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YELLOW LEAF DISEASE OF ARECANUT : RECOMMENDATIONS OF VARIOUS COMMITTEES

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A number of committees headed by specialists in various fields have been appointed from time to time to look into the problem of yellow leaf disease (YLD) of arecanut and make suitable recommendations for tackling the disease. A brief account of these aspects is given below.

I. *Raychaudhuri Committee.*—An expert team headed by Dr. S. P. Raychaudhuri (Head, Division of Mycology and Plant Pathology, IARI, New Delhi) has visited the disease affected arecanut gardens during the year 1960. They pointed out that most of the gardens were in a state of neglected conditions with regard to irrigation, manuring, intercultivation and spraying against insect pests. They opined that although the soil conditions play an important role in symptom expression of the disease, soil was not the real cause. The team has eliminated fungi, bacteria, and insects from the list of suspected causative organisms of the malady and recommended that the virus nature of the disease should be confirmed by transmission test under insect proof conditions.

II. *Pal Committee.*—A Committee conisting of Dr. NL Pal (Officiating Director, Central Tobacco Research Institute, Rajahmundry, Andhra Pradesh), Prof. TA Davis (Bioscience Division, Indian Statistical Institute, Calcutta), Dr. SG Joshi (Address not available), Prof. CV Subrahmanian (Prof. of Botany, Univ. of Madras, Madras) and Dr. Radha Menon (Research Officer, Regional Arecanut Research Station, Palode, Kerala) made on exhaustive survey in Kerala in 1960. The Committee reported that yellowing due to YLD was distinct from the yellowing caused by mites in arecanut palms. They recommended to intensify the physiological investigations on a more comprehensive and coordinated basis to look into the role of macro and micro-nutrients in the cause and spread of the malady.

III. *Lal Committee.*—At the 15th Annual General Meeting of the Indian Central Arecanut Committee held at Ernakulam on 18 January 1964, it was decided that a Sub-Committee should visit the different YLD affected centres in Kerala and Mysore (Karnataka) States to decide on the future programme of work on the disease. Accordingly the Sub-Committee consisting of Dr. SB Lal (Director, Coconut Research Station, Kayangulam, Kerala), Dr. KM Pandalai (Joint Director, Coconut Research Station, Kasaragod, Kerala), Dr. J. Samraj (Plant Pathologist, Agricultural College, Vellayani, Kerala) and Mr. KV Ahamed Bavappa (Arecanut Specialist, Central Arecanut Research Station, Vittal) visited some of the disease affected areas in Kerala and Mysore States between 5 and 12 October 1964. Considering the symptoms they felt that the YLD of Kerala and the new YLD of Karnataka were different.

YLD of Kerala.—For the YLD of Kerala, the Committee recommended that—

(1) the sequence of symptoms as they appear may be fully elucidated. The symptoms should be recorded with respect to the condition of the leaves on the crown, the inflorescence, fruit set, viability of the pollen, number and size of the nuts produced, and tapering tendency of the stem.

(2) Comparative studies of the roots of the affected and healthy palms may be made in detail. Studies on the extent of decay to roots and the rate of production of fresh roots should be undertaken so as to have a comprehensive idea about the damage to the root system. If severe damage to the root system is noticed, the fungi associated with such a condition may be isolated and studied for their possible pathogenecity.

(3) The studies to determine the extent of damage to the size and weight of the nuts may be intensified.

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(4) More elaborate studies on the role of bacteria, fungi, virus, soil conditions and nutritional imbalances in the aetiology of the disease may be taken up.

(5) Studies on the transmissibility of the disease to healthy seedlings by sap inoculation may be taken up under properly controlled conditions. Simultaneously healthy palms in healthy areas may also be inoculated with the diseased sap mechanically. It may also be worthwhile to remove a few infected plants, plant them in the disease free areas, and watch their reaction. Possibilities of transmission using insect vectors, soil and parasitic angiosperms such as *Cuscuta* sp. and *Cassytha* sp. may also be tried. Biochemical, serological and such other specialised studies may be postponed until the disease is shown to be reproducible. Work on collateral host plants may be continued.

(6) The possible role of nematodes and Cockchafer grubs in casting the disease has also to be ascertained.

(7) More systematic trials with individual micronutrients over a basic dose of N,P,K plus Ca may be carried out using sand culture of field trials. Stem and root injection trials with smaller doses than those reported to have been proved to be toxic may be repeated to ascertain the amounts which would be tolerated. Observations and data collected on the general appearance of the foliage, percentage of yellow to green leaf and yield, particularly regarding the disappearance of blackening of the nuts suggests that the nutritional trials may be run for a period of at least three years.

(8) The nutrient levels of soil and plant tissues under healthy and diseased conditions may be collected mainly to ascertain whether there is any accumulation or insufficiency of any of the nutrients causing nutritional imbalances in the tissues and if this is correlated with blackening of Kernels. The nutrients may include macro and micro elements, organic and amino acid content of leaves and also oxidative enzyme activity.

(9) Soil management trials may be laid out by opening drainage channels, raising soil levels for increasing the zone of root activity, incorporating sand and adopting other cultural practices to improve soil aeration etc.

New YLD of Karnataka.—The Committeee felt that the disease which occurs in Ganjigudige (Koppa Taluk) was identical to that occurring in Kerala and that the malady of Sagar was entirely different. The Committee recommended that—

(1) In view of the success achieved in the control of the malady in Sagar area by application of micronutrients in combination with N,P,K and Ca in the early and middle stages of the malady, it may be worthwhile following up these studies to confirm the efficiency of this treatment.

(2) At Ganjigudige, investigations might be taken up on similar lines as recommended for Kerala State.

IV. *Dr. Francis O. Holmes* (Rockfeller University, New York, USA).—Dr. Holmes who came to the then Central Coconut Research Station (CCRS) Kayangulam, under an EAO assignment made a field examination of some affected areas of Trivandrum district in November, 1964 following a request made by the ICAC to the Director, CCRS, Kayankulam. From his studies, he opined that the disease symptoms are not suggestive of a virus infection but are likely to be toxic or deficiency symptoms involving Mn or Fe. He proposed the following lines of investigations:

(1) Determination of total soluble salts and pH in the sap of healthy and diseased leaves.

(2) Analysis of healthy and diseased leaves for N, P, K, ash, moisture, micro-nutrients such as Mn, Fe, Na, Ca, Cu, Zn, Mg, etc.

(3) Foliar application of different concentrations (0.05%; 0.1%; 0.25%; 0.5%; 1.0%; 2.5% and 5.0%) of $FeSo_4$. Half portions of the intact leaflets showing yellowing may be dipped in each of the solutions kept in proper containers and watched for improvement in colour. If there is improvement, it may indicate iron deficiency brought about by Mn toxicity.

(4) The above test may also be done with $MnSo_4$. This will indicate Mn deficiency resulting from excessive iron.

(5) Application of individual micronutrients and combinations without Mn and Fe to soil in a regular experiment.

(6) A systemic study of soil pH in areas where the disease appears and find out the correlation of the incidence of disease with soil pH.

(7) Application of lime alone to correct acidity.

(8) Application of vermiculite alone and in combination with lime, and

(9) Application of fresh earth brought from disease-free areas to affected palms which are in the initial stages of the disease.

V. *Dr. B. Weischer (Institute for Nematode Research, University of Munster, West Germany.*—Between 22 October 1966 to 2 February 1967, Dr. Weischer visited Anad, Kurupuzha, Nanniyode and Palode areas under an FAO assignment. He examined the nematode fauna of the arecanut soil samples collected from the above areas and found seven plant parasitic genera of nematodes—*Meloidogyne, Rotylenchulus, Hoplolaimus, Pratylenchus, Helicotylenchus, Tylenchorhynchus and Xiphinema* in them. He however found, neither their presence nor their population density was correlated to the incidence of the disease. Since he had examined only small number of samples, he recommended that intensive studies were necessary to determine the role of nematodes. He made the following suggestions:—

(1) A comprehensive survey of plant parasitic nematodes of the rhizosphere of arecanut may be undertaken.

(2) The host-parasite relationship between the arecanut and nematodes may be studied.

(3) The possible role of plant parasitic nematodes in the yellow disease may be determined.

VI. *Dr. SP Raychaudhuri (Head, Division of Mycology and Plant Pathology, IARI, New Delhi)*:—Raychaudhuri examined the leaf extracts of diseased arecanuts during the year 1966. He was not able to detect any virus-like particles. He opined that some more materials should be examined for confirmation of the results. He suggested to initiate the following experiments:

(1) Transmission studies to see if any viruses are involved; and

(2) Studies to see if the malady is caused by any deficiency.

VII. *Special discussions*: 1. During 26-27 August 1974, a special meeting was held at the Central Plantation Crops Research Institute (CPCRI) Regional Station, Kayangulam. The sessions were chaired by Dr. D. R. Bhumbla (Deputy Director General, ICAR, New Delhi) and Dr. K. Ramakrishnan (Dean, University of Agricultural Sciences, Bangalore, Karnataka). The following outside scientists participated in the deliberations in addition to those of CPCRI. Dr. C. H. Krishnamurthy (Assistant Director General-cum-Project Director (Dry Farming); I.C.A.R., Rajendranagar, Hyderabad, A.P.), Dr. J. V. Bhat (Emeritus Scientist, Department of Microbiology, Kasturba Medical College, Manipal), Dr. A. S. Summanwar (Virus Pathologist, IARI, New Delhi), Dr. K. K. Krishnamurthy (Professor of Soil Chemistry, Tamil Nadu Agricutural University, Coimbatore, Tamil Nadu), and Dr. J. Samraj (Principal) and N. S. Money (Vice-Principal) of Agricultural College, Kerala Agricultural University, Trivandrum, Kerala, Mr. Jacob P. John (Additional Director, Department of Agriculture, Kerala) and Mr. E. Velappan (Deputy Director, Directorate of Arecanut & Spices Development, Calicut, Kerala). The group identified the following areas as requiring intensification of efforts:

A. *Pathological and Nematological Studies*:

(1) Any injury or infection by fungi at leaf base or root that is seasonal has to be assessed;

(2) Check if, periodicity of intensity of root rot could be correlated with seasonal change in yellowing;

(3) More intensive work to determine the involvement of a fungus in root rot;

(4) Study the effect of soil fungicides like PCNB, Vitavax, Benlate, Furadon, Vapam, Dexon and copper oxychlorides as soil treatments against root rot;

(5) Phase contrast microscopy for spirochaetes;

(6) Survey of nematode population in diseased areas.

B. *Microbiological and Biochemical Studies*:

(1) Examine identical sets of roots from healthy and diseased palms for bacterial streaming movement. The dominant organisms may be isolated and identified;

(2) Check for the presence of mycoplasma;

(3) Study the levels of polyphenols in the healthy and diseased arecanut palms;

(4) Study biochemical/microbiological aspects of blackened arecanuts;

(5) Initiate intercropping programmes and make microbiological studies.

C. *Nutritional Studies*:

(1) A pot culture experiment may be laid out using soil rich in alumina (Palode soil) and pH raised to different levels by application of

lime to study its effect on growth of palms and availability of nutrients.

(2) No experiment need be conducted with graded doses of phosphorus application since the leaf analysis data have shown that the phosphorus content of leaf was above normal with 0.21-0.34%.

(3) The pot culture experiment planned to study the effect of water logging may be deferred.

(4) A survey of the disease affected areas may be made and the data processed as was done for the coconut root (wilt) disease.

(5) The following exploratory trials may also be taken up:—

(a) Determine the biologically active Zn in the standard arecanut leaf.

(b) Trials may be taken up to increase leaf nitrogen through foliar spray or split application of fertilizers to soil.

2. Another special meeting was at CPCRI Regional Station, Kayangulam on 8-9 December 1975. It was chaired by Dr. HC Govindu (Senior Professor and Head, Department of Plant Pathology, University of Agricultural Sciences, Bangalore, Karnataka). Besides the scientists of CPCRI, the following outside scientists participated in the deliberations: Dr. AR Seshadri, (Head of the Division of Nematoloyg, IARI, New Delhi), Dr. K. S. Krishna Sastry (Professor of Crop Physiology, University of Agricultural Scientes, Bangalore, Karnataka), Dr. N. N. Prasad (Head of the department of Microbiology and Plant Pathology, Annamalai University, Tamil Nadu) and Dr. DE Etheridge (Forest Pathologist, Canadian Department of Agriculture). The following lines of investigations were proposed by them:—

A. Pathological and Nematological studies:

(1) For determining the involvement of fungus in root rot and its relationship with the disease, 30 palms from Koppa, 20 from Sullia, and 50 each from Palode and Vittal may be sampled in February, May, July, and October at the rate of 5-12 trees each time from each locality.

(2) The root samples collected in October may be examined for nematode infestation also.

(3) The nematode *R. similis* may be included as inoculum along with the two fungi in the fungal inoculation trials at Vittal.

(4) The symptomatology of the disease at Koppa may be studied in detail.

(5) Studies on periodicity and intensity of root rot with seasonal changes in yellowing may be continued round the year. It may be desirable to fix certain trees at Koppa also and observe them periodically as is being done at Palode.

(6) The field trials at Palode on nematodes may be continued.

(7) The histopathological studies may be closed as the data obtained have not indicated any relationship between the disease and anatomical abnormalities.

B. Microbiological and Biochemical studies:

(1) Root samples collected in October from disease affected areas of Palode, Koppa, and Sullia and from healthy areas of Vittal may be studied for association of bacteria.

(2) Biochemical/Microbiological examination of blackened arecanuts may be made.

(3) An intercropping programme may be started at Palode immediately and related microbiological studies may be taken up.

C. Nutritional studies:

(1) The present field experiment at Sullia and sand culture experiment at Vittal may be continued. Tissue and soil samples may be collected in February, May, July and October and analysed for various major and minor elements. The soil samples collected may also be studied for the presence of pathogens.

(2) New field experiments may be laid out at Koppa and Palode at low and high elevations with the following four treatments: (a) lime alone at 1 lime requirement, (b) phosphorus alone at phosphorus fixing capacity, (c) lime and phosphorus together as above, and (d) local practices. Each treatment will consist of 15 seedlings. The soils and leaves may be sampled and analysed as for experiment (1) above. Pathogenic studies may also be taken up as indicated above.

(3) An experiment may be laid out at Vittal in glasshouse to separate out the effect of pathogenic factors from nutritional factors using soil from affected areas. One set of study will be carried out with sterilized soil, and the other set with unsterilized soil. The soil will be corrected for acidity and phosphorus as in (2) above. The moisture in the soil will be fixed at (a) half field capacity;

(b) 1 field capacity; and (c) saturation. Each treatment should have four seedlings.

(4) Soil samples in low lying areas may be sampled during rainy season preferably at weekly intervals and analysed to see if variations occur in nutrient levels consequent on rainfall.

(5) The effect of foliar application of diammonium phosphate may be taken up to determine the uptake of P_2O_5 by leaves. A similar foliar application trial will be taken up to study the uptake of manganese also since analysis of the leaf had shown a disturbed iron-manganese ratio.

3. Recently a special meeting was held at CPCRI Regional Station, Kayangulam on 25 August 1976. It was chaired by Prof. K. K. Nanda (Prof. of Plant Physiology, Punjab University, Chandigarh) and Prof. H. C. Govindu (Senior Prof. and Head, Department of Plant Pathology, University of Agricultural Sciences, Bangalore, Karnataka). The following scientists were present besides those of CPCRI. Dr. S. K. Sinha (Senior Plant Physiologist, IARI, New Delhi), Prof. K. S. Krishna Sastry (Prof. of Crop Physiology, Univ. of Agricultural Sciences, Bangalore-Karnataka), Dr. C. G. Shaw (UNDP Specialist, UAS Bangalore, Karnataka), Dr. R. C. Yaraguntiah (Senior Scientific Officer, Mudigere, Karnataka), Dr. V. V. Sulladmath (Assistant Plant Pathologist, Regional Coconut Research Station, Arsikere, Karnataka), Dr. T. Jaganathan (Assistant Plant Pathologist, Coconut Wilt Disease Scheme, Muthupet, Tamil Nadu), and Shri K. P. Vijayan (Jr. Physiologist, Coconut Research Station Vepankulam, Tamil Nadu). The group proposed that—

(1) The following experiments which are in progress will be continued:

(a) The sand culture experiment at Vittal to study the effect of aluminium toxicity.

(b) The field experiment at Sullia to study the effect of drainage and average management.

(c) The field experiment at Peechi to study the effect of soil fungicides on root rot.

(d) Foliar Spraying experiments at Palode to study the uptake of N. P and K and Mn.

(e) The field experiment at Palode to study the effect of nematicides on diseased palms.

(f) The pot culture studies at Palode to assess the effect of nematicides on the development of disease in seedlings.

(g) Inoculation experiments at Vittal on seedlings to study the role of fungi (*Colletotrichum* sp. and *Acrimonium* sp.) isolated from diseased arecanut roots.

(h) Mixed farming experiments at Palode with fodder and dairy.

(2) The following experiments approved earlier will be taken up:

(a) study the symptomatology of the disease in Karnataka.

(b) Determine the role of fungi in the incidence of the disease in Karnataka.

(c) The glass house experiment at Vittal to eliminate the pathogens from nutritional factors.

(d) To determine the role of fungi in the incidence of disease in Karnataka.

(e) Field experiments at Koppa, Sringeri, Sullia, and Palode to study the ameliorating effect of application of lime and phosphorus plus package of practices on disease development.

(f) Maintenance of observational plots in Sringeri, Arsikere and Palode for management of disease affected gardens.

(3) The following new experiments will be taken up:

(a) Analysis of growth and yield in relation to disease appearance. The data already available will be processed.

(b) Physiology and Bio-chemistry of roots under water-logged conditions: (i) Dehydrogenase. (ii) Ion uptake using excised roots. (iii) Regenerating roots after pruning.

(c) Accumulation of toxic substances in the rhizosphere.

(d) A sand culture experiment will be started to study the Fe, Mn, Ca and Bo nutrition.

(e) Examination of organometallic enzymes in leaf and root.

(f) A survey of diseased areas in Karnataka and Kerala to assess the extent and severity of the disease.

(g) To determine the role of virus and mycoplasma in the etiology.

(h) To determine the role of bacteria in the etiology of the disease.

(i) To determine the critical levels of important major and micro-elements.