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Sensitivity of *Trichoderma harzianum* Rifai against systemic fungicides

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Abstract
Sensitivity test of *Trichoderma harzianum* against systemic fungicides revealed metalaxyl MZ-02 % as the safer fungicide for mycelial growth showed 42.59 % growth inhibition with Ed_{50} value 2553µgml^{-1} followed by triadimefon 0.1 % recorded 1531 µgml^{-1}Ed_{50} value. Whereas, benomyl, penconazole, propiconazole and prochloraz were proved highly toxic for mycelial growth with ED_{50}values of 1µgml^{-1}, 11µgml^{-1}, 29µgml^{-1}and 34µgml^{-1} respectively.
Keywords: *Trichoderma harzianum*, metalaxyl MZ, triadimefon, benomyl, penconazole, propiconazole and prochloraz.

Keywords: Sensitivity, *Trichoderma harzianum*, systemic fungicides.

1. Introduction
The efficacy of the bioagents was found to be hampered due to poisonous nature of different pesticides viz, fungicides, insecticides, nematicides and weedicides etc. used simultaneously in crop production technology. Therefore, different workers have tested the sensitivity and tolerance of bioagent i.e. *Trichoderma* spp. against these pesticides. Vijji *et al.* (1997) [10] reported the non-target effect of systemic fungicides on the bioagent *Trichoderma* spp. Ortiz Molievo *et al.* (1996) [6] reported that there was no growth of bioagents in the presence of carbendazim and benomyl *in vitro.* Thus *in vitro* study was evaluated by testing the effect on radial growth of the bioagent by employing poisoned food technique (Grover and Moore, 1962) [4].

Material and Methods
The systemic fungicides viz. metalaxyl MZ (Ridomil MZ 72 WP), triadimefon (Bayleton 50WP), propiconazole (Tilt 25 EL), penconazole (Topas 10 EC), prochloraz (Octare 50 WP) and benomyl (Benlate 50 WP) were used against *Trichoderma harzianum* at 25, 50, 125, 250, 500, 1000 and 2000 µg ml^{-1} concentrations.

Effect on radial growth
The experiment was conducted by employing poisoned food technique (Grover and Moore, 1962) [4] with PDA as basal medium. Each treatment was replicated thrice. The *Trichoderma* inoculated petri plates were incubated at 27 ± 1^{0}C till the control plates were full with its mycelial growth. The linear mycelial growth of the bioagent in the bioagent in the treatment and in control plates was measured in two directions at right angle to each other. The per cent inhibition of the mycelial growth was calculated by using the formula of Bliss (1934) as under

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

Where I- Inhibition per cent, C- Colony diameter in control plate and T- Colony diameter in treated plate

ED_{50} values of systemic fungicides

ED_{50} values of the systemic fungicides were determined by plotting the fungicidal concentrations against percentage inhibition on a log-probit scale as described by (Horsfall, 1956)

Results and Discussion

The results of the study presented in Table 1 showed significant differences in the radial growth of *Trichoderma harzarium* due to fungicides and their concentrations revealed metalaxyl MZ as significantly superior as showed no adverse effect on radial growth (76.71 mm) followed by triadimefom (60.76 mm). Whereas, other fungicides viz. propiconazole, prochloraz, penconazole and benomyl showed different level of toxicity to the bioagent.

Table: Effect of systemic fungicides with different concentrations on radial growth of *Trichoderma harzarium*

Sr. No.	Fungicides	Average radial growth (mm) Concentrations (µg ml^{-1})							Fungicidal mean
		25	50	125	250	500	1000	2000	
1	Benomyl	0.00 (100.00)	0.00 (100.00)	0.00 (100.00)	0.00 (100.00)	0.00 (100.00)	0.00 (100.00)	0.00 (100.00)	0.00 (100.00)
2	Metalaxyl	90.00 (0.00)	90.00 (0.00)	85.67 (4.81)	81.33 (9.63)	74.33 (17.41)	64.00 (28.89)	51.67 (42.59)	76.71 (14.76)
3	Penconazole	11.33 (87.41)	7.00 (92.22)	0.00 (100.0)	0.00 (100.0)	0.00 (100.0)	0.00 (100.0)	0.00 (100.0)	2.61 (97.10)
4	Prochloraz	50.67 (43.70)	37.67 (58.14)	10.33 (88.52)	0.00 (100.00)	0.00 (100.00)	0.00 (100.00)	0.00 (100.00)	14.09 (84.34)
5	Triadimefon	90.00 (0.00)	83.67 (7.03)	78.67 (12.59)	74.67 (17.03)	70.33 (21.86)	57.33 (36.30)	33.67 (62.59)	69.76 (22.48)
	Concentration Mean	50.05 (44.38)	39.72 (55.86)	31.55 (64.94)	27.72 (69.20)	25.27 (71.92)	20.22 (77.53)	14.22 (84.20)	
	Control	90.00							
		SE±	CD at 0.05%		CV%				
	Fungicides (F)	0.10	0.31						
	Concentration(C)	0.11	0.33						
	Interaction (F × C)	0.29	0.82						
	Control Vs Rest	0.21	0.57						

*****Average of three replications

(Figures in parentheses are percent growth inhibition over control)

Among the fungicides metalaxyl MZ showed no inhibition to the bioagent upto 50 µg ml^{-1} and little inhibition (<10%) upto 250 µg ml^{-1}. However, it grow safely upto 2000 µg ml^{-1} with radial growth of 51.67 mm and growth inhibition of 42.59 per cent.

Similarly, triadimefon was found a little inhibitory in comparison to metalaxyl MZ, wherein the bioagent growth of 57.330mm and growth inhibition of 36.30 per cent was recorded at 1000 µg ml^{-1}.

However, propiconazole and prochloraz were next in order of the toxicity to bioagent is at 25 µg ml^{-1} both showed 58.33 and 50.67 mm radial growth and 35.19 and 43.70% growth inhibition, respectively.

Among the fungicides tested, benomyl was found to be most toxic as no no growth of bioagents was observed at any concentration tested. This was followed by penconazole wherein 11.33 mm mycelia growth with 87.41 percent growth inhibition was obtained at 25 µg ml^{-1}.

In an experiment Agarwal and Tripathi (1999) [1] recorded 2.22 and 1.11 percent growth inhibition of *Trichoderma viride* at 500 µg ml^{-1} of metalaxyl MZ and triadimefon respectively. Similarly, Akbari *et al* (2001) [2] isolated the strains of *Trichoderma harziarum*-II, *Trichoderma viride*-II and *Gliocladium virens* the growth of which were not inhibited by metalaxyl MZ at any of the concentrations tested.

In case of benomyl, Vijji *et al.* (1997) [10] reported, it to be the most toxic as it suppressed the growth of all the bioagents viz. *Trichoderma harzianum*, *Trichoderma longibrachiatum* and *Gliocladium virens.*

Peechia (1996) [7] found many tolerant mutants of *Trichoderma harzianum* when mycelia and conidia of awild strain were exposed to propiconazole. Similarly, Roco *et al.* (1996) [8] developed UV mutants tolerant to prochloraz from a wild type isolate of *Trichoderma harzianum.*

ED_{50} Values for radial growth:

ED_{50} values (Table 2) for radial growth of *Trichoderma harzianum* indicated maximum tolerance *Trichoderma harzianum* for metalaxyl MZ at 2553 µg ml^{-1}. it was followed by triadimefon 1551 µg ml^{-1}, prochloraz 34 µg ml^{-1}, propiconazole 29 µg ml^{-1}, penconazole 11 µg ml^{-1} and benomyl 1 µg ml^{-1}.

Sharma *et al.* (2001) [9] reported 1050 and 2392 µg ml^{-1} as ED_{50} and ED_{90} values of metalxyl MZ for radial growth of *Trichoderma harzianum* respectively. While Vijji (1997) [10] found 2.0 µg ml^{-1} as ED_{50} value for MBC fungicides i.e. benomyl and carbendazim against *Trichoderma harzianum*, *Trichoderma longibrachiatum* and *Gliocladium virens*

Conclusions

From these studies it can be calculated that metalaxyl MZ was found to be least toxic and safer fungicide for growth of *Trichoderma harzianum* while benomyl was found highly toxic among all the fungicides tested.

Table 2: ED_{50} values at systemic fungicides against *Trichoderma harzianum*

Sr. No.	Fungicides	ED_{50} for radial growth (µg ml^{-1})
1	Benomyl (Benlate)	1
2	Metalaxyl MZ (Ridomil MZ)	2553
3	Penconazole (Topas)	11
4	Prochloraz (Octave)	34
5	Propiconazole (Tilt)	29
6	Triademefon (Bayleton)	1531

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