

Studies on soil conditions in relation to the "Root" and "Leaf" diseases of the coconut palm in Travancore-Cochin

Part VII. The mechanical composition of coconut soils of healthy and diseased areas

BY

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INTRODUCTION

It is well known that the physical properties of a soil have much to do with its suitability for the many agricultural uses to which it is put. The rigidity and supporting power both wet and dry, the freedom of drainage, capacity for moisture storage, plasticity, ease of penetration by roots, aeration and retention of plant nutrients are all among others, intimately connected with the physical conditions of the soil. Since the coconut is found growing on several different soil types throughout the tropics it is pertinent that information is gathered on the soil characteristics which appear to be common in the different soil types which form conducive to good coconut growth. The physical properties of soils are dependent mainly on the surface exposed by the particles and

on the content of organic matter, although the chemical properties of the particles are also a contributory factor. The surface exposed by the particles is primarily a function of their size, and the determination of the percentage of the different size groups or separates present in the soil is achieved by the mechanical analysis of the soils. Soil texture refers to the proportion of the different sized particle groups in the soil on a percentage basis. This is important because it is directly related to the total surface of the soil particles and therefore to many phenomena in soils that have a bearing on management practices and productivity.

In a scheme of study to throw light on the soil conditions in relation to health and disease of the coconut palms it can be seen

that information on the physical properties of the soil and the relative role of the differences of these properties in the different soil types in orientating or predisposing disease conditions in the palm, would be of paramount importance. This was sought to be gathered by a scheme of mechanical analysis of the soil samples collected and examined in the general scheme (Sankarasubramoney *et al.*, 1954, 1955, 1956, and Pandalai *et al.*, 1958) of studies on the soil conditions in relation to the diseases of the coconut palm in the Travancore-Cochin area (Kerala State). The results are reported in this paper which is the last in this series of studies.

MATERIALS AND METHODS

The different soil samples examined in this investigation have been described including details of profile, collection, sampling, etc., in the first paper of this series (Sankarasubramoney *et al.*, 1954, *loc. cit.*).

For the determination of the mechanical composition of the soils, the method of dispersion described by Robinson and Richardson (1933) and adopted by the International Society of Soil Sciences was used (1934). The sample (usually twenty gms) of

oven dry soil was first of all treated with 6 per cent. hydrogen peroxide and boiled to remove organic matter. Then sufficient 1.0 N hydrochloric acid was added to the material to remove carbonates and exchangeable bases. The mixture was allowed to stand for two hours after which it was filtered. The whole of the soil was transferred to the filter paper and washed with distilled water till it was free from acid. It was then completely washed down into a 0.2 mm. sieve and washed with a jet of hot water until only clean sand remained on the sieve. This was dried at 105°C and weighed to obtain the quantity of coarse sand. The material passing through the sieve was transferred to a shaking bottle and 4 cc. of normal sodium hydroxide solution added to it. It was subjected to frequent shakings by the hand for a period of 24 hours. The contents were then transferred to a 1000 cc. tall cylinder and made up to volume.

A Robinson's pipette was used for drawing samples for the determination of the silt and clay fractions. The material in the cylinder was shaken by repeated immersion and allowed to stand for three minutes and forty-eight seconds (corresponding to 4 minutes and forty-eight seconds at 20°C) and then 20 cc. of the

suspension were withdrawn by the pipette from a depth of 12.6 cms. (corresponding to a depth of 10.0 cms. at 20°C). The pipetted suspension was transferred to a weighed silica basin evaporated on a water-bath, dried at 105°C in an air oven, cooled and weighed. The percentage of *silt and clay* was calculated from this.

For taking out the clay fraction sample, the material in the cylinder was shaken and allowed to settle for a period of six hours and twenty-one minutes (corresponding to 8 hours at 20°C) and 20 cc. of the suspension withdrawn from a depth of 12.6 cms. This was evaporated to dryness, dried in an air oven at 105°C, cooled and weighed. From this weight, the percentage of clay was computed.

For the separation of the *fine sand* the supernatant liquid in the

cylinder was carefully poured off. Then water was added to the sediment so that the level of the water was 12.6 cms. from the base of the cylinder. The mixture was thoroughly shaken and allowed to settle for three minutes and forty-eight seconds after which time the supernatant liquid was poured away. This process was repeated until no more material remained suspended at the end of the settling period. The residue was transferred to a basin, dried at 105°C, cooled and weighed to give the quantity of fine sand.

RESULTS AND CONCLUSIONS

The results of the different determinations are given in Tables 1, 2, 3 and 4 which give the mean values for the percentage of coarse sand, fine sand, silt and clay in the soil samples under examination.

TABLE I
Showing the mean values for the percentages of coarse sand

Group	Horizon	Soil type			
		Sandy	Alluvial loam	Red loam	Laterite
Diseased	A	81.0	38.2	62.3	32.1
	B	80.5	40.5	61.2	39.6
	C	—	—	—	26.0
Healthy	A	76.4	41.7	53.3	35.2
	B	75.6	40.5	41.9	35.5
	C	—	—	—	33.8

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TABLE 2

Showing the mean values for the percentages of fine sand

Group	Horizon	Soil type			
		Sandy	Alluvial loam	Red loam	Laterite
Diseased	A	13.9	24.9	15.6	14.1
	B	16.0	23.5	14.6	15.9
	C	—	—	—	15.3
Healthy	A	16.0	24.8	18.9	16.0
	B	17.5	24.7	23.3	17.9
	C	—	—	—	21.8

TABLE 3

Showing the mean values of the percentages of silt

Group	Horizon	Soil Type			
		Sandy	Alluvial loam	Red loam	Laterite
Diseased	A	1.4	12.6	2.8	7.8
	B	1.3	12.2	3.3	7.0
	C	—	—	—	9.8
Healthy	A	1.2	7.9	6.7	8.1
	B	0.9	7.4	4.5	10.1
	C	—	—	—	8.8

TABLE 4

Showing the mean values for the percentages of clay

Group	Horizon	Soil type			
		Sandy	Alluvial loam	Red loam	Laterite
Diseased	A	2.4	21.9	17.9	42.6
	B	3.9	22.9	22.2	33.9
	C	—	—	—	48.6
Healthy	A	5.0	21.8	20.6	37.1
	B	5.1	22.6	28.8	43.7
	C	—	—	—	39.0

In Tables 5 to 12, given as Appendix are presented the mechanical composition of the soil samples belonging to the different soil types and under the category of healthy coconut areas and diseased areas.

The following conclusions can be drawn from the results presented.

1) *Sandy areas*: Comparatively there is a greater percentage of coarse sand in the soils from diseased areas and a greater percentage of fine sand and clay in the soils from healthy areas. Regarding the percentage of silt there is no significant difference between the soils of diseased and healthy areas.

2) *Alluvial loam*: Considering the coarse sand fraction, samples

from the A horizons of healthy areas contain a higher percentage of the same than the corresponding samples from diseased areas. Samples from the B horizons exhibit no difference. There is also significant difference in the samples from diseased and healthy areas in the quantity of the fine sand and clay fractions. The percentage of silt however is higher in the soils of diseased areas.

3) *Red loam*: There is a greater percentage of coarse sand in the samples from diseased areas while the soils of healthy areas contained higher contents of the other three fractions.

4) *Laterite*: There is comparatively a higher percentage of coarse sand in the samples from

the A and C horizons of healthy areas and a higher percentage in the samples from the B horizons of diseased areas. The healthy areas had higher fine sand fractions than the diseased areas. In the samples from the A horizon of both categories of areas there was no significant difference in the silt content while those from the B horizons of the healthy areas have a higher percentage of the fraction than the corresponding samples from diseased areas. As far as the C horizons are concerned the samples from the diseased areas had a greater silt fraction. In the case of the clay contents the samples from the A and C horizons of diseased areas had greater percentage while the B horizon samples appeared to show higher clay percentage in the healthy category of soils.

The determination of the mechanical composition of a soil has been considered by Robinson (1951) to be the most important laboratory examination to which a soil is subjected. The content in the soil of the finer sized particles is of particular importance in determining its properties. These particles are the seats of the cation and anion exchange properties. Among the finer sized particles, the clay fraction is considered to be the most important

since its colloidal characteristics distinguish it most markedly from the fine sand and silt fractions. The presence of good proportion of clay confers a high water holding capacity and cohesive properties on soils. Most important of all is the fact that the clay fraction is pre-eminently the reactive constituent of the mineral portion of soils. It is the seat of base exchange although there are a few instances cited where much of the exchange capacity of a soil has been found to be due to the fractions of coarser than clay size (Mitchell and Muir, 1937).

Soil texture is also known to have some influence on the activity of fungi parasitic on plant roots. Thus a low percentage of clay, leading to light texture is known to favour root disease conditions in the coconut (Bryce, 1924). Other plant diseases of the same category are the panama disease of bananas (Reinking, 1935), internal root rot of tea (Tunstall, 1922), cotton wilt (Young, 1928), etc. A heavy soil texture has been recorded to favour 'snow mould' of cereals (Khokhryakoff, 1935), violet root rot of tea (Pinching, 1925).

However, as regards the diseases affecting the coconut palms considered in this paper, it would appear that the mechanical com-

position of the soil plays little or no part in providing predisposing conditions for disease attack since there is no significant difference between healthy and diseased areas in the soil content of any of the fractions when all the soil types are considered together. Although there is not much significant difference in the soil quality as far as the healthy or diseased category of soils are concerned it should be emphasised that coconut soils should have good drainage, good moisture holding capacity and should have fine sand, clay and silt fractions since various aspects of soil fertility are intimately tied up with these soil qualities.

SUMMARY

1. The results of studies on the mechanical composition of soils from healthy and diseased coconut areas in relation to the root and leaf diseases of the coconut palms have been presented and discussed.

2. The disease appears to be prevalent in all the main soil types on which coconuts are found to grow. Since the results presented do not show any significant differences in the mechanical composition of soils from the two different categories of soils, healthy and diseased although there are slight differences in the different soil types, it would appear that differences in the mechanical composition are not responsible for predisposing conditions for the disease attack.

3. The need, however, for a free working soil with good drainage and free water movement in the soil as well as the presence of higher fine sand, silt and clay fractions and the absence of any impermeable or compact layer or hard pans near the surface soil likely to cause water stagnation etc., has been emphasised for maintaining the palms in good healthy conditions.

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APPENDIX

TABLE 5

Showing the mechanical composition of the soil samples belonging to the type Sandy Loam

Lab. No.	DISEASED AREAS				Lab. No.	HEALTHY AREAS			
	Coarse sand %	Fine sand %	Silt %	Clay %		Coarse sand %	Fine sand %	Silt %	Clay %
1	77.0	17.5	0.8	3.5	19	68.5	13.5	1.0	14.3
2	82.5	10.0	0.3	6.5	20	63.0	13.5	1.2	19.8
2b	74.5	17.5	0.8	7.0	21	87.0	7.5	0.3	0.5
3	87.5	9.0	0.5	2.5	22a	84.0	13.8	1.5	1.1
4	85.0	10.0	1.0	3.0	22b	80.0	15.5	0.6	0.7
5a	75.0	20.0	1.5	2.0	23	92.0	4.0	1.8	1.3
5b	74.0	20.0	1.5	3.0	24	91.8	6.3	0.5	2.3
6a	88.0	7.5	1.5	6.0	25a	78.5	12.3	3.8	6.0
6b	77.5	14.0	2.0	7.3	25b	83.0	9.3	1.3	5.8
6c	86.0	7.5	0.7	6.8	26	85.0	8.0	1.8	4.5
7	91.0	7.0	0.5	1.5	27a	56.8	38.8	0.8	Trace
8	92.0	6.5	0.2	1.3	27b	56.8	40.5	0.3	Trace
9	82.5	16.8	1.8	1.4	28a	59.5	43.5	Trace	Trace
10	75.5	19.6	1.9	1.9	28b	36.0	64.0	0.3	Trace
11	72.5	17.3	2.5	4.5	28c	64.0	35.0	Trace	Trace
12	79.0	16.8	2.5	0.8	29	73.3	20.7	1.0	7.8
13	76.0	16.0	2.7	4.5	30a	68.5	21.1	1.3	3.3
14	82.3	15.8	0.9	4.7	30b	88.5	7.8	0.6	2.6
15	78.5	15.3	1.9	3.5					
16	72.8	21.3	0.5	2.2					
17	79.2	13.5	1.8	2.8					
18	72.8	20.8	1.5	4.7					

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TABLE 6
Abstract of Table 5

Factor		Diseased		Healthy	
		A horizon	B horizon	A horizon	B horizon
Coarse sand	Mean Range	81.0 72.0 - 92.0	80.5 72.8 - 87.0	76.4 56.8 - 92.0	75.6 53.2 - 91.8
Fine sand	Mean Range	13.9 6.5 - 17.5	16.0 9.7 - 21.3	16.0 4.0 - 39.7	17.5 6.3 - 47.8
Silt	Mean Range	1.4 0.2 - 2.7	1.3 0.5 - 2.5	1.2 0.3 - 2.6	0.9 0.1 - 1.8
Clay	Mean Range	2.4 1.3 - 4.5	3.9 0.8 - 6.8	5.0 0 - 14.3	5.1 0 - 19.8
No. of values		10	8	6	6

TABLE 7
Showing the mechanical composition of the soil samples belonging to the type Alluvial Loam

Lab. No.	DISEASED AREAS				Lab. No.	HEALTHY AREAS			
	Coarse sand %	Fine sand %	Silt %	Clay %		Coarse sand %	Fine sand %	Silt %	Clay %
31	37.5	20.0	16.0	26.0	47	40.0	17.5	9.3	31.0
32	52.0	19.0	7.5	22.3	48a	22.5	14.0	5.7	54.3
33	10.0	26.0	24.2	36.5	48b	28.5	12.0	7.8	47.5
34	9.0	29.0	24.4	37.2	49a	38.0	28.0	12.5	20.5
35	47.0	32.0	6.9	11.6	49b	36.5	25.0	7.0	27.5
36	12.5	31.5	14.9	36.4	50a	40.0	34.5	3.5	22.3
37a	36.0	24.0	15.4	23.1	50b	37.0	33.6	4.8	19.5
37b	37.0	21.0	13.0	24.5	51a	23.5	61.9	7.8	7.8
38	32.5	22.5	17.8	25.2	51b	25.2	47.4	8.0	13.5
39a	41.0	25.0	10.6	18.7	51c	23.3	52.0	7.3	12.8
39b	21.5	17.5	20.4	35.2	52a	36.0	34.5	10.0	13.8
40	59.0	16.5	8.1	12.8	52b	24.3	48.0	8.3	12.8
41	49.8	25.0	5.2	17.8	53	50.5	24.9	7.5	14.7
42	52.8	22.0	9.1	9.3	54	45.2	19.5	8.4	20.5
43	49.0	25.0	11.2	15.3	55	47.3	22.9	6.2	25.0
44	58.0	20.5	9.5	14.2	56	45.9	17.3	10.2	22.2
45	43.0	27.5	7.8	16.4	57	49.1	19.5	6.7	24.2
46	36.2	27.0	6.6	25.6	58	57.8	21.8	5.4	8.0

TABLE 8

Abstract of Table 7

Factor		Diseased		Healthy	
		A horizon	B horizon	A horizon	B horizon
Coarse sand	Mean Range	38.2 10.0-49.8	40.5 9.0-58.0	41.7 24.0-49.1	40.5 25.5-57.8
Fine sand	Mean Range	24.9 20.0-32.0	23.5 16.5-31.5	24.8 17.5-57.7	24.7 13.0-42.3
Silt	Mean Range	12.6 5.2-24.2	12.2 6.6-24.4	7.9 6.2-9.8	7.4 4.2-10.2
Clay	Mean Range	21.9 11.6-36.5	22.9 9.3-37.2	21.8 11.7-31.0	22.6 8.0-50.9
No. of values		8	8	6	6

TABLE 9

Showing the mechanical composition of the soil samples belonging to the type Red Loam

Lab. No.	DISEASED AREAS				Lab. No.	HEALTHY AREAS			
	Coarse sand %	Fine sand %	Silt %	Clay %		Coarse sand %	Fine sand %	Silt %	Clay %
59	47.5	23.9	4.3	22.2	68	66.0	18.5	2.0	13.5
60	53.5	19.3	2.7	22.6	69	61.0	20.0	2.3	16.0
61a	55.3	20.0	3.0	23.7	70a	71.5	16.5	2.2	8.8
61b	55.5	20.0	3.7	19.5	70b	58.0	15.0	4.3	21.5
62a	78.0	9.0	3.3	10.4	71a	33.0	31.0	8.5	27.0
62b	78.0	7.0	2.0	14.9	71b	15.5	42.0	9.5	33.0
63	70.5	9.0	3.0	17.9	72	61.0	16.0	4.2	17.8
64	64.5	18.0	2.3	16.4	73a	49.5	19.5	1.7	27.3
65	54.6	16.5	3.9	26.7	73b	51.5	15.5	6.7	25.3
66	68.1	9.0	1.8	15.5	74	52.0	21.5	6.3	18.0
67a	60.0	13.2	3.3	24.3	75a	44.0	17.5	3.8	32.5
67b	68.5	11.0	2.0	20.9	75b	35.5	22.5	2.5	38.5
					76	22.5	16.5	17.7	38.3
					77a	33.0	25.0	3.5	35.3
					77b	38.0	20.0	2.5	37.5

THE MECHANICAL COMPOSITION OF COCONUT SOILS OF HEALTHY AND DISEASED AREAS

TABLE 10

Abstract of Table 9

Factor		Diseased		Healthy	
		A horizon	B horizon	A horizon	B horizon
Coarse sand	Mean Range	62.3 47.5 - 78.0	61.2 54.6 - 70.5	53.3 22.5 - 66.0	41.9 22.3 - 61.0
Fine sand	Mean Range	15.6 8.0 - 23.9	14.6 9.0 - 20.0	18.9 16.0 - 21.5	23.3 17.5 - 36.5
Silt	Mean Range	2.8 1.8 - 4.3	3.3 2.7 - 3.9	6.7 2.0 - 17.7	4.5 2.3 - 9.0
Clay	Mean Range	17.9 12.7 - 22.6	22.2 17.9 - 26.7	20.6 13.5 - 38.3	28.8 16.0 - 36.3
No. of values		5	4	5	5

TABLE 11

Showing the mechanical composition of the soil samples belonging to the type Laterite

Lab. No.	DISEASED AREAS				Lab. No.	HEALTHY AREAS			
	Coarse sand %	Fine sand %	Silt %	Clay %		Coarse sand %	Fine sand %	Silt %	Clay %
78	29.3	13.0	4.8	41.9	90	46.0	11.5	9.2	27.3
79	27.6	18.5	4.1	39.5	91	30.0	16.5	9.5	41.0
80	24.8	11.5	3.2	58.2	92	39.0	13.0	6.7	38.3
81	29.8	13.5	13.2	38.3	93	19.0	15.0	10.3	55.0
82	26.5	12.5	8.8	42.7	94	31.0	19.0	8.5	39.5
83	36.0	17.0	2.1	40.5	95	28.0	21.0	16.5	31.3
84	40.5	18.0	5.9	32.6	96	29.0	15.0	11.5	41.0
85	25.1	21.0	17.5	36.5	97	23.0	12.5	15.5	45.8
86	40.4	16.5	7.8	36.8	98	22.0	17.5	14.0	41.0
87	54.3	14.5	9.1	20.5	99	38.5	17.5	5.0	35.0
88a	33.5	14.0	12.3	42.2	100	40.0	17.5	5.3	32.5
88b	22.5	13.0	5.8	59.8	101	19.5	15.0	6.8	55.3
89	25.0	10.5	11.3	55.4	102	43.5	21.0	4.5	27.4
					103	42.5	23.8	1.6	29.5
					104	26.8	42.5	Trace	29.6

TABLE 12

Abstract of Table II .

Factor		Diseased			Healthy		
		A horizon	B horizon	C horizon	A horizon	B horizon	C horizon
Coarse sand	Mean Range	32.1 25.0-40.4	39.6 26.5-54.3	26.0 24.8-28.0	35.2 19.0-46.0	35.5 23.0-42.5	33.8 19.5-39.0
Fine sand	Mean Range	14.1 10.5-17.0	15.9 12.5-18.5	15.3 11.5-21.0	16.0 11.5-21.0	17.9 12.7-23.8	21.8 13.0-42.5
Silt	Mean Range	7.8 2.1-13.2	7.0 4.1-9.1	9.8 3.2-17.5	8.1 4.5-11.5	10.1 1.6-15.5	8.8 0.0-16.5
Clay	Mean Range	42.6 38.3-55.4	33.9 20.5-42.7	48.6 36.5-58.2	37.1 27.3-55.0	43.7 29.5-45.8	39.0 29.6-55.3
No. of values		5	4	3	5	5	5