Biological Control of *Bemisia tabaci* (Homoptera, Aleyrodidae) in Protected Tomato and Pepper Culture in Southern Spain

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Abstract

The whitefly *Bemisia tabaci* Gennadius biotype "Q" is an efficient vector of tomato yellow leafcurl virus (TYLCV), the principal cause of damage in tomato, and also causes direct injury to pepper. Management of this pest in protected culture of these crops in southern Spain has relied primarily on chemical control. aHowever, overlapping crop cycles, insecticide resistance and public pressure have spurred development of alternative management tactics more compatible environment for biological control such as insect netting for pest exclusion, and, in tomato, TYLCV-tolerant cultivars. Nevertheless, there is minimal information on the feasibility of biological control in the commercial tomato and pepper production systems of this region. In pepper, control of *B. tabaci* using augmentative releases of two parasitoids, *E. mundus* and *E. eremicus* alone and in combination (3 treatments) was compared in 12 commercial greenhouses (4 replicates) in Campo de Cartagena. In tomato, a biologically based integrated pest management (IPM) system was evaluated in 12 greenhouses throughout the production area compared with 7 greenhouses utilizing only chemical control. Parasitism rates in pepper were greater and whitefly populations were lower in greenhouses where *E. mundus* was released alone or with *E. eremicus* in a 1:1 mixture as compared to *E. eremicus* alone confirming the value of augmentation with *E. mundus*. In tomato, incidence of parasitized whiteflies in IPM greenhouses where both parasitoids were released averaged around 50%, with E. *mundus* predominating, compared to less than 3% parasitism in conventional greenhouses. Insecticide use was lowest and biological control most effective where TYLCV-resistant cultivars and exclusion strategies (insect netting) were used to reduce whitefly populations and the risk of virus disease. The effectiveness of *E. mundus* and increasing use of compatible control tactics should lead to greater implementation of biologically based pest management in protected tomato and pepper culture.

INTRODUCTION

Spain is a major producer of both tomato and pepper. Production of tomato reached 3.7 million tons from 147,000 acres in 1998, with almost 40% consisting of fresh market tomatoes grown in greenhouses on the southern Mediterranean coast. Sweet pepper is also a major horticultural crop in Spain, with almost 1 million metric tons produced in 2000 (M.A.P.A. 2002). Almost 14% of this production was grown on 1,500 ha in Murcia, principally in greenhouses of "Campo Cartagena" (CC) on the southern Mediterranean coast (INE, 1998).

Transplanting of tomatoes begins in late summer, with a possible additional planting in late winter. Harvesting begins in October, peaks in March, but continues through early summer. The whitefly *Bemisia tabaci* Gennadius is key pest, due primarily to its role as of two types of tomato yellow leaf curl virus (TYLCV). Overlapping crop cycles assure high pest and inoculum levels and heavy pesticide use against captive pest populations. Resistance against imidacloprid and other neonicotinoids has been documented (Cahill et al., 1996, Elbert and Nauen, 2000).

Planting of pepper in Campo de Cartegena typically occurs in late fall and harvest ends in late summer. The principal pest in this crop and region is the western flower thrips, *Frankliniella occidentalis* (Pergande) (Thysanoptera: Tripidae), primarily due to its role as a vector of tomato spotted wilt virus (TSWV). Sweetpotato whitefly *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae) Biotype "Q" (Guirao et al. 1997, Simón, 2002) is an important secondary pest that debilitates the crop through sap removal and downgrades fruit quality through the buildup of sooty mold.

In response to customer demand, buyers are in turn pressuring growers to reduce pesticide use and provide some produce using IPM methods that include only natural enemies and selective chemicals. Pepper growers in the Campo de Cartagena is widely practiced against the western flower thrips *Frankliniela occidentalis* (Pergande) in greenhouse pepper in the northern part of the region around Cartagena, where pepper is planted in late fall or early winter. This system allows sufficient time early in the crop cycle for establishment of the mite *Amblyseis cucumeris* (Oudemans) (Acari: Phytoseiidae) and the minute pirate bug *Orius laevigatus* (Fieber) (Hemiptera: Anthocoridae) (Van der Blom et al. 1997, Monserrat et al. 1998). However, an effective agent against *B. tabaci* was still lacking. Most tomato growers are already conditioned to use selective insecticides because of the almost universal practice of bumblebee pollination. However, biological control is directed at immature stages and cannot control the spread of TYLCV by the whitefly adult in tomato. Virus spread in tomato must first be controlled through a combination of tactics such as TYLCV-resistant cultivars, whitefly-excluding structures, late planting to reduce migration from the previous season's crop, and selective insecticides.

Commercially available options for biological control of *B. tabaci* include *Eretmocerus eremicus* Rose & Zolnerowich (Hymenoptera: Aphelinidae). Thus, North American species is mass reared on the greenhouse whitefly *Trialeurodes vaporariorum* (Westwood) (Homoptera: Aleyrodidae) but equally adapted to both whitefly species as host (Greenberg et al., 2002). However, *E. eremicus* released to control *B. tabaci* on greenhouse tomato and pepper is typically displaced by an indigenous cogenitor, *Eretmocerus mundus* Mercet (Hymenoptera: Aphelinidae), immigrating from outside (Van der Blom, 2002). *E. mundus* is maladapted to *T. vaporiarorum* (Greeenberg et al., 2002) necessitating rearing systems based on *B. tabaci*. The objective of the present studies were to test the feasibility of biologically based IPM in greenhouse tomato and pepper using *E. mundus* for control of *B. tabaci*.

MATERIALS AND METHODS

Tomato Study

1. Greenhouses. A total of 19 greenhouses were selected for the study in four provinces of the southern Mediterranean coast of Spain: Murcia (Águilas, Mazarrón), Almería (Cañada, El Ejido) Granada (Motril), and the Canary Islands (Tenerife, Las Palmas, Fig. 1. All were covered with polyethylene film except those in the Canary Islands, which were covered with polyethylene mesh screen.

2. Pest Management. Natural enemies were released to control whiteflies and other pests in 12 of the greenhouses designated "IPM". The 7 remaining greenhouses relied totally on insecticidal control and were termed "conventional". In five cases, an IPM and conventional greenhouse shared the same location, grower/operator, and growing conditions for paired comparison. Each greenhouse was divided into 4 equal-sized sectors for sampling purposes. In addition, sectors in IPM greenhouses were used for two replicates each of two treatments in a Latin square design. *E. eremicus* (Ercal, Koppert Biological Systems, Berkel en Rodenrijs Holland) (reared on *T. vaporariorum*) was released in 2 of the sectors and *E. mundus* (Bemipar, Koppert Biological Systems S.A., Águilas (Murcia) Spain) (reared on *B. tabaci*) was released in the remaining two. Release rates and timing (based on weekly counts of whiteflies) were made at the discretion of the Koppert consultant responsible for the greenhouse, subject to the grower's approval. Decisions on natural enemy releases and pesticide applications in the IPM greenhouses jointly by the grower and a consultant from Koppert Biological Systems and on pesticide applications in conventional greenhouses by the grower.

3. Pesticide Impact Pesticide applications were noted and their likely impact on natural enemies assessed according to the Koppert Side Effects Guide (Anonymous, 2002). In this guide, effects of pesticides are rated for pupae or nymphs and adults of each natural enemy as: (1) harmless (reduction in control capacity < 25%), (2) slightly harmful (25-50% reduction in control capacity), (3) moderately harmful (50 – 75% reduction in control capacity), or (4) very harmful (> 75% reduction in control capacity). A third rating for persistence in weeks is given as a single number or as a range. The impact of each application in the greenhouse was valued as the sum of the ratings (1 through 4) for pupae and adults of *E. eremicus* or the closest other species given (usually *Encarsia formosa* Gahan (Hymenoptera: Aphelinidae), and the mean number of weeks of residual effect. The sum of these 3 numbers varied between 2 and 18. Impact ratings were summed for each greenhouse and then divided by the number of weeks of monitoring to give an index of incompatibility (II) during the period of study.

4. Monitoring. Each of the 4 sectors of each greenhouse was monitored weekly for pests and diseases by the assigned consultant. Eight yellow sticky traps (Hombio BVBA, Sint-Katelijne Waver, Belgium) were placed at canopy height in each sector, exposing a single fresh 20x12 cm surface every week. Whiteflies were counted up to 25, or classified as medium (26-100) or high (100+). Adult whiteflies and nymphs on an upper, middle and lower leaf of 8 plants in each sector were counted until 10 per leaf or classified as medium (11 to 25) or high (25+).

The incidence of parasitism was estimated from samples taken during between mid-October and February. Leaves with late 4th instar whitefly nymphs (wingbuds visible, heretofore referred to as "pupae") were collected at random by sector, placed in plastic bags, and transported to the laboratory in an insulated cooler. Whitefly pupae and exuviae were classified to species and as parasitized (presence of parasitoid pupa) or not parasitized (presence of whitefly wingbuds) using a stereoscopic microscope. Leaves samples were incubated in a controlled temperature cabinet (25 ± 2 °C, 75 ± 5% RH, 16:8 h L:D) for 3 weeks to allow parasitiods to emerge. Whitefly parasitoids (n = 750 total) were mounted on microscope slides directly into Hoyers mounting medium and identified at 100 and 400x (Polaszek et al., 1992, Schauff et al. 1996, Rose and Zolnerowich, 1997, Zolnerowich and Rose, 1998).

5. **Analysis.** Mean incidence of each parameter was compared between IPM and conventional greenhouses over all sample weeks using a one-way analysis of variance with the greenhouse X week interaction as the error term (SAS Institute 2000). One-way analysis of variance was also used to evaluate whitefly and incidence of parasitism within IPM greenhouses between sectors receiving *E. mundus* or *E. eremicus*. Consistency of sex ratio with the 1:1 null hypothesis was tested using chi-square (Sokal and Rohlf, 1981). Correlation analysis was used to look for relationships among pesticide use and incidence of pests. Data are reported as mean ± standard error throughout.

Peppers

1. Greenhouses. Twelve greenhouses were chosen on 3 farms in the CC for the study

(Table 2). Each greenhouse was considered a plot in a replicated complete block design with 3 treatments and 4 replicates. The three greenhouses within each replicate were all adjacent. Management practices were uniform within replicates.

2. Sampling. Whitefly and parasitoid populations were monitored weekly. Movement of adults was monitored from week 3 through week 8 by counting captures on 8 yellow sticky placed at canopy height in each greenhouse. A fresh 20x12 cm surface was exposed every week. Resting populations in each greenhouse were monitored on 3 randomly selected plants in each of 16 randomly selected zones from weeks 3 through 27. Whitefly and parasitoid adults, whitefly nymphs and parasitized "pupae" were counted on 3 leaves of each plant selected one each from the 3rd node, 6th node, and lower canopy. Unparasitized pupae were counted as a separate category beginning week 16, permitting calculation of percent parasitization.

Leaf samples from the lower canopy containing whitefly pupae were collected every 2 weeks and brought to the laboratory to further evaluate parasitism levels and to determine species of emerging parasitoids. Whitefly pupae and nymphs were classified using a stereoscopic microscope as parasitized or unparasitized. Parasitized nymphs were recognized by displacement of mycetomes and parasitized pupae by presence of the parasitoid pupa and lack of whitefly wingbuds. Parasitoids from 3 or 4 leaves were allowed to emerge, processed and identified as above.

3. Parasitoid Releases. Each greenhouse was randomly designated for treatment with *E. mundus* (Bemipar™), *E. eremicus* (Ercal 3000™) or a 1:1 mixture of the two (Bemimix™, Koppert Biological Systems, Águilas (Murcia) Spain. Bemipar and Bemimix came in bottles of 500 viable pupae diluted in sawdust and dispensed in the field using cardboard "D-Boxes"™. Each D-Box was provided with 1/8 of a bottle to yield approximately 60 adult parasitoids per 6x6x7 cm box (70% emergence). Ercal came as pupae glued in a narrow strip to a 6x4 cm paper card also calibrated to release 60 adult parasitoids each (60% emergence). Cards or D-boxes were hung on plants distributed uniformly throughout the greenhouse. All releases were initiated in week 3 through week 21. In addition, the grower at El Romero had released *E. eremicus* at 0.25/m^2 in all 3 greenhouses the last week of December. Pupae from 6 or 8 D-Boxes or cards were collected weekly and the proportion containing parasitoid emergence holes estimated by examination with a stereoscopic microscope. It was thus determined that actual emergence was 63, 77, and 81% for Ercal, Bemipar, Bemimix, respectively, or 3, 7, and 11% above the expected emergence rates of 60, 70 and 70%. Timing and rate of parasitoid release was determined in function of whitefly populations and grower criteria were 4.44 ± 0.80/m^2 (mean ± SE) were *E. eremicus* was released compared 3.94 ± 0.70 m^2 in greenhouses receiving *E. mundus* and 4.56 ± 0.77/m^2) were released in greenhouses receiving the mixture.

4. Analysis. Data from individual sample dates was subjected to one way analysis of variance with mean separation using LSD in the event of a significant F ($P < 0.05$). Proportions (parasitized whiteflies) were transformed to the arc sine square root before analysis to stabilize error variance (Gomez and Gomez, 1984), although untransformed data are given in tables and figures. Treatment effects over all sample weeks were evaluated by using a univariate repeated measures analysis, considering each week as a subplot in a split plot design, with the replicate x treatment interaction serving as error term (Freund et al. 1986).

RESULTS

Tomato

1. Pesticide Use. Growers either planted TYLCV-resistant cultivars or used broad-spectrum insecticides early in the season (September-October) except one who did both.

Resistant cultivars, fewer applications, fewer and more selective products tended to be used in greenhouses originally designated for IPM although differences were not significant (Table 1). However, if one considers use of resistant cultivars and insect proof netting as indispensable components of an IPM system, then two conventional greenhouses with effective netting could be designated as IPM and 4 IPM growers using susceptible cultivars as conventional. These latter used broad spectrum insecticides early in the crop cycle in an attempt to control immigrating whiteflies and did not release parasitoids until later. All parameters of pesticide use were significantly different using this new designation (Table 1

2. Incidence of Parasitism. Incidence of parasitized pupae from leaf samples taken in IPM greenhouses where *Eretmocerus* spp. were released was estimated at 50.7 ± 3.7% (n = 108), compared to 2.2 ± 0.97% (n = 16) in conventionally managed greenhouses. The corresponding numbers for emerged adults were 41.6 ± 3.5% (n = 113) and 0.73 ± 0.46% (n = 20), respectively. In IPM greenhouses, no differences were observed by either measure between sectors where E. mundus or E. eremicus was released ($F = 1.39$ $P = 0.27$, df =1:10 and $F = 0.22$, $P = 0.65$, df = 1.11 respectively). Of 570 Eretmocerus spp. adults that emerged from IPM greenhouse leaf samples, 85.0 ± 3.7% (n = 113) were E. mundus. Overall, the percentage of E. mundus rose from 47.5 ± 20.6% (n= 4) during the last 2 weeks of October to 100% the last 2 weeks of January. However there were no differences in incidence of parasitism over all dates between sectors regardless of which Eretmocerus species was released ($F = 0.001$, $P < 0.98$, df = 1,10).

3. Pest and Natural Enemy Incidence: IPM vs Conventional. Numbers of adults captured on sticky traps were not different overall between IPM and conventional greenhouses ($F = 0.09$, df = 1,23, $P < 0.77$, Table 2). Nevertheless, almost twice as many whitefly adults and 3 times as many nymphs were observed overall on plants in IPM greenhouses compared to conventional greenhouses ($F = 36.1$ and 35.1 respectively, df = 1,23, $P < 0.001$). Significantly more parasitoid adults were observed in IPM greenhouses compared to conventional greenhouses ($F = 26.7$ and 21.8, respectively, df = 1,23, $P < 0.0001$), as were numbers of the whitefly predator Nesidiocoris tenuis ($F = 8.04$, df = 1,23, $P < 0.009$) which appeared spontaneously in some IPM greenhouses.

The greatest differences in pesticide use within one paired set of IPM/Conventional greenhouses occurred at *Águilas_1*. The grower ordered mixtures of broad-spectrum insecticides to be applied once or twice a week against whiteflies in the conventional greenhouse, accumulating an incompatibility index of 35.7 (Table 3). In contrast, only selective pesticides were used in the IPM greenhouse, resulting in an incompatibility index of only 4.5. Although captures on sticky traps were 50% higher in the IPM greenhouse (Fig. 2a), there was little difference in numbers of adults or nymphs of *B. tabaci* overall. Furthermore, almost 5 times fewer *B. tabaci* adults plus nymphs were observed on leaves in the IPM greenhouse (0.083 ± 0.0. Fig. 2b) compared to the IPM greenhouse. The decline of the whitefly population in the IPM greenhouse may have been due to the effect of parasitization which averaged 43% (Table 6). In contrast to *B. tabaci*, greenhouse whitefly was eliminated in the conventional greenhouse but rose toward the end in the IPM greenhouse, probably because *E. mundus* is not effective against this species (Greenberg et al., 2002 (Fig. 2c).

Sweet Pepper

1. Whitefly Populations. Ingress of whiteflies was moderate as indicated by number on sticky traps, rising from a low of 0.28 ± 0.16 on week 3 to 0.65 ± 0.28 on week 8. No significant treatment effects were observed ($F = 2.2$, df = 1,6, $P = 0.19$). Numbers of whiteflies on plants were also relatively low averaging 0.45 ± 0.02/leaf (Mean ± SE) adults and 3.02 ± 0.09 nymphs+pupae/leaf over all weeks and treatments with the exception of the mixed species treatment in the 3rd greenhouse block. Plants in that greenhouse began the first week with an order of magnitude more whiteflies than the others (0.38 ± 0.26 adults and 8.38 ± 4.23 nymphs + pupae) as compared to 0.03 ± 0.01, and 1.01 ± 0.18 for the other treatments. Thus, although the infestation finished the season below the global average, data from this greenhouse were dropped from the analysis.

Treatment effects over all weeks on number of whiteflies were significant for both adults and immatures ($F = 5.6$ and 5.3) respectively ($P < 0.5$, $df = 2,5$ for both, Table 2). Numbers of adults were significantly less in greenhouses receiving *E. mundus* alone or the mixture compared to those receiving *E. eremicus* alone. Numbers of nymphs+pupae were significantly less in greenhouses receiving *E. mundus* alone compared to those receiving *E. eremicus* alone with no differences between the mixture and the two other treatments.

2. Incidence of Parasitism. Incidence of parasitism from week 16 onward was greater than 75% in all treatments with significant effects observed over weeks ($F = 7.3$, $df = 2,5$, $P < 3.3$, Table 2). Separation among all treatments was significant with the lowest level of parasitization being observed in greenhouses receiving only *E. eremicus*, and the highest with the mixture. These results largely agreed with those obtained by microscopic examination of immature stages and emergence from leaf samples in the laboratory except that differences between the *E. mundus* and mixture treatments were not significant (data not shown).

3. Relative abundance of parasitoid species. *E. mundus* constituted 91.1 ± 2.9% of parasitoids emerging from weekly leaf samples in greenhouses receiving the 1:1 mixture of *E. mundus* and *E. eremicus* ($N = 79$). All the rest were *E. eremicus* except for 0.2% *Encarsia lutea* (Masi) (Hymenoptera: Aphelinidae) and one *Encarsia formosa* (Gahan) individual. The greatest proportion of *E. eremicus* emerging from greenhouses receiving the mixture (60.3%) was seen in week 14, after few *E. eremicus* were seen (Fig. 3A). Even where only *E. eremicus* was released, *E. mundus* constituted 56.7 ± 8.8% of emerging parasitoids and predominated on week 14 and from week 18 onward (Fig. 3B). Nevertheless, a few (2.1%) *E. eremicus* originating from releases made in 3 greenhouses before the experiment was initiated emerged where only *E. mundus* was released, (Fig. 3C).

DISCUSSION

E. mundus replaced *E. eremicus* in both tomato and pepper wherever the latter was released. Many undoubtedly came from adjacent plots (tomato) and/or outside the greenhouse (tomato and pepper). In addition, *E. mundus* was probably able to compete better for host because it is better suited to *B. tabaci* than is *E. eremicus* (Greenberg et al. 2002). In pepper, better control was seen where *E. mundus* was released alone or in combination with *E. eremicus* compared to where *E. eremicus* was released alone. This would indicate not only that *E. mundus* was the better parasitoid, but also that control was improved by the releases.

Fewer and more selective pesticides were used in IPM greenhouses than in conventional greenhouses included in the tomato study. Where the index of incompatibility exceeded 5, minimal benefit from biological control of whitefly could be demonstrated. The “pesticide first” strategy using broad-spectrum chemistry did not appear to be compatible with biological control using *E. mundus*. In contrast, incidence of parasitism was moderate to high and whitefly populations on plants remained moderate to low in IPM greenhouses where the index of incompatibility was less than 5. Whitefly populations tended to decline in IPM greenhouses in contrast to conventional greenhouse, consistent with an increasing influence of natural enemies over the crop cycle in the absence of insecticidal interference.

E. mundus appears to be equally well adapted to tomato as to pepper (Stansly et al. 2002a, Urbaneja et al. 2003) although higher release rates may be necessary in tomato due to more rapid whitefly population growth on that crop (Stansly et al. 2002b). It is also clearly well adapted to *B. tabaci* biotype “Q” and the Mediterranean environment where both evolved. The evident advantages of this parasitoid coupled with increasing use of compatible control tactics such as virus resistant cultivars, insect screening and selective pesticides should favor the increasing adaptation of biologically based IPM greenhouse tomato and pepper production of the region.

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Tables

Table 1. Mean (± SE) duration of study (weeks), number of pesticide applications and products included, and the number of those classified as broad spectrum insecticides (score of 9 or more), selective insecticides/acaracides or fungicides, sum of side effect ratings for all pesticides used, and index of incompatibility of pesticide regime by management system according to original designation or the later designation based on choice of cultivar (resistant or susceptible to TYLCV) and efficiency of pest exclusion system.

	Original Designation				New Designation			
	Conventional (N = 7)		IPM (N = 12)		Conventional (N = 9)		IPM (N = 10)	
Production (kg/m^2)	7.7	±1.9	8.4	±1.9	9.5	±1.7	5.5	±1.6
Duration (weeks)	24.1	±2.1	19.8	±1.7	22.6	±2.7	20.3	±1.2
Applications (No.)	16.6	±3.7	12.4	±2.1	21.0	±2.2	7.6	±0.7
Products (No.)	40.0	±9.8	20.4	±2.5	40.3	±6.9	16.2	±2.1
Broad Spectrum (No.)	8.6	±5.6	2.3	±0.8	9.2	±4.1	0.4	±0.4
Selective (No.)	14.6	±5.7	8.6	±1.4	15.0	±4.1	7.0	±1.6
Fungicides (No.)	16.9	±3.3	9.6	±1.4	16.1	±2.6	8.8	±1.4
Side Effects (Sum)	251.0	±84.2	99.0	±19.5	276.4	±59.1	60.0	±9.7
Incompatibility Index	11.3	±4.4	4.5	±0.7	11.4	±3.2	3.0	±0.5

Table 2. Mean incidence of whiteflies, parasitoids, and *N. tenuis* in IPM and Conventional Greenhouses (Stansly et al. 2004).

	Conventional		IPM	
Adults Whiteflies (No./trap/wk)	30.2	± 1.52 a[1]	28.4	± 1.01 a
Adult Whiteflies (No./leaf)	0.29	± 0.011b	0.54	± 0.014a
Whitefly Nymphs (No./leaf)	0.39	± 0.02 b	0.99	± 0.03 a
Parasitized “pupae” (%)	0.90	± 0.08 b	3.7	± 0.13 a
Eretmocerus sp (Adults/leaf)	0.0003	± 0.0002 b	0.0083	± 0.0008 a
N. tenuis (No./leaf)	0.004	± 0.001 b	0.053	± 0.003 a

[1]Means in the same row followed by the same letter are not sigificantly different (LSD, $P < 0.05$)

Table 3. Number (Mean ± SE) of whitefly adults and nymphs + pupae per pepper leaf over 25 weeks and incidence of parasitized pupae (%) over 12 weeks in 12 greenhouses, Campo de Cartagena Spain, spring 2002.

Treatment	Whiteflies per leaf		Incidence Parasitism[1] (%)
	Adults (Mean±SE)	Nymphs + Pupae (Mean±SE)	(Mean±SE)
E. mundus	0.38 ± 0,03 b	2.20 ± 0.11 b	83.2 ± 2.2 b
Mixture	0.29 ± 0.02 b	3.00 ± 0.15 ab	90.1 ± 1.7 a
E. eremicus	0.65 ± 0.04 a	3.90 ± 0.19 a	75.3 ± 1.9 c

[1]Beginning week 16

Figures

Fig. 1. Map of Spain showing location of study sites (Stansly et al. 2004).

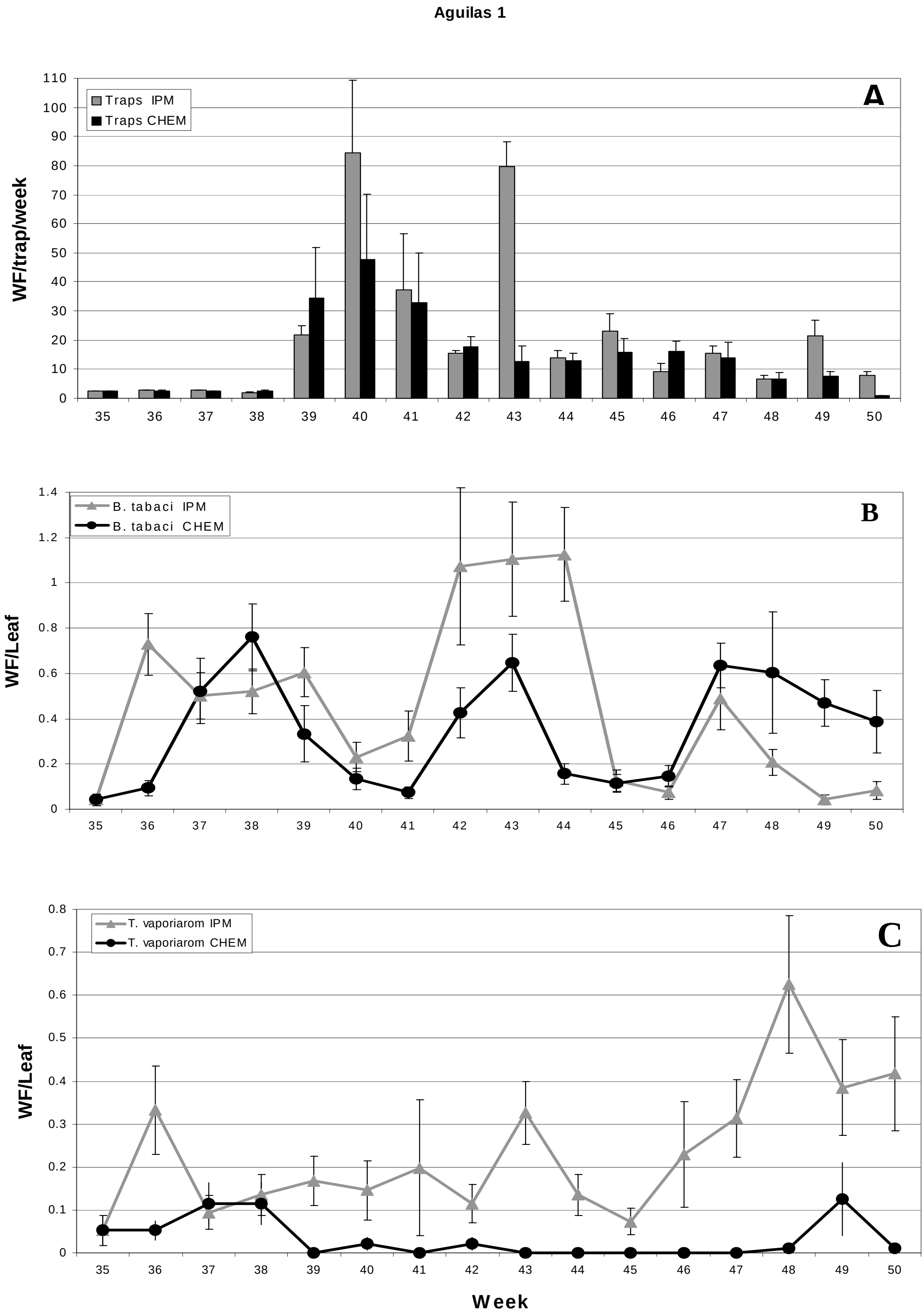

Fig. 2. (A) Mean (SE) number of whiteflies per trap per week, (B) mean (SE) number of *B. tabaci* nymphs per tomato leaf, and (C) mean number of *T. vaporiariorum* nymphs and pupae per tomato leaf in the IPM and conventionally managed greenhouses at Águilas_1 IPM Sep. – Dec. 2001 (Stansly et al. 2004).

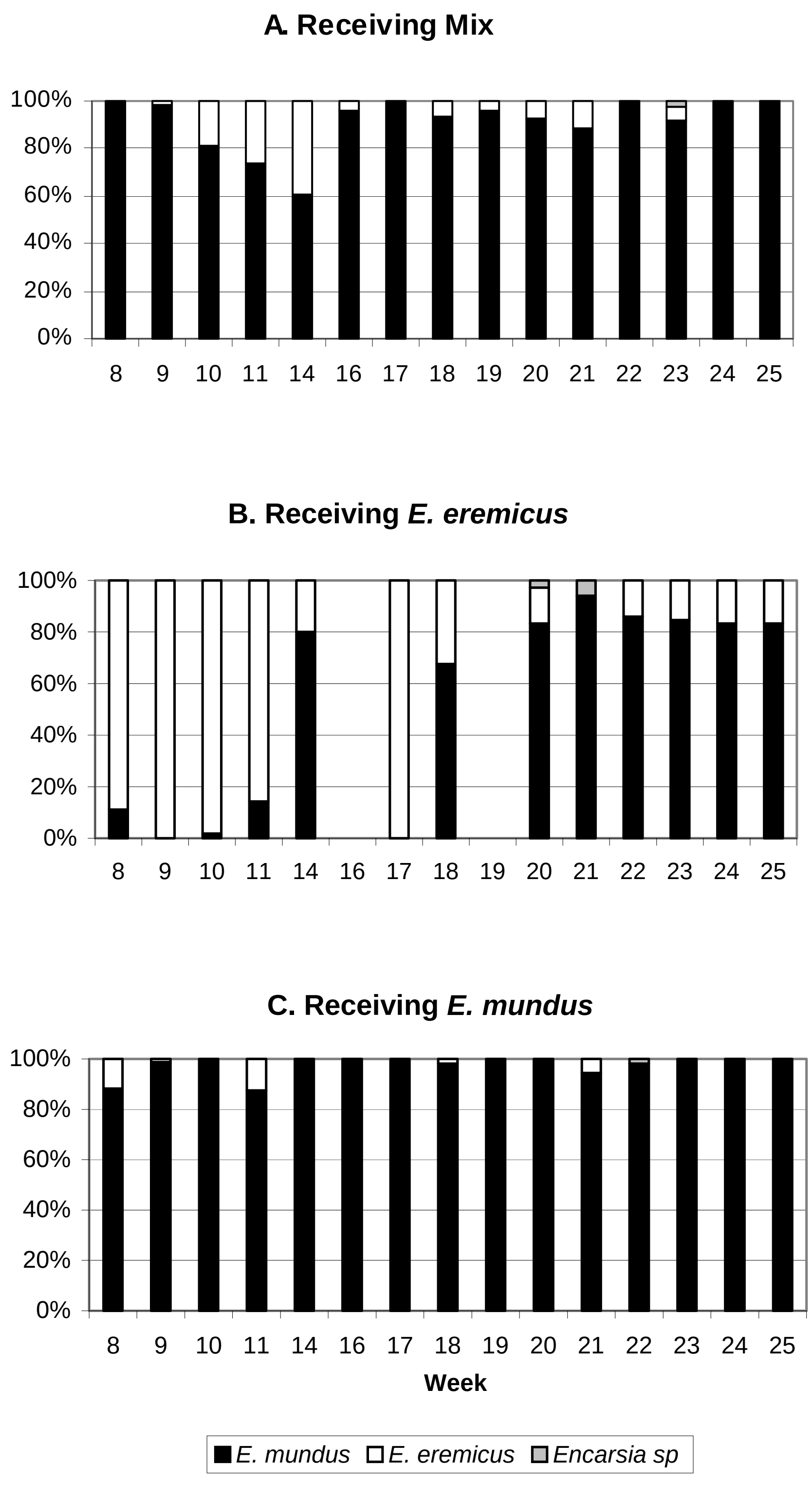

Fig. 3. Relative incidence of parasitoid species emerging from pepper leaf samples taken in greenhouse grouped by released species.