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SURVEY OF PARASITOIDS AND PREDATORS OF TOMATO LEAF MINER, *TUTA ABSOLUTA* (MEYRICK) (LEPIDOPTERA: GELECHIIDAE) IN EGYPT

[38]

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ABSTRACT

The tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is an invasive pest, that caused a significant damage to the tomato crop in the Middle East area. It infests Solanaceae plants especially tomato, *Lycopersicon esculuntum* Mill. To find parasitoids and predators for biological control of this pest, samples of tomato leaves infested with *T. absoluta* were collected from Qualiobya and Giza Governorates. Three genera of hymenopterous parasitoids, *Diglyphus* sp. (Eulophidae), *Elasmus* spp. (Elasmidae) and *Telenomus* sp. (Scelionidae) are the first record in Egypt. The predator bug, *Nesidiocoris tenuis* Reuter (Heteroptera: Miridae) was also recorded. *T. absoluta* showed two peaks of 30.3 and 25.0 leaf mines/10 leaflets on 7th and 28th of May, 2013, respectively. *N. tenuis* also recorded two peaks of 58.8 and 73.3 nymphs and adults/plant on the same previous dates, respectively. *N. tenuis* was mass reared to evaluate the predatory efficiency of nymph and adult stages on *T. absoluta* eggs. The nymph, adult male and female consumed 113.3, 81.5 and 125.3 eggs of *T. absoluta*, respectively. The 4th nymphal instar devoured the highest number (30.6 eggs), while the 1st nymphal instar ate the lowest (7eggs). Therefore, *N. tenuis* was highly effective in controlling *T. absoluta* eggs under laboratory conditions.

INTRODUCTION

The tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is a neotropical oligophagous pest infesting Solanaceae plants especially tomato, *Lycopersicon esculentum* Mill. In Europe (Spain), it was recorded for the first time at the end of 2006 **(Urbaneja et al 2007)**. Afterwards, it spread very rapidly along the Mediterranean Basin and in Central Europe and the Middle East **(Desneux et al 2010).**

Natural enemies such as parasitoids and predators were used successfully in biological control of *T. absoluta*.**Mahdi et al (2011)** recorded a parasitoid wasp, *Diglyphus* sp. (Hymenoptera: Eulophidae) and a predatory bug, *Nesidiocoris tenuis* Reuter (Heteroptera: Miridae) in Algeria. **Giorgini et al (2012) and Zappala et al (2012)** found 16 hymenopterous species including *Diglyphus crassinervis* Erdös belong to 13 genera and 6 families in Italy. **Gabarra et al (2013)** found 13 larval-pupal parasitoid species including *Elasmus phthorimaeae* Ferriere (Elasmidae) and *D. crassinervis* occasionally parasitize *T. absoluta* in Spain. **Payer et al (2015)** observed that females of *Diglyphus isaea* Walker are able to predate *T. absoluta* larvae, but they apparently do not parasitize this species in Spain. **Al-Gerrawy et al (2013)** identified two egg parasitoids, *Tricogramma* sp. (Tricogrammatidae) and *Telenomus* sp. (Scelionidae) from *T. absoluta* in Iraq. **Perdikis et al (2016)** used different sticky traps to attract the braconid, *Dacnusa sibirica* Telenga and *D. isaea* parasitizing *T. absoluta* in Greece. They also studied their efficiency in capturing the effective predator *N. tenuis*, whose high population levels may cause damages on the tomato crop.

Molla et al (2009) mentioned that *N. tenuis* was highly effective in controlling *T. absoluta* on tomato under field conditions causing infestation reductions of 97% in leaflets and 100% in fruits in Spain. This predator preyed actively on eggs and all larval instars of *T. absoluta*, although it pre-

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ferred first instar larvae under laboratory conditions. **Guenaoui and Bensaad (2011)** observed young nymphs of *N. tenuis* preying on *T. absoluta* larvae in galleries inside the tomato fruit in France. **Molla et al (2011)** found that *N. tenuis* can regulate *T. absoluta* populations, because it is able to prey efficiently on pest eggs in Spain. **Abbes and Chermiti (2012)** used *N.tenuis* to control *T. absoluta* on tomato crops in nurseries, greenhouses and open fields in Tunisia. **El-Arnaouty and Kortam (2012)** recorded *N. tenuis* for the first time in Egypt associated with *T. absoluta* in aubergine and tomato plantations in Giza, Qaluobia and Fayoum Governorates.

The present study aimed to survey parasitoids and predators of *T. absoluta* in some Egyptian Governorates. Seasonal abundance of *N. tenuis* associated with *T. absoluta* and its predatory efficiency on pest eggs were also studied

MATERIAL AND METHODS

1. Survey of parasitoids and predators

Samples of tomato leaves infested with *T. absoluta* were collected from fields at Qualiobya and Giza Governorates during 2012. Leaves were placed in rearing boxes covered with muslin cloth and secured with rubber bands. Emerging parasitoids were collected and kept in ethanol 70%. Parasitoids were identified in Department of Entomology, Faculty of Science, Cairo University. However, predators associated with *T. absoluta* were easily recognized and identified.

2. Seasonal abundance of *N.tenuis* associated with *T. absoluta*

The experiment was carried out in the farm of Faculty of Agriculture at Shoubra Elkheima, Qualiobya Governorate. Seedlings of tomato cultivars were cultivated on 16thApril, 2013 in pots in a randomized completed block design. This experiment contained eight tomato cultivars namely, Hybrid Super Strain B, Super set, Hybrid Bito86, Nema guard, Rio grande, Baladi, Red sun and Castle Rock. Each cultivar was replicated five times and each replicate contained eight pots (40 pots / cultivar). The experimental plot received the normal agricultural practices of mechanical weed control, irrigation and fertilizers and was kept free from any pesticide applications.

One week after cultivation, weekly randomized samples of 250 leaflets (10 leaflets x 5 plants x 5 replicates) for each cultivar were taken early in the morning during 10 weeks. Leaflets were kept in tightly closed paper bags and transferred to the laboratory. The pest mine was detected and counted by aid of a stereomicroscope. Total leaf mines of *T. absoluta* and total numbers of *N. tenuis* (nymphs and adults) were estimated on tomato cultivars. Statistical analysis procedures included the simple correlation coefficient and the regression coefficient. All calculations were carried out using **SAS program (1988).**

3. Predatory efficiency of *N.tenuis* on *T. absoluta* eggs

3.1. Prey culture

Tomato leaves infested with *T.absoluta* were collected from fields of Faculty of Agriculuture, Ain Shams University at Shoubra Elkheima, Qualiobya Governorate. A laboratory stock of the prey was reared in wooden boxes measured (30×20 cm) with sides made of cloth screen,the top was made of glass to observe emerging insects. Fresh tomato plants were transfered daily to boxes to allow *T. absoluta* laying its eggs on lower surfaces of leaves.

3.2. Predator culture

The original culture of *N. tenuis* adults was collected from tomato fields infested with *T. absoluta* and located at Dokki, Giza Governorate in April, 2014 by using sucking traps. *N. tenuis* adults were kept in rearing glass jars (20×10 cm) and daily provided with adequate numbers of *T. absoluta* eggs. Glass jars were then covered with muslin cloth tied with rubber bands to prevent insects from escaping and to allow ventilation. Small branches of tomato plants were provided daily as oviposition sites for the predator. Leaves bearing deposited eggs of *N. tenuis* were cut, transferred to clean jars and maintained until hatching under laboratory conditions. Newly hatched nymphs of *N.tenuis* were daily provided with adequate numbers of prey eggs until adult emergence.

3.3. The experiment:

Twenty prey eggs were daily placed on a fresh leaf of tomato provided with a piece of absorbent cotton to avoid drying the eggs and were introduced into a glass tube (7×2.5cm) containing one nymph of *N. tenuis*. Ten nymphs (replicates) of the predator were maintained to evaluate their predatory efficiency. Number of eggs consumed by *N. tenuis* nymphs was recorded daily and replaced with other freshly deposited eggs. Durations of five nymphal instars of the predator were also estimated. This experiment was examined daily until adult emergence. The previous technique was also conducted on 10 adults of *N. tenuis*.

RESULTS AND DISCUSSION

1. Survey of parasitoids and predators

1.1. Parasitoids

Three different specimens of hymenopterous parasitoids were obtained from *T. absoluta* and identified to the genus level. Larval parasitoids of *T. absoluta* include *Diglyphus* sp. (Eulophidae) and *Elasmus* spp. (Elasmidae). The egg parasitoid is *Telenomus* sp. (Scelionidae). These parasitoids are the first record in Egypt.

1.1.1. *Diglyphus* sp.

Diglyphus sp. is a larval ectoparasitoid of *T. absoluta*. This result agrees with that of **Lopez et al (2011)** who reported that *D. isaea* is a larval ectoparasitoid of *T.absoluta* in Spain. **Mahdi *et al* (2011)** recorded *Diglyphus* sp.parasitizing *T.absoluta* in Algeria. **Giorgini et al (2012) and Zappala et al (2012)** found 16 hymenopterous species including *D. crassinervis* belong to 13 genera and 6 families in Italy**. Gabarra et al (2013)** found 13 larval-pupal parasitoid species including *D.crassinervis* occasionally parasitize *T. absoluta* in Spain. **Perdikis *et al.* (2016)** recorded *D. isaea* parasitizing *T. absoluta* in Greece. On the other hand, **Payer *et al.* (2015)** observed that females of *D. isaea* are able to predate *T. absoluta* larvae, but they apparently do not parasitize this species in Spain **(Fig.1)**.

Fig.1. Adult of *Diglyphus* sp.

Description

Fore wing with submarginal vein (SMV) with 3 or more setae dorsally. Postmarginal vein (PMV) present: at most 1.25 times longer than stigmal vein (STV), often equal or shorter. Scape usually slender, sometimes swollen and not exceeding apex of vertex. Funicle 2-segmented and club 3-segmented both in male and female. Fronto-facial suture (ffs) adjacent anterior ocellus and one transverse groove (gr) between eye margin and scrobal cavity placed about halfway between ocellus and torulus. Malar sulcus present and straight. Propleura separated posteriorly and not covering prosternum.Notauli either incomplete, or complete and curving to meet axilla. Scutellum with 2 pair of setae and with 1 pair of longitudinal grooves. Propodeum with or without median carina and always with outplicae. Petiole not distinct.Coloration entirely or prevalently metallic **(Reina and La Salle, 2003**).

1.1.2. *Elasmus* spp.

There are two unidentified species of *Elasmus*. *Elasmus* sp. is a larval-pupal parasitoid of *T.absoluta*. **Giorgini et al (2012) and Zappala et al (2012)** found 16 hymenopterous species including *Elasmus* sp. belong to 13 genera and 6 families in Italy.**Gabarra et al (2013)** found 13 larval-pupal parasitoid species including *E. phthorimaeae* occasionally parasitize *T. absoluta* in Spain **(Fig.2).**

Species A **Species B**

Fig. 2. Adult of *Elasmus* spp.

Description

Fore wing densely setose and wedge-shaped, with elongate marginal vein, short postmarginal, and slightly reduced stigmal vein. Female funicle 3-segmented with two anelli and 3-segmented clava; male funicle 4-segmented, F1-F3 with branches, clava 2-segmented with pronounced apical sensilum. Mesosoma densely setose, metasoma subsessile and gaster triangular in cross. Metanotum projecting as flat, triangular, often translucent plate over propodeum. Dorsal metanotal lamella projecting posterior over propodeum with partial and complete lateroventral keels. Scutellum with 2 pairs of long setae. Metacoxa greatly enlarged and flattened plate-like hind tibia with short bristles forming distinct diamond-shaped or undulating pattern (**Yefremova and Strakhova, 2010**).

1.1.3. *Telenomus* sp.

Telenomus sp. is an egg parasitoid of *T.absoluta*. **Al-Gerrawy et al (2013)** also recorded *Telenomus* sp. parasitizing *T.absoluta* eggs in Iraq **(Fig.3).**

Description

Small wasp, almost always black or dark brown. Female antenna with 5-segmented club (when present), male antenna 12-segmented. Frons smooth **(Polaszek and Kimani, 1990).**

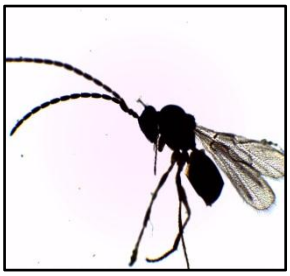

Fig. 3. Adult of *Telenomus* sp.

1.2. Predator

N. tenuis

N.tenuis was the only predator species, that was found in the survey. It is an important predator of *T. absoluta* eggs. In this context, *N.tenuis* was recorded associating with *T. absoluta* on tomato by several authors in different countries **(Arno et al 2009** in Spain; **Cabello et al 2009** in Spain; **Molla et al 2009** in Spain; **Arno and Gabarra, 2010** in Spain**; Guenaoui and Bensaad, 2011** in France; **Mahdi et al 2011** in Algeria; **Molla et al 2011** in Spain; **El-Arnaouty and Kortam, 2012** in Egypt; **Biondi et al 2013** in France; **Sohrabi and Hosseini, 2015** in Iran**) (Fig. 4).**

Fig. 4. Adult of *N. tenuis*

Description

Body size 3–3.3 mm. Pale whitish green. Ocular index: 1.3–1.5. Left parameter very slender, strongly curved sickle shaped. Middle of the first segment, and base of the second segment of antenna-black. A dark ring at the apex of the 2nd antennal segment, 3rd and 4th segment - brown. At the rear edge of the corium there was a small dark brown spot and at the tip of the cuneus there was a small dark brown spot. Membrane – gray, veins – brown. Base of the tibia (knee) narrowly black **(Hosseini, 2013).**

1. Seasonal abundance of *N. tenuis* associated with *T. absoluta*

Data tabulated in **Table (1)** and **Figure (5)** revealed that *T.absoluta* appeared one week earlier than *N. tenuis*. The population of *T. absoluta* had two peaks of 30.3 and 25.0 leaf mines/10 leaflets on 7th and 28th of May, 2013, respectively. *N.tenuis* similarly had two peaks of 58.8 and 73.3 nymphs and adults/plant on the same previous dates, respectively.

This predator was significantly and positively correlated with *T.absoluta* (r = +0.87 and b= 0.26).

3. Predatory efficiency of *N. tenuis* on *T. absoluta* eggs

Mean numbers of eggs consumed by nymph and adult stages of *N.tenuis* are shown in **Table (2).**The adult female consumed a higher number (125.3 eggs) than the adult male (81.5 eggs). The 4th nymphal instar devoured the highest number (30.6 eggs), while the 1st nymphal instar ate the lowest (7 eggs). *N. tenuis* was highly effective in controlling *T. absoluta* eggs. Several authors reported that *N.tenuis* preyed actively on *T.absoluta* eggs and could regulate pest populations **(Arno, et al 2009; Molla et al 2009; Arno & Gabarra, 2010; Molla et al 2011 and Biondi et al 2013).**

Table 1. Seasonal abundance of *N.tenuis* associated with *T. absoluta*

Inspection date	Leaf mines of *T. absoluta* /10 leaflets	*N. tenuis* (nymphs+ adults) /plant
April,23th	0	0
30th	10.8±0.2	0
May, 7th	30.3±0.3	58.8±0.6
14th	13±0.3	25.5±0.2
21th	24.3±0.6	48.8±0.5
28th	25±0.3	73.3±0.9
June,4th	0	0
11th	0	0
18th	0	0
25th	0	0
Total	103.3	206.4
Mean	10.3	20.6
Correlation coefficient(r)	0.87+	
Regression coefficient (b)	0.26+	

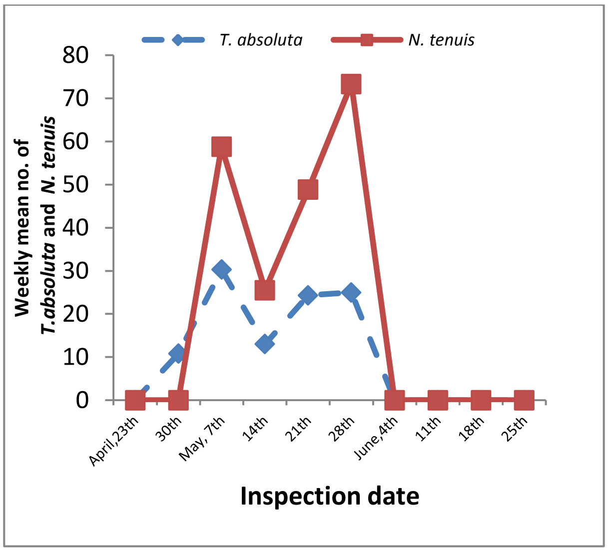

Fig. 5. Seasonal abundance of *N. tenuis* associated with *T. absoluta*

Table 2. Predatory efficiency and durations of nymphal instars and adults of *N. tenuis* reared on *T. absoluta* eggs

Predator stages	Nymphal instar					Adult	
	1st	2nd	3rd	4th	5th	Male	Female
No. of prey eggs consumed (Mean+S.E.)	7±0.2	20.5±0.5	26.6±0.4	30.6±0.6	28.6±0.5	81.5±1.2	125.3±0.3
Duration (Mean+S.E.)	2.1±0.03	2.2±0.04	2.2±0.04	2.4±0.06	3.3±0.05	7.5±0.65	12.3±0.4

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