

STUDIES ON SOIL CONDITIONS IN RELATION TO THE 'ROOT' AND 'LEAF' DISEASES OF THE COCONUT PALM IN TRAVANCORE-COCHIN

PART II. Total phosphoric acid, 'available' phosphoric acid and iron content of coconut soils

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Introduction

In a previous publication from this Institution (H. Sankarasubramoney et-al) the nitrogen and organic matter status and the carbon nitrogen ratio of coconut soils in Travancore-Cochin had been discussed in detail, with particular reference to the incidence of coconut diseases. In general, it was found that the factors mentioned above do not appear to influence the healthy or diseased condition of the coconut palm. In the present paper the phosphoric acid status of the soil and some other related factors are considered.

Phosphorus has been found to be a constituent of nucleic acids which are

essential components of plant material especially of plant enzymes, etc. Phosphorus is also of importance in the metabolism of fats, respiration processes, and in the efficient functioning and utilisation of nitrogen. With the possible exception of nitrogen, no other element has been found to be so critical for plant growth in the field as phosphorus, since a lack of this element may result in a decrease in the ease with which other elements are absorbed by the plant. (Lyon et-al 1952).

Estimates of the coconut palm's requirements of phosphoric acid, have been made by different workers and some of these are given in Table-1.

TABLE I

Quantity of P ₂ O ₅ required		Authority
1.	41.38 Kgms/hectare	Copeland (1921)
2.	40.00 Kgms/hectare	Eckstein et-al (1937)
3.	5.00 lbs./acre	Pillai (1919)
4.	26.00 lbs./acre	Jacob & Coyle (1926)
5.	12.00 lbs./acre	Patel (1938)

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In the present paper no attempt is made to assess the actual requirement of phosphoric acid of the coconut. The phosphoric acid status of the soils of healthy and diseased areas has been carefully determined to find out whether this factor has any bearing on the incidence of the 'root' (wilt) and 'leaf' diseases. Phosphorus exists both in organic and inorganic forms in the soil. Naturally, water soluble forms of the element are most easily available to plants. A number of factors are known to control the availability of phosphorus. The most important of these factors are the pH., iron, aluminium and calcium content of the soil.

The soil samples described in the first paper of this series, were used for these determinations also. In general the methods of analysis recommended by Wright (1939) and Piper (1944) have been followed for the determination of total phosphoric acid, 'available' phosphoric acid and iron.

Results

The values for total phosphoric acid, 'available' (1 % citric acid soluble) phosphoric acid, and iron are given in Tables 2 to 5 (see appendix).

In Tables 6 and 7 are presented the mean values for total and 'available' phosphoric acid in the soils examined.

TABLE 6
Total phosphoric acid

Group	Horizon	Soil Type			
		Sandy	All. Loam	Red Loam	Laterite
Diseased	A	0.036	0.073	0.042	0.050
	B	0.036	0.068	0.036	0.030
	C	..	..	..	0.026
Healthy	A	0.034	0.051	0.039	0.082
	B	0.028	0.042	0.042	0.078
	C	..	..	..	0.085

TABLE 7
'Available' phosphoric acid

Group	Horizon	Soil Type			
		Sandy	All. Loam	Red Loam	Laterite
Diseased	A	0.014	0.006	0.007	0.004
	B	0.018	0.007	0.006	0.006
	C	..	..	..	0.002
Healthy	A	0.020	0.006	0.010	Trace
	B	0.009	0.004	0.006	Trace
	C	..	..	..	0.001

The following conclusions can be drawn from the results presented above:—

1. *Sandy type*.—There is a higher concentration of total and available phosphoric acid in the B horizons of diseased areas as compared with healthy areas. Samples from the A horizons do not present any significant difference.

2. *Alluvial loam*.—Concentration of total phosphoric acid is higher in the samples from diseased areas. There is no significant difference between healthy and diseased areas, in the content of available phosphoric acid.

3. *Red Loam*.—Samples from the B horizons of healthy areas have a higher total phosphoric acid status than those from the B horizons of diseased areas. Samples from the A horizons do not present any significant difference. In the case of available phosphoric acid, the A horizons of healthy areas have a higher concentration of this factor, than the A horizons of diseased areas, while there is no difference between the B horizons.

4. *Laterite*.—Total phosphoric acid content is higher in the healthy areas, while available phosphoric acid content is higher in diseased areas.

Since there is no significant difference, common to all the four soil types, between healthy and diseased areas, in the content of total and available phosphoric acid, it has to be concluded, that the phosphorus status of the soil (both total and available) has very little influence in orientating the diseases of the coconut palm.

Phosphorus, like nitrogen is an element closely concerned with the vital growth processes in plants, since it is a constituent of nucleic acids, a factor of much importance in plant enzyme reactions,

respiration and plant genetics. Compounds of phosphorus are known to influence efficient functioning and utilisation of nitrogen. This element is also considered to be of special importance in root development and in the ripening of fruits and seeds.

A deficiency of this element, produces symptoms which are in many ways similar to those due to nitrogen deficiency. However, the colour of the foliage does not become yellow or red, but rather a dull bronze, accompanied in many cases by marginal scorching. The flesh of phosphorus deficient fruits is known to be soft, with very poor keeping qualities. (Wallace 1951). Phosphorus deficiency appears to be rather wide-spread, since, in many countries like Australia and S. Africa, production is limited over enormous areas on this account. As in the case of nitrogen, certain plant diseases caused by parasitic fungi are aggravated by deficient phosphorus supply, while certain others are aggravated by an excessive phosphorus status of the soil. However, the phosphorus status of the soil does not appear to have any influence in orientating the diseased conditions of the coconut palm here. A similar conclusion has also been arrived at by Hale (1947) with reference to the chlorosis and bronzing of oil palms in W. Africa.

It is well known that as far as plant growth is concerned, it is not the total content of phosphorus in the soil, that matters. Of more importance is what is called the 'available' phosphorus content of the soil. Phosphorus in the soil is rendered unavailable to plants by a number of factors. One of the most important of these factors is the iron in the soil. So, it naturally follows, that in a discussion of the phosphorus status of soils, the iron content of the soil is an important

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factor to be considered. The importance of this is more apparent, when we consider the fact that most of the soils examined had an acidic reaction.

In Table 8 are given the mean values for the percentage of total ferric oxide, in the soil samples examined.

TABLE 8

Group	Horizon	Soil type			
		Sandy	All. Loam	Red Loam	Laterite
Diseased	A	0.93	5.42	2.40	6.30
	B	0.88	6.03	2.84	5.50
	C	..	..	..	6.85
Healthy	A	1.14	6.63	3.63	8.44
	B	0.98	6.01	3.90	8.89
	C	..	..	..	8.73

The results presented above show, that in general there is a higher concentration of total iron in the soils of healthy areas, than in the soils of diseased areas.

Considering the supply of iron as a plant nutrient, the difference noticed in the content of total ferric oxide between soils of healthy and diseased areas, cannot be said to be a very significant factor, because the figures represent only the total content of iron in the soils and not the quantity actually available for utilisation by plants. If ever there is a deficiency of available iron in the soils of diseased areas, it will have to be proved by other methods, like analysis of plants, and pot culture experiments.

The values for iron, when examined from the point of view of phosphorus availability, have no significance at all, in relation to the diseases of the coconut palm. The higher content of iron in the healthy areas, may be naturally expected to render a greater quantity of the soil phosphorus unavailable. So, it has to be concluded that phosphorus availability is

not a factor which can be correlated with incidence of the diseases affecting the coconut palm.

Summary

Soils from diseased and healthy areas have been examined for both total and available phosphorus and total iron. The conclusions arrived at are:—

(1) There is no significant difference between healthy and diseased areas, in the phosphoric acid status of the soil (total and 'available').

(2) Although soils from healthy areas have a higher content of total iron, as compared to soils of diseased areas, it cannot be concluded that there is an iron deficiency condition in diseased areas, since the quantity of 'available' iron could not be determined. Whether such a deficiency actually exists, has to be found out by other means.

(3) Fixation of phosphorus by iron, and consequent non-availability of phosphorus, does not appear to be a factor correlated with disease incidence, since it is obvious that a greater quantity of

phosphorus would be rendered unavailable in healthy soils, due to their higher content of iron.

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APPENDIX

TABLE 2

Total phosphoric acid, 1 per cent citric acid soluble phosphoric acid and ferric oxide
in the soil samples belonging to the type

SANDY LOAM

DISEASED AREAS				HEALTHY AREAS			
Lab. No.	Total (P ₂ O ₅) Per cent	Available (P ₂ O ₅) Per cent	(Fe ₂ O ₃) Per cent	Lab. No.	Total (P ₂ O ₅) Per cent	Available (P ₂ O ₅) Per cent	(Fe ₂ O ₃) Per cent
1	0.088	0.042	1.04				
2 (a)	0.036	Trace	1.27				
2 (b)	0.025	Trace	1.81				
3	0.036	0.007	0.77	19	0.050	0.043	1.63
4	0.029	0.004	0.64	20	0.030	Trace	1.71
5 (a)	Trace	Trace	0.29	21	0.039	0.024	0.80
5 (b)	Trace	Trace	0.55	22 (a)	0.047	0.025	0.48
6 (a)	Trace	Trace	0.21	22 (b)	0.034	0.018	0.32
6 (b)	Trace	Trace	0.36				
6 (c)	Trace	Trace	0.57	23	0.034	0.014	0.80
7	0.022	Trace	0.68	24	0.023	0.007	0.80
8	Trace	Trace	0.46	25 (a)	0.057	0.031	1.36
9	0.053	0.013	0.80	25 (b)	0.055	0.030	1.12
10	0.011	Trace	0.72	26	0.033	0.014	0.96
11	Trace	Trace	1.04	27 (a)	Trace	Trace	1.36
12	0.051	0.022	1.28	27 (b)	Trace	Trace	1.44
13	0.024	0.009	0.96	28 (a)	Trace	Trace	1.28
14	0.013	0.004	0.48	28 (b)	Trace	Trace	1.44
15	0.080	0.048	1.12	28 (c)	Trace	Trace	0.72
16	0.066	0.051	0.80	29	0.024	0.007	0.92
17	0.061	0.057	2.00	30 (a)	0.038	0.008	1.04
18	0.085	0.060	1.20	30 (b)	0.046	0.010	0.64

Abstract of Table 2

Factor			Diseased		Healthy	
			A Horizon	B	A Horizon	B
Total ($P_2 O_5$)	Mean	..	0.036	0.036	0.034	0.028
	Range	..	0-0.085	0-0.085	0-0.056	0-0.042
Av. ($P_2 O_5$)	Mean	..	0.014	0.018	0.020	0.009
	Range	..	0-0.057	0-0.060	0-0.043	0-0.022
$(Fe_2 O_3)$	Mean	..	0.93	0.88	1.14	0.98
	Range	..	0.42-2.000	38-1.54	0.80-1.63	0.40-1.71
No. of readings		..	10	8	6	6

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TABLE 3

Total phosphoric acid, 1% citric acid soluble phosphoric acid and ferric oxide
in the soil samples belonging to the type
ALLUVIAL LOAM

Diseased Areas				Healthy Areas			
Lab. No.	Total (P ₂ O ₅) %	Available (P ₂ O ₅) %	(Fe ₂ O ₃) %	Lab. No.	Total (P ₂ O ₅) %	Available (P ₂ O ₅) %	(Fe ₂ O ₃) %
31	0.188	0.006	10.50	47	0.190	0.012	7.52
32	0.199	0.006	10.20	48 (a)	0.123	0.004	5.68
33	0.062	0.008	8.72	48 (b)	0.101	Trace	8.12
34	0.020	0.013	8.72	49 (a)	0.033	Trace	5.04
35	0.030	0.007	3.04	49 (b)	0.029	Trace	6.96
36	0.034	Trace	4.56	50 (a)	0.023	Trace	3.60
37 (a)	0.043	Trace	5.12	50 (b)	0.024	Trace	3.60
37 (b)	0.048	Trace	5.84	51 (a)	0.033	Trace	3.20
38	0.047	Trace	7.90	51 (b)	0.048	Trace	4.64
39 (a)	0.037	0.011	4.72	51 (c)	0.041	Trace	4.00
39 (b)	0.034	0.005	5.04	52 (a)	0.033	Trace	3.68
40	0.041	0.003	3.44	52 (b)	0.040	Trace	3.60
41	0.044	0.005	2.08	53	0.010	0.008	6.88
42	0.009	0.004	1.92	54	0.033	0.008	6.48
43	0.076	0.005	4.16	55	0.024	0.007	7.28
44	0.076	0.018	4.24	56	0.031	0.009	8.32
45	0.103	0.009	4.48	57	0.011	0.008	8.16
46	0.115	0.008	7.28	58	0.012	0.005	7.12

Abstract of Table 3

Factor		Diseased		Healthy	
		A Horizon	B	A Horizon	B
Total (P ₂ O ₅)	Mean	0.073	0.068	0.051	0.042
	Range	0.030—0.188	0.020—0.199	0.011—0.190	0.012—0.112
AV. (P ₂ O ₅)	Mean	0.006	0.007	0.006	0.004
	Range	0—0.009	0—0.018	0—0.012	0—0.009
(Fe ₂ O ₃)	Mean	5.42	6.03	6.63	6.01
	Range	2.08—10.50	1.92—10.20	3.95—8.16	3.60—8.32
No. of readings		8	8	6	6

TABLE 4

Total phosphoric acid, 1% citric acid soluble phosphoric acid and ferric oxide in the soil samples belong to the type

RED LOAM

Diseased Areas				Healthy Areas			
Lab. No.	Total (P ₂ O ₅) %	Available (P ₂ O ₅) %	(Fe ₂ O ₃) %	Lab. No.	Total (P ₂ O ₅) %	Available (P ₂ O ₅) %	(Fe ₂ O ₃) %
59	0.029	Trace	2.48	68	0.088	0.032	2.12
60	0.025	Trace	2.96	69	0.063	0.008	2.14
61 (a)	0.005	Trace	2.80	70 (a)	0.066	0.016	1.77
61 (b)	0.022	0.002	3.20	70 (b)	0.107	0.017	2.91
62 (a)	0.038	0.005	1.60	71 (a)	0.110	0.025	3.25
62 (b)	0.056	0.016	2.08	71 (b)	0.151	0.016	4.26
63	0.040	0.009	2.64	72	0.019	Trace	4.08
64	0.037	0.005	2.08	73 (a)	0.017	Trace	4.88
65	0.041	0.001	2.80	73 (b)	0.019	Trace	5.12
66	0.073	0.018	2.64	74	Trace	Trace	5.04
67 (a)	0.071	0.020	2.72	75 (a)	Trace	Trace	4.40
67 (b)	0.026	0.006	3.12	75 (b)	Trace	Trace	4.96
				76	Trace	Trace	4.56
				77 (a)	Trace	Trace	3.52
				77 (b)	Trace	Trace	4.32

Abstract of Table 4

Factor	Diseased		Healthy	
	A Horizon	B	A Horizon	B
Av. (P ₂ O ₅)				
Mean	0.007	0.006	0.010	0.006
Range	0.005—0.018	0.001—0.013	0.0—0.032	0.0—0.021
Total (P ₂ O ₅)				
Mean	0.042	0.036	0.039	0.042
Range	0.025—0.073	0.014—0.049	0.019—0.088	0.018—0.131
(Fe ₂ O ₃)				
Mean	2.40	2.84	3.63	3.90
Range	1.84—2.96	2.64—3.00	2.12—5.04	2.14—5.00
No. of readings	5	4	5	5

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TABLE 5
Total phosphoric acid, 1 per cent citric acid soluble phosphoric acid and ferric
oxide in the soil samples belonging to the type
LATERITE

Diseased Areas				Healthy Areas			
Lab. No.	Total (P ₂ O ₅) %	Available (P ₂ O ₅) %	(Fe ₂ O ₃) %	Lab. No.	Total (P ₂ O ₅) %	Available (P ₂ O ₅) %	(Fe ₂ O ₃) %
78	0.040	0.003	5.60	90	0.142	Trace	7.96
79	0.043	0.003	5.28	91	0.138	Trace	8.16
80	0.042	0.002	6.16	92	0.130	Trace	7.06
81	0.041	0.003	5.12				
82	0.016	0.002	2.00	93	0.128	Trace	10.25
				94	0.126	Trace	10.29
83	0.017	0.004	1.44	95	0.127	Trace	11.06
84	0.020	0.007	4.80				
85	0.012	0.001	4.48	96	0.100	Trace	8.57
				97	0.105	0.002	9.44
86	0.026	0.005	9.60	98	0.103	0.004	9.04
87	0.040	0.008	9.92				
88 (a)	Trace	Trace	9.84	99	0.041	Trace	6.16
88 (b)	0.049	0.003	10.00	100	0.023	Trace	6.96
				101	0.021	Trace	5.20
89	0.127	0.004	9.76				
				102	Trace	Trace	9.28
				103	Trace	Trace	9.60
				104	Trace	Trace	11.28

Abstract of Table 5

Factor	Diseased			Healthy		
	A Horizon	B	C	A	B	C
Total(P ₂ O ₅)						
Mean	0.050	0.030	0.026	0.082	0.078	0.085
Range	0.017—0.127	0.016—0.043	0.012—0.042	0.041—0.142	0.023—0.138	0.021—0.130
Av. (P ₂ O ₅)						
Mean	0.004	0.005	0.002	Trace	Trace	0.001
Range	0.003—0.005	0.002—0.008	0.001—0.002	0—0	0—0.002	0—0.004
(Fe ₂ O ₃)						
Mean	6.30	5.50	6.85	8.44	8.89	8.73
Range	1.44—9.76	2.00—9.92	4.48—9.92	6.16—10.25	6.96—10.29	5.20—11.28
No. of readings	5	4	3	5	5	5