30. Chemical studies on the leaf and root (wilt) diseases of coconuts in Travancore and Cochin

IV. Detailed Soil Survey and Study of Soils of a healthy area

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INTRODUCTION

SURVEYING the coconut areas of Travancore-Cochin from the Sea Coast on the West to the hill ranges in the East, one comes across: (1) the coastal sandy tract with fairly high water table (three feet to eight feet); (2) the clayey reclaimed areas of the backwaters with high water table (about three feet); (3) the midland or upland region lying between the backwaters and the hill slopes with sandy loam soil with low water table (about 20 feet); (4) laterite soil of the hill slopes with a fairly high percentage of gravel and sand with low water table (about 20 to 35 feet); (5) loamy soil of the hill slopes of laterite *cum* gneiss origin with a low percentage of gravel and very low water table and (6) the alluvial deltaic soils. In all these major coconut soils coconuts were found by Menon and Nair (1949), Menon *et al.*, (1950), Sankarasubramoney *et al.*, (1954), Verghese *et al.*, (1959), and others, to be infected by the Leaf and Root (wilt) diseases. Menon and Nair (1949, 1951) further found that the northern boundary of the disease zone was between Narakkal and Thottuva in the north and the southern boundary between Quilon in the South West and Punalur in the South East. Menon and Nirula (1956) were of the view that the spread of the diseases could be retarded by creating sanitary belts, a little beyond the infected zone, one of the outskirts of Trichur District in the north and the other on the northern boundary of Trivandrum District.

The chemical and physical characteristics of coconut soils in relation to the diseases have been studied by Menon *et al.*, (1950), Sankarasubramoney *et al* (1954; 1955, 1956) and Pandalai *et al* (1958). Menon and Pandalai (1958), reviewing the results of these investigations, stated that there are significant differences between the soils of

the healthy and diseased areas particularly in respect of available potassium, total calcium, total exchangeable bases and percentage base saturation, pH and iron content which were lower in the diseased group. It was, however, felt desirable to continue the investigaticns by a detailed soil survey and study of soils of the healthy and diseased tracts. Detailed investigations have been planned by the authors. The result of the survey of a very healthy area about 60 miles to the south of the southern sanitary belt recommended by Menon and Nirula (1956) and stretching from the Sea Coast to the hill slopes are presented in this paper.

Materials and Methods

The soil samples collected during the detailed soil survey of Kulathur and Chenkal villages of Neyyattinkara Taluk, Trivandrum District, were used for the laboratory studies. The detailed survey was commenced from the Sea Coast on the south-western end of the Kulathur village and ended with hill ranges on the north east of Chenkal village. The village litho maps 16" to 1 mile were used as the base map. Anger samples upto a depth of 2 feet were taken at two furlong intervals or nearer where variation was expected as a result of earlier rapid traverse of the area and were examined for texture, consistence, colour and other characters. The procedure for this and other lines of work laid down by Raychaudhuri (1958a) for the All India Soil and Land Use Survey was followed in toto. The profile pits were dug upto a depth of 6 feet or the water table or any impermeable layer, whichever was reached earlier, as advised by Raychaudhuri (1958b) and Govindarajan (1958).

Laboratory investigations were carried out to study the mechanical composition, base exchange properties, organic carbon, carbon-nitrogen ratio and fertility status. The standard methods of Piper (1944), Wright (1939) and A. O. A. C. (1950) were followed.

Results and Discussion

General features

Kulathur being a sea coast village has a sandy belt of low leve ground along the seaside. In the interior are found uplands, slopes, valleys and paddy fields. Red loamy soil covers considerable extent of the area. Sandy, sandy loam and gravelly loam soils are also met with, but altogether the soil finds its origin from the parent material granite and laterite.

Chenkal is a village of hills and vales with few acres of paddy fields. Soils come broadly under two heads, laterite and sandy soils;

but may be further classified as gravelly laterite, gravelly loam and red loam under the former head and sandy loam and sandy clay loam under the latter. Laterite gravels with coarse sand cover the major hills, the soils of the rest being of a loamy texture and reddish tinge.

In both the villages coconut forms the major crop, inter-cultivated with tapioca. Palmyrah palms were also found here and there. The coconut palms particularly in Kulathur are in very good condition, free from any disease and are high yielding. Particularly heavy bearing palms were found along the Sea Coast in Kulathur having an average yield of about 300 nuts per tree per year.

Profile characters

The profile characters are described below :—

Pit I Kulathur

0—12" Yellowish red loam, slightly moist, few roots, sticky when wet, moderately permeable, acidic, pH 5.1.

12—24" Roots of coconut in abundance, pH 5.0.

24—60" Very few roots, deep red, moist, pH 5.2. Hard layer below 60".

In general, there is not much distinction among the three layers, except for the colour, which gradually deepens to the bottom. This is a normal profile in the village.

Pit II Kulathur

0—12" Colour 10 YR 4/4 single grain, slightly moist, loose sand. Rapidly permeable coconut roots present, pH 6.3.

12—24" Colour 10 YR 5/4, other feature as above, pH 6.0.

24—36" 10 YR 4/4, moderately permeable, coarse sand, acidic, pH 5.6. Below 36" coarse sand and quartz form a hard layer.

Pit III Kulathur

0—13" Dark brown moist gravelly loam soil, abundant roots, moderately permeable, acidic, pH 6.3.

13—33" Yellowish brown, loamy, sticky, few roots of coconuts slowly permeable, pH 5.9.

33—53" Slightly yellowish brown, hard soil, less moist, very slow permeability, blocky structure, acidic, pH 5.3.
Below, very hard pan.

Pit IV Kulathur

0—11" Sandy loam in texture, colour 5 YR 3/4, single grain structure, roots in abundance, loose when dry, pH 6.2.

11—29" More moist, fewer roots, pH 5.7.

29—4″ Coarser fractions, less moist, colour 5 YR 4/6, slow permeability, pH 5.7.
Hard pan at 45″.

Pit I Chenkal

0—9″ Loose sandy soil, slightly moist, yellowish brown colour, single grain structure, free of concretions, mottling and carbonates, moderately well drained. Almost neutral, pH 6.9.

9—25″ More moist, sandy loam in texture, dark yellowish brown rapidly permeable, root distribution in abundance, almost neutral pH 6.9.

25—37″ Sandy loam, slightly yellow, fewer roots present, rapidly permeable, wet, slightly alkaline, pH 7.6.
Water table reached at 37″.

Pit II Chenkal

0—9″ Sticky, structureless, loamy, fine sand, colour 5 YR 3/4, moderately permeable, slightly moist, flac of concretions, carbonates and mottling, roots of weeds and coconut, pH 7.3.

9—24″ Colour 5 YR 4/6, loamy in texture, roots of coconut slow permeability, pH 7.1.

24—72″ Colour 5 YR 4/8, more moist, slightly acidic pH 5.8.

Pit III Chenkal

0—12″ Loamy moist soil, colour 2.5 YR 2/6, roots of coconut, structureless, cohensive, acidic, pH 5.8.

12—24″ 2.5 YR 2/5, roots abundant, moist, pH 5.6.

24—36″ Colour 7.5 YR 6/6, Kaolin formation, very few roots, permeability very poor, pH 5.8.
Below 36″, hard layer of laterite.

Pits I and II (Chenkal) are from typical types of soil confined to a limited area. They are at places locally known by the names, Poozhikunnu and Vlathankara respectively. Pit III (Chenkal) represents the major area, the depth of the laterite layer reaching at different levels according to locality.

All the above soils, in general, are free of carbonates, salt accumulations, concretions etc. and more or less, devoid of structure.

Mechanical composition

In the foregoing paragraphs on general features and profile characters the texture of the soil as found by "feel" in the field is recorded. The mechanical composition of the soil samples and the textural class to which each of them belongs as revealed by the relative proportion of sand, silt and clay are presented in Table 1.

TABLE 1

Showing the mechanical composition of the soils

Lab. No.	Village and Pit No.	Clay %	Silt %	Fine sand %	Coarse sand %	Textural class
38	Chenkal	8.15	1.80	28.91	62.51	sandy soil
39	Pit I	14.60	4.45	22.56	59.00	loamy sand
40	,,	13.35	1.50	21.59	63.04	loamy sand
41	Pit II	11.25	1.85	21.45	66.50	loamy sand
42	,,	28.35	1.15	19.26	50.37	sandy clay loam
43	,,	39.00	1.48	14.65	43.16	sandy clay
44	Pit III	33.78	4.00	15.25	45.20	sandy clay loam
45	,,	44.20	3.30	14.77	34.19	sandy clay
46	,,	41.67	3.38	16.42	34.97	sandy clay
47	Kulathur	45.65	5.85	16.17	33.80	sandy clay
48	Pit I	45.85	6.60	14.41	33.14	sandy clay
49	,,	51.45	5.65	12.45	30.13	clay
51	Pit II	5.75	3.00	26.50	65.00	sandy soil
52	,,	10.65	5.35	24.60	58.56	loamy sand
53	,,	14.80	5.90	20.59	57.50	sandy loam
55	Pit III	21.90	5.60	23.50	48.70	sandy clay loam
56	,,	30.75	5.50	19.49	44.11	sandy clay loam
57	,,	32.60	6.15	19.75	40.51	sandy clay loam
59	Pit IV	27.20	4.50	16.83	50.71	sandy clay loam
60	,,	26.15	3.05	18.80	51.81	sandy clay loam
61	,,	48.30	3.15	11.77	36.99	sandy clay

The soils can be grouped under three heads, viz. (1) sandy soil and loamy sand, (2) sandy loam and sandy clay loam and (3) clay and sandy clay.

Base exchange properties

Data in respect of base exchange properties of the 21 soil samples studied are given in Table 2.

It may be seen from Table 2 that the quantities of exchangeable cations present in the soil are low compared to values reported in literature for soils of similar soil climatic zones. It is however interesting to note that the percentage of calcium and magnesium in the exchange complex is fairly high. Sodium is not present except in a few cases.

Carbon-nitrogen ratio

The literature on organic carbon, nitrogen, carbon-nitrogen ratio and the theoretical considerations relating to them are rather very extensive and no attempt is made here to review them. With regard to coconut soils, Sankarasubramoney *et. al.* (1954) have reported for

sandy, alluvial, red loam and laterite, soils from healthy areas, organic carbon content ranging from 0.125 to 0.222, 0.645 to 0.745, 0.681 to 0.717 and 0.554 to 0.754 per cent respectively. The carbon-nitrogen ratio for these soils ranged respectively from 4.9 to 6.9, 8.5 to 9.3, 10.2 to 10.7 and 7.1 to 22.0. From the data obtained in the present study presented in Table 2 it may be seen that most of the soil samples contain low amounts of carbon and nitrogen. The average values for carbon-nitrogen ratio of the three classes of soils viz., (1) sandy soil and loamy sand, (2) sandy loam and sandy clay loam and (3) clay and sandy clay are respectively 6.44, 7.44, and 6.17. It is important to note that the ratio is lower than 10:1, the dynamic equilibrium ratio reported by many workers as the optimum per plant growth.

Fertility status

Data in respect of the fertility status of the soil samples are given in Table 3.

Scrutiny of the data presented in Table 3 would show that the soils are of low fertility status according to the accepted standards. According to the yard-stick of soil fertility laid down for soils of the Travancore-Cochin area, viz., 0.15 per cent N, 0.15 and 0.01 per cent of total and available phosphoric acid respectively, 0.25 and 0.005 per cent total and available potash respectively and 0.5 per cent lime, none of the soils under investigation can be said to be fertile; on the other hand the fertility status is very low.

The very interesting and important observation already pointed out viz., that high yielding palms were observed in the area, particularly in Kulathur, bring to the fore-front the problem of crop yield in relation to soil fertility as judged by the commonly accepted standards based on soil analytical data. The problem is particularly interesting in view of the fact that the coconut palm is in a state of continuous bearing for a period 60 years or more and soil sampling during the off-season as obtained in other crops does not apply here. It appears to be very necessary to standardise methods of soil sampling under the peculiar conditions under which coconuts are grown and lay down standard values to assess the fertility level of coconut tracts under different textural classes and other conditions of soil.

The soil of Kulathur, of low fertility status having only low amounts of plant food elements, organic matter and exchangeable cations and with the carbon-nitrogen ratio well below the dynamic equilibrium point, has produced a coconut crop the yield of which is often as high as 300 nuts per tree. The remarks of Menon and Pandalai (1958) on underground water of villages near the sea-coast as a source of nutrients may be noted in this context. Further, according to Wilson

TABLE 2

Exchangeable bases, base exchange capacity, organic carbon, nitrogen and C/N ratio

Lab. No.	Exchangeable Ca me/100 gm.	Ex. Magnesium me/100 gm.	Ex. Potassium me/100 gm.	Ex. sodium me/100 gm.	Percentage of exchangeable cations				Base Exchange capacity me/100 gm.	Organic carbon %	Nitrogen %	C/N
					Ca	Mg	K	Na				
1	2	3	4	5	6	7	8	9	10	11	12	13
38	1.00	Trace	Trace	Trace	100	—	—	—	1.1	0.133	0.035	3.80
39	1.40		,,	,,	100	—	—	—	1.5	0.254	0.059	4.30
40	1.2	,,	,,	,,	100	—	—	—	1.4	0.145	0.025	5.80
41	0.9	,,	0.088	,,	91.08	—	8.93	—	1.3	0.194	0.035	5.54
42	1.0	,,	0.563	,,	63.98	—	36.02	—	2.4	0.194	0.042	4.62
43	0.7	,,	1.036	,,	40.33	—	59.67	—	3.3	0.054	0.032	1.70
44	1.0	,,	0.055	,,	94.77	—	5.23	—	3.2	0.390	0.046	8.26
45	0.8	,,	0.507	,,	61.37	—	38.63	—	3.4	0.452	0.055	8.20
46	0.8	,,	0.221	,,	78.36	—	21.64	—	3.2	0.232	0.034	7.00
47	0.2	0.75	2.800	0.20	5.06	19.01	70.87	5.06	4.2	0.525	0.057	9.20
48	0.1	0.75	2.800	0.21	2.59	19.43	72.54	5.44	4.0	0.244	0.051	4.80
49	0.1	0.75	1.540	0.32	3.70	27.68	56.82	11.80	4.0	0.257	0.040	6.40
51	0.1	0.50	0.070	Trace	14.92	74.63	10.45	—	1.9	0 293	0.028	10.50
52	0.1	0.50	0.130	,,	13.70	68.50	17.80	—	2.2	0.269	0.031	8.70
53	0.3	0.50	0.090	,,	33.70	56.18	10.12	—	2.2	0.159	0.024	6.60
54	1.1	1.00	0.150	0.40	41.50	37.74	5.66	15.10	2.9	0.375	0.045	8.30
56	1.3	1.00	1.130	0.42	45.61	35.10	4.56	14.73	3.0	0.255	0.044	5.80
57	1.1	1.25	0.090	0.40	38.74	44.01	3.16	14.09	3.6	0.270	0.045	6.00
59	1.2	1.00	0.090	Trace	52.40	43.67	3.93	—	3.2	0.600	0.047	12.80
60	0.7	0.75	0.070	,,	46.05	49.35	4.60	—	2.3	0.270	0 038	7.10
61	1.5	1.00	0.180	,,	55.98	37.32	6.70	—	3.5	0.255	0.043	5.90

TABLE 3

Results of analysis of soil samples. Fertility status

Lab. No.	Village and Pit No.	Depth in inches	Moisture %	N %	P_2O_5 %	K_2O %	Ca O %	Mg O %	Fe_2O_3 %	Al_2O_3 %	Available P_2O_5 %	Available K_2O %	pH	Loss on ignition %
38	Chenkal Pit I	0—9	0.38	0.035	0.021	0.034	0.017	0.025	1.7	2.2	0.001	0.001	6.9	1.19
39		9—25	0.63	0.059	0.033	0.054	0.028	0.034	2.5	4.2	0.001	0.003	6.9	2.05
40		25—37	0.60	0.025	0.025	0.064	0.022	0.025	2.2	3.6	0.001	0.003	7.6	1.76
41	Pit II	0—9	0.44	0.035	0.032	0.042	0.022	0.034	1.0	2.8	0.003	0.006	7.3	1.21
42		9—24	0.35	0.042	0.040	0.131	0.022	0.025	1.7	9.4	0.001	0.029	7.1	1.26
43		24—72	1.34	0.032	0.045	0.213	0.022	0.032	2.8	13.9	0.002	0.044	6.0	3.37
44	Pit III	0—12	1.38	0.046	0.048	0.237	0.016	0.032	4.4	13.9	0.003	0.007	5.8	0.48
45		12—24	1.70	0.055	0.036	0.130	0.011	0.024	4.2	15.6	0.002	0.009	5.6	4.34
46		24—36	1.60	0.034	0.009	0.151	0.028	0.024	3.5	16.3	0.002	0.010	5.8	4.32
47	Kulathur Pit I	0—12	1.70	0.057	0.032	0.061	0.017	0.058	4.4	15.9	0.001	0.0017	5.1	4.13
48		12—24	1.71	0.051	0.026	0.051	0.006	0.033	4.7	17.4	0.0008	0.0015	5.0	4.57
49		24—60	1.93	0.040	0.027	0.062	0.006	0.058	5.3	19.4	0.0017	0.0039	5.2	4.80
51	Pit II	0—12	0.21	0.028	0.009	0.027	0.017	0.016	1.3	3.0	0.0015	0.0051	6.3	0.96
52		12—24	0.39	0.031	0.012	0.032	0.006	0.024	1.6	3.9	0.0012	0.0031	6.0	0.31
53		24—36	0.56	0.024	0.023	0.046	0.011	0.016	1.8	5.0	0.0013	0.0057	5.6	1.36
55	Pit III	0—13	1.07	0.045	0.027	0.049	0.040	0.025	3.3	7.8	0.0015	0.0081	6.3	2.10
56		13—33	1.34	0.044	0.031	0.048	0.017	0.025	3.7	11.7	0.0017	0.0145	5.9	2.48
57		33—53	1.50	0.045	0.044	0.084	0.040	0.033	4.1	11.5	0.0021	0.0175	5.3	2.34
59	Pit IV	0—11	1.20	0.047	0.031	0.065	0.051	0.041	3.1	12.1	0.0015	0.0085	6.2	2.10
60		11—29	1.06	0.038	0.031	0.034	0.028	0.033	2.7	8.3	0.0011	0.0004	5.7	1.33
61		29—45	1.69	0.043	0.041	0.048	0.040	0.025	3.1	15.2	0.0010	0.0007	5.7	1.94

(1959) elementary nitrogen dissolves in the sea and is fixed by marine micro organisms. These essentially rise to the surface and are caught in surface layer where some are partly decomposed by other micro organisms into ammonia and other products. The micro organisms and their decomposition products are carried into the air by a bursting air bubble in a "white cap" (when a wave breaks). In the air the droplets would loose its moisture and a part of its ammonia, and as a small and light particle be carried far inland to settle out or to serve the very useful function of seeding rain clouds. On reaching the ground this material would contribute to the soil nitrogen and potassium and possibly other materials necessary for plant growth.

The problems of having very good healthy coconut gardens in soils of apparently low fertility status requires further study and elucidation, particularly with regard to the diagnostic methods at present used for assessing the fertility status of soils.

The fertility status, base exchange properties, mechanical composition and other values obtained in the present investigation have to be compared with those of soils of diseased area. The analysis of soils of the latter group are now in progress and this will form the subject of a future communication.

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