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YELLOW LEAF DISEASE OF ARECANUT : PHYSIOLOGICAL STUDIES*

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SYMPTAMATOLOGY

General symptoms

The palms which show the visible symptoms first are more often those growing near running or standing water. In most of south Kerala, where the diease first made its appearance, and where the topography consists of hills and valleys, arecanut is planted along the bunds of gulleys and ravines with paddy in the valleys (Annual Report, 1959-60). A number of herbs and shrubs growing wild as weeds and also cultivated with affected arecanut palms were found to produce chlorosis, in some of the gardens. Arecanut seed nuts from the healthy area, sown around the basins of diseased palms also exhibit symptoms on sprouting (Annual Report, 1961-62). Water table in affected gardens are generally high between 10-20 cm during the period of symptom emergence.

Morphological symptoms

The intervenial foliar yellowing, the first visible symptom of this malady, begins with the onset of rains. The effected leaves are brittle to touch. The foliar yellowing generally starts from the tips of lowermost leaves.

Root studies have shown that the affected palms possess lesser quantity of lateral roots with poor spread. They also showed necrosis, browning and ponginess (Annual Report, 1959-60). Further observations show blackening of root tips and decay of the entire root system in due course (Annual Report, 1961-62).

Tapering of stem is seen in palms at advanced stages of this malady. Reduced nut set accompanied by occasional kernel discolouration is also reported.

Physiological symptoms

The leaf samples of the affected palms showed that the moisture touch the lowest level in June—the month of symptom emergence—by 59.10%. The corresponding value in healthy leaves was 70.84%. Root samples of the above groups did not vary much (Yadava *et al.*, 1972).

A hole made at the base of trunk of affected palms allows a viscous dark liquid to come out and such palms recoup temporarily from this malady.

The affected palms showed a high leaf sap acidity of 3.29 pH as compared to the 4.63 of healthy ones. Leaves of the affected palms have further shown lower total phenols and total solids along with higher tannin content. The dehydrogenase activity was found enhanced in the affected leaves (Annual Report, 1961-62).

A higher accumulation of carbohydrates in the leaf tissues of the diseased palms points to the affected carbohydrate metabolism. This was observed by Yadava *et al.* (1972).

NUTRITIONAL STUDIES

After reviewing the results of the work done on the disease, the expert team from I.A.R.I. in 1960 (headed by Dr. Roy Chowdhury) was of the opinion that although the soil conditions play an important role in symptom expression of the disease, soil was not the real cause. It further eliminated fungi, bacteria and insects also from the list of suspected causative organisms of this malady.

The healthy nature of well managed gardens and the favourable response obtained to field experiments on nutritional aspects led the Pal Committee

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to recommend intensification of Physiological investigations on a more comprehensive and co-ordinated basis to look into the role of macro and micronutrients in the cause and spread of this disease (Report of the Sub-committee, 1960).

The field trials conducted on the basis of the recommendations of the Pal Committee, using macro and micronutrients showed a general improvements in the health of palms, especially those at the initial stages of infection. (Annual Report, 1963-64).

After evaluating the work, Lal Committee in 1964 recommended an extensive survey on symptamatology, studies on the effects of physical factors in the spread and also the individual and group effects of various elements in the incidence of this malady, to be taken up (Report of the Sub-committee, 1964).

Effects of major elements

The first report on the nutritional aspects of this malady (Annual Report, 1959-60), showed the existence of nitrogen and phosphorus deficiencies in the soils of diseased gardens. Lime application in improving the soil conditions was also reported along with that.

Sand culture experiments to study the deficiency symptoms exhibited, chlorosis to start from the tips of lamina towards base, in seedlings which were deficient in calcium (Annual Report, 1962-63). The leaves of diseased palms are found to have a higher calcium/magnesium ratio.

Though the diseased palms are reported to have high total ash, phosphorus, potash and insoluble silica, they are deficient in nitrogen, calcium and moisture at the same time. (Annual Report, 1963-64).

Velappan (1969) in his pot culture experiments studied the effects of major and minor elements on the symptom expression. He observed that deficiencies of nitrogen, phosphorus and magnesium had some relationships with the disease.

Yadava *et al.* (1971) found that nitrogen, phosphorus and magnesium deficient but potassium and calcium present in normal quantities in the affected palms at the time when symptoms begin to appear.

Another set of pot culture studies to examine the role of major nutrient deficiencies in the symptom expression of this disorder could not produce any symptoms typical of this malady (Yadava *et al.* 1972).

Contradictory to the past observations, tissue analysis (Mohapatra *et al.* 1976) showed that except phosphorus, all other elements are in sufficiency in the leaves of diseased palms of Kerala State.

A recent study on the leaf nitrogen status of the arecanut palms showed a generally poor content of this element, but the palms of Karnataka State showed a higher accumulation than those of Kerala State (Mathai *et al.* 1975).

Studies on the nutritional aspects of this malady helped in standardising the leaf sampling technique in arecanut (Yadava *et al.*, 1971). It also helped in modifying the colorimetric method of magnesium estimation (Yadava *et al.* 1969).

Effects of minor elements

Manganese deficiency in the soils of diseased gardens was reported in 1959-60 (Annual Report). Foliar spray of manganese is reported to have suppressed chlorosis to some extent, when used as manganese sulphate at 1 per cent concentration (Annual Report, 1959-60).

Root feeding of iron solution (as ferrous sulphate) did not produce any symptoms similar to the disease (at 0.1 per cent level). Manganese and magnesium at 0.5 per cent levels also failed likewise. Both leaf and root feeding of boric acid produced chlorosis but the leaves formed after the feeding were normal (Annual Report, 1964-65; Samraj and Paily, 1965).

Dipping leaves in solutions of iron, manganese and magnesium sulphates indicated 0.03% of iron to be toxic and lower levels of manganese and magnesium to be non toxic to arecanut palms (Annual Report, 1964-65).

On the basis of the past work, higher hydrochloric acid and water soluble iron and also on the basis of leaf dipping experiments conducted, Holmes (1964, Private communication) suggested the existence of serious disturbances in the manganese/iron and magnesium/calcium ratios in the affected plant tissues. Dipping of leaves in 1% manganese and magnesium was found to be more effective in checking chlorosis (Annual Report, 1964-65). The leaf

tissues from the diseased palms showed a wider iron/manganese ratio of 4.31 and the healthy 2.25. This may be due to the lower availability of manganese in the soils of the diseased gardens.

Sanford (1964, Official communication to the Arecanut Specialist, Vittal) after studying the symptoms suggested to look into the effects of copper, molybdenum and manganese. Wallace (1965, Official communication to the Arecanut Specialist, Vittal) also suggested studies to determine the roles of manganese and magnesium.

Deficiency of zinc also showed some relationship to the disease symptoms (Velappan, 1969).

Yadava *et al.* (1969) found that the diseased palms contained more iron and aluminium in the leaf tissues. They also observed the soils of the affected gardens in a highly reduced condition.

In another experiment, it was found that aluminium did not vary between healthy and diseased tissues.

The results of Comprehensive Package Plan trials laid out in the diseased gardens have been given elsewhere. It showed that out of the thirteen treatments, the one getting manganese and magnesium in addition to NPK and lime having notable general improvement though these were not statistically significant. It also reduced the foliar yellowing considerably (Mathai, *et al.*, 1969).

A later visit in 1973 to three of the gardens which were under the micro and macronutritional experiments in the Kerala State, showed a comparatively reduced foliar yellowing in treatments which were getting zinc and manganese separately in addition to the major nutrients, cattle manure and lime.

Work in Progress

(a) Effect of graded doses of aluminium in the incidence of yellow leaf disease.

(b) Effect of manganese sulphate 0.5 per cent and 1.0 per cent and diammonium phosphate 1.5 per cent and 3.0 per cent as foliar spray on affected palms.

(c) Effect of fertilization and drainage on the incidence of disease.

Suggestions for Future Work

A search on the microflora which flourish under varying deficiency and sufficiency conditions, at the root zone, of proven elements and their effect on soil could be a reasonable approach.

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