Reprinted from the Journal of Plantation Crops 8(2): 98-105. December, 1980.

WORKSHOP ON PHYTOPHTHORA DISEASES OF TROPICAL CULTIVATED PLANTS 19–23, SEPTEMBER 1980, KASARAGOD/CALICUT, KERALA, INDIA: SUMMARY OF PROCEEDINGS AND RECOMMENDATIONS*

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This Workshop was organized by the Indian Council of Agricultural Research at the Central Plantation Crops Research Institute, Kasaragod. It was held in two parts. The first part, held at Kasaragod during 19-21 September, comprised presentation of status and lead papers and contributed research papers. The second part, held at Calicut during 22-23 September, consisted of a day-long field visit, and representation of papers and discussion on black pepper *Phytophthora.*

The Workshop was organized to provide a forum for the meeting of *Phytophora* scientists working in various crops in the tropics and subtropics, to exchange informations and to see if the advances made in the study of *Phytophthora* diseases in temperate crops could be made use of for furthering the studies on *Phytophthora* diseases of tropical cultivated plants. It was the first of its kind to be organized, in that it covered the *Phytophthora* diseases of all the tropical crops. It discussed particularly, problems relating to: (1) epidemiology; (2) physiologic specialisation; (3) resistance; (4) texonomy; (5) mode of screening, and control aspects of various *Phytophthora* dieases.

The participation in the Workshop was limited to 51 scientists from India and 15 scientists from overseas, with an additional 36 participants as observers representing plant protection firms and other interests. The financial assistance rendered by Sandoz India Limited, Bombay, May & Baker (India) Limited, Bombay, and Travancore Chemicals & Manufacturing Co. Limited, Alwaye (Kerala), who readily agreed to be the donors for the Workshop, is gratefully acknowledged. The travel assistance extended by The Commonwelth Foundation, London U. K., to four overseas scientists for the participation of the Workshop is gratefully acknowledged.

The inaugural session was held on 19 September at CPCRI, Kasargod at 11 AM. Dr NM Nayar(Director,CPCRI,Kasaragod) welcomed the delegates. The Workshop was inaugurated by Dr G Rangaswami (Adviser Agriculture, Planning Commission New Delhi). In his inaugual address, he stressted the importance of taking up the following studies.

1. In spite of the fact that severe economic losses are caused to cash crops every year, adequate research input in still wanting. Studies to assess the monetary losses due to

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the diseases occurring on different crops in different areas would help in obtaining proper attention to the research needs.

2. The nomenclature and host specificity of *P. palmivora* and other related species have to be studied. Studies on the occurrence of different strains/races of this fungus also are needed.

3. The life cycle of the fungus needs to be studied immediately. The means of oversummering of the fungus under different ecological and agroclimatic conditions are to be better understood.

4. Studies on the effect of environmental factors such as high humidity and critical maximum and minimum atmospheric temperatures for rapid asexual reproduction would help in understanding the disease onset and spread leading to forecasting of the same and this would enable the farmers to take adequate preventive measures against the disease.

5. A critical evaluation of the host-pathogen-fungicide interaction under the prevalent agroclimatic conditions should be done to understand and evolve effective control measures.

6. Detailed studies should be taken up on the post harvest losses caused by *Phytophthora* affecting fruits.

7. More effective steps should be taken to combat the virulence of the pathogen by evolving disease resistant cultivars in the different cultivated crops.

8. Studies on the generic and biochemical basis of the phenomenon of members of certain plant families being not attacked while those of other families are more susceptible, would help in formulating better means of countering the attack by *Phytophthora.*

9. The specific physiologic requirements to induce sexual phase and also germination of oospores should be determined.

10. Factors, which protect the fungus from diverse climatic conditions, enabling it to survive needs to be better understood.

The inaugural session was concluded at 12 noon with a vote of thanks by Dr KKN Nambiar (Convenor, WoPD and Scientist, CPCRI). This was followed by scientific sessions in the afternoon. There were six sessions, four at Kasaragod and two at Calicut.

AT KASARAGOD, 19-21 SEPTEMBER, 1980

Session I: Phytophthora Diseases of Crops

1. This Session started at 2.30 PM. It was chaired by Dr SY Padmanabhan (Former Director of Central Rice Research Institute, Cuttack) and rapporteured by Dr (Mrs) Rohini Iyer (Scientist, CPCRI). There were 8 status papers on different crops. Dr (Mrs) K Radha (CPCRI) presented a status paper on bud rot of coconut, which was coauthored by Mr Thomas Joseph. In this, Dr Radha highlighted the gaps in our knowledge on the disease as follows:

(*i*) Information is lacking on the dispersal of the pathogen. The part, if any, played by insects in dispersal is not understood.

(*ii*) Further investigations may be carried out on the effect of microclimatic factors on the build up of inoculum and development of the disease.

(*iii*) The role of bacteria if any in the incidence of bud rot disease requires to be determined.

2. The next paper, Abnormal leaf fall disease of rubber caused by *Phytophthora* presented by Dr PN Radhakrishna Pillai (Rubber Research Institute of India, Kottayam, Kerala) was presented by Mr MK George (RRII) in the absence of Dr Pillai. The paper discussed the history of the disease, distribution of the pathogen, epidemiology, varietal reaction and control measures.

(*i*) *Phytophthora botryosa* is associated with the disease in Andaman Islands. Hence,

utmost care is to be taken to prevent introduction of this pathogen to other places.

(*ii*) Information on strainal variation in the different species of *Phytophthora* infecting rubber is lacking.

(*iii*) Pruning of inflorescenc followed by adoption of plant protection steps could be tried; but the economics of this practices should be also looked into.

(*iv*) For administering systematic chemicals, tree injection methods could be devised.

3. The next paper, *Azhukal* disease of cardamom, by Drs R Radhakrishnan Nair and M Ramanatha Menon (Kerala Agricultural University, Vellayani, Kerala), was presented by Dr Nair. The authors dealt with in detail the different aspects of this disease as distribution, symptomatology, etiology, epidemiology, and control. They made the following suggestions:

(*i*) The possible involvement of *Phytophthora palmivora* in the disease incidence may be studied.

(*ii*) The role of nematodes in the symptomatology of the disease requires to be studied.

(*iii*) The mechanism of fungicidal and fungistatic actions of neem cake and lime as probable factors in influencing/inhibiting infection by the pathogen and seed borne nature of the fungus needs study.

4. Dr BL Dutt (Central Potato Research Institute, Simla) in his status paper on late blight of potato in India highlighted the race problems in *P. infestans*, breeding work in progress to incorporate field resistance to evolve suitable cultivars for the plants and hills.

(*i*) The occurrence of late blight in the plains was attributed to infected, cold-stored potato seed material, but the exact role played by seedborne inoculum needed to be determined.

5. Prof. HS Sohi (Botany Department, Punjab University, Candigarh) in his paper, *Phytophthora* disease of citrus, dealt with at great length the symptoms, host range of the fungus, and control. He proposed further studies on the following aspects:

(*i*) Morphology of the sporangia particularly caducity and its significance in dispersal of the fungus;

(*ii*) Importance of rain splash dispersal in spreading inoculum. This would indicate the possibility of preventing epidemics by removing lower branches of trees.

(*iii*) The influence of scion in root stock and vice versa on the susceptibility of plants to the pathogen;

(*iv*) The role of mycorrhiza in preventing/containing the disease;

(*v*) Susceptibility to *Phytophthora* vis-a-vis age of the plants.

6. The next status paper on *Piper betle* wilt caused by *P. parasitica* var. *piperina* Dastur by Prof. RS Mehrotra (Department of Botany, Kurukshetra University, Kurukshetra, Haryana) reviewed the information available on symptomatology, etiology, epidemiology, natural antagonism and control of the disease. He identified the gaps in knowledge as under:

(*i*) Role of apparently healthy cuttings in dissemination of the disease;

(*ii*) Effect of superphosphate in reducing disease incidence.

7. Dr TN Srinivasan (Cocoa Research Unit, University of West Indies, Trinidad) presented the status paper, Recent studies on cacao *Phytophthora*. The paper covered the different species of *Phytophthora* associated with cacao, geographic distribution, compatibility types and taxonomical position of the pathogen. He suggested further studies on the following aspects:

(*i*) Taxonomic studies with isolation obtained from cacao gardens in other countries;

(*ii*) Reaction of cacao cultivars to black pod pathogens;

(*iii*) Adoption of quarantine measures to prevent unnecessary spread of the pathogens.

8. The next paper on *Koleroga* on arecanut by Dr M Koti Reddy and Mr M Anandraj (CPCRI) was presented by Dr Reddy. The authors reviewed the history, geographical distribution, etiology, and control of the disease. The following gaps in knowledge were identified.

(*i*) Epidemiology of the disease;

(*ii*) Studies on the sources of primary inoculum and the environmental factors favouring disease so as to evolve a forecasting system which could be linked with effective control measures.

Session II: Epidemiology and Forecasting

1. The session was held on 20 September forenon with Dr DN Srivastava (Deputy Director General (Crop Sciences), ICAR, New Delhi) as Chairman and Dr YR Sarma (Jr Scientist, CPCRI) as Rapporteur. The Session started at 10.30 AM. There were two lead papers. The lead paper on Epidemiology in the genus *Phytophthora* was presented by Prof FJ Newhook (Department of Plant Pathology, University of Auckland, Auckland, New Zealand). It dealt with epidemiological situations in diseases associated with four species of *Phytophthora*, viz., *P. infestans*, *P. cinnamomi*, *P. colocasiae* and *P. palmivora*. The paper highlighted that soil moisture and temperature were the major factors governing disease development. He made the following observations:

(*i*) The rootlet loss to rootlet regeneration is crucial. Practices which promote more root growth are to be adopted. The response of the infected host plant to phosphorus was of considerable interest as this boosted up growth of the tree by ensuring increased root regeneration and abundant mycorrhizal development.

(*ii*) Reduction of the impact of the disease by closer plantings as revealed by studies on taro blight may be an example requiring testing in other diseases.

2. Dr DH Lapwood (Rothamsted Experimental Station, Harpenden, UK) presented a lead paper, Field studies on late blight of potato. He highlighted that meteorological factors and source of inoculum as critical factors governing disease development. He suggested that a critical study of these factors in a given locality would help in efficient forecasting of blight epidemics.

3. The contributed research papers were presented next. Dr SK Bhattacharya (Central Potato Research Institute, Simla) presented data to show that precipitation of 28.9-38.5 mm and mean temperature of 23.9°C or less for 7 continuous days resulted in blight appearance within three weeks in Simla conditions. At lower temperatures combined with high humidity, the time taken for blight appearance was less. Using this information, a forecasting system has been developed. This information is being relayed to the farmers during the years through the All India Radio for taking effective preventive measures.

Prof. J. Subbaiah (Plant Pathology Department, S. V. Agrl. College, APAU, Tirupathi) in his paper mentioned that enormous loss was caused to the farmers by betel vine wilt in Andhra Pradesh. He suggested the following lines of study.

(*i*) The source of inoculum in endemic areas should be identified.

(*ii*) Sandy soil is recommended for fresh plantations. Good drainage should be provided in clayey soils.

The next paper on The occurrence of A-1 mating type in *P. colocasiae* of *P. betle* of Northern India, was presented by Mr KL Narula (Department of Botany, Kurukshetra University). Dr MP Jain (Department of Plant Pathology, Rajasthan College of Agriculture, Udaipur (reported that *P. nicotianae* var. *nicotianae* causing fruit rot of brinjal was vitamin deficient. Prof. Newhook's paper on *P. colocasiae* in Solomon Islands indicated that higher density of plants in high

leaf blight areas still gave increased yields. In another paper by Prof. Newhook on the source of *P. palmivora* inoculum in cacao in Solomon Islands, the stem canker associated with the flower cushion in cacao trees was reported as the continuing source of infection. Rats and harvesting tools aided in the spread of inoculum into newer areas.

Winding up the discussions, the Chairman emphasised the importance of the effect of environmental factors in the development of the epidemics in different diseases in different locations. He emphasized the need for carrying out critical studies on pest and pathogenig responses to the environmental factors for evolving practical and effective programmes for reducing disease losses.

Session III: Taxonomy, Physiologic Specialisation, and Resistance

This session was held on 20 September afternoon. Prof. HS Sohi, (Chairman, Department of Botany, Punjab University, Chandigarh) chaired the session and Dr P Chidambaram (Scientist, CPCRI) was the Rapporteur. There were four lead papers and two research papers. Dr DJ Stamps (Commonwealth Mycological Institute, Kew) presented a lead paper on Taxonomy of *Phytophthora*. She highlighted the importance of taxonomic characters of both sexual and asexual phases of the fungus for the identification of species.

Prof PH Tsao (University of California, Riverside, California) presented the lead paper on Morphology and identity of black pepper *Phytophthora* based on the sporangial morphology and identity of black pepper isolates from different parts of the world. He felt that black pepper isolates were entirely different from *P. palmivora*, and until more information was available, this should be kept in MF4 of *P. palmivora*.

Dr B Boccas (ORSTOM, Noumea, New Caledonia) presented a lead paper on Genetics of the genus *Phytophthora*. He said that little was known on the genetical regulations of the mating types. He felt that this could be determined by a complex system of genes.

In the lead paper on Physiologic specialisation in the genus *Phytophthora*, Dr BL Dutt (CPRI, Simla) explained the criteria used in determining races of *P. infestans*. He emphasised the need for carrying out further studies on the mechanism involved in the differentiation and germination of oospores resulting from crosses of different mating types.

Dr Bhattacharya (CPRI, Simla) in his paper mentioned that 74 races have been recorded so far in India and that the appearance of complex races in the hills was due to introduction of complex R-gene types; however, in the plants, only simple races were noticed. Dr JT Dakwa (Cocoa Research Institute, Tafo, Ghana) stated that the time for appearance of black pod lesions, sporangial production, and girdling of cacao pods wound-inoculated with 97 isolates of *P. palmivora* were not affected by susceptibility ratings of the parents with which the crosses were made, the type of cacao, or the ecological zones from which the isolates were collected.

The session made the following recommendations: (1) There is a need to collect *Phytophthora* diseases of different crops at one place. This will help in later studying them critically particularly for identifying the species.

(2) The research workers engaged on *Phytophthora* diseases in India may be required to record data of various taxonomic characters in different species on a standard proforma which could be prepared in consultation with Dr Stamps and Dr Tsao. This could help to remove the prevalent confusion in the identity of the species.

Session IV: Screening Methods and Control Measures

The session was held on 21 September forenoon. It was chaired by Dr CS Venkata-

raman (Director, United Planters Association of South India, Cinchona, Tamil Nadu) with Mr Thomas Joseph (Scientist, CPCRI) as Rapporteur. There were seven research papers on different crops. Dr AA Adebayo, Cocoa Research Institute of Nigeria, Ibadan presented a paper on Agronomic problems of cacao *Phytophthora* pod rot control. Dr Adebayo highlighted the influence of environmental features such as rainfall, temperature, relative humidity, and soil on the incidence, development, and spread of pod rot. He proposed that detailed studies of shade management, planting at wider spacing, and use of herbicides to control weeds should form an integral part of new programmes on black pod control.

The second paper, Screening cacao cultivars for black pod resistance, by Dr S Kularatne (Minor Export Crops Research Station, Matale, Sri Lanka) reported that the cacao clone W5/47, an introduction from Nigeria, has been found to be promising in Sri Lanka in view of the slower rate of spread of infection. He felt that the practice of wounding before inoculation should be continued.

In his paper on Chemical control of *Phytophthora* diseases of citrus, Dr DM Sawant (Citrus Dieback Scheme, Shrirampur, Maharashtra) suggested the following:

(*i*) The need to have fresh look on the etiology on the disease as *Phytophthora* appeared te be only one of the incitants.

(*ii*) The possibility of root stocks being involved in the carry-over of the pathogen should be studied.

Dr TSN Reddy (Central Tobacco Research Institute, Rajahmundry, Andhra Pradesh) presented the lpaper Evaluation of germplasm and chemical control of *Phytophthora parasitica* on tobacco. A cigar cultivar Beinhart 1000-1 was resistant and McNair-12 was tolerant to the pathogen. Ridomil @ 0.1% controlled the disease.

Prof. Newhook's (Department of Plant Pathology, University of Auckland, Auckland, New Zealand) paper, Studies on the taro leaf blight fungus in Solomon Islands, was interesting because of the new information contained in the paper that (i) leaf removal to maintain four leaves per plant did not cause any loss in yield; and (*ii*) closer spacing to give higher population density under conditions of high blight hazard increased yield.

Dr Sawant (Citrus Dieback Disease Scheme, Shrirampur, India) in his paper, Reaction of citrus root stocks to *Phytophthora* diseases, reported that cultivars from Jamberi, Limonia, and Reshini)groups and a few citranges were tolerant to the disease. A paper on Reaction of citrus and related genera to *Phytophthora* was presented by Dr R Naidu (University of Agricultural Sciences, Bangalore; now at CPCRI.) A high degree of resistance was found in *Citrus*, *Poincirus* and *Severinia*. Out of the 16 species evaluated, *Citrus aurantium* was highly resistant. Most of the trifoliate clones and their hybrids showed high tolerance.

Winding up the session, the Chairman commented about the valuable information presented in the papers. Further, he suggested that a Symposium should be arranged to mark the centenary of the development of Bordeaus mixture, which continues to be the most popular and reliable fungicide even today.

In connection with the Workshop, an exhibition had also been arranged at the premises to depict *Phytophthora* disesaes of various crops. Through the courtesy of Dr B. Boccas, a silent movie film on *P. palmivora* (15 min) was also screened. The Kasaragod part of the Workshop was over with a vote of thanks proposed by Dr KKN Nambiar (Convenor, WoPD). The second part of the Workshop was held at Calicut during 22-23 September, 1980.

AT CALICUT

Theree was a day-long study tour on 22 September during which delegates were

taken to different estates in Wynad area in the Western Ghats where they could see crops like cardamon black pepper, arecanut, cacao and rubber. This gave them an opportunity to observe the diseasee occurring on these crops. The delegates visited Meenakshi Vilas Estate, Kalladi, 80 km from Calicut, where they saw capsule rot disease of cardamom; Koyappathodi Rubber Estate, Adivaram, where they saw the abnormal leaf fall of rubber in non-sprayed blocks, and in the evening, the Amalgamated Estates, Pudupady. Mr MC Pothen, Managing Director showed them koleroga and bud rot of arecanut, foot rot of pepper, and pod rot in cacao.

Session V: Foot Rot of Pepper

This session was held on 23 September forenoon at CPCRI, Regional Station's new Chelavoor Campus at Calicut. Prof. RS Mehrotra was the Chairman. Dr R Naidu Scientist, CPCRI) acted as Rapporteur. The session started at 9.30 AM. Dr YR Sarma (CPCRI) presented the status paper on foot rot of black pepper. He gave a comprehensive account of the disease covering its history, distribution, crop loss, symptomatology, etiology, taxonomy, biology, epidemiology, and control measures. He made the following suggestions:

(*i*) Priority should be given to screen wild *Piper* forms to locate resistance.

(*ii*) Ecological factors that predispose the vine to infection under different cropping systems should be determined.

(*iii*) A search for possible existence of strainal variation may be made.

(*iv*) Management practices that ensure greater root regeneration in infected vines should be taken up.

(*v*) Crop loss survey should be conducted.

Five research papers were presented in the session. Dr KKN Nambiar, in his paper explained that the foot rot of black pepper spread in centrifugal fashion and that the disease was more severe in years of heavy rainfall. There was a direct correlation between soil temperature and disease incidence. The next paper presented by Dr Sarma showed that the fungus *P. palmivora* causing foot root of pepper could be grouped in MF 4 type. A paper on the distribution of *P. palmivora* in the North Kanara soils was presented by Dr MLN Sastry. He studied the population density of the pathogen in different localities. In the paper on screening of black pepper against *P. palmivora*, Dr Sarma presented the methods employed for screening black pepper for resistance to foot rot. He stated that stem inoculation method was more convenient than root inoculation. Mr Ramachandran (CPCRI) showed that metalaxyl was more effective than other fungicides against *P. palmivora* on black pepper.

After the presentation of these papers, there was a discussion on the future programme of work on foot rot and the following recommendations emerged.

(1) Studies may be initiated for early detection of infection

(2) Greater emphasis may be given to the taxonomy of the pathogen.

(3) Duplication of work at the international level may be avoided through a coordinated approach.

(4) To make cheap and effective control measures against foot rot disease, research on pathological aspects, breeding and selection of resistant types, cultural practices, management practices, and chemical control through systemic fungicide may be initiated.

5. Vigorous efforts should be made to obtain funds from International and national agencies and through bilateral aid programmes for intensifying and coordinating research on foot rot of black pepper.

Session VI: Plenary Session

The Plenary Session of the Workshop on *Phytophthora* Diseases was held on 23 Septem-

ber afternoon at CPCRI, Chelavoor Campus, Calicut. Dr NM Nayar (Director, CPCRI) chaired the session and Dr KKN Nambiar (Scientist, CPCRI Kasaragod and Convenor, WoPD) was the Rapporteur. The Chairmen/Rapporteurs of various sessions presented the summary and recommendations of the respective sessions. After this, the Chairman invited the delegates to give their impressions on the Workshop. Several delegates spoke that the Workshop's objectives have been fulfilled and that their participation in the Workshop has been very beneficial to them. The following additional recommendations were then made during the discussions.

(1) All the *Phytophthora* isolates except those from black pepper may be sent to Dr DJ Stamps (CMI) for identification. The black pepper isolates may be sent to Prof. PH Tsao (University of California) for reference purposes.

(2) Studies on the epidemiology of *Phytophthora* diseases should be intensified for developing effective forecasting system.

(3) Efforts should be made to organize the next Workshop in Melbourne in 1983 along with the ISPP meetings.

(4) A symposium may be held to celebrate the centenary of the development of Bordeaux mixture.

(5) International assistance should be obtained for intensifying foot rot research. An international collaborative research programme should be developed with such funds in view of the seriousness of the disease in all the black pepper growing countries of the world to ensure a coordinated approach to the problem and to avoid duplication. Provision may also be made for exchange visits of scientists among the collaborating countries.

The following resolution proposed jointly by Prof Newhook, Prof PH Tsao and Dr PWF de Waard was unanimously approved.

"The Workshop recommends that an action plan should be formulated aiming at field control of *Phytophthora* in black pepper taking into account the following areas of investigations: (*i*) Pathogen biology and epidemiology; (*ii*) Plant breeding; grafting, and selection; (*iii*) Cultural practices; (*iv*) Plant nutrition; and (*v*) Chemical control.

The Workshop further recommends that national funds, international aids, and bilateral assistance for implementing the above programme may be sought for this purpose".

The Workshop meeting came to a close at 3.15 PM on 23 September, 1980 with the vote of thanks by Dr MK Nair (Joint Director, CPCRI Regional Station, Calicut).