A note on the Strontium content of coconut leaves and soils in relation to 'Leaf' and 'Root' (wilt) diseases of coconuts in Travancore & Cochin

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STRONTIUM nutrition of plants has been investigated by a number of workers. Sen (1937), Collander (1941), Jacobson and Overstreet (1948), Spooner (1949), Rediske and Selders (1953), Epstein and Legett (1954), Menzel and Heald (1955), Walker (1956) and others found that strontium reacts similarly to calcium. Wolf and Cesare (1952) showed that strontium sprays cured the chlorotic conditions of peach trees. Some authors, however—vide Hurd-Karrer, Annie M. (1937, 1939), Walsh (1949) and Martin (1954), have reported that strontium is toxic to plants. With regard to the coconut, Hansen (1952) suggested that the toxin producing the "Unknown disease" of coconut palms in Jamaica might be strontium. Strontium has also of late assumed greater importance as a product of nuclear fission. It was therefore felt worthwhile to study the strontium content of coconut leaves and soils in relation to the 'Leaf' and 'Root' (wilt) diseases of coconuts in Travancore-Cochin, an area noted for its large deposits of rare earths.

The 'Leaf' and 'Root' (wilt) diseases of coconut palms

The nature of the 'Leaf' and 'Root' (wilt) diseases has been reported by Menon and Nair (1948, 1949). Briefly, the symptoms of the 'Leaf' disease is a blackening and shrivelling of the distal ends of leaflets in some of the inner whorls of the leaves. On drying up, these are broken off in bits by the wind and the infected leaf assumes a fan-like appearance. If the disease is un-

checked, each successive central shoot of the diseased tree gets infected in turn and a stage is soon reached when all the leaves of the tree will show diseased symptoms. In the case of the 'Root' (wilt) disease, the most common and obvious symptom is a general yellowing and drooping of the outer whorls of leaves. In some cases, a sickly pale yellow colour is developed in the leaves of the inner whorl also. The leaves become flaccid, the leaflets curling slightly at the tips, sometimes becoming brown and drying at the tips. Generally the 'Leaf' and 'Root' wilt diseases are found to occur together.

A diseased palm is illustrated in plate I.

MATERIALS & METHOD

After a detailed survey of the coconut growing areas of Travancore and Cochin, Kerala State, leaf and soil samples were collected from representative healthy and diseased areas. In sampling leaf material, the standard procedure evolved in these laboratories was adopted, i. e. the 30th to 50th leaflets of the middle leaf were collected, dried at 60 to 65°C. and suitably powdered to pass through a one mm. sieve. The soil samples were collected from profile pits 0·91 m. deep and cut approximately 3·0 m. away from the base of the healthy or diseased tree selected for leaf sampling.

Analytical technique

Five gm. of powdered leaf sample were ashed in a muffle furnace at 450°C. The ash was dissolved in 5 cc. of redistilled hydrochloric acid, evaporated to dryness and silica dehydrated by heating for one hour over a medium hot plate. The residue was taken up in 2 cc. to 2·5 cc. of redistilled hydrochloric acid, filtered and washed with hot water and the solution made up to 50 cc.

One gm. of soil sample, finely ground in an agate mortar, was fused with sodium corbonate and extracted with redistilled hydrochloric acid. The hydrochloric acid extract, after removal of silica and sesquioxides and ammonium salts with nitric acid, was taken up with 2 cc. to 2·5 cc. of redistilled hydrochloric acid and made up to 50 cc.

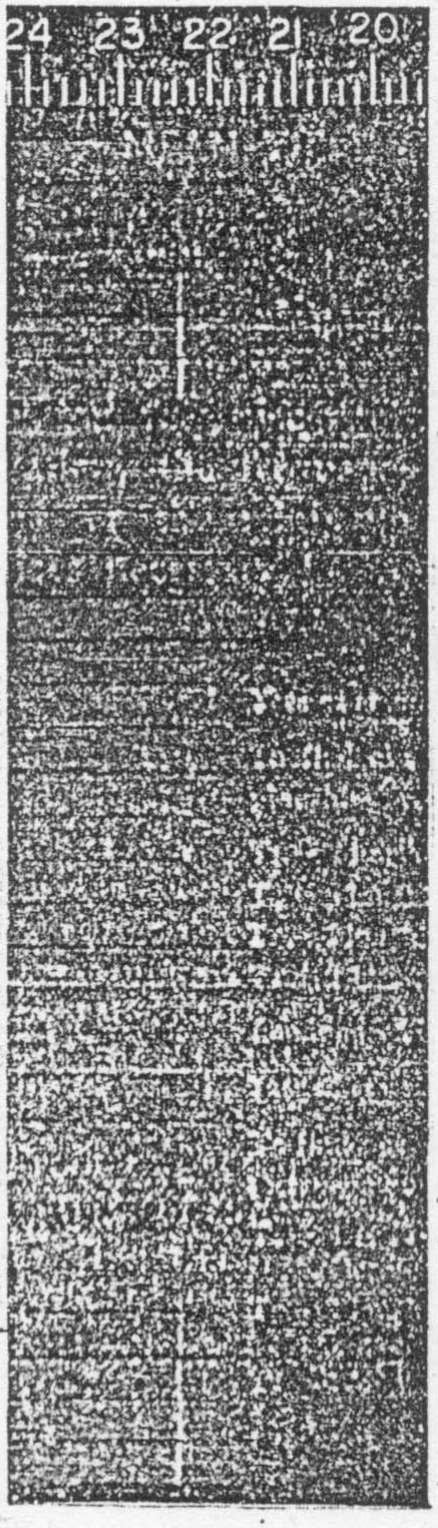
The final concentration of the extracts closely approximated that recommended by Mitchell (1936, 1948).

In the above extracts and suitable dilutions, strontium was determined spectrographically in a Lundergardh spectrograph according to the method of Mitchell (*loc. cit*). Prior standardisation showed

A coconut palm affected by the 'Leaf' and 'Root' (wilt) diseases.

Plate I

Portion of Spectrogram showing strontium line, taken according to the method of Lundegardh.



Strontium line.

Standards

Extracts From Healthy and Diseased Coconuts Leaves.

Standards.

that an air pressure of 1·69 kg. per square cm. and acetylene pressure of 44 cm. of water were the optimum for these estimations. These pressures were maintained throughout. The unknown solutions and the standards were exposed to the same plate, each determination being done in duplicate.

Observations

The type of results obtained is illustrated in Plate II.

It will be seen from plate II that the strontium content of the leaves is less than that represented by the lowest concentration of the standard, viz., M/100,000 of $SrCl_2 . 6H_2O$. The strontium lines of the unknowns were not readable. Taking into account the weight of sample taken for analysis and the limiting value of the lowest concentration of the standard, the following values were computed for the healthy and diseased leaf samples.

LOCALITY	SOIL TYPE	STRONTIUM CONTENT OF LEAVES	
		Healthy less than	Diseased less than
Ethamulai, South Travancore ..	Sandy	0·2780 ppm.	0·2130 ppm.
Kayangulam, Central Travancore ..			
Vytilla, Cochin ..			0·1901 "
Kasaragod, Noth Malabar ..	Laterite	0·2877 "	0·1999 "
Thodupuzha, North Travancore ..			
Chirayinkil, South Travancore ..	Reclaimed clayey soil	0·2918 "	0·2362 "
Kumarakom, North Travancore ..			
Pachallur, South Travancore ..	Red loam	0·2463 "	0·2178 "
Thiruvalla, Central Travancore ..			
	Average	0·2760 ppm.	0·2114 ppm.

It will thus be seen that the leaves from healthy and diseased trees contained on an average less than 0·28 and 0·21 ppm. of strontium respectively. Remembering the fact that these figures represent only the lower limit of sensitivity of the method followed, and are not absolute values, it may be inferred that these samples contain only minute traces of strontium and that there is no appreciable difference in this regard between healthy and diseased leaves.

The soil extracts also contained, similarly, only traces of strontium, lower than that represented by the lowest concentration of the standard.

DISCUSSION

The results obtained in this preliminary study would show that coconut soils and leaves contain only

minute traces of strontium lower than 0·2 to 0·3 ppm. It is not known whether such amounts will be toxic to a perennial crop like the coconut. In the light of the results reported by Rediske and Selders (1953), Walker (1956) and others it is unlikely that toxicity might result.

It may be interesting here to state that abundant deposits of black sea and river sands from which are processed minerals like ilmenite, monazite, leucoxene, zircon, rutile, garnet, etc., occur in the coastal regions of South Travancore and that coconut trees in these regions are generally healthy and free from the 'Leaf' and 'Root' (wilt) diseases. In fact, these sands are paid a premium price and transported over long distances for application to coconut gardens. In the coconut crop competition conducted in the Travancore-Cochin State in 1953, the District prize was won by the owner of a garden who applied this sand in his garden. The water table in the garden is 1·06 m. during rains and 1·37 m. in summer. A ring trench 0·46 m. broad and 0·46 m. deep was cut at a distance of 2·44 m. from the tree and a mixture of 2721·6 kg. of black estuarine sand, 2721·6 kg. of ordinary white coloured river silt and 13·6 kg. to 18·1 kg. of wood ash was applied in the ring trench and to a height of 5·1 cm. to 7·6 cm. on the surface soil round the tree, in the circle formed by the ring trench. No other manure was applied. This treatment was given to all the trees in the garden in 1950-51 and the yield in 1953-54 rose to 11,334 nuts per acre, the highest yield in the District.

From the above, it might be inferred that strontium which might probably be associated with the rare earths may have, if at all, only a beneficial effect on coconut trees at the concentrations used. The soil and leaf samples studied show that their strontium content is less than 0·28 ppm. The strontium present in traces may not be a factor in the 'Leaf' and 'Root' (wilt) diseases of coconut trees in Travancore and Cochin. In fact, the question of toxicity can be decided only on the basis of well laid out experiments. Experiments in progress in these laboratories, attempting to produce toxicity symptoms in trees treated with different doses of strontium chloride might clarify this issue and this will form the subject of a future communication.

SUMMARY

Representative samples of coconut leaves and soils were analysed spectrographically for strontium. Strontium was found in these samples only in traces. The relation of strontium to the 'Leaf' and 'Root' (wilt) diseases of coconut

trees in Travancore and Cochin is discussed.

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LITERATURE CITED

1 Collander, R. ... (1941) Selective absorption of cations by higher plants. *Plant Physiol.*, 16, 691-720.

2 Epstein, E. & Legett, J. E. (1954) The absorption of alkaline earth cations by barley roots, *Amer. J. Botany*, 41, 785-91.

3 Hansen, H. P. ... (1952) On the so-called 'Unknown disease' and related diseases on coconut palms in the West Indies. *Plant Dis. Reptr.*, 36, (2). 66-67.

4 Hurd-karrer, Annie, M. (1937) Rubidium and Strontium toxicity to plants inhibited by potassium and calcium respectively. *Wash. Acad. Sci.*, 27, 351-53.

5 Hurd-karrer, Annie, M. (1939) Antagonism of certain elements essential to plants towards chemically related toxic elements. *Plant Physiol.*, 14, 9-20.

6 Jacobson, L. & Overstreet, R. (1948) The uptake by plants of plutonium and some products of nuclear fission absorbed on soil colloids. *Soil Sci.*, 65, 129-34.

7 Martin, D. C. ... (1954) Absorption and translocation of radio strontium by leaves, fruits and roots of certain vegetable plants. *Diss. Abstr.*, 14, 1875, cited from *Horti. Abstr.*, 25. 1647.

8 Menon, K. P. V. & Nair, U. K. (1948) The 'Leaf rot' disease of coconuts in Travancore and Cochin—Symptoms, incidence and cause of the disease. *Indian Coconut J.*, 1. (2), 33-39.

9 Menon, K. P. V. & Nair, U. K. (1949) The wilt (Root Disease) disease of coconuts in Travancore and Cochin *Indian Coconut J.*, 3, (1). 5-10 and 40-44.

10 Menzel, R. G. & Heald, W. R. (1955) Distribution of potassium, rubidium, caesium, calcium and strontium within plants grown in nutrient solutions. *Soil Sci.*, 80, 287-93.

11 Mitchell, R. L. ... (1936) Spectrographic analysis of soils by the Lundergardh method. *J. Soc Chem. Ind, Lond.*, 55, 267T-69T.

12 Mitchell, R. L. ... (1948) *The spectrographic analysis of soils, plants and related materials.* Tech. Communication No. 44. Commonwealth Bureau of Soil Science.

13 Rediske, J. H. & Selders, A. A. (1953) The absorption and translocation of strontium by plants. *Plant Physiol*, 28, 594-605.

14 Sen, B. ... (1937) The effect of different cations on the living protoplasm of the root hairs of *Azolla pinnata*. *Indian J. Agric. Sci.*, 7, 479-85.

15 Spooner, M. A. ... (1949) Observations on the absorption of radio active strontium and yitrium by marine algae. *Jour. Marine Biol. Assoc.*, 28, 587-625

16 Walker, James, B. ... (1956) Strontium inhibition of calcium utilization by a green algae cited from *Chem. Abstr.*, 50, 6605-6606.

17 Walsh, T. ... (1949) The effect of plant growth of substituting strontium for calcium in acid soils. *Proc. Roy. Irish Acad.*, 53B, 287-94.

18 Wolf, B. & Cesare, S. J. (1952) Response of field grown peaches to strontium sprays. *Science*, 115, 606-607.