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Monitoring of olive leaf moth *Palpita unionalis* (Lepidoptera: Pyralidae) and evaluation the efficiency of *Trichogramma evanescens* (Hymenoptera: Trichogrammatidae) for its control in Middle Egypt

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Abstract

Olive leaf moth *Palpita unionalis* (Hübner) (Lepidoptera: Pyralidae) is considered one of the most severe pests attacking olive trees. In the current study, the seasonal population of *P. unionalis* at Naser, Beni-Suef Governorate, was investigated during two successive seasons (2021 and 2022). *Trichogramma evanescens* (Hymenoptera: Trichogrammatidae) was evaluated during the two seasons (2021 and 2022) of the study as a biocontrol agent for controlling the olive leaf moth. Data revealed that the olive leaf moth has three peaks during the three seasons: spring, summer, and autumn for the two seasons. The highest activity was recorded during the summer of the two seasons of the study. Daily and night temperatures and relative humidity had a highly significant effect on this pest in the two years of study The parasitoid release proved to be efficient in controlling *P.unionalis* on olives.

Introduction

The olive tree (*Oleae uropaea* L.) is an ancient and important, conventional crop in the Mediterranean basin (Arenas-Castro *et al*., 2020). It is assumed that the olive tree originated in the Mediterranean region and has been cultivated since 4800 B.C. Today, these permanent evergreen trees have great socioeconomic value for numerous countries in Southern Europe (Arenas-Castro *et al*., 2020).

Several insect pests attack olive trees causing extensive yield losses in quality and quantity for crops. The most widespread pests observed in Egypt, were *Bactrocera oleae* (Rossi) (Diptera: Tephritidae), *Prays oleae* Bernard (Lepidoptera: Yponomeutidae), *Palpita unionalis* (Hübner) (Lepidoptera: Pyralidae), *Zeuzera pyrina* (Linnaeus) (Lepidoptera: Cossidae), *Saissetia oleae* (Olivier) (Hemiptera: Coccidae) and *Parlatoria oleae* (Colvée) (Hemiptera: Diaspididae) (Mohamed, 2009).

The olive leaf moth *P. unionalis*, also known as the jasmine moth, is considered one of the severe pests that infest olive trees, causing mild to severe damage depending on the population density and the host plant (Mostafa *et al*., 2020).

Using commercial insecticides to control insect pests caused a slew of issues because insecticide residues on plants were

undesirable, causing harm to natural enemies, ecological hazards, and severe toxicological harm to humans, as well as the development of insect resistance to various insecticides (Mostafa *et al*., 2020 and Alotaibi *et al*., 2022). So, it's important to expand safe control measures against the pest in order to improve integrated pest management programs.

Trichogramma species make up one of the mainly commonly used groups of natural enemies for biological control programs worldwide. Given the chief successes in using *Trichogramma* to control economically destructive lepidopterous insects on agricultural crops (Zang *et al*., 2020).

The present study was designed to determine the seasonal population fluctuation of the olive leaf moth at Naser, Beni-Suef Governorate, and the effect of prevailing temperature and relative humidity on the pest population. Also, investigation of the effects of releasing egg parasitoid, *T. evanescens* as a biocontrol agent against the olive leaf moth.

Materials and methods

1. Seasonal activity of olive leaf moth *Palpita unionalis* on olive trees:

One feddan in Beni-Suef Governorate with olive trees of about five years old was chosen to conduct the study over two consecutive seasons, 2021 and 2022, from January, 1st to December,15th variety picual. This area was divided into four plots as replicates every plot containing 16 trees. Twenty five olive newly vegetative infested twigs (10-15 cm in height) were randomly collected from each plot (As replicates). Samples were collected randomly from the different directions of the trees at biweekly intervals and kept inside paper bags to be examined in the laboratory. On every sample, the number of larvae was counted and recorded.

2. Meteorological data:

Half-monthly means of relative humidity, minimum and maximum temperatures for Beni-Suef Governorate during 2021 and 2022 were obtained from Meteorological Station of Sids Research Centre, Beni-Suef Governorate.

3. Statistical analysis:

Data were analyzed using one-way ANOVA, correlation, and partial regression coefficients using the statistical program SPSS V.20. Partial regression and correlation coefficient values were calculated between the population of *P. unionalis* (Dependent variable Y) and the weather factors (Maximum, minimum temperatures, daily mean relative humidity) and parasitoids (Independent variable X) during the two years of study.

Generally, weather factors data can be used to predict the occurrence and population dynamics by using the following equation of regression:

$Y = a + bX_1 + bX_2 + bX_3$

(a=constant, b=coefficient value of each factor, X_1= maximum temperature (max. T.), X_2= minimum temperature (min. T.), X_3= percentage of relative humidity (R. H. %)

The explained variance E.V.% = $r^2 \times 100$ (r = correlation value).

2.The olive leaf moth *Palpita unionalis* management using the egg parasitoid, *Trichogramma evanescens* :

An area of one feddan of land cultivated with olive trees was used for this experiment. The paper cards were obtained from the laboratory of *Trichogramma*, Beni-Suef Governorate, Egypt. *T. evanescens was reared in a restricted climate room at 25 2 °C, 70% RH., and 16:8 L:D photoperiod on sterilized eggs of the grain moth, Sitotroga cerealella Olivier (Lepidoptera: Gelechiidae). T. evanescens egg release included 25 hangable cards that were hung on the branches.* Each card contains about 850–1000 parasitized eggs of *T. evanescens*. These cards had different ages of 48 hrs. for

obtaining two waves of emerging parasitoids on olive trees. *Trichogramma* cards were attached to the trees alternately. During the two successive seasons (2021 and 2022), four releases per spring season were applied at 15-day intervals per season. The dates for the releases were March 1st, 15th, and 1st and 15th, April.

Results and discussion

***1.The population density of* the olive leaf moth *Palpita unionalis*:**

Seasonal population dynamics of the olive leaf moth during seasons (2021 and 2022) were illustrated in Figures (1 and 2). *P. unionalis* had three peaks a year during the spring and summer flushes. peaks for the first season occurred on 1st April (With 3.25larvae/25 twigs at means of max. T. = 24.8°C, min. T=13.1°C, RH. = 49.5%), 1st June (With 7.75larvae/ 25 twigs at means of max. T. = 33.6°C, min. T=20.3°C, RH. = 33.2%) and 15th August (With 3 larvae/ 25 twigs at means of max. T. = 38.9°C, min. T=26.9°C, R H. = 40.3%) (Figure 1). While in the second season peaks were on 15thApril (With 3.75 larvae/ 25 twigs at means of max. T. = 33.7°C, min. T=13.9°C, RH. = 34%), 15th June (With 7 larvae/ 25 twigs at means of max. T. = 37.9°C, min. T=23.9°C, R. H. = 36.1%) and 1st August (With 3.25 larvae/ 25 twigs at means of max. T. = 37.6°C, min. T=24.7°C, RH. = 38.6%) (Figure 2). During the two study seasons, the month of June had the highest population.

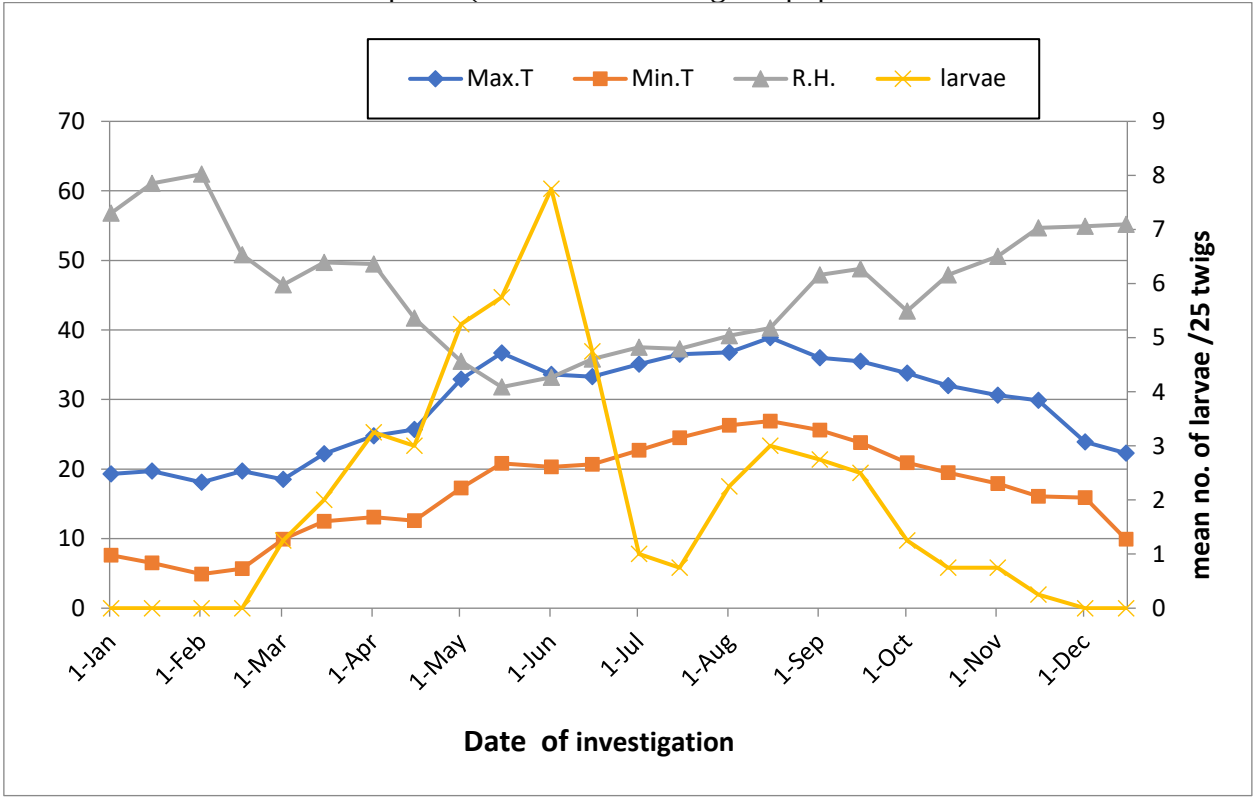

Figure (1) Biweekly means of seasonal population fluctuation of the *Palpita unionalis* larvae/25 twigs of olive and the corresponding means of maximum (Max. T.) and minimum (Min. T.) temperatures (°C) and percentage of relative humidity (RH. % throughout the seasons 2021 (from 1st Jan. to 15th Dec.) in the field in Naser, Beni-Suef Governorate, Egypt.

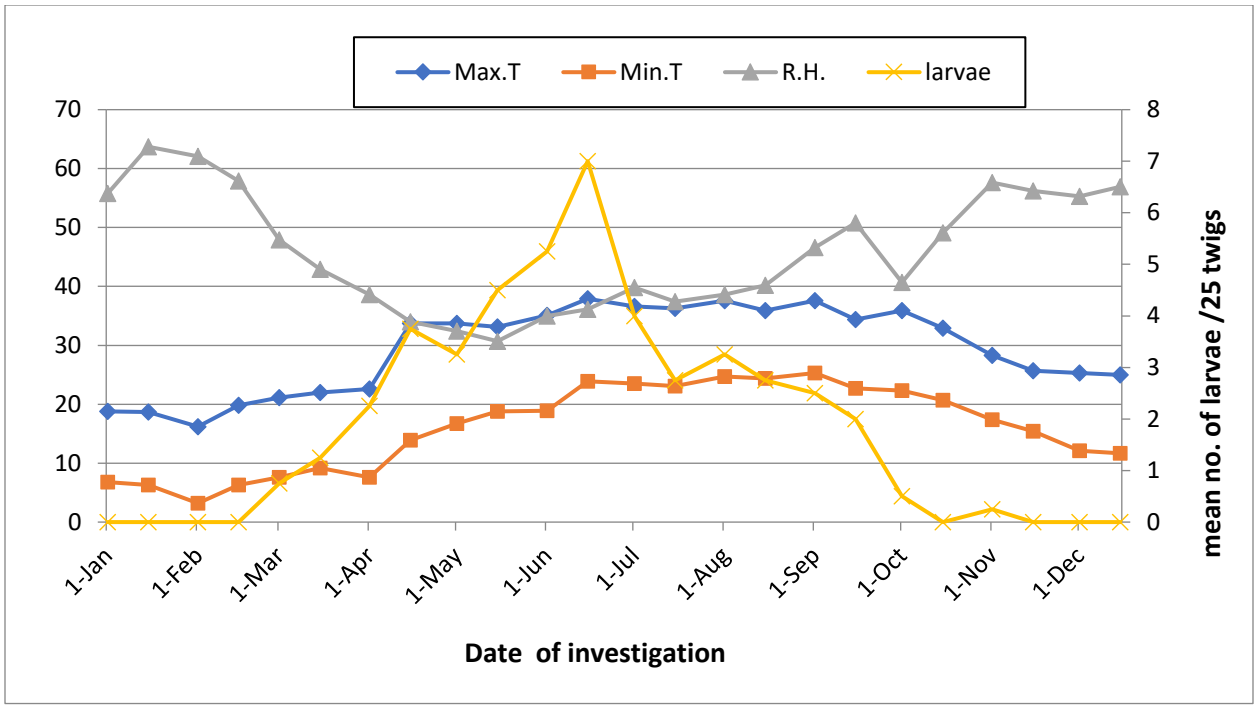

Figure (2): Biweekly means of seasonal population fluctuation of the *Palpita unionalis* larvae/25 twigs of olive and the corresponding means of maximum (Max. T.) and minimum (Min. T.) temperatures (°C) and percentage of relative humidity (RH. % throughout the season 2022 (From 1st Jan. to 15th Dec.) in the field in Naser, Beni-Suef Governorate, Egypt.

2. Impact of temperatures and relative humidity on olive leaf moth population:

As regard the sensitivity of the olive leaf moth to the two tested environmental weather factors, the results are compiled in Table 1, which clearly reveals that the larval population density of the olive leaf moth was highly significantly correlated with both the temperature and the relative humidity of the two seasons (P > 0.01). During the two years of investigation, the prediction regression equation was:

$Y_1 = 10.24 + 0.12X_1 - 0.16X_2 - 0.2X_3$ for the first year, 2021

$Y_2 = 3.71 + 0.17X_1 - 0.1X_2 - 0.11X3$ for the second year, 2022

The population activity of the olive leaf moth was positively correlated to the maximum temperature, while it was negatively correlated to the two other factors. So, the mean of *P.unionalis* population increased by 0.12 and 0.17 larvae/25 twigs with every one degree increase in the maximum temperature but decreased by 0.16 and 0.1 larvae/25 twigs for every one degree increase in the minimum temperature in the two seasons, respectively. Also, it decreased 0.2 and 0.11 larvae/25 twigs when relative humidity increased by one degree, respectively, for the two seasons of study.

On the other hand, the percentages of the explained variance values were 60.3 % and 70.7%, while F-test was 10.11 and 16.12 for the two seasons, respectively. The remaining unexplained difference is assumed to be owing to the influence of other rash factors such as speed of wind or total amount of rainfall adding to the experimental error that affected the population density of *P. unionalis* during the period of the two seasons of study.

Table (1): Statistical analysis of correlation and partial regression of the weekly mean counts of *Palpita unionalis* larvae/ 25 twigs of olive trees as affected by corresponding means of Max., Min. temperatures and percentage of relative humidity (%RH.) throughout two successive seasons 2021 and 2022 (From 1st Jan. to 15thDec.) in Naser, Beni-Suef Governorate, Egypt.

Season	X factor	Analysis of partial regression				Analysis of variance	
		r	B	SE	T	F	E.V. %
1st season	MAX. T. (X_1)	0.78	0.12	± 0.18	0.69	10.11*	60.3
	MIN. T. (X_2)		-0.16	± 0.17	-0.95		
	RH.% (X_3)		-0.2	± 0.05	-3.82		
2nd season	MAX. T. (X_1)	0.84	0.17	± 0.19	0.9	16.12*	70.7
	MIN. T. (X_2)		-0.1	± 0.16	-0.6		
	RH.% (X_3)		-0.11	± 0.05	-2.5		

***Highly significant at probability level 0.01**

Correlation (r), standard coefficient (B), standard error (SE), t-values (t), F- test (F)and percentage of explained variance E.V. %

3. Efficiency of *Trichogramma evanescens* in controlling olive leaf moth:

Eggs of the parasitoid, *T. evanescens* evanescens, were used during the two seasons of study to control the olive leaf moth. Releasing this parasitoid succeeded in lowering the population of olive leaf moth on olive trees from 2.01 to 0.27 and from 1.92 to 0.29 larvae/25 twigs during the seasons of 2021 and 2022, respectively (Figures 3 and 4).

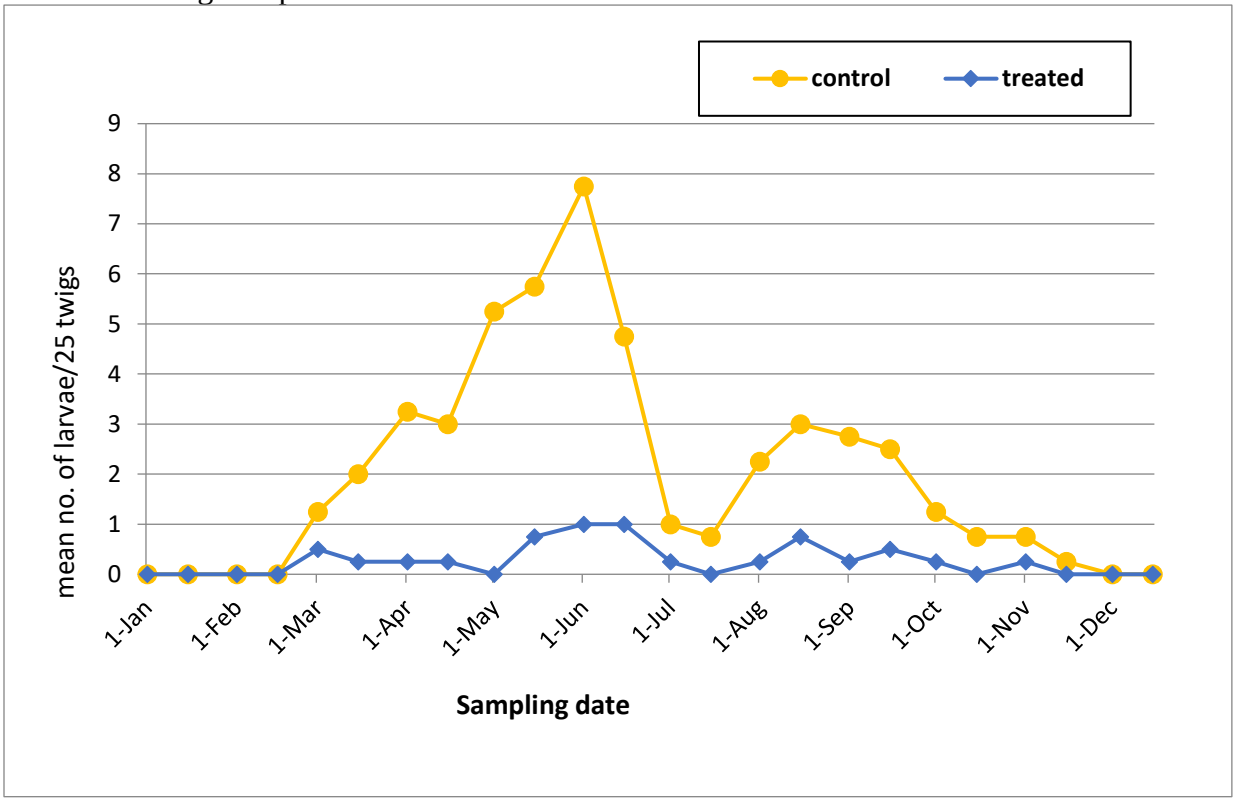

Figure (3). Biweekly mean counts of the *Palpita unionalis* larvae/ 25 twigs of olive from control and the treated areas with releasing the egg parasitoid, *Trichogramma evanescens* throughout the seasons 2021 (From 1st Jan. to 15th Dec.) in the field in Naser, Beni-Suef Governorate, Egypt.

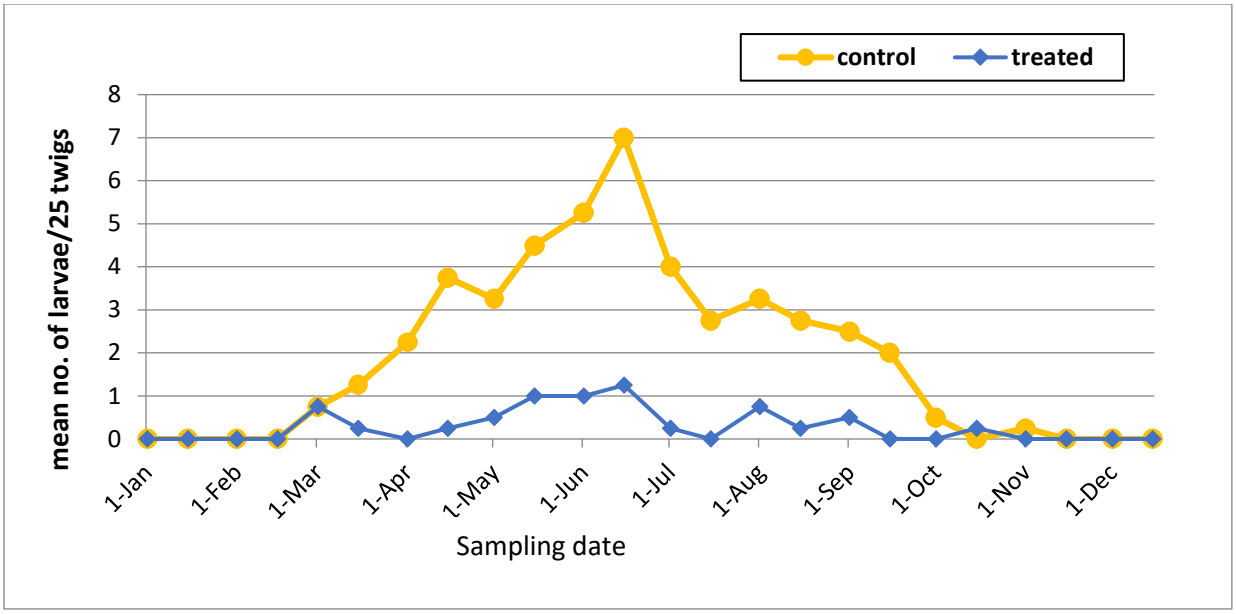

Figure (4): Biweekly mean counts of the *Palpita unionalis* larvae/ 25 twigs of olive from control and the treated areas with releasing the egg parasitoid, *Trichogramma evanescens* throughout **the seasons 2022 (From 1st Jan. to 15th Dec.) in the field in Naser, Beni-Suef Governorate, Egypt.**

Monitoring of the olive leaf moth at Naser, Beni-Suef Governorate, during the two successive seasons, 2021 and 2022, from 1st January to 15th December, showed the presence of three peaks for the pest in spring, summer, and autumn during the two seasons.

These results were similar to El-Kenawy (2012) who recorded the highest populations in the month of May in the coastal region and Middle Egypt. Also, Hegazi *et al.* (2011) said the moth had three peaks annually in Egypt. 1st flight was in March to April, 2nd was in May to June while 3rd took place from August to October.

In Alexandria, the highest activity was recorded during the summer, particularly in June (Hegazi *et al*., 2012). While the obtained results in Dakahlia Governorate by Mostafa *et al.* (2020) indicated that the larval population of *P. unionalis* exhibited four to five peaks of abundance during the seasons of (2018 and 2019) and the highest activity for the pest was recorded during the autumn and spring of the first and second seasons. The differences between the current results and others may be explained by the study (Ghoneim, 2015), which mentioned that in the same country, *P. unionalis* has various numbers of generations annually, depending on many factors such as the host plant, seasonal conditions, Also, Kacar and Ulusoy (2013) observed that weather factors (Temperature and humidity) and developing of the shoots greatly effect on the population fluctuation of pest larvae.

T. evanescens played a great role in the reduction of the population of olive leaf moth during the seasons of study on olive orchards in Naser, Beni-Suef Governorate. These results agree with Hegazi and Khamis (2007) who tested the efficiency of releasing eggs of an indigenous parasitoid of four species of *Trichogramma (bourarachae, cordubensis, euproctidis and evanescens*) for controlling the olive leaf moth in olive plantations in Egypt. The reduction in the number of olive leaf moth reached 83% compared with control trees.

P.unionalis had three peaks a year in April, June, and September of the two successive seasons of study 2021 and 2022. Temperature and relative humidity had a highly significant effect on this pest in the two years of study. *T. evanescens* release was

effective in controlling *P. unionalis* on olives. On the other hand, this pest still needs research interest for the investigation of several aspects. Nevertheless, the information reviewed in this article will support the development of strategies for the management of this pest.

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