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YELLOW LEAF DISEASE OF ARECANUT IN SOIL FERTILITY STUDIES*

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The earliest information on yellow leaf disease of arecanut is found in the publication "Diseases of Coconut Palm" by MK Verghese published in 1920 (Nambiar and Sreenivasan, 1951). Radha Menon (1960; 1961) reported the presence of virus in diseased arecanut palms from Kerala growing in soils low in available nutrients. She suggested that lack of balanced nutrition and improper cultivation practices made the palms susceptible to virus infection. Water logging was considered as one of the predisposing factors in the incidence of this disease (Anonymous, 1960; Pal *et al.,* 1960). Application of fertilizers improved the conditions of the diseased palms (Anonymous. 1967). Radha Menon and Kalyanikutty (1961) reported that intensity of yellowing in plants decreased when sprayed with salts of magnesium and manganese. Nutrient culture experiments with major and micronutrients did not produce any symptoms on arecanut seedlings similar to that of yellow leaf disease (Anonymous, 1960; 1962).

Holmes (1964) opined that yellow leaf disease was due to deficiency or toxicity of either manganese or iron. Lal *et al.* (1964) also suggested a nutritional approach to the problem. They felt that drainage should be improved in low lying areas.

Qualitative tests on diseased arecanut leaf recorded low pH, more water and hydrochloric acid-soluble iron. The high CaO/MgO ratio obtained was attributed to low content of magnesium in the diseased tissue (Anonymous, 1967). In an earlier study, diseased leaf was found to contain more silica, phosphorus, and potash (Anonymous, 1964).

Sam Raj and Pailey (1965) reported reproducing symptoms similar to those of the disease by applying boron to soil. Subsequently, work done at Vittal showed that yellowing caused by boron was different from the foliar symptoms of yellow leaf disease. No visible symptoms of the disease were produced after root feeding with 1% solution of ferrous sulphate (Anonymous, 1967).

Some field trials have been carried out in diseased areas to find out the effect of lime, fertilizers and micronutrients on affected palms. Dastagir (1963) observed that soil application of NPK fertilisers + lime with or without zinc sulphate reduced foliar yellowing in palms in Karnataka. A field experiment laid out at Palode (Kerala State) in 1961 to study the effects of major nutrients, micronutrients and irrigation showed that none of these treatments were effective in controlling the disease (Rawther and Abraham, 1972). Later, a Comprehensive Package Plan Scheme was started in 1965 with 13 treatments comprising of all the major and micronutrients at five centres situated in Kerala and Karnataka States. The results from these were inconclusive (Anonymous, 1971).

Earlier studies during 1959-1962 in diseased areas of Kerala showed that their soils are acid with pH as low as 3.8 and deficient in all the three major nutrients (Anonymous, 1960; 1961; 1962). Velappan (1969) analysed soils from apparently healthy and diseased gardens of Trivandrum district (Kerala). The soils from diseased gardens were low in pH, organic carbon, available phosphorus and magnesium. Leaf of healthy palms contained higher amounts of nitrogen, phosphorus, magnesium and zinc than those of diseased palms. He also found that the toxicity symptoms obtained in arecanut seedlings grown in soil added with Mn, Cu, Bo and Zn did not resemble those of the yellow leaf disease.

Systematic work on nutritional aspects of the disease was taken up at Vittal in 1969. Rapid tests were carried out on soils from diseased gardens of Palode and completely healthy areas of Kanniyakumari and Vittal. Samples from diseased gardens showed more than 3 ppm of dilute acetic acid extractable aluminium which is considered as

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a dangerous level for plants. Water table in most of the diseased gardens was within the root zone of the palms. This gave rise to reduction conditions particularly during the rainy season (Mohapatra and Nagaraj, unpublished, cf., Anonymous, 1971).

Chemical analysis of 117 samples from the above areas showed that soils from disease affected gardens were acid in reaction, high in nitrogen and low in available phosphorus and potassium. Soil from both healthy and diseased gardens were low in available micronutrients like zinc, copper, manganese and boron, and high in exchangeable iron. Samples from diseased tracts recorded higher contents of exchangeable aluminium than healthy areas (Mohapatra, Bhat and Devaraju, 1975). Roots of diseased palms from Palode (Kerala) and Sullia (Karnataka) contained more aluminium than those of healthy palms from Vittal (Mohapatra and Bhat, unpublished, cf., Anonymous, 1974).

In an another comprehensive fertility survey carried out during October-November of 1974, a total of 155 soil samples from diseased districts of Trivandrum and Quilon in Kerala, and 132 from healthy areas with diseased pockets in Chickmagalur and South Kanara districts of Karnataka were collected for analysis. The soils from both these states were high in organic carbon, and medium to low in available phosphorus and potassium. The soils from Karnataka contained higher amounts of organic carbon, available phosphorus, potassium, calcium, magnesium, manganese, zinc and copper than those of Kerala. The contents of exchangeable iron, manganese, zinc and copper were above the level of sufficiency in both the states. The soils from Karnataka were slightly acid in reaction and free from exchangeable aluminium (Table I). Leaf analysis showed that the samples from Karnataka contained more of N (14.93%), P (23.68%), K (3.37%), Ca (29.42%), Mg (13.77%), Fe (36.70%), Zn (25.22%) and Cu (76.38%) than those of Kerala. Phosphorus content of leaf from Kerala was low ($<$ 0.20% P) and likely to be deficient in this vital nutrient (Mohapatra, Wahid and Kamala Devi, unpublished, cf., Anonymous, 1975; 1976).

Correlations were worked out between two fractions of aluminium and the soil factors such as pH (H_2O), pH (KCl), organic carbon, available P_2O_5 and clay associated with their availability. Increase in soil acidity and clay contents significantly increased the quantity of exchangeable aluminium in Kerala State. The correlation between NH_4OAc-Al and organic carbon was positive in all the groups except the soils from healthy gardens of Karnataka (Mohapatra, unpublished, cf., Anonymous, 1976).

Thirteen acid soils from diseased gardens of Palode were used in the laboratory to study the effect of submergence on soil reaction and exchangeable aluminium. These soils showed an increase in their pH from 5.01 to 6.08 during the first 15 days of submergence which later decreased to 4.27 at the end of 90 days. The exchangeable aluminium was inversely related to the increase and decrease in the pH of soils (Mohapatra, unpublished, cf., Anonymous, 1974).

A pot culture study was conducted using 13 acid soils from diseased areas of Trivandrum district to find out the effect of liming on growth and nutrient composition of French bean plant (*Phaseolus vulgaris L.*) receiving a basal dose of NPK. In the initial stage of growth, the plants in limed soils looked healthier than those without it. Yellowing was first observed during flowering on the older leaves, in plants of the limed treatments and then in plants without lime. This was found to be the result of phosphorus deficiency as indicated by low P content of leaves in plants from plus lime (0.04%) and minus lime (0.06%) treatments both supplied with 25 ppm of P_2O_5 (Mohapatra, unpublished, cf., Anonymous, 1974).

The role of soil reaction was examined in pot experiments using soil from diseased areas of Palode, and French bean and maize as test plants. Over a common level of NPK fertilizers, carbonate and sulphate salts of calcium, and calcium + magnesium were added to the soil to correct acidity on one side and to increase it on the other. The increase in soil acidity first showed typical phosphorus deficiency symptoms in test plants. Subsequently, the same thing was also noticed in treatments receiving carbonate salts of calcium and calcium + magnesium. Application of 50, 100 and 200 ppm P_2O_5 to soil correspondingly reduced the severity and delayed the appearance of symptoms on the leaf (Mohapatra, unpublished).

The possible association of zinc deficiency with yellow leaf disease was examined by raising maize (variety: Ganga 5), paddy (variety: Annapurna) and ragi (variety: Purna) plants in pots containing Palode soil fertilized with 300 ppm of P_2O_5. The plants were supplied with all the macro and micronutrients except zinc. No foliar symptoms of zinc deficiency were observed in any of these plants tested. On the contrary, phosphorus deficiency was seen in all the crop plants (Mohapatra, unpublished, cf., Anonymous 1976).

The effect of addition of lime and phosphorus was studied in a field experiment with diseased palms at Palode in 1970. After four years of the trial it was found that lime applied at 4 and 8 kg as dolomite per palm had not corrected acidity and also that phosphate at 1 kg as superphosphate increased the available phosphorus status of subsoil layers. None of these treatments had an ameliorative effect on the disease condition of the experimental palms (Mohapatra, Abraham and Rawther, unpublished, cf., Anonymous, 1974).

In 1974, a field experiment was laid out in a highly diseased low lying garden at Aranthodu near Sullia (Karnataka) to find out the effect of maintaining optimum soil fertility, liming and drainage on the incidence of yellow leaf in arecanut seedlings. These practices have not helped to keep the plants free of the disease (Mohapatra and Bhat, unpublished, cf., Anonymous, 1976).

To investigate the role of aluminium in symptom production on leaf, a sand culture experiment was started with arecanut seedlings in July 1974. Aluminium was added from June 1975 at 5, 10 and 20 ppm. This has not so far produced any characteristic toxic symptoms on the foliage but they reduced the leaf size and growth of plants (Mohapatra, and Bhat, unpublished, cf., Anonymous, 1976).

Conclusion

The foregoing account on the yellow leaf disease of arecanut and the inferences that can be drawn from the two farms, one completely healthy located at Vittal, and the other highly diseased at Palode, and both receiving the same package of practices suggest that it is probably the exchangeable aluminium that is responsible directly or indirectly for this malady. The yellow leaf disease encountered in Karnataka are generally seen in areas of high watertable and is possibly different from that of Kerala. It may be either due to the direct or indirect effects of the prevailing anerobic conditions.

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TABLE I

Mechanical and fertility constituents of soils from yellow leaf disease affected and healthy areas of Kerala and Karnataka States

(Mean values expressed on air dry basis)

Category	Kerala State				Karnataka State			
	Apparently healthy palm		Diseased palm		Healthy palm		Diseased palm	
Constituents	Low lying	High elevation	Low lying	High elevation	Low lying	High elevation	Low Lying	High elevation
Sand (%)	72.48	62.60	69.92	65.91	59.68	55.84	56.77	58.45
Silt (%)	8.42	8.92	8.87	8.39	15.52	16.85	16.22	17.86
Clay (%)	19.08	26.34	21.20	25.68	24.79	27.29	27.26	23.68
pH (H_2O)	5.66	5.60	5.58	5.58	6.34	6.36	6.54	6.14
pH (KCl)	4.39	4.27	4.31	4.26	5.13	5.16	5.30	5.06
Organic Carbon (%)	0.82	0.91	0.84	0.96	1.27	1.32	1.38	1.10
Available P_2O_5 (ppm)	12.17	6.06	9.23	6.01	21.46	14.84	18.95	9.05
Available K_2O (ppm)	66.52	84.00	75.81	84.90	144.10	163.18	153.18	130.80
Exchangeable Ca (ppm)	179.50	215.00	186.20	185.40	692.90	720.30	834.00	497.50
Exchangeable Mg (ppm)	47.90	68.80	45.20	59.00	173.10	190.90	220.10	152.40
Exchangeable Al (ppm)	54.35	64.53	59.95	68.84	1.59	0.10	0.45	Trace
Extractable Al (ppm)	66.97	97.48	83.30	105.60	41.21	42.10	48.23	37.84
$Fe^{2}+Fe^{3}+$ (ppm)	19.53	14.77	23.98	16.16	14.84	12.80	12.90	12.36
Exchangeable Mn (ppm)	8.03	8.83	7.65	8.82	12.50	17.47	15.68	16.30
Dithizone extractable Zn (ppm)	1.03	1.08	1.15	0.98	2.32	2.36	2.49	2.22
Exchangeable Cu (ppm)	2.04	1.92	1.99	1.97	3.94	4.02	3.57	3.32