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

V. The effect of lime and ash on disease conditions

M. RAJAPPAN CHETTIAR, E. J. VERGHESE AND M. P. SANKARANARAYANAN
Central Coconut Research Station, Kayangulam

INTRODUCTION

THE symptoms of calcium and potassium deficiency have been reported for many plants by Mc Murtrey (1948) and Wallace (1951). The outstanding symptoms of calcium deficiency generally appear in the young leaves and growing points of stems and in the roots. The young leaves may be severely distorted, irregular and ragged, forked and turned, with the tips hooked back and the margins curled backwards or forwards. The leaf margins have thin chlorotic or scorched bands. The leaf surfaces are discoloured light green or yellowish, containing yellowish, brown-spotted, purple-coloured mottling, scorched or necrotic areas. The leaves are also small with short petioles, stiff and hard. The roots die back from tips after making a short growth, followed by development of new rootlets behind the dead portions. The entire root systems consist of short-growth, are poorly developed and lack fibre and the roots may appear gelatinous. They are also brown and decomposed. The stems are weak and early deaths of root hairs, root-tips, young leaves, terminal buds, petioles etc. take place followed by wilting and premature death of the plant.

Potash deficiency symptoms vary according to the degree of deficiency. In trees a slight deficiency leads to somewhat restricted shoot growth and the shoots are thin whilst in severe cases terminal shoots do not grow and shoots or entire branches die back followed by the eventual death of the tree. Potassium deficient plants are as a rule characterised by mottling or chlorosis of older leaves followed by more or less necrosis, browning or burning of the tips (tip burn), marginal scorching (leaf scorch) and the development of brown spots, usually most numerous near the margins. In some cases the margins

tear and present a ragged appearance. Intervenal necrosis, weathering and drooping of older leaves are other symptoms. The roots are poorly developed and tend to rot. Failure to produce flowering buds and presence of immature fruits are also met with. The leaf stalks are also short and weak. Potash deficient plants are also more susceptible to diseases.

With regard to the coconut, the symptoms of palms affected by the Leaf and Root (Wilt) diseases of coconuts in Travancore-Cochin have been described by Menon and Nair (1949, 1951). It is very difficult to say with any degree of certainty how far these symptoms correspond to symptoms of calcium and potassium deficiency noted above and the conditions of the roots and leaves of palms subject to potassium deficiency as reviewed by Pandalai and Menon (1957) and Menon and Pandalai (1958). The common experience, however, is that a very large number of severely diseased palms are found in sandy soils deficient in calcium and potassium. It was therefore felt worthwhile to study if the disease could be cured or kept under control by manuring with calcium and potassium. The results of this study are presented in this paper.

Plan of the Experiment

A garden of the Central Coconut Research Station, Kayangulam deficient in calcium and potassium was selected for the study. The selected area, containing 50 diseased palms, were divided into 10 plots. Every alternative plot was manured with slaked lime and ash at 8 lb. and 60 lb. per tree respectively while, the other plots were kept as controls. All the trees received a basal dressing of groundnut cake at 7 lb., bonemeal at 3 lb. and muriate of potash at 2 lb. per year. The ash was applied in two doses of 30 lb. each.

Observations on the trees such as the total number of leaves, number of leaves showing yellowing, forked tips, flaccidity etc. number of bunches and number of nuts including tender nuts were recorded every year.

Prior to the commencement of the experiment soil samples from the plot were drawn and analysed for nutrient status. Samples were drawn every year thereafter and analysed for calcium and total and available potash. Leaf samples were also collected every year and analysed for calcium and potassium.

Methods

Leaf samples were collected according to the standard procedure evolved in the Soil Chemistry Laboratory of the Central Coconut

Research Station, Kayangulam, viz. in a tree with 'n' number of leaves $(\frac{n}{2}+1)$th leaf was taken as the proper leaf to be sampled and the fortieth to the fiftieth leaflets of this leaf were sampled for analysis.

Standard methods recommended by Piper (1944) and A.O.A.C (1950) were followed for the chemical analysis. Extraction of available potash was done with one per cent citric acid.

Results and Discussion

Fertility status

Average values for the initial fertility status of the soil are given in Table 1 below.

Table 1

Showing the initial fertility status of lime-ash experimental plots

	A horizon	B_1 horizon	B_2 horizon
Nitrogen (N) %	0.024	0.025	0.023
Phosphoric acid (P_2O_5) %	0.016	0.002	0.018
Potash (K_2O) %	0.034	0.032	0.036
Lime (CaO) %	0.062	0.045	0.039
Magnesia (MgO) %	0.035	0.036	0.040
Available phosphoric acid (P_2O_5) %	0.010	0.006	0.004
Available potash (K_2O) %	0.002	0.001	Trace

It will be seen from the above that the garden has a very low fertility status. Values for the important nutrients are of a very low order, much below the standards set for Travancore soils viz. 0.15% nitrogen, 0.15% phosphoric acid, 0.25% potash, 0.5% lime, 0.01% av. phosphoric acid and 0.005 av. potash.

Calcium and potassium status of soil

The results of analysis of calcium and potassium of soil samples collected yearly from the experimental plots are given in Table 2.

TABLE 2

Lime and ash manurial experiment – Central Coconut Research Station, Kayangulam – Soil Samples - Results of analysis for lime and ash.

Plot and horizon		Treatment	Calcium (Ca 0) %				Percentage increase(+) or decrease(—)	Potash (K_2O) % (Total)				Percentage increase(+) or decrease(—)	Potash (K_2O) % (Available)				Percentage increase(+) or decrease(—)
			1953	1954	1955	1956		1953	1954	1955	1956		1953	1954	1955	1956	
1	A	Control	0.062	0.045	0.056	0.042	—32.2	0.108	0.038	0.006	0.042	—61.1	—	0.023	Tr.	0.0034	—85.2
	B		0.074	0.034	0.042	0.034	—54.1	0.132	0.043	0.046	0.031	—76.5	0.013	0.024	Tr.	0.0078	—40.0
2	A	Treated	0.124	0.028	0.022	0.031	—75.0	0.085	0.033	0.039	0.097	+12.4	0.013	0.036	Tr.	0.0021	—83.9
	B		0.090	0.014	0.006	0.011	—87.8	0.153	0.061	0.078	0.057	—68.2	0.002	0.020	Tr.	Tr.	—
3	A	Control	0.180	0.048	0.039	0.020	—88.9	0.089	0.026	0.023	0.075	— 6.3	Tr.	0.017	Tr.	Tr.	—
	B		0.073	0.014	0.028	0.025	—65.8	0.179	0.048	0.050	0.093	—48.0	—	0.023	Tr.	0.01	—56.5
4	A	Treated	0.140	0.045	0.056	0.028	—80.0	0.118	0.023	0.017	0.031	—79.7	0.009	0.010	Tr.	Tr.	—
	B		0.045	0.014	0.030	0.011	—75.6	0.126	0.035	0.028	0.025	—80.2	Tr.	0.009	Tr.	0.0024	—36.7
5	A	Control	0.028	0.017	0.048	0.036	+28.6	0.163	0.054	0.028	0.018	—89.0	Tr.	0.021	Tr.	0.0034	—83.8
	B		—	—	0.034	0.028	—17.6	—	—	0.050	0.043	—14.0	—	—	0.005	0.01	—
6	A	Treated	0.084	0.020	0.034	0.014	—83.3	0.034	0.038	0.031	0.017	—50.0	0.004	0.005	0.006	Tr.	+30
	B		0.039	0.020	0.022	0.008	—79.5	0.023	0.019	0.027	0.015	—34.8	Tr.	0.003	Tr.	Tr.	—
7	A	Control	0.096	0.034	0.034	0.020	—79.2	0.035	0.022	0.056	0.013	—62.9	—	0.020	Tr.	0.0049	—75.5
	B		Tr.	0.045	0.028	0.010	—77.8	0.043	0.022	0.022	0.018	—58.1	—	0.007	Tr.	0.0100	—42.9
8	A	Treated	0.078	0.022	0.062	0.030	—61.5	Tr.	0.019	0.050	0.009	—52.6	—	0.008	Tr.	0.0080	—
	B		0.050	0.022	0.045	0.030	—40.0	0.019	0.020	0.010	0.016	—15.8	Tr.	0.006	Tr.	0.012	+50.0
9	A	Control	Tr.	0.017	0.025	0.030	+76.5	0.040	0.020	0.020	0.019	—32.5	Tr.	0.004	0.008	0.0031	—22.5
	B1		—	—	0.031	0.010	—67.7	—	—	—	0.029	—	Tr.	0.005	0.005	—	—
	B2		—	—	—	0.008	—	—	—	—	0.015	—	—	—	—	Tr.	—
10	A	Treated	0.056	0.022	0.046	0.040	—28.6	0.021	0.041	0.043	0.029	+38.1	—	0.009	0.011	0.0070	—22.2
	B		0.039	0.011	0.024	0.030	—23.1	0.062	0.030	0.024	0.025	—50.7	—	0.009	0.010	0.0040	—55.6
	B2		—	—	—	0.020	—	—	—	—	0.019	—	—	—	—	Tr.	—

It is seen that irrespective of whether the trees are treated or not there is generally a decrease in the calcium and potassium status of the soil. Figures for percentage decrease are given in Table 3.

TABLE 3

Showing percentage decrease in calcium and potassium in lime-ash experimental plots

	Horizon	Lime (CaO)	Potash (K_2O) Total	Potash (K_2O) Available
Percentage decrease over initial values. Average for plots 1, 3, 5, 7, and 9 (Control)	A	25.0	54.4	66.7
	B	68.3	49.2	17.9
Percentage decrease over initial values. Average for plots 2, 4, 6, 8 and 10 (Treated)	A	70.3	43.6	18.7
	B	70.1	51.7	14.1
Percentage decrease over initial values. Total for all plots	A	47.7	49.0	42.7
	B	69.1	50.5	16.0
Percentage decrease over initial values. Total for all plots for A and B horizons		116.8	99.5	58.7

There is thus considerable loss in lime and potash. In the case of lime the loss is greater in the treated plots. The loss assumes greater importance in view of the yearly application of the nutrients.

The data were analysed statistically. The salient features of the results presented in Table 4 are:— There is no evidence of increase in the potassium content of the soil due to the yearly application of lime and ash. On the other hand, though not statistically significant, there is an apparent deterioration over 1953 values. This holds good for control plots also. With respect to calcium status apparent decrease over 1953 level is significant in the case of treated plots. In all cases the deteriorative tendency is observed both for control and treated plots. But these deviations in the negative direction have no definite trends over years. Moreover for any particular year the level of the difference between 'treated' and 'not treated' groups is not significant. For all years the same feature is displayed.

The amount of calcium removed from an acre of coconut garden has been computed at 13.0 to 15.7 lb. *vide*. Georgie and Teik (1932) and Cooke (1950). This would correspond to about 0.25 lb. of calcium

oxide per tree. 8.0 lb. of slaked lime were added every year to the treated trees under this study. This was supplemented by lime contained in the ash. The latter analysed to 15.96 per cent of calcium oxide. The ash alone at the rate of 60 lb. per tree would supply 9.6 pound of calcium oxide per tree. Thus there is a considerable reserve quantity of lime, after meeting the requirements of the palm. This is true of potash also. Menon and Pandalai (1958) have quoted authority to show that on an average 87 lb. of potash (K_2O) is removed annually by the palms in one acre of a coconut garden, corresponding to about 1.5 lb. of potash per tree. The potash (K_2O) content of the ash used for the study was 4.5 per cent. Thus each tree was supplied with 2.7 lb. of potash, in addition to 1.2 lb. of potash supplied as muriate of potash in the basal dressing or a total of 3.9 lb. of potash per tree per year. This would mean a reserve of 2.4 lb. of potash (K_2O) per tree. These figures would show that the lime and potash status of the soil shows decreasing values of a high order.

One obvious reason for the loss of nutrients is their absorption by the palms. Unsuccessful attempts made earlier to effect a complete cure of the Leaf and Root (Wilt) diseases by application of suitable manures have led to the doubt as to whether the roots of the diseased palms are functioning properly and still retain the power to absorb and translocate nutrients. Data on potash and calcium content of leaves obtained in this study (see below) show that the roots are functioning and nutrients are absorbed.

Apart from removal by the palms, the nutrients might also have been lost by leaching. Loss of lime and potash due to leaching to the extent of 322.0 lb. CaO and 69.0 lb. K_2O per acre from cropped soils has been reported in literature. The soil under study is a coarse sandy soil and subject to heavy rainfall of the order of 108 inches per year. The loss of nutrients by leaching from coconut gardens in similar situations has also been noted by Menon and Pandalai (1958).

Calcium and potassium status of leaves

Data in respect of the calcium and potassium status of the leaf samples collected from the experimental trees are presented in Table 5.

The calcium status and potassium status of the leaves have increased irrespective of whether the trees are treated or not. Both are having rising trends over years. Further in the case of potassium, significant increase is observed from 1954 onwards whereas for calcium this starts only in 1956. For any particular year the level of differences of calcium and potassium contents for the treated and untreated groups of trees are not statistically significant, This is true for all years. This

TABLE 5

Lime and Ash manurial experiment – Central Coconut Research Station, Kayangulam – Leaf Samples – Results of analysis for Lime and Potash

Plot No. and treatment	Tree No.	CaO					Percentage increase over initial values	K_2O					Percentage increase over initial values
		1953	1954	1955	1956	1957		1953	1954	1955	1956	1957	
1	67	0.30	0.24	0.34	0.45	0.51		0.73	1.23	1.45	2.03	1.30	
	150	0.12	0.21	0.19	0.50	0.43		0.85	1.37	1.03	1.52	1.90	
	164	0.15	0.19	0.26	0.62	0.43		1.41	1.61	1.68	2.10	2.65	
	174	0.16	0.33	0.33	0.56	0.46		1.86	2.20	2.08	2.20	2.90	
Control	175	0.27	0.31	0.31	0.75	0.49		1.66	1.80	1.40	2.38	2.99	
	Average	0.20	0.66	0.29	0.58	0.46	130	1.10	1.66	1.53	2.05	2.35	114
2	77	0.12	0.26	0.22	0.50	0.56		0.72	0.57	0.85	1.70	1.71	
	108	0.22	0.26	0.30	0.67	0.51		1.04	0.84	1.63	2.10	1.85	
	114	0.18	0.13	0.25	0.39	0.52		0.73	1.13	1.35	1.70	1.90	
Treated	116	0.27	0.26	0.34	0.62	0.68		1.16	0.91	1.36	1.86	1.96	
	125	0.21	0 20	0.21	0.50	0.44		0.95	1.36	1.07	1.70	2.20	
	Average	0·20	0.22	0.26	0.54	0.54	170	0.92	0.90	1.25	1.81	1.92	109
3	101	0.22	0.06	0.20	0.45	0.58		0.75	1.62	1.64	1.80	1.78	
	119	0.19	0.30	0 41	0.61	0.64		0.66	0.90	1.45	1.25	1.69	
	138	0.33	0.19	0.13	0.50	0.64		1.48	2.05	1.67	2.05	—	
	139	0.19	0.16	0.26	0.45	0.45		1.21	2.38	2.44	2.04	2.40	
Control	145	0.19	0.17	0.20	0.50	0.59		1.54	1.69	1.92	1.64	2.50	
	Average	0.22	0.18	0.24	0.50	0.60	173	1.09	1.83	1.82	1.76	2.09	92
4	151	0.13	0.18	0.22	0.28	0.64		0.82	0.96	1.50	1.66	2.10	
	154	0.29	0.22	0.26	0.50	0.63		0.88	1.89	1.82	1.85	2.50	
	165	0.11	0.18	0.21	0.56	0.50		1.05	1.08	0.99	2.17	1.90	
	171	0.28	0.27	0.28	0.61	0.63		1.41	1.90	1.38	1.73	2.20	
Treated	177	0.22	0.21	0.26	0.50	0.67		0.99	1.35	0.72	1.44	2.30	
	Average	0.21	0.21	0.25	0.49	0.61	191	1.02	1.60	1.27	1.75	2.20	114

TABLE 4

Lime and ash manurial experiment, Central Coconut Research Station, Kayangulam – Soil Samples – Results of statistical analysis – calcium and potassium (total) contents for different years over pre-treatment value (1953)

Year and Block	CALCIUM (CaO)								POTASSIUM (K_2O)							
	No. of observations (n)		Average difference over 1953 ($\bar{z}j^*$)		S. D. of differences σ (zj)		Whether observed mean deviation from 1953 is significant (at 5% level)		No. of observations (n)		Average difference over 1953 ($\bar{z}j^*$)		S. D. of differences σ (zj)		Whether observed mean deviation from 1953 is significant (at 5% level)	
	Control	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control	Treatment
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1954 (a)	5	5	—0.0404	—0.0690	0.5292	0.02657	No	Yes	5	5	—0.0532	—0.0218	0.03910	0.05029	Yes	No
(b)	3	5	—0.0367	—0.0364	0.03917	0.02258	No	Yes	3	5	—0.0803	—0.0436	0.05554	0.04550	No	No
1955 (a)	5	5	—0.0328	—0.0324	0.06966	0.04058	No	Yes	5	5	—0.0670	—0.0156	0.05069	0.05035	No	No
(b)	3	5	—0.0103	—0.0260	0.03838	0.03277	No	No	3	5	—0.0787	—0.0414	0.05433	0.04506	No	No
1956 (a)	5	5	—0.0436	—0.0678	0.07621	0.03764	No	Yes	5	5	—0.0518	—0.0170	0.05682	0.04050	No	No
(b)	3	3	—0.0200	—0.0346	0.03143	0.02070	No	Yes	3	5	—0.0707	—0.0490	0.04021	0.04705	No	No

(a) = A horizon

(b) = B horizon

$\bar{z}j^*$ = xij — yi Where xij = i th value for j th year

yi = i th value for 1953

i = 1, 2, ... n, j = 1954, 1955, 1956.

Year 1953	CaO	K_2O	Total
Control	(a) 0.0732	0.0852	
	(5)	(5)	
Mean ($\bar{y}$)	(b) 0.0490	0.1180	
(n)	(3)	(3)	
Treatment	(a) 0.0964	0.0516	
	(5)	(5)	
Mean ($\bar{y}$)	(b) 0.0526	0.0766	
(n)	(5)	(5)	
Combined	(a) 0.0848	0.0684	
	(10)	(10)	
Mean ($\bar{y}$)	(b) 0.0512	0.0921	
(n)	(8)	(8)	

Plot No. and treatment	Tree No.	CaO					Percentage increase over initial values	K_2O					Percentage increase over initial values
		1953	1954	1955	1956	1957		1953	1954	1955	1956	1957	
5	39	0.21	0.21	0.35	0.39	0.61		1.92	2.03	2.01	1.95	1.79	
	45	0.19	0.09	0.24	0.45	0.48		1.46	1.98	1.47	2.42	2.08	
	47	0.16	0.13	0.27	0.45	0 61		0.87	1.05	0.87	1.82	1.79	
	57	0.20	0.12	0.18	0.34	0.67		1.43	1.66	1.04	2.23	2.20	
Control	64	0.19	0.24	0.21	0.50	0.36		0.80	0.82	2.08	3.06	2.08	
	Average	0.19	0.16	0.25	0.55	0.55	189	1.30	1.51	1.60	2.30	2.17	67
6	120	0.20	0.24	0.31	0.50	0.35		1.67	1.07	1.71	1.42	2.68	
	122	0.28	0.33	0.35	0.50	0.55		0.98	1.31	1.94	1.91	2.30	
	132	0.35	0.22	0.46	0.56	0.69		1.04	0.52	0.94	1.48	1.39	
	169	0.34	0.25	0.52	0.67	0.40		0.48	0.97	0.82	—	2.20	
Treated	170	0.37	0.21	0.07	0.45	0.39		1.42	1.20	0.63	1.48	2.08	
	Average	0.31	0.21	0.30	0.54	0.48	55	1.12	1.01	1.21	1.57	2.13	90
7	60	0.21	0.15	0.10	0.39	0.46		1.76	1.15	1.63	2.02	3.04	
	61	0.09	0.12	0.12	0.34	0.31		1.59	2.03	1.36	2.56	2.52	
	82	0.19	0.11	0.11	0.39	0.53		1.47	1.50	1.42	1.85	2.56	
	107	0.25	0.24	0.18	0.67	0.64		0.94	0.73	1.22	1.76	2.02	
Control	119	0.46	0.64	0.22	0.39	0.89		1.48	1.22	1.86	2.68	2.64	
	Average	0.24	0.25	0.15	0.44	0.57	138	1.45	1.33	1.46	2.17	2.56	77
8	123	0.42	0.36	0.38	0.67	0.60		1.51	1.51	1.49	2.17	2.52	
	139	0.31	0.35	0.19	0.45	0.43		1.34	1.38	1.04	1.99	2.37	
	152	0.16	0.20	0.29	0.56	0.43		1.00	1.06	1.22	1.81	2.10	
	153	0.24	0.20	0.40	0.50	0.52		0.90	0.83	0.84	1.30	1.65	
Treated	156	0.17	0.33	0.11	0.56	0.68		0.77	1.31	1.27	1.71	1.70	
	Average	0.26	0.29	0.27	0.55	0.53	104	1.10	1.22	1.35	1.80	2.07	88

Plot No. and treatment	Tree No.	CaO					Percentage increase over initial values	K_2O					Percentage increase over initial values
		1953	1954	1955	1956	1957		1953	1954	1955	1956	1957	
9	108	0.17	0.33	0.16	0.68	—		0.93	1.55	1.40	2.03	—	
	111	0.28	0.30	0.19	0.56	—		1.27	1.63	1.66	1.27	—	
	115	0.30	0.33	0.16	0.50	—		1.06	1.36	1.69	2.23	—	
	125	0.16	0.11	0.05	0.50	—		2.03	1.60	2.07	2.24	—	
Control	126	0.30	0.37	0.19	0.56	—		1.44	1.45	1.85	2.64	—	
	Average	0.24	0.29	0.15	0.56		133	1.35	1.52	1.73	2.06		53
10	96	0.27	0.28	0.18	0.68	—		1.71	1.28	1.85	2.13	—	
	99	0.29	0.28	0.18	0.56	—		0.80	1.55	2.13	2.35	—	
	113	0.20	0.17	0.15	0.68	—		0.83	0.83	1.48	2.06	—	
	114	0.18	0.24	0.17	0.68	—		0.66	1.17	0.96	2.06	—	
	144	0.11	0.17	0.28	0.50	—		0.82	1.68	1.06	2.37	—	
Treated	Average	0.21	0.22	0.18	0.62	—	195	0.96	1.30	1.50	2.19	—	128
													81
Percentage increase over initial values (average)			Control 163										106
			Treated 143										

TABLE 6

Lime and ash manurial experiment - Central Coconut Research Station, Kayangulam – Leaf Samples – Mean and standard deviations (S. D.) values of calcium and potassium contents for different years over pre-treatment value (1953)

Year and Block	CALCIUM (CaO)								POTASSIUM (K_2O)							
	No. of observations (n)		Average difference over 1953 ($\bar{z}j^o$)		S. D. of differences σ (zj)		Whether observed mean deviation from 1953 is significant (at 5% level)		No. of observations (n)		Average difference over 1953 ($\bar{z}j^o$)		S. D. of differences σ (zj)		Whether observed mean deviation from 1953 is significant (at 5% level)	
1	Control 2	Treatment 3	Control 4	Treatment 5	Control 6	Treatment 7	Control 8	Treatment 9	Control 10	Treatment 11	Control 12	Treatment 13	Control 14	Treatment 15	Control 16	Treatment 17
1954	25	25	0.0059	0.0007	0.07288	0.09221	No	No	25	25	0.2637	0.1902	0.42803	0.43806	Yes	Yes
1955	25	25	-0.0044	0.0248	0.11602	0.11025	No	No	25	25	0.3362	0.2639	0.40025	0.43600	Yes	Yes
1956	25	25	0.2810	0.3100	0.13127	0.11165	o Yes	o Yes	25	24	0.8029	0.7863	0.46926	0.44049	o Yes	o Yes
1957 Block (1)	10	10	0.3104	0.3625	0.07557	0.06862	o Yes	o Yes	19	20	1.0183	1.0375	0.43343	0.32505	o Yes	o Yes
Block (8)	10	10	0.3410	0.2218	0.10437	0.14655	Yes	Yes								

o highly significant at 5% level

$\bar{z}j^o$ = xij — yi where xij = i th value for j th year

yi = i th value for 1953

i = 1, 2 ... n; j = 1954, 1955, 1956, 1957.

Year 1953	CaO	K_2O
Control		
Mean ($\bar{y}$)	0.2226	1.3004
(n)	(25)	(25)
Treatment		
Mean ($\bar{y}$)	0.2367	1.0275
(n)	(25)	(25)
Combined		
Mean ($\bar{y}$)	0.2296	1.1639
(n)	(50)	(50)

may be due to the fact that both potassium and calcium contents have the same rising trends.

The lime and potash contents of leaves of coconut palms in health and disease reported by other workers are compared to those obtained in the present study in Table 7 below.

TABLE 7

Showing the calcium and potassium content of leaves of healthy and diseased palms

Description of sample	Healthy			Diseased			Authority
	Calcium (CaO)%	Potash (K_2O)%	K_2O/ CaO	Calcium (CaO)%	Potash (K_2O)%	K_2O/ CaO	
Bearing coconut tree	0.28	0.56	—	—	—	—	Sampson (1923)
Collected from trees growing in different classes of soils (including sandy soil) in Travancore-Cochin	0.46	1.39	3.00	0.50	1.66	3.34	Verghese *et al.*, (1959)
–do– for sandy soil alone	0.47	1.53	3.25	0.49	1.67	3.41	–do–
Collected from diseased trees under the present experiment.							
Control — Initial values				0.22	1.26	5.70	—
Control — Final values				0.055	2.29	4.16	—
–do– treated — Initial values				0.24	1.03	4.29	—
–do– treated — Final values				0.54	2.08	3.85	—

It will be seen from the above data that the lime and potassium contents and the potassium / calcium ratio of leaflets of coconut palms growing under varying soil conditions in Travancore-Cochin are not appreciably different whether the trees are healthy or diseased. Compared to these figures the trees under the present study show lower initial values. This is particularly true cf lime resulting in a comparatively high potassium / calcium ratio. With the continued application of lime and ash these nutrients are absorbed in greater quantities. The absorption of the nutrients is not however proportional as indicated by the appreciable lowering of the potassium / calcium ratio from the initial values. In this connection may be mentioned the need for the proper balance of lime and potassium required for optimum plant growth as noted by York *et al.*, (1953 a, 1953 b) and the observations about calcium / potassium antagonism noted by Salgado (1955) and Ehrenberg (1919). According to them there would be an antagonism between potassium and calcium above a certain critical level of calcium.

Observations on morphological characters and visual symptoms of disease did not reveal appreciable curative effect due to the yearly application of lime and ash for five years.

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