COMPATIBILITY BETWEEN THE ENTOMOPATHOGENIC FUNGUS *METARHIZIUM ANISOPLIAE* SOROKIN AND SOME PESTICIDES AGAINST RED SPIDER MITE, *TETRANYCHUS URTICAE* KOCH

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Abstract

The compatibility of *Metarhizium anisopliae* Sorokin with three pesticides was studied *in vitro* and under field condition. Three concentrations of each pesticide were tested in the laboratory to study its effect on the mycelial growth of the entomopathogenic fungus *Metarhizium anisopliae*, at recommended concentrate, at half of recommended concentrate and fourth of recommended concentrate.

There is no inhibition of mycelial growth with Baioca at the three concentrates 100 % (++++). On the other hand, Bermectine has the same effect at 1/2RC and 1/4RC100 % (++++), but at RC it exhibit 50 % mycelial growth (++). However Ortus exhibit 25 % mycelial growth (+) at RC and exhibit 50 % mycelial growth (++) at 1/2RC while at 1/4RC mycelial growth was approximate 100 % (++++).

In addition, the efficacy of tested combinations (Bioranza plus, Ortus, Baioca and Bermectine) were evaluated in the field on eggplant against the red spider mite, *Tetranychus urticae* Koch at the recommended and half recommended rates and could be stated that, the bioinsecticide Bioranza 4%WP could be successfully used for controlling *Tetranychus urticae* at recommended rate (200 gm. / 100 L.) in combination of Ortus (25 cm^3/100 L.) , Baioca (50 cm^3/100 L.) and Bermectine (20 cm^3/100 L.) at their half recommended application rates. This gives us the significance value for protecting the environment and our selves by reducing the used rates of pesticides and then less hazards and problems resulting from excessive use of pesticides achieving the significance value by decreasing the application rates of pesticides on crops and obtaining good production with less residuals and good quality.

Also, co-toxicity resulted from addition of Bioranza to Ortus, Baioca, and Bermectine against *Tetranychus urticae* individuals stated that, the type of joint action obtained from the addition of the bioinsecticide at its recommended RC to Ortus, Baioca and Bermectine at the two application rates induced regular joint action against *Tetranychus urticae*, indicating a dominated additive effect where, the additive effect for the total mortality of the combination is higher than the mortality of summation of each compound separately, Thus, the joint action of the two compounds in the mixtures was more effective against the two spotted spider mite *Tetranychus urticae* than the compound alone.

Key words: compatibility, *Metarhizium anisopliae*, insecticides, *Tetranychus urticae*

INTRODUCTION

The conservation of biological control agents within agro ecosystems is one of the strategies adopted for the exploitation of entomopathogens. Equally important are the techniques of inoculative, inundative and incremental introductions. In all cases, either to preserve the entomopathogen or to use it in combination with chemical pesticides, it is necessary to know the action of these products on the microorganism and then determine their compatibility. This interaction should be considered before recommending a given chemical agent and represents an important tool in programs of integrated pest management. Several studies have contributed information for the choice of pesticides with more selective action on the entomopathogens and most of them was conducted under laboratory conditions and concerned entomopathogenic fungi (Ramaraje *et al.*1967, Alves 1986, Silva *et al.* 1993).

Ignoffo *et al.* (1975) studied *in vitro* several chemical products employed in soybean crop and observed that almost all fungicides and some insecticides and herbicides tested inhibited fungal growth and affected fungal virulence. The fungi *Aschersonia aleyrodis, Hirsutella thompsonii, Paecilomyces farinosus and Verticillium lecanii* are pathogens of great importance for the natural control of different insects and mites and occurs in various agro ecosystems. The interaction between *Beauveria bassiana* and mineral oil was evaluated by Batista Filho *et al.* (1995) in order to control the banana plant borer. *Cosmopolites sordidus* (Gem.). These investigators observed an additive effect of the combination, which caused 98 % adult insect mortality compared to 70 % caused by the fungus alone and 33 % by mineral oil alone.

The present work aims to study the compatibility between the entomopathogenic fungus *Metarhizium anisopliae* and three pesticides against the two spotted spider mite *Tetranychus urticae* Koch.

MATERIALS AND METHODS

Laboratory experiments:

The present study was conducted in the Bio-insecticides Production Unit at Plant Protection Research Institute, Agriculture Research Center, Ministry of Agriculture, Dokki, Giza, Egypt.

- Isolation of *Metarhizium anisopliae*:

Metarhizium anisopliae was isolated in pure culture on Czapeks Dox agar medium (CDA) from infected adults of *Rhynhophorus ferruginens* collected from Ismailia Governorate, Egypt (Ibrahim, 2006).

- Mass production of the entomopathogenic fungus *Metarhizium anisopliae*:

Conidia were produced on agar Petri-dishes of semi-synthetic Czapeks Dox agar medium which consists of sucrose 20.0 g/L, K_2HPO_4 1.0 g/L, KNO_3 2.0 g/L, yeast extract 2.0 g/L, KCL 0.5 g/L, $MgSO_4$ $7H_2O$ 0.5 g/L, $FeSO_4$ $7H_2O$ 0.002 g/L, agar-agar 20.0 g/L, up to 1000 ml distilled H_2O. The medium was prepared and adjusted pH (5.5-6.5). Petri-dishes were inoculated with *Metarhizium anisopliae* and incubated for two weeks at 25 ± 1ºC & 50 – 60 % RH. At the end of incubation period the conidia were harvested from the surface of the culture directly by scraping with sterile solution of 0.01 % tween-80. The conidia were separated by filtration through sterilized glass-wool. The resulting suspension was counted according to hemocytometer counts technique.

- Insecticides:

Three common commercial formulations of pesticides are in use against red spider mite *T. urticae* in Egypt [Fenpyroximate, (Ortus 5% SC), the bioinsecticide, Matrine (Baioca 0.36% AS), the bioinsecticide, Abamectin (Bermectine 1.8% EC)]. These Compounds were tested for their growth inhibition on *Metarhizium anisopliae* by poison food technique on Czapeks Dox agar medium (CDA) in three replications, one at recommended concentrate (RC), second at half of the recommended concentrate (1/2 RC) and the third at fourth of the recommended concentrate (1/4RC).

Each 100 ml portion of the medium was dispensed into a 250 Erlenmeyer conical flask and autoclaved at 121ºC for 20 minutes. It was then cooled to about 45ºC stock solutions of the pesticides were prepared in sterilized distilled water and incorporated into each flask to provide different levels of concentrates. Each flask was shaken well and poured into sterilized Petri-plates (90 mm). Medium without insecticides served as a control. Each plate was inoculated with 1×10^7 conidiospores from 12 days old culture of *Metarhizium anisopliae* The inoculated plates were incubated at 25±1ºC. After 15^{th} days of incubation, the growth of *Metarhizium anisopliae* colony in the Petri-plates treated with different insecticides at different concentrates was recorded.

Field experiments:

Experiments were carried out at Qalyubia Governorate during the season 2008. An area of 1\2 feddan was sown of Eggplant (*Solanum melongena* L.) variety 'White Balady'.

Crop:

Eggplant *Solanum melongena* L. (Class: Dicotyledonae, Order: Solanales, Family: Solanaceae)

Tested pest:

The red spider mite, *Tetranychus urticae Koch* (*Acari : Tetranychidae*), immature stages and adults.

Tested compounds:

1-The bioinsecticide, *Metarhizium anisopliae* (Bioranza 4%WP) produced by Plant Protection Research Institute, Egypt.

2- Fenpyroximate, (Ortus 5% SC), distributed by Shoura Company, Egypt. Chemical name: 1, 1-dimethylethyl (E)-4-[[[[(1, 3-dimethyl-5-phenoxy-1H-pyrazol-4-yl) methylene] amino] oxy] methyl] benzoate.

3- The bioinsecticide, Matrine (Baioca AS 0.36% Matrine aqueous solution), distributed by Eurochem Co., Egypt.

Chemical name: Matrine, Sophocarpidine (Calculated as Oxymatrine)

4- The bioinsecticide, Abamectin (Bermectine 1.8% EC), distributed by Al-Esraa Co., Egypt. Chemical name: 5-O-demethylavermectin A1a (i) mixture with 5-O-demethyl-25-de (1-methylpropyl)-25-(1-methylethyl) avermectin A1a (ii)

Treatment procedures:

The area of the experiment (2100 m^2) was divided into 36 equal blocks, the experimental blocks were arranged in complete randomized design with three replicates for each treatment. All agricultural practices were run in this experiment except for the studied variant.

Application concentrations:

1- Bioranza at 200 gm. and 100gm. /100L.

2- Ortus at 50 cm^3 and 25 cm^3/100L.

4- Baioca at 100 cm^3 and 50 cm^3/100L.

5- Bermectine at 40 cm^3 and 20 cm^3/100L.

6- Combinations of the chemical compounds used:

6. a- Bioranza + Ortus at 200 gm.+ 50 cm^3

Bioranza + Ortus at 200 gm. + 25 cm^3

Bioranza + Ortus at100 gm. + 25 cm^3

6. b- Bioranza + Baioca at 200 gm. + 100 cm^3

Bioranza + Baioca at 200 gm. + 50 cm^3

Bioranza + Baioca at 100 gm. + 50 cm^3

6. c- Bioranza + Bermectine at 200 gm. + 40 cm^3

Bioranza + Bermectine at 200 gm. + 20 cm^3

Bioranza + Bermectine at 100 gm. + 20 cm^3

7- Control, water used without any insecticides.

By using a knapsack sprayer (20 liters) the compounds were sprayed, the sprayer was filled with the prepared concentrations just before each treatment.

Eggplants were treated on August 7th, 2008.

Inspection of plants was carried out one day before spraying and after 1, 3, 5 and 7 days from application to calculate the effect of the different treatments on the numbers of spider mite individuals.

Samples of 10 leaves from each replicate representing the upper, middle and lower levels of plant were picked, put in a paper bags and transferred to the Laboratory, then examined on the same day with the aid of a stereomicroscope for counting *Tetranychus urticae* Koch (Immature stages and adults) by choosing 10 random inches per replicate.

The obtained data were statistically analyzed at 5% probability level according to Snedecor and Cochran (1967).

The percentage of population reduction (% mortality) was calculated according to the equation of Hinderson and Tilton (1955) as follow:

$$\text{Reduction (\% mortality)} = \left[(C_b) \frac{}{C_a} \times \frac{}{T_b}\right] \times 100$$

Where:

T= number of alive mites individuals in treatment.

C= number of alive mites individuals in control.

a= number of alive mites individuals after treatment.

b= number of alive mites individuals before treatment.

While, to evaluate the effect of different pairs of insecticides used here, the following equation was used:

$$\text{Co-toxicity factor} = \frac{\text{Observed \% mortality} - \text{Expected\% mortality}}{\text{Expected \% mortality}} \times 100$$

This factor was used to differentiate the results into three categories. A positive factor of 20 or more meant potential, a negative factor of 20 or more meant synergistic, and any intermediate value (*i.e.,* between –20 and +20) was considered only additive effect .

The expected mortality for the mixture of 2 insecticides was the sum of the expected mortalities of each of dosage used in the combination, (After, Mansour *et al.*, 1966).

RESULTS AND DISCUSSION

1- Effect of the chemical insecticides on *Metarhizium anisopliae* growth:

Data in (table 1) showed no inhibition of mycelial growth with Baioca at the three concentrates 100 %, On the other hand, Bermectine has the same effect at 1/2RC and 1/4RC 100 %. But at RC they exhibits 50% mycelial growth. However Ortus exhibit 25% mycelial growth at RC and 50 % mycelial growth at 1/2RC while at 1/4RC mycelial growth was approximate 100 %.

On the other hand, Batista Filho *et al.*(2001) stated that endosulfan and monocrotophos used at maximum concentrations reduced the production conidia and vegetative growth, whereas at minimum concentrations they had no effect on the fungal growth. Also Camargo (1983) observed that *M. anisopliae* is inhibited by different concentrations of pyrethroid insecticides. Deltamethrin had the highest inhibitory action.

Table 1. In vitro compatibility of *Metarhizium anisopliae* with some pesticides.

Treatment	Baioca	Bermectine	Ortus
RC	++++	++	+
1/2RC	++++	++++	++
1/4RC	++++	++++	++++
Control*	++++	++++	++++

RC=Recommended concentrate

1/2RC=half of the Recommended concentrate

1/4RC=fourth of the Recommended concentrate

*=without chemical insecticide

2- Efficacy of combining *Metarhizium anisopliae* with certain pesticides against *Tetranychus urticae* Koch infesting eggplant in the field.

2. I- Efficacy of the tested compounds alone:

Results in (Table 2) showed that, the average number of red spider mite per 10 inches was noticeably reduced during the following 3 days after treatment to reach (97, 205), (48, 142), (112, 190) and (55, 135 individuals/10 inches) on the 3rd day for the two application rates {recommended (RC) & half recommended (½RC)} of Bioranza at 200 gm. and 100gm. /100L., Ortus at 50 cm^3 and 25 cm^3/100L., Baioca at 100 cm^3 and 50 cm^3/100L.and Bermectine at 40 cm^3 and 20 cm^3/100L., respectively.

The corresponding reduction rates of individuals were (78.4, 56.0), (88.5, 66.7), (76.3, 52.9) and (87.1, 71.0%) for the various treatments, respectively. However, the number of individuals was gradually increased on the 5th and 7th day

after zero time and amounted (210, 300), (78, 240), (230, 310) and (112, 295 individuals/10 inches) at the 7th day after application for the two application rates of various compounds, respectively.

The average reduction rates of red spider mite population size after the investigation periods (residual effect) reached (69.0, 49.05), (86.1, 56.4), (69.0, 42.3) and (82.6, 55.6%) for the bioinsecticide, *Metarhizium anisopliae* (Bioranza 4%WP), Fenpyroximate, (Ortus 5% SC), the bioinsecticide, Matrine (Baioca AS 0.36%) and the bioinsecticide, Abamectin (Bermectine 1.8% EC) respectively.

It was found that, values of the general mean of red spider mite individuals detected significant reduction for the various treatments at the two application rates as compared with the control.

Statistically, the data revealed no significant differences in the general means of individuals between RC and ½RC of the above treatments regarding Bioranza, Ortus, Baioca and Bermectine.

The previous results indicated that the efficacy of the tested compounds in controlling the red spider mite, *Tetranychus urticae* could be arranged in descending order as follows: Ortus followed by Bermectine, Bioranza and Baioca that was the least effective one.

Table 2. Efficacy of certain treatments against *Tetranychus urticae* Koch infesting eggplant in the field.

Treatments	Rate /100L	Pre-spray	Mean number of individuals per 10 inches and reduction rates at indicated days from treatments				
			1	Residual effect			Average
				3	5	7	
Bioranza	200 gm.	579	112 (72.0)	97 (78.4)	133 (69.7)	210 (58.8)	138.0* (69.0)
	100 gm.	600	220 (46.8)	205 (56.0)	230 (49.5)	300 (43.1)	238.8* (49.5)
Ortus 5% SC	50 cm^3	540	70 (81.2)	48 (88.5)	56 (86.3)	78 (83.6)	63.0* (86.1)
	25 cm^3	550	155 (59.1)	142 (66.7)	200 (52.1)	240 (50.4)	184.3* (56.4)
Baioca AS 0.36%	100 cm^3	610	143 (66.0)	112 (76.3)	122 (73.6)	230 (57.1)	151.8* (69.0)
	50 cm^3	520	200 (44.2)	190 (52.9)	230 (41.7)	310 (32.2)	232.5* (42.3)
Bermectine 1.8% EC	40 cm^3	550	78 (79.4)	55 (87.1)	67 (83.9)	112 (76.8)	78.0* (82.6)
	20 cm^3	600	178 (57.0)	135 (71.0)	220 (51.7)	295 (44.1)	207.0* (55.6)
Control	--	580	400	450	440	510	450.0

L.S.D. = 67.7

*= Significant at 5% level.

% Reduction rates are given in brackets.

Table 3. Efficacy of various combinations on Tetranychus urticae Koch infesting eggplant in the field.

Treatments	Rate /100L	Pre-spray	Mean number of individuals per 10 inches and reduction rates at indicated days from treatments				
				Residual effect			Average
			1	3	5	7	
Bioranza + Ortus5% SC	200 gm.+ 50 cm3	570.0	100 (74.6)	50.8 (88.5)	51 (88.2)	75 (85.0)	69.2* (87.3)
	200 gm. + 25 cm3	610.0	109.5 (74.0)	53.4 (88.7)	54.8 (88.2)	85 (84.2)	75.7* (87.0)
	100 gm. + 25 cm3	556.0	154 (59.8)	133 (69.2)	122 (71.1)	155 (68.3)	141.0* (69.5)
Bioranza + Baioca AS 0.36%	200 gm. + 100 cm3	640.0	114 (74.2)	54.4 (89.0)	60 (87.6)	95 (83.1)	80.9* (86.6)
	200 gm. + 50 cm3	590.0	135 (66.8)	68.2 (85.1)	62.8 (86.0)	112 (78.4)	94.5* (83.2)
	100 gm. + 50 cm3	498.0	114 (66.8)	95 (75.4)	69 (81.7)	103 (76.5)	95.3* (77.9)
Bioranza + Bermectine1.8% EC	200 gm. + 40 cm3	600.0	109.5 (73.5)	65 (86.0)	70.6 (84.5)	100 (81.0)	86.3* (83.9)
	200 gm. + 20 cm3	555.0	112 (70.7)	52.8 (87.7)	51.6 (87.7)	95 (80.5)	77.9* (85.3)
	100 gm. + 20 cm3	605.0	135 (67.6)	100 (78.7)	98 (78.6)	122 (77.1)	113.8* (78.1)
Control	--	580	400	450	440	510	450.0

L.S.D. = 40.1

*= Significant at 5% level.

% Reduction rates are given in brackets.

2. II- Efficacy of combining *Metarhizium anisopliae* with certain pesticides:

The effects of mixtures of the bioinsecticide, Bioranza at (recommended, 200 gm and half recommended rate, 100 gm/100 L.) plus Ortus5% SC at its RC & ½RC (50 & 25 cm^3/100L.), Baioca AS 0.36% at its RC & ½RC (100 & 50 cm^3/100L and Bermectine1.8% EC at its RC & ½RC (40 & 20). against red spider mite are presented in (Table 3).

Results revealed that, the average numbers of *Tetranychus urticae* individuals decreased clearly during the following 3 days after spraying as compared with control and amounted (50.8, 53.4, 133.0), (54.4, 68.2, 95.0), (65.0, 52.8, 100.0 individuals/10 inches) on the 3rd day for mixtures of Bioranza plus Ortus, Baioca and Bermectine respectively. Thereafter, the values of the average numbers of *Tetranychus urticae* individuals increased gradually from the 5th days after spraying for various combinations, respectively.

The average reduction rates (residual effect) of *Tetranychus urticae* population during the period of investigation reached (87.3, 87.0, 69.5), (86.6, 83.2, 77.9) and (83.9, 85.3, 78.1) for the various combinations, respectively.

Values of the general mean count of *Tetranychus urticae,* showed a significant decreased in all combinations as compared with the control.

In addition, there were insignificant differences between the general mean of *Tetranychus urticae* individuals for the mixtures, Bioranza plus Ortus at (RC+RC) and (RC+½RC), Bioranza plus Baioca and plus Bermectine at (RC + RC), (RC + ½RC) and (½RC + ½RC) for each combination separately.

Results obtained revealed that, all mixtures of tested compounds at half recommended rates stated in insufficient reduction in *Tetranychus urticae* population.

These results are in agreement with the findings of Mayoral *et al.* (2006) who stated that, the efficacy of Naturalis alone at 200 ml/hl was lower than that of the chemical Imidacloprid-based reference product of the bioinsecticide applied at the same concentrate in tank mixture with an adjuvant, and of the biocontrol agent alone at 300 ml/hl. However, when the product was applied at 200 ml/hl in tank mixture with the adjuvant and alone at 300 ml/hl, its efficacy was always comparable to that of the chemical standard.

Co-toxicity resulted from addition of Bioranza to Ortus, Baioca, and Bermectine against *Tetranychus urticae* individuals was presented in (Tables 4, 5 and 6).

Results in (Tables 4, 5 and 6) show that, the type of joint action obtained from the addition of the bioinsecticide at its recommended RC to Ortus, Baioca and Bermectine at the two application rates induced regular joint action against *Tetranychus urticae*, indicating a dominated additive effect where, the additive effect for the total mortality of the combination is higher than the mortality of summation of each compound separately, thus, the joint action of the two compounds in the mixtures was more effective against the tested pest than the compound alone. Whereas, the type of joint action obtained from the addition of the bioinsecticide at its

half recommended rate ½RC to Ortus, Baioca and Bermectine at their ½RC induced a dominated antagonistic effect.

In this respect, Mansour *et al.* (1966) found that, the toxicity of 11 organophosphorus and 2 carbamate insecticides were determined by topical application to 3rd instar larvae of the Egyptian cotton leaf worm, *Prodenia litura* F. Several organophosphorus insecticides were potentiated when pairs were applied jointly. Most of the potentiated pairs contained 1 strong and another weak insecticide. There were also antagonistic pairs as well as other pairs producing only additive effect when jointly applied. In addition, co-toxicity resulted from addition of the LC50 of Malathion (145 ppm) to Neemazal at (50 – 4000 ppm) for *Rhizopertha dominica* showed an additive effect at all tested concentrations. In case of mixtures of Sumithion plus Neemazal, an additive effect was obtained at higher concentrations (500, 1000 ppm) but at 50, 100 and 250 ppm an antagonistic effect was obtained, (El-Lakwah, 1997).

Additionally, Shalaby (2004) stated that, results obtained of addition of the botanical compound, Achook at its high and low application rate, (200 & 100cm^3) to Admiral at its recommended rate (300 cm^3/100L.) induced an additive effect. Thus, the joint action of the two compounds in the mixtures was more effective against *Tetranychus urticae* than each compound alone. But, an antagonistic effect was obtained from the same combination at the low application rate of Achook and low application rate of Admiral (150 cm^3/100L.).

Generally, the bioinsecticide Bioranza could be successfully used for controlling *Tetranychus urticae* in combination of certain insecticides (Ortus, Baioca and Bermectine) at their half recommended application rates. This gives us the significance value for protecting the environment and our selves by reducing the used rates of pesticides and then less hazards and problems resulting from excessive use of pesticides.

Table 4. Co-toxicity resulted from addition of Bioranza at 200 and 100gm/100L to Ortus at two rates for *Tetranychus urticae* Koch.

Application rate (cm^3/100 L.)	% Mortality after 3 days from treatment			Co-toxicity factor	Type of joint action
	Bioranza alone	Ortus alone	Bioranza + Ortus		
	Expected mortality		*Observed mortality*		
At 200gm/100L					
50	72.0	88.5	88.5	-11.5	d
25		66.7	88.7	-11.3	d
At 100gm/100L.					
25	48.8	66.7	69.2	-30.8	a

a: antagonistic effect (-20 or more)

d: additive effect (between –20 & +20)

Table 5. Co-toxicity resulted from addition of Bioranza at 200 and 100gm/100L to Baioca at two rates for Tetranychus urticae Koch.

Application rate (cm^3/100 L.)	% Mortality after 3 days from treatment			Co-toxicity factor	Type of joint action
	Bioranza alone	Baioca alone	Bioranza + Baioca		
	Expected mortality		*Observed mortality*		
At 200gm/100L					
100	72.0	76.3	89.0	-11	d
50		52.9	85.1	-14.9	d
At 100gm/100L.					
50	48.8	52.9	75.4	-24.6	a

a: antagonistic effect (-20 or more)

d: additive effect (between –20 & +20)

التوافق بين فطر *Metarhizium anisopliae* وبعض المبيدات الأكاروسية ضد العنكبوت الأحمر العادي *Tetranychus urticae* Koch

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يهدف البحث الحالي إلى كيفية استخدام ممرضات الآفات بالتكامل مع بعض المبيدات الأكاروسية في مكافحة الآفات المستهدفة وكذلك إمكانية تأخير مقاومة الآفات لفعل المبيدات وذلك باستخدام معدلات استخدام منخفضة من المبيد وبالتالي تقليل الأخطار الناتجة من الاستخدام المفرط للمبيدات.

تم اختبار تأثير ثلاثة مبيدات معمليا على نمو الفطر الممرض *Metarhizium anisopliae* وذلك باستخدام ثلاث تركيزات من كل مبيد على حدة وهى:مبيد Ortus 5% SC، مبيد Baioca AS 0.36% ومبيدBermectine 1.8% EC. وكان التركيز الأول من كل مبيد هو التركيز الموصى به، أما الثاني فهو نصف التركيز الموصى به والثالث هو ربع التركيز الموصى به. وقد اتضح من النتائج أنه لم يلاحظ اى تأثير على نمو الفطر بالنسبة للمبيد بايوكا باستخدام الثلاث تركيزات (++++) % 100 ، بينما أعطت نفس النتيجة باستخدام نصف وربع التركيز الموصى به بالنسبة لمبيد بيرمكتين (++++) % 100 لكن عند التركيز الموصى به أدى الى خفض نمو الفطر بنسبة ٥٠% (++) % . بينما أدى المبيد اورتس إلى خفض نمو الفطر بنسبة ٢٥% عند استخدام التركيز الموصى به وكانت نسبة الخفض ٥٠% عند نصف التركيز الموصى به بينما عند استخدام ربع التركيز الموصى به لم يحدث تأثير على نمو الفطر.

وقد تبين أنه عند تطبيق فاعلية خلط المبيدات سالفة الذكر مع الفطر الممرض (بيورانزا ٤% WP) يمكن استخدامها بنجاح فى مكافحة العنكبوت الأحمر العادي فى الحقل على محصول الباذنجان وذلك باستخدام المعدل الموصى به من مخلوط المبيد الحيوي بيورانزا مع نصف التركيز الموصى به من مبيد أورتس (٢٥سم٣/١٠٠ لتر)، مبيد بايوكا (٥٠سم٣/١٠٠لتر) ، مبيد بيرمكتين (٢٠سم٣/ ١٠٠لتر) وذلك يحقق الغرض من البحث بتخفيض معدلات استخدام المبيدات تحت الدراسة على المحاصيل والحصول على منتج عالي الجودة لا يحتوى على متبقيات مبيدات.

أعطت كل المخاليط تأثيرا إضافيا (additive) علي العنكبوت الأحمر حيث زادت سمية المخاليط عن سمية المركبات منفردة. وبالتالي فإن joint action للمركبين في المخلوط كانت أكثر فعالية ضد هذه الآفة عن استعمال المركب منفردا، فيما عدا خلط المبيد الحيوي بيورانزا بنصف التركيز الموصى به مع باقى المركبات باستخدام التركيز الموصى به ونصف الموصى به حيث أدى الخلط إلى فعل تضادى.