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EVALUATION OF SOME SYSTEMIC AND NON-SYSTEMIC FUNGICIDES AGAINST THE CHARCOAL ROT PATHOGEN *MACROPHOMINA PHASEOLINA* (TASS1) GOID. OF MAIZE

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Abstract: Eight fungicides of both systemic (Agrizim, Bavistin, Derosal and Mopsin) and non-systemic (Captaf, Foltaf, Thiride and Rizolex) groups were tested against *Macrophominaphaseolina* (Tassi) Goid. inciting charcoal rot in maize. *In vitro* study showed complete inhibition of growth of the pathogen at a very low concentration (30 ppm) with Bavistin followed by Mopsin (40 ppm), Agrizim (100 ppm), Rizolex (120 ppm), Derosal (200 ppm), Foltaf (500 ppm), Captaf (600 ppm) and Thiride (1000 ppm). Complete inhibition **of** sclerotial germination, however, occurred with Mopsin and Thiride, and the germination was poor to very poor with the remaining fungicides. Pot culture experiments in 'sick soil' showed that Derosal, Foltaf and Mopsin were the best in reducing charcoal rot incidence while field experiments in 'sick plot' showed that Bavistin was the best followed by Mopsin, Derosal and Agrizim.

Key words: Charcoal rot, fungicide evaluation, *Macrophomina phaseolina,* maize

INTRODUCTION

Charcoal rot caused by *Macrophominaphaseolina* (Tassi) Goid. [*Rhizoctonia bataticola* (Taub.) Butl.] is a major stalk rot of maize (*Zea mays* Linn.) in India capable of causing appreciable damage to the standing crop in comparatively dry and low rainfall areas and it may attack all types of com (Renfro and Ullstrup, 1976). Characteristic symptom is the discolouration of the lower internodes and the pith that generally occurs after flowering, the lower internodes become straw coloured, and even the pith sometimes becomes dark brown. In the disintegrated strands of the pith small, black sclerotia appear.

Although some workers were successful in controlling a number of diseases caused by *M. phaseolina* on different host plants by using both systemic and non-systemic fungicides (Vir, 1976; Goyal and Mehrotra, 1981; Narasimhan and Prakasam, 1983; and Satija and Indra, 1987), knowledge on this aspect is scanty in respect of charcoal rot of maize.

MATERIALS AND METHODS

The study was undertaken in the Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Kalyani (22.5° N, 89.0 E) located on the Gangetic plains of West Bengal, India during December to April (rabi season) of 1991 and 1992. The soil of the experimental field was alluvial with pH 6.7. The field had been covered with maize only for the previous years with normal agronomic practices. From an ecological point of view the existing weather conditions during rabi season in the Gangetic plains at Kalyani are conducive for the development of charcoal rot of maize (Kaiser and Das, 1988).

Eight fungicides were included in the present study. The systemic fungicides were: (i) Agrizim 50 WP (carbendazim 50% WP) [methyl-1H-benzimidazole-2-yl carbamate], (ii) Bavistin 50 WP (carbendazim), (iii) Derosal 50 WP (carbendazim 50% WP) and (iv) Mopsin 70 WP (thiophanate methyl 70% WP) [dimethyl 4, 4-0 phenyl enebis (3-thioallophanate)], while the non-systemic protectants were : (i) Captaf 75 SD (captan 75 SD) [N-(trichloromethylthio)-4-cyclohexane 1,2-dicarboximide], (ii) Foltaf 80 W (captafal 80W) [cis-N-(1,1,2,2-tetrachloroethylthio) 4-cyclohexane 1,2-dicarboximide], (iii) Thiride 75 D (thiram) [thiram disulphide (D)] and (iv) Rizolex 50 WP [O,O-dimethyl-O-(2,6-dichloro-4-methyl)-phosphorothioate]. A virulent strain of *M. phaseolina* isolated from the

sclerotia occurring inside the charcoal rot affected stalks of a susceptible maize hybrid VL 54 was used. Efficacy of these fungicides against *M. phaseolina* was first tested in the laboratory *(in vitro)* followed by their test on maize plants *(in vitro).* Methods adopted for different experiments related to the efficacy were as follows:

Effect on mycelial growth of the pathogen

Linear growth of mycelium was studied by using different concentrations (ppm) of the fungicides prepared by adding the requisite quantity to 1 litre of sterilized potato dextrose agar (PDA) cooled to 45°C. Twenty ml of this medium was then aseptically poured in each of the sterilized 10 cm petri-plates and was allowed to solidify. The plates were inoculated at the centre with 6 mm discs of the pathogen from the growing culture. Such plates replicated five time were incubated at 29±1 C and the linear growth was recorded after 5 days.

Effect on sclerotial germination of the pathogen

Germination of sclerotia was studied at 2000 ppm prepared by adding 2 g of the respective fungicide to 1 litre of sterile distilled water. Sclerotia were harvested from the mycelial mat, grown inside 250 ml Erlenmeyer flasks on sterilized potato dextrose broth (PDA) at 29±1°C for 15 days, following the method described by Singh (1991). Viability of sclerotia was then tested on moist filter paper and nearly 100% of them were found viable through germination. Sclerotial germination in the test solution was studied in double groove slides incubated in a moist chamber at 29±1 C. The slides were observed at different time intervals and germination percentage was recorded after 24 hours.

Effect on charcoal rot incidence in 'sick soil' by pot culture experiment

Large (31 cm diameter) earthen pots were filled with sterilized garden soil and compost (5:1 ratio). 'Sick soil' in these pots were prepared by adding suspension of the pathogen at 15 day intervals up to 4 months following the process described by Singh (1991). A susceptible maize hybrid Deccan 101 was planted in these pots during the end of December. Before planting N, P and K fertilizers in the form of ammonium sulphate, superphosphate and muriate of potash were added to the soil in pots @ 400 kg, 250 kg and 120 kg ha^{-1} respectively. After germination a single plant was maintained in each pot using near optimum irrigation with sterile tap water.

Fungicides were applied separately to each pot by soil drenching @ 2000 ppm or 2 g 1^{-1} of water about 7 days prior to flowering. For each treatment a set of six plants represented a single replication and five such replications were kept. For comparison, controls were kept without adding any fungicide to the pots.

Symptoms appeared in these plants about 21 days after silking and the disease severity was recorded by splitting open the stalks longitudinally following 1 to 10 (1 = very slight to slight infection and 10 = very heavy infection leading to the premature wilting) scale described earlier (Kaiser and Das, 1988).

Effect on charcoal rot incidence in 'sick plot' under field condition

The effect of different fungicides on charcoal rot incidence in the field was studied by growing the same susceptible maize hybrid Deccan 101 in 'sick plot'. Seeds were planted following the split plot technique during the middle of December in two row plot with three replications under normal agronomic practices of N, P and K fertilizer doses mentioned before. Each row was 5 m long and contained approximately 25 plants. About 45 days prior to planting finely chopped charcoal rot affected maize stalks and compost were thoroughly mixed with the soil by ploughing for increasing the inoculum density following the method adopted by Kaiser and Das (1983).

Each fungicide was applied as soil drenching @ 2000 ppm or 30 g of fungicide in 15 1 of water to cover an approximate area of 25 m^2

Table 1. Efficacy of different fungicide against linear growth of charcoal rot pathogen *M. phaseolina* on PDA medium

Fungicide	Linear growth (mm) at different concentration (ppm) after 5 days					
	mm/ppm	mm/ppm	mm/ppm	mm/ppm	mm/ppm	mm/ppm
Agrizim	90.0/20	72.0/30	61.8/40	32.2/60	8.6/80	0.0/100
Bavistin	63.8/5	41.2/10	25.0/15	7.8/20	0.0/30	
Captaf	90.0/100	91.0/200	34.2/300	15.0/400	7.2/500	0.0/600
Derosa 1	90.0/100	85.0/120	60.0/140	46.0/160	21.8/180	0.0/200
Foltaf	90.0/100	70.0/200	25.0/300	11.8/400	0.0/500	
Mopsin	83.4/5	73.8/10	54.0/15	30.0/20	10.2/30	0.0/40
Rizolex	73.2/20	25.8/40	14.8/60	11.4/80	8.0/100	0.0/120
Thiride	70.4/500	66.0/600	43.4/700	28.6/800	10.6/900	0.0/1000

about 7 days prior to flowering. Adequate controls were kept without application of any fungicide. Normal irrigation was provided except at the time of application of fungicide extending up to a period of 10 days and no other plant protection measure was undertaken. Symptoms appeared in about 21 days after silking and the disease severity was recorded following the same 1 to 10 scale as before.

RESULTS AND DISCUSSION

In vitro study by the food poisoning method of PDA medium by using different doses of the test fungicides showed that linear growth of the pathogen gradually decreased with the increase in fungicidal dose (Table 1). Complete inhibition of linear growth was recorded at a very low concentration of 30 ppm with Bavistin, followed by Mopsin (40 ppm), Agrizim (100 ppm), Rizolex (120 ppm), Derosal (200 ppm),Foltaf (500 ppm), Captaf (600 ppm) and Thiride (1000 ppm). The data on the sclerotial germination (Table 2) showed that Mopsin and Thiride completely inhibited sclerotial germination and it was also poor to very poor with the remaining fungicides. Although sclerotial germination was recorded with some of these fungicides further growth and branching of germinating hyphae were not observed in any case after 24 hours. *In vitro* study revealed that all these systemic fungicides belonging to both carbendazim (Agrizim, Bavistin and Derosal) and thiophanate methyl (Mopsin) groups, in general, were superior to non-systemic protectants of different chemical groups.

Some workers have demonstrated the efficacy of both systemic and non-systemic fungicides *in vitro* against *M. phaseolina*. Tripathi *et al.* (1977) observed that Captafol and thiophanate methyl inhibited growth of charcoal rot pathogen *M. phaseolina* of sesame while Sarwar and Raju (1985) recorded inhibition of growth of *R. bataticola (M. phaseolina)* causing root and stem rot of castor. Ramadoss and Sivaprakasam (1987) also observed that carbendazim and TMTD (Thiram) were inhibitory to linear growth of *M. phaseolina* infecting cowpea, and these were fungicidal at 10 ppm and 500 ppm respectively.

Evaluation of these fungicides by pot culture experiments in 'sick soil' showed that Derosal, Foltaf and Mopsin were the best in their action without showing any significant difference in reducing the charcoal rot incidence (Table 3). The remaining fungicides also resulted in a

Table 2. Effect of different fungicides on the germination of sclerotia of charcoal rot pathogen *M. phaseolina*

Fungicide	% germination of sclerotia	
	Original value	Transformed value
Agrizim	3.00	9.91
Bavistin	0.60	2.77
Captaf	4.60	12.33
Derosal	8.20	16.60
Foltaf	3.20	10.28
Mopsin	0.00	0.00
Rizolex	11.60	19.90
Thiride	0.00	0.00
Unsupplemented (control)	82.00	64.90
SE (mean)		±0.69
CD (0.05)		1.92

Table 3. Effect of different fungicides on the incidence of charcoal rot *(M. phaseolina)* of maize by pot culture experiments in `sick soil'

Fungicide	Average disease index
Agrizim	3.30
Bavistin	3.20
Captaf	3.60
Derosal	3.00
Foltaf	3.10
Mopsin	3.00
Rizolex	3.60
Thiride	3.70
Unsupplemented (control)	6.70
SE (mean)	±0.07
CD (0.05)	0.19

Table 4. Effect of different fungicides on the incidence of charcoal rot *(M. phaseolina)* of maize in the infested field conditions

Fungicide	Average disease index
Agrizim	3.80
Bavistin	3.30
Captaf	5.00
Derosal	3.60
Foltaf	4.80
Mopsin	3.50
Rizolex	5.10
Thiride	3.60
Unsupplemented (control)	7.20
SE (mean)	±0.08
CD (0.05)	0.22

good inhibition of disease symptoms but no significant difference in this regard was recorded between Bavistin and Foltaf.

Field experiments in `sick plot', however, showed that Bavistin was the best in action followed by Mopsin, Derosal and Agrizim all of which significantly reduced the charcoal rot incidence over control (Table 4). Although Foltaf, Captaf, Rizolex and Thiride significantly reduced the disease incidence, the pathogenic effect remained fairly high with these fungicides, the highest was with Thiride.

Application of both systemic and non-systemic fungicides by soil drenching was also reported to be useful in the control of some other diseases incited by *M. phaseolina.* But most of those observations indicate the effectiveness of systemic fungicides. Vir (1976) reported control of damping off *(M. **phaseolina)*** of *Capsicum* seedlings by soil drenching with 0.1% aqueous solution of Bavistin while Tripathi *et al.* (1977) showed that soil drenching with Captafol, Carbendazim and Thiram + Captan were effective against

charcoal rot of sesame. Satija and Indra (1987) also reported that Thiophanate methyl and Bavistin (carbendazim) were highly effective in controlling damping off of tomato and chilli caused by *R. solani* and *R. bataticola* respectively.

From the results of the present study it may be concluded that the systemic fungicides Agrizim, Bavistin, Derosal and Mopsin may be effectively utilized in the control of charcoal rot of maize in the field. Although the non-systemic fungicides Captaf, Foltaf, Rizolex and Thiride were all effective on the inhibition of mycelial growth and germination of sclerotia as well as disease symptom in pot culture, they were not equally effective in the field in reducing the disease. The present findings also indicate that growth of the charcoal rot pathogen *M. phaseolina* in response to different non-systemic fungicides under *in vitro* conditions has no direct relation with the disease incidence under field conditions.

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