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Sensitivity of some Fusarium species to fungicides and Trichoderma isolates

Soad M. Ahmed* and Amal A. H. Hemada**

* Pesticide Chemistry Dept., Fac. of Agric. (Elshatby), Alex. Univ. Egypt

** Plant Pathology Dept., Fac. of Agric. (Elshatby), Alex. Univ. Egypt

ABSTRACT

Three laboratory experiments were done in order to assess the effectiveness of both most commonly used fungicides and Trichoderma isolates against pathogenic *Fusarium spp.*, as well as the interaction between fungicides and Trichoderma isolates. In the first one: Eighteen of commonly used fungicides as chemical control for Fusarium diseases (thiabendazole, thiophanate-methyl, imazalil, monceren, carboxin, vitavax-200, vitavax-300, captan, tolclofos-methyl, triadimefon, penconazole, propiconazole, hexaconazole, mancozeb, ridomil MZ, ridomil plus, iprodione and homai) were evaluated against eight species of Fusarium which cause Fusarium diseases of different legumes (*Fusarium oxysporum f.sp. phaseoli*, *F. solani f.sp.phaseoli* from bean seeds "F1, F2"; *F. oxysporum f.sp lupini*, *F. solani f.sp.lupini* from lupine seeds "F3, F4"; *F. oxysporum f.sp ciceris*, *F. solani f.sp ciceris* from chickpea seeds "F5, F6" and *F. monliforme*, *F. solani* from cowpea seeds "F7, F8"). The results in this part showed that Imazalil was extremely highly effective fungicide since the EC_{50} values for all tested Fusarium species were ranged from less than 0.1 $\mu g\ ml^{-1}$ to 0.22 $\mu g\ ml^{-1}$. Thiabendazole, homai, and thiophanate-methyl were highly effective fungicides with EC_{50} values less than 10$\mu g\ ml^{-1}$ (0.03 $\mu g\ ml^{-1}$ for thiabendazole against F2 and 6.05 $\mu g\ ml^{-1}$ for homai against f7), and generally we can arrange the eight species of Fusarium according to their sensitivity to the tested fungicides in ascending order as follows: F1, F8, F4, F2, F6, F5, F3, and F7. In the second part of work: efficacy of biological antagonists was studied by using twenty four isolates of Trichoderma against the eight species of Fusarium, and we found that most of the Trichoderma isolates had antagonistic effect against most of the tested Fusarium species. Finally we examined the most effective tested fungicides against the most antagonists of Trichoderma against Fusarium species. The data revealed that most of Trichoderma isolates are insensitive (tolerant) than fungi of *Fusarium spp.* to all the tested fungicides. Imazalil was the most suitable fungicide because it was highly effective fungicide against Fusarium species (pathogenic fungi), while the Trichoderma (non pathogenic fungi) are insensitive to it without any exceptions, followed by thiabendazole with only one exception.

Keywords: Fusarium species, Fungicides, Trichoderma isolates, Antagonistic activity.

INTRODUCTION

Seeds of bean (*Phaseolus vulgaris L.*), cowpea (*Vigna sinensis Erdl*), chickpea (*Cicer arientinum L*) and lupine (*Lupinus termis L*) remain as important part of diet for both humans and animals in Egypt.

Different fungal species were reported as seed borne pathogens on legumes which causes different types of diseases and the major type of these pathogens is Fusarium i.e. *Fusarium oxysporum f.sp. lupini* (Morkunas *et al.*, 2004 & Morkunas *et al.*, 2005), *Fusarium acutatum* (Gopalakrishnan *et al.*, 2005), *Fusarium oxysporum f.sp ciceris* (Kaur and Mukhopadhyay, 1992; Hervas *et al.*, 1998 and Cho and Muehlbauer, 2004) and *Fusarium solani f.sp. phaseoli* (Estevez *et al.*, 2001).

Trichoderma spp. as *T. harzianum* and *T. Viride* are filamentous soil fungi and thev are present in substantial numbers in nearly all agricultural soil. Their mycoparasitism involves a complementary action of antibiosis, nutrient competition and cell wall degradion of the target fungi (Viterbo *et al.*, 2001). Trichoderma have been investigated extensively as bio-control agent of several plant pathogenic fungi especially *Fusarium spp. in vitro* and *in vivo* in legumes as chickpea (Kaur and Mukhopadhyay, 1992); cowpea (Ushamalini *et al.*, 1997) and bean (Estevez *et al.*, 2001).

We realize that *in vitro* screening with our arbitrary rating system for integrated control including chemical control with fungicides and biological effective antagonists against soil borne plant pathogens especially *Fusarium spp.* is a simplistic approach to understanding a small sector for integrated control systems in disease control. So this research aimed to find out one or more fungicide possess high potential fungicidal property against the pathogenic fungi (*Fusarium spp.*) meanwhile the non-pathogenic fungi (*Trichoderma spp.*) is insensitive or tolerant toward them.

MATERIALS AND METHODS

1- Source of isolates

a- Fungi

The tested eight species of fungi were isolated, purified and then identified in the Department of Plant Pathology, Faculty of Agriculture, Alexandria University, Egypt and in Agriculture Research Center, Ministry of Agriculture, Cairo, Egypt as follow: F1: *Fusarium oxysporum f.sp.phaseoli* and F2: *Fusarium solani f.sp. phaseoli* from bean seeds, F3: *Fusarium oxysporum f.sp. lupini* and F4: *Fusarium solani f.sp. lupini* from lupine seeds, F5: *Fusarium oxysporum f.sp ciceris* and F6: *Fusarium solani f.sp ciceris* from chickpea seeds, F7: *Fusarium monliforme* and F8: *Fusarium solani* from cowpea seeds.

b- Trichoderma

Trichoderma isolates were isolated from diseased plants as follow: isolates No. 1 to 6 from bean, 7 to 13 from lupine, 14 to 21 from chickpea and isolates No. 22 to 24 from cowpea.

2- Fungicides used

Eighteen different commonly used fungicides are: thiabendazole, thiophanate-methyl, imazalil, monceren, carboxin, vitavax-200, vitavax-300, captan, tolclofos-methyl, triadimefon, penconazole, propiconazole, hexaconazole, mancozeb, ridomil MZ, ridomil plus, iprodione and homai.

3- Antifungal assay

a- against *Fusarium spp*

The antifungal activity of eighteen common fungicides against eight species of Fusarium was tested using the radial growth technique method (Zambonelli *et al.*, 1996). Appropriate volumes of the stock solutions of the tested fungicides were added to molten potato dextrose agar (PDA) media to obtain a range of concentrations (0.1, 1, 5, 10, 100, 1000 $\mu g\ ml^{-1}$) immediately before pouring into the Petri dishes (9.0 cm diameter) at 40-45 °C. Each concentration was tested in triplicate and all the experiment was repeated twice. The discs of mycelial felt (0.5 cm diameter) of the tested pathogenic fungi, (eight species of *Fusarium*) or non-pathogenic fungi (four isolates of *Trichoderma*) taken from 8-day-old cultures on PDA plates, were transferred aseptically to the centre of Petri dishes. The treatments were incubated at 25 °C in the dark. Colony growth diameter was measured after the fungal growth in the control treatments (without any fungicides) had completely covered the Petri dishes. Percentage of mycelial growth inhibition was calculated from the formula: Mycelial growth inhibition = $[(DC-DT)/DC] \times 100$ (Pandey *et al.*, 1982), where DC and DT are average diameters of fungal colony of control and treatment, respectively. The concentration of the fungicide that inhibiting the mycelial growth by 50 % (EC_{50}), was determined by a linear regression method, (Finney, 1971).

b- against Trichoderma isolates

The most effective fungicides (thiabendazole, thiophanate-methyl, imazalil, vitavax-200 and homai) were evaluated against four Trichoderma isolates (the most antagonistic isolates "one for each plant": T5, T12, T18 and T22) using the previously mentioned method. EC_{50} values were calculated and the relative effectiveness was expressed as tolerance or insensitivity. This parameter (tolerance or sensitivity) was estimated by dividing the EC_{50} of fungicide against Trichoderma over EC_{50} of fungicide against fungi.

4- Antagonistic activity

Agar discs, 7mm diam., taken from the growing margin of the pathogen and Trichoderma isolates were transferred on malt extract agar (MEA) medium (17 %) in 9 cm diameter Petri dishes, containing 10 ml. medium. Inocula of antagonists and tested fungi were plated on the opposite sides on the surface of MEA medium and incubated at 25 - 27 °C. Five replicates per each treatment were prepared. Degree of antagonism was scored according to Bell *et al.*, (1982) using a scale from 1 – 5 classes as the following: class1: Trichoderma completely overgrew the pathogen and covered the entire medium surface, class 2: Trichoderma overgrew at least two – thirds of medium surface, class 3: Trichoderma and the pathogen each colonized approximately one – half of the medium surface (more than one – third and less than two – thirds) and neither organism appeared to dominate the other, class4: The pathogen colonized at least two – thirds of the medium surface and appeared to withstand encroachment by Trichoderma, and class 5: the pathogen overgrew the Trichoderma and occupied the entire medium surface.

RESULTS AND DISCUSSIONS

Fungicidal activity against *Fusarium spp.*

The activities of the tested fungicides in terms of radial growth inhibition are summarized in Table (1). Imazalil is extremely highly effective fungicide since the EC_{50} values of it against all tested species of Fusarium was less than 1µg ml^{-1} and these values ranged from less than 0.1µg ml^{-1} to 0.22 µg ml^{-1}. Thiabendazole, homai, and thiophanate methyl were highly effective fungicides and arranged after imazalil in their effectiveness with EC_{50} less than 10 µg ml^{-1} (0.03 µg ml^{-1} for thiabendazole against F2 and 6.05µg ml^{-1} for homai against F7). This result is in agreement with the finding of Ilyas *et al.*, (1992) who found that Thiophanate-methyl was effective against F*usarium oxysporum f.sp ciceris.*

Triazole fungicides include propiconazole, hexaconazole and penconazole were ranged from extremely highly effective to effective fungicides with EC_{50} value equal to 0.06µg ml^{-1} for penconazole against F4 and 33.21µg ml^{-1} for propiconazole against F7, concerning to the activity of propiconazole against *Fusarium spp.* of chickpea. The obtained data are coincide with Ilyas *et al.*, (1992). Triadimefon as triazole fungicide arrange in the order thirteen in the effectiveness since the EC_{50} value reached to more than 1000µg ml^{-1} in most cases except against *Fusarium solani* of cowpea (F8) it was 0.91µg ml^{-1}. The formula of carboxin with captan (vitavax-300) and thiram (vitavax-200) were moderately effective fungicides (EC_{50} values ≤100µg ml^{-1} in most cases) while carboxin alone was non effective fungicide with EC_{50} value reached to ≥ 1000µg ml^{-1} in many cases, and this was the same which found by Estevez *et al.*, (2001) using captan and vitavax-200 against *Fusarium solani f.sp. phaseoli*. We can arrange the remaining fungicides according to their effectiveness in descending order as follow: Iprodione, ridomil plus, mancozeb, monceren, tolclofos-methyl, ridomil MZ and captan. Our data for Tolclofos-methyl is

Table (1): Fungicidal Activity of tested fungicides against different Fusarium species.

Fungicides	F1	F2	F3	F4	F5	F6	F7	F8
	EC_{50} ($\mu g\ ml^{-1}$)							
Thiabendazole	1.58(B)	0.03(A)	1.43(B)	0.44(A)	3.81(B)	0.47(A)	2.03(B)	0.22(A)
Thiophanate- methyl	2.43(B)	3.48(B)	1.12(B)	2.56(B)	4.67(B)	0.52(A)	3.34(B)	4.48(B)
Imazalil	≤0.1(A)	≤0.1(A)	0.14(A)	≤0.1(A)	0.17(A)	0.22(A)	≤0.1(A)	≤0.1(A)
Monceren	43.25(C)	12.74(C)	≥1000(E)	8.57(B)	≥1000(E)	84.45(C)	≥1000(E)	87.94(C)
Carboxin	14.05(C)	100.00(C)	556.31(D)	101.97(D)	153.31(D)	≥1000(E)	≥1000(E)	≥1000(E)
Vitavax 200	3.07(B)	0.92(A)	8.46(B)	1.48(B)	12.74(C)	2.11(B)	12.93(C)	1.32(B)
Vitavax 300	6.70(B)	5.39(B)	17.56(C)	7.24(B)	25.00(C)	31.77(C)	36.12(C)	6.21(B)
Captan	33.15(B)	≥1000(E)	≥1000(E)	648.81(D)	≥1000(E)	188.25(D)	≥1000(E)	≥1000(E)
Tolclofos-methyl	≥1000(E)	3.10(B)	≥1000(E)	2.32(B)	≥1000(E)	7.33(B)	≥1000(E)	75.47(C)
Triadimefon	17.40(C)	15.26(C)	422.89(D)	13.70(C)	9.91(B)	226.56(D)	≥1000(E)	0.91(A)
Penconazole	0.26(A)	0.13(A)	31.13(C)	0.06(A)	23.96(C)	12.66(C)	31.46(C)	0.09(A)
Propiconazole	0.08(A)	0.23(A)	3.73(B)	0.13(A)	5.33(B)	18.53(C)	33.21(C)	0.21(A)
Hexaconazole	0.50(A)	3.70(B)	14.02(C)	1.80(B)	2.77(B)	6.12(B)	20.65(C)	0.11(A)
Mancozeb	0.08(A)	279.76(D)	167.45(D)	2.74(B)	43.67(C)	0.59(A)	119.05(D)	4.27(B)
Ridomil MZ	7.73(B)	486.76(D)	152.07(D)	17.84(C)	87.17(C)	899.34(D)	353.96(D)	17.98(C)
Ridomil plus	0.42(A)	75.14(C)	47.11(C)	16.65(C)	140.07(D)	1.22(B)	703.48(D)	11.54(C)
Iprodione	31.72(C)	66.04(C)	16.41(C)	36.27(C)	52.86(C)	5.50(B)	0.68(A)	4.66(B)
Homai	2.45(B)	0.77(A)	2.10(B)	1.27(B)	3.20(B)	0.48(A)	6.05(B)	3.50(B)

F1: *Fusarium oxysporum f.sp. phaseoli* (Bean)
F2: *Fusarium solani f.sp. phaseoli* (Bean)
F3: *Fusarium oxysporum f.sp. lupini* (Lupine)
F4: *Fusarium solani f.sp. lupini* (Lupine)
F5: *Fusarium oxysporum f.sp.ciceris* (Chickpea)
F6: *Fusarium solani f.sp.ciceris* (Chickpea)
F7: *Fusarium moniliforme* (Cowpea)
F8: *Fusarium solani* (Cowpea)

A: Exteremly highly effective fungicide ($EC_{50} \leq 1\ \mu g\ ml^{-1}$)
B: Highly effective fungicide ($EC_{50} \leq 10\ \mu g\ ml^{-1}$)
C: Effective fungicide ($EC_{50} \leq 100\ \mu g\ ml^{-1}$)
D: Less effective fungicide ($EC_{50} \leq 1000\ \mu g\ ml^{-1}$)
E: Non effective fungicide ($EC_{50} \geq 1000\ \mu g\ ml^{-1}$)

in-contrast with the finding of Ilyas *et al.*, (1992). Also, from Table (1), we can arrange the eight species of Fusarium according to their sensitivity to the tested fungicides in ascending order as follow: F1, F8, F4, F2, F6, F5, F3, and F7. The obtained results are supported by many researches of many authors who used our fungicides against another *Fusarium spp.* (Buchvarova *et al.*, 1989; Champawat and Pathak, 1991; Gopinath and Shetty, 1992; Vuksa *et al.*, 1994; Allen, *et al.*, 2004 and Raja *et al.*, 2004).

Antagonistic activity

Interactions between isolates of Trichoderma and Fusarium species were recorded (Table 2). Antagonism was not apparent against F2 and F1 (rating $\geq$ 3), only 50 % of Trichoderma isolates had a high level of antagonism (rating $\leq$ 2). Hundred percentages of isolates of Trichoderma were antagonistic against F4 and 57 % against F3 and the remaining isolates rated $\geq$3. One hundred percent and 37.5 % of Trichoderma isolates appeared to be antagonistic against F6 and F5, respectively. Only one isolate of Trichoderma was non antagonistic against F8, but the remaining isolates were antagonistic to F8 and F7. Concerning to the antagonistic activity of Trichoderma isolates, our data are supported by Thangavelu *et al.*, (2004) who found that *Trichoderma harzianum* was effective in inhibiting the growth of Fusarium *in vitro*; Estevez *et al.*, (2001) who found that *Trichoderma harzianum* was effective against *Fusarium solani f.sp. phaseoli.*; Hervas *et al.*, (1998) showed that *Trichoderma harzianum* effectively suppress wilt disease of chickpea caused by *Fusarium oxysporum f.sp. ciceris* and Kaur and Mukhopadyay (1992) who demonstrated that the chickpea wilt complex caused by several soil borne fungi including *Fusarium oxysporum f.sp. ciceris* was effectively controlled by *Trichoderma harzianum.*

Table (2): Effectiveness of Trichoderma isolates against Fusarium species.

Trichoderma isolates	F1	F2	F3	F4	F5	F6	F7	F8
T1	Class 3	Class 3	-	-	-	-	-	-
T2	Class 3	Class 3	-	-	-	-	-	-
T3	Class 3	Class 3	-	-	-	-	-	-
T4	Class 2	Class 3	-	-	-	-	-	-
T5	Class 1	Class 3	-	-	-	-	-	-
T6	Class1	Class 3	-	-	-	-	-	-
T7	-	-	Class 2	Class 2	-	-	-	-
T8	-	-	Class 3	Class 2	-	-	-	-
T9	-	-	Class 2	Class 2	-	-	-	-
T10	-	-	Class 2	Class 2	-	-	-	-
T11	-	-	Class 3	Class 2	-	-	-	-
T12	-	-	Class 1	Class 2	-	-	-	-
T13	-	-	Class 3	Class 2	-	-	-	-
T14	-	-	-	-	Class 3	Class 1	-	-
T15	-	-	-	-	Class 2	Class 1	-	-
T16	-	-	-	-	Class 3	Class 1	-	-
T17	-	-	-	-	Class 2	Class 1	-	-
T18	-	-	-	-	Class 1	Class 1	-	-
T19	-	-	-	-	Class 3	Class 1	-	-
T20	-	-	-	-	Class 3	Class 1	-	-
T21	-	-	-	-	Class 3	Class 2	-	-
T22	-	-	-	-	-	-	Class 2	Class 1
T23	-	-	-	-	-	-	Class 2	Class 3
T24	-	-	-	-	-	-	Class 2	Class 2

F1: *Fusarium oxysporum f.sp. phaseoli* (Bean)
F2: *Fusarium solani f.sp. phaseoli* (Bean)
F3: *Fusarium oxysporum f.sp. lupini* (Lupine)
F4: *Fusarium solani f.sp.lupini* (Lupine)
F5: *Fusarium oxysporum f.sp. ciceris* (Chickpea)
F6: *Fusarium solani f.sp. ciceris* (Chickpea)
F7: *Fusarium moniliforme* (Cowpea)
F8: *Fusarium solani* (Cowpea)

T1 – T6 : Trichoderma isolated from diseased bean
T7 – T13: Trichoderma isolated from diseased lupine
T14 – T21: Trichoderma isolated from diseased chickpea
T22 – T24: Trichoderma isolated from diseased cowpea

Class 1: Trichoderma compeletely overgrew the pathogen and covered the entire medium surface
Class 2: Trichoderma overgrew at least two – thirds of medium surface
Class 3: Trichoderma and the pathogen each colonized approximately one – half of the medium surface (more than one – third and less than two – thirds) and neither organism appeared to dominate the other.

Effectiveness of the fungicides against trichoderma isolates

The effect of the most effective fungicides against the eight Fusarium species, (thiabendazole, thiophanate-methyl, imazalil, vitavax-200 and homai) are examined against four isolates of Trichoderma (the most antagonistic isolates of Trichoderma "one for each plant ": T5, T12, T18 and T22) using radial growth technique. The obtained data expressed as EC_{50} are shown in Table 3. From the obtained data, it was found that most of Trichoderma isolates are insensitive (tolerant) than F*usarium spp.* to all the tested fungicides. The values of tolerance or insensitivity are shown is Table (4). The insensitivity ranged from 1.41 to 81 for T1; 1.65 to 17.2 for T2; 2.24 to 18.15 for T3 and 1.15 to 7.36 for T4. From Table (4), we can conclude that imazalil is the most suitable fungicide because it is highly

Table (3): Effectiveness of certain fungicides against some Trichoderma isolates

	Tb	Tl	Tch	Tc
Fungicides	EC_{50} (μg ml^{-1})			
Thiabendazole	2.43	2.37	8.53	1.62
Thiophanate-methyl	2.66	2.11	1.07	5.13
Imazalil	1.92	1.78	3.02	0.65
Vitavax 200	4.32	18.95	11.16	5.78
Homai	1.74	1.21	1.97	1.80

Tb (T5) : Trichoderma isolated from bean

Tl (T12) : Trichoderma isolated from lupine

Tch (T18): Trichoderma isolated from chickpea

Tc (T22) : Trichoderma isolated from cowpea

Table (4): Insensitivity (Tolerance) of Trichoderma isolates to fungicides (comparing with Fusarium)

Fungicides	Tb/F1	Tb/F2	Tl/F3	Tl/F4	Tch/F5	Tch/F6	Tc/F7	Tc/F8
Thiabendazole	1.54	81.00	1.65	5.39	2.24	18.15	0.80	7.36
Thiophanate-m	1.09	0.76	1.88	0.82	0.23	2.06	1.54	1.15
Imazalil	19.20	19.20	12.71	17.20	17.76	13.73	6.50	6.50
Vitavax 200	1.41	4.70	2.24	12.8	0.88	5.29	0.45	4.38
Homai	0.71	2.26	0.58	0.95	0.62	4.10	0.30	0.51

T(b,l,ch,c): EC_{50} ($\mu g\ ml^{-1}$) of fungicides against Trichoderma isolates

F(1,2,3,4,5,6,7,8) EC_{50} ($\mu g\ ml^{-1}$) of fungicides against Fusarium species

effective fungicide against Fusarium species (pathogenic fungi) and the four Trichoderma (non pathogenic fungi) are insensitive to it without any exceptions, followed by thiabendazole which had one exception. The data of this point are in agreement with Montealegre and Henriquez (1990); Kay and Stewart (1994) and Figueras *et al.*, (1996).

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حساسية بعض أنواع الفيوزاريم للمبيدات الفطرية وعزلات من فطر الترايكوديرما

د. سعاد محمدين أحمد*- د.أمال على حسن حميدة**
* قسم كيمياء المبيدات – كلية الزراعة (الشاطبى) - جامعة الأسكندرية – مصر.
** قسم أمراض النبات – كلية الزراعة (الشاطبى) – جامعة الأسكندرية – مصر.

تم اجراء ثلاثة تجارب معملية وذلك لتقديركفاءة كل من معظم المبيدات الفطرية الشائعة الأستخدام وكذلك عزلات من الترايكوديرما ضد أنواع من الفيوزاريوم الممرضة، وكذلك التداخل بين المبيدات الفطرية وعزلات الترايكوديرما. ابالنسبة للتجربة الأولى أختصت بتقييم ثمانية عشر مبيد فطرى ذات استخدام شهير فى مكافحة أمراض الفيوزاريم (ثيابندازول، ثيوفينيت-ميثيل، امازاليل، مونسرين، كربوكسين، فيتافكس ٢٠٠، فيتافكس ٣٠٠، كابتان، تولكلوفوس ميثيل، تراى ادميفون، بنكونازول، بروبيكونازول، هكساكونازول، مانكوزيب، ريدوميلMZ، ريدوميل بلس، ايروديون والهوماى) ضد ثمانية انواع من الفيوزاريم والتى تسبب امراض الفيوزاريم للعديد من البقوليات (فيوزاريم اكسىسبورم فاصيولاى، فيوزاريم سولانى فاصيولاى (الفاصوليا) & فيوزاريم اكسىسبورم ليوبناى، فيوزاريم سولانى ليوبناى (الترمس) & (فيوزاريم اكسىسبورم ساسيرس، فيوزاريم سولانى ساسيرس (الحمص) & فيوزاريم مونيليفورم وفيوزاريم سولانى (اللوبيا) F1، F2، F3، F4، F5، F6، F7، F8 على الترتيب. واوضحت النتائج فى هذا الجزء ان مبيد الأمازاليل كان شديد الفعالية على معظم الفطريات المختبرة بقيمة EC_{50} اقل من ١ميكروجرام/مل حيث تراوحت القيمة من٠,١ الى ٠,٢٢ ميكروجرام/مل تلاه فى الفعالية مبيد الثيابندازول، الهوماى والثيوفينيت ميثيل بقيمة EC_{50} اقل من ١٠ ميكروجرام/مل (٠,٠٠٣ ميكروجرام/مل للثيابندازول ضد F2 و٦,٠٠٥ ميكروجرام/مل للهوماى ضد F7). بصفة عامة يمكن ترتيب انواع الفيوزاريم من حيث حساسيتها للمبيدات الفطرية المستخدمة كما يلى:$F7 \leq F3 \leq F5 \leq F6 \leq F2 \leq F4 \leq F8 \leq F1$

بالنسبة للتجربة الثانية وهى عبارة عن دراسة للتأثير البيولوجى المضاد لـ ٢٤ عزلة من الترايكوديرما ضد الثمانية انواع من الفيوزاريم وقد وجد ان معظم تلك العزلات من الترايكوديرما كان لها تأثير مضاد لمعظم انواع الفطريات المستخدمة. وفى النهاية تم اختبار اكثر المبيدات كفاءة ضد انواع الفيوزاريم (من التجربة الأولى) ضد اكثر العزلات من الترايكوديرما تضادا للفطريات (من التجربة الثانية) وقد وجد ان معظم عزلات الترايكوديرما تحت التجربة كانت متحملة عن الفطريات لكل المبيدات الفطرية المختبرة. وان المبيد الفطرى امازاليل هو اكثر المبيدات الفطرية ملائمة حيث انه شديد الفعالية ضد الفيوزاريم (الفطريات الممرضة) بينما كانت الترايكوديرما (الفطريات الغير ممرضة) غير حساسة (متحملة) له، تلاه فى ذلك المبيد الفطرى الثيابندازول.