

Full Length Research Paper

Population of *Tuta absoluta* and natural enemies after releasing on tomato grown greenhouse in Turkey

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The study was conducted to evaluate the population of tomato leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) and efficiency of natural enemies on tomato grown greenhouse in Mediterranean Region of Turkey during 2010 and 2011. *Trichogramma evanescens* Westwood (Hymenoptera: Trichogrammatidae) and *Nesidiocoris tenuis* (Reuter) (Hemiptera: Miridae) were used for biological control of the pest. Both the egg parasitoid and predatory bug were released alone and combined. The decrease of egg and larva numbers of *T. absoluta* were higher in plots released *T. evanescens* with *N. tenuis* together than each one released separately. However, the decrease of eggs was higher than larvae in plots released *N. tenuis* and *T. evanescens* alone. Population of *T. absoluta* and fruit numbers were influenced by the treatments. The number of fruit directly affected negatively by increasing the population density of *T. absoluta*. The trial demonstrated that it was necessary to establish *N. tenuis* population at the starting of the crop season with *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) eggs, at least two or three weeks ago, and together with parasitoid release, had a better significant reduction of *T. absoluta* population to reach maximum number of fruits.

Key words: Greenhouse, tomato, biological control, *Tuta absoluta*, *Trichogramma evanescens*, *Nesidiocoris tenuis*.

INTRODUCTION

Recently, *Tuta absoluta* has spread very quickly in Turkey, as well as in Mediterranean countries. *Tuta absoluta* first reported in Turkey in 2009 (Kilic, 2010), and is now posing a serious threat on tomato production. Tomato plants may be attacked at any development stage from seedlings to mature plants. The potential damage could lead up to 100% yield loss without control measure (EPPO, 2005). Larvae feed between the epidermal layers on leaves, causing irregular mines. This mining protects the larvae from getting in contact with insecticides and decreases the effects of chemical control. So, an alternative management approach is urgently needed. One possible solution is the use of biological control agents. More than 20 species of parasitic wasps have been described for *T. absoluta* (Luna et al., 2007).

One of them is the egg parasitoid *Trichogramma* species (Medeiros et al., 2006). *Trichogramma* species

are the most widely used as biocontrol agents in the world and they are effective against lepidopteran eggs such as the leafminer, *T. absoluta*.

Furthermore, several species of predators have been evaluated as biological control agents mainly the mirid bugs *Nesidiocoris tenuis* (Reuter) and *Macrolophus pygmaeus* (Rambur) (Urbaneja et al., 2009). Both nymph and adult stages of *N. tenuis* are prey on *T. absoluta* eggs and larval stages. It is also able to feed on the plants when the prey population is low and *Nesidiocoris* population is high. *T. absoluta* population and natural enemies with efficacy of these biological control agents after releasing are unknown in our country. The objective of the study is to evaluate the population of *T. absoluta* as well as *T. evanescens* and *N. tenuis* after releasing against pest on greenhouse-grown tomato of Mediterranean Region, Turkey. The preliminary results are presented in the study.

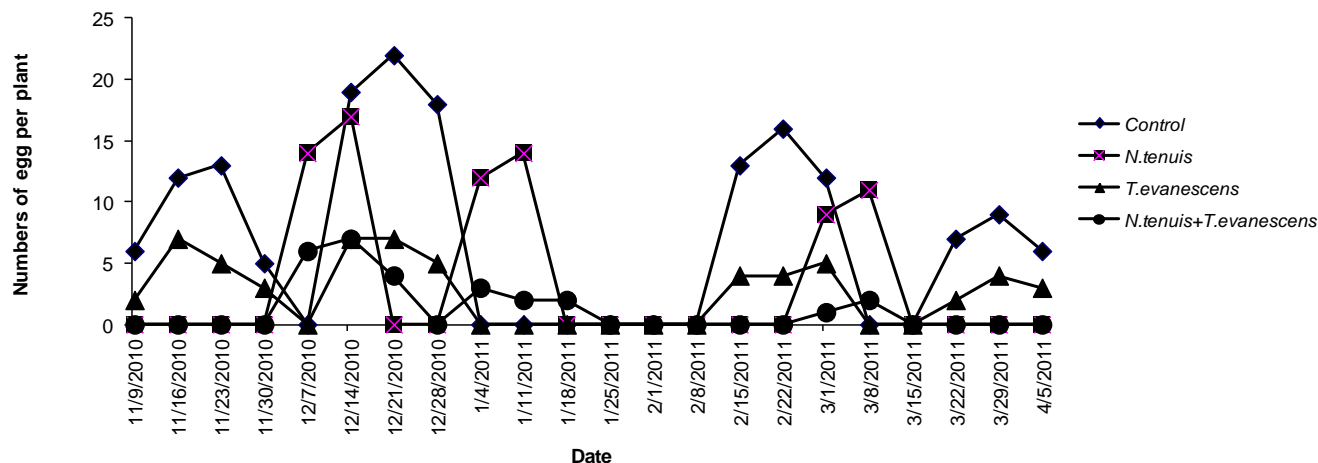


Figure 1. The population of *Tuta absoluta* egg on tomato plants counted in a greenhouse according to the treatments (releasing of *T. evanescens* and *N. tenuis* alone or combined together and control).

MATERIALS AND METHODS

Insects rearing

The individuals of *T. absoluta* used in the trials were obtained from a laboratory rearing on tomato plants in Biological Control Research Station, Adana, Turkey. The rearing of *T. evanescens*, also in the laboratory, as alternative host, according to the methodology described by Hassan (1981). *Nesidiocoris tenuis* used in the bioassay was obtained from commercial rearing (Koppert Antalya, Turkey).

Greenhouse bioassay

To evaluate the population of *T. absoluta* and efficacy of *T. evanescens* and *N. tenuis* on greenhouse of Turkey, between October and March of 2010 to 2011, 12 cages (10 m²) were placed into the greenhouse with 24 tomato plants (Buffalo variety, commercially grown) per cage (Cabello et al., 2009). Tomato plants were transplanted in October. The experimental design was at "randomized complete blocks" with three replicates. There were four treatments: release of *T. evanescens* alone (RT), release of *N. tenuis* alone (RN), releases of *T. evanescens* combined with *N. tenuis* (RTN) and control (C) (no release of any biological control agent). Each treatment was replicated three times including twelve experimental cages. Plants were infested with *T. absoluta* (two adults plant⁻¹) when tomato plants were three or four leaf stage in all cages. A total of seven releases of *T. evanescens* (75 adults m⁻² in each release) were conducted every three or four days on six cages (Cabello et al., 2009). *N. tenuis* was released (two individuals m⁻² in each release) two times in two weeks interval in November in three cages before the pest infestation about three weeks early. Because the mirids need a long time to establish well in the crops (Calvo et al., 2010). *E. kuehniella* eggs were given as a food source. The other three cages were leaved as a control. Cultivation practices were normally used in tomato greenhouse. The numbers of egg and larva of *T. absoluta* were counted once a week until harvest. Five plants in each plot selected were counted for sampling. Besides, number of fruit was counted in each plot at harvest. Data on number of pest and fruit number were submitted to the variance and correlation analyses (ANOVA) (Zar, 1999) and these averages compared by the LSD (Least Significant Difference)

test (Fischer, 1954; Zar, 1999) at 1% of probability error.

RESULTS AND DISCUSSION

Compared with the control plots, the decrease of egg numbers of *T. absoluta* was higher in plots RTN than RN (Figure 1). Similarly, result was also obtained from the larval stage of the pest (Figure 2). Although the decrease of eggs and larva of *T. absoluta* had similar results in the plots RTN, the decrease of eggs of the pest was higher than larvae in plots RN and RT.

The first parasitized eggs were seen on 9 November in the plots RT, but the parasitized eggs were seen late (on 7 December) in the plots RTN (Figure 3).

The parasitization was related with egg population of the pest and reached its highest level at the end of February in the plots RT. Although, the numbers of egg were lower in the plots RTN, parasitization was found to be higher than that of the released parasitoid alone (Figure 3). Because *N. tenuis* preferred egg stage and preyed actively on *T. absoluta* eggs. The decrease of eggs was higher than larvae in the plots RN. Similarly result reported by Arno et al. (2009) that *N. tenuis* is important predator of *T. absoluta* eggs than that of larvae.

The population of predatory bug was lower in plots where *N. tenuis* combined with parasitoid than that of the released alone (Figure 4). Predatory population were recorded at varying levels throughout the vegetation period of tomatoes, from November to April, which reached the peak level in the second part of December in both plots where released alone and combined with parasitoid. Because *N. tenuis* preyed on not only *T. absoluta* eggs but also all larval stages, especially first-instar larvae. Besides, predatory bug has a shorter life cycle (on tomato, about two weeks) when it feeds on eggs or larvae of moth.

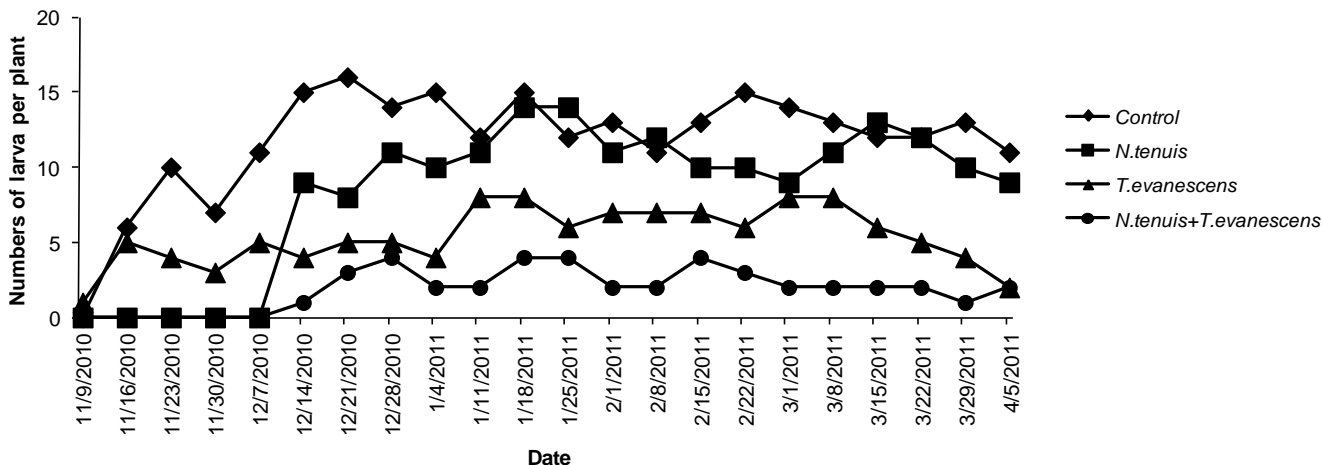


Figure 2. The population of *Tuta absoluta* larva on tomato plants counted in a greenhouse according to the treatments (releasing of *T. evanescens* and *N. tenuis* alone or combined together and control).

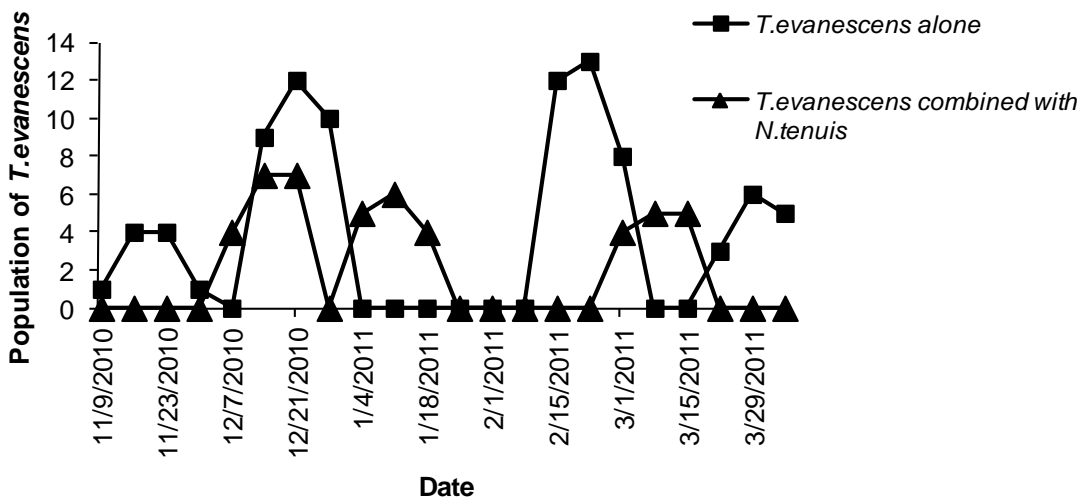


Figure 3. Population of *T. evanescens* by releasing alone and combined with *N. tenuis*.

The study shows that *N. tenuis* did not cause damage on tomato plants because of low population and had a prey. Eggs of *E. kuehniella* were provided as prey in the study. This prey was proven a high quality food resource for the predator population (Urbaneja et al., 2005).

However, tomato grown in greenhouses, damage occurs when population of *N. tenuis* is high (100 or more bugs per plant) and if the pest population is low or no prey available. To estimate the pest population in the crop accurately to introduce the predatory bug is very important. The population densities of *N. tenuis* were related to the damage incidence on the plants. It was found that the highest damage incidence was obtained when 3 *N. tenuis* individuals per leaf occurred in a period when the number of the pest had been low (Perdikis et

al., 2009). Sanches (2008) reported that the maximum average population density of *N. tenuis* was about 5 individuals per tomato leaf. The peak densities of *N. tenuis* individuals per plant in tomato grown in greenhouse and open field crops were ranged at similar levels (Arno et al., 2006). These different conclusions among studies might be due to the different experimental material used, such as the tomato varieties, *N. tenuis* populations originating from different geographical areas and factors such as temperature, humidity and day length. As stated by Sanchez (2008), the number of necrotic rings was closely correlated with temperature increase from 20 to 30°C. However, in this study average temperature was mostly kept at levels lower than 30°C. Thus, further studies should be conducted for the

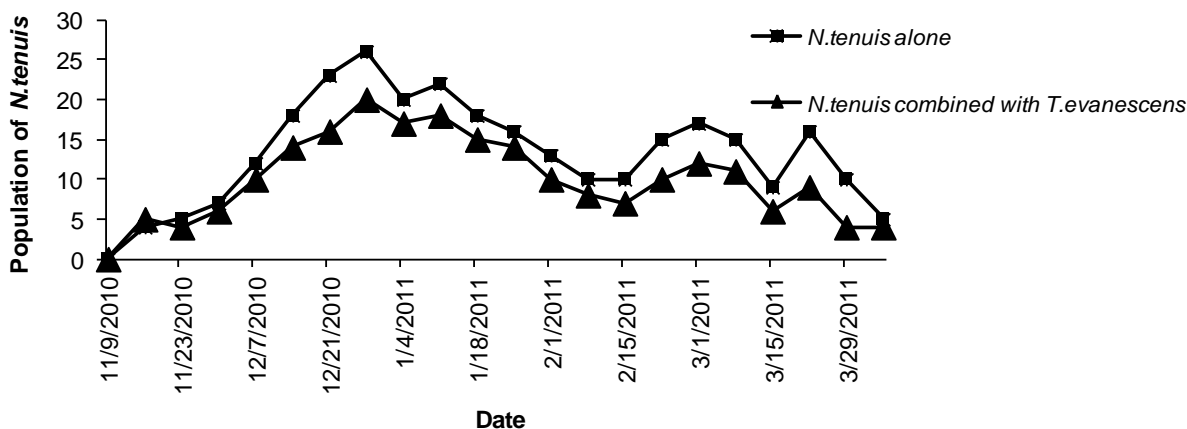


Figure 4. Population of *N. tenuis* by releasing alone and combined with *T. evanescens*.

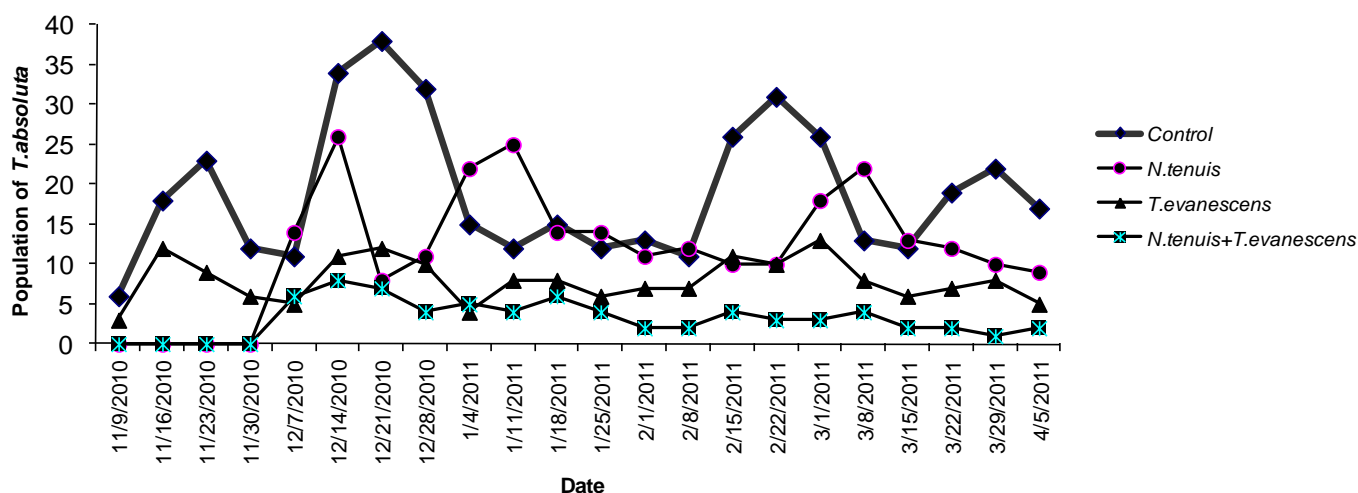


Figure 5. The population of *Tuta absoluta* on tomato plants counted in a greenhouse according to the treatments (releasing of *T. evanescens* and *N. tenuis* alone or combined together and control).

evaluation of temperature and likely other abiotic factors, on flower abortion and fruit number by *N. tenuis*.

The results demonstrated that it was necessary to establish *N. tenuis* population at the starting of the crop season, at least two or three weeks ago, and to release together with parasitoid, had a better significant reduction of *T. absoluta* (Figures 5 and 6).

Gabarra and Arno (2010) reported that the pest incidence was lower when biological control strategies based on the use of polyphagous predators (*Macrolophus pygmaeus* and *Nesidiocoris tenuis*) were applied instead of conventional chemical control.

The low population of *T. absoluta* was remarkable in the RTN plots comparing with control plots. It is clear that the host eggs and larvae have been destroyed by the parasitoids and predators. The most reduction of the host eggs was observed in the RTN plots and followed by the

RT and RN plots (Figure 6). The number of *T. absoluta* and number of fruits developed on the plants were influenced by the treatment ($F = 90.9$, $LSD = 80.98$, $d.f. = 11$, $p < 0.01$). The minimum number of the pest and maximum number of fruits were observed when releasing both biological control agents together.

In the research, the number of fruit directly affected negatively by increasing of population density of *T. absoluta* ($r = -0.990^{**}$) (Table 1).

In this study, it was found that *T. absoluta* had three or four generations in a greenhouse of tomato production in autumn-winter period. Undoubtedly, the pest had more generation during spring and summer than in autumn and winter because of the climatic conditions. The effect of climate change had a significant effect on number and duration of generations of *T. absoluta* (CABI, 2007; EPPO, 2005). *N. tenuis* has a low potential in the change

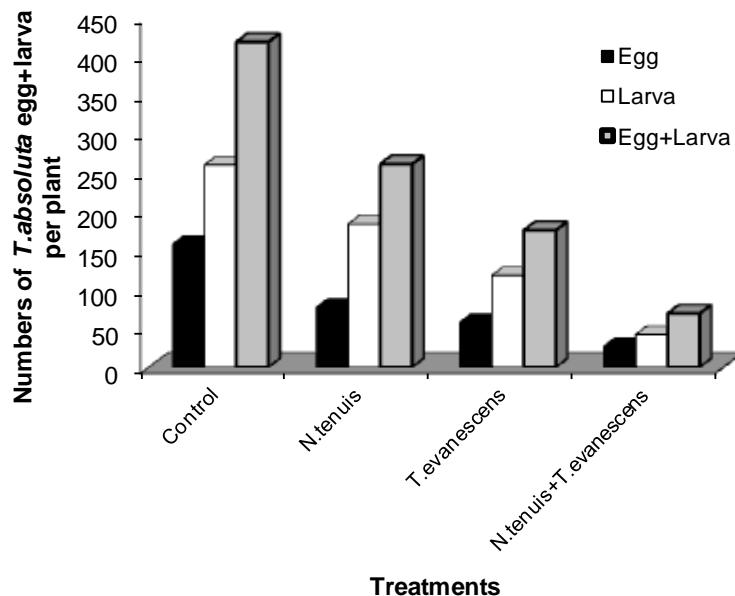


Figure 6. The numbers of *Tuta absoluta* per tomato plant counted in a greenhouse according to the treatments (releasing of *T. evanescens* and *N. tenuis* alone or combined together and control).

Table 1. Mean (\pm SE) number of fruit and *T. absoluta* in greenhouse-grown tomatoes following the release of the parasitoid *T. evanescens* alone, the predator *N. tenuis* alone, and combined release of both agents and control, Turkey.

Treatment*	Number of <i>T. absoluta</i>	Number of fruit
<i>N. tenuis</i>	261 \pm 14.73 ^b	410 \pm 11.71 ^b
<i>T. evanescens</i>	176 \pm 20.29 ^c	486 \pm 23.45 ^b
<i>N. tenuis</i> + <i>T. evanescens</i>	69 \pm 6.11 ^d	649 \pm 22.57 ^a
Control	418 \pm 8.50 ^a	144 \pm 10.39 ^c

*Means within a column followed by the different lower case letter are significantly different (LSD, $p < 0.01$).

records on tomato plants because of low population in the study.

Therefore, it could be considered as a beneficial predator at least which occurs at densities similar to those used in the study. However, further studies should search its damage potential in different population densities at the growth stage of tomato plants, in the protected crops of the Mediterranean region of Turkey. However, factors stimulating population densities of both pest and natural enemies should be considered while designing IPM programs for tomato leafminer.

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