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Effect of some insecticides on the immature stages of the egg parasitoid *Trichogramma evanescens* West. (Hym., Trichogrammatidae)

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ABSTRACT

The effect of five insecticides, Profect (w.p.), CAPL- 2, Lambda-cyhalothrin, Spinosad, and Fenitrothion (Sumithon) on the immature stages of the first and the second generations of the egg parasitoid *Trichogramma evanescens* was studied in laboratory at 25 ± 1 ^{0}C, 65± 5% R.H. and 12:12 L:D. The study was carried out on parasitized eggs one, two, four and eight days post parasitism. Results showed that: 1) Longevity of the emerged parasitoid was affected by the tested insecticides. The recorded values of the adult longevity emerged from treated eggs ranged from 12 hrs to 7 days (for females) and from 12 hrs to 4 days (for males). Treating eggs with chemical insecticides caused death of the emerged adults within few hours post emergence when the treatment was carried out 4 days post parasitism or one day before adult emergence. 2). The number of host eggs turned to black (the parasitoid larvae developed to pupae) varied according to timing of treatment. 3). Adult emergence rate varied according to the used insecticide, the parasitoid stage and the generation. 4) No parasitoids emerged from parasitized eggs treated with CAPL-2. 5).

There was no emergence for the parasitoid treated with Lambda-cyhalothrin, spinosad, and fenitrothion (Sumithon) one, two or four days after parasitism. However, emergence was recorded with very low percentages when the eggs were treated 24 hrs before parasitoid emergence. 6) Female percentage slightly decreased in the adults emerged from paeasitized eggs treated with chemicals.

Keyword: Insecticides, parasitoid, *Trichogramma evanescens*

INTRODUCTION

Recently, plant protection strategy has recommended, minimizing the use of chemical pesticides. It is very important to study the side effect of insecticides on the natural enemies to exclude the ones that have detrimental effect on such natural enemies. *Trichogramma* spp. have been extensively used as biological control agent. Hassan (1982) and Bigler (1983, 1984) reported that 65 – 93% reduction in larval infestations of the Europian corn borer, *Ostrinia nubilalis* in corn fields was achieved following *Trichogramma* releases during 1970 in Germany and Switzerland. Vornin and Grinbert (1981) reported a positive reduction of pests such as *Loxstege* spp. *Agrotis* spp. and *Ostrinia* spp. following *Trichogramma* releases. In China significant reductions in populations of *Ostrinia* spp., *Heliothis* spp. and *Cnophalocis* spp. as well as in crop damage were obtained by using *Trichogramma* as a biological control agent, (Li, 1984). In Egypt, *T. evanescens* has been used successfully since 1984 as a biocontrol agent against different insect pests; the sugar-cane borer, *Chilo agamenon* on sugar-cane and rice, the olive pest *Prays oleae*, the peach bud borer, *Anarsia lineatella* on peach and apricot, the grape-fruit worm, *Lopezia botrana* and the date fruit worms, *Ephestia* spp. on date palms (Abbas, 2004). Faria (2000) stated that *Trichogramma pretiosum* Riley, was applied in Brazil for the control of several pests in corn, cassava and cotton crops. Furthermore, in the tomato crop, the control of the

moth, *Tuta absoluta* was carried out in some countries, through inundative releases of *T. pretiosum* (Amaya-Navarro, 1988; Faria., 1992; Haji, 1996, 1997). The utilization of selective insecticides is a reasonable strategy in pest management, because it favors the conservation of natural enemies in the agro-ecosystem (Carvalho *et al*., 1999). Works aiming to study the physiological selectivity of different chemical groups of pesticides to *Trichogramma* spp. were accomplished. Cônsoli *et al*. (1998), by evaluating the effects of several insecticides on the immature stages of *T. pretiosum*, concluded that phenthoate and cartap were harmful, lambda-cyalothrin and abamectin had moderate effect, tebufenozid and teflubenzuron were harmless to slightly harmful. Brunner *et al*. (2001), using Potter's tower, sprayed insecticides on adults of *T. platneri* Nagarkatti up to two days old and observed that the compounds oxamyl, imidacloprid and *Bacillus thuringiensis var. kurstaki* caused 100% mortality 48 hours after spraying, while selectivity was observed for diflubenzuron, fenoxycarb and tebufenozide.

The present study deals with the effect of five insecticide groups, Profect W.P. (biocide), CAPL-2 (mineral oil), Lambda-cyhalothrin, spinosad, and fenitrothion (Sumithon) on the immature stages of the egg parasitoid *T. evanescens* (1, 2, 4 days post parasitism, and one day before adult emergence) under laboratory conditions of 25±1^{o}C, 65±5% R.H. and 12:12 L:D.

MATERIAL AND METHOD

The tested insecticides:

1- Profect 7% W.P. (bioside group) contains *Spodoptera Littoralis* NPV 2% and *Bacillus thuringensis* 6%. Product of Plant Protection Research Institute**,** applied at 300 gm/feddan.
2- CAPL-2: 96.62 % (V.V.) (mineral oil group) applied at 1.5 %.
3- Fenitrothion (Sumithon), organophosphate insecticide, applied at 0.375%
4- Lambda-cyhalothrin (pyrethriod group): Formulation is Karate 1 EC (Zeneca, Wilmington, DE) with concentration 478.2 mg /ml, applied at 0.187 %
5- Spinosad. The commercial product Tracer (24% spinosad, suspension concentrate, Dow Agroscience, Egypt) was used in this study, applied at 0.037 %. (Mandour, 2009).

The host and the parasitoid:

Both *Sitotroga. cerealella* eggs and *Trichogramma evanescens* were obtained from the mass rearing unit at the Department of Biological Control. Plant Protection Institute, Agric. Res. Centre.

Procedure

Fresh *Sitotroga cerealella* eggs (less than 24 h. old) were glued onto cartoon cards, each contained nearly 500 eggs. These cards were placed in glass tubes. Newly emerged *T. evanescens* adults were transferred to the glass tubes containing *S. cerealella* egg-cards and kept for 24 hrs. The exposed eggs were divided into five groups; the 1st group was treated with the tested insecticides 24 h after parasitism, 2nd group was treated 48 h after parasitism, 3rd group was treated four days after parasitism, 4th group was treated eight days after parasitism (one day before adult emergence), while the 5th group was treated with water after parasitism to serve as a control**.** Treatment of parasitized eggs (egg-cards) was carried out by a 0.5 L sprayer containing 100 ml of the insecticide solutions at the above mentioned concentrations.

The treated eggs were kept on paper-sheets until drying. All the five groups were kept in glass tubes, and checked daily for emergence of the adult parasitoids. Droplets

of honey were scattered on the inner surface of the tube's walls as food for the parasitoid.

Biological aspects of the emerged parasitoids

The following biological aspects were studied for the parasitoids emerged from treated parasitized eggs: average number of black eggs (containing parasitoids' pupae), emergence rate, longevity of adults, and female percentage.

Each group was tested for the ability of emerged females to parasitize new untreated host eggs, (second generation (GII), and the previous biological aspects were determined for the second generation (if any).

The experimental design used was completely randomized with six treatments five insecticides and a control (15 replicates for each treatment and 100 eggs for each replicate).

- Statistical analysis was achieved using the SPSS Software.

RESULTS AND DISCUSSION

CAPL-2: The parasitized eggs treated with CAPL-2 one day post parasitism did not turn black (the parasitoid larvae died and did not develop to pupal stage). Similarly, the parasitized eggs treated 8 days post parasitism did not give rise to adult parasitoids. Consequently, there were no available adult parasitoids to conduct studies on the 2nd generation (GII).

Profect 7%: The bio-insecticide was found to have considerable detrimental effect on the development of the parasitoid inside the treated host eggs. The recorded values for the number of black eggs were (44.4, 44.1, 41.3 and 39.2 for the GI & 42.1, 39.2, 41.4 and 34.1 for GII, compared to 67.2, 66.1, 68.3, 65.1 for the control), for the eggs treated 1, 2, 4 and 8 days post parasitization, respectively. The respective values for the emergence rate for GII decreased compared to GI and the control, the recorded values were 68%, 62%, 63%, 61% for GI & 54%, 50%, 48%, 42% for GII, compared to 77%, 75%, 75%, 77% for the control. The longevity and sex ratio did not differ significantly from those recorded for the control.

Fenitrothion (Sumithon): Treatment with this chemical insecticide caused a highly decrease in the emergence rate, the recorded values were 0% - 16% compared to 73% -77% for the control. Also this chemical caused death of the emerged adults within few hours post emergence (0–1 day) compared to (4–7 days) for the control so no data were recorded for the second generation.

Lambda-cyhalothrin: The number of black eggs was slightly affected, but the emergence rate highly decreased compared to the control. The recorded values for the emergence rate were (31% and 23%) for those treated one and two days post pararsitism, while no emergence was recorded for those treated 4 and 8 days post parasitism compared to (73% - 77%) for the control. As for the second generation, the emergence rates were 39% and 40% when treatment was one and two days post parasitism.

Spinosad: The emergence rate for all treatments was very low (3-5%) and the emerged adults died within 6-12hrs after emergence. It was noticed that the two concentrations of Spinosad gave the same effect on the immature stages of the egg parasitoid *T. evanescens* (same number of black eggs – same emergence rate – same percentage of females – same longevity for females and males)

Statistical analysis, showed highly significant differences of black eggs between the control and all the studied insecticides. As for comparing insecticides with each other there were significant and insignificant differences between each other for the

numbers of black eggs as well as emergence rates (Table 1). The differences in percentages of females between the tested insecticides and the control were significant (Table 2).

Table (1): Number of black eggs and emergence rate of the egg parasitoid *Trichogramma. evanescens* treated with five insecticides. (n =20)

Insecticides	Time of treatment after parasitism (days)															
	One – day				Two - days				Four - days				Eight – days			
	No of black eggs		Emer. Rate %		No of black eggs		Emer. Rate %		No of black eggs		Emer. Rate %		No of black eggs		Emer. Rate %	
	G I	G II	G I	G II	G I	G II	G I	G II	G I	G II	G I	G II	G I	G II	G I	G II
CAPL-2	0.0	==	==	===	0.0	===	===	===	44.2±3.2 b	===	0.0	===	45.2±2.1 b	==	0.0	===
fenitrothio (Sumithon)	43.2±3.1 b	0.0	16±1.8% b	===	45.1±3.2 b	0.0	12±2 % d	===	40.3±2.6 c	0.0	0.0	====	41.2±3.1 c	0.0	15±1.9% c	===
Profect (w.p.).	44.2±3.1 b	42.2±3.1 b	68±4.8% b	54±3% b	44.1±3.2 b	39.2±3.9 b	62±2 % b	50±3.6% b	41.3±2.6 c	41.4±3.9 b	63±3.9% b	48±4.1% b	39.2±3.1 c	34.1±2.2 b	61±3.9% b	42±1.8% b
Lambda-cyhalothrin	44.2±3.7 b	36.1±3.3 c	31±2.2% c	40±1.8% c	42±2.2 c	34.2±3.2 c	2±2.43% C	39±3.9% c	37.2±3.3 d	===	0.0	===	35.2±3.2 d	===	0.0	===
Spinosad	38±1.7 c	0.0	3±0.7% d	===	40±3.1 d	0.0	3±0.9% e	==	38±2.7 d	0.0	8±.0.7% c	===	33±3.2 e	0.0	3±0.7% d	==
Control	67.2±2.5 a	67.2±2.5 a	77±4.1% a	77±4.1% a	66.1±3.1 a	66.1±3.1 a	73±4.% a	73±4.% a	68.3±2.3 a	68.3±2.3 a	75.3±2.9 a	75.3±2.9 a	65.2±2.3 a	65.2±2.3 a	77±29.% a	77±29.% a
LS D	2.02	1.71	1.79	1.67	1.69	1.55	1.60	1.67	1.84	1.31	0.99	1.18	1.98	1.15	1.48	0.99

Means with the same letter are not significantly different GI = first generation GII= second generation

Table (2): Longevity (days) and female percentage of the egg parasitoid *Trichogramma. evanescens* treated with five insecticides. (n =20)

Insecticides	Time of treatment after parasitism (days)															
	One – day				Two - days				Four - days				Eight – days			
	Longevity (days)		Female %		Longevity (days)		Female %		Longevity (days)		Female %		Longevity (days)		Female %	
	G I	G II	G I	G II	G I	G II	G I	G II	G I	G II	G I	G II	G I	G II	G I	G II
CAPL-2	===	==	==	===	===	===	===	===	===	===	====	===	===	==	===	===
fenitrothio (Sumithon)	1.0	===	49±0.8% d	===	1.0	===	52±2 % c	===	===	===	===	====	1.0	===	54±1.8% c	===
Profect (w.p.).	F 7, M 4	F 6, M 3	65±2.2% b	64±1.8% b	F 7, M 4	F 7, M 3	62±2.3% b	64±3.9% b	F 6, M 4	F 6, M 4	63±3.9% b	68±3.9% b	F 6, M 4	F 7, M 4	61±3.9% b	62±3.9% b
Lambda-cyhalothrin	F 6, M 3	F 6, M 3	59±2.2% c	55±3.2% c	F 6, M 3	F 6, M 3	63±2.2% b	49±2.4% b	===	===	===	===	===	===	===	==
Spinosad	12 hrs	0.0	65±4.4% b	====	12 hrs	0.0	61±3.6% b	====	6 hrs	0.0	62±2.9% b	===	6 hrs	0.0	55±3.4% c	===
Control	F 7, M 4	F 7, M 4	68±2.1% a	68±2.1% a	F 7, M 4	F 7, M 4	63±2.% a	63±2.% a	F 7, M 4	F 7, M 4	65±2.2.% a	65±2.2.% a	F 7, M 4	F 7, M 4	67±2% a	67±2% a

Means with the same letter are not significantly different F = female M = male GI = first generation GII= second generation

Vianna *et al.* (2009) studied the toxicity of certain insecticides to *Trichogramma* spp. and their effect on descendant generation. They reported that the parasitism rates were reduced, also the females emerged from eggs treated with insecticides were not able to lay eggs. Shoeb (2005), studied the effect of insecticides on *T. evanescens* and found that profenofos and the natural oil, K-Z, were harmful to the immature stages of the parasitoid while the bio-insecticide, Protecto (*Bacillus Thuringiensis*.) had the least deleterious effect. Longevity of adults emerged from the treated eggs did not differ significantly from that of the control. It was interesting that K-Z oil was found to be detrimental to the parasitoid with almost similar effect of the chemical insecticide. This fact could be interpreted as K-Z oil may contain a toxic material which harms the parasitoid, or the oil, covering the egg-shell, prevents oxygen from the egg and immatures. Kawamura *et al*. (2001) studied the toxicity of six insecticides, acephate, methomyl, ethofenprox, cartap, chlorfluazuron, and *Bacillus*

thuringiensis (Bt) to different developmental stages of *Trichogramma dendrolimi*. The results indicated that each of the insecticides tested showed different degrees of toxicity to the parasitoid. Ethofenprox showed the highest toxicity followed by cartap. compared to the other insecticides. The development of the parasitoids in eggs treated with these two insecticides was normal, similar to that of the control group. Only the emergence of adult wasps from host eggs was disturbed. Adult female wasps, which emerged from host eggs treated with such two insecticides had the ability to oviposit normally. Vianna *et al.* (2009) studied the effect of nine insecticides used in tomato production on adults of two populatios of *Trichogramma pretiosum* Riley. They reported that *Bacillus thuringiensis*, lufenuron and triflumuron had the lowest negative effects on parasitism; however, abamectin and pyrethroids (betacyflurin 50 and esfenvalerate) insecticides reduced parasitism rates. *T. pretiosum* emerged from *A. kuehniella* eggs treated with esfenvalerate were not able to parasitize untreated eggs of this host. Geraldo *et al.* (2003) reported that: Abamectin, lufenuron and pirimicarb decreased the lifetime of females exposed during the egg or larval stage. The capacity of parasitism was significantly reduced by all the products when females were treated in pupal stage. Jayf *et al.* (2001), reported that pesticides were evaluated for their effect on two parasitoid species, *Colpoclypeus florus* and *Trichogramma platner*. Results indicated that spinosad was moderately toxic at 10% and highly toxic at 100% of the recommended rate. Adeney *et al*. (2008), reported that Esfenvalerate 7.5 and spinosad 24 grams/ ha were harmful to all immature stages of *T.pretiosum.* Negative results with spinosad on parasitoids from the genus *Trichogramma* were also reported by Canete (2005). Chares *et al.* (2000), reported that spinosad and prophenofos were the most toxic compounds to *T. exiguum* adults, followed by lambda cyhalothrin, cypermethrin, and thiodicarb. Plewka *et al.* (1975), also reported that some insecticides did not penetrate the host egg-chorion (*Sitotroga cerealella*), and *Trichogramma* spp. were affected only upon emergence from the eggs. Delpuech and Meyet (2003), reported that there was a decrease in sex ratio for the offspring of treated females. This decrease in sex ratio was interpreted to be resulting from a decrease in fertilized eggs due to the perturbation of nerve transmissions induced by the insecticide. On the other hand, Suh *et al*. (2000), reported that, regardless of the developmental stage treated, none of the insecticides tested had a significant effect on the sex ratio.

Thus, this study gives important results that will help to choose the best pesticide to be applied since products with the lowest impact on biological control agents are the most appropriate to be used in IPM programs. However, it is important to point out that this research was carried out under laboratory conditions where the parasitoid was submitted to the highest possible pesticide pressure, then, under field conditions pesticides might have their negative impact reduced because the biological control agents can benefit from natural shelters or avoid treated areas. Moreover, sunlight degradation plays an important role in the field that also helps to decrease the impact of pesticides on the beneficial arthropods observed in laboratory (Rocha & Carvalho, 2004).

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ARABIC SUMMERY

تأثير بعض مبيدات الآفات على الأطوار غير الكاملة لطفيل الترايكوجراما ايفانسينس *Trichogramma evanescens* West.

منى عبد الحميد شعيب
قسم المكافحة البيولوجية - معهد وقاية النباتات – مركز البحوث الزراعية – الدقى

تم اجراء دراسات معملية لدراسة تأثير مبيدات الآفات (Profect (w.p.), CAPL- 2, Lambda-cyhalothrin, Spinosad, and Fenitrothion (Sumithon) على الأطوار غير الكاملة لطفيل الترايكوجراما ايفانسينس وذلك لجيلين متتاليين.

فى هذه الدراسة تم معاملة بيض العائل المعملى (بيض فراشة الحبوب) المتطفل عليه بطفيل الترايكوجراما ايفانسينس بعد يوم ، يومين ، 4 أيام و 8 أيام عقب التطفل (أى عندما يكون الطفيل فى أطواره غير الكاملة).

و قد أوضحت النتائج أن:-

1- معاملة البيض المتطفل عليه بالمبيدات أدى الى تأثير كبير فى فترة حياة الطفيليات الخارجة من البيض المعامل . حيث تراوحت فترة حياة الاناث الخارجة من البيض المعامل بالمبيدات من 12 ساعة الى 7 أيام (مقارنة بالكنترول 7 أيام) ، أما فترة حياة الذكور فقد تراوحت من 12 ساعة الى 4 أيام (مقارنة بالكنترول 4 أيام).
2- تأثر عدد البيض المعامل بالمبيدات الذى تحول الى اللون الأسود (تحول يرقة الطفيل داخل بيضة العائل من طور اليرقة الى طور العذراء) بتوقيت معاملة البيض المتطفل عليه (الفترة من التطفل الى المعاملة بالمبيدات).
3- تأثرت نسبة خروج الأفراد الكاملة من البيض المعامل بالمبيدات بكل من :- نوع المبيد – الطور غير الكامل للطفيل داخل بيض العائل – الجيل الذى تمت دراسته.
4- لم يحدث خروج للأفراد الكاملة للطفيل عند معاملة البيض (فى أى عمر من أعمار الطفيل) بمبيد CAPL- 2 .
5- لم يحدث خروج للأفراد الكاملة للطفيل عند معاملة البيض بمبيدات (Lambda-cyhalothrin, pinosad, and fenitrothion (Sumithon)) وذلك عندما تمت معاملة البيض بعد يوم ، يومين ، 4 أيام بعد التطفل ولكن سجلت نسب خروج ضئيلة جدا عندما تمت المعاملة بعد 8 أيام من التطفل (24 ساعة قبل الخروج).
6- انخفاض ضئيل فى نسب الآناث بين الأفراد الخارجة من بيض العائل المعامل بالمبيدات وذلك لجميع أنواع المبيدات.