26. Observations on the seasonal variations in the rhizosphere microflora of coconut with special reference to fungi

K. RADHA AND T. S. S. RAWTHER,
Central Coconut Research Station, Kayangulam.

INTRODUCTION

IN an earlier publication (Radha and Menon, 1954) the importance of the study of rhizosphere microflora and rhizosphere effect as related to the Wilt (Root) disease of coconut had been emphasised. The fact that microfloral changes are influenced by environmental factors such as soil fertility and climate, had been established by Waksman (1917). The soil texture, pH, organic content, base exchange status, aeration and moisture, all effect the soil microflora in one way or other. Fluctuations in the rhizosphere microflora may be attributed to a seasonal effect on plant growth and consequently upon the microclimate (Starkey, 1929).

The susceptible and resistant nature of plants to any specific disease may also influence the rhizosphere microflora (Timonin, 1940). Coleman (1916) has observed that some fungi require moisture conditions that are at a variance to the requirements of other fungi whereas temperature has got rather uniform effect. Saksena (1955) has reported that moisture is favourable for the growth of soil fungus as long as there is no water-logging when the consequent anaerobic conditions begin to play against them.

In the present paper an attempt has been made to correlate the variations in the rhizosphere microflora in coconut gardens in relation to seasonal changes.

MATERIALS AND METHODS

Root and soil samples were collected from (1) Kayangulam - Diseased area during March to August, (2) Pandalam - Healthy area in April, June and August and (3) Chavara - Diseased area in August and December. The soils of Kayangulam and Chavara were sandy with a

pH varying between 5 and 6. Both at Kayangulam and Chavara, samples were collected from the base of healthy palms and palms presenting typical symptoms of Root (Wilt) disease, viz, flaccidity and abnormal drooping of leaves and leaflets. At Pandalam the collections were made from a river bed and the soil was alluvial loam with acidic reaction. Two sets of samples were collected from Pandalam (1) from the base of perfectly healthy palms and (2) from the base of palms showing foliar yellowing and designated as diseased. Samples were taken from depths of 1 and 2 feet at Kayangulam and Chavara, and from 1 to 6 feet at Pandalam by opening pits 5 feet away from the bole of palms. The mode of sampling and the method of estimation of microflora were similar to those followed by Radha and Menon (1954).

Root samples were cultured to study the fungal population. The root bits were surface sterilized with an aqueous solution of calcium hypochlorite (1/14), washed in several changes of sterile tap water and plated on potato-dextrose agar. Percentage occurrence of fungi was expressed on 15 root bits basis.

The data on rainfall and temperature for 1958 as recorded at the research station is given in table 1.

TABLE 1

Rainfall and temperature during 1958 as recorded at the Research Station

Month	Mean temperature °C		Rainfall m.m.
	Maximum	Minimum	
January	30.3	21.6	0.0
February	33.5	23.5	10.7
March	35.5	24.4	66.3
April	34.4	24.99	88.1
May	32.4	25.02	326.0
June	31.1	24.08	885.1
July	30.9	24.5	239.7
August	29.6	23.7	339.1
September	31.7	24.2	27.1
October	31.3	23.9	175.9
November	31.4	23.6	145.1
December	33.5	21.5	0.0

RESULTS

A. *Kayangulam Samples* (Tables 2 a & b)

(1) The rhizosphere yielded a greater number of fungi at a depth of 2 ft. than at 1 ft. in the case of diseased samples while the healthy samples showed no such distinct variation.

TABLE 2(a)

Microflora of Kayangulam Samples - Fungi expressed in ten thousand and bacteria and actinomycetes in millions per gram dry soil

Period and Depth of sampling		Healthy									Diseased								
		Rhizosphere			Soil			R/S			Rhizosphere			Soil			R/S		
		F	B	A	F	B	A	F	B	A	F	B	A	F	B	A	F	B	A
March	1.	21.0	11.0	4.3	2.4	3.4	0.55	8.7	3.2	8.0	11.2	63.5	12.6	0.8	4.7	1.3	14.0	13.0	10.0
	2.	5.58	22.0	8.4	2.1	4.5	1.31	2.5	5.0	6.4	19.7	26.6	8.0	0.7	2.9	0.7	28.0	9.0	11.0
May	1.	7.4	82.9	21.4	0.77	2.77	1.34	9.6	30.0	16.0	12.7	464.9	138.6	0.2	2.7	0.6	63.0	172.0	231.0
	2.	3.7	16.5	9.4	1.55	3.44	5.77	2.4	4.8	1.6	94.1	569.5	20.5	1.2	1.5	0.9	78.0	380.0	23.0
June	1.	18.0	76.0	5.0	2.45	5.5	2.45	7.0	14.0	2.0	5.7	28.6	10.9	0.61	2.6	1.4	9.0	11.0	6.0
	2.	8.0	60.0	34.0	0.35	4.4	3.5	22.7	13.5	9.7	8.3	38.0	14.7	0.8	2.07	2.0	10.0	19.0	7.0
July	1.	10.3	42.48	70.3	0.55	15.8	4.2	18.7	2.6	17.0	15.0	33.7	15.0	0.22	2.15	2.0	9.3	15.2	7.5
	2.	22.6	117.3	2.0	1.4	20.7	2.0	16.3	5.5	10.0	5.5	25.0	17.0	—	0.53	2.0	5.5	47.0	8.5
August	1.	12.5	31.1	10.0	0.22	2.15	2.0	57.0	14.4	5.0	12.5	139.7	23.0	1.1	8.4	2.6	11.0	17.0	9.0
	2.	45.4	81.2	9.7	0.97	11.7	0.52	46.0	7.0	19.0	51.5	69.9	27.8	1.2	7.5	1.9	43.0	9.0	15.0

F = Fungi
B = Bacteria
A = Actinomycete
R/S = $\frac{\text{Rhizosphere}}{\text{Soil}}$

TABLE 2 (b)

Percentage occurrence of fungi in roots on 15 roots picce basis in Kayangulam Samples

Period and depth of sampling in ft		Healthy					Diseased				
		R.s	R.b	Dip.	Other fungi	Total	R.s	R.b	Dip.	Other fungi	Total
March	1.	0	0	0	112	112	6.6	6.6	0	166	179
	2.	0	0	0	165	165	0	0	0	141	141
May	1.	0	0	0	203	203	6.6	0	0	114	120
	2.	0	0	0	212	212	13.0	6	0	156	175
June	1.	0	0	0	218	218	6.6	13.0	13.0	137	169.6
	2.	0	0	12	103	115	13.0	0	10.0	94	117
July	1.	0	0	0	112	112	0	0	0	105	105
	2.	0	0	0	112	112	0	13	0	111	124
August	1.	0	0	0	185	185	24	0	0	108	132
	2.	0	0	0	233	233	20	0	0	124	144

R.s = *Rhizoctonia solani* R.b = *Rhizoctonia bataticola*
Dip. = *Botryo diplodia theobromae.*

TABLE 3 (a)

Rhyzosphere fungi in Pandalam Samples - in ten thousands per gram soil

Depth of sampling in ft.	Healthy			Diseased		
	April	June	August	April	June	August
1	4.4	1.9	13.7	6	9.2	5.1
2	10.4	0.14	9.7	13.6	0.88	6.54
4	2.94	0.27	4.2	11.0	0.8	6.3
6	1.0	—	—	7.8	—	—

(a) During June the water-table was above 4 ft.
(b) In August the water-table was at 4 ft. level.
No samples were collected below the level of the water-table.

(2) The maximum number of fungi and bacteria were recorded in the rhizosphere during May and August in the case of the diseased, whereas in the case of healthy similar regularity in the occurrence of the rhizosphere flora was not observed.

(3) No significant variation in the soil microflora in the different samples was noticed.

(4) Species of *rhizoctonia*, namely *R. solani* and *R. bataticola* were isolated from the root platings of the diseased samples in addition to *Fusaria, Aspergilli, Penicillia* etc.

B. *Pandalam Samples* (Tables 3 a & b)

(1) The maximum number of fungi was recorded during August, fewer in April and the minimum in June.

(2) The fungal population was at its height at a depth of 2 ft. in April and August.

(3) The root pieces on plating also yielded a greater number of fungi in April and August than in June.

TABLE 3(b)

Percentage occurrence of fungi in roots - on 20 root piece basis

Period and Depth of sampling		Healthy					Diseased				
		R.s	R.b	Dip.	Other fungi	Total	R.s	R.b	Dip.	Other fungi	Total
April	1.	0	0	0	80	80	0	50	6	73	129
	2.	0	0	15	20	35	0	26	3	89	118
	4.	0	0	60	25	85	0	25	0	55	80
	6.	0	0	0	40	40	0	0	0	80	80
June	1.	0	0	20	40	60	0	0	60	12	72
	2.	0	0	0	60	60	0	0	65	30	95
	4.	—	—	—	—	—	0	0	20	55	75
	6.	—	—	—	—	—	—	—	—	—	—
August	1.	0	0	0	108	108	0	0	30	90	120
	2.	0	0	6	78	84	0	0	13	128	141
	4.	0	0	25	60	85	0	0	63	72	135
	6.	—	—	—	—	—	—	—	—	—	—

C. *Chavara Samples* (Tables 4 a & b)

(1) The fungal population was more abundant in the rhizosphere of both healthy and diseased samples during August than in December.

TABLE 4 (a)

Microflora of Chavara Samples - Fungi in ten thousands and bacteria and actinomycetes in millions per g dry soil

Period and Depth of Sampling in ft.		Healthy									Diseased								
		Rhizosphere			Soil			R/S			Rhizosphere			Soil			R/S		
August	1.	36.3	97.0	30.3	1.0	2.45	0.6	36.6	39	3.8	12.0	38.4	8.0	16.0	4.9	1.1	0.75	7.9	7.0
	2.	35.4	6.15	0.0	1.05	0.65	0.0	33.7	9.4	0.0	1.2	46.2	3.1	0.12	4.9	2.1	10.0	9.5	1.5
December	1.	5.6	3.2	5.7	0.44	8.76	0.48	12.6	2.7	12.0	3.1	26.9	5.38	0.45	0.66	2.6	7.0	404	2.0
	2.	2.9	80.0	4.35	0.33	4.81	0.25	9.0	16.5	17.4	1.06	42.0	11.6	0.12	1.05	0.7	9.0	40	16.6

TABLE 4 (b)

Percentage occurrence of fungi in roots - on 15 root piece basis

Period and Depth of Sampling in ft.		Healthy					Diseased				
		R.s	R.b	Dip.	Other fungi	Total	R.s	R.b	Dip.	Other fungi	Total
August	1.	0	0	6.6	180	186.6	33.0	0	33.0	205	271
	2.	0	0	0	149	149.0	6.6	0	6.6	252	265
December	1.	0	0	13	241	254.0	13.3	0	20.0	209	242
	2.	0	0	19	121	140.0	6.6	0	13.0	99	118.6

(2) A greater number of fungi was recorded in the healthy samples both in the August and December collections as compared to the diseased.

(3) 'Rhizosphere effect' of fungi was found to decrease with increasing depth in healthy samples whereas the diseased samples showed no marked variation.

(4) *Rhizoctonia solani*, a suspected coconut pathogen was isolated only from diseased roots.

(5) The total fungal population was more abundant in the diseased roots than in the healthy during August, while the December samples were more or less similar.

Discussion

The data presented above indicate a negative correlation between the rhizosphere fungi and rainfall, this being more pronounced in the case of diseased samples collected from Kayangulam. The rhizosphere fungi and the rhizosphere effect of fungi in the diseased samples of Kayangulam is at the minimum during June-July, i.e. when the rainfall is at the maximum. The moderate rains before and after the monsoon appear to be favourable for the fungal population as is evident from the data for May and August. In contrast to the above observation, both the rhizosphere fungi and the Rhizosphere/Soil value are not so significantly affected by the variations in the rainfall, although with increase in rainfall the fungal population also increases to a certain extent. Thus the condition of the palm seems to be a determining factor in the influence of the environment on the rhizosphere fungal flora. That seasonal factors like rainfall and soil moisture will no doubt play an important role in the normal physiological activities of the plant and that in its turn on the rhizosphere microflora is of course an established fact. Our results further indicate the increased susceptibility of the palm in the diseased condition to environmental factors and consequently on the rhizosphere population. This is in accordance with the observations of Timmonin (1940) that the rhizosphere population is closely associated with the nature of the host. How far this increased susceptibility of the diseased palm to environmental conditions affects the occurrence and activity of *R. solani*, the fungus associated with the Root (Wilt) disease of coconut is yet to be studied. Although correlative data on the rhizosphere flora and rainfall is presented by the Pandalam samples, both the healthy and diseased samples are comparable. This may perhaps be explained as due to the fact that the samples designated as diseased did not present the typical symptoms of disease as in the case of Kayangulam

samples. The foliar yellowing exhibited by the palms designated as diseased at Pandalam might either be temporary or have lesser influence in the physiology of the palm than the Root (Wilt) disease.

SUMMARY

(1) The influence of environmental conditions on the rhizosphere microflora with reference to the Root (Wilt) disease of coconut has been indicated.

(2) The importance of rainfall and consequently soil moisture in determining the nature (quantitative) of the rhizosphere fungal flora was shown by the data collected from Kayangulam and Pandalam.

(3) The increased susceptibility of the diseased palms to environmental factors and its indirect effect on the rhizosphere fungal population has been presented.

ACKNOWLEDGEMENT

Thanks are due to Dr. K. P. V. Menon, Director, Central Coconut Research Station, Kayangulam for his interest in this investigation.

REFERENCES

1. Coleman, D. A., (1916) Environmental factors influencing the activities of soil fungi. *Soil Sci.*, **2**: 1-65.
2. Radha, K. and Menon, K. P. V., (1954) Studies on the Wilt (Root) disease of coconut palm. *Indian Coconut J.*, **7** (3): 99-106.
3. Saksena, J. B., (1955) Ecological factors governing the distribution of soil microfungi in some forest soils of Sagar. *The Journal of Ind. Bot. Soc.*, **34** (3): 262 - 298.
4. Starkey, R. L., (1929) Some influences of the development of higher plants upon the microorganisms in the Soil. II. Influence of the stage of plant growth upon abundance of organisms. *Soil Sci.*, **27**: 355-78.
5. Timonin, M. I., (1940) The interaction of higher plants and soil micro-organisms. II. Study of the microbial population of the rhizosphere in relation to resistance of plants to soil borne diseases. *Can. Jour. Res.* **18**: 444-455.
6. Waksman, S. A., (1917) Is there any fungus flora of the soil. *Soil Sci.*, **3**: 565-589.