Proc. Indian natn. Sci. Acad. B53 No. 2 pp 173-176 (1987)

Temporal and Depth-wise Variations in Dehydrogenase and Urease Activities and Bacterial Population in Pineapple Plantation Soils

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(Received 29 December 1986; after revision 2 May 1987)

The study reports monthly and depth wise variations in dehydrogenase and urease activities and bacterial population in soils under pineapple plantations for 1–10 years. Generally, surface (0–10 cm) soils showed higher bacterial population and enzymatic activities. Bacterial population as well as activities of both the enzymes were higher during spring (March–May) and lower during winter months.

Key Words: Soil, Bacteria, Urease, Dehydrogenase

Introduction

Soil enzyme activity estimates are often used as indices of microbial activity and soil fertility (Skujins 1978). Most studies on microbial population and their activities have been confined to forests, grasslands and agricultural soils (Das & Mishra 1986, Dormaar et al. 1984, Baruah & Mishra 1984). The soils of orchard crops differ to a great extent from the above soils in physical, chemical and biological characteristics as these soils are neither tilled annually nor left fallow for a very long time. Microbiological and biochemical studies on soils under orchard crops have not received sufficient attention (Paylenko 1985).

The present paper aims to study the temporal and depth-wise variation in microbial activities of soil under pineapple cultivation.

Materials and Methods

The study was conducted at the Pineapple Research Station, Nayabaunglow (altitude 800 m, latitude 25°44″N, longitude 91°53′E). Pineapple plantations of three ages namely, 1, 5 and 10 year old were selected for the study. Total size of the farm was approximately 15 ha and the plantations of three ages were grown side by side for experimental purposes. The soil was sandy loam. Data on rainfall, minimum and maximum temperature and humidity have been shown in figure 1.

Soils from 0–10, 10–20 and 20–30 cm depths were collected at monthly intervals using a sterilized soil sampler. Soil temperature was noted using soil thermometer at the time of sampling. Percentage moisture was estimated on W/W basis by drying the soil at 105°C for 24 hr. *p*H was determined using digital *p*H meter in 1 : 5 soil-water suspension (Jackson 1973). Walkley and Black's (1934) rapid titration method was followed for determination of organic carbon of soil. Dehydrogenase activity was assayed by 2,3,5 triphenyl tetrazolium chloride (TTC) reduction technique (Casida 1977). Urease activity was assayed following McGarity and Mayers (1967). Dilution plate method was followed for enumeration of bacteria on nutrient agar medium (Waksman 1922). Estimations were done for the three age plantations (1–10 years); however, data are clumped together as statistical analysis of variance showed that the variations due to age were not significant. Values given in table and figures are means of nine estimations.

Results

The soil temperature ranged between 14 and 30°C. Moisture content of the soil varied from 13% to 30%. *p*H of soils ranged between 4.2 and 5.9 and organic carbon content of soil varied between 0.5% and 2.25% (table 1).

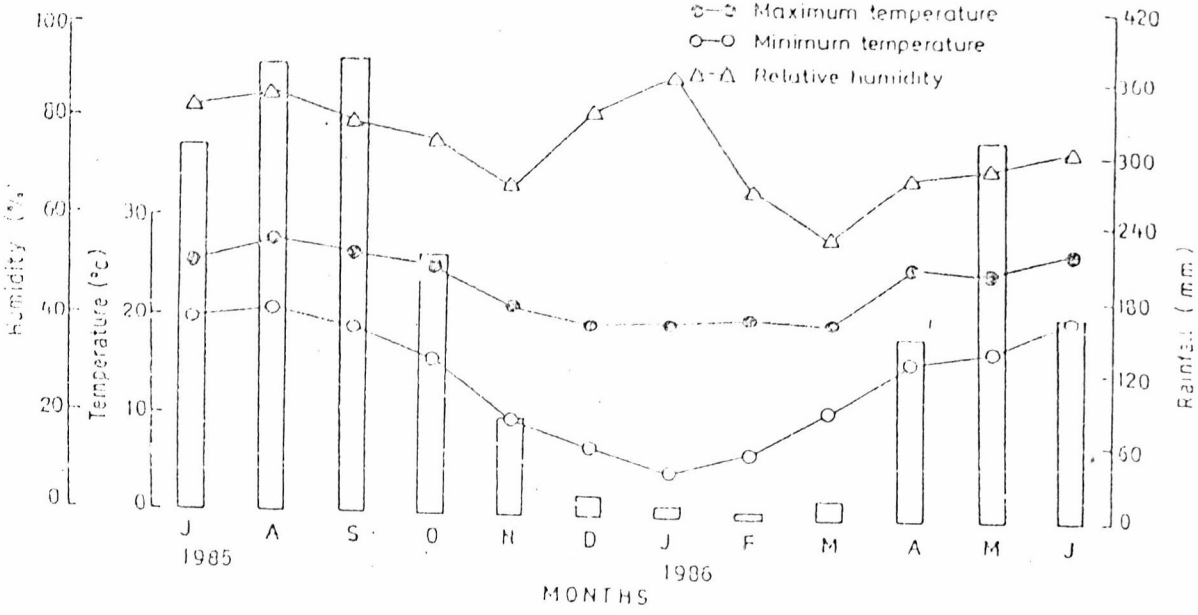


Figure 1 Monthly variation in rainfall (histogram), ambient temperature and relative humidity of the study area

Table 1 *pH and organic carbon (%) of soil under pineapple plantation. Values are means (±SE) of 12 estimations as monthly intervals*

Depths (cm)	pH	Organic carbon (%)
0–10	5.05 ± .034	1.76 ± .054
10–20	4.96 ± .029	1.64 ± .055
20–30	4.89 ± .040	1.39 ± .059

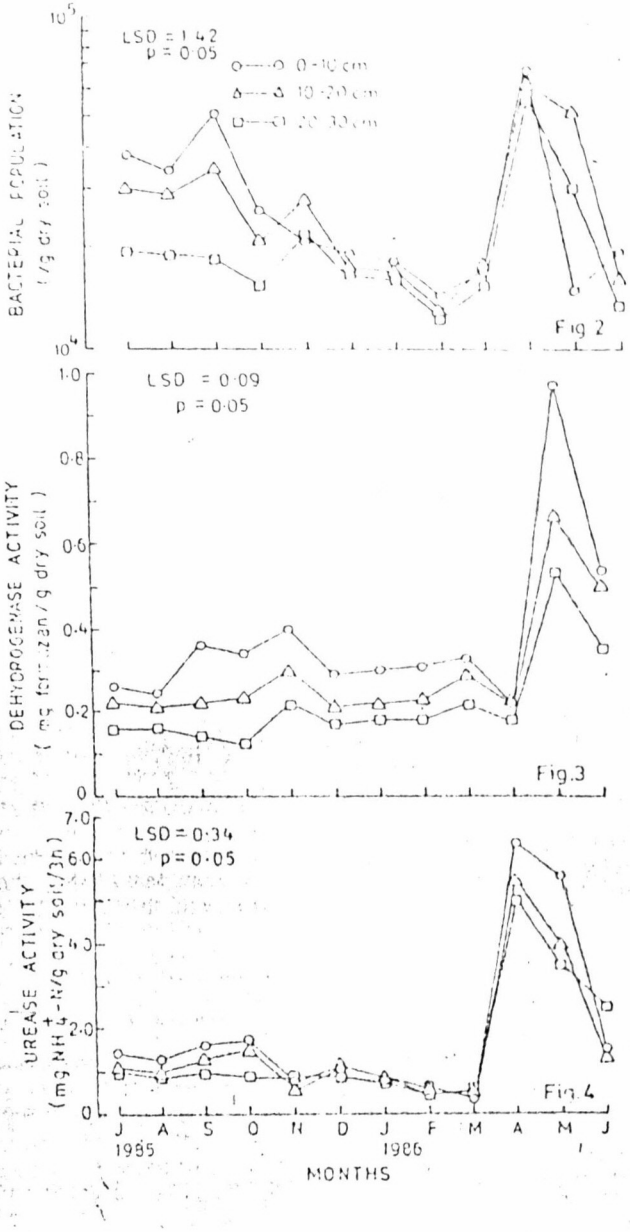
Population estimates of bacteria are given in figure 2. The total density of bacteria was generally higher in the surface soil. Two peaks were recorded, one in September and another in April. Minimum density was recorded in winter while maximum was noted in April. Monthly variation in dehydrogenase activity is depicted in figure 3. Maximum dehydrogenase activity was recorded in May in surface soil. During most period dehydrogenase activity varied within a narrow range.

Urease activity was generally higher in surface soil (figure 4) and did not show significant difference along depths. Maximum urease activity was recorded in the months of April. Almost similar temporal trends occurred for all depths.

Discussion

Bacterial population was always higher in surface soil which might be due to high amounts of organic carbon, higher aeration, temperature and favourable moisture. Similar observations were also reported by Yamamoto and Glenn (1985) and Tiiu (1982). In September higher moisture level of surface soil of the plantation might have resulted in the increased bacterial population. The drop in bacterial population during winter may be attributed to low temperature of the soil. Higher bacterial density during March and April may be due to increase in moisture which could solubilize some of the organic matter from decomposing and senescen. leaves as most leaf litters are added to the soil during this period.

Higher dehydrogenase activity occurred in the surface soil which might be due to higher bacterial population and higher amount of organic carbon (Dash et al



Figures 2–4. Monthly variation in: 2, Bacterial population; 3, Dehydrogenase activity; and 4, Urease activity

1985). Maximum dehydrogenase activity during March and April may be due to higher bacterial density and increased moisture level as also observed by Baruah and Mishra (1984).

Higher urease activity during April and May in surface soil of the plantation may be due to higher organic carbon, bacterial population and favourable moisture (O'Tool et al. 1985). Sahrawat (1984) noted that urease activity increased with the increase in soil temperature while Peri et al. (1978) found that the activity was principally associated with the organic carbon content of the soils. Similar results were also observed in the present study.

Similar trends in bacterial density and enzyme activities show that most of these parameters are governed by same or similar set of environmental factors. Soil temperature, moisture and organic carbon appear to be most important factors that regulate the bacterial population as well as activities of urease and dehydrogenase enzymes. The seasonal pattern in microbial activity is more like forest soils of this region (Das & Mishra 1986) than the soil under annual crops (Baruah & Mishra 1984). It appears that within the same climatic belt the seasonality of microbial activity differs widely depending on the types of vegetation and agricultural practice.

Acknowledgement

One of the authors (S. C. T.) thanks the Council of Scientific and Industrial Research, New Delhi for a Junior Research Fellowship.

References

Baruah M. and Mishra R. R. 1984 Dehydrogenase and urease activities in rice field soils; *Soil Biol. Biochem.* 16 423–424

Bera V., Goswami K. P. and Brar S. S. 1978 Urease activity and its michaelis constant for soil systems; *Pl. Soil* 49 105–115

Casida L. E. 1977 Microbial metabolic activity in soil as measured by dehydrogenase determinations; *Appl. Environ. Microbiol.* 34 630–636

Das B. K. and Mishra R. R. 1986 Dehydrogenase activity and CO_2 evolution from *Pinus kesiya* Ex-Gordon forest soil; *Geobios* 13 12–15

Dash M. C., Mishra P. C., Mohanty R. K. and Bhatt N. 1981 Effect of specific conductance and temperature on urease activity in some Indian soils; *Soil Biol. Biochem.* 13 73–74

Doxtader J. F., Johnston A. and Smoliak S. 1984 Seasonal changes in carbon content and dehydrogenase, phosphatase, and urease activities in mixed prairie and fescue grassland ah horizons; *J. Range Manage.* 37 31–35

Jackson M. L. 1973 *Soil Chemical Analysis* New Delhi: Prentice Hall India (P) Limited) 485

McGinity J. W. and Mayers M. G. 1967 A survey of urease activity in soils of northern New South Wales; *Pl. Soil* 27 237–238

O'Tool E. P., Morgan M. A. and McGarry S. J. 1985 A comparative study of urease activity in pasture and tillage soils; *Soil Sci. Plant Anal.* 16 759–774

Pavlenko V. F. 1985 Microflora and biochemical activity of the soil in rhizosphere of the apple tree at various depths; *Dokl. Akad. Nauk Ukr. Ssr. Ser. B (Geol. Khim. Biol. Nauki)* 7 75–78

Sahrawat K. L. 1984 Effect of temperature and moisture on urease activity in semiarid tropical soils; *Pl. Soil* 78 301–308

Skujins J. 1978 History of abiontic soil enzyme. in *Soil Enzymes* pp 1–4 ed R. G. Burns (London: academic Press)

Tiu K. 1982 Seasonal fluctuations in numbers of aerobic bacteria and their spores in four horizons of a beech forest soil; *Soil Biol. Biochem.* 14 185–190

Waksman J. H. 1922 A method of counting the numbers of fungi in the soil; *J. Bact.* 7 339–341

Walkley A. and Black I. A. 1934 An examination of the Degtjareff method for determining soil organic matter and proposed modification of the chromic acid titration method; *Soil Sci.* 37 29–38

Yamamoto N. and Glenn L. 1985 Bacterial abundance in relation to surface area and organic content of marine sediments; *J. Exp. Mar. Biol. Ecol.* 90 209–220