Optimization of the Field Performance of Released *Trichogramma* spp. in Olive Groves in Egypt

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ABSTRACT

The egg parasitoid species *Trichogramma bourarachae* Pinturaeu and Babault, *T. codubensis* Vargas and Cabello, *T. euproctidis* Girault, all collected from olive groves in Egypt as well as the commercially available *T. evanscens* Westwood, originating from sugarcane fields in Egypt, were released and monitored under laboratory and olive field conditions in 2004 season to study their emergence rate and duration of wasp availability. The releasing doses were ca 3000 wasps/card/species. Peaks of adult emergence varied according to the species and date of testing. In contrast to the commercial species, the achieved doses of the three local species did not differ between the laboratory and field conditions also during the third trial "release" and accounted in all cases to satisfying values. However, reduction in emerged *T. evanescens* wasp was significantly greater under field conditions (41%) than under laboratory conditions (23%). The results suggested that *T. bourarachae* and *T. cordubensis* were better adapted to warm and dry weather conditions than the other test species. The pattern of emergence and the resulting duration of availability of wasps in the field were more promising for the species *T. bourarachae* and *T. cordubensis* to be used for inundative releases in olive farms in arid areas. The results: a) suggest the importance of such studies to select and manage available local wasp species as a prerequisite for successful control of target pests and 2) provide useful information for timing of inundative releases during the olive season.

Key Words: *Trichogramma bourarachae, T. cordubensis, T. euproctidis, T. evanescens*, releases, olive groves, emergence pattern, wasp availability

INTRODUCTION

The olive moth, *Prays oleae* (Bernard) (Lepidoptera, Yponomeutidae) and the jasmine moth, *Palpita unionalis* Huebner (Lepidoptera, Pyralidae) are major pests on olive in Egypt. They cause direct yield loss by increasing fruit fall, damaging leaves, flowers and fruits, thus lowering tree growth, fruit set and fruit/oil quality. The olive moth infests all cultivated varieties of olives, wild species of the genus *Oleae* and also other species of different genera in the family Oleaceae (Lopez-Villalta, 1999). It is one of the most important insect pests of olives in the Mediterranean basin. The moth develops three generations per year (Pelekasis, 1962 & Arambourg, 1986). In Egypt, the presence of ovipositing females is prolonged resulting in a long overlapping of the first and second generations (Hegazi *et al.*, 2004). The damage caused by this insect can reduce production at a level of 50 to 60% which equates to 8-11 kg per tree of modern cultivars (Ramos *et al.*, 1998 & Patanita and Mexia, 2004). The jasmine moth distributes throughout the Mediterranean region, Asia Minor, and North Africa. It attacks several plant species belonging to the Oleaceae (*Jasminum* sp., *Ligustrum* sp., *Olea europea* and *Phillyrea media*) (Mazomenos *et al.*, 1994). It develops seven generations throughout the year in Egypt (Hegazi *et al.*, 2007). In nurseries or young orchards, it can cause severe damage on olive leaves and shoots, thus seriously affecting tree growth. During heavy outbreaks, the larvae also attack the olive fruits, especially of table varieties, making them unacceptable to the commercial market (Balashowsky, 1972; Foda, 1973; El-Kifl *et al.*, 1974 & El-Sherif, 1975).

Control of olive and jasmine moths is usually achieved by application of insecticides such as dimethoate, methidathion, endosulfan, cypermethrin, carbaryl and trichlorfon (Lopez-Villalta, 1999). In Egypt, the usual chemical control strategy implies 7 to 8 insecticide treatments. The method is effective for the jasmine moth and the first generation of the olive moth (>90% mortality). However, chemical application against the second generation of *P. oleae* larvae often caused a mortality rate of only 30 to 45% (pers. com., Egyptian Ministry of Agriculture, Cairo). In general, the use of insecticides and other chemical treatments implies the risk of adverse ecological, toxicological and economic effects (Youssef *et al.*, 2004). Both jasmine and olive moths can be controlled by using preparations of *Bacillus thuringiensis kurstaki*, but only external feeding stages of the target pests are affected by this method (Yamvrias *et al.*, 1986). Alternative techniques include the use of insect predators and parasitoids.

Today, egg parasitoids of the genus *Trichogramma* are the most widely used insect natural enemies in the world (Li-Ying, 1994). When selecting species for biological control, naturally occurring species and their particular biology should be considered. A local species is generally preferred on the basis that it is likely to be better adapted to the ecological conditions than an exotic species (Smith, 1996). Monitoring of the existing local *Trichogramma* species in olive groves in Egypt revealed the presence of four *Trichogramma* species which naturally parasitized the eggs of the olive and jasmine moths. *T. bourarachae* was exclusively collected from Burg El-Arab (semi-arid area), near the coast at Alexandria. The three other species (*T. cordubensis*, *T. cacociae* and *T. euproctidis*) were isolated from an olive grove near Cairo (arid area) (Hegazi *et al.*, 2005).

In order to test the suitability of these species for field releases to control the olive and jasmine moths, this study was conducted to investigate the emergence pattern and achieved releasing doses of mass reared wasps under field conditions in comparison to laboratory conditions .

MATERIALS AND METHODS

The local species of olive farms and the commercial available species *T. evanescens* were reared on the Angoumois grain moth, *Sitotroga cerealella*. *T. bourarachae*, *T. euproctidis* and *T. evanescens* are biparental (arrhenotokous) species, while *T. cordubensis* is thelytokous. For each species, a mixture of parasitized eggs including immature stages of the parasitoids from 2 to 7 days of age was used. The parasitized eggs were glued on paper stripes (3 x 2.5 cm) which were fixed on the inner surface of a cardboard piece as releasing card (Hassan, 1998). Each releasing card contained approximately 3200 parasitized host eggs and was expected to yield a dose of ca 3000 wasps/card. For field exposure, releasing cards were installed in an olive grove near Cairo (arid area). Five of these cards for each species were randomly distributed among 20 trees located in the centre of the farm (one card/tree). In addition, five cards of each species were kept under laboratory conditions at Alexandria, protected from sun and rain. The number of emerged wasps was recorded daily (laboratory conditions) and after two weeks (field conditions). This experiment was carried out three times to cover the whole period of the presence of the olive and jasmine moths in the field of 2004 olive season. In a separate study, 2 years before the present work, it was observed that ants were predominantly responsible for the removal of considerable amounts of the released material or sentinel eggs shortly after installation in the field (Hegazi *et al.*, 2005). In 2004, we used improved releasing cards that wrapped up the releasing material completely and were stapled on their sides, so that ants could not contact it by their antennae (Herz *et al.*, 2005). Furthermore, the experimental trees were protected against the access of ants from the soil by rat's glue (Temo rat, AM-Advanced Industries Co., Egypt) applied on the base of the tree 15 cm above the ground before each release. For data evaluation, percentages were arcsine square root transformed. In the case of differences between means, Duncan's multiple range test or Student's t-test were applied for mean separation (SAS Institute, 1989).

RESULTS AND DISCUSSION

Daily emergence patterns of *T. evanescens*, *T. cordubensis*, *T. bourarachae* and *T. euproctidis* under laboratory conditions are shown in Figs. (1-3). The onset of emergence from the releasing cards slightly varied among the test species. In the first trial, it took 3 days for the local species; *T. cordubensis*, *T. bourarachae* and *T. euproctidis* to emerge (Fig. 1, B-D), whereas *T. evanescens* was available within one day after installation. In the second and third trials, all species except *T. bourarachae*, started to emerge within one day after installation of the released cards under the laboratory conditions (Figs. 2 & 3). During the first trial, wasps emerged over a period exceeding ten days, whereas during the subsequent trials the emergence was completed after 7 to 9 days (Figs. 1 & 3). The peak of emergence varied among the species and the date of testing.

Achieved total doses of various tested species under the laboratory and field conditions are compared in Fig. 4. The difference between the total numbers of emerged wasps at laboratory and field conditions were significant for *T. evanescens* ($P<0.05$) during the third trial, when higher temperatures occurred in the field. Also, the total number of emerged wasps/card varied greatly among the tested species at field conditions. The number of emerged wasps in the first trial reached 3072 ± 90 (*T. evanescens*), 2672.8 ± 80.9 (*T. cordubensis*), 3002 ± 30.5 (*T. bourarachae*) and 2771 ± 60.3 (*T. euproctidis*) wasps/card. These figures accounted to 2246.8 ± 43 (*T. evanescens*),

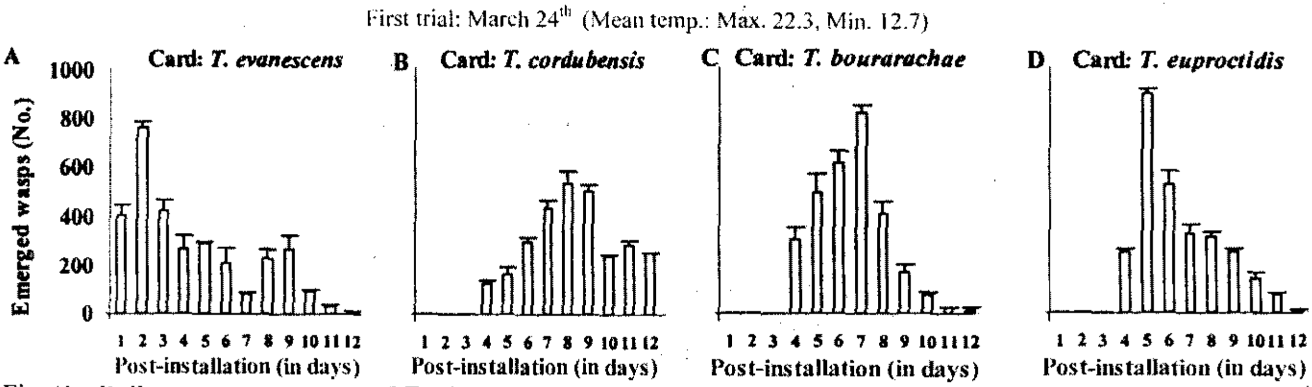

Fig. (1): Daily emergence pattern of *Trichogramma* wasps ("laboratory data") from releasing cards exposed during the egg laying period of the flower generation of *P. oleae* and *P. unionalis*.

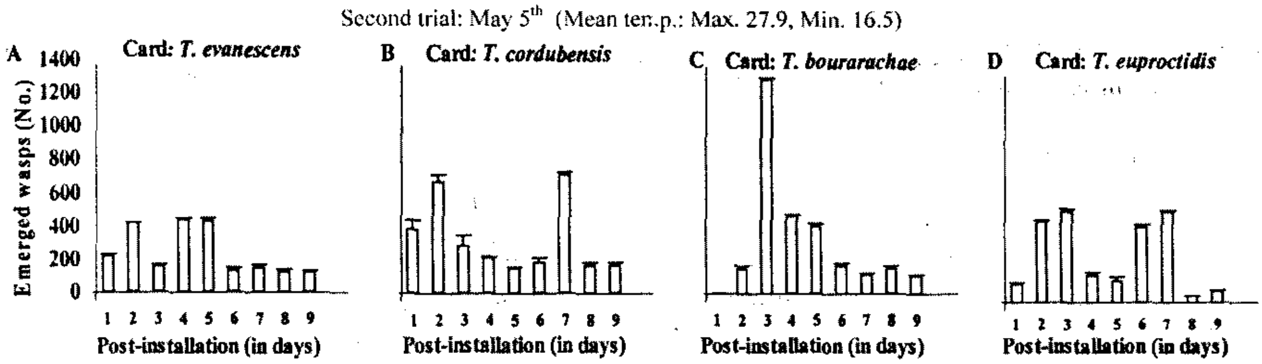

Fig. (2): Daily emergence pattern of *Trichogramma* wasps ("laboratory data") from releasing cards used during the egg laying of the fruit generation of *P. oleae* and *P. unionalis*.

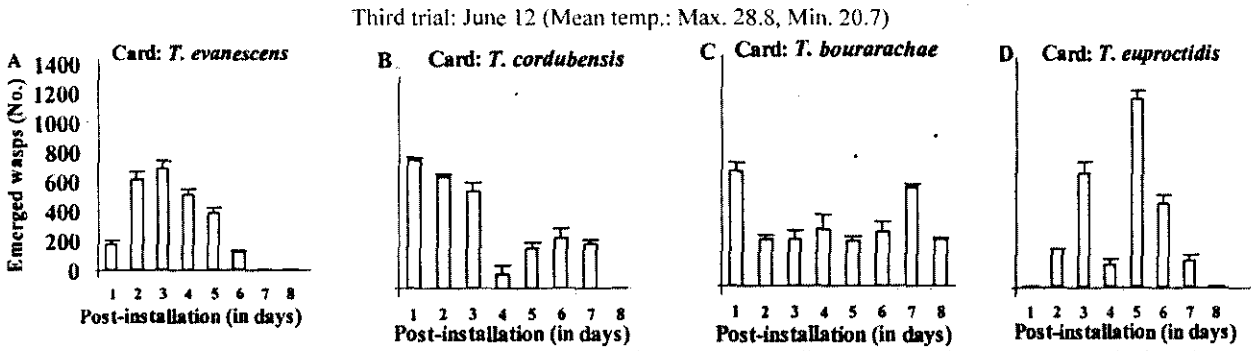

Fig. (3): Daily emergence pattern of *Trichogramma* wasps ("laboratory data") from releasing cards used during the egg laying period of the fruit generation of *P. oleae* and of *P. unionalis*.

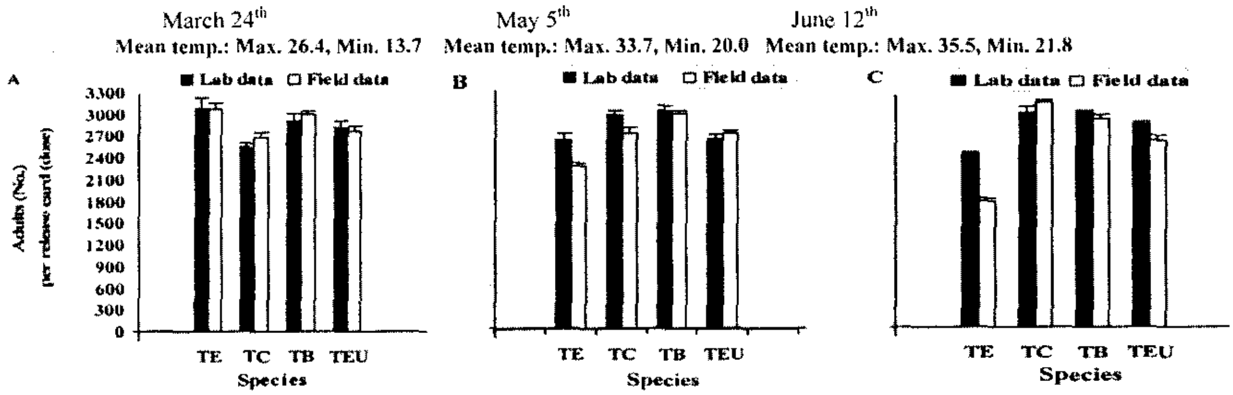

Fig. (4): Laboratory and field data (Mean ±S.E) of wasps emerged from releasing cards (wasp dose) of three trials of four *Trichogramma* species. Temperatures refer to field conditions.

TE: *T. evanescens*, TC: *T. cordubensis*, TB: *T. bourarachae*, TEU: *T. euproctidis*.

2694.5±81.5 (*T. cordubensis*),, 2961.6±55 (*T. bourarachae*) and 2688.1±49.9 (*T. euproctidis*) wasps/card in the 2[nd] trial vs. 1814.0±39.5 (*T. evanescens*), 3221.5±30 (*T. cordubensis*),, 2992.1±50.7 (*T. bourarachae*) and 2679.3±70.4 (*T. euproctidis*) wasps/card in the 3[rd] trial, respectively. There was a significant reduction ($P<0.01$) in the number of emerged *T. evanescens* wasps during the 3[rd] trial (Fig. 4, C) compared with either emerged *T. evanescens* wasps in the 1[st] or 2[nd] trials or with the other tested species. In the third trial, reduction in emergence of *T. evanescens* attained 23 and 41 %at the laboratory (mean Temp. 24.5°C) and at the field (mean Temp. 29.1°C), respectively. This may be due to poor adaptation of *T. evanescens* to hot and dry weather conditions, as they are common during the summer months in olive plantations in arid areas. The obtained results agree with those of Shoeb (2005) who mentioned that under laboratory conditions at 30°C the reduction in emergence rate of *T. evanescens* attained 37.9 compared to 74.7 at 26°C. Poor adaptation to weather conditions is assumed as one factor responsible for failures of *Trichogramma* releases in the field (Hommay *et al.*, 2002). In contrast, the achieved doses of the three local species did not differ between the laboratory and field conditions also during the third trial and were accounted in all cases to satisfying values. Thus, our data suggest that local species may be more adapted to warm weather conditions. But further understanding of the behavior of these local *Trichogramma* species in the olive grove ecosystem is necessary until these species can successfully be used for biological control of olive pests.

The majority of *Trichogramma* species are polyphagous egg parasitoids with an ability to successfully develop in a variety of lepidopterous eggs (Pintureau, 1990). If high numbers of *Trichogramma* are needed to reduce damage by the olive and jasmine moths, do such releases pose a significant risk for other insects that live in the surrounding environment? As consequence of this question, also the interactions of released *Trichogramma* with other pests and other beneficials (e.g. *Chrysoperla carnea*, a common and important predator of olive pests) has to be studied in detail (Kuske, *et al.*2003). In addition, the diversity of locally occurring egg parasitoids in different olive growing zones should be further explored to obtain strains suitable for use in several climatic regions.

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