension. Phosphatase activity (acid) was assayed by the method of Tabatabai and Bremner (1969). Warcup's (1950) soil plate method and dilution plate method (Waksman, 1922) were used for the estimation of fungal and bacterial populations respectively.

For chemical analyses soils were air dried and sieved (<0.2 mm). Organic carbon was determined by Walkley and Black's (1943) method. The semi-micro-kjeldahl method as described by Allen (1974) was used for the estimation of percentage nitrogen. Phosphorus was determined calorimetrically by molybdenum blue procedure and potassium by flame photometer (Allen, 1974). Each value reported is the mean of triplicate analyses.

### Results and Discussion

The experimental soil was of a sandy loam type. It contained sand 66.68 per cent, silt 15.77 per cent and clay 17.40 per cent. Moisture content of different plantation soils ranged between 12.50 per cent and 28.97 per cent and pH of three plantation soil was found acidic which ranged between 4.20 and 5.32. Organic carbon content of soils varied from 1.18 to 2.24 per cent while nitrogen content of soils ranged between 0.42 per cent and 0.68 per cent. Available phosphorus of three plantation soils showed a range between 6.0 mg and 11.6 mg 100 g<sup>-1</sup>. The range of exchangeable potassium was 8.6 mg to 22.2 mg 100 g<sup>-1</sup> in all the three plantation soils.

Population estimates for fungi and bacteria are shown in figure 2. Low population of fungi was recorded during winter months in all the three plantation soils. But contrary to the above, Behera and Mukerji (1985) reported higher population of fungi during the same period; could be the above studies were conducted at lower altitudes where winter temperature did not drop beyond the tolerance limit of the fungi. In many cases fungal population increased in March

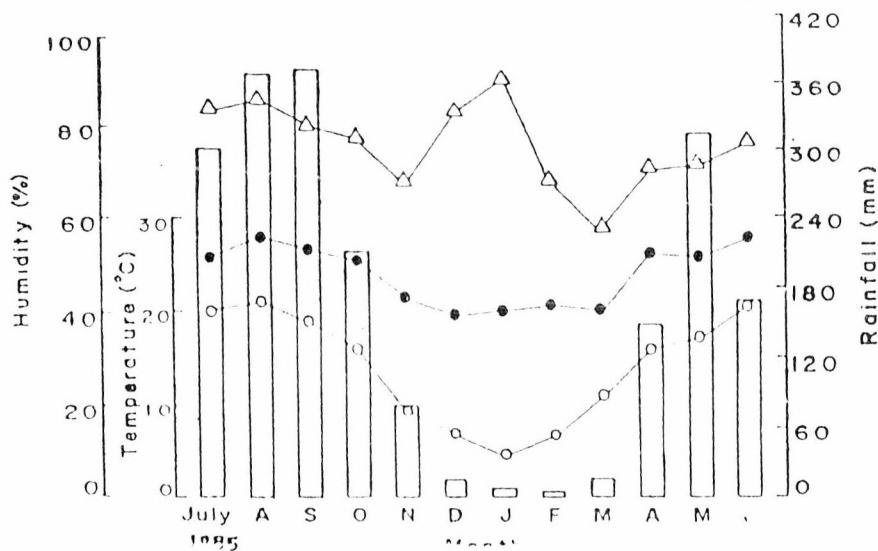


Fig. 1 Monthly variation in rainfall, ambient temperature and relative humidity of the study area. Rainfall : histogram, Maximum temperature : closed circle, Minimum temperature : open circle, Relative humidity : open triangle.

which was followed by a drop in April and with a further increase in May. Increased population during spring may be attributed to increased soil moisture and organic matter contents (Baruah and Mishra, 1983). Two peaks in bacterial number were recorded one in September and another in April. In September the higher moisture level of soils might be responsible for the increased bacterial population. Higher bacterial population during spring (April) may also be due to increase in moisture which could bring under solution the nutrients from decomposing and senescent leaves as most leaf litter decomposition occurs during this period. During winter months the bacterial population depleted to a minimum which may be attributed to low temperature and/or depletion of the available soluble organic nutrients. Generally, bacterial population was higher in ten year plantation soils followed by five year and one year plantations soils. The fungal population was maximum in one year plantation soil. Seasonal variation in microbial (fungi and bacteria) population is attributable to the changes in soil organic matter content, moisture, temperature and pH (Mishra and Kanaujia, 1972).

Data on phosphatase activity are presented in figure 2. Soil from ten year plantation had the highest levels of activity followed by five year and one year old plantations. Phosphatase activity peaked in the month of April. Bacterial population of soils followed analogous trends to that of phosphatase activity in monthly

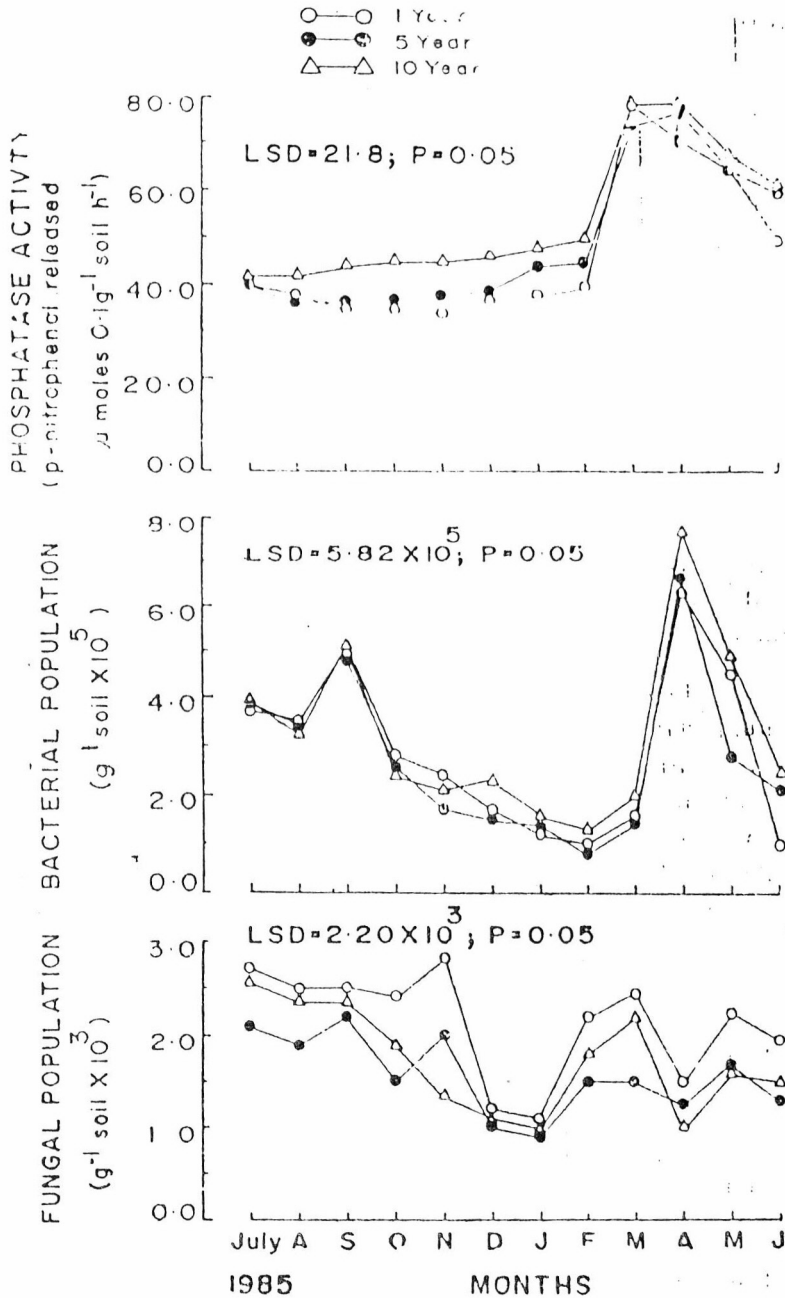


Fig. 2 Monthly variation in microbial (fungi and bacteria) population and phosphatase activity of soils.

TABLE I

Correlation coefficient (r) values between phosphatase activity and physico-chemical characteristics of the soils.  
 1) One year plantation 2) Five year plantation 3) Ten year plantation

	Soil temperature	Soil moisture	Soil pH	Organic carbon	Total nitrogen	Available phosphorus	Exchangeable potassium	Fungal population	Bacterial population
Phosphatase activity									
1-	.679‡	NS	-.481*	.670‡	.724‡	NS	.48‡*	NS	.503*
2-	.580‡	NS	NS	.665‡	NS	NS	.528‡	NS	.736‡
3-	.533‡	NS	NS	.541‡	.518*	NS	NS	NS	.717‡

Values marked with \*, †, ‡ are significant at 0.05, 0.01 and 0.001 probability levels respectively.  
 NS = Not significant.

variation. Possibly it is the temperature which regulate both the bacterial number as well as the rate of enzyme activity. Higher phosphatase activity in the month of April may be attributed to the higher temperature and higher bacterial populations. Appiah and Thomas (1982) have also reported similar results. In another study we have also observed higher levels of dehydrogenase in orchard soils during the same period (Tiwari *et al.*, 1987a). Tiwari *et al.*, (1987b) have also demonstrated that soil moisture significantly alters the microbial population, its activity and the relationships between various parameters.

Phosphatase activity was found positively correlated with organic carbon, total nitrogen, exchangeable potassium, bacterial population and soil temperature (Table I). Soil moisture, pH, available phosphorus and fungal population did not correlate with the phosphatase activity (Table I). Phosphatase activity was generally higher in older plantations. Both monthly variations in phosphatase activity and differences between plantations in activity levels were statistically significant (Table II).

TABLE II

Analysis of variance of phosphatase activity in soils over 12 months

Source of variation	Degrees of freedom	Sum of squares	ratio	Significance
Between plantations	2	37373	33.39	P 5%
Between months	11	666134	108.22	P 1%
Residual	22	12310		
Total	35	715817		

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