# THE MANGANESE CONTENT OF SOIL AND PLANT TISSUE IN RELATION TO THE ROOT AND LEAF DISEASES OF THE COCONUT PALM

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IT is now well established that trace element nutrients exert their influence on plants either by producing a deficient condition due to non-availability or lack of nutrient on the one hand, or by exerting toxic effects due to their release into the soil in large quantities in an available form on the other. In either case, disease symptoms manifest and the plant ultimately succumbs to the effects. Deficiencies may usually exist either as single or multiple deficiencies, and when elements are present at very low levels they act as limiting factors to growth. When present in excess the plants may merely absorb unnecessary amounts of the elements without any beneficial or harmful effects or excesses sometimes produce harmful effects characteristic for individual elements. Excesses also result in total failure of crops. An observation made by Innes[1] (1949) that there is no obvious relationship between the incidence of disease and the manganese content of palm leaf tissue in the case of the "unknown disease" of the coconut palm in Jamaica suggested the desirability of tracing whether any correlation existed between disease incidence in this country and the deficiency or excess condition of manganese in the soils here, particularly because the diseases prevalent here show similar or identical symptoms to the "unknown disease" of coconuts in Jamaica or the "Cadang-Cadang" disease of coconuts in the Philippines: Menon and Nair[2] (1949). It was also thought that if the normal range of variation in the manganese content was established, analysis of individual samples might be of diagnostic value in identifying

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areas in which a slight deficiency of the element exists; that is, a deficiency not sufficiently severe to induce specific pathological symptoms in the crop. The fact has to be considered that in the case of a deep-rooting plant, such as the coconut palm, various factors are liable to influence a comparative study of the plant in health and disease, especially with work involving the association of the trace-nutrients like manganese.

Daji[3] (1948) working on the 'band' disease of areca palms in Bombay, while examining the soils of affected gardens by the quin-hydrone method, found a considerable difference in potential suggesting the presence of manganese oxides. Comparative analysis of samples taken from affected and healthy areas, showed a much higher content of total and available manganese in the first named. A particularly striking feature was the presence of large quantities of the mineral in an available form in the upper layers of the soil near the diseased palms. It thus appeared to be interesting to investigate the manganese status of soils and plant tissues from areas where trees appeared to be quite healthy and from affected areas. A brief account of the work done on these aspects forms the subject matter of this paper.

Tissue analysis is now a very well recognised method applied to the growing crop, in health and disease, to find out how far its nutrition is adequate in time for curative treatment to be effective on the same crop. As suggested by Roach[4] (1948) a correct procedure would be to compare extremely diseased trees, with a range of the more healthy ones of comparable physiological age that can usually be found growing near by and with comparable really satisfactory plants from elsewhere. Similarly observations can be made in the case of soils also from healthy and diseased gardens. In the case of soils the hydrochloric acid extract was used for the estimations and in the case of tissues, the extract obtained by wet digestion with perchloric, nitric and sulphuric acids was used. The manganese present was estimated colorimetrically using the periodate oxidation method as described by Piper[5] (1944). Sampling was done (1) in the case of soils, by air-drying and passing through a 2 mm. seive, the portion passing through being used and (2) in the case of tissues, by sun-drying and thorough crushing in a laboratory crusher. The figures for the manganese content in various tissue samples of the palm and different soil samples are presented in the following tables.

TABLE 1.

Showing the manganese content in parts per million in different tissues of healthy and diseased palms standing side by side in a diseased area. C. C. R. S., Kayangulam.

| Tree No. and condition. | Manganese content in p.p.m. of | | | | |
|---|---|---|---|---|---|
| | Tender Leaves | Middle leaves | Leaf stalk | Oldest unopened spathe | Functioning roots. |
| No. 251 healthy | 36.2 | 144.2 | 34.4 | 49.5 | Trace |
| No. 155 Healthy | 15.2 | 55.6 | 48.5 | 11.2 | ,, |
| No. 63 Healthy | Trace | 137.9 | 68.5 | 60.6 | ,, |
| No. 138* Diseased | 88.7 | 176.5 | 56.8 | 111.9 | 7.7 |
| No. 162* Diseased | 61.5 | 58.8 | 46.5 | 75.8 | Trace |
| No. 151* Diseased | 34.5 | 39.2 | 37.7 | 85.7 | ,, |

* These trees were in the advanced stage of the disease.

TABLE 2.

Showing the manganese content in parts per million in soil samples collected from the base of healthy and diseased trees standing side by side in the same garden (C. C. R. S., Kayangulam).

| From base of healthy trees. | | | From base of diseased trees. | | |
|---|---|---|---|---|---|
| Tree No. | Horizon | Manganese p.p.m. | Tree No. | Horizon | Manganese p.p.m. |
| 3 | 0–24'' | 57.4 | 11 a | 0–24'' | 62.5 |
| | 24–48'' | 64.1 | | 24–48'' | 53.3 |
| 6 | 0–24'' | 57.5 | 11 b | 0–24'' | 93.8 |
| | 24–48'' | 61.7 | | 24–48'' | 105.6 |
| 12 | 0–24'' | 51.9 | 15 | 0–24'' | 90.9 |
| | 24–48'' | 18.9 | | 24–48'' | 81.5 |
| 24 | 0–24'' | 71.4 | 16 | 0–24'' | 63.3 |
| | 24–48'' | 54.1 | | 24–48'' | 40.8 |
| 25 | 0–24'' | 92.0 | 32 | 0–24'' | 44.7 |
| | 24–48'' | 109.5 | | 24–48'' | 47.6 |
| 86 | 0–24'' | 14.4 | 73 | 0–24'' | 8.8 |
| | 24–48'' | 8.1 | | 24–48'' | 11.6 |
| 251 | 0–24'' | 29.8 | 141 | 0–24'' | 61.7 |
| | 24–48'' | 24.9 | | 24–48'' | 83.3 |

| | | |
|---|---|---|
| Quilon: healthy well bearing palm. Soil:–Sandy. | Outer leaf | 14.9 |
| | Middle leaf | 37.9 |
| | Inner leaf | 12.6 |

The figures show that the manganese content of leaves collected from healthy trees in healthy gardens range between 12.6 p. p. m. and 126.3 p. p. m. These results make it rather difficult to decide the role of manganese in the physiology of the coconut palm in relation to its health.

In table 5 are given the manganese figures of a diseased locality in Edapally in N. Travancore.

TABLE 5.

Showing the manganese content and pH of soils from a diseased locality in Edapally.

| Sample No. | Mn p.p.m. | pH. | Remarks. |
|---|---|---|---|
| 4/51 | 74.4 | 6.8 | The soil be- |
| 5/51 | 72.5 | 6.6 | longs to the |
| 6/51 | 82.3 | 6.0 | sandy loam |
| 7/51 | 112.2 | 5.4 | type: Sub- |
| 8/51 | 102.1 | 6.0 | soil is sub- |
| 9/51 | 90.1 | 5.6 | jected to bad |
| 10/51 | 103.4 | 7.2 | conditions of |
| 11/51 | 104.9 | 7.2 | drainage. |
| 12/51 | 111.1 | 6.8 | |
| 13/51 | 94.3 | 7.4 | |

The palms are mostly suffering from leaf disease and have been poor yielders. The manganese contents vary between 72 to 112 p. p. m. The soils are mostly acidic. Even though the soils are fairly well supplied with manganese, the trees are bad yielders and unhealthy. This aspect presents another extreme case and another clue to the non-justification to assign to manganese any important physiological role, orientating health or disease conditions of the coconut palm.

## DISCUSSION

These results tend to indicate that the degree of divergence of the manganese contents of both soils and plant tissues is very appreciable, irrespective of the sources of the same, whether from healthy or diseased areas or whether from healthy well-bearing palms or badly diseased ones. While in a healthy locality in Nedumangad where the trees were healthy and well bearing, the manganese content of the soil was as high as 435 p. p. m., the manganese content went down to traces only in some Quilon samples where also trees appeared to be equally healthy and well-bearing. Similarly the manganese content of the leaves collected from quite healthy trees growing in healthy areas range between 12.6 p.p.m. to 120.3 p.p.m. These results throw some doubt as to the extent to which manganese acts toxically in soils, with regard to coconuts. It also appears doubtful

whether the pathological symptoms exhibited by the root disease of coconuts could be brought about by a deficiency of manganese. Innes (loc. cit) also appears to be of this view. According to him the cause of the disease is unlikely to be associated with soil aeration or soil oxidation reduction conditions since disease is found to occur in trees growing in swamp soils, laterite regions, loams and in loose sandy type of soil, where these two conditions are bound to vary.

Some work is in progress in this station on solid injection of manganese salts into the diseased palms as well as manganese salt sprays and the results of these, when completed might show how far manganese is responsible for the cause of the disease. Responses, if any, to such treatments will give some conclusions of indicative value even in the case of such perennial crops, as the coconut palm, such responses could be manifested only at far-drawn intervals. These results also show that what Daji (loc. cit) assumes to be the cause of the 'band' disease of areca palms, does not apply to the coconut palm. In judging these results it has to be remembered that numerous interfering factors have to be carefully analysed and studied before one can affirm and confirm the tentative conclusions reported above. Such aspects are being looked into.

## SUMMARY

Data is given on the manganese contents of tissues collected from healthy and diseased coconut trees and of soils of the respective areas. The manganese contents vary between very wide ranges, from traces up to 435 p.p.m. in soils and from traces to 176.5 p.p.m. in tissue samples. These make it difficult to diagnose the disease as involving a manganese factor and there appears to be no correlation between disease incidence and manganese status of the soils and tissues of the coconut palm. Work to elucidate the problem further is in progress in these laboratories.

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