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

Part IV. Total and exchangeable calcium and magnesium contents of coconut soils

BY

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INTRODUCTION

EARLIER papers in this series (Sankarasubramoney *et al.*, 1954, 1955, 1956) have dealt with the studies on the nitrogen, phosphorus and potassium contents of coconut soils. The two nutrient elements next in the order of their importance, *viz.*, calcium and magnesium in coconut soils of Travancore-Cochin and their influences in relation to the "root" and "leaf" diseases of the palm have been considered in the present paper. The methods of collection, sampling, etc. of the different soil samples examined in this study have been discussed in the first paper of this series.

Calcium is known to be a constituent of the cell walls of plants, the middle lamella of which consists largely of calcium pectate. It provides the base for the neutralisation of organic acids produced during metabolism. Calcium is considered to be concerned with the activities of the growing points, especially root tips. In the soil, calcium is a component of a large number of minerals and comprises the major portion of the exchangeable bases in the soil. Deficiencies of calcium are generally known to occur in loose sandy soils, acid soils and soils derived from rocks of low calcium content. The element is important from the point of view of soil fertility in as much as it helps nitrification and nitrogen fixation in the soil. The influence of calcium-potassium interaction in soils and plants on growth and chemical composition of plants has been studied by York *et al.* (1953). Ehrenberg (1919) has shown that calcium ions may inhibit absorption of potassium by plants. There is good evidence for the fact that lime also influences the concentration of exchangeable and water soluble potassium in soils.

STUDIES ON SOIL CONDITIONS IN RELATION TO THE "ROOT" AND "LEAF" DISEASES OF THE COCONUT PALM IN TRAVANCORE-COCHIN. PART IV. TOTAL AND EXCHANGEABLE CALCIUM AND MAGNESIUM CONTENTS OF COCONUT SOILS

Magnesium is well known to be the metallic constituent of chlorophyll, the green colouring matter of plants and is essential for its formation and function. The element functions as the carrier of phosphorus within the plant and, thus, has important bearing on the energy exchanges during the physiological processes in the plant tissues. Since magnesium is known to be more abundant in oil seeds than in starchy cereals and is believed to be associated with the formation of vegetable oils, the place of magnesium in the physiology of oil producing plants should, according to Miller (1938), be very important. There has been evidence of serious injuries caused to plants by magnesium deficiency in the soil. A deficiency of magnesium can arise in plants either from a true deficiency in the soil or from the unbalance with other nutrients, which is often associated with high levels of manuring. Mc Murtrey (1947) has pointed out that usually magnesium deficiency is most prevalent in deep sandy soils and is accentuated by excessive rainfall. Gammon *et al.* (1953) have shown that the quantity of magnesium in sandy soils is correlated with the content of organic matter. Garner *et al.* (1930) have given evidence to show that the magnesium content of soils is not always a good index of the adequacy of the element for plant use. These considerations appear to be important from the point of view of the coconut palm which is an inhabitant of the sandy soils in the high rainfall areas of the tropics. Magnesium, like calcium, occurs in soils as a component of a large number of minerals. It constitutes a good percentage of the exchangeable bases in a soil. Magnesium deficiency is generally known to go hand in hand with deficiencies of calcium in ordinary soils.

The amounts of calcium and magnesium required by the coconut palm have been roughly computed by two previous workers, and their figures give an approximate idea of the annual removal of these two nutrients from an acre of coconut garden.

TABLE I

Showing the annual removal of nutrients from an acre of coconut garden

In lb. per acre		Basis	Authority
CaO	MgO		
15·7	28.6	From a soil rich in plant nutrients by 60 palms per acre with 25 nuts each per annum	Georgi and Teik (1932)
13.0	20.0		Cooke (1950)

CONCENTRATION OF CALCIUM AND MAGNESIUM IN THE PALM TISSUES*

The analyses of the different parts of a bearing coconut palm have been given by Sampson (1923) and the figures shown below help to have an idea of the concentration of the important plant nutrients in the different parts of the palm.

TABLE 2

Showing the concentration of calcium and magnesium in the different tissues of a bearing coconut palm

Tissue (Dry matter)	CaO%	MgO%
Root	0.20	0.68
Stem	0.27	0.65
Stipules	0.084	0.065
Petiole and leaf stalk	0.27	0.44
Leaflets	0.28	0.57
Spathe	0.30	0.32
Husk	0.089	0.19
Shell	0·030	0·039
Meat	0.006	0.17
Water	0.69	0·59

Calcium and magnesium, therefore, appear to be important for the nutrition of the palm and these must be present in the soil in sufficient quantities and in available forms for the optimum growth and yield of the coconut palm.

ANALYTICYAL METHODS

The hydrochloric acid extracts obtained as described by Sankarasubramoney *et al.* (1954) were used for the determination of calcium by the method of Hillebrand and Lundell (1929) and magnesium was determined by the double precipitation method described by Epperson (1928). Willam's method (1928) was used for the determination of the exchangeable calcium and exchangeable magnesium. The results of the different determinations made in the different soil types, etc. are given in the following Tables.

RESULTS AND CONCLUSIONS

The mean values for the percentages of total calcium oxide are given in Table 3 and the exchangeable calcium (in mgm. equivalent per 100 gms.) in the different soil samples in Table 4. Detailed analytical results of the different soil types, etc. are presented in Tables 7 to 22 given as appendix.

TABLE 3

Total calcium oxide

Group	Horizon	Soil type			
		Sandy	Alluvial loam	Red loam	Laterite
Diseased	A	0.115	0.026	Trace	0.004
	B	0.091	0.040	Trace	Trace
	C	—	—	—	0.004
Healthy	A	0.111	0.075	0.026	0.015
	B	0.168	0.093	0.029	Trace
	C	—	—	—	Trace

TABLE 4

Exchangeable calcium

Group	Horizon	Soil type			
		Sandy	Alluvial loam	Red loam	Laterite
Diseased	A	0.80	0.13	Trace	Trace
	B	0.64	0.37	Trace	Trace
	C	—	—	—	0.004
Healthy	A	1.29	0.81	Trace	Trace
	B	0.75	0.89	Trace	Trace
	C	—	—	—	Trace

The following conclusions could be drawn from the above results:-

(1) In general, the total calcium contents of the soils from healthy coconut areas are greater than those in the diseased areas.

(2) The exchangeable calcium in the healthy areas of the sandy and alluvial loam types of soils are higher, but there is no significant difference in the red loams compared to diseased areas.

As regards the laterite soils, the A and B horizons exhibit no significant difference, while in the C horizon, the diseased areas have a slightly higher concentration of exchangeable calcium than the healthy areas.

The mean values for the percentage of total magnesium oxide and exchangeable magnesium (in mgm. equivalent per 100 gms.) of the soil samples examined are given in Tables 5 and 6 respectively.

TABLE 5

Total magnesium oxide

Group	Horizon	Soil type			
		Sandy	Alluvial loam	Red loam	Laterite
Diseased	A	0.055	0.108	0.012	0.025
	B	0.077	0.101	0.031	0.020
	C	—	—	—	0.024
Healthy	A	0.025	0.073	0.017	0.086
	B	0.058	0.092	0.048	0.045
	C	—	—	—	0.076

TABLE 6

Exchangeable magnesium

Group	Horizon	Soil type			
		Sandy	Alluvial loam	Red loam	Laterite
Diseased	A	0.11	0.61	Trace	0.41
	B	0.09	0.62	Trace	0.33
	C	—	—	—	0.32
Healthy	A	Trace	1.24	Trace	0.57
	B	Trace	1.12	0.22	0.39
	C	—	—	—	0.71

The following conclusions could be drawn from the results:–

(1) There is a greater concentration of total magnesium in the soils from the diseased areas belonging to the sandy and alluvial loam types as compared to healthy areas of the same soil types.

(2) In the case of red loam and laterite type soils from the healthy areas, the total magnesium content is higher than those from the diseased areas.

(3) As far as the figures for exchangeable magnesium are concerned, soils from healthy areas have a greater content of the same campared with those from diseased areas. There is, however, an exception in the soils belonging to the sandy types in which exchangeable magnesium content appears to be higher in the samples from the diseased areas.

DISCUSSION

Calcium occurs in plants chiefly in the leaves. One of its main functions is as a constituent of cell walls. This function is also of fundamental importance, since, if calcium is replaced by any other of the essential elements, the organic materials and mineral salts are easily leached out of the cells. In plants suffering from a deficiency of calcium the young leaves are severely distorted with the tips hooked back and the margins curved either inward or outward. The margins of leaves also show scorching or thin chlorotic streaks. Root systems of such plants appear poorly developed and root functions are impaired, particularly the activity of the root tips. According to De Sigmond (1938), the calcium content of soils is of great importance for their chemical characterisation and the quantity of calcium present in the soil determines its physical, chemical and biological behaviour. Soils of which exchange complexes are saturated with calcium have, in general, better tilth than calcium deficient or base unsaturated soils. The presence of a sufficient amount of calcium in the soil ensures optimum conditions for nitrification and nitrogen fixation and adjusts the availability of several nutrients to the plant in a favourable manner. According to Kelly (1950), the relationship between exchangeable calcium ions and exchangeable hydrogen ions has the most potent effect on microbiological activity in the soil. He has reported that nitrogen fixing organisms are almost completely absent from certain calcium depleted soils and that when the soil becomes excessively base unsaturated, nitrification is very much retarded.

It is difficult to say whether the symptoms exhibited by the coconut palms attacked by the 'root' and 'leaf' diseases could be attributed to a deficiency of calcium as a nutrient in the soil. It may affect the palm directly by its effect on the cell walls which become thin and permeable affecting to some extent the osmo-regulations in the cells and also by reducing the activity of growing points, especially root tips. It is more probable that the poor calcium status of the soils of the diseased areas might be exerting injurious effects on the palms indirectly. Thus a low calcium status or a low pH value of the soil may produce a weakened condition in the palms due to iron, manganese or aluminium toxicity (Wallace 1944). A lack of optimum conditions in the soil for microbiological processes due to the high soil acidity may result in non-availability of adequate nutrients, such as nitrates. There are some references regarding liming of the coconut areas. Patel (1938) has reported that the application of lime to coconut gardens at the rate of 10 lb. per tree does not benefit either low or high yielding trees. He found a regression coefficient of a negative value for lime, indicating a probable depressing effect. He has also stated that application of lime in combination with green manure also did not benefit either low or high yielding trees. According to Belgrave and Lambourne (1933, 1934), liming is of benefit on excessively acid soils (pH 2.0–3.5), under which extreme soil conditions severe foliar yellowing in the palms (Pandalai *et al.* unpublished results 1954), and in some cases sudden wilting in some areas have been recorded. It is interesting to note in this connection that Van Vambeke (1957) has reported malformation of the crown and yellowing of leaflets common in oil palms in Belgian Congo associated with calcium and magnesium deficiencies in the leaves. Salgado (1947) considers that in Ceylon the actual lime requirement of coconut soils is small and should be adequately met by the calcium in the bone meal, superphosphate, cynamide and other fertilizers.

In order that the best effects of of fertilizers are derived by the palms, great care has to be exercised in meeting the lime needs of the soil. Overliming is not only wasteful but actually does harm in several ways by interfering with the supply of some of the micronutrients, particularly boron and manganese. This may also be the cause of lime induced chlorosis in the palms. When liming materials not containing magnesium are used, the latter tends to become a limiting element and the soil would need an addition of magnesium compounds. Sampson (1923) is of the view that lime helps to replace potash in the soil. In some places, according to him, quick lime or freshly slaked lime gives remarkable results in increasing the yield of the coconuts.

The results reported on the magnesium content of the soil tend to show that the total or exchangeable magnesium have little bearing on the incidence of disease conditions in the trees, although a major symptom of the root diseased trees is of the nature of a chlorosis of the leaves which should have some connection at least indirectly in magnesium deficiency or magnesium non-availability conditions in the soil. The foliar yellow colour which is the result of inadequate chlorophyll formation in the leaves, always manifests initially in the older leaves and gradually proceeds towards the younger leaves. This phenomenon usually manifests during the high rainfall season. The photosynthetic activity of the leaves is greatly reduced and this may impart lack of resistance to disease attack. The chlorosis and bronzing of oil palms in certain localities in West Africa has been attributed by Hale (1947) to a combined effect of magnesium and potassium deficiency. The tapering disease of the coconut palms in Ceylon has been attributed by Cooke (1950) to a possible localised deficiency of magnesium. It would, thus, be quite possible that the disease conditions of the coconut trees in Travancore-Cochin area which has been shown to be prominently a potassium deficient one may also, among other factors, be due to the combined effect of major nutrient deficiencies in the soil. The individual cation concentrations in the leaf tissue are very much inter related. According to Russell (1954), the plant tends to maintain its potassium content more soluble than its magnesium, and its magnesium more soluble than its calcium, as the concentration of other cations around the plant roots varies. These aspects are rather complicated due to the prominent inter relationships of bases in the absorption of nutrients by the plants and the role of some of these, like potassium for example, in plant sap buffer systems, discussed in detail by Hoagland (1948). The healthy coconut palm has a large contingent of green leaves and the magnesium requirements of the palm should naturally be fairly high, and either soil deficiency in magnesium or non-availability of the element, due to other inter-metal relationships in the leaf tissue, could, certainly, be expected to orientate disease conditions. Whether the effect is direct or only indirect can be said only by further experimental trials, the available results being too meagre for the purpose. However, when liming of the soils is practised, generally magnesium deficiency is invariably automatically rectified.

SUMMARY

(1) The results of studies on the total and exchangeable calcium as well as the total and exchangeable magnesium contents of healthy and diseased coconut soils have been presented and discussed.

(2) Total calcium content is, in general, lower in the diseased areas as compared to healthy areas.

(3) Values for total exchangeable bases are lower in the diseased areas than the healthy areas.

(4) No definite conclusion regarding the role of magnesium in relation to the disease condition of the trees could be drawn, although it is clear that either lack of or non-availability of the nutrients in the soil is tied up with it.

(5) The need for a systematic observational trial involving potassium, calcium and magnesium manuring of the attacked palms for assessing the interrelationships of these cations in the soil and the palm tissue in relation to the disease conditions has been emphasised.

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APPENDIX

TABLE 7

Total exchangeable bases, exchangeable calcium and exchangeable magnesium (in mgm. equivalent per 100 gms.) in the soil samples belonging to the type SANDY LOAM

Diseased areas				Healthy areas			
Lab. No.	Total Ex. bases	Ex. Ca.	Ex. Mg.	Lab. No.	Total Ex. bases	Ex. Ca.	Ex. Mg.
1	2.40	Trace	1.12	19	2.44	1.26	Trace
2 a	1.96	Trace	0.80	20	1.10	0.82	Trace
2 b	1.90	Trace	0.64	21	1.44	Trace	Trace
3	1.23	Trace	Trace	22 a	1.20	Trace	Trace
4	1.41	Trace	Trace	22 b	1.04	Trace	Trace
5 a	0.54	Trace	Trace	23	0.96	Trace	Trace
5 b	0.54	Trace	Trace	24	0.96	Trace	Trace
6 a	0.16	Trace	Trace	25 a	5.92	4.64	Trace
6 b	0.16	Trace	Trace	25 b	6.96	5.92	Trace
6 c	0.48	Trace	Trace	26	4.40	3.68	Trace
7	2.78	2.11	Trace	27 a	2.31	1.03	Trace
8	2.39	0.23	Trace	27 b	1.60	1.44	Trace
9	2.41	1.77	Trace	28 a	0-56	Trace	Trace
10	1.72	1.00	Trace	28 b	0.64	Trace	Trace
11	0.97	0.25	Trace	28 c	0.42	Trace	Trace
12	2.94	2.70	Trace	29	1.68	Trace	Trace
13	0,96	Trace	Trace	30 a	1.68	Trace	Trace
14	0.96	Trace	Trace	30 b	1.52	Trace	Trace
15	1.94	1.60	Trace				
16	0.48	Trace	Trace				
17	0.72	Trace	Trace				
18	1.76	1.44	Trace				

TABLE 8

Abstract of Table 7

Factor		Diseased		Healthy	
		A. Horizon	B. Horizon	A. Horizon	B. Horizon
Total ex. bases	Mean	1.63	1.43	2.49	1.62
	Range	0.54—2.78	0.27—2.94	0.96—6.44	0.54—4.40
Ex. Ca.	Mean	0.80	0.64	1.29	0.75
	Range	0—2.23	0—2.70	0—5.28	0—3.68
Ex. Mg.	Mean	0.11	0.09	Trace	Trace
	Range	0—1.12	0—0.72	0—0	0—0
No. of values		10	8	6	6

TABLE 9

Total exchangeable bases, exchangeable calcium and exchangeable magnesium (in mgm. equivalent per 100 gms.) in the soil samples belonging to the type

ALLUVIAL LOAM

Diseased areas				Healthy areas			
Lab. No.	Total Ex. bases	Ex. Ca.	Ex. Mg.	Lab. No.	Total Ex. bases	Ex. Ca.	Ex. Mg.
31	4.64	Trace	3.68	47	3.92	Trace	1.28
32	3.52	Trace	2.56	48 a	3.76	Trace	1.40
33	4.72	Trace	Trace	48 b	2.80	Trace	0.80
34	4.64	Trace	Trace	49 a	2.24	Trace	0.44
35	1.60	Trace	Trace	49 b	1.52	Trace	Trace
36	6.08	Trace	0.46	50 a	2.24	Trace	Trace
37 a	2.72	Trace	0.42	50 b	1.92	Trace	Trace
37 b	5.36	Trace	Trace	51 a	4.24	Trace	1.42
38	5.92	Trace	Trace	51 b	5.16	4.64	Trace
39 a	1.44	Trace	0-29	51 c	4.36	3.68	Trace
39 b	2.56	Trace	0.42	52 a	3.92	3.20	Trace
40	2.40	Trace	Trace	52 b	3.68	3.04	Trace
41	1.04	Trace	Trace	53	4.64	0.80	3.32
42	0.96	Trace	Trace	54	6.38	1.92	3.70
43	1.04	Trace	Trace	55	5.76	0.48	1.13
44	1.92	1.00	0.30	56	6.00	0.32	0.97
45	3.52	1.02	0.64	57	4.80	0.80	1 13
46	4.88	1.92	1.61	58	4.32	Trace	0.97

TABLE 10

Abstract of Table 9

Factor		Diseased		Healthy	
		A. Horizon	B. Horizon	A. Horizon	B. Horizon
Total Ex. bases	Mean	2.83	3.79	4.18	4.31
	Range	1.04—4.72	0.96—6.08	1.88—5.76	2.08—6.38
Ex. Ça.	Mean	0.13	0.37	0.81	0.89
	Range	0—1.02	0—1.92	0—2.77	0—3.12
Ex. Mg.	Mean	0.61	0.62	1.24	1.12
	Range	0—3.68	0.22—3.22	0—2.56	0—3.70
No. of values		8	8	6	6

TABLE 11

Total exchangeable bases, exchangeable calcium and exchangeable magnesium (in mgm. equivalent per 100 gms.) in the soil samples belonging to the type

RED LOAM

Diseased areas				Healthy areas			
Lab. No.	Total Ex. bases	Ex. Ca.	Ex. Mg.	Lab. No.	Total Ex. bases	Ex. Ca.	Ex. Mg.
59	0.80	Trace	Trace	68	2.43	Trace	Trace
60	2.08	Trace	Trace	69	3.31	Trace	1.09
61 a	0.88	Trace	Trace	70 a	2.41	Trace	Trace
61 b	0.56	Trace	Trace	70 b	6.14	Trace	Trace
62 a	1.36	Trace	Trace	71 a	10.45	Trace	Trace
62 b	1.76	Trace	Trace	71 b	8.40	Trace	Trace
63	1.84	Trace	Trace	72	1.84	Trace	Trace
64	0.64	Trace	Trace	73 a	1.60	Trace	Trace
65	0.64	Trace	Trace	73 b	1.20	Trace	Trace
66	0.32	Trace	Trace	74	2.24	Trace	Trace
67 a	0.08	Trace	Trace	75 a	2.08	Trace	Trace
67 b	0.16	Trace	Trace	75 b	1.52	Trace	Trace
				76	2.32	Trace	Trace
				77 a	2.16	Trace	Trace
				77 b	1.84	Trace	Trace

TABLE 12

Abstract of Table 11

Factor		Diseased		Healthy	
		A. Horizon	B. Horizon	A. Horizon	B. Horizon
Total ex. bases	Mean	1.08	0.83	2.62	3.59
	Range	0.32—3.08	0.12—1.84	1.84—4.28	1.40—9.43
Ex. Ca.	Mean	Trace	Trace	Trace	Trace
	Range	0—0	0—0	0—0	0—0
Ex. Mg.	Mean	Trace	Trace	Trace	0.22
	Range	0—0	0—0	0—0	0—1.09
No. of values		5	4	5	5

TABLE 13

Total exchangeable bases, exchangeable calcium and exchangeable magnesium (in mgm. equivalent per 100 gms.) in the soil samples belonging to the type

LATERITE

Diseased areas				Healthy areas			
Lab. No.	Total Ex. bases	Ex. Ca.	Ex. Mg.	Lab. No.	Total Ex. bases	Ex. Ca.	Ex. Mg.
78	1.36	Trace	Trace	90	1.84	Trace	1.28
79	1.28	Trace	Trace	91	1.04	Trace	0.48
80	2.56	0.32	Trace	92	0.96	Trace	0.80
81	1.76	Trace	Trace	93	1.44	Trace	1.28
82	1.20	Trace	Trace	94	2.24	Trace	0.98
83	1.36	Trace	Trace	95	2.08	Trace	1.76
84	0.08	Trace	Trace	96	1.44	Trace	0.28
85	0.64	Trace	Trace	97	1.20	Trace	0.48
86	6.96	Trace	2.03	98	2.80	Trace	1.00
87	5.52	Trace	1.42	99	2.16	Trace	Trace
88 a	4.96	Trace	1.12	100	1.92	Trace	Trace
88 b	2.24	Trace	0.81	101	1.92	Trace	Trace
89	2.00	Trace	Trace	102	1.76	Trace	Trace
				103	2.16	Trace	Trace
				104	1.84	Trace	Trace

TABLE 14

Abstract of Table 13

Factor		Diseased			Healthy		
		A. Horizon	B. Horizon	C. Horizon	A. Horizon	B. Horizon	C. Horizon
Total Ex. bases	Mean	2.69	2.02	2.27	1.73	1.71	1.92
	Range	1.36—6.96	0.08—5.52	0.64—3.60	1.44—2.16	1.04—2.24	0.96—2.80
Ex. Ca.	Mean	Trace	Trace	0.11	Trace	Trace	Trace
	Range	0—0	0—0	0—0.32	0—0	0—0	0—0
Ex. Mg.	Mean	0.41	0.33	0.32	0.57	0.39	0.71
	Range	0—2.03	0—1.42	0—0.97	0—1.28	0—0.98	0—1.76
No. of values		5	4	3	5	5	5

TABLE 15

Percentage of lime* and magnesia* in the soil samples belonging to the type

SANDY LOAM

Diseased areas			Healthy areas		
Lab. No.	CaO%	MgO%	Lab. No.	CaO%	MgO%
1	0.016	0.051	19	0.084	Trace
2 a	0.008	0.077	20	0.046	Trace
2 b	Trace	0.081	21	Trace	0.016
3	Trace	0.086	22 a	Trace	0.016
4	Trace	0.075	22 b	Trace	0.010
5 a	Trace	Trace	23	0.229	0.044
5 b	Trace	Trace	24	0.270	0.046
6 a	Trace	Trace	25 a	0.238	0.050
6 b	Trace	Trace	25 b	0.255	0.044
6 c	Trace	Trace	26	0.194	0.048
7	0.104	Trace	27 a	0.045	0.044
8	0.162	Trace	27 b	0.154	0.040
9	0.165	0.120	28 a	0.358	0.154
10	0.151	0.148	28 b	0.613	0.044
11	0.420	0.156	28 c	0.423	0.520
12	0.350	0.208	29	0.008	Trace
13	0.025	0.044	30 a	0.025	Trace
14	0.020	0.026	30 b	0.039	Trace
15	0.154	0.054			
16	0.112	0.046			
17	0.101	0.040			
18	0.090	0.034			

* *Total lime and magnesia obtained by the hydrochloric acid extraction method.*

TABLE 16

Abstract of Table 15

Factor		Diseased		Healthy	
		A. Horizon	B. Horizon	A. Horizon	B. Horizon
CaO	Mean	0.115	0.091	0.111	0.168
	Range	0—0.420	0—0.350	0—0.247	0—0.465
MgO	Mean	0.055	0.077	0.025	0.058
	Range	0—0.156	0—0.208	0—0.047	0—0.237
No. of values		10	8	6	6

TABLE 17

Percentage of lime* and magnesia* in the soil samples belonging to the type

ALLUVIAL LOAM

Diseased areas			Healthy areas		
Lab. No.	CaO%	MgO%	Lab. No.	CaO%	MgO%
31	0.148	0.560	47	0.041	0.067
32	0.220	0.510	48 a	0.049	0.065
33	Trace	Trace	48 b	0.032	0.045
34	Trace	Trace	49 a	Trace	0.020
35	Trace	0.030	49 b	Trace	0.012
36	Trace	0.020	50 a	Trace	0.018
37 a	Trace	0.030	50 b	Trace	0.042
37 b	Trace	Trace	51 a	0.226	0.052
38	Trace	0.016	51 b	0.206	0.064
39 a	Trace	0.024	51 c	0.348	0.050
39 b	Trace	0.020	52 a	0.319	0.084
40	Trace	0.018	52 b	0.397	0.116
41	Trace	0.046	53	0.062	0.140
42	0.017	0.040	54	0.106	0.260
43	0.028	0.122	55	0.039	0.058
44	0.028	0.072	56	0.031	0.052
45	0.031	0.066	57	0.050	0.104
46	0.053	0.130	58	0.022	0.054

* *Total lime and magnesia obtained by the hydrochloric acid extraction method.*

TABLE 18

Abstract of Table 17

Factor		Diseased		Healthy	
		A. Horizon	B. Horizon	A. Horizon	B. Horizon
CaO	Mean	0.026	0.040	0.075	0.093
	Range	0—0.148	0—0.220	0—0.260	0—0.358
MgO	Mean	0.108	0.101	0.073	0.092
	Range	0—0.560	0—0.510	0.016—0.140	0.030—0.260
No. of values		8	8	6	6

TABLE 19

Percentage of lime* and magnesia* in the soil samples belonging to the type

RED LOAM

Diseased areas			Healthy areas		
Lab. No.	CaO%	MgO%	Lab. No.	CaO%	MgO%
59	Trace	0.006	68	Trace	Trace
60	Trace	0.020	69	Trace	0.090
61 a	Trace	0.014	70 a	Trace	Trace
61 b	Trace	0.016	70 b	Trace	Trace
62 a	Trace	0.012	71 a	0.055	Trace
62 b	Trace	0.008	71 b	0.066	Trace
63	Trace	0.016	72	0.128	0.024
64	Trace	0.012	73 a	0.107	0.048
65	Trace	0.036	73 b	0.058	0.030
66	Trace	0.012	74	Trace	0.034
67 a	Trace	0.066	75 a	Trace	0.028
67 b	Trace	0.044	75 b	Trace	0.038
			76	Trace	0.028
			77 a	Trace	0.068
			77 b	Trace	0.084

* *Total lime and magnesia obtained by the hydrochloric acid extraction method.*

TABLE 20

Abstract of Table 19

Factor		Diseased		Healthy	
		A. Horizon	B. Horizon	A. Horizon	B. Horizon
CaO	Mean	Trace	Trace	0.026	0.029
	Range	0—0	0—0	0—0.128	0—0.083
MgO	Mean	0.012	0.031	0.017	0.048
	Range	0.006—0.020	0.015—0.055	0—0.034	0—0.090
No. of values		5	4	5	5

TABLE 21

Percentage of lime* and magnesia* in the soil samples belonging to the type

LATERITE

Diseased areas			Healthy areas		
Lab. No.	CaO%	MgO%	Lab. No.	CaO%	MgO%
78	0.022	0.036	90	0.058	0.220
79	Trace	0.040	91	Trace	0.070
80	0.020	0.050	92	Trace	0.122
81	Trace	0.034	93	Trace	0.115
82	Trace	0.014	94	Trace	0.038
83	Trace	Trace	95	Trace	0.167
84	Trace	Trace	96	Trace	0.027
85	Trace	Trace	97	Trace	0.047
86	Trace	0.036	98	Trace	0.040
87	Trace	0.026	99	Trace	0.026
88 a	Trace	0.028	100	Trace	0.032
88 b	Trace	0.016	101	Trace	0.020
89	Trace	0.020	102	Trace	0.042
			103	Trace	0.040
			104	Trace	0.032

* *Total lime and magnesia obtained by the hydrochloric acid extraction method.*

TABLE 22

Abstract of Table 21

Factor		Diseased			Healthy		
		A. Horizon	B. Horizon	C. Horizon	A. Horizon	B. Horizon	C. Horizon
CaO	Mean	0.004	Trace	0.004	0.015	Trace	Trace
	Range	0—0.022	0—0	0–0.020	0—0.058	0—0	0—0
MgO	Mean	0.025	0.020	0.024	0.086	0.045	0.076
	Range	0—0.036	0—0.040	0—0.050	0.026—0.220	0.032—0.070	0.032—0.167
No. of values		5	4	3	5	5	5