STUDIES ON MICROBIAL COMMUNITIES AND THEIR ACTIVITIES IN SOILS OF PINEAPPLE PLANTATIONS

By

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C O N T E N T S

G E N E R A L   I N T R O D U C T I O N

Climate and edaphic conditions of north-eastern India is favourable for the cultivation of pineapple (Ananas comosus L.) and during recent years it is the most important cash crop of this region. Establishment of fruit pulp based industries and improved marketing facilities during recent years have given added boost to this crop. Total area under this crop is on increase and growers are getting better price for their produce. In addition to the direct economic gains, the cultivation of pineapple also helps in conservation of top soils on hill slopes as the roots of this plant have tremendous soil binding capacity. Importance of bacteria and fungi in soil ecosystem can hardly be over emphasised. They are responsible for the breakdown of complex organic compounds, transformation of nutrients in soil and for the improvement of soil structure. The population and activity of microbes are generally governed by the climate, physico-chemical characteristics of soil and plant cover (Waksman, 1952; Mishra and Kanaujia, 1972; Tyagi, 1975; Kauri, 1982; Dunn et al. 1985; Tiwari et al. 1987 a). During recent times much emphasis is laid on the activity of microorganisms in the soil. Generally, the rates of microbial mediated biochemical reactions are used for this purpose as they provide an index of microbial activity (Skujins, 1978). Dehydrogenase, urease and phosphatase are commonly used for this purpose. Dehydrogenase being a respiratory enzyme provides a measure of catabolic activity (Lenhard, 1956; Stevenson, 1959; Casida *et al*. 1964. Urease acts as an intermediary enzyme in the transformation of organic nitrogen, while phosphatase provides an estimate of breakdown of organic phosphate compound and release of phosphate in the soil (Cosgrove, 1967). The estimation of the activity of these enzymes provides an assessment of three different microbe-mediated processes in soil and the estimation of the activity of the three enzymes in soil gives the most reliable measure of microbial activity.

During the last three decades a large number of studies on relationship of enzymes activities with the physico-chemical and biological characteristics of soils have been carried out. A close positive relationship of dehydrogenase has been reported with CO_2 release, O_2 uptake, microbial number, organic carbon, soil moisture, temperature, pH etc. (Kuprevich and Scherbakova, 1971; Skujins, 1973; 1976; Casida, 1977; Speir, 1977; Dash *et al*. 1981; Baruah and Mishra, 1984; Rao and Ghai, 1985; Das and Mishra, 1986; Tiwari *et al*. 1987 b). Contrary to the above, Gray and Williams (1971 b) did not find correlation between dehydrogenase activity and microbial numbers. Urease activity has been found to be positively correlated with microbial biomass and number, organic carbon, total nitrogen, available phosphorus, potassium, soil moisture, temperature, pH and cation exchange capacity of soils (Skujins, 1973; Dalal, 1975; O'Toole *et al*. 1982;1985; Dkhar and Mishra, 1983;

O'Toole and Morgan, 1984; Sahrawat, 1980, 1983, 1984; Baruah and Mishra, 1984). However, Zantua et al. (1977) reported that urease activity negatively correlates with the organic carbon, pH and cation exchange capacity of soils. Like dehydrogenase and urease, phosphatase activity has also been reported to be positively correlated with microbial biomass, organic carbon, total nitrogen, exchangeable phosphorus, soil moisture, pH and clay + silt content of soils (Speir, 1977; Ladd, 1978; Klein and Koths, 1980; Speir and Ross, 1981; Appiah and Thomas, 1982; Frankerberger and Dick, 1983; Harrison, 1983). The variations in the pattern of relationship between enzyme activities and soil characteristics have been generally attributed to the difference in soil characteristics, vegetation type, cropping system and use of agro-chemicals.

Studies of various workers (Warcup, 1957; Dwivedi, 1966; Mishra, 1966; 1968; Prakash and Khan, 1971; Wong, 1975; Martinez and Remirez, 1979) have demonstrated that climatic and edaphic factors modify the distribution of soil microbes. Agricultural activities and burning practices greatly affect the soil microflora (Tiwari and Rai, 1977; Hattori, 1973).

Most of the carbon dioxide evolved from the soils comes from the microbial respiration (Smith and Brown, 1932) and, therefore, it has been used as a measure of microbial activity Wagner, 1975; Julia and Pedziwilk, 1985). CO_2 concentration in the soil affects the soil pH, nutrient availability, redox potential, organic matter decomposition and microbes number (Bohn et al. 1979 ' Alexander, 1977). A positive correlation between CO_2 evolution and various physico-chemical and microbiological characteristics of the soil has been noted by several workers (Singh and Gupta, 1977; Singh, 1984; Keeney et al. 1985; Das and Mishra, 1986; Baruah and Mishra, 1986; Dkhar and Mishra, 1987; Tiwari et al. 1987 c).

Since soil enzyme-systems are associated with organic residue management burying of crop residues into the soil not only plays an important role in chemical and biological environment of the soil, it also affects the rate at which nutrients become available to crop plants as well as to other forms of life in the soil (Power and Legg, 1978). Fungi and bacteria play an important role in the process of plant litter decomposition. A large amount of plant litter is added annually to the soil through leaf fall and death of plants and animals. Studies on decomposition provide information on the rate of turn over of the nutrients. The rate of decomposition is governed by the climate (Shukla et al. 1978; Shukla and Singh, 1984), soil microbial population (Witkamp, 1963; Mishra, 1979) and chemical composition of litter (Christensen, 1986). It is envisaged that the study on the microbial succession and chemical change in the litter would help to understand the complex process of decomposition of pineapple litters.

Earthworms are beneficial to the soil as they represent a large part of the soil faunal biomass. They play an important role in improving the soil fertility by influencing aeration, water retaining capacity and nutrient status (McColl et al. 1982). Earthworms also play an important role in plant litter decomposition. They are mainly responsible for the distribution of microbial communities by feeding on soil at one place and laying their casts at another (Lofty, 1974; Dash et al. 1979). Activities of earthworms significantly affect the physico-chemical and biological properties of soils. A comparative study on microbial population and their activities (dehydrogenase, urease, phosphatase) in earthworm casts and the surrounding soil would help to understand that how microbial population and their activities are altered in the soils after passing through the guts of earthworm.

The study has been dealt under following headings :

1. Temporal and depth-wise variations in physico-chemical characteristics of pineapple orchard soils.
2. Temporal and depth-wise variations in microbial population and their activities in pineapple orchard soil.
   (i) Estimations of microbial population (fungi and bacteria).
   (ii) Determination of dehydrogenase, urease, phosphatase activity and CO_2 evolution.

3. Microbial decomposition of pineapple litter (leaf and root).
4. Estimation of earthworm population in pineapple orchard soil.
5. Estimation of microbial population and their activities in casts of earthworms and in the surrounding soils of pineapple orchard.