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Study of the bioecology of aleurolobus olivinus silvestri (1911) (homoptera, aleyrodidae) on olive trees in algeria

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Aleurolobus olivinus is an insect of the family Aleyrodidae and the subfamily Aleyrodinae, considered as a secondary pest of olive trees, Olea europea, and has also been reported on Phillyrea angustifolia, P. latifolia and on Erica spp.It consists of a bio-ecological study, in particular of the life cycle that has been carried out on the branches of trees covered with a fine mesh net to avoid possible exchanges of individuals, while for the ecological study, leaf samples have been taken according to cardinal directions and branches 50 cm long according to their age, on 4 varieties of olive tree. The black whitefly generates two generations, one from April to September and the other from October to March. The life cycle lasts 79 to 98 days. Larvae mainly prefer the upper surface of the foliage in the South and East are abundant in autumn and winter the varieties Zaiti (33.3%) and Sorani (27.4%) are the most infested compared to Terella and Khodeiri (21.8%) and (17.4%). It is the twigs of the year that are most attacked. The parasitism rate varies according to the month and season, it is 17% in autumn and 7.6% in winter while the monthly rate is 6% in May and 21.5% in November.

Keywords:Aleurolobus olivinus, olive tree, life cycle, distribution, parasitism.

INTRODUCTION

Aleurolobus Olivinus is an insect belonging to the order Homoptera, and to the family Aleyrodidae (Costa Lima, 1942, Byrne & Bellows Junior, 1991,Grazia et al. 2012) and was first reported in the Maltese Islands by Mifsud & Porta-Puglia (2005).A typical Mediterranean species, it has been recorded in most countries in this region, including Corsica, Crete, Cyprus, France, Greece, Israel, Jordan, Majorca, Morocco, Portugal, Sardinia, Sicily, Spain, Syria and Turkey (Martin et al. In Egypt, it was first observed by Abd-Rabou (1996) and in Tunisia, a border country in 1926 (El Khawas, 2000); in Algeria, despite its presence in the north of the country, it has never been officially reported since no work has been published to date.But it is known to be inferior to oleaceae (*Olea europaea, Phillyrea angustifolia, Phillyrealatifolia*) and Erica spp where it is sometimes considered as a secondary pest of olives (Simala et al. 2015, Bink-Moenen, 1989) This white fly is polyphagous and can cause direct economic losses due to the injection of toxins into sap-conducting tissues.Little studied throughout the world, the first observations on the morphology of adults and larvae and their differentiation on the basis of morphological characteristics (size, shape, segmentation, pygidium, etc.) were made by Silvestri (1911) in Italy. It is described as producing only one generation per year in Western Sicily (Italy), adults emerging in June/July, and sometimes as producing two generations per year, adults emerging in June/July and September/October

(Maniglia, 1985).

The black whitefly has a few parasitoids reported hère and there around the world. Indeed Viggiani (1983) reports that A. olivinus can be parasitized by three hymenopteranaphelidae in Italy: Encarsia elegans Masi, E. olivina (Masi) and Eretmocerussp. E. elegans was recorded in December 1995 in the region of El-Arish in Egypte of *A.olivinus* where its parasite rate reaches 12.8% (Abd-Rabou, 1997). According to Morsi et al, 2010, this takes place in early March, mid-May, mid-August, early October, mid-November and mid-December in 2006 and early April, mid-July, early September, early October, early November and early December in 2007 (Morsi et al., 2010). In Iran, Amitusminervae SILVESTRI 1911, a palearctic species, parasite of two whitefly species *Aleurolobusolivinus* (SILVESTRI) (Ghahari&Buhl, 2011). According to Polaszek (1991*) A. minervae* is a solitary nymph endoparasite

Due to the lack of studies on this insect as a secondary pest of oleaceae, we have found it useful to make our contribution by studying some aspects of its bio-ecology including its life cycle and some preliminary data on its ecology including its parasites which remain the subject of many other investigations. Indeed, this is the first time that a study on this pest has been carried out in Algeria.

MATERIALS AND METHODS

Description of the site

The farm of the Technical Institute of Fruit Tree Growing (ITAF) (36°55 N, 2° 55 E) is located in Tessala El Merdja, at the foothills of the southern slope of the Mitidja (Blida), at an altitude of 50m on clay and silt soil. The orchard covers an area of 1.2 ha and has not been maintained or treated since its planting in 2002. It carries a collection of 4 varieties of olive trees of Syrian origin: Khodeiri, Sorani, Zaiti and Terella whose trees are separated from each other by 7m.

- The Terella and Sorani variety consists of 4 rows with 26 trees each, for a total of 104 trees
- The Khodeiri variety consists of 3 rows with 26 trees, for a total of 78 trees
- The Zaitise variety consists of two rows, each with 26 trees, for a total of 52 trees

Determination of the life cycle of A. Olivinus

The study of the life cycle of *A. olivinus* was carried out in the field, taking into consideration a branch 50cm long, per tree and per variety, which is covered with a fine mesh net to avoid exchanges with the outside of the proof insect. Observations are made 4 times a month for 2 consecutive years, from April 2016 to March 2018.

Removal of leaves according to cardinal orientation

Samples are taken from 25 leaves per tree / row / variety / cardinal orientation. Indeed, for the Sorani and Terella varieties, each having four rows, the number of leaves collected is 25 leaves*4 orientations*4 trees, or 800 leaves per variety. The same is true for the Khodeiri and Zaiti variety, where samples were taken respectively from 4 orientation*3 trees, i.e. 300 leaves and 4 orientation*2 trees, i.e. 200 leaves. Samples are placed in plastic bags on which are mentioned the date of sampling, location, orientation and variety. Larvae are counted on both the upper and lower sides of the leaf under a binocular magnifying glass. The samples were taken over a period of 2 years, from April 2016 to March 2018.

Twig sampling

Observations on the leaves of the one-, two- and three-year-old branches, 50 cm long, were made, taking into account the number of rows and variety, as in the previous case, but without taking into account the cardinal orientations of the tree. The twigs are stored in plastic bags on which the date of sampling, location and variety are indicated before counting in the larvae laboratory on the upper surface of the leaf.

Demographic study of larval stages

The demographic study was conducted 4 times/month, for two consecutive years, from April 2016 to March 2018, on 3 trees/variety from which 100 leaves were randomly collected. The counting of live and parasitized larvae, according to their stage, is done only on the upper surface of the leaves to study monthly variations in the insect and to evaluate the infestation and parasitism rates of the insect for each variety.

Physico-chemical characterization of sheets

The physico-chemical characterisation of the leaves of four varieties of olive trees was carried out using traditional methods of analysis and concerns dry matter, Ph, ash content, fatty acidity, as well as the determination of lipids, proteins and carbohydrates.

RESULTS

Life cycle of the black whitefly *A. olivinus*

The eggs, which are yellow in colour when laid, measure between 0.1 and 0.3 mm. They become darker at the end of embryonic development; they are placed on the upper

surface of the leaf on which they are held by a short peduncle that is inserted into the plant tissues. After an incubation period of 11 to 15 days, the egg hatches and gives birth to a mobile first instar larva (L1), which soon sets on the leaf. This one turns into an L2 after 17 to 21 days and in turn generates an L3 larva 20 to 24 days later. The nymph occurs after 16 to 18 days before giving birth to an adult who is incorrectly called a "white fly" because of the powdery material that sprinkles its wings. Larval development lasts 79 to 98 days and includes 4 stages, 3 larval stages, a nymph and an adult. The adult emerges from the puparium through a T-shaped slit.(fig 1)

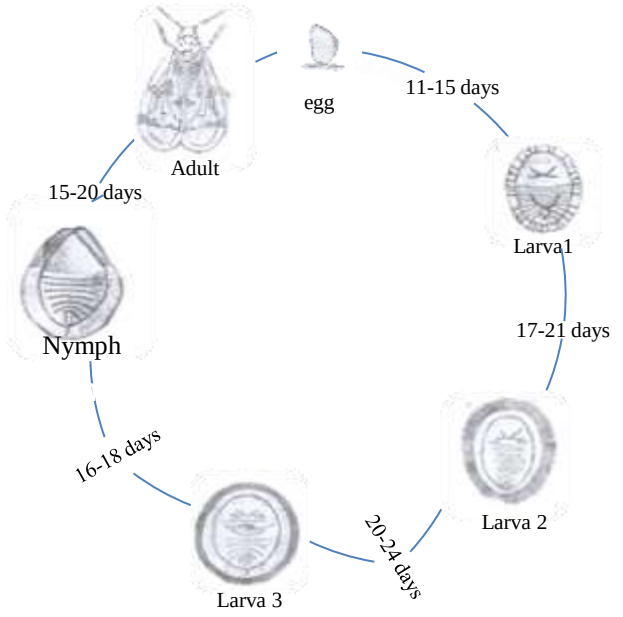

Figure1 ; Life cycle of *A. Olivinus*

Distribution according to the face of the sheet

Larvae prefer the upper surface of the leaf where more than 95% of individuals are located, regardless of the variety, and their presence on the lower surface is low and does not exceed 31 out of 703 individuals in Zaiti variety, or 4.4% (Table 1). Indeed, the t-test for independent samples gives a very high significance (tobs=51.82 ;ddl,5740, p0.05).

Table 1 ; Distribution of larvae by leaf face in 4 varieties of olive trees in Tassala El Merdja

Varieties	Upper side	Lower side
Zaiti	672 (95.6%)	31 (4.4%)
Sorani	256 (99.2%)	2 (0.8%)
Terella	418 (97.2%)	12 (2.8%)
Khodeiri	**146 (96.1%)**	**6 (3.9%)**

Distribution by Cardinal Direction

The southern and eastern directions are the most sought after by the insect regardless of the variety. The presence rate of this one in the West is about half compared to previous cardinal directions (14% larvae in Sorani and 19.1% in Terella). In the North, it is lower in the North and ranges from 7.4% in Sorani to 16% in Terella (Table 2). The analysis of variance (F=34.62 ;ddl 4, 2296 ; Pr < 0.0001) indicates a very significant difference between the cardinal directions. The Newman-Keuls test (SNK), which consists of an Analysis of differences between modalities with a 95% confidence interval, reveals that the difference is significant between the orientations where the South and East are most affected by whitefly and to a lesser degree the West (Table 3).

Age distribution of twigs

It clearly appears that the twigs of the year are the most infested by whitefly among all varieties and Zaiti is the most affected since its twig of the year has 452 individuals, or 64.3%. Then come the twigs of 2 and 3 years old with 160 and 91 individuals respectively, or 22.4% and 12.9%. The one-year-old shoots of the Sorani and Khodeiri varieties have a rate of 79.1% and 72.4%, i.e. 204 individuals for Sorani and 110 for Khodeiri, while the two- and three-year-old shoots have fewer individuals, which increases the rate of the varieties without making them more attractive than Zaiti, which has a lower rate (64.3%) (Table 4, Figure 2).The analysis of variance (F=496.38, ddl2, 8513, p < 0.0001) shows that the difference is very highly significant and that the twig of the year is the most sought-after regardless of the variety. In the same vein, the Newman-Keuls test (SNK) confirms this significant difference, i.e. the twig of the year is the most attractive for the insect (Table 4, 5).

Table 2 ; Distribution of larvae according to cardinal direction in 4 varieties of olive trees in Tassala El Merdja

Variétés	South	East	North	West	Center
Zaiti	230(32,7%)	202(28,7%)	86(12,2%)	127(18,1%)	58(8,3%)
Sorani	101(39,1%)	78(30,2%)	19(7,4%)	36(14,0%)	24(9,3%)
Terella	101(23,5%)	109(30,2%)	69(16,0%)	82(19,1%)	69(16,0%)
Khodeiri	71(46,7%)	37(24,3%)	12(7,9%)	28(18,4%)	4(2,6%)

Table 3 : Comparison of cardinal directions

Modality	Estimated average	Groups			
South	1,1082	A			
East	0,9241		B		
West	0,5846			C	
North	0,4106				D
Center	0,3319				D

Table 4 ; Larval distribution according to branch age in 4 olive tree varieties in Tassala El Merdja

variety	Branch 1 year	Branch 2 years	Branch 3 years
Zaiti	452 (64,3%)	160 (22,4%)	91 (12,9%)
Sorani	204 (79,1%)	35 (13,6%)	19 (7,4%)
Terella	244 (56,7%)	108 (25,1%)	78 (18,1%)
Khodeiri	110 (72,4%)	21 (13,8%)	21 (13,8%)

Table 5 :Twig groups

Modality	Estimated average	Groups		
b1	0,3555	A		
b2	0,1141		B	
b3	**0,0736**			**C**

Table 6 ; Physico-chemical analyses of olive leaves before and after whitefly attack on 4 olive varieties in Tessala El Merdja

Parameters	Zaiti		Sorani		Terella		Khodeiri	
	before	after	before	after	before	after	before	after
Humidity %	16,8	21,7	9,4	11,9	9,3	18,9	10,4	13,7
PH	6,7	5,1	6,7	5,3	7,4	6,2	6,6	5,5
Dry matter %	80,7	81,1	85,8	85,3	76,6	73,2	80,6	81,3
Ashes %	1,4	1,7	1,3	1,6	1,4	1,5	1,2	1,2
Fatty acidity (100g MS).	0,1	0,1	0,0	0,03	0,1	0,1	0,0	0,1
lipids (% MS)	46,5	40,1	45,7	41,7	32,0	27,04	40,2	36,5
Proteins (%) MS)	13,1	9,3	16,1	11,5	10,4	9,3	18,1	14,2
Glucides (% MS)	17,1	10,4	21,1	9,1	14,1	10,6	15,3	10,1
Energetic value (Kcal/100g)	539,2	440,1	560,0	457,9	386,0	323	495,5	425,5

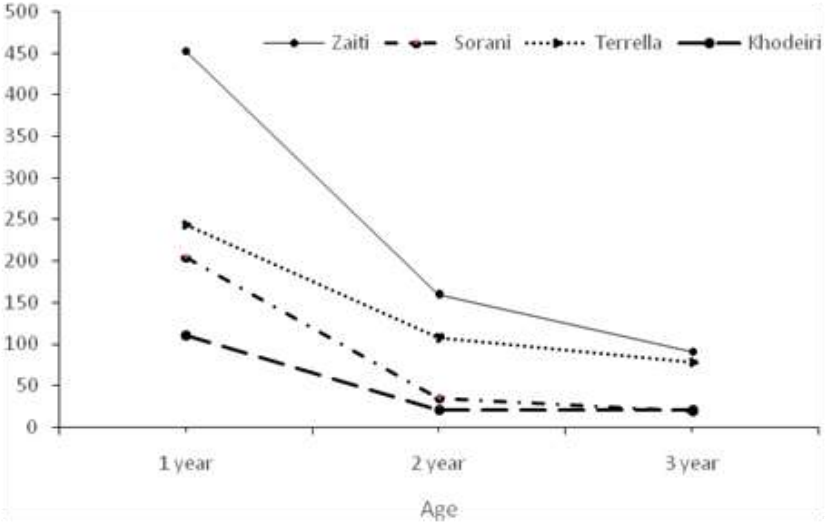

Figure 2 ; Distribution of larval stages according to the age of the branch on 4 olive varieties at Tessala el Merdja

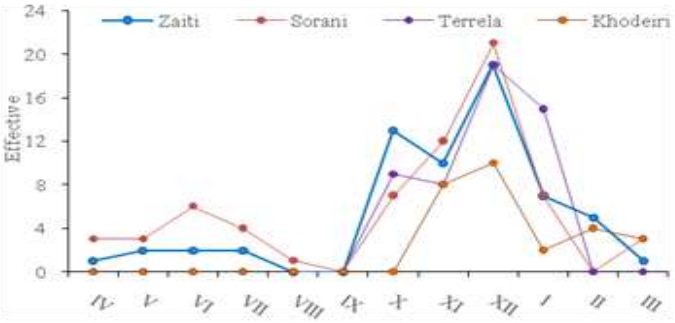

Figure 3 ; Monthly evolution of L1 larvae on four varieties of olive trees in Tessala El Merdja

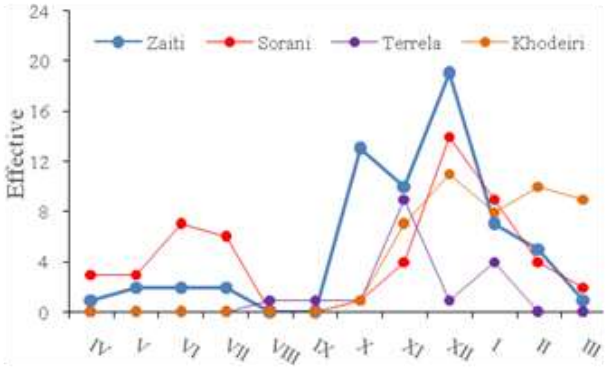

Figure 4 ; Monthly evolution of L2 larvae on four varieties of olive trees in Tessala El Merdja

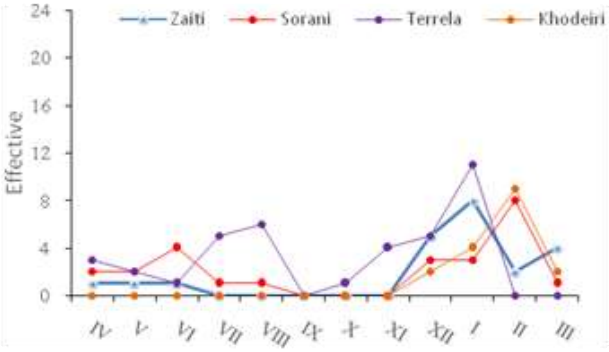

Figure 5 ; Monthly evolution of L3 larvae on four varieties of olive trees in Tessala El Merdja

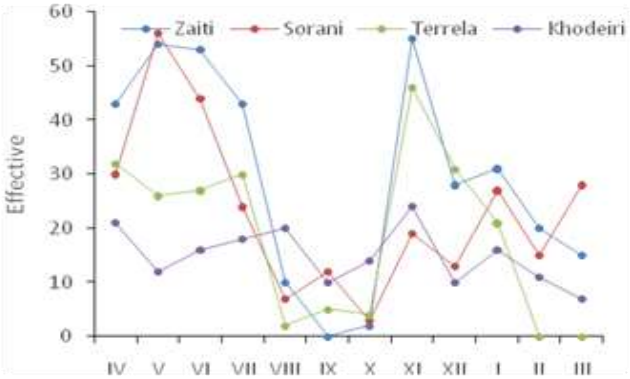

Figure 6 ; Monthly evolution of Nymph on four varieties of olive trees in Tessala El Merdja

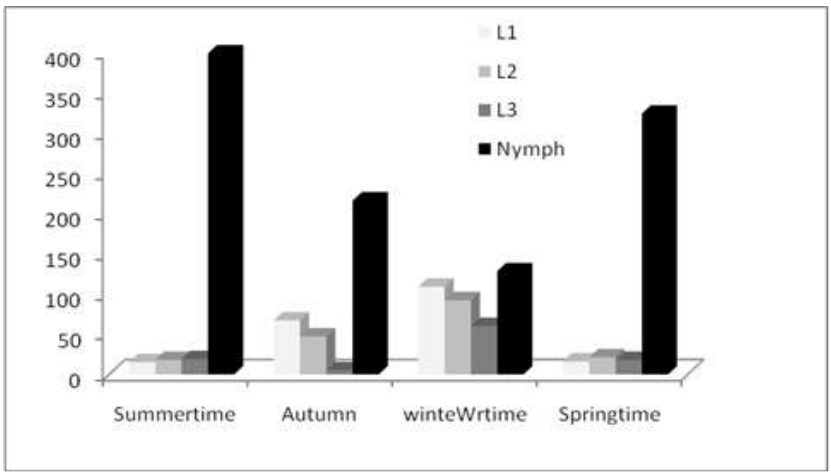

Figure7 ; Seasonal variation of larval stages and nymphs in four olive varieties at Tessala ElMerdja

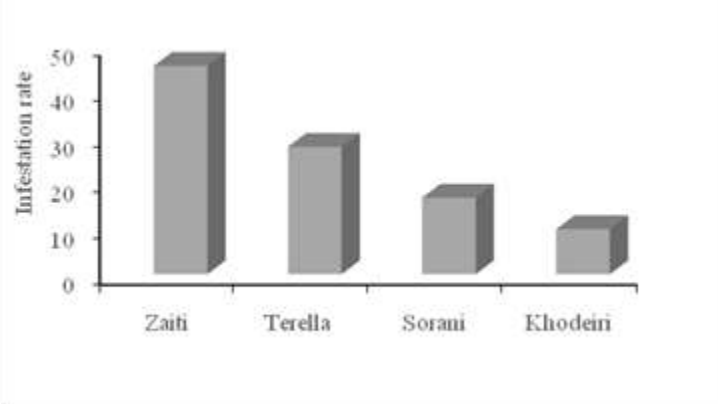

Figure 8. Infestation rate on four varieties of olive trees in Tessala El Merdja

A

B

c

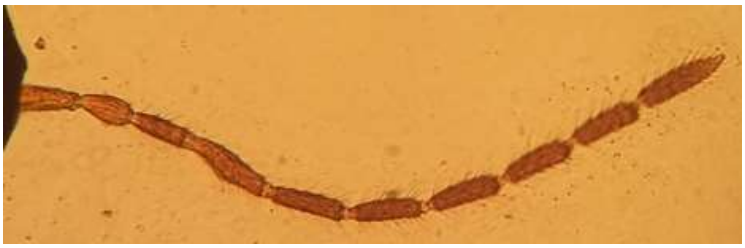

Figure 9.a – Adult of *A. minervae* Silvestri, 1911.,b -Detail of the wing and elytra. c –Detail of the antenna

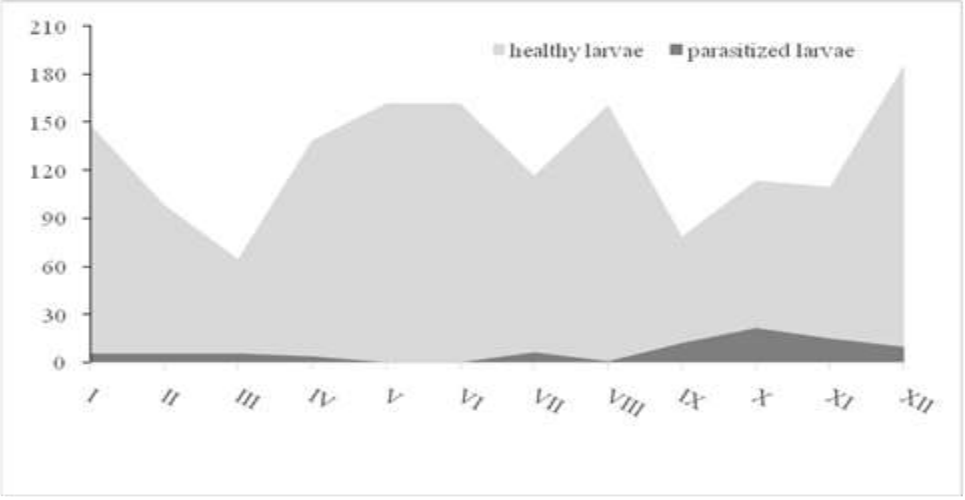

Figure 10. Monthly evolution of the larvae parasitism rate by *Amitus minervae* on olive trees in Tessala El Merdja

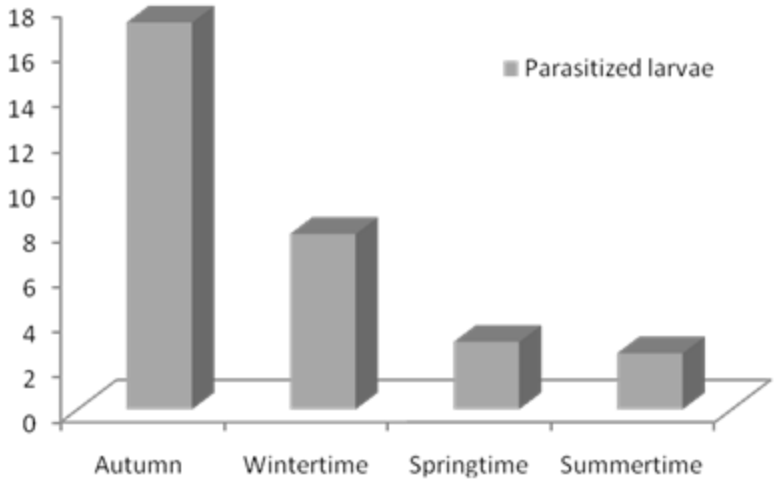

Figure 11. Parasitism rate on four olive tree varieties in Tessala El Merdja

Monthly demographic evolution of development stages

There are probably two generations, one from April to September, and the other from October to March. Stage L1 appeared, for the 1st generation between April and September in the varieties Zaiti and Sorani with a population of 24 individuals. During the 2nd generation, larvae 1 appeared between the last dekad of September and the end of March with a total number of 183 individuals in the four varieties. The L2 stage of the 1st generation was observed between late April and late August in the Zaiti and Sorani varieties with a total number of 23 individuals. On the other hand, the L2 of the 2nd generation emerged between the end of September and the end of March with a total number of 135 individuals while the L3 are present from the end of April to September, and from the end of September to the end of March, respectively for the 1st and 2nd generation with numbers of 30 and 79 larvae. Nymphs were observed throughout our sampling period (Figures 3, 4, 5, 6).

Seasonal demographic evolution of development stages

The seasonal abundance of larvae is greater

in autumn and winter, but varies from season to season. Nymphs thrive in summer and spring and are important in both autumn and winter (Figure 7).

Infestation rate for four varieties of olive trees

The Zaiti variety has the highest infestation rate (45.6%). It is followed by Terella (27.9%), while Sorani and Khodeiri have respective rates of 16.7% and 9.9%, which would indicate that they are less attractive than the two previous varieties (Figure 8).

Description of *Amitus minervae* Silvestri, 1911

A minervae Silvestri, 1911 (Hymenoptera, Platygastridae) is black in color, it is characterized by a short abdomen, almost as long as it is wide. The antennas are equipped with 11 segments for males with hairs in segment III. The hairy forewings are veinless, while the tarsus have 5 items in the 3 pairs of legs (Figure 9).

Monthly and seasonal variation in parasitism

Amitus minervae Silvestri, 1911, is a Hymenoptera of the family Platygastridae, long known as endoparasites of larvae and nymphs of whiteflies in general and of *A. olivinus*. It was first observed in Algeria. Its monthly parasitism rate varies according to the month, reaching 21.9% in October, the highest rate recorded during our observations. This more or less appreciable rate is found in September (12.7%), November (15.5%) and December (10.2%) when the whitefly population appears to be affected in the presence of the predator. In May and June, it is 0.6% and 0.5%, the lowest rate for each of them (Figure10), and the parasitism rate also varies according to the season, so that it is high in autumn (17.2%) and winter (7.8%) and low in summer and spring (2.5 and 3.01%) (Figure 11). On the other hand, the annual parasitism rate, however low, is 7%.

Physico-chemical characterisation of olive leaves

After the whitefly infestation, some biochemical constituents were affected: mainly lipids, carbohydrates and energy value. The latter fell from 539.2 to 440.1 and from 560 to 457.9 Kcal/100g respectively at Zaiti and Sorani. Nevertheless, this energy value has also suffered a slight decline in Terella and Khodeiri. Carbohydrates and lipids have dropped significantly in all varieties. Similarly, PH, dry matter...etc. have also declined, except for ash, which increases slightly after infestation (Table 6).

DISCUSSION

The eggs of *A. olivinus*, freshly laid on the upper surface of the leaves, are provided at their base with a short pedicel which they use to fix them on the plant support. They are recognizable by their whitish colour which gradually turns brown during their embryonic development. The last larval stage or puparium (L4) is the site of a near-metamorphosis, in particular with the appearance of ocular spots and drafts of legs and wings that place this insect at the hinge of heterometabolism and holometabolism (Thierry, 2011).Adult emergence occurs through a median T-shaped opening in the anterior part of the puparium (Berlinger, 1986 ;Gerling, 1990). The life cycle of the black olive whitefly varies from 79 to 98 days under ambient temperature conditions.

In general, A. olivinusse is located much further south than east, perhaps because of the light intensity and high temperature which can jointly favour the insect's flight, while the north and west orientations remain the least desirable and the insect mainly prefers the upper surface of the leaves, on which it lives, from egg to adult, whatever the variety of olive tree (Fraval, 2009). Similarly, it is preferentially located on the twig of the year due to the presence of buds and young leaves, which are not only important spawning sites, but also a source of nutrients for larvae (Blowers and Moran, 1967). In addition, these young leaves promote the penetration of the egg stem into the plant tissues due to their low hardness. They are then more receptive to egg laying.

In Algeria the black whitefly shows two peaks probably indicating that these are two generations occurring during two distinct periods, one from April to September and the other from October to March. In southern Italy Maniglia (1985) reports two generations/year, one of which emerges in June/July, and the other in September/October, but in other parts of southern Italy it has only one generation per year emerging in June-July (Maniglia, 1989; Mifsudet Porta-Puglian, 2005, Fraval, 2009). In Egypt, whitefly abundance is generally observed between April and January (Morsi et al. 2010). Seasonal abundance of A. olivinus reaches its maximum in April 560 and 480 individuals / 60 leaves and 15 twigs respectively in 2009 and 2010 in the governorate of El-Arish in Egypt (Abd-Rabou& Ahmed, N. 2011) In addition, larvae feed at all stages of their development on the elaborate sap of their host plant (Germain et

al. 2005). Their damage can be recognized by the black spots they cause on the leaves as a result of sap sucking.

Due to its chemical constituents, the varietal aspect is important on the distribution of species (Fraval, 2009), as the Zaiti and Sorani varieties with the highest energy values are the most attacked because carbohydrates are the main energy elements for the synthesis of chitin, a major compound of the insect's exoskeleton. Similarly, the whitefly has also obtained its proteins, an energy source in the formation of gametes, (Borsa and Millet, 1992) which it needs in Zaiti and Sorani. This shows the important role that the host plant can play in whitefly density due to its chemical constituents (Speight et al. 1999).

During our surveys, only one endoparasite of *A. olivinus* was observed: it is A. minervae which has also been reported on A. olivinus in Iran (Ghahari and Buhl, 2011). It is the female pupae and nymphs that are parasitized. The monthly parasitism rate of *A. minervae* is 21.9% in October, then declines in September (12.7%), November (15.5%) and December (10.2%) when the whitefly population has dropped significantly. In Egypt, Morsi et al (2010) reported that parasitism rates for A. olivinu were observed in early March, mid-May, mid-August, early October, mid-November and mid-December 2006 and in 2007 in early April, mid-July, early September, early October, early November and early December.Six peaks were counted, the most important of which occurred in mid-May (31%) and (58%) in mid-December (58%) in 2006 and early October (48%) in early December (53%) in 2007 (Morsi et al., 2010).The percentage of parasitism in *Encarsia olivina* (Masi) (Hymenoptera:Aphelinidae) reached its maximum of 0.6 and 0.5% for 60 leaves and 15 twigs in April, when the white fly also prospered in 2009 and 2010 (Abd-Rabou& Ahmed, N. 2011).

CONCLUSION

This preliminary study remains a subject for many other studies, especially since the insect's bio-ecology is little studied in the world and completely unknown in Algeria, which opens up many prospects for research on this insect, which causes direct damage due to the toxins it injects into the plant and the transmission of viruses to it.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

FA, performed the experiment and also wrote the manuscript. BA, AA contributed to complete the fieldwork and ensure the determination of species. All authors read and approved the final version.

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