STUDIES ON *PHYTOPHTHORA* DISEASES OF CACAO OCCURRING IN INDIA

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ABSTRACT

The phytophthora diseases of cacao (*Theobroma cacao* L.) so far reported from India are: black pod, canker and sseedling die back. Twig dieback and chupon blight of cacao caused by *Phytophthora palmivora* (Butler) Butler were severe in Kerala and Karnataka states of India. The fungus was isolated and its pathogenicity was proved. The symptoms of these diseases are described. This is the first reported occurrence of twig die back and chupon blight of cacao caused by *P. palmivora* from India.

In cross inoculation studies, the *P. palmivora* isolate from cacao did not infect areca palm fruits, neither did the *Phytophthora arecae* (Coleman) Pethybridge isolated from 'mahali' affected fruits infect cacao pods.

***P. palmivora* is the most destructive of all the fungal pathogens attacking cacao in India and requires regular prophylatic measures. Ten fungicides were evaluated using detached cacao pods against *P. palmivora* of cacao. Among them, captafol ('Difolatan 80W') at 0.2% and copper oxychloride ('Cupramar'), guazatine ('Panoctine') and fenfuram ('Panoram') each at 0.3% inhibited lesion development on pods completely.**

INTRODUCTION

In India cacao is mainly grown in Kerala, Karnataka and Tamil Nadu and is gaining much importance. The cacao plantings in these states were relatively fewer when compared with other plantation crops. But it has been found to be a suitable and profitable crop when grown as a mixed crop with coconut and arecanut, and is now being planted on a large scale.

As more and more area is planted, the diseases may become severe resulting in high economic losses. Diseases of cacao

caused by *Phytophthora palmivora* (Butler) Butler are of special interest in that these occur in most cacao-growing countries. *P. palmivora* infection on cacao has been reported from fiftynine countries (Thorold, 1975). In India too, *P. palmivora* is the most destructive of all the other fungal pathogens of cacao. Black pod disease (Ramakrishnan and Thankappan, 1965), canker (Chandra Mohanan, 1978) and seedling dieback (Chandra Mohanan, in press) are the *Phytophthora* diseases so far reported from India on cacao.

During the monsoons of 1978, twig dieback and chupon blight of cacao were observed in a severe form in many plantations in Kerala and Karnataka. This paper briefly summarizes the studies on chupon blight and twig die back of cacao, and on the fungus *P. palmivora*.

Materials and Methods

Chupon blight and twig die-back

Field symptoms of these diseases were studied. The causal organism was isolated on potato dextrose agar from the infected tissues. Pathogenicity of the organism was tested on Forestero cacao plants. The pathogen was reisolated from the artificially inoculated plants. Important morphological and cultural characteristics of the organism were studied.

P. arecae (Coleman) Pethybridge and *P. palmivora*: Cross inoculation studies

A strong belief exists among the cultivators that losses from 'Koleroga' are more in areca gardens mixed cropped with cacao; and that such losses are increasing ever since cacao was introduced as a mixed crop. This cross inoculation trial was conducted to find out whether *P.palmivora* from cacao contributes to the inoculum build-up of 'Koleroga.'

P. palmivora was isolated from black pod affected cacao pods. Since this disease is the most important of all the fungal diseases

of cacao in India, this particular isolate was used for cross inoculation studies. 'Mahali' or 'Koleroga' of arecanut caused by *P. arecae* is a serious disease of areca palm, occurring every year during the south-west monsoons (Coleman, 1910).

Healthy cacao pods and areca fruits of different age-groups were used for these trials. Inoculum consisted of mycelial discs from 7-day-old cultures as well as infected tissue cut from artificially inoculated cacao pods and arecanut fruits. In all the pathogenicity tests, the site of inoculation was surface sterilized with 0.1% mercuric chloride solution, rinsed with sterile water and the fruits were wounded with a 3 mm cork borer. These were then inoculated as detailed below.

1. Cacao pods inoculated with *P.arecae.*

   a) Inoculum from a 7-day-old culture on oat meal agar.

   b) Inoculum from rotting areca fruits.

2. Areca fruits inoculated with *P.palmivora.*

   a) Inoculum from 7-day-old culture on potato dextrose agar.

   b) Inoculum from infected cacao pods.

3. Cacao pods inoculated with *P. palmivora* from culture and from pods, separately.

4. Areca fruits inoculated with *P.arecae* from culture and from rotting fruits, separately.

Each treatment was replicated five times. Uninoculated but wounded fruits served as controls.

Efficacy of fungicides against *P.palmivora* on detached cacao pods.

The following ten fungicides were tested against *P.palmivora* on detached cacao pods: copper oxychloride ('Cupramar'), 80%

ziram (Cuman L), tetramethyl thiuram disulphide (Thiram 75% WDP), carbendazin ('Bavistin WP'), Carboxin (Vitavax) 'Kitazin, tridemorph (Calixin EC), Captafol ('Difolatan 80W'), guazatine (Panoctine 35), and fenfuram (Panoram 25).

Nearly mature cacao pods were harvested, washed thoroughly with tap water and the cut ends of the stalks were sealed with paraffin wax. The surface of the pod was wounded with a 3 mm cork borer and the whole pod surface was immediately sprayed with the fungicides with the help of a hand Pneumatic sprayer (Aspee 'Ganesh'). The holes or 'wells' cut by the cork borer filled with the spray fluid. Controls were sprayed with sterile water. The sprayed pods were then inoculated with the fungal growth (Sporangia + mycelium) scraped out with the help of a sterile scalpel from a 3 mm area on the surface of the cacao pod artificially inoculated 10 days prior to the experiment. The inoculum was mixed with the fungicides, or sterile water within the 'wells' on the pod surface. The inoculated area was covered with a small pad of moist cotton. The pods were then kept inside polythene bags containing cotton pads moistened with sterile water to provide humidity. The mouth of the bags were folded.

Each pod was wounded at two locations and 5 pods were maintained for each treatment. The formation of chocolate brown to dark brown lesion, typical of *P.palmivora* infection around the inoculated area was noted on the 10th day to determine the efficacy of the fungicides used. The fungus was reisolated from the lesion wherever the infection had established itself.

Results and Discussion

Twig die-back and chupon blight

Symptoms: In nature the infection is usually initiated in the axils of leaves at the tip of the twigs or young chupons. It was seen as water soaked lesions. The infection was also found starting from anywhere on the leaf blade or petiole and extending

backwards into the stem. In any case the chief characteristic symptom was the appearance of water soaked lesion which soon turned dark brown to black. The lesions coalesced to form bigger lesions. The lesion on stem was found spreading longitudinally in all directions and turned dark brown to black and shrunken. When the lesions girdled the stem the portion above the point of infection died showing twig die back or chupon blight.

Infection on leaves generally started from the apex or margin of the leaves, more at the apical portion and usually enlarged and coalesced forming bigger patches. The infection resulted in much difoliation and die back.

Isolation of the pathogen and pathogenicity

The causal organism was isolated in pine culture on the potato dextrose agar medium. On the basis of morphological and cultural characteristics the fungus was identified as *P. palmivora*

The fungus produced abundant sporangia and chlamydospores on PDA and oat meal agar. The sporangia were ellipsoidal or ovoid, papillate and caducous. The length breadth ratio was 1.3—2.2, usually 1.6. These characters were typical of *P. palmivora*. The stalks of the sporangia were short and thick, which closely resembled the group I of the morphological groups described by Zentmyer *et al* (1977). These characters were similar to that of *P. palmivora* isolated from cacao stem canker in India (Chandra Mohanan, 1978). The chlamydospores were produced on short lateral branches or were intercalary. They were mostly spherical in shape.

The pathogenicity of *P.palmivora* was established by artificially inoculating twigs and young chupons. The pathogen was reisolated from the artificially inoculated plants and found to be identical with the original one,

This disease has been reported in Surinam, Nigeria, Ghana, Costa Rica and Brizil (Gregory, 1974); from India it is the first report.

Cross inoculation studies

P.palmivora isolated from black pod disease affected cacao pods did not infect areca fruits, neither did the *P.arecae* isolated from 'mahali' affected arecanut cause any infection on cacao pods on artificial inoculation. But *P.palmivora* and *P.arecae* caused infection on cacao pods and arecanut respectively and showed typical symptoms of black pod and 'mahali' on artificial inoculation, under similar conditions as that of cross inoculation.

Earlier workers (Coleman, 1910; Trucker, 1931) also found that *P. arecae* did not infect cacao pods.

Efficacy of fungicides against *P. palmivora* infection on detached cacao pods.

Table I Efficacy of Fungicides against *P. palmivora* on detached cacao pods.

Fungicide	No. of infections/No. of inoculations				
	Concentration in ppm.				
	500	1000	2000	3000	5000
Cupramar	—	8/10	—	0/10	0/10
Cuman L	—	10/10	—	10/10	0/10
Thiram 75% WDP	—	10/10	—	8/10	0/10
Bavistin WP	10/10	10/10	6/10	—	—
Vitavax	10/10	10/10	10/10	—	—
Kitazin	10/10	10/10	3/10	—	—
Calixin EC	10/10	8/10	6/10	—	—
Difolatan 80W	—	1/10	0/10	0/10	—
Panoctine 35	—	10/10	10/10	0/10	—
Panoram 25	—	10/10	7/10	0/10	—

The results of the fungicidal trial are given in Table 1. Out of the ten fungicides tested, Difolatan 2000 ppm, Cupramar,

Panocline and Panoram each at 3000 ppm concentration and Cuman and Thiram each at 5000 ppm concentration as well as Vitavax 2000 ppm concentration inhibited the *P.palmivora* infection on cacao pods completely, whereas Bavistin, Kitazin and Calixin did not show complete inhibition of infection in any of the concentration tested. Difolatan 1000 ppm concentration (lowest concentration tested) caused only 10% infection(1 infection/ 10 inoculations). All the controls were infected and the whole pod surface was covered by the choclate brown lesion within 10 days.

Treatment with 2% Difolatan 4F was found to be effective against cacao canker caused by P.palmivora (Turner, 1974). Newhall and Diaz (1966) found Ortho-Difolatan very promising for control of Phytophthora leaf blight. Muller and Njomou (1970) also found Difolatan as good as copper oxychloride. The above fungicidal trial also shows that difolatan is effective against *P.palmivora* infection. Therefore, Difolatan can be tried in the field to control *P.palmivora* infection of cacao.

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