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FACTORS AFFECTING THE NATURAL OCCURRENCE OF SOME INSECT BIOCONTROL AGENTS IN CULTIVATED SOIL IN ISMAILIA GOVERNORATE

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Abstract

Six hundred forty eight random soil samples from fields cultivated with vegetables, field crops and fruit trees were examined for the occurrence of biocontrol agents of insect pests using *Tenebrio molitor* larvae bait. Such agents are found in 24.07% of the total tested soil samples collected at depths of up to 5.0 cm . Such occurrence is detected in 53.8% of samples from under fruit trees, in 30.8 % of samples under field crops and in only 15.4% of vegetables soil . Entomopathogenic fungi occur at 19.2% and entomoparastic nematodes at 69.78% as an average for five surveyed districts. Other unknown agents also exist in 11.1% of the samples. The fungus *Beauveria bassiana* occurring at 8.4% frequency is found at the five districts except El-Tall El-Kebeer, while *Metarhizium anisopliae* occurring at 10.8% is absent in each of Ismailia and Fayed districts. The entomoparasitic nematodes *Heterorhabditis* spp. accompanied by the fungus *Fusarium* spp. are found at the five districts at an average of 59.7%, while the same species of nematodes accompanied by unidentified bacteria is found at each of Quantara Shark and Ismailia at 10.0%. Other agents are found also in Quantara Gharb and El-Tall El-Kebeer.

Soil type affects bioagents occurrence percentage, but not the occurrence itself. *B. bassiana* is found in high percentage in the soil samples rich in organic matter. The same was recorded with *M. ansopliae* in clay soil. Nematodes are less frequent in clay soil than other types. No relationship between soil chemical composition and the occurrence of the bioagents is noticed.

The herbicides nabu, the fungicides, topsin and sumi-8, the insecticides, selecron, actellic and the nematicide, nemacur cause the highest inhibitive effect (92.2-96.5 % reduction), whereas the fungicides topas and the ridomil, the herbicides gallant and sencor and the nematicides vydate and furadan have a moderate effect (72.2-83.3% reduction) on the growth of the fungus *B. bassiana*. The least inhibitive effect on fungal growth is exerted by sulfur (55.6%) and robigan (42.7%). Topsin, vydate, sencor and furadan show the highest inhibitive effect (91.1-94.4 %) to the fungus *Metarhizium anisopliae*, whereas topas, gallant, nemacur, sumi-8 and selecron resulted in 72.2-77.7% reduction. Actellic, robigan and nabu have the least effect (34.2-66.0% reduction). Sulfur and ridomil have no effect on the growth of the fungus. The tested nematicides and the insecticides, selecron and actellic exert high killing effect to nematodes (90.3-94.6 %), whereas the other pesticides show inferior effect (11.3-21.6 %).

INTRODUCTION

The adverse effects of the widespread use of pesticides in pest control such as development of insect resistance, residues and wide toxicity spectrum, warrant for a change in control tactics. Several fungi have shown considerable promise as biocontrol agents in field trials. Labatte *et al.* (1996) stated that the efficacy of *Beauveria bassiana* was similar to that of chemicals against the larvae of European corn borer, *Ostrinia nubilalis.* Suzuki *et al.* (1971) reported that *Metarhizium anisopliae* and *Aspergills flavus* kill insects by production of toxin, (destruxins).

Any successful microbial control system depends on some basic principles, particularly the availability of local strains of the entomopathogenic organisms. The establishment of such a system requires a survey of the biocontrol agents existing in the agricultural soils followed by selecting the agents capable of depressing pests population. The increase in population size of promising bioagents through different strategies is a significant prerequisite for an active biocontrol approach.

The present investigation aimed at the following :

1. Compile information about the occurrence and distribution, if any, of entomopathogenic and parasitic agents in cultivated soil in Ismailia Governorate.
2. Study the effect of some edaphic factors on the occurrence and distribution of such bioagents in soil.
3. Study the side effect of the recommended pesticides on the survival and population density of the prevailing bioagents.

MATERIALS AND METHODS

This work was carried out in 1999 in Ismailia Governorate at five districts (Ismailia area, Fayed, El-Tall El-Kebeer, Quantra East and West). Six hundred and forty eight random soil samples (4 replicates for each crop at 3 villages in each district) were taken from soil under cultivated vegetable crops (okra, cabbage, tomato, pepper, cucumber and strawberry), field crops (maize, peanut, cotton, sesame, wheat and berseem) and fruit trees (mango, citrus, guava and olive).

Soil samples were collected at depths of 0-5 and 5-10 cm using sterilized auger. Each sample was separately mixed well and two 500 gm/soil samples of each were submitted to examination at the Plant Protection and Soil Testing Laboratories of Ismailia Agricultural Research Station. The method of Zimmermann (1986) was followed, however, *Tenebrio molitor* larvae was used as insect baits as well as nematodes for trapping entomopathogenic and parasitic agents in soil.

Fungi were isolated and identified using selective medium according to Muller (1976). Nematodes were collected from the infected larvae using the technique of Flegg and Hooper (1970). The identification of obtained organisms were confirmed at the Finnish Agricultural Research Centre, Jokioinen, Finland. To study the distribution of agents that exist under fruit trees, soils under mango trees, the most common in this area, (18.000 feddan), were resampled at a depth of 0-5cm at the four sides of each tree (one tree from each village) at three distance from the trunk (below, at and the away from outer edge of the canopy). Soil samples were submitted to the previous procedures for trapping the bioagents.

To determine the relationship between the occurrence of the agent and the chemical and physical structure of the soil, 250gm soil sample were submitted to chemical analysis using the method adopted by Richard (1954) and Soltanpour (1985) and particle size distribution was determined using dry sieving method according to USDA Handbook No. 210 (1973).

The susceptibility of the obtained agents was tested against certain registered pesticides, commonly used in this area, Table 1. The pesticides were applied at their recommended concentrations and tested according to the method of Gardner and storey (1985).

Nematodes were tested using 10 ml of suspension of nematodes extracted and the number of alive nematodes was counted before treatment and after 24 hours. The percentages of dead nematodes were calculated. Four replicates were used for each pesticides as well as the untreated check. Petri dishes of the tested fungi were incubated at 25°C and the linear growth was measured. Average diameter of colonies (mm) and the percentage of decrease relative to the control were recorded. All data were computerized and statistically analyzed using complete random design.

Table 1. The tested pesticides: their trade names, active ingredients contents and applied concentration.

Trade Name	Active ingredient	Recommended Concentration g or ml/100 liter water
Insecticide		
Sulfur WP	Sulfur	250
Selecron 72 EC	Profenofos	375
Actellic 50 EC	Pirimifos methyl	375
Fungicides		
Topsin 70 WP	Thiofanat methyl	100
Topas 20 EC	Penconazol	15
Robigan 12 EC	Finarimol	25
Ridomel Plus 50 WP	Metaloxyl + copper	1500
Sumi-eight5 EC	Diniconazol	35
Herbicides		
Sencor 70 WP	Metribuzin	175
Gallant 12.5 EC	Haloxyfop-methyl	750
Nabu 20 EC	Sethoxydim	1000
Nematicides		
Furadan 10 G.	Carbofuran	2500
Vydate 24 L.	Oxamyl	500
Nemacur 10 G.	Fenamiphos	6250

RESULTS

Results showed the occurrence of entomopathogenic fungi and parasitic nematodes in 156 soil samples among the total of 648 samples, thus representing 24.07%. These agents were more abundant under mango trees, especially in not well attended orchards (53.8% of the samples) followed descendingly by soil cultivated with field crops, i.e. 30.8% of the samples and vegetable crops soil in 15.4% of cases, respectively. Data also indicate the occurrence of these bioagents only in the top 5 cm of the soil, while completely absent at 5-10 cm. The bioagents were found only under the canopy of mango trees.

Data in Table 2 show the occurrence of the biological agents in the five surveyed districts. *Heterorhabditis* spp + *Fusarium* spp. representing 59.7% and found in all districts, whereas the same nematodes + undescribed bacteria existed only in two districts (Quantra Shark and Ismailia) at a 10% frequency, the fungus *Beauveria bassiana* at an average of 8.4%, existed in the five districts except El-Tall El-Kebeer, while *Metarhizium anisopliae* exists in three districts (El-Tall El-Kebeer, and each of Quantra Shark and Gharb) with a mean occurrence of 10.8% .

Nematodes were found in considerably more frequency (69.7%), while fungi were less occurring (19.2%) in the samples. It is also noted that some unidentified insects killing agents were encountered at 11.2% frequency.

Table 2. Percentage of bioagents associated with the larvae of *Tenebrio molitor* baits.

Organism \ District		Quantra Shark	Quantra Gharb	El-Tall El-Kebeer	Ismailia	Fayed	Means	
Fungi	*M. anisopliae*	14.2	25	14.3	-	-	10.8	19.2
	B. bassiana	14.3	8.3	-	7.1	12.5	8.4	
Nematodes	*Heterorhabditis* + *Fusarium spp.*	28.6	25	71.4	85.8	87.5	59.7	69.7
	Heterorhabditis + Bacteria	42.9	-	-	7.1	-	10.0	
	Others	-	41.7	14.3	-	-	-	11.2
L.S.D.							28.147	

The fungus *Metarhizium anisopliae* was more abundant (10.8%) than *Beauveria bassiana* (8.4%) as evidenced by examining the baits. The nematode *Heterorhabditis* is accompanied by either the fungus *Fusarium* (59.7%) or with bacteria 10% (yet unidentified). Several soil samples yielded more than one bioagents species.

Data in Table 3 indicate that the electrical conductivity in all soil samples ranged from 0.17 to 2.00 mhos/cm. i.e. from 0.05 to 0.64 as a total salinity (TSS). The salinity level was higher in Quantra Gharb than in other districts as evidenced by the EC values. Concerning the macronutrients (N, P, K) which refer to fertility status of the studied soil samples, nitrogen content was very low in Quantra Gharb (13.2 ppm) compared with Fayed which is considered rich in nitrogen content (94.9 ppm), while potassium is very low in each of Quantra and Fayed, it is very high in Ismailia and El-Tall El-Kebeer. Phosphorus recorded very high level in all the tested samples. The data of the micronutrient status show that the samples contain low level of available Zn except in one sample in Ismailia district, at depth 0-5cm in which insect control agent was present contained 1.57ppm. The samples also contain a low level of copper except in Fayed (0.77-0.10.7) and some samples in Ismailia district. The soil of Quantara Shark is rich in iron and decreased with the depth and its maximum values exist in the surface layer. Magnesium content in Ismailia and Fayed is high, but low in the other districts. The dominant anion in El-Quantra Shark is sulphate at the different depths, while chloride is least soluble salts and these data are in harmony with the electrical conductivity which ranged from 0.37 to 0.44 mhos/cm.

Table 3. Chemical analysis of the studied soil samples

District	* Insect C.A	Depth cm	Ec moh cm	Cations meq/l				Anion meq/l			Macro nutrient ppm			Micro nutrients ppm			
				Ca	Mg	Na	K	HCO_3	cl	SO_4	N	P	K	Zn	Cu	Fe	Mn
Quantra Shark	Present	0-5	0.37	2.2	1.1	0.2	0.6	0.4	0.4	3.15	30	110.9	1.38	1.08	0.35	6.0	0.90
	Absent	5-10	0.44	2.4	1.1	0.15	0.65	0.4	0.4	3.4	67	87.5	1.38	1.5	0.41	3.3	1.2
	Absent	0-5	0.40	2.6	1.1	0.17	0.8	0.3	0.6	3.5	49.8	44.1	2.1	1.11	0.59	1.5	2.3
Quantra Gharb	Present	0-5	2.0	6.5	6.2	6.5	0.7	4.2	13.0	2.7	13.2	37.8	27.6	0.22	0.4	0.52	1.92
	Absent	5-10	1.43	6.2	4.0	3.8	0.6	4.1	7.8	2.7	17.6	21.2	17.7	0.2	0.39	0.58	1.58
	Absent	0-5	1.30	6.0	4.0	3.5	0.6	4.1	7.8	1.2	16.6	16.85	16.85	0.22	0.39	0.47	1.79
El-Tall El-Kebeer	Present	0-5	0.17	0.40	0.3	1.0	0.1	0.6	0.8	0.4	38.4	18.1	148.2	0.04	0.06	0.29	1.4
	Absent	5-10	0.24	1.00	0.5	0.7	0.3	1.0	1.1	0.4	36.6	25.0	135.7	0.08	0.08	0.29	1.6
	Absent	0-5	0.17	0.8	0.4	0.3	0.3	0.8	0.7	0.3	36.9	17.6	135.7	0.06	0.16	0.29	1.8
Ismailia	Present	0-5	0.34	1.4	1.2	0.2	1.0	0.5	0.8	2.5	45.4	30.2	107.0	1.57	0.42	3.1	1.17
	Absent	5-10	0.29	1.3	0.7	0.2	0.9	0.5	0.6	2.0	45.6	24.1	2.6	0.49	0.77	0.4	3.44
	Absent	0-5	0.32	1.3	1.0	0.26	1.0	0.5	0.8	2.3	52.6	236.4	2.6	0.54	0.83	0.42	2.66
Fayed	Present	0-5	0.56	1.3	2.0	1.2	1.7	0.7	3.2	2.3	74.1	75.6	4.4	1.28	0.9	1.1	1.84
	Absent	5-10	0.45	1.1	1.3	0.8	1.4	0.8	1.5	2.4	92.0	40.0	6.5	1.33	0.9	1.23	1.93
	Absent	0-5	0.97	1.2	1.3	0.5	1.8	0.6	1.5	2.7	94.9	83.4	3.2	1.36	1.07	1.05	2.14

* Insect control agent

Data in Table 4 show that clay loam is dominant in Quantra Shark and Fayed Soil, whereas sandy soil is dominate in El-Tall El-Kebeer and Ismailia soil. Quantra Gharb tends to have clay soil. The high percentage of organic matter is found in samples of Quantra Shark soil (0.63) followed descendingly by Fayed (0.5%), Ismailia (0.231), Quantra Gharb (0.2%) and El-Tall El-Kebeer (0.15%), respectively.

A number of pesticides commonly used in the areas under consideration are tested to clarify their effect on the growth of the fungus *Beauveria bassiana, Metarhizium anisopliae* and also on the population of the nematode *Heterorhabditis*.

Not as expected, data in Table 5 show that nabu achieved a very strong inhibition effect to the radial growth of the fungus *B. bassiana* (92.2% reduction), thus more superior than the other five tested fungicides (42.7 and 94.4%). The insecticides, selecron and actellic and the fungicides topsin and sumi-8 caused superior reduction (94.4%) in the growth of same fungus and followed by topas (83.3%), ridomil (81.1%), sulfur (55.6) and robigan (42.7%). The nematicides nemacur, vydate and furadan also have strong inhibition effects; causing 92.2, 80.0 and 72.2 % growth reduc-

Table 4. Physical and organic matter contents of the studied soil samples

District	Particle size distribution %							Texture class	% O.M.
	VCS	CS	MS	FS	VFS	Silt	Clay		
Quantra Shark	0.4	3.6	31.0	8.0	0.6	20.4	36.0	Clay loam	0.63
Quantra Gharb	1.6	0.4	2.6	9.6	5.2	25.6	55.0	Clay	0.2
El-Tall El-Kebeer	3.2	17.2	55.0	19.0	3.0	0.6	2.0	Sand	0.15
Ismailia	-	23.0	50.0	20.0	-	4.0	3.0	Sand	0.23
Fayed	1.0	2.8	26.0	7.5	0.7	24.0	38.0	Clay loam	0.50

VCS = Very coarse sand CS = Coarse sand
MS = Medium sand FS = Fine sand
VFS = Very fine sand O.M. = Organic matter

Table 5. Effect of certain pesticides on the growth of the fungus *B. bassiana* and *M. anisopliae* and the nematodes *Heterorhbditis spp.*

Pesticides	Organism				
	B. bassiana		*M. ansiopliae*		*Heterorhabiditis spp.*
	Means of radial growth cm	% reduction over control	Means of radial growth cm	% reduction over control	% death
Insecticide					
Sulfur WP	40.0	55.6	90.0	0.0	17.8
Selecron 72 EC	5.0	94.4	25.0	72.0	94.1
Actellic 50 EC	5.0	94.4	30.0	66.0	90.3
Fungicides					
Topsin 70 WP	5.0	49.4	5.0	94.4	21.6
Topas 20 EC	15.0	83.3	15.0	83.3	13.3
Robigan 12 EC	52.0	42.7	33.0	64.8	17.3
Ridomel Plus 50 WP	17.0	81.1	90.0	0.0	12.1
Sumi-eight5 EC	5.0	94.4	21.0	76.3	12.7
Herbicides					
Sencor 70 WP	23.0	74.8	6.0	93.8	11.7
Gallant 12.5 Ec	12.0	81.5	11.0	82.0	13.3
Nabu 20 Ec	3.0	96.5	50.0	34.2	11.3
Nematicides					
Furadan	25.0	72.2	8.0	91.1	94.6
Vydate 24 Ec	18.0	80.0	5.0	94.4	93.1
Nemacur	7.0	92.2	20.0	77.7	93.6
L.S.D.	15.02	11.93	14.62	16.93	14.94

tion of *B. bassiana,* respectively. Other herbicides, gallant and sencor caused 81.5 and 74.8% reduction in fungal growth, respectively. As for the fungus *Metarhizium anisopliae,* the highest effect is manifested by each of the fungicides topsin and the nematicide vydate (94.4% growth reduction), followed by the herbicide, sencor (93.8%). The fungicides ridomil and sulfur had no effect on the fungus. The remaining pesticides come between the two former values. The tested nematicides and the insecticides, selecron and actellic, caused the highest nematicidal activity (90.3-94.6%), whereas the other pesticides showed low effect (11.3 - 21.6%).

DISCUSSION

It is obvious that the cultivated soil in Ismailia Governorate contain different species of entomopathogenic fungi (*Beauveria bassiana* and *Metarhizium anisopliae* besides the parasitic nematodes *Heterorhabditis* spp. These fungi and nematodes are distributed in all the five surveyed districts. The nematodes were more abundant than the fungi. *Heterorhabditis* spp., was always accompanied with either *Fusarium* spp. or bacteria, not yet to be identified. These organism (fungus and bacteria attack the *Tenebrio* bait larvae after the entrance of nematodes. Although there was no significant difference between the percentage occurrence of each of *B. bassiana* and M. *anisopliae,* however, the latter occurs at higher frequency. This may be due to the higher susceptibility of *B. bassiana* to the environmental factors compared with *M. anisopliae.* Latch and Fallon (1976) reported that the spores of *B. bassiana* do not survive in the soil as well as those of *M. anisopliae.* Clay soil in Quantra Gharb is favorable for *M. anisopliae* compared with other districts. The high occurrence of *B. bassiana* in Quantra Shark and Fayed may be due to soil richness in organic materials, especially when insect host is absent. The absence of *M. anisopliae* in each of Ismailia and Fayed and *B. bassiana* in El-Tall El-Kebeer is difficult to explain. No evidence was found to confirm or deny the relation between the isolated fungi and chemical composition of soil. It can be said that soil type affect the level of occurrence of the fungi quantitatively not qualitatively. Vanninen *et al.* (1989) mentioned that poor aeration of clay soil may be unfavorable for *B. bassiana,* whereas the more resistant *M. anisopliae* is not negatively affected by this factor. Considering the chemical composition of soil at different locations and at different depths, it is obvious that no specific trend could be drawn between the occurrence of the bioagents and such chemical composition.

The parasitic nematodes are found in each of the five tested districts, which may indicate that these nematodes have the ability to survive in different types of soil, high and low salinity, different levels of cations, anions, and macro and micro nutrients. The low occurrence percentage of nematodes in Quantra Shark soil samples may be attributed to the clay soil type that makes the movement of nematodes uneasy. The occurrence of the entomopathogenic fungi and entomoparasitic nematodes at 0-5 cm depth and under the canopy of mango trees or out of that area may be affected by the presence of the host pest at the location as well as the depth of the soil which may also be influenced by the physical structure of the soil. Moreover, it is not expected that the distribution of such fungi is homogeneous throughout the top soil.

It is obvious that many pesticides belonging to the four tested groups may have caused great damage to the biocontrol agents. This effect could explain the presence of the bioagent under the mango tree's soil, or in not well attended orchards, where no chemical control is applied against mango pests and consequently no damage effect is exerted on the agents and the insect host would be present for maintaining the biocontrol agent.

In conclusion, biocontrol agents are found in only 24.07% of the tested soil samples. This proportion of occurrence is not enough to set any effective pest control strategy based solely on biocontrol and many practices must be carried out. The most important of which is to avoid the use of pesticides harmful to these agents to preserve their populations. Furthermore, such agents may be introduced artificially.

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العوامل التى تؤثر على التواجد الطبيعى لبعض عناصر المكافحة الحيوية للحشرات فى الأراضى المنزرعة فى محافظة الإسماعيلية

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٣ معهد بحوث الأراضى والمياه والبيئة. مركز البحوث الزراعية - جيزة

تم جمع ٦٤٨ عينة تربة عشوائياً من حقول منزرعة خضروات ومحاصيل حقلية وأشجار فاكهة فى محافظة الإسماعيلية، اختبرت العينات للكشف عن عناصر مكافحة الحشرات الحيوية التى تتواجد طبيعياً فى التربة باستخدام حشرة *Tenebrio molitor* كطعم حشرى لهذه العناصر مع دراسة العوامل المؤثرة فيها. أوضحت النتائج وجودها فى ٢٤,٠٧ ٪ من عينات التربة المفحوصة. ووجدت أيضاً تحت أشجار الفاكهة بنسبة (٥٣,٨ ٪)، تحت المحاصيل الحقلية بنسبة ٣٠,٨ ٪ وتحت محاصيل الخضر بنسبة ١٥,٤ ٪ على عمق صفر-٥ سم وتحت المجموع الخضرى لأشجار المانجو. اتضح أن النسبة المئوية لتواجد الفطريات المتطفلة على الحشرات ١٩,٢ ٪ والنيماتودا المتطفلة على الحشرات ٦٩,٧ ٪ كما وجدت مسببات أخرى غير معروفة تسبب موت الحشرات فى ١١,١ من العينات.

وجد الفطر *Beauveria bassiana* بنسبة ٨,٤ ٪ فى المناطق الخمسة المختبرة عدا منطقة التل الكبير، بينما وجد فطر *Metarhizium ansopliae* بنسبة ١٠,٨ ٪ لكنه لم يتواجد فى منطقتى الإسماعيلية وفايد. وجدت النيماتودا المتطفلة على الحشرات من جنس *Heterorabditis* والتى صاحبها الفطر *Fusarium spp* بنسبة ٥٩,٧ ٪ فى الخمسة مناطق المختبرة. كما وجدت بنسبة ١٠٪ مصحوبة ببكتريا (لم يتم تعريفها) فى منطقتى القنطرة شرق والإسماعيلية. أما العوامل الأخرى التى لم تعرف، وجدت فى كل من القنطرة غرب والتل الكبير. أثر نوع التربة فى النسبة المئوية لتواجد عوامل المكافحة الحيوية بطريقة كمية وليست وصفية، وجد الفطر *Beauveria bassiana* فى عينات التربة الغنية بالمواد العضوية، بينما وجد فطر *Metarhizium ansopliae* بأعلى نسبة فى الأراضى الطينية والتى قلت فيها نسبة النيماتودا إلى حد كبير. لم توجد علاقة واضحة بين تركيب التربة الكيماوى وتواجد هذه العوامل.

بالنسبة لتأثير المبيدات المختبرة والمستخدمة فى المنطقة على نمو فطر *Beauveria bassiana* أوضحت التجارب أن أكثر المبيدات إحداثاً لتثبيط النمو هو مبيد الحشائش نابو والمبيدان الفطريان توبسين وسومى ايت والمبيدان الحشريان سيليكرون واكتيليك والمبيد النيماتودى نيماكور فلقد سببت نقصاً يتراوح ما بين ٩٢,٢ - ٩٦,٥ ٪ فى حين أن المبيدان الفطريان توباز وريدوميل ومبيد الحشائش جالانت وسنكور والمبيد النيماتودى فايديت وفيورادان أحدثت تأثيراً متوسطاً يتراوح بين ٧٢,٢ - ٨٣,٣ ٪ نقصاً فى نمو الفطر. وكان الكبريت أقل المبيدات تأثيراً على نمو الفطر حيث سبب ٥٥,٦ ٪، بينما أحدث الروبيجان ٤٢,٧ ٪ نقصاً فى نمو الفطر.

أحدثت المركبات توبسين وفايديت وسنكور وفيوردان أعلى تأثير مثبط على نمو الفطر

Metarhizium ansopliae تراوح بين ٩١,١ و٩٤,٤ ٪ نقصاً فى النمو، فى حين أن مبيد توباز وجالانت ونيماكور وسومى وسيليكرون سببت نقصاً فى النمو تراوح بين ٧٢,٢ و٧٧,٧ ٪ أما مبيدات أكتيليك وروبيجان ونابو كانت أقل المركبات تأثيراً على النمو (٣٤,٢ - ٦٦ ٪) أما الكبريت وريدوميل لم يكن لهما تأثير يذكر على نمو الفطر.

أحدثت المبيدات النيماتودية المختبرة والمبيدان الحشريان سيليكرون وأكتيليك أعلى نسبة موت للنيماتودا تراوحت بين ٩٠,٣ - ٩٤,٦ ٪ فى حين أن باقى المركبات المختبرة كان لها تأثيراً منخفضاً تراوح بين ١١,٣ و ٢١,٦ ٪.