

Relative efficacy of fungicides *in vitro* against *Botryodiplodia theobromae* causing charcoal pod rot of cacao*

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INTRODUCTION

CHARCOAL pod rot of cacao (*Theobroma cacao* L.) incited by *Botryodiplodia theobromae* Pat. takes a heavy toll of the crop in summer months, particularly in Criollo variety (Nambiar and Nair, 1972). We have noticed that this fungus also infects the pods of Forestero cacao, which is the dominant cacao variety of India. Pods of all ages are susceptible to the disease and are found throughout the year. The internal tissues of pods are rotten and the beans turn black in colour and are underdeveloped if the infection is in the early stages of pod development. As cacao is valued for its beans in the pods it is of utmost need to find out control measures against this pod rot disease. The present investigation was undertaken to evaluate the relative efficacy of 17 different fungicides *in vitro* on *B. theobromae* isolated from the rotting cacao pods.

MATERIALS AND METHODS

THE poisoned food technique was employed for the studies. The fungicides tested were: Bordeaux mixture (a mixture of copper sulphate and lime), Blue copper-50 (copper oxychloride), Wettable sulphur (inorganic sulphur fungicide), Ziram (zinc dimethyl dithiocarbamate), Zineb (zinc ethylene bisdithiocarbamate), Thiram (tetramethyl thiuram disulphide), Dithane M-45 (manganous ethylene bisdithiocarbamate and zinc ion), Miltox (37.5% copper and 12.0% zineb), Ceresan wet (methoxyethyl mercury chloride), Leytosol (phenyl mercury urea), Captan (N-(trichloromethyl thio-4-cyclohexene-1, 2-dicarboximide), Difolatan (N-1,1,2,2-tetrachloroethyl thio-cis-4-cyclohexene-1,2-dicarboximide), PCNB (pentachloronitrobenzene), Benlate (methyl-1-butyl carbamoyl)-2-benzimidazole carbamate), Vitavax (5,6-dihydro-2-methyl-1, 4-oxathiin-3-carboxanilide), Plantvax (2,3-dihydro-5-carboxanilido-6-methyl-1, 4-oxathiin-4,4-dioxide), and Hinosan (o-ethyl s,s-diphenyl-dithio-

phosphate). Measured quantities of these fungicides were incorporated in sterile glucose-nitrate agar medium (Hendrix, 1964) cooled to 45°C, to get the required concentration. The medium was shaken well to give uniform dispersal of the fungicide. Fifteen ml of this was then poured into each of the sterile plates, keeping three replicates for each treatment and a check in which no fungicide was added. After solidification of the medium the plates were inoculated with mycelial discs of 5 mm diameter taken from the periphery of 4 days old pure culture of the test fungus from PDA plates. Petri-dishes were incubated at room temperature (28±2°C) for 4 days and radial growths of the fungus were recorded. The percent inhibition of growth of *B. theobromae* in treatment was calculated by the equation given by Vincent (1927).

$$I = \frac{100 (C - T)}{C}$$

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 obtained. For this purpose, inoculum discs were picked from poisoned media after 4 days of incubation, transferred to glucose-nitrate agar and recovery of the fungus was noted. The results are incorporated in Table I.

RESULTS AND DISCUSSIONS

THE per cent inhibition of growth in different fungicides is given in Table I. The mean radial growth of the fungus in control was 92 mm. Out of the 17 fungicides tested, Bordeaux mixture 7500-10,000 ppm, Thiram 1000-3000 ppm, Dithane M-45 2000-3000 ppm, and Ceresan wet, Leytosol, Benlate and Vitavax each at 500-3000 ppm concentrations as well as Plantvax 3000

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TABLE I — PER CENT INHIBITION OF GROWTH OF *BOTRYODIPLODIA THEOBROMÆ* AT DIFFERENT CONCENTRATIONS OF FUNGICIDES

Fungicide	Per cent inhibition							
	Concentration in ppm							
	500	1000	2000	3000	4000	5000	7560	10,000
Bordeaux mixture	—	—	—	—	—	F.S.	100	100
Blue copper-50	—	—	—	44.57	73.79	84.78	—	—
Wettable sulphur	—	4.35	18.48	39.13	40.22	—	—	—
Ziram	—	F.S.	F.S.	F.S.	F.S.	—	—	—
Zineb	—	77.17	89.13	96.74	—	—	—	—
Thiram	—	100	100	100	—	—	—	—
Dithane M-45	—	96.74	100	100	—	—	—	—
Milttox	—	F.S.	F.S.	F.S.	F.S.	—	—	—
Leytosol	100	100	100	100	—	—	—	—
Ceresan wet	100	100	100	100	—	—	—	—
Captan	—	F.S.	F.S.	F.S.	F.S.	—	—	—
Difolatan	—	97.83	97.83	97.83	—	—	—	—
PCNB	—	94.57	95.65	96.74	—	—	—	—
Benlate	100	100	100	100	—	—	—	—
Vitavax	100	100	100	100	—	—	—	—
Plantvax	55.43	83.69	94.57	100	—	—	—	—
Hinosan	89.13	83.48	100	100	—	—	—	—

F.S. — Fungistatic

— Not tested

ppm and Hinosan 2000-3000 ppm inhibited the fungal growth completely, whereas Wettable sulphur gave least inhibition of growth in all the concentrations tested. Bordeaux mixture 5000 ppm, Ziram, Milttox and Captan each at 1000-400 ppm concentration exhibited fungistatic activity whereas other compounds showed varied toxicity towards the fungus. Benlate has been widely used to control *B. theobromae* in a number of hosts (Bammi et al., 1972; Chee, 1971; and Ogundana, 1972). The present investigation shows that besides Benlate, the Bordeaux mixture, Thiram, Dithane M-45, Ceresan wet, Leytosol and Vitavax were also effective against the fungal growth at low concentrations and could therefore, be tried in the field to control charcoal pod rot of cacao.

REFERENCES

- Bammi, R. K., V. Rama Rao, G. S. Randhava, and Y. Selvaraj. 1972. Control by benomyl of tuber rot in *Dioscorea floribunda*. *Plant Dis. Repr.* 56: 990-991.
- Chee, K. H. 1971. A new disease of *Hevea brasiliensis* caused by *Fusarium solani* and *Botryodiplodia theobromae*. *Plant Dis. Repr.* 56: 152-153.
- Hendrix, J. W. 1964. Sterol induction of reproduction and stimulation of growth of *Pythium* and *Phytophthora*. *Science*. 144: 1028-1029.
- Nambiar, K. K. N. and K. R. Nair. 1972. Charcoal pod rot of cacao. *Indian Phytopath.* 25: 595-597.
- Ogundana, S. K. 1972. The control of soft rot of yams in Nigeria. *Int. Biodeterior. Bull.* 8: 75-78.
- Vincent, J. M. 1927. Distortion of fungal hyphae in the presence of certain inhibitors. *Nature*. 159: 850.