

MICROBIOLOGICAL AND ENZYME ACTIVITIES PROFILE IN THE ROOT ZONE AND INTERSPACE SOILS OF COCONUT AND ARECANUT PALMS *

B. M. BOPAIAH

Central Plantation Crops Research Institute, Kasaragod 670 124, Kerala, India

ABSTRACT

The microflora, enzyme activities, carbon and nitrogen mineralisation at three soil depths in the root zone and interspaces of coconut and arecanut palms were studied. The bacteria and fungi were more in the root zone soils of both the crops as compared to their respective interspace soils. Urease, phosphatase and dehydrogenase activities were greater in the root zone soils of coconut as compared to the interspace soils. In arecanut, only urease and phosphatase activities were higher in the root zone soils. Seasonal variation in the population of bacteria, fungi and actinomycetes was studied. Among fungi, *Trichoderma* spp. (30.5-49.0%) and *Aspergillus* spp. / *Penicillium* spp. (11.4 to 29.0%) were dominant in the root zone of arecanut palm. The carbon and nitrogen mineralisation was higher in the root zone soil in both the crops as compared to the interspace soil.

INTRODUCTION

The nature and activities of microflora depends on the crop grown and management practices. As the spread and concentration of root varies in the soil the microflora and their activities in the basin and interspaces of palms are influenced. In coconut about 74% of the roots do not extend beyond 2m from the bole and the vertical distribution is 0-120 cm (Kushwah et al., 1973). Bhat and Leela (1969) reported that in arecanut 60-67% of major roots and 57% of fine roots are confined within 50cm radius from the basin. The rhizosphere microflora of coconut and arecanut have been studied by some workers (Nair and Subba Rao, 1976,

Potty, Mathew George, and Jayasankar, 1977; Bopaiah, 1979; Bopaiah and Kott Reddy, 1982). But in the present investigation in addition to soil microflora, the enzyme activities and the mineralization of carbon and nitrogen in three soil depths both in the root zone and interspaces of coconut and arecanut palms were studied.

MATERIALS AND METHODS

Soil samples were collected from a 20 year old coconut garden at Central Plantation Crops Research Institute, Kasaragod, Kerala. Soil is sandy loam with acidic pH (5.2-5.5). In arecanut, samples were collected from 18 year old areca garden of Central Plantation Crops

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Research Institute, Regional Station, Vittal, Karnataka where the soil is laterite with acidic pH (5.0-5.5). Sampling was done from 5 palms using soil auger both from the basin and interspace region. The root zone (basin) soils were collected from 100 cm and 60 cm from the base of coconut and arecanut palms respectively. The interspace soils were collected from the centre of the four palms.

Soil dilution plate count method was followed for the enumeration of microflora (Allen, 1957). The bacteria, fungus and actinomycete counts were enumerated using nutrient agar, Martins Rose Bengal agar and Kuters agar respectively. The urease, (Pancholi and Rice, 1973), dehydrogenase (Casida, Klein and Santoro, 1964) and phosphatase (Tabatabai and Bremner, 1969) enzyme activities were assayed. The carbon (Primer and Schmidt, 1964) and nitrogen (Stanford and Smith 1973) mineralisation *in vitro* was studied. The carbon mineralisation rate was also studied with cellulose (0.5%) amendment. The pH of the soil (1:2.5 ratio soil: water) and the organic C content of the soil was determined (Walkley and Black, 1965).

Soil samples were collected at monthly intervals from the root zone of areca palms (0-25 cm depth) to monitor the population dynamics of bacteria, fungi and actinomycetes. The percentage occurrence of *Trichoderma*, *Aspergillus*/*Penicillium* and other fungi groups were recorded.

RESULTS AND DISCUSSION

The data on microflora and enzyme activities in the root zone and interspace

soils of coconut and arecanut are presented in Table I. Bacteria and fungi were more in the root zone soil as compared to the interspace soil in both coconut and arecanut. The surface soil (0-25 cm) recorded higher microbial load than at the other two depths (26-50 and 51-100 cm). The bacteria and fungi were more in 0-15 and 16-30 cm depth soil between the lateral distance of 30 cm and the population decreased at lower depths (31-45 and 46-60cm) in arecanut palms (Bopaiah and Koti Reddy, 1982). The urease and phosphatase activities were greater in 0-25cm depth and the enzyme activities decreased with depth in coconut. In arecanut soils only urease and dehydrogenase activities were less in the interspace soils, whereas the phosphatase activity was greater in 0-25 and 26-50cm depth as compared to root zone soils. Several workers have reported that the urease and phosphatase activity decreased with depth (Musa and Mukhtar, 1969; Kiss, Dragan Bularda and Radulescu 1975; Hault and Mc Garity, 1986). The type of plants grown in a soil have a marked effect with enzyme activities (Khan, 1970; Kiss et al, 1975; Dalal, 1982; Dick, 1984).

The population dynamics of bacteria, fungi and actinomycetes in the root zone soils of areca indicated that bacterial numbers were less from March to May and fungi from March to July (Table II). Among the fungi, *Trichoderma* spp. (30-49%) and *Aspergillus* spp. / *Penicillium* spp. (11.4-29.0%) were predominant in the root zone of areca palms.

The carbon and nitrogen mineralisation rates were higher in the surface

Table I. *Microflora and enzyme activities profile in the root zone and interspace soil of coconut and arecanut palms**

Place of collection	Soil depth (cm)	Bacteria X 10 ⁴	Fungi X 10 ³	Actinomy-cetes X 10 ⁴	Urease (μ g NH ₄ formed/g soil/h)	Phosphatase (μ g P-nitro-phenol/g soil/h)	Dehydroge-nase (μ g formazon/g soil/h)
<i>Coconut</i>							
Basin	0-25	45.7	36.6	4.7	5.02	122.5	1.76
	26-50	29.9	13.9	2.0	3.65	80.5	×
	51-100	13.8	4.7	1.4	2.68	42.0	×
Interspace	0-25	6.8	12.6	1.8	3.60	40.8	0.67
	25-50	15.8	4.8	2.3	4.04	23.9	×
	51-100	3.1	4.3	1.5	2.33	20.4	×
<i>Arecanut</i>							
Basin	0-25	242.0	53.3	1.4	7.7	150.7	1.34
	26-50	159.0	27.9	1.8	5.5	93.0	×
	51-100	88.0	20.7	2.3	3.9	75.7	×
Interspace	0-25	44.9	24.4	5.1	4.5	161.7	0.65
	26-56	19.2	20.0	1.8	3.9	134.3	×
	51-100	10.4	8.7	1.7	1.8	67.3	×

* Average of 5 values × Not determined

Table II. *Seasonal variation in soil microflora and percentage occurrence of different fungi in the root zone of areca palm**

Month	Bacteria X 10 ⁵	Fungi X 10 ³	Actinomycetes X 10 ⁵	Trichoderma	Aspergillus/ Penicillium	Other fungi
Jan.	28.4	14.2	4.6	43.4	22.0	34.6
Feb.	21.2	18.5	3.4	41.5	24.3	32.5
March	14.9	12.9	2.3	40.3	29.1	35.4
April	12.0	15.1	2.8	39.2	18.8	44.7
May	12.3	11.4	2.8	45.2	19.5	36.0
June	17.2	11.8	2.4	49.0	21.3	31.5
July	20.3	11.3	1.9	32.4	22.3	38.3
Aug.	21.3	12.9	2.8	48.5	23.9	30.2
Sep.	20.8	17.5	1.6	41.2	18.6	35.3
Oct.	24.2	19.8	2.5	30.5	15.8	50.9
Nov.	21.6	15.3	2.9	39.5	16.5	44.0
Dec.	22.7	15.0	4.1	40.5	11.4	48.1

* Average of 6 samples

soils in both root zone and interspace of coconut and arecanut (Table III). Two to three fold increase in carbon mineralisation was observed in cellulose (0.5%) amended soil. In the case of nitrogen mineralization, $\text{NH}_4\text{-N}$ and $\text{NO}_3\text{-N}$ concentration was slightly higher in the root zone soils of coconut, wherein arecanut soil, $\text{NO}_3\text{-N}$ was more in the root zone soils and $\text{NH}_4\text{-N}$ was less as compared to interspace soils. The soil pH tended to increase with depth resulting in soil acidity and the organic carbon also decreased with depth.

Urease and phosphatase activities of jute soils were positively correlated with organic C, fungi and bacteria (Tarafder, Roy and Mandal, 1981). Similarly in the present investigation, the reduction in microflora, enzyme activities and C and N mineralisation at lower depths can be attributed to acidity and organic C content of the soil. Thus the present study has revealed an activity gradient both in the root zone (basin) and interspace soils of coconut and arecanut palms.

Table III. Carbon and nitrogen mineralisation in the root zone and interspace soil of coconut and arecanut palm *

Place of sampling	Soil depth (cm)	Soil pH	Organic carbon %	Carbon mineralisation (mg/100g soil)		Nitrogen mineralisation (mg/100g soil)	
				Native carbon	Cellulose (0.5%)	$\text{NH}_4\text{-N}$	$\text{NO}_3\text{-N}$
<i>Coconut</i>							
Coconut basin	0-25	5.50	0.32	38.2	100.5	0.84	4.9
	26-50	5.28	0.19	24.0	61.2	0.16	3.7
	51-100	4.44	0.10	13.2	38.4	0.10	2.6
Coconut Inter-space	0-25	5.40	0.21	12.0	63.4	0.18	4.6
	26-50	4.93	0.11	19.0	75.8	0.10	4.9
	51-100	4.80	0.06	18.0	48.7	0.08	2.3
<i>Arecanut</i>							
Areca basin	0-25	5.31	0.92	54.3	120.5	0.10	7.4
	26-50	5.05	0.52	21.2	77.4	0.08	5.3
Areca Inter-space	0-25	5.32	0.65	25.6	90.5	0.16	6.0
	26-5	5.00	0.45	18.8	72.6	0.26	3.6

* Average of 5 values

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