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SOIL MICROFLORA AND VA-MYCORRHIZAE IN ARECA BASED HIGH DENSITY MULTISPECIES CROPPING AND ARECA MONOCROPPING SYSTEMS*

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ABSTRACT

Soil microflora in the root zone and rhizosphere of areca based high density multispecies (HDMS) cropping and areca monocropping systems were studied. The population of bacteria, fungi, actinomycetes, N_2–fixers and P–solubilizers were more in the rhizosphere as compared to their respective root zone soils in various crops. The bacterial numbers were more in the root region and rhizosphere of areca, cacao and pineapple in HDMS cropping system as compared to areca monocropping system. The N_2–fixers were more in rhizosphere and root region of cacao as compared to other crops. The spore count, VAM root infection (%) and extent of root colonization (%) was least in banana and coffee. Microbial biomass in soil (CO_2–C, N and P in biomass) was higher in areca HDMS cropping system as compared to areca monocropping system.

INTRODUCTION

The practice of growing other crops in areca gardens is a common practice. The intensive cropping systems involving areca are essentially crop combinations, which envisage the cultivation of other compatible crops in the interspaces between the palms. The nature and the activity of microflora and fauna in a given environment depends upon the crops grown and management practices. The activity of rhizosphere and root zone microflora can affect the nutrient uptake (Bower and Rovira, 1968; Nair and Subba Rao, 1977). The distribution of microflora in soil profile and the nature of rhizosphere microorganisms of areca monocropping system have been studied (Bopaiah, 1979; Bopaiah and Koti Reddy, 1982). The nature and activity of microorganisms associated with perennial monocrop, can change with introduction of other crops. This study compares the microflora in the root zone and rhizosphere of areca based high density multispecies cropping and areca monocrop.

MATERIALS AND METHODS

The experiment on areca based high density multispecies cropping consisting of cacao, banana, pineapple, pepper, coffee and clove crop combinations in the interspaces was initiated in a 17 year old areca garden at CPCRI, Regional Station, Vittal in 1983. The samples were collected in October, 1986 for the various studies from the root zone and rhizosphere of various crops and from the areca monocropping plot. The bacterial, fungal and actinomycetes were enumerated quantitatively using soil extract agar, Martins' rose bengal agar and Kusters' agar medium respectively by soil dilution and plate count method (Allen, 1957). The

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enumeration of N_2–fixers was carried out using Waksman's media No. 77 and Beeking's medium (Beeking, 1959). The phosphate solubilizing organisms were counted following method of Katznelson and Bose (1959).

The enumeration of nitrifying bacteria such as *Nitrosomonas* and *Nitrobacter* from the root region soils of various crops was carried out by following the most probable number method (Alexander and Clark, 1965). The endogone spores were extracted by wet sieving and decanting technique (Gerdemann and Nicolson, 1963). Roots were collected from five plants each (10 roots from each plant) for the VA–mycorrhizal colonisation studies. The processing and staining of roots for VA–mycorrhizal infection was carried out following the procedure outlined by Phillips and Hayman, (1970).

The soil microbial biomass was determined following the chloroform fumigation technique (Jenkinson and Powlson, 1976) and the biomass C and N were calculated (Jenkinson and Ladd, 1981).

RESULTS AND DISCUSSION

The microflora population in the rhizosphere and root zone of areca based high density cropping system and areca monocropping system are presented in Table I. In general, the bacterial, fungal and actinomycetes numbers were more in the rhizosphere of various crops than their respective root zone soils. Bacterial and fungal counts were more in the rhizosphere and root region of pineapple. The population of actinomycetes did not reveal any difference in the various crops studied. The greater microbial population in the rhizosphere might be due to the availability of root exudates. Rhizosphere is characterized by greater

Table I. *Soil microflora in the rhizosphere and root zone of areca based high density multispecies cropping system*

Crop		Soil moisture (%)	Bacteria* (R x 10^6) (RZ x 10^5)	Fungi* (x 10^3)	Actinomycetes* (x 10^5)
High density cropping system					
Areca	R**	14.1	12.0	10.5	1.4
	RZ**	13.8	9.5	5.9	0.6
Cacao	R	13.7	16.5	8.4	1.1
	RZ	13.3	10.6	5.3	0.4
Banana	R	15.3	9.7	10.0	2.1
	RZ	12.3	4.5	2.1	0.7
Pineapple	R	17.7	20.1	10.3	1.6
	RZ	17.5	19.6	8.3	0.7
Monocropping system					
Areca	R	13.0	10.5	10.2	0.7
	RZ	12.1	8.1	6.1	0.4

* Average of three replications ** R = Rhizosphere soil RZ = Root zone soil

microbial activity (Lakshmikumari, 1964). Coconut–cacao mixed cropping have shown greater microbiological activities than coconut monocropping system (Nair and Subba Rao, 1977).

The asymbiotic N_2-fixers and P-solubilizers were enumerated from the rhizosphere and root zone of the various crops (Table II). The N_2–fixers were fairly high in the rhizosphere as compared to the root zone of various crops. Similar trend was also recorded for the phosphate solubilizer counts. The enumeration of *Nitrosomonas* (53–72 x 10^3) and *Nitrobacter* (47 – 64 x 10^3) did not reveal much variation among the various crops.

The endogone spore counts and VAM colonisation of roots in various crops are presented in Table III. The data revealed that the endogone spores were less in banana as compared to areca, pepper and cacao. The percentage VA–mycorrhizal colonisation was also low in coffee (10.0%) and banana (35%) as compared to other crops (45–56%). Satyanarayana and Venkataraman (1979) have reported 70–80 per cent infection of VAM in tea and other weeds in the soils of North Eastern India.

The microbial biomass estimation of soils in areca high density cropping and areca monocropping has indicated higher Co_2–C flush in HDMS cropping system (Table IV). The nitrogen and phosphorus in the biomass flush was also higher in HDMS cropping systems as compared to areca monocropping system. This can be attributed to the rhizosphere effect and higher biological activities in the HDMS cropping system. Thus, the high density multispecies cropping system does not influence on the soil

Table II. *Population of N_2–fixers and P–solubilizers in the rhizosphere and root zone of areca based cropping system**

Crop		N_2–fixers (x 10^3)		P–solubilizers (x 10^4)
		Azotobacter medium	Beeking's medium	
High density cropping system				
Areca	R**	3.17	4.22	8.34
	RZ**	0.92	1.39	2.04
Cacao	R	6.32	6.35	2.10
	RZ	1.75	2.20	3.16
Banana	R	2.16	3.25	9.65
	RZ	0.34	1.04	2.41
Pineapple	R	5.02	4.54	4.30
	RZ	3.42	0.34	2.20
Monocropping system				
Areca	R	3.13	4.59	6.27
	RZ	0.83	0.69	1.37

* Average of three replications ** R = Rhizosphere, RZ = Root zone soil

Table III. *VA-mycorrhizal spore counts and root colonisation in areca HDMS and areca monocrop*

Crop	Endogone spores No./50 g soil	VAM colonisation (%)	
		Root infection	Extent of colonisation
High density cropping system			
Areca	126.6	56.0	40.0
Cacao	96.0	55.0	31.9
Pepper	99.0	42.0	30.8
Banana	73.0	35.0	37.5
Pineapple	ND	50.0	35.0
Coffee	ND	7.5	10.9
Monocropping system			
Areca	118.0	52.0	35.4
Pineapple	ND	43.8	32.2
Banana	60.0	28.0	35.0
Coffee	ND	10.0	9.4
C. D. at 5%	—	13.7	6.9

ND = Not determined

Table IV. *Soil microbial biomass in areca based high density multispecies cropping and areca monocropping system*

	High density cropping	Mono-cropping
Flush of Co_2-C, μg per gram of soil	366.67	322.2
Microbial biomass from flush kg C/ha	806.7	708.9
Nitrogen in biomass kg N/ha	134.4	118.2
Phosphorus in biomass kg P/ha	16.1	14 2

microflora after three years substantially as compared with the monocropping system. Further, the long term effect of high density multispecies cropping system on soil microflora and microbiological activities will have to be studied after 5 or 10 years to monitor the changes.

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