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Studies on the reaction of pods of different cocoa accessions to *Phytophthora palmivora*

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Cocoa (Theobroma cacao *L.*) *is extensively cultivated in the southern states of India,* viz., *Kerala, Karnataka and Tamil Nadu. Black pod disease caused by* Phytophthora palmivora *(Butl.) Butl. has been found to be of greater economic importance. The susceptibility of different cocoa varieties/types to* P. palmivora *infection varies. The present investigation was undertaken to study the reaction of pods of 19 cocoa accessions to wound infection by* P. palmivora.

Nearly mature pods on trees were inoculated with 3 mm discs of seven-day-old culture of P. palmivora *on potato dextrose agar (PDA). Rate of infection per day was calculated from the lesion diameter recorded seven days after inoculation. Comparative density of sporulation at the site of lesion of each pod was determined.*

The studies on P. palmivora *isolate, used in the present investigation revealed that this isolate closely resembled MF1 of the morphological groups of cocoa* Phytophthora.

All the cocoa accessions studied were susceptible to wound infection by P palmivora. *But the rate of infection varied. Cocoa pods of C–78 was found to be comparatively less susceptible and C-42 and ICS–1 highly susceptible from the rate of infection. The sporulation at the site of lesion was very poor on less susceptible cocoa pods and abundant on highly susceptible pods. Thus the sporulation at the site of lesion appeared to be closely related to the infection rate of* P. palmivora *on cocoa pods.*

Large scale cultivation of cocoa (*Theobroma cacao* L.) in India is of recent origin. The crop is extensively cultivated in all the districts of Kerala, the Dakshina Kannada district of Karnataka and the Kanyakumary district of Tamil Nadu. Among the *Phytophthora* diseases of cocoa reported in India, black pod disease caused by *Phytophthora palmivora* (Butl.) Butl. is widespread and occurs in all parts of the three southern states of India. Black pod disease has been reported as the most important and major cocoa disease in India (Chandra Mohanan and Kaveriappa, 1981). Different cocoa varieties and clones have been reported to show varying degree of resistance to *Phytophthora* pod rot disease in other countries (Rocha, 1965; Akinrefon, 1971). This paper gives an account of studies on the reaction of pods of different cocoa accessions to *P. palmivora* infection.

MATERIALS AND METHODS

For the inoculation of pods on trees, open pollinated, nearly mature pods of nineteen different accessions available at Central Plantation Crops Research Institute, Regional Station, Vittal, India were selected. These plants were obtained earlier as seedlings of 19 different clones or hybrids *(Table 1).*

P. palmivora was isolated from the infected cocoa pods in the Dakshina

TABLE 1. REACTION OF COCOA PODS (ON TREES) TO WOUND INFECTION BY *P. PALMIVORA*

Cocoa accessions	*Rate of infection* (cm/day)*	*Lesion colour*	*Degree of lesion sporulation*
C 78	0.9	Brown	+
P6 x P11A	1.2	Brown	++
W 5/1 (T63/884)	1.3	Dark brown	+++
P9 x P7	1.3	Chocolate brown	++++
W 6/56 (T63/910)	1.4	Reddish brown	++
P7 x P6	1.6	Dark brown	+++
C83	1.7	Brown	++++
P3 x P4	1.8	Brown to dark brown	+++
T86/2	1.8	Brown	++++
P3 x P	1.8	Reddish brown	+++++
C76	1.9	Brown	++++
T30/10 x Na 32	2.0	Brown	+++++
P9 x P7	2.0	Brown	++++++
P6 x P6	2.1	Reddish brown	++++
P12 x P2	2.1	Reddish brown	++++++
T85/5 x Na 32	2.1	Chocolate brown	++++++
T17/11	2.2	Chocolate brown	++++++
ICS–1	2.4	Black	++++++
C42	2.5	Black	++++++

CD (P = 0.05) = 0.28
*Mean of 5 replications.
Sporulation: Very poor (+) to abundant (++++++)

Kannada district, one of the major cocoa growing areas in India. This isolate was assigned to one of the morphological groups described earlier (Griffin, 1977), on the basis of the studies on the nature of growth of the fungus on potato dextrose agar (PDA) and morphological characters of the sporangia, such as length to breadth (L/B) ratio of the sporangia and sporangial stalk size. This isolate was used throughout the study.

To inoculate the pods on trees, a 3 mm deep wound was made midway between the stalk and the tip on the surface of each pod with a sterile cork borer of 3 mm diameter. An inoculum disc of similar size cut with a sterile cork borer from the advancing edge of the seven-day-old culture on PDA was placed in the cavity on the pod surface. The pod tissue was replaced and the wound was sealed with paraffin-wax to avoid secondary infection. Each pod was then covered with a polythene bag containing sterile cotton pad dipped in 100 ml sterile water to provide high humidity. Five pods from each tree were thus inoculated.

The lesion diameter was measured in two directions on the seventh day after

inoculation. The sporulation at the site of lesion was scored visually and also by counting the number of sporangia per microscopic field under the low power (10 x 10). For this 5 mm discs were taken from the pods at different points on the lesion, and 5 such discs were shaken with 1 ml sterile distilled water for two minutes to make a spore suspension. From this suspension 0.03 ml was placed on a slide and observed under the low power of the microscope. The number of sporangia per microscopic field was counted and the mean number of five fields was taken as the degree of sporulation and classified as very poor to abundant depending on the number of sporangia.

RESULTS AND DISCUSSION

Studies on the fungus

The studies on the fungus showed that the *P. palmivora* isolate used for the present study closely resembled the MF1 of the morphological group described in the recent cocoa *Phytophthora* workshop (Griffin, 1977). The cultures on PDA had a smooth, combed appearance with sharp and well-defined edge *(Figure 1).* The sporangia were ellipsoidal or ovoid, caduceous and papillate with a L/B ratio of 1.1 to 1.9 (usually 1.5). The stalks of the sporangia were short and thick with a length of 2.3 to 4.6 microns (usually 3.45 microns). The lesions on cocoa pods were circular and the advancing edge of the lesion was usually sharp and well defined. Chandra Mohanan (1978) reported that the *P. palmivora* isolated from cocoa stem canker also resembled the MF1 group.

Reaction of pods to P. palmivora *infection*

The rate of infection per day was determined from the lesion diameter and the mean of five replications is given in *Table 1.*

All the cocoa accessions studied were susceptible to wound infection by *P. palmivora,* but the rate of infection varied significantly. Akinrefon (1971) also reported that the level of susceptibility of pods of different cocoa varieties to wound infection by *P. palmivora* varied.

The level of susceptibility in T85/5 x Na 32, P6 x P6, P12 x P2, T30/10 x Na 32, C42, ICS–1, P9 x P7 and T17/11 was high, and low in P9 x P7, P6 x P11A, W5/1 (T63/884), W6/56 (T63/910) and C78. The accessions P7 x P6, C76, T86/2, P3 x P, P3 x P4 and C83 exhibited almost a similar level of susceptibility. The fungus grew most rapidly on C42 and ICS–1, and most slowly on C–78 *(Table 1).* The other accessions came in between as shown in the mentioned *Table 1.*

The colour of the lesion also varied from brown to black.

The sporulation at the site of lesion was very poor on less susceptible cocoa pods (C78) and abundant on highly susceptible pods (C42 and ICS–1). Coefficient of correlation (r = 0.88) between rate of infection and scored degree of lesion sporulation was significant at P = 0.01. Akinrefon (1971) reported that the sporulation was scanty in the less susceptible cocoa type T9/15 and high in the more susceptible cocoa type T86/2. The sporulation at the site of lesion on pods appeared to be related

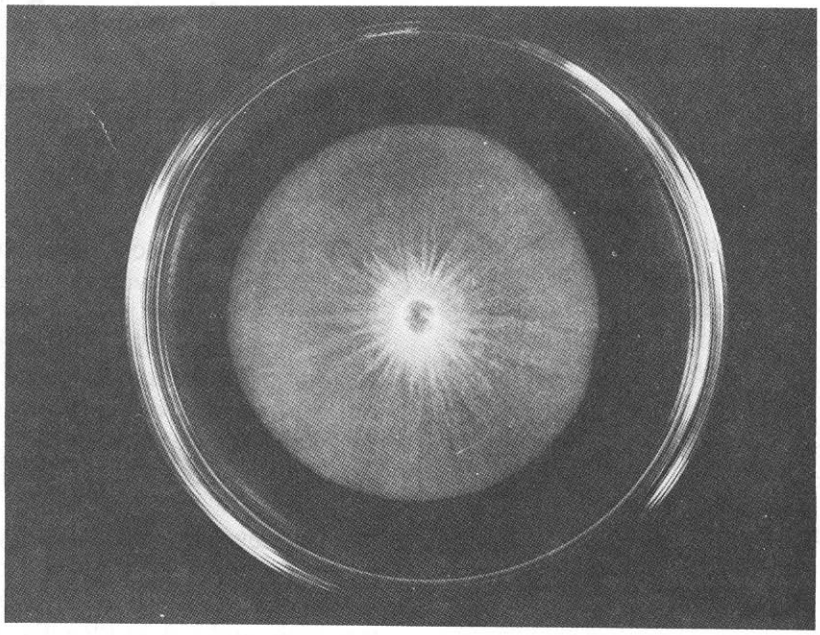

Figure 1. Culture of Phytophthora palmivora *(Butl.) Butl. from cocoa on Potato Dextrose Agar.*

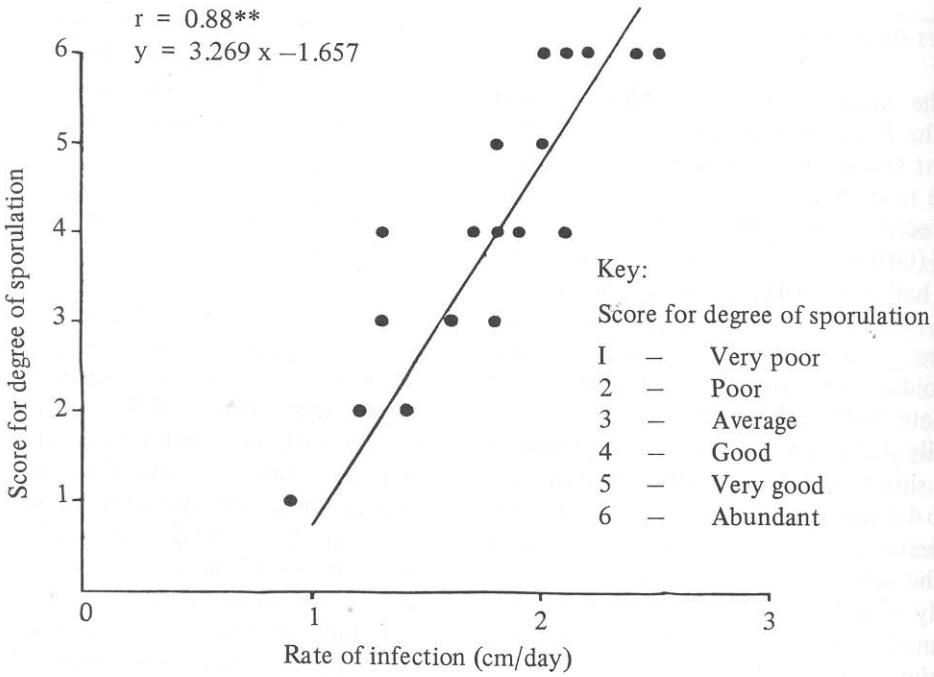

Figure 2. Relationship between rate of infection and degree of lesion sporulation.

to the infection rate of *P. palmivora (Figure 2).* The comparative density of sporulation may, therefore, be considered as one of the important factors in screening cocoa germplasm against black pod disease caused by *P. palmivora.*

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