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EFFICACY OF NATURAL COMPOUND ON THE WHITEFLY *Bemisia tabaci* BIOTYPE "B" (HEMIPTERA: ALEYRODIDAE) AND ITS NATURAL ENEMIES OF CUCUMBER CROP

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ABSTRACT

The tomato and cotton whitefly, *Bemisia tabaci* (Gennadius) Biotype "Q" (Hemiptera: Aleyrodidae) is an important pest on cucumber. The present work deals with the efficacy of the compounds, Mineral oil, Jojoba oil , Sulphur, *Peacilomyces fumosoroseus,* Azdrachtin*, Verticellium lecanii* and Actara on *B. tabaci* Biotype "Q" and its parasitoid, *Eretmocerus mundus* (Mercet) (Hymenoptera : Aphelinidae) and predator, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae). Field experiments were carried out to evaluate of the seven compounds on *B. tabaci* Biotype "Q" and associated natural enemies (*E. mundus* and *C. carnea*) on cucumber crop at Dakahliya Governorate. When the numbers of whitefly and its parasitoid and predator were high during October. The results indicated that the four compounds Jojoba oil , *Peacilomyces fumosoroseus,* Azdrachtin and *Verticellium lecanii* gave moderate effect against *B. tabaci* Biotype "Q" (59.3-66.7 and 58.7-66.3%), the parasitoid, *E. mundus* (59.9-66.7%) and the predator, *C. carnea* (60.3-67.7 and 60.3-67.3%) during the two years under consideration, respectively. On the other hand, Actara gave high efficacy against *B. tabaci* Biotype "Q" (85.2 and 87.0%) , *C. carnea* (86.3 and 85.0 %) and on *E. mundus* (85.0 and 88.3%) . While, Mineral oil and Sulphur compounds gave 79.2 & 72.6 and 79.9-70.9 % for *B. tabaci*; 78.1 & 71.7 % and 78.2 & 72.2 for *E. mundus* and 78.1 & 72.5 % and 78.9 & 72.5 for *C. carnea* mortality during the two years under consideration, respectively. It is concluded that the use of certain botanical extracts (Azdrachtin) and fungi (*Peacilomyces fumosoroseus* and *Verticellium lecanii*)for the control tomato and cotton whitefly, *B. tabaci* Biotype "Q" is an important and useful approach. As well as using these compounds safely effect of natural enemies and environment.

INTRODUCTION

The tomato and cotton whitefly, *Bemisia tabaci* (Gennadius) Biotype "Q" (Hemiptera: Aleyrodidae), is a major pest of economically important crops worldwide (Xu *et al.* ,2012). Feeding injury by this species had serious adverse effects on plant growth, i.e. reduce plant height, weight, leaf number, and leaf area. Further more, injury adversely affect leaf gas change processes in tomato by impairing stomatal function, reducing leaf chlorophyll content and photosynthetic capacity. Whitefly-transmitted (WFT) gemini-viruses have emerged as important global plant virus pathogens. These have increased in number, distribution and importance during the last decade. The primary working hypothesis is that it is a vector transmitting these viruses (Martin and Mound, 2007).

Applied biological control by natural enemies has been an effective and highly desirable. Utilization of natuarl enemies provide an inexpensive, non-hazardous mean of reducing pest populations and maintaining them often permanently below their economic thresholds. In Egypt, *B. tabaci* Biotype "Q" attacked by sixteen natural enemy species of aphelinids, coccinellids, anthocorids, lygaeids and mirids (Abd-Rabou, 2005). Many workers studied the effect of different natural compounds on the parasitoids and predators of the tomato and cotton whitefly for example, Hussey and Scopes (1977), Dowell *et al.* (1986) and Delorme *et al.* (1985), Kumar *et al.* (2005), Naveen and Brar (2006), Santiago-Álvarez *et al.* (2006) , Olleka and Ren (2008) and Swaran *et al.* (2008).

In Egypt Abdel-Salam *et al.* (1971), Abdel-Salam *et al.* (1972), Shaheen *et al.* (1973), Darwish and Farghal (1990), Radwan *et al.* (1990), Halawa *et al.* (1992) , Mohamed *et al.* (1992) , Hassan (1996) evaluated the efficiency of conventional insecticids for the control of *B. tabaci*. While Hegab and Moawad (1994) , El-Rafi (1995), El-Sayed and Aboel-Ghar (1997), Badary (1997), Zaki, (1998), Abd-Rabou (2001) and Simmons and Abd-Rabou (2005) tested non-conventional insecticides in controlling *B. tabaci* and its natural enemies.

The aim of this work is to test the efficacy of the compounds, Mineral oil, Jojoba oil , Sulphur, *Peacilomyces fumosoroseus,* Azdrachtin*, Verticellium lecanii* and Actara on the tomato and cotton whitefly, *B. tabaci* Biotype Q and its parasitoid, *E. mundus* and predator*, C. carnea* .

MATERIALS AND METHODS

The experiments were carried out to evaluate seven compounds (Mineral oil, Jojoba oil , Sulphur, *Peacilomyces fumosoroseus,* Azdrachtin*, Verticellium lecanii* and Actara) on *B. tabaci* Biotype "Q" and associated parasitoid and predator on cucumber crop at Dakahliya Governorate. When the numbers of *B. tabaci* Biotype "B" and its parasitoid and predator were high during October.

2.1. The experiments comprised 7 compounds:

Mineral oil was applied at a rate of 10ml / liter of water
Jojoba oil was applied at a rate of 10ml / liter of water
Sulphur was applied at a rate of 2.5gm / liter of water
Peacilomyces fumosoroseus was applied at a rate of 5ml / liter of water
Azdrachtin was applied at a rate of 5ml / liter of water
Verticellium lecanii was applied at a rate of 5ml / liter of water
Actara25% WG was applied at a rate of 2 gm / liter of water

Each treatment conducted in 1/4 Fadden. One quarter of Fadden was also used as an untreated check (control). Spraying was applied at the rate of per plant which was accomplished by the use of a Knapsack sprayer Cp-20 of 20 liter capacity. Pre-spraying counts were made just before spraying.

The post spraying counts were made after 3, 7 and 15 days from application. Random samples of 20 leaves were picked up from each replicate. A total number of 60 infested leaves for each treatment were

examined. By means of a stereoscopic microscope insect whitefly and its natural enemies were inspected.

2.2. Statistical analysis:

The percent reduction of infestation was statistically calculated according to the equation of (Henderson and Tilton, 1955).

$$\% \text{ Reduction} = 100 \left[1 - \frac{Ta \times Cb}{Tb \times Ca}\right]$$

Where:
Ta = Post treatment insect counts
Cb = Untreated insect count before treatment
Tb = Pretreatment counts
Ca = Untreated insect count after treatment.
The "F" value were calculated and the least significant difference (L.S.D.) between treatments were considered when "F" value was significant.

RESULTS AND DISCUSSION

The experiments were carried out to evaluate of the seven compounds (on *B. tabaci* Biotype "Q" and its parasitoid, *E. mundus* and predator*, C. carnea* on cucumber crop at Dakahliya Governorate. When the numbers of whitefly and its parasitoid and predator were high during October.

2.1. First season (2012)

In the first season, the average pre-spraying counts of larvae and adult stages of *B. tabaci* Biotype "Q" were 68.8-78.7 and 15.1-17.7/leaf and the average number of larvae and pupa of *E. mundus* were 24.3-32.1 and 40.0-53.5% and also the average numbers of mature and immature stages of *C. carnea* were 1.3-1.5 and 2.0-2.6/leaf,respectively (Tables ,1, ,5, 9). Results in Tables (2,6,10) indicated that in first year (2012), the four compounds (Jojoba oil , *Peacilomyces fumosoroseus,* Azdrachtin and *Verticellium lecanii*) gave moderate toxic effect against *B. tabaci* Biotype "Q"and its natural enemies (*E. mundus and C. carnea)* and percent reduction ranged between (57.8 -67.7%) after 15 days. Mineral oil and Sulphur compounds gave 79.2 and 72.6 for *B. tabaci*; 78.1 and 71.7 % for *E. mundus* and 78.1 and 72.5 % for *C. carnea* mortality during the two years under consideration, respectively. On the other hand, Actara gave high efficacy against *B. tabaci* Biotype "Q" (85.2%), *E. mundus* (85.0 %) and on *C. carnea* (86.3 %) . (Tables, 2,6,10).

Results of statistical analysis (F value and L.S.D.) (Tables, 2,6,10) and graphically illustrated in Figs (1-3) showed that seven treatments had significant effect on populations.

2.2. The second season (2013):

In the second season, the average prespraying counts of larvae and adult stages of *B. tabaci* Biotype "Q" were 58.0-65.5 and 17.5-24.3/leaf and the average number of larvae and pupa of *E. mundus* were 30.0.3-36.6 and 44.5-55.4% and also the average numbers of mature and immature stages of *C. carnea* were 1.2-1.7 and 2.0-2.5/leaf,respectively (Tables,3, 7, 11). Results in Tables (4, 5, 12) indicated that in first year (2007), the four

compounds (Jojoba oil , *Peacilomyces fumosoroseus,* Azdrachtin and *Verticellium lecanii*) gave moderate toxic effect against *B. tabaci* Biotype "Q"and its natural enemies (*E. mundus and C. carnea),* and percent reduction ranged between (58.7 -67.3%) after 15 days. Mineral oil and Sulphur compounds gave 79.9-70.9 % for *B. tabaci*; 78.2 & 72.2 for *E. mundus* and 78.9 & 72.5 for *C. carnea* mortality during the two years under consideration, respectively. On the other hand, Actara gave high efficacy against *B. tabaci* Biotype "Q" 87%, *C. carnea* (85 %) and on *E. mundus* (88.3 %) (Tables ,4, 5, 12).

Results of statistical analysis (F value and L.S.D.) (Tables ,4, 5, 12) and graphically illustrated in Figs (1-3) showed that seven treatments had significant effect on populations.

In the present work the traditional compound, Actara gave high efficacy against *B. tabaci* Biotype "Q" was 85.2 and 87 % during the two years under considration. Abdel-Salam *et al.* (1971), Abdel-Salam *et al.* (1972), Shaheen *et al.* (1973), Darwish and Farghal (1990), Radwan *et al.* (1990), Halawa *et al.* (1992) , Mohamed *et al.* (1992), Hegab and Moawad (1994) and Hassan (1996) evaluated the efficiency of some traditional compounds as spray for the control of *B. tabaci* on vegetables including cucumber. The results gave effective control and the mortality ranged from 87.95 to 96.75% . Role of the fungi, *Beauveria bassaina* as virulence agent in suppressing whitefly populations was studied by Al-Deghairi, (2008). El-Rafi (1995) recorded 62.84% reduction of the effect Naturalis (*B. bassiana*) on *B. tabaci* . While in this work, the mortality of the fungi, *Peacilomyces fumosoroseus* and *Verticellium lecanii* were ranged between 66.3-66.7 and 64.6-64.8% during the first and second years of the investigation, respectively. Santiago-Álvarez *et al.* (2006) determined the pathogenicity of the entomopathogenic fungus *B. bassiana* (1×10^7 conidia/ml *B. bassiana* EABb 93/14-Tp isolate) to the sweetpotato whitefly, *B.tabaci* on the nymphs reared on different vegetables. Mortality caused by *B. bassiana* was 91.8±5.8%. Olleka. and Ren (2008) demonstrated the importance of entomopathogenic fungi as an agent microbial control on whitefly, *B. tabaci*. Zaki (1998), the results of his work indicated that *B. bassiana* showed high effects on the whitefly *B. tabaci* infesting cucumber, a dose of 1 $mg.ml^{-1}$ killed 100% . Kumar *et al.* (2005) tested the efficacy of two different commercial neem products (NeemAzal T/S 1% azadirachtin and NeemAzalU 17% azadirachtin) against the whitefly, *B. tabaci* on tomato plants . Results indicated that reduction ranged from 74 to 82%. Results of our research observed the mortality of Azdrachtin was ranged from 60.2 to 60.3%, during the first and second years of the investigation, respectively. Azadirachtin-A (Aza-A) also recorded as an effective control measure of *B. tabaci* on okra by Badary (1997) and Swaran *et al.* (2008).

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The insecticides Methomyl and indoxacarb caused low mortality of *E. mundus* pupae, 17.6% and 7.8% respectively, although methomyl mortality was significantly higher. Methomyl produced 100% mortality on *E. mundus* adults with fresh and 24 h old residues on leaves, significantly higher than the mortality produced by indoxacarb (values ranged from 43.9% to 34.4%) (Gonzalez-Zamora *et al.* 2004). Bacci *et al.* (2007) stated that the compound insecticide, abamectin at 100% FR decreased *B. tabaci* field populations but can still be harmless to parasitoids and predators. The whitefly population was lower in treatments with thiacloprid and higher in those with black warrant and cypermethrin, the number of predators was higher with the compound Agri-50 and spinosad and lowest with cypermethrin whereas percent parasitism was higher in those with thiacloprid and lower with methamidophos (Naveed *et al.* 2008).

Al-Deghairi (2009) stated that the effect of the fungi, *B. bassaina* on the whitefly parasitoid, *E. mundus* population were very low limited compared to chemical insecticide, if used in the appropriate time. Here in the present work, the fungi, *Peacilomyces fumosoroseus* and *Verticellium lecanii* caused mortality ranged between 66.1-66.7 and 63.8- 64.8 during the first and second years of the investigation, respectively. Also during the present work Azdrachtin gave moderate mortality ranged between 57.8-59.6% during the first and second years of the investigation, respectively. Abd-Rabou (2001) tested Neemazal 3ml/L on the parasitoids of *B.tabaci* on different host plants and in different locations in Egypt. Results observed the present parasitism reduced from 37.1 to 24.5% for *E. mundus*. Here the mortalities ranged from 64.17% to 61.30%. Successful parasitism was the lowest when adult parasitoids were introduced after dipping second instars in the *Melia azedarach* L. fruit extract and when whitefly nymphs were dipped in extract 2 d after parasitism. However, the level of parasitism in parasitized nymphs dipped in extracts 4 and 8 d after parasitism was comparable with that of the control. The number of dead whitefly nymphs in combined treatments declined as the age of whitefly nymphs at application increased, with a concomitant increase in successful parasitism (Abou-Fakhr and McAuslane, 2006).

Also in this paper, Mineral oil and Sulphur compounds gave 79.2 & 72.6 and 79.9-70.9 % for *B. tabaci*; 78.1 & 71.7 % and 78.2 & 72.2 for *E. mundus* and 78.1 & 72.5 % and 78.9 & 72.5 for *C. carnea* mortality during the two years under consideration, respectively. Simmons and Abd-Rabou (2005) stated that the compounds when were sprayed on the crops at the rates of 0.5 to 1.5 ml/liter for Biofly®; 0.5 to 1 ml/liter for buprofezin; 5 to 15 ml/liter for jojoba oil and KZ oil each; 1.5 to 2.5 ml/liter for M-Pede®; and 2 to 3 ml/liter for NeemAzal®. Regardless of concentration, parasitism by either *Encarsai. sophia* (Hymenoptera : Aphelinidae) or *E. mundus* was low (< than 5% by each of 2 species) following treatment with either KZ oil or buprofezin (an insect growth regulator), and remained low for 3 wk after the application. Parasitism was relatively high (~25-40% by each of two species) for crops treated with either NeemAzal® or M-Pede® at the lowest concentrations In our investigation, Actara gave high efficacy against *B. tabaci* Biotype “Q” (85.2 and 87.0%) , *C. carnea* (86.3 and 85.0 %) and on

E. mundus (85.0 and 88.3%). The commercial products, two potassium soaps (Tec Bom™ and Soapline 60™), one mineral oil (Sunspray Ultrafine™), neem (Iber-Neem™), algae extracts (Agri Sea-Green™) and two conventional insecticides: thiamethoxam (Actara™) and thiacloprid (Calypso™). Water was used as a control. To test the efficacy of the products to control *B. tabaci* nymphs and their effect on parasitoid emergence, all the compounds, except Actara™, were sprayed on poinsettia plants until run-off. Actara™ was applied by irrigation at two doses, the maximum labeled rate and a 2.5 times higher rate. The mineral oil Sunspray Ultrafine was the product that killed most nymphs (58%). A second group of compounds, including Tec-Bom, Agri Sea-Green and Calypso, produced mortalities between 30 and 49%, while, Actara, at both doses, and Iber-neem killed less than 20% of whitefly nymphs. Regarding toxicity on *B. tabaci* adults, the two conventional insecticides Actara (at labeled dose) and Calypso produced the highest mortalities (70 and 88%, respectively). Less effective were the soaps (Tec-Bom and Soapline 60) and the mineral oil Sunspray Ultrafine that produced mortalities ranging from 35 to 40%. The least effective among the tested compounds, were Agri Sea-Green and Iber-neem (causing mortalities around 20%). None of the insecticides evaluated caused mortality to *Er. mundus* significantly different than the control. On the other hand, emergence of *Encarsia formosa* (Gahan) (Hymenoptera : Aphelinidae) adults from pupae treated with Soapline 60 was significantly greater than emergence from pupae treated with Tec-Bom, Sunspray Ultrafine and Agri Sea-Green. *Encarsia pergandiella* (Hymenoptera : Aphelinidae) proved very sensitive to all the tested products and significantly fewer parasitoids emerged from pupae treated with all the formulations when compared with the control. To control *B. tabaci* nymphs, our results demonstrate than some of the called "biorational" insecticides (e.g. potassium soaps or mineral oil) are as effective as conventional insecticides, or even better. In contrast, to control *B. tabaci* adults, the most effective products were the two conventional insecticides tested (Actara and Calypso) (Roig and Gabarra,2006).

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تـأثير المركبـات الطبيعيـة علـى السـلالة البيولوجيـة Q لذبابـة القطـن و الطمـاطم البيضاء وأعدائـها الحيويةعلى الخيار

علـــى علـــى عبـــد الهـــادي*، فـــؤاد عبـــد الله شـــاهين*، ســـلوي الســـعيد نجـــم *، إبراهيم حسن محمد هيكل ** و دينا فايز على الأشرم **

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يعتبر السلالة البيولوجية Q لذبابة القطن و الطماطم البيضاء من أهم الآفات التى تصيب الخيار. هذا العمل تضمن تأثير مركبات الزيت المعدنى وزيت الجوجوبا و الكبريت و فطر بيسيلوميسس فيوسوروسيس وفطر فيرتيسيليم لكانى و ازدراكتين و مبيد أكتر على السلالة البيولوجية Q لذبابة القطن و الطماطم البيضاء والطفيل المتخصص عليها أريتموسيرس مندز والمفترس المصاحب لها كريزوبا كارنى .. التجارب الحقلية والتى تم تجريب تأثير المركبات التى تم ذكرها على السلالة البيولوجية Q لذبابة القطن و الطماطم البيضاء وأعدائها الحيوية على نبات الخيار فى محافظة الدقهلية عندما كانت أعداد الذباب الأبيض و الطفيل و المفترس عالية فى شهر أكتوبر. وقد أشارات النتائج بالنسبة لتأثير 4 مركبات وزيت الجوجوبا و فطر بيسيلوميسس فيوسوروسيس وفطر فيرتيسيليم لكانى و ازدراكتين على السلالة البيولوجيةQ لذبابة القطن و الطماطم البيضاء أن نسب الموت قد تراوحت 66.7-59.3 % و 66.3- 58.7% . أما بالنسبة للطفيل فقد كانت نسب الموت 66.7 – 59.9 و بالنسبة للمفترس 60.3-67.3 %. أما بالنسبة لمركب أكترا السلالة البيولوجية Q لذبابة القطن و الطماطم البيضاء والطفيل المتخصص عليها أريتموسيرس مندز والمفترس المصاحب لها كريزوبا كارنى قد تراوحت نسب الموت 87.0% and 85.2 و 88.3% and 85.0 و 85.0 % and 86.3على الترتيب. أما الزيت المعدنى و الكبريت السلالة البيولوجية Q لذبابة القطن و الطماطم البيضاء قد تراوحت نسب الموت 72.6 % & 79.2 و % 70.9-79.9 والطفيل المتخصص عليها أريتموسيرس مندز 71.7 % & 78.1و 72.2 & 78.2 والمفترس المصاحب لها كريزوبا كارنى 72.5 % & 78.1و72.5 & 78.9 خلال عامى الدراسة. يتضح من هذا العمل ان المستخلصات النباتية والفطريات لها دور فعال فى مكافحة ذبابة القطن و الطماطم البيضاء السلالة البيولوجية Q والتى ايضا لها تأثير آمن على الأعداء الحيوية و البيئة.

Table (1):Average numbers of the whitefly, *Bemisia tabaci* Biotype Q after treatment with different compounds on cucumber during first season.

Treatment	Rate of Applic. /L.W.	Pre spraying count		Post spraying count after:						Average number		
				3		7		15				
		L	A	L	A	L	A	L	A	L	A	T
Mineral oil	10ml	73.1	15.3	23.5	4.5	19	3.9	13	3	18.5	3.8	11.2
Jojoba oil	10ml	75.2	16.2	36	7.9	31	7.8	38	10.9	35	8.9	22.0
Sulphur	2.5gm	75	16.4	27	6	23.5	5.8	21	5.5	23.8	5.8	14.8
Peacilomyces fumosoroseus	5ml	69.2	15.6	28.5	6.5	23.5	6	28	8	26.7	6.8	16.8
Azdrachtin	5ml	69.8	15.1	32.9	7.1	28	7	35	9.9	32	8.0	20.0
Verticellium lecanii	5ml	68.8	17	29.5	7.4	25	6.9	30	9.7	28.2	8.0	18.1
Actara	2 gm	78.7	16.3	20	3.8	14	3.4	7	1.5	13.7	2.9	8.3
Control		75.3	17.7	79	20	83	25	88	29	83.3	24.7	54

L: Larvae A. Adult T: Total

Table (2):Reduction percentage of different compounds on the whitefly, *Bemisia tabaci* Biotype Q on cucumber plants during first season.

Treatment	Rate of Applic. /L.W.	%Reduction after:						Average %reduction		
		3		7		15				
		L	A	L	A	L	A	L	A	T.
Mineral oil	10ml	69.4	74	76.5	82	84.8	88.1	76.9 ab	81.4 ab	79.2
Jojoba oil	10ml	54.4	56.9	62.7	66	56.8	59	58.0 d	60.6 d	59.3
Sulphur	2.5gm	65.7	67.7	71.6	75	76.1	79.6	71.1 bc	74.1 bc	72.6
Peacilomyces fumosoroseus	5ml	60.8	63.2	69.2	72.8	65.4	68.8	65.1 cd	68.3 cd	66.7
Azdrachtin	5ml	55.1	58.4	63.7	67.2	57.1	60	58.6 d	61.9 d	60.3
Verticellium lecanii	5ml	59.2	61.5	67.1	71.3	62.7	65.6	63.0 cd	66.1 cd	64.6
Actara	2 gm	75.8	79.4	83.9	85.3	92.4	94.4	84.0 a	86.4 a	85.2
F value								8.73	8.55	
L.S.D.								9.98	10.15	

L: Larvae A. Adult T: Total

Table (3): Average numbers of the whitefly, *Bemisia tabaci* Biotype Q after treatment with different compounds on cucumber during second season.

Treatment	Rate of Applic. /L.W.	Pre spraying count		Post spraying count after:						Average number		
				3		7		15				
		L	A	L	A	L	A	L	A	L	A	T
Mineral oil	10ml	62.2	22.9	20	7.5	14	5.5	11	5	15.0	6.0	10.5
Jojoba oil	10ml	64.5	18.8	32	10	2.8	9.6	34	14	22.9	11.2	17.1
Sulphur	2.5gm	58	21.8	23	9	20.5	8.5	17.5	8	20.3	8.5	14.4
Peacilomyces fumosoroseus	5ml	61.5	21.6	26.5	9.8	22.1	8.9	25	12	24.5	10.2	17.4
Azdrachtin	5ml	62	17.5	30	9	25.5	8.1	32	12.8	29.2	10.0	19.6
Verticellium lecanii	5ml	59.3	22.1	26	10.5	22	9.5	26	13	24.7	11.0	17.9
Actara	2 gm	65.1	24.3	16	6	10	3.8	5	1.8	10.3	3.9	7.1
Control		65.5	21.5	69.5	26	75	31.3	79.2	38.9	74.6	32.1	53.4

L: Larvae A. Adult T: Total

Table (4): Reduction percentage of different compounds on the whitefly, *Bemisia tabaci* Biotype Q on cucumber plants during second season.

Treatment	Rate of Applic. /L.W.	%Reduction after:						Average %reduction		
		3		7		15				
		L	A	L	A	L	A	L	A	T.
Mineral oil	10ml	69.2	73	80.4	83.6	85.4	88	78.3 ab	81.5 ab	79.9
Jojoba oil	10ml	53.3	56.1	62.1	65	56.5	58.9	57.3 c	60.0 d	58.7
Sulphur	2.5gm	62.2	65.8	69.2	73.3	75.1	79.8	68.8 bc	73.0 bc	70.9
Peacilomyces fumosoroseus	5ml	59.4	62.5	68.7	71.7	66.4	69.3	64.8 c	67.8 cd	66.3
Azdrachtin	5ml	54.4	57.5	64.1	68.3	57.4	59.6	58.6 c	61.8 cd	60.2
Verticellium lecanii	5ml	58.2	60.8	67.6	70.5	63.8	67.5	63.2 c	66.3 cd	64.8
Actara	2 gm	76.9	79.6	86.6	89.3	93.7	96	85.7 a	88.3 a	87
F value								8.46	8.22	
L.S.D.								10.91	11.03	

L: Larvae A. Adult T: Total

Table (5):Average numbers of the parasitiod, *Eretmocerus mundus* after treatment with different compounds on cucumber during first season.

Treatment	**Rate of Applic. /L.W.**	**Pre spraying count**		**Post spraying count after:**						**Average number**		
				3		**7**		**15**				
		L	**P**	**L**	**P**	**L**	**P**	**L**	**P**	**L**	**P**	**T**
Mineral oil	10ml	32.1	53.5	13.3	16.5	9.5	12	7.5	9	10.1	12.5	11.3
Jojoba oil	10ml	25	48.3	14	22.5	13	20	18	23	15	21.8	18.4
Sulphur	2.5gm	26.4	46.7	12	16.9	10	13.9	8.5	12.1	10.2	14.3	12.3
Peacilomyces fumosoroseus	5ml	28.7	44.9	13.9	17	11.5	14	13.5	17	13.0	16	14.5
Azdrachtin	5ml	24.3	45.2	13.8	21.6	13	19	15	22.5	13.9	21.0	17.5
Verticellium lecanii	5ml	28.4	40	14.5	17.5	12	13.2	14	16	13.5	15.6	14.6
Actara	2 gm	25.4	45.3	18	11	5.5	7	2.5	2.7	8.5	6.2	7.4
Control		30	51	36	55.5	39.5	59	41.5	63.2	39	59.2	49.1

L: Larvae P. Pupae T: Total

Table (6): Reduction percentage of different compounds on the parasitoid , *Eretmocerus mundus* on cucumber plants during first season.

Treatment	Rate of Applic. /L.W.	%Reduction after:						Average %reduction		
		3		7		15				
		L	P	L	P	L	P	L	P	T.
Mineral oil	10ml	68.6	71.7	77.6	80.7	83	86.9	76.4 ab	79.8 ab	78.1
Jojoba oil	10ml	53.4	57.2	66.6	64.3	56.4	60.8	58.9 cd	60.8 d	59.9
Sulphur	2.5gm	62.2	66.8	71.3	74.3	76.6	79.1	70.0 bc	73.4 bc	71.7
Peacilomyces fumosoroseus	5ml	59.7	62.2	69.6	73.1	65.8	69.5	65.0 bcd	68.3 cd	66.7
Azdrachtin	5ml	52.7	56.1	59.4	63.7	55.1	59.9	55.7 d	59.9 d	57.8
Verticellium lecanii	5ml	57.5	59.8	68	71.5	64.1	67.8	63.2 cd	66.4 cd	64.8
Actara	2 gm	73.8	77.7	83.6	86.7	92.9	95.2	83.4 a	86.5 a	85.0
F value								6.53	7.60	
L.S.D.								11.65	10.81	

L: Larvae P. Pupae T: Total

Table (7): Average numbers of the parasitoid, *Eretmocerus mundus* after treatment with different compounds on cucumber during second season.

Treatment	Rate of Applic. /L.W.	Pre spraying count		Post spraying count after:						Average number		
				3		7		15				
		L	P	L	P	L	P	L	P	L	P	T
Mineral oil	10ml	34.6	51.3	12.5	16.2	13.5	13.5	10.5	9.9	12.2	13.2	12.7
Jojoba oil	10ml	34.2	50.2	19	25	20	22	25.5	28.9	21.5	25.3	23.4
Sulphur	2.5gm	35.2	48.1	15	17.9	16.9	16.6	14.9	14.2	15.6	16.2	15.9
Peacilomyces fumosoroseus	5ml	35.6	55.4	18	24.9	19.2	21.9	23.7	27.5	20.3	24.8	22.6
Azdrachtin	5ml	36.6	51.3	21	26.5	21	22.5	26.9	30	23.0	26.3	24.6
Verticellium lecanii	5ml	30	50	15.5	22.5	16.9	21	19.3	23.9	17.2	22.5	19.9
Actara	2 gm	34.5	44.5	9.9	8.8	6.6	4.8	4.1	1.9	6.9	5.2	6.1
Control		33	51.5	40	60.1	52.7	69.8	57.1	7.4	49.9	66.8	58.4

L: Larvae P. Pupae T: Total

Table (8): Reduction percentage of different compounds on the parasitiod, *Eretmocerus mundus* on cucumber plants during second season.

Treatment	Rate of Applic. /L.W.	%Reduction after:						Average %reduction		
		3		7		15				
		L	P	L	P	L	P	L	P	T.
Mineral oil	10ml	70.2	73.5	75.6	80.6	82.5	86.9	76.1 ab	80.3 b	78.2
Jojoba oil	10ml	54.2	57.4	63.4	66.3	57	60.3	58.2 d	61.3 d	59.8
Sulphur	2.5gm	64.9	68.2	70	74.6	75.6	79.5	70.2 bc	74.1 bc	72.2
Peacilomyces fumosoroseus	5ml	58.3	61.5	66.3	70.9	61.6	65.5	62.1 cd	66.0 cd	64.1
Azdrachtin	5ml	52.7	55.8	64.1	67.7	57.6	59.4	58.1 d	61.0 d	59.6
Verticellium lecanii	5ml	57.4	61.5	64.8	69.1	62.9	66.8	61.7 cd	65.8 cd	63.8
Actara	2 gm	76.4	83.1	88.1	92.1	93.2	97.1	85.9 a	90.76 a	88.3
F value								10.14	11.52	
L.S.D.								9.96	9.88	

L: Larvae P. Pupae T: Tota

Table (9): Average numbers of the predator, *Chrysoperla carnea* after treatment with different compounds on cucumber during first season.

Treatment	Rate of Applic. /L.W.	Pre spraying count		Post spraying count after:						Average number		
				3		7		15				
		M	I	M	I	M	I	M	I	M	I	T
Mineral oil	10ml	1.5	2.6	0.7	1	0.6	0.8	0.55	0.6	0.62	1.1	0.86
Jojoba oil	10ml	1.4	2.1	0.9	1.15	0.87	1.1	1.35	1.7	1.04	1.32	1.18
Sulphur	2.5gm	1.5	2.5	0.79	1.1	0.7	1	0.8	0.99	0.76	1.0	0.88
Peacilomyces fumosoroseus	5ml	1.3	2.4	0.75	1.16	0.65	0.97	1	1.4	0.8	1.2	1.0
Azdrachtin	5ml	1.6	2	1	1.05	0.95	1	1.5	1.59	1.15	1.2	1.2
Verticellium lecanii	5ml	1.5	2.2	0.9	1.1	0.80	0.95	1.2	1.4	0.96	1.15	1.1
Actara	2 gm	1.3	2.4	0.8	0.65	0.35	0.46	0.2	0.19	0.45	0.4	0.43
Control		1.4	2.3	2	3	2.5	3.8	3.1	4.5	2.5	3.8	3.2

M: Mature I: Immature T: Total

Table (10): Reduction percentage of different compounds on the *Chrysoperla carnea* on cucumber plants during first season.

Treatment	Rate of Applic. /L.W.	%Reduction after:						Average %reduction		
		3		7		15				
		M	I	M	I	M	I	M	I	T.
Mineral oil	10ml	67.2	70.6	77.6	81.4	83.5	88.3	76.1 ab	80.1ab	78.1
Jojoba oil	10ml	55	58.1	65.2	68.3	56.5	58.7	58.9 c	61.7 c	60.3
Sulphur	2.5gm	63.2	66.3	73.9	75.8	76	79.8	71.0 bc	74.0 bc	72.5
Peacilomyces fumosoroseus	5ml	59.7	63	72	75.6	65.3	70.2	65.7 bc	69.6 bc	67.7
Azdrachtin	5ml	56.3	59.8	66.8	69.8	57.7	59.4	60.3 c	63.0 c	61.7
Verticellium lecanii	5ml	58	61.7	70.2	75.9	63.9	67.5	64.0 bc	68.4 bc	66.2
Actara	2 gm	75.8	79.3	85	88.4	93.1	96	84.6 a	87.9 a	86.3
F value								5.46	5.19	
L.S.D.								11.98	12.49	

M: Mature I: Immature T: Total

Table (11): Average numbers of the predator, *Chrysoperla carnea* after treatment with different compounds on cucumber during second season.

Treatment	Rate of Applic. /L.W.	Pre spraying count		Post spraying count after:						Average number		
				3		7		15				
		M	I	M	I	M	I	M	I	M	I	T
Mineral oil	10ml	1.3	2.1	0.55	0.82	0.5	0.62	0.45	0.49	0.5	0.64	0.57
Jojoba oil	10ml	1.5	2.1	0.9	1.2	0.99	1.15	1.4	1.6	1.1	1.32	1.21
Sulphur	2.5gm	1.4	2.3	0.66	1	0.69	0.92	0.78	0.95	0.71	0.95	0.83
Peacilomyces fumosoroseus	5ml	1.5	2.5	0.8	1.25	0.77	1.05	1.15	1.5	0.9	1.27	1.09
Azdrachtin	5ml	1.7	2.4	1.05	1.4	1.14	1.65	1.65	1.85	1.3	1.63	1.47
Verticellium lecanii	5ml	1.6	2.1	0.9	1.1	0.88	1.3	1.3	1.35	1.0	1.25	1.13
Actara	2 gm	1.2	2	0.39	0.55	0.32	0.4	0.18	0.15	0.3	0.37	0.34
Control		1.4	2.2	1.9	3	2.5	3.6	3.1	4.2	2.5	3.53	3.01

M: Mature I: Immature T: Total

Table (12): Reduction percentage of different compounds on the *Chrysoperla carnea* on cucumber plants during second season.

Treatment	Rate of Applic. /L.W.	%Reduction after:						Average %reduction		
		3		7		15				
		M	I	M	I	M	I	M	I	T.
Mineral oil	10ml	68.9	71.4	78.5	82	84.4	87.8	77.3 ab	80.4ab	78.9
Jojoba oil	10ml	55.8	58.1	63.1	66.6	57.9	60.1	58.9 d	61.6d	60.3
Sulphur	2.5gm	65.3	68.2	72.4	75.6	74.9	78.4	70.9 bc	74.1bc	72.5
Peacilomyces fumosoroseus	5ml	60.8	63.4	71.3	74.4	65.4	68.6	65.8 cd	68.8cd	67.3
Azdrachtin	5ml	54.5	57.3	62.5	65.4	56.2	59.7	57.7 d	60.8d	59.3
Verticellium lecanii	5ml	58.6	61.6	69.2	73.9	63.4	66.4	63.7 cd	67.3cd	65.5
Actara	2 gm	76.1	79.9	85.1	88.4	93.3	96.3	81.8 a	88.2a	85
F value								8.28	7.81	
L.S.D.								10.42	10.88	

M: Mature I: Immature T: Total

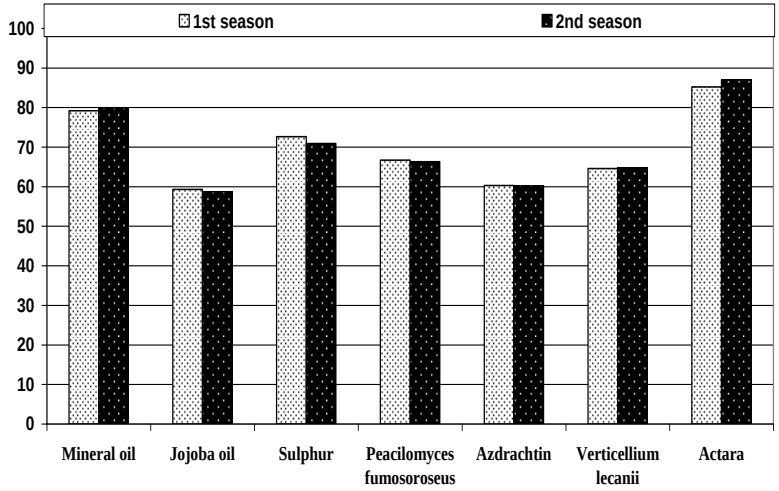

Fig. (1): Percent reduction of *Bemisia tabaci* Biotype "Q" by different natural compounds on cucumber in Daqahliya Governorate

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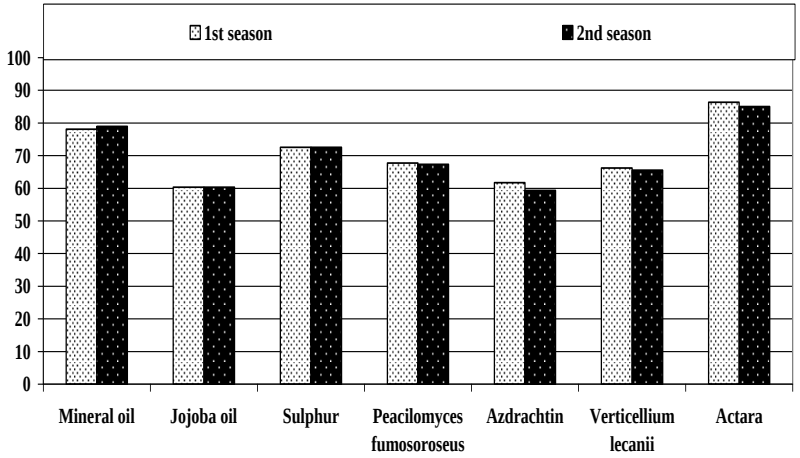

Fig. (3): Percent reduction of *Chrysoperla carnea* by different natural compounds on cucumber in Daqahliya Governorate

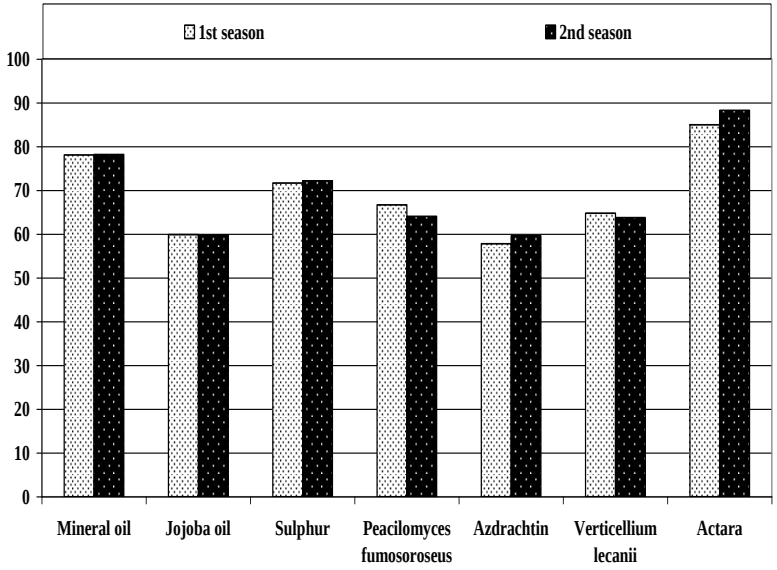

Fig. (2): Percent reduction of Eretmocerus mundus by different natural compounds on cucumber in Daqahliya Governorate