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Effect of pesticides on biocontrol potential of *Trichoderma*

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The effect of various pesticides on six strains/species of *Trichoderma* have been studied of the six strains of *Trichoderma* H-14 (S), Panna, Mush-T and H-19(RDVV) were found to tolerate fytolan. All the strains tolerated dithane M-45 except Mush-T in which no growth occurred. Thiram inhibited growth and sporulation of all the strains. Vitavax also inhibited growth of all the strains. Carbendazim checked the growth of *Trichoderma* strains completely. All the strains except Mush-T were found to tolorate all the insectices except carbosulfan. Monocrotophos also found to tolerate all the insecticides except carbosulfan. Monocrotophos also found to tolerte all the strains of *Trichoderma*. Except H-14(S) and Mush-T, all the remaining strains to *Trichoderma* were found to tolerate the insecticides, endosulfan and trizophos. The H-19 (RDVV), Soil-T and G strains of *Trichoderma* were found to tolerate Cypermethrin while in dimethoate, except Mush-T, all the remaining strains were found to tolerate the insecticide. Of the seven herbicides tested, all the strains of *Trichoderma* were found to tolorate persuit. The strains were found to tolerate whipsuper and kloben H-19 (RDVV), Soil-T and G strains. While all the remaining herbicides namely isoproturon, diuron, stomp, basalin, metolachlor, lasso and machete were found to inhibit growth of all the strains of *Trichoderma*.

Key words : *Trichoderma*, biopesticides, factors affecting biopesticide

INTRODUCTION

Trichoderma has been shown to be potential biocontrol agent and has been widely used in biological control of several plant disease (Papavizas, 1985 ; Chet, 1987, Samules, 1996, Cooke and Baker 1986). But various factors affect the efficacy of *Trichoderma* based pesticide, hence the results in field are not uniform. In view of this the varibality of *Trichoderma* strain species have been tested *in vitro* against various pesticides such as fungicids, insecticides and herbicides to observe their effect on growth and sporulation of *Trichoderma*.

MATERIALS AND METHODS

In vitro testing of strains was done by growing 24/ isolates/strains on potato dextrose medium. Of these 6 isolates/strains of the fungus like H-14, H-19, Panna, Mush-T, Soil-T and G, were selected as these are good sporulating and show varying growth behaviour in culture. The desired quantities of various pesticides (5 : fungicides, 6 : insecticides ; 10 herbicides) were added in the previously molten potato dextrose agar (PDA) medium. The inoculation was done with the 5 mm disc of the selected strains of the *Trichoderma* and these plates were incubated at 25° ± 2 and observations were recorded at 5th and 10th day of inoculation.

RESULTS AND DISCUSSION

Trichoderma has been shown to be potential biocontrol agent and has been widely used in biological control of several plant diseases (Papavizas, 1985 ; Chet, 1987 ; Samules, 1996) but

various factors affect the efficacy of *Trichoderma* based pesticides. The common agrochemicals are directly or indirectly affect the efficacy of *Trichoderma* based biopesticides.

Effect of Fungicides

Integrated seed treatment (IST) with chemical and compatible antagonists not only protects the seeds and seedlings from soil borne inoculum but also provides protection from seed borne inoculum. Compatible fungicides are therefore essential for IST. Considering this different fungicides at 50% concentration of their recommended dose were evaluated against six strains of *Trichoderma* to find out the adverse effect of fungicides. (Table 1 and 2).

Table 1 : Effect of fungicides on sporulation of *Trichoderma* on 5th day

Trichoderma strains	Control	Fytolan	Dithane M-45	Thiram	Vitavax	Bavistin
	S*	S*	S*	S*	S*	S*
H-14(S)	+++	+	–	–	–	–
H-19(RDVV)	+++	–	+	–	–	–
Panna	+++	++	–	–	–	–
Mush-T	++	++	–	–	–	–
Soil-T	+++	–	–	–	–	–
G	+++	–	–	–	–	–

Table 2 : Effect of fungicides on sporulation of *Trichoderma* on 10th day

Trichoderma strains	Control	Fytolan	Dithane M-45	Thiram	Vitavax	Bavistin
	S*	S*	S*	S*	S*	S*
H-14(S)	+++	+++	+	+	–	–
H-19(RDVV)	+++	–	+++	+	–	–
Panna	+++	+++	+++	+	–	–
Mush-T	+++	+++	–	–	–	–
Soil-T	+++	–	+++	–	–	–
G	+++	–	+++	+	+	–

– = Nil, + = Poor, ++ = Medium, +++ = Good
S = Sporulation
* = Average of 3 replications

Of the fungicides tested, fytolan was found to inhibit mycelial growth and sporulation of all the strains on 5th day but on 10th day, it showed no inhibition in H-14(S), Panna and Mush-T strains. These strains may be adaptive to the chemical. This result is in agreement with Karunanithi and Usman (1999) who showed soil drenching with copperoxychloride supported the survival and competitive saprophytic ability of *Trichoderma viride*. Sharma and Mishra (1995) reported Blitox-50 reduced population of antagonistic fungi by 50 per cent @ 500 ppm. H-19 (RDVV) strain also tolerate the fungicide but sproulation was inhibited completely whereas inhibition of growth and sporulation was observed in Soil-T and G.

In dithane M-45, no inhibition of growth were observed in H-19 (RDVV) and G strains of *Trichoderma* while H-14(S), Panna and Soil-T strains were inhibited by the fungicide whereas no growth occurred in Mush-T on 5th day. But on 10th day, no inhibition were observed in five stains. These strains may show resistance to the fungicide. The growth the completely inhibited in Mush-T on 5th and 10th day. This result is in aggrement with Gupta *et al.*, (1995) who showed inhibition of *Trichoderma* species by dithane M-45 at 500 ppm.

Thiram inhibited growth and sporulation of all the strains of *Trichoderma* on 5th and 10th day. This result confirms the findings of Richardson (1954) who showed thiram had selective effect on *Trichoderma* in thiram treated soil. Sharma and Mishra (1995) reported that thiram was highly inhibitory even at lower doses to *Trichoderma* spp. Gupta *et al.* (1995) showed inhibition of *Trichoderma* species by thiram at 500 ppm. Karunanithi and Usman (1999) reported marked reduction of the survival and competitive saprophytic ability of *Trichoderma viride* by thiram. Dubey and Patel (2001) reported that thiram, at different concentrations such as 0.2, 0.1, 0.05, 0.02 and 0.01% significantly inhibited the radial growth of *Trichoderma viride*. On the contrary, Singh *et al.*(1995) observed that thiram was less inhibitory to *Trichoderma harzianum*.

In vitavax, no growth occurred in H-14(S), H-19(RDVV), Panna and Mush-T while it was inhibited in soil-T and G aon 5th day whereas on 10th day also no growth occurred in H-14(S) and Mush-T strains while it was inhibited in the remaining strains of *Trichoderma*. This result is in agreement with findings of Dubey and Patel (2001) who reported that vitavax inhibited cent percent radial growth of *Trichoderma viride* at 0.2 and 0.1% concentration. On the country, Mukhopadhyay

et al. (1992) reported the insensitivity of *Trichoderma* species against carboxin. Selvakumar *et al.* (2002) reported that TV 5-2 isloate a radiated mutant of *Trichoderma viride* could tolerate upto 50 aeg/ml of carboxin.

Bavistin checked the growth of all strains completely on 5th and 10th day. The result confirms the findings of Viji *et al.* (1997) who found cerbendazim to be toxic to *Trichoderma* sp. Dubey and Patel (2001) reported that carbendazim checked the growth the *Trichoderma viride* completely at 0.2, 0.1, 0.05, 0.02 and 0.01 per cent concentraion. On the contrary, Alagarsamy and Sivaprakasam (1988) showed carbendazim had not adverse effect on *T. viride* and *T. harzianum in vitro* or in pot cultures. Vyas (1994) reported that carbendazim together with *T. viride* and *T. harzianum* reduced dry root of soybean in field condition. Karunanithi and Usman (1999) reported soil drenching with carbendazim had an intermidate effect on the survival and competitive saprophytic ability of T. *viride*.

In the above fungicides inhibition of the strains of *Trichoderma* may be because of the sensitive nature of the strains and also due to different chemical nature of the fungicides.

Effect of Insecticides

Insecticides play an important role in high crop productivity management system. Sometimes most of the insecticides after its application wash off due to rain in the soil and it may affects the soil populatin densities of *Trichoderma*. By considering this concept, six insecticides viz., carbosulfan, monocrotophos, endosulfan, trizophos, cypermethrin and dimethoate were evaluated *in vitro* at 50% concentration of their recommended dose against six strains of *Trichoderma* (Table 3 and 4).

Of the insecticides tested, carbosulfan inhibited growth and sporulation of all the strains of *Trichoderma* on 5th day. Whereas, on 10th day except Mush-T, all five strains found to tolerate the insecticide. In monocrotophos, no inhibition was observed in five strains while it inhibited growth and sporulation of Mush-T on 5th day while all the strains while in inhibited growth and sporulation of Mush-T on 5th day while all the strians found to tolerate the insecticide on 10th day. Endosulfan inhibited growth and sporulation of all the strains of *Trichoderma* on 5th day. Endosulfan inhibited

Table 3 : Effect of Insecticides on sporulation of *Trichoderma* on 5th day

Trichoderma strains	Control	Carbo-sulfan	Mono-crotophos	Endo-sulfan	Trizo-phos	Cyper-methrin	Di-methoate
	S*	S*	S*	S*	S*	S*	S*
H-14(S)	+++	+++	+++	+	++	+++	++
H-19(RDVV)	+++	–	+++	++	++	+++	+++
Panna	+++	++	+++	+	+++	+++	+++
Mush-T	+++	+	++	–	–	++	+
Soil-T	+++	++	+++	–	+	+++	+
G	+++	–	+++	++	++	++	++

Table 4 : Effect of Insecticides on sporulation of *Trichoderma* on 10th day

Trichoderma strains	Control	Carbo-sulfan	Mono-crotophos	Endo-sulfan	Trizo-phos	Cyper-methrin	Di-methoate
	S*	S*	S*	S*	S*	S*	S*
H-14(S)	+++	+++	+++	+++	+++	+++	+++
H-19(RDVV)	+++	+++	+++	+++	+++	+++	+++
Panna	+++	+++	+++	+++	+++	+++	+++
Mush-T	+++	++	+++	+	+	+	+++
Soil-T	+++	+++	+++	+++	+++	+++	+++
G	+++	+++	+++	+++	+++	+++	++

S = Sporulation
– = Nil, + = Poor, ++ = Medium, +++ = Good
* = Average of 3 replications

growth and sporulation of all the strains of *Trichoderma* on 5th day while except H-14(S) and Mush-T, all the remaining strains of *Trichoderma* found to tolerate the insecticide. In trizophos, no inhibition was observed in Panna strain while all the remaining strains were inhibited by the insecticide on 5th day. Whereas, except H-14(S) and Mush-T, all the remain strains found to tolerate the insecticide on 10th day. On 5th and 10th day, no inhibition of growth and sporulation of H-19 (RDVV), Soil-T and G was observed in cypermethrin while the insecticide inhibited growth and sporulation of all the remaining strains of *Trichoderma*. In dimethoate, no inhibition was observed in H-19 (RDVV) and Soil-T, while all the strains ws found to tolerate the insecticide. No inhibition was observed in most of the strains of

Trichoderma on 10th day. This may be because of the adapted resistance towards the insecticides and the inhibition may be due to the sensitive nature of the strains to the different chemical nature of the insecticides.

Specfic reviews of above insecticides are not available but Das and Mukherjee (2000) showed stimulation of growth and sporulation of *Trichoderma* by some of the insecticides tested such as HCH, phorate, carbofuran and fenvelrate while Omar and Abd-Alla (2000) reported some inhibition to enzyme activity of *Trichoderma koningii* at 50 ppm by insecticide kelthane and fenvelrate.

Effect of Herbicides

Noxious weeds interfere with crop plants and leads to low productivity. Now a days, herbicides are widely used in crop plants for eradicating the noxious weeds, but at the same time many herbicides persist in the soil and this many affects soil microflora. Considering this view, herbicides were evaluated *in vitro* at 50% concentration of their recommended dose against six strain of *Trichoderma* (Table 5-12).

Table 5 : Effect of herbicides on sporulation of *Trichoderma* on 5th day

Trichoderma strains	Control	Persuit	Whipsuper	Kloben
	S*	S*	S*	S*
H-14(S)	+++	+++	++	–
H-19(RDVV)	+++	+++	+++	–
Panna	+++	+++	+++	–
Mush-T	+++	+++	++	++
Soil-T	++	+	–	–
G	+++	+++	++	+

Table 6 : Effect of herbicides on sporulation of *Trichoderma* on 10th day

Trichoderma strains	Control	Persuit	Whipsuper	Kloben
	S*	S*	S*	S*
H-14(S)	+++	+++	+++	–
H-19(RDVV)	+++	+++	+++	++
Panna	+++	+++	+++	–
Mush-T	+++	+++	+++	+++
Soil-T	+++	+++	++	–
G	+++	+++	+++	+++

– = Nil, + = Poor, ++ = Medium, +++ = Good, S = Sporulation, * = Average of 3 replications, . = Assuming as 50% WP

Table 7 : Effect of herbicides on sporulation of *Trichoderma* on 5th day

Trichoderma strains	Control	Diuron	Isoproturon	Stomp
	S*	S*	S*	S*
H-14(S)	+++	++	++	–
H-19(RDVV)	+++	++	+	–
Panna	+++	++	++	–
Mush-T	+++	+	+	–
Soil-T	++	+	–	–
G	+++	+	+	–

Table 8 : Effect of herbicides on sporulation of *Trichoderma* on 10th day

Trichoderma strains	Control	Diuron	Isoproturon	Stomp
	S*	S*	S*	S*
H-14(S)	+++	+++	+++	–
H-19(RDVV)	+++	+++	+++	+
Panna	+++	+++	+++	+
Mush-T	+++	+++	+++	–
Soil-T	+++	++	++	–
G	+++	+++	+++	++

– = Nil, + = Poor, ++ = Medium, +++ = Good
S = Sporulation
* = Average of 3 replications

Table 9 : Effect of herbicides on sporulation of *Trichoderma* on 5th day

Trichoderma strains	Control	Basalin	Metolachlor	Lasso
	S*	S*	S*	S*
H-14(S)	+++	+	+	+
H-19(RDVV)	+++	+	+	–
Panna	+++	+	+	+
Mush-T	+++	–	–	–
Soil-T	++	–	–	–
G	+++	+	+	+

Table 10 : Effect of herbicides on sporulation of *Trichoderma* on 10th day

Trichoderma strains	Control	Basalin	Metolachlor	Lasso
	S*	S*	S*	S*
H-14(S)	+++	++	+	+
H-19(RDVV)	+++	++	+	+
Panna	+++	+	–	+
Mush-T	+++	–	–	–
Soil-T	+++	–	–	–
G	+++	+	–	++

– = Nil, + = Poor, ++ = Medium, +++ = Good
S = Sporulation
* = Average of 3 replications

Table 11 : Effect of herbicides on sporulation of *Trichoderma* on 5th day

Trichoderma strains	Control	Machete
	S*	S*
H-14(S)	+++	+
H-19(RDVV)	+++	+
Panna	+++	+
Mush-T	+++	–
Soil-T	+++	–
G	+++	–

Table 12 : Effect of herbicides on sporulation of *Trichoderma* on 10th day

Trichoderma strains	Control	Machete
	S*	S*
H-14(S)	+++	+++
H-19(RDVV)	+++	+++
Panna	+++	+++
Mush-T	+++	+++
Soil-T	+++	+
G	+++	+++

– = Nil, + = Poor, ++ = Medium, +++ = Good
S = Sporulation
* = Average of 3 replications

Of the herbicides tested, persuit was found to tolerate all the strains of *Trichoderma* on 5th and 10th day. Whipsuper inhibited growth and sporulation of all the strains on 5th day but on 10 day it was found to tolerate H-19 (RDVV), Soil-T and G while the weedicide inhibited growth and sporulation of H-14(S), Panna and Mush-T strains of *Trichoderma*. In Kloben, no growth was occurred in H-14(S) and Mush-T strains while it inhibited growth and sporulation of remaining strains of *Trichoderma* pm 5th day. On 10th day no growth was occurred in Mush-T strain while the weedicide found to tolerate H-19(RDVV), Soil-T and G and it inhibited growth of all the remaining strains of *Trichoderma*. Isoproturon as 50% WP and 75% WP, inhibited the growth of all strains of *Trichoderma* on 5th and 10th day. Diuron also inhibited growth and sporulation of all the strains on 5th day while on 10th day in inhibited only growth of all the strains. Manish Sushir and Pandey (2001) reported diuron was found safer upto 1000 $\mu g\ ml^{-1}$ concentration wherein growth inhibition of *Trichoderma harzianum* ws 43.33 per cent. In stomp, no growth was occurred in Mush-T, while the growth of all the strains were inhibited on 5th and 10th day. The result confirms the findings of Sharma and Mishra (1995) who showed pendimethalin was toxic to *Trichoderma* sp. the contradictory results were given by Ruppel *et al.* (1988) who reported pendimethalin had no detectable effect on soil population densities of *Trichoderma* in field study. Tripathi *et al.* (1993) reported that, in field trials, application of pendimethalin at 0.5 kg/ha + 1 hand weeding stimulatd the growth of *Trichoderma harzianum* in green peas. Basalin inhibited growth and sporulation of all the strains of *Trichoderma* on 5th and 10th day. The result is in accordance with Sharma and Mishra (1995) who reported fluchloranil was toxic to *Trichoderma* sp. Metolachlor also inhibited growth and sporulation of all the strains fo *Trichoderma* on 5th and 10th day. Lasso was also found to inhibit the growth and sporulation of all the strains of *Trichoderma*. This result confirms the findings of Abdel Mallek *et al.* (1994) who showed alachlor at 100, 500 and 1000 mg/1 reduced the radial growth of *Trichoderma harzianum* in pure culture experiment. Mechete was also found to inhibit redial growth of all the strains of *Trichoderma* on 5th and 10th day. This result confirms the findings of Sushir and Pandey (2001) who reported mechete was most toxic weedicide to *Trichoderma harzianum* at 125 $\mu g\ ml^{-1}$. The inhibition of *Trichoderma* strains may be due to the sensitive nature of the strains towards different chemical nature of the weedicides.

Many workers reviewed effect of herbicides on growth of *Trichoderma* : Ruppel *et al.* (1988) showed minimum, moderate and intensive use of the herbicides cyanazine, desmedipham, dicamba, EPTC, ethofumesate, phenmediapham, trifluralin and 2, 4-D amine had no detectable effect on soil population densities of *Trichoderma* in field study. Abdel Mallek *et al.* (1994) reported haloxyfop at 100, 500 and 1000 ml/1 reduced the radial growth of *Trichoderma in vitro.* Ciraj (1996) reported that sulfonylurea based herbicides (rimsulfuron, thifensulfuron, primisulfuron) had no statistically significant negative effect on *Trichoderma* and in some conditions they stimulated the growth of the fungi and also showed at different concentration atrazine inhibited growth of *Trichoderma in vitro.* Wachowsha (1998) reported fungistatic activity of

glyphosate against *Trichoderma hamatum* tested *in vitro*. Wachowska *et al.* (1999) showed that roots of grasses previously treated with glyphosate showed domination by *Trichoderma in vitro*.

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