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Preliminary Study on the Combined Effect of Mating Disruption and Inundative Releases of *Trichogramma evanescens* (West.) against the Olive Moth, *Prays oleae* (Bern.)

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ABSTRACT

Three comparable olive groves (3.1 ha, each) of the same olive varieties (Toffahi and Shamy) were chosen in 2002-2003 olive season to study the combined effects of mating disruption and releases of an egg-parasitoid on the olive moth, *Prays oleae*. Field releases of 900000 wasps/ha/release were applied on olive trees against the anthophagous, carpophagous and phyllophagous generations of the olive moth on plots of the first and second olive groves. In addition to *Trichogramma* releases on plots of the first olive grove, mating disruption technique was performed once against the carpophagous generation of the same pest. The third olive grove was left without treatments for comparison. In *Trichogramma* releasing plots, parasitization by female wasps was mostly encountered on eggs of the jasmine moth, *Palpita unionalis* than on *P. oleae* eggs. The outcome of the combined effect of inundative releases of egg wasps with mating disruption technique was successful and could provide a model for control of lepidopterous pests of olive trees. Olive grove received both treatments characterized by lowest male catches in delta-wing traps, lowest weight of pre-mature fall of olive fruits and highest weight of fruit harvest/tree. Importantly, two different endemic *Trichogramma* species other than *T. evanescens* were collected for the first time in olive farms during the present work. Those were *T. cordubensis* and *T. nr. Pretiosum*. The new species will be mass-reared and tested during the next olive season.

Key Words: *Prays oleae*, mating disruption, *T. evanescens*, endemic species

INTREODUCTION

The olive moth *Prays oleae* (Bern) (Lepidoptera; Yponomeutidae) is an oligophagous insect, infesting all cultivated varieties of olive. *P. oleae* also develops on all wild species of the genus *Oleae* and even on plant species of different genera in the family Oleaceae (Katsoyannos, 1992). It is one of the most important insect pests of olives in the Mediterranean basin (Lopez-Villalta, 1999). There are three generations of olive moth, each of which develops on different plant organs. The first (anthophagous) generation lives and develops on the flower buds and flowers; the second (carpophagous) generation lives on the fruit and the larvae develop inside the fruit, damaging the kernel; the third (phyllophagous) generation develops on the leaves. The second and third generations of moth are relatively difficult to reach with insecticides, because the larvae bore into the fruits and make mines in the leaves immediately after hatching, in respect (Pelekasis, 1962). Only the first generation is regarded as rather easy to control by spraying insecticides targeted at the larval stage. The characteristic of feeding behaviour of this moth species, during its larval stage, requires the development of an integrated pest management approach for its suppression (Mazomenos *et al.*, 1999).

Various methods used for the suppression of the moth population have been reported. The larvae of the first generation are susceptible to commercially available standard strains of *Bacillus thuringiensis* (var. *kurstaki*). Under the most optimal conditions, 90% mortality has been achieved (Yamurias *et al.*, 1986). For the second and third generations, the control measures should be concentrated on the adult stage (Mazomenos *et al.*, 1999). Recently, with the development of slow release formulation technology sex pheromones have been used successfully in mating disruption trials for suppression of the population in many lepidopterous species including *P. oleae* (Campion *et al.*, 1979; Ramos *et al.*, 1989; Mazomenos *et al.*, 1999).

Egg parasitoids, however, have been widely used against several pests on agriculture and forestry. *Trichogramma* spp. have been used, on a particular large scale, on corn, sugar cane, cotton, fruit trees and vegetables (DeBach, 1974; Stinner, 1977; DeBach and Rosen, 1991; Li Li-Ying, 1994), and researches are still carried out in several laboratories in order to develop new biological control programs with these tiny hymenopterous parasitoids. However, no one has investigated the combined use of *Trichogramma* and other useful methods such as mating disruption.

This paper describes the possibility *P. oleae* control by the combined use of mating disruption and *T. evanescens*.

MATERIALS AND METHODS

Field releases of *T.evanescens* (TR) were applied against flower, fruit and leaf generations of the olive moth *Prays oleae*. An olive farm of 8-9 y old in olive producing zone between Alexandria and Cairo, 177 km south Alexandria was selected. A large plot (5 ha) of Toffahi and Shamy varieties was divided into five sub-plots, each of about 1 ha. One (in sub-plot I) and two (in sub-plot IV) areas (each 6x6 trees/area) were selected for *Trichogramma* releases. Twelve releases were performed to cover the first (anthophagous), the second (carpophagous) and the third (phyllophagous) generations of the olive moth, *P. oleae* and also against the permanent presence of the jasmine moth, *Palpita unionalis* during the olive season of 2003. In each release, the recommended dose, 900000 wasps/ha, was applied where 3 cards (3000 wasps/card) were installed on each tree. Three areas of the same size were selected in sub-plots II, III and V and left without treatment. The experimental area on sub-plot I was treated with *P. oleae* pheromone (40 g a.i./ha) in addition to the regular releases of *Trichogramma* wasps. Pheromone dispensers were placed in the field in coincidence with the second flight of the olive moth. The area was treated by installing 3 pheromone dispensers on each tree of the selected area of sub-plot I. At each experimental area, delta wing traps, baited with (Z)-7-tetradecental were installed to monitor the flight phenology of the olive moth. The pheromone dispensers of the traps were changed every generation. The distance between traps was more than 60 m from each other. The traps (3/ha) were served once a week from Feb, 19th to end of August, 2003. For evaluation of infestation rates by *P. oleae* or jasmine moth, *P. unionalis* , ten trees of each selected area of sub-plots I-V were randomly chosen. Ten olive shoots from each of four cardinal quadrant/tree were collected once per week. Number of eggs/species and percentages of parasitism were carefully recorded. Premature fruit drop caused by *P. oleae* or *P. unionalis* was recorded by spreading a plastic sheet on the ground under the trees (4 trees/site) from time of fruit setting to the harvest. All fallen fruits on the sheet were collected and weighed. For each sample, the number of fruits in 100 g per tree was counted to extrapolate the total number of fallen fruits/tree from their weights. In the lab at each time, 200 fruits/sample were examined to record reasons of dropping. Olive harvest of the treated and untreated sites was carefully gathered and weighed.

RESULTS AND DISCUSSION

Due to the unusual weather conditions of 2003 which coincided with low fruit yield, it was decided to perform twelve inundative regular releases of *T. evanescens* wasps at 2-week intervals to cover the three generations of the olive moth *P. oleae* and also the permanent presence of jasmine moth, *P. unionalis* in 2003 season.

In plot 4 where 2 sites (each 6x6 trees) were only treated with *Trichogramma* wasps, the range of male population of *P. oleae* was at lower level in TR sites compared to "CO" plot (Fig. 1). In plot I where one site (6x6 trees) was treated once on April 16th with *P. oleae* pheromone in addition to the regular releases like those of plot IV, no olive moths were caught in the delta trap that was installed in the site centre (Fig. 2). Reduction in catches of TR plots resulted in decreasing number of eggs of target insects on olive shoots in treated sites compared to "CO" site (Fig. 3). The differences in reduction of proportions of eggs of olive or jasmine moths were greater in samples of TR sites during the periods of late Feb. to late March and from late May to late July (data not shown). The full season count of eggs/20 olive shoots/tree of either olive or jasmine moth was significantly ($P<0.001$) higher on CO site than on the other treated sites. Interestingly, no significant differences were detected between the full season counts of eggs of the olive moth, *P. oleae* on TR- and TR-Pher-sites. The latters are non-isolated sites. So, the high density of *P. oleae* moths in untreated sites surrounding the mating disruption site on sub-plot I, placed pressure on the mating disruption and gravid female moths might be emigrated from untreated sites into the TR-Pher-sites. The combined effect of mating disruption and *Trichogramma* wasps on reduction of *P. oleae* population size might be masked by the presence of foreign gravid females in TR-Pher site. Pelekasis (1962) estimated that the olive moth adults are able to disperse for up to 200-400 m within the olive grove.

Importantly, parasitization by *Trichogramma* wasps in eggs of either olive or jasmine moth was commonly encountered in the treated plots during the study period (Feb. 2nd - July 23rd, 2003) with higher values in TR-site than TR-Pher-one. Generally, Parasitism in eggs of the target pests was higher on TR sites than CO site. Moreover, in CO site, parasitism on *P. unionalis* was mostly encountered than on *P. oleae* eggs.

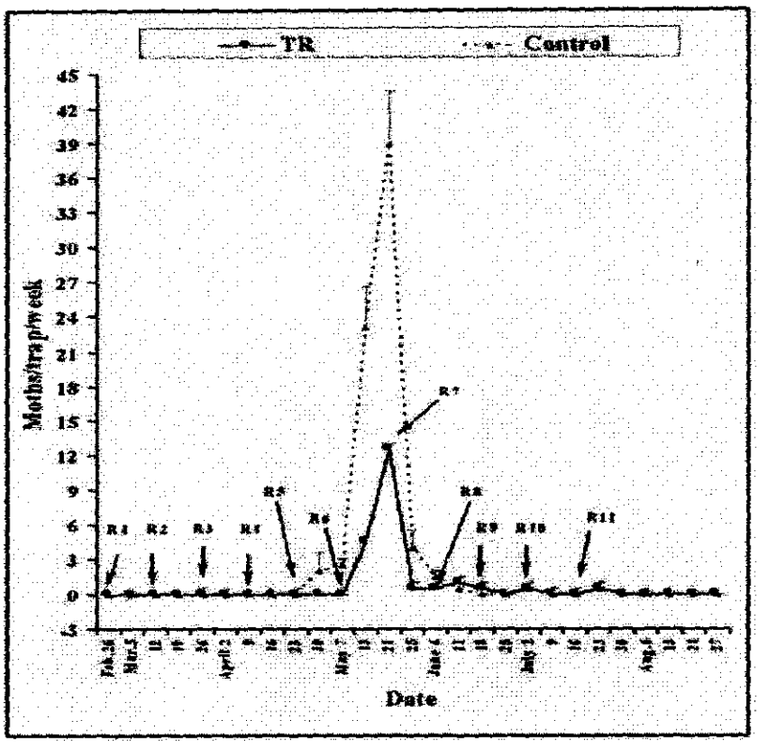

Fig. (1): Weekly catches of *Prays oleae* moths in delta-wing traps installed in control and *Trichogramma* releasing sites at Paradise Park (plot IV), in 2003 season.

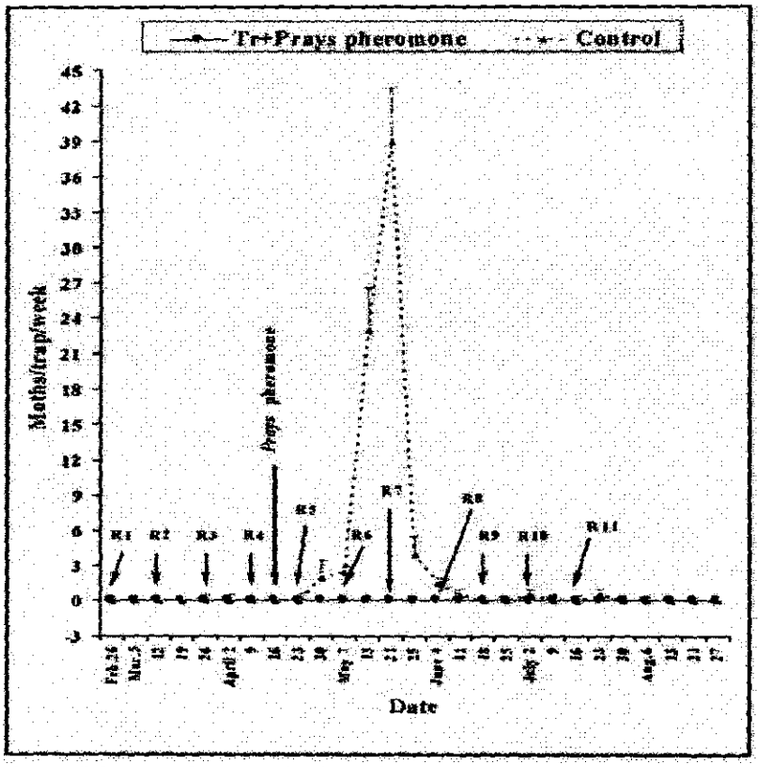

Fig. (2): Weekly catches of *Prays oleae* moths in delta-wing traps installed in *Trichogramma* release site combined with treatment of *P. oleae* pheromone (TR + Prays Pheromone for MD) and control site at Paradise Park (plot 1), in 2003 season.

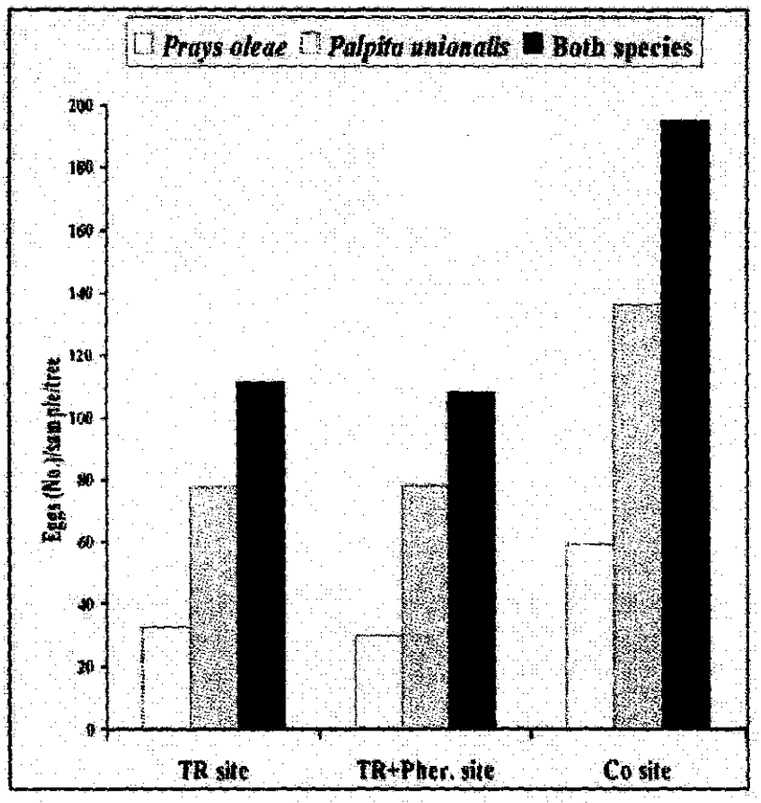

Fig. (3): Full season counts of eggs of the olive, *Prays oleae*, and jasmine, *Palpita unionalis*, moths per 20 olive shoots/tree at *Trichogramma* release site (TR site), *Trichogramma* release site treated with Prays pheromone (TR + Pher. site) and control site (Co site).

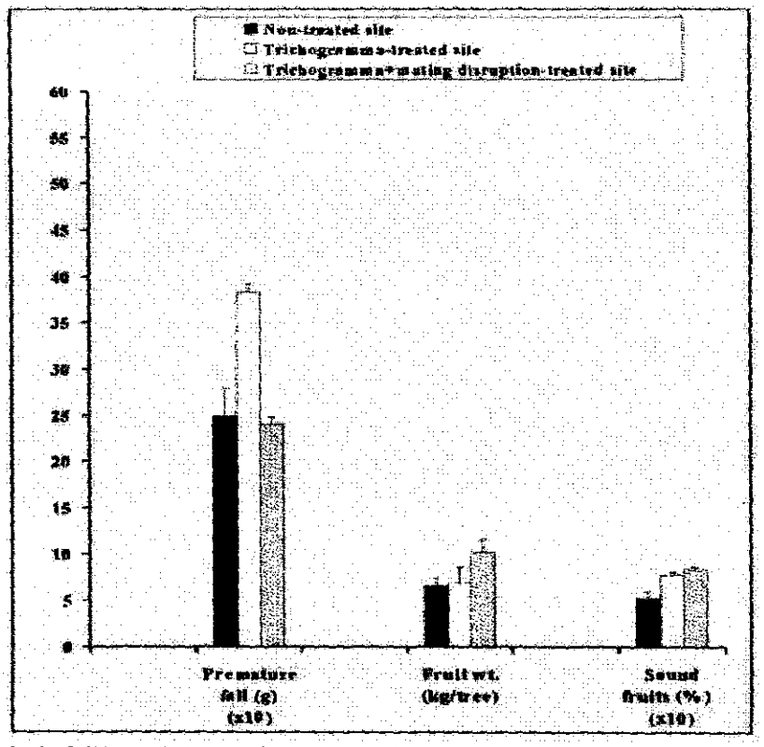

Fig. (4): Premature fruit fall/tree (May 15th - August 8th), fruit yield/tree and percentage of sound fruits at harvest time of plots of three sites.

This is possibly due to activity of two endemic *Trichogramma* species other than *T. evanescens*. One is very interesting theletokous species, a little bit darker than *T. cacoeciae*. It was bred from eggs of both species. The other one is arrhenotoky (*T. nr. pretiosum*) collected from naturally parasitized *P. oleae* eggs.

As far as fruit fall (infested and natural) is concerned (Fig. 4), the amounts of fallen fruits were, in general, low (year 2003 of low fruit crop) with an up and down changes in densities. This was, in part, due to unusual prevailed weather conditions in 2003-season. In most cases, greater weight fall was observed on TR site than on either CO or TR-Pher-sites. The premature fall of fruits on all sites was mostly from factors other than insect infestation. However, the percentage of infestation of the fruits that fell by *P. oleae* was generally very low, but higher on CO site than on TR-treated ones during the period from late May to the first decade of August. Fruit fall caused by *P. unionalis* larvae was also low on both sites with higher values from June 25th to August 8th on CO site compared with TR-treated sites (data not shown). It was observed that when the fallen fruits dried out, they become infested by 3 microlepidopterous species. The eggs of the latter are attacked by *Trichogramma* wasps which leave the tree canopy during the hot summer months and stay active during summer and autumn time of the year under the tree's canopy.

Figure 4 shows the fruit yield/olive tree and percentages of sound harvested fruits on CO and treated sites. Fruit harvest/tree was slightly greater by weight, but significantly greater by numbers of fruits/tree of TR site compared with CO site (data not shown). Weight of fruit yield/olive tree (Fig. 4) was significantly greater ($P<0.05$) on olive trees of TR-Pher-sites than either on olive trees of TR or CO sites suggesting a positive combined effect of mating disruption and *T. evanescens* wasp. Interestingly, percentage of fruits infested by the olive fly (*Bactrocera oleae*) was significantly higher in 2003 season than in the preceding year (data not shown). This may be due to the lower yield of fruits in 2003 season. The percentage of sound fruits was significantly higher on treated sites than CO one (Fig. 4).

The outcome of inundative releases of *Trichogramma* wasps combined with mating disruption was partially successful and could provide a model for control of lepidopterous pests of olive trees, especially when: (1) the endemic species, e.g., *T. cordubensis* and *T. nr. pretiosum* are used, (2) the right adapted candidate of *Trichogramma* would be reached (Hassan and Zang, 2001) It should be taken in consideration the right time and dose of each release, the emergence time of adult wasps and duration of activity of wasps under field conditions (Hassan, 1993), and (3) isolated olive groves are available (Mazomenos *et al.*, 1999).

The study concluded that it was feasible to manage the olive moth, *P. oleae* in olive farms by applying the technologies of mating disruption and inundative release of *Trichogramma* wasps. The small plots received both treatments showed reduction of the pest population size (Fig. 2) and significant increase in crop yield (Fig. 4).

ACKNOWLEDGEMENT

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دراسة تمهيدية عن التأثير الجامع لإعاقة التزاوج والإطلاقات الإغراقية لطفيل البيض *Trichogramma evanescens* West. ضد فراشة الزيتون *Prays oleae* Bern.

ع.م. حجازى [•]، ع. عجمى [••]، ش. حسن [•••]، أ. هرتز [•••]، و. خفاجى [••••]، س. شويل [••••]، ل. أبو عبدالله [••••]، أ. زيتون [•]، م. حافظ [•]، س. السيد [•]، أ. الشاذلى [•]، ع. المنشاوى [•]، هـ. كرم [•]، ن. خميس [•]، س. القمنى [•]

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تم إختيار ثلاث مزارع متقاربة تحوى نفس أصناف الزيتون لدراسة التأثير الذى يجمع إعاقة التزاوج وإطلاقات طفيل البيض *Trichogramma evanescens* West. على فراشة الزيتون *Prays oleae* Bern. تم إطلاق ٩٠٠٠٠٠ طفيل/هكتار/إطلاق ضد جيل الأزهار وجيل الثمار لفراشة الزيتون فى القطاعات التجريبية فى المزرعة الأولى والثانية. فى المزرعة الأولى، بالإضافة إلى إطلاق الترايكوجراما، فقد تم تطبيق تكنيك إعاقة التزاوج ضد جيل الثمار على نفس الآفة. تركت المزرعة الثالثة دون معاملات للمقارنة. تميزت مزرعة الزيتون التى تم معاملتها بالطفيل وإعاقة التزاوج بأقل تعداد لذكور الحشرة فى المصائد الفرمونية وبأقل نسبة سقوط للثمار الساقطة غير مكتملة النمو وبأعلى إنتاج لثمار الزيتون/شجرة. لم تشاهد إختلافات معنوية بين عدد البيض/٢٠ فرع زيتون/شجرة عوملت فقط بطفيل الترايكوجراما وتلك التى عوملت بالطفيل وفرمون فراشة الزيتون معا. ومع ذلك كانت نوعية وكمية ثمار الزيتون/شجرة أعلى على الأشجار التى عوملت بكلا المعاملتين مقارنة مع تلك التى عوملت فقط بالطفيل. أمكن جمع نوعان جديدان من طفيل الترايكوجراما أثناء إنجاز هذا العمل سيجرى لها إنتاج موسع وإختبار فى موسم الزيتون القادم. وقد أوضحت النتائج نجاح التأثير الجامع لإعاقة التزاوج وإطلاق الطفيل وإمكانية إمدادنا بنموذج عن مكافحة الآفات حرشفية الأجنحة لأشجار الزيتون.