EFFECT OF CERTAIN FUNGICIDES ON *PHYTOPHTHORA PALMIVORA* (BUTL.) BUTL., THE CAUSAL ORGANISM OF BLACK POD DISEASE OF COCOA*

P.A. RAGHU+ AND R.CHANDRA MOHANAN

Central Plantation Crops Research Institute, Regional Station, Vittal 574 243, Karnataka

ABSTRACT

Comparative *in vitro* sensitivity of certain fungicides on *Phytophthora palmivora* (Butl.) Butl., revealed that Ridomil MZ at 0.2 and 0.3 per cent , Fytolan, Blitox, Foltaf, Dithane M-45 and Captaf each at 0.3 per cent concentration were fungicidal, whereas, Blitox, Fytolan, Dithane M-45 and Foltaf each at 0.2 per cent concentration, Captaf 0.1 and 0.2 per cent and Hexathir 0.3 per cent were fungistatic.

Ridomil MZ, Foltaf and Captaf (0.1 to 0.3%) inhibited *P.palmivora* infection on detached cocoa pods completely even seven days after inoculation.

INTRODUCTION

Black pod, stem canker, seedling dieback, twig dieback and chupon blight are the *Phytophthora* diseases so far reported from India. Of these, black pod disease caused by *Phytophthora palmivora* (Butl.) Butl. was found to be the most important and major disease of cocoa.

Since the early 1900's the use of Bordeaux mixture has been recommended for controlling this disease. Of the copper fungicides, Bordeaux mixture still remains good to a certain extent in the control of black pod disease. But to some extent it has been replaced by various cuprous oxide or copper oxychloride formulations.

A perusal of available literature on the chemical control of black pod disease of cocoa reveals that there is great variation as to the fungicide used, volume and concentration of the spray fluid and the timing and frequency of application in different cocoa growing countries.

Since black pod disease is causing severe losses in all the cocoa growing countries, it is of utmost urgency to find out effective control measures. Several newer fungicide formulations other than copper formulations are being tested for the efficacy in controlling black pod disease in other countries. In India, chemical control trials against black pod disease are in its infancy. This paper summarises the studies on the effect of certain fungicides other than Bordeaux mixture on *P.palmivora*. The fungicides which were found to be effective in the *in vitro* studies were tested for their efficacy in checking lesion development on detached cocoa pods, inoculated with *P.palmivora.*

MATERIAL AND METHODS

The relative efficacy of 13 fungicides on the *in vitro* growth of *Phytophthora palmivora* (Butl.) Butl. was tested in the laboratory by poisoned food techique. The fungicides tested

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+Present address: Division of Applied Botany, Mangalore University, Mangalagangothri 574 199.

were : Akomin (salts of phosphoric acid), Bavistin WP and J.K. stein (both carbendazim 50% : 2-methoxy carbamoylbenzimidazole), Calixin EC(tridemorph) N -tridecyl-2,6-dimethyl morpholine),Kitazin 48 % EC (S-Benzyl -0,0-Disopropyl-phosphorothiate), Ridomil MZ 72 WP (metalaxyl 8 % + mancozeb 64 %), Blitox 50 WP and Fytolan WDP (Copper Oxychloride), Captaf 75 WP (Captan 75%), Cuman L. (Ziram: Zinc dimethyl dithio carbamate + Zinc ion), Hexathir 75 % WP (Thiram : tetra methyl thiuram disulphide), Dithane M-45 (mancozeb : manganese ethylene bisdithio carbamate + zinc ion) and Foltaf 80 WP (captafol 80% : Cis N-(1,1,2,2 tetra chloro ethyl thio)- 4- cyclohexane 1,2-dicarboximide). Measured quantity of fungicide solution prepared in sterile distilled water was incorporated into sterilized carrot agar medium (CA) to get the required concentration. Fifteen ml of the poisoned medium was then poured into each of the sterile plate. After solidification of the medium each plate was inoculated cenrtrally with mycelial disc of 8 mm diameter cut from the periphery of 5-day-old culture of *P.palmivora* growing on CA medium. The plates were incubated at room temperature (28 ± 2°C) for seven days. In control, sterile distilled water alone was added. Three replications were maintained for each treatment. Radial growth of the fungus in each plate was recorded on third, fifth and seventh day of inoculation. The per cent inhibition of growth of *P.palmivora* in treatment was calculated by the equation given by Vincent (1927).

$$I = \frac{C - T}{C} \times 100$$

where, I = Inhibition of fungal growth
C = Growth in check
T = Growth in treatment

The nature of fungicidal action was also recorded in cases where no fungal growth was observed. For this purpose, inoculum discs were picked from the poisoned media after seven days of incubation, transferred to CA medium and recovery of fungus was observed.

Efficacy of fungicides against *P.palmivora* on detached cocoa pods: Seven fungicides, which were found to be promising based on the *in vitro* studies were selected to study their efficacy against *P.palmivora* infection on detached cocoa pods. The fungicides tested were : Ridomil MZ, Blitox, Fytolan, Dithane M-45, Foltaf, Captaf and Hexathir. Nearly mature pods of 'Forestero' variety were surface sterilized with 0.1 per cent mercuric chloride solution for about two min. and washed in three changes of sterile distilled water. A tissue plug was removed from the surface of the pod to a depth of three mm with the help of 8 mm diam sterile cork borer. Each fungicide was mixed with sterile distilled water to get 0.1, 0.2 and 0.3 per cent concentration. Each fungicide at the required concentration was filled in the cavity made on the cocoa pod surface. The 'wells' or cavities in the control pods were filled with sterile water. The pods were then inoculated with fungal growth (sporangia + mycelia) scraped out with the help of sterile scalpel from an 8 mm diam area on the surface of cocoa pod artificially inoculated ten days prior to the experiment . The inoculum was mixed with the fungicide or sterile water within the wells on pod surface.Each pod was wounded at the middle region with one cavity per pod and three pods were maintained for each treatment. Each inoculated pod was kept inside a polythene bag containing cotton pads moistened with sterile water to provide high humidity. The mouth of the polythene bag was closed by tying with rubber band. The inoculated pods were incubated at room temperature ranging from 22 to 28°C. Lesion diameter was measured in two directions at right angles to each other on third, fifth and seventh day of inoculation. The average of two measurements was taken as the lesion diam.

RESULTS AND DISCUSSION

***In vitro* studies:** Out of the 13 fungicides tested, Captaf (Captan 75%) was found to be superior. Captaf, even at 0.1 per cent concentration inhibited the growth of *P.palmivora* completely. (Table 1). Ridomil MZ, Blitox, Fytolan and Dithane M-45 each at 0.2 and 0.3 per cent concentration, Foltaf (0.3%) and Hexathir (0.3

Table 1.

Per cent inhibition of growth of *Phytophthora palmivora* at different concentration of fungicides.

S.No	Fungicides	Per cent inhibition*								
		Days after inoculation								
		3			5			7		
		Concentration (%)								
		0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3
1.	Akomin	82.35	82.81	96.39	73.11	77.03	94.40	77.23	80.09	97.00
2.	Bavistin WP	18.54	40.73	64.24	15.97	31.09	60.22	20.33	40.04	55.70
3.	Calixin	84.60	90.04	90.50	86.00	90.47	91.04	82.11	89.63	91.26
4.	J.K.Stein	89.14	91.39	92.75	84.59	85.43	86.55	80.89	83.13	85.16
5.	Kitazin	87.32	89.60	90.50	76.18	87.68	91.88	79.67	91.46	91.87
6.	Ridomil MZ	89.14	100.00	100.00	91.31	100.00	100.00	92.68	100.00	100.00
7.	Blitox	92.32	100.00	100.00	94.12	100.00	100.00	94.91	100.00	100.00
8.	Fytolan	90.96	100.00	100.00	92.72	100.00	100.00	93.70	100.00	100.00
9.	Captaf	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
10.	Cuman L.	78.74	89.60	93.67	75.92	86.84	93.56	79.67	87.40	93.70
11.	Dithane M-45	93.67	100.00	100.00	95.80	100.00	100.00	95.94	100.00	100.00
12.	Foltaf	84.17	86.89	100.00	87.39	87.68	100.00	86.89	87.80	100.00
13.	Hexathir	100.00	100.00	100.00	100.00	100.00	100.00	91.87	95.52	100.00

Mean of three replications.

Table 2.

Efficacy of fungicides against *Phytophthora palmivora* infection on detached cocoa pods

S.No.	Treatments	Lesion diameter (in mm)*								
		Days after inoculation								
		3			5			7		
		0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3
1.	Ridomil MZ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.	Blitox	0.00	0.00	0.00	6.00	5.17	4.50	12.33	10.50	8.83
3.	Fytolan	0.00	0.00	0.00	5.83	3.67	3.50	16.67	12.17	9.33
4.	Captaf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.	Dithane M-45	23.33	22.67	17.17	57.33	29.83	19.67	94.67	56.67	29.83
6.	Foltaf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.	Hexathir	52.83	47.17	42.00	83.50	76.00	67.83	144.00	120.00	113.67
	Control			53.00		111.17			145.17	

* Mean of three replications.

%) also inhibited the growth completely. Other fungicides showed varied toxicity towards *P.palmivora.* Fungitoxicity varied with the concentration of fungicides and days of incubation. Ridomil MZ at 0.2 and 0.3 per cent, Fytolan, Blitox, Foltaf, Dithane M-45 and Captaf each at 0.3 per cent concentration were fungicidal, whereas, Blitox, Fytolan, Dithane M-45 and Foltaf each at 0.2 per cent concentration Captaf 0.1 and 0.2 per cent concentration and Hexathir 0.3 per cent were fungistatic. Various workers have reported the efficacy of copper oxychloride in inhibiting the growth of *P.palmivora* under *in vitro* condition as well as in reducing the disease incidence in the field (Figueiredo and Lellis, 1981 and Koti Reddy and Mohan, 1984).

Efficacy of fungicides against P.palmivora on detached cocoa pods: The results of fungicidal trial on detached cocoa pods are presented in Table 2. Out of the seven fungicides tested, Ridomil MZ, Foltaf and Captaf at all concentration tested, inhibited *P.palmivora* infection on cocoa pods completely and there was no lesion development even seven days after inoculation. Ridomil was reported as an effective systemic fungicide in black pod disease control (Mc Gregor, 1981 and 1983; Eberle, 1981; Kuch, 1984; Vantil Borgh, 1987 and Chan and Lim, 1987). Chandra Mohanan *et.al* (1979) also found Difolatan as effective in inhibiting the *P.palmivora* infection on detached cocoa pods. Blitox and Fytolan showed complete inhibition of infection in all the concentration tested only for three days though at 0.3 per cent concentration they were effective in inhibiting the fungal growth completely and fungicidal under *in vitro* conditions.

Dithane M-45 even at 0.3 per cent concentration was not very effective though the lesion size was smaller than that in 0.1 and 0.2 per cent. Hexathir was not at all effective in inhibiting *P.palmivora* infection on detached cocoa pods. Thus the present *in vitro* and *in vivo* studies revealed that among the fungicides tried Captaf, Ridomil MZ and Foltaf are the most promising fungicides and hence these could be used for field trials to control black pod disease of cocoa caused by *P.palmivora.*

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