



## Spreading, Infestation and Damage Rates and Adult Population Monitoring of Tomato Leaf Miner [*Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae)] on Open Field Tomato Grown in the South Marmara Region of Turkey

Gürsel ÇETİN\* Pınar GÖKSEL Onur DURA Cemil HANTAŞ  
Atatürk Central Horticultural Research Institute, Yalova, Turkey  
\*Corresponding author: gurselcetin77@gmail.com

### Abstract

This study was conducted in order to determine spreading, infestation and fruit damage rates and adult population monitoring of Tomato leaf miner, (*Tuta absoluta*, Meyrick) on open field tomato grown in the South Marmara Region (Bilecik, Bursa, Kocaeli, Sakarya and Yalova provinces) of Turkey in 2011-2012. As result of spreading studies carried out according to systematic sampling method, it was determined that all tomato locations in every province were infested by this pest. Infestation rates were varied between 1% and 10% in the industrial tomato production areas and between 5% and 10% in late season (June- November) fresh tomato production areas. Also, as regards the damage to tomato fruits, there was no damage in the industrial tomato production areas but, fruit damage in fresh tomato production areas were varied between 3% and 5%. In study of the population monitoring, male adults were observed on traps in the months of April and May for first time. The highest population densities were encountered in the months of August, September and October. Adults were caught on traps till end of every year.

**Keywords:** Tomato, *Tuta absoluta*, Spreading, Infestation, Population monitoring, Marmara Region

### Introduction

Tomato (*Lycopersicon esculentum* Mill) contains a large amount of lycopene and is also rich with regard to A, B6, B1, C vitamins. Its homeland is America continent's west coast extending from Ecuador to Chile. It has spread to the world from Mexico. Tomato production of the world according to 2010 data is 150 million tons approximately. Turkey, the annual average with 10 million tons, ranks as fourth after China, the U.S. and India in terms of tomato production area and quantity in the world (FAO, 2012). In Turkey, tomato was grown for first time in 1900 in Adana province. Now, its total tomato production is 11.35 million tons (TUİK, 2012).

The South Marmara Region (Bilecik, Bursa, Kocaeli, Sakarya and Yalova provinces) has a large part of industrial tomato producing areas in Turkey and its tomato production is 1.1 million tons in 146.510 hectares area, also fresh tomato production is 442.000 tons in 79.850 hectares area approximately (TUİK, 2012).

Tomato leaf miner which was one of the most important pests of tomato is the South

American origin. It was observed for the first time in Spain in the continent of Europe in 2006 and then France, Italy, Malta, Holland, Great Britain, Hungary, Bulgaria and Greece also appeared in Algeria, Morocco Tunisia such as North African countries, (Potting 2009; Roditakis et al 2010). In Turkey, it was determined for the first time in İzmir's Urla district in August 2009 (Kılıç, 2010) and then had spread other region within a short time.

It has been acquiring resistance against insecticides because pest fed in the leaf tissue and has been spreading widely by reproducing extraordinary (Liatti, 2005). Pest reproducing quickly and giving 10-12 generation per year (Vercher et al. 2010) in locations having Mediterranean climate has caused significant crop losses in Eastern Mediterranean and Aegean regions of Turkey (Kılıç 2010; Portakaldalı et al 2013).

The aim of this study is to investigate spreading, infestation, damage and population of this pest on open field tomato in south Marmara Region.

### Materials and Methods

Spreading studies were conducted in 0.1% and 0.5% of all tomato production areas in the sought Marmara Region according to systematic sampling methods (Bora and Karaca, 1970). These studies were carried out in 0.1% of tomato production areas that are 200 ha and more; in 0.5% of tomato production areas that are less than 200 ha. All parts of a total of 40 plants were examined with magnifier (x10) at 10 different sites of a randomly-selected row in a 0.1-ha of tomato fields

studied in each location. Locations were recorded as infested when any biological stage of pest or typical damage symptoms pertaining to this pest were detected. Studies were carried out once per month during seedling, vegetative growth, and flowering and fruiting period. Location coordinates and altitude were obtained with GPS, the Magellan SporTrak brand hand tool. Data related to the studied locations in the South Marmara Region were the following Table 1.

**Table 1.** Altitudes and sizes of studied tomato areas for determining spreading of *Tuta absoluta* in South Marmara Region

Province	District	Tomato area		Altitude (m)
		Total field (ha)	Examined field (n)	
Bilecik	Osmaneli	990	10	103
Bursa	Karacabey	8.410	84	33
	Mustafakemalpaşa	5.000	50	34
	İznik	2.500	25	101
	Yenişehir	342	3	235
Kocaeli	Merkez	150	2	76
	Kandıra	106	2	39
Sakarya	Pamukova	255	3	102
Yalova	Merkez	0.5	1	7

Infestation rates were determined in a 0.1-ha area of a tomato field infested by *T. absoluta* for each location. For that, it was examined all parts of a total of 100 plants from 10 different sites of a randomly-selected row, with magnifier (x10) in July and August. To calculate infestation rates were used the following formula;

$$\text{Infestation (\%)} = \frac{\text{Number of infested plants}}{\text{Number of examined plants}} \times 100$$

Also, rates related to fruits damage caused by larvae were determined in a 0.1-ha area of a tomato field infested by *T. absoluta* for each location. For that, it was examined all fruits of a total of 100 plants from 10 different sites of a randomly-selected row, with magnifier (x10) with magnifier (x10) and visually, in July and August. To calculate was used the following formula;

$$\text{Damage (\%)} = \frac{\text{Number of the damaged fruit}}{\text{Number of total fruit examined}} \times 100$$

Population monitoring of male adult was conducted a 0.1-ha areas of tomato fields in each of two locations (Table 2).

**Table 2.** Locations and dates of trap placing regarding population monitoring

Location	Date of trap placing	
Yalova	19.04.2011	19.04.2012
Bursa (İznik)	17.04.2011	17.04.2012

Pheromone traps (QLure-TUA *Tuta absoluta*-500) were placed in tomato production areas in both locations. Traps were controlled every three days until adults were caught firstly and after adults were caught they were controlled as weekly and recorded. In the study of population fluctuation, data related to relative humidity and average temperatures were obtained with Hobo brand climate recording-device.

### Results

Findings related to pest's biological stages, spreading, infestation and fruit damage rates obtained from studies conducted on open field tomato from on 27 May 2011 to on 27 November 2012, monthly were given in Table 3.

**Table 3.** Spreading, infestation and damage rates of *Tuta absoluta* in the South Marmara Region in 2011-2012

Province	District	Location	Coordinate	Spreading	Biological stage		Infestation (%)		Damage on tomato fruit (%)	
					2011	2012	2011	2012	2011	2012
Bilecik	Osmaneli	Merkez	40°21'33"N, 30°01'18"E	+	-	l,a	-	2	-	-
		Çerkeşli	40°26'27"N, 29°58'01"E	+	l	-	1	-	-	-
		Ericek	40°25'49"N, 29°59'14"E	+	l	l	1	1	-	-
		Beşevler	40°26'14"N, 29°54'06"E	+	l, a	e,l,p	3	2	-	-
Bursa	Karacabey	Yeşildere	40°18'13"N, 28°11'28"E	+	l, a	e,l,p	2	5	-	-
		Dağkadı	40°15'43"N, 28°11'44"E	+	l,	l,p,a	3	5	-	-
		Tophisar	40°13'17"N, 28°10'01"E	+	l	l	2	5	-	-
		Akhisar	40°09'93"N, 28°11'02"E	+	-	l	-	1	-	-
		Sultaniye	40°11'57"N, 28°11'77"E	+	l, a	l,p,a	2	1	-	-
		İsmetpaşa	40°09'76"N, 28°10'60"E	+	-	e,l	-	2	-	-
		*Beylik	40°06'03"N, 28°11'66"E	+	l, a	e,l,a	5	3	3	3
		*Hayırlar	40°17'25"N, 28°26'11"E	+	l, a	l,p,a	10	6	5	4
		*Ekinli	40°21'49"N, 28°30'09"E	+	l, a	l,p,a	10	7	5	4
		*Ballıkaya	40°22'04"N, 28°31'54"E	+	l, a	e,l,a	9	5	3	3
	Mustafa Kemalpaşa	Çeltikçi	40°03'47"N, 28°14'01"E	+	l, a	e,l	3	2	-	-
		Koşuboğazı	40°03'10"N, 28°14'56"E	+	l, a	e,l,p	4	2	-	-
		Kumkadı	40°09'18"N, 28°27'52"E	+	l, a	e,l,p	1	2	-	-
		Tepecik	40°07'21"N, 28°25'36"E	+	l, a	e,l,p	2	3	-	-
	İznik	Merkez	40°25'44"N, 29°43'10"E	+	l, a	l	3	2	-	-
		Karatekin	40°26'23"N, 29°52'48"E	+	l, a	l	3	3	-	-
		Kaynarca	40°24'57"N, 29°49'30"E	+	l, a	l	1	-	-	-
		Elbeyli	40°29'08"N, 29°43'36"E	+	l, a	l, a	1	1	-	-
		*Çakırca	40°28'15"N, 29°39'47"E	+	l, a	l, a	4	5	-	4
		Hocaköy	40°24'22"N, 29°45'59"E	+	l, a	l,p	5	1	-	-
*Ömerli		40°30'33"N, 29°43'13"E	+	l, a	l,p	4	5	-	4	
*Çiçekli		40°24'34"N, 29°46'54"E	+	l,p	l, a	7	4	-	3	
Yenişehir	Selimiye	40°18'01"N, 29°29'21"E	+	l, a	l,p	1	1	-	-	
	Köprühisar	40°16'44"N, 29°47'08"E	+	l,a	l,p	1	1	-	-	
Kocaeli	Merkez	Eseler	40°53'08"N, 29°32'33"E	+	l, a	l,p	1	1	-	-
		Bayraktar	40°51'36"N, 29°44'32"E	+	l, a	l, a	2	1	-	-
Sakarya	Pamukova	Merkez	41°06'05"N, 30°10'16"E	+	l, a	-	2	-	-	-
		Örentepe	40°46'48"N, 30°24'20"E	+	l,a	l,p	2	2	-	-
		Fevziye	40°28'09"N, 30°06'41"E	+	l, a	l, a	3	1	-	-
		Özbek	40°28'19"N, 30°07'33"E	+	l, a	l,p	3	2	-	-
		Çardak	40°28'20"N, 30°09'27"E	+	l, a	l,p	1	2	-	-
Yalova	Merkez	Enstitü	40°39'38"N, 29°17'24"E	+	l, a	l, a	1	1	-	-
		Kazımiye	40°37'36"N, 29°18'43"E	+	l, a	e,l,p	2	1	-	-
		Kadıköy	40°37'07"N, 29°13'29"E	+	-	l	-	1	-	-

\*= Fresh tomato production areas, e=egg, l=larvae, p=pupae, a= adult, += infested, -= not observed

As result of the spreading studies, all tomato locations in every province were infested by this pest but each tomato field in these locations was not infested (Table 3). Infestation rates were varied between 1% and 10% in the industrial tomato production areas and between 5% and 10% in late season fresh tomato production areas, but infestation were not observed in a few fields in some tomato locations (Table 3). Infestation studies revealed that larvae stage of pest was usually appeared in leaves and shoots of plants in both the industrial and fresh tomato production areas. Also, there was no fruit damage in the industrial tomato

production areas, but fruit damage was determine on fresh tomato produced in late season and their rates were varied between 3% and 5% (Table 3). Whereas fruit damage and egg, larva, adult stages of pest were observed in fresh tomato production areas in 7 locations, in the all industrial tomato production was detected only larvae and adult stage of pest (Table 3).

Findings pertaining to adult population monitoring studies were given following Figure 1 and 2. According to Figure 1 and 2, first capture dates of male adults in Yalova and Bursa (İznik) were on 26 April 2011 and 01 May 2012 respectively.

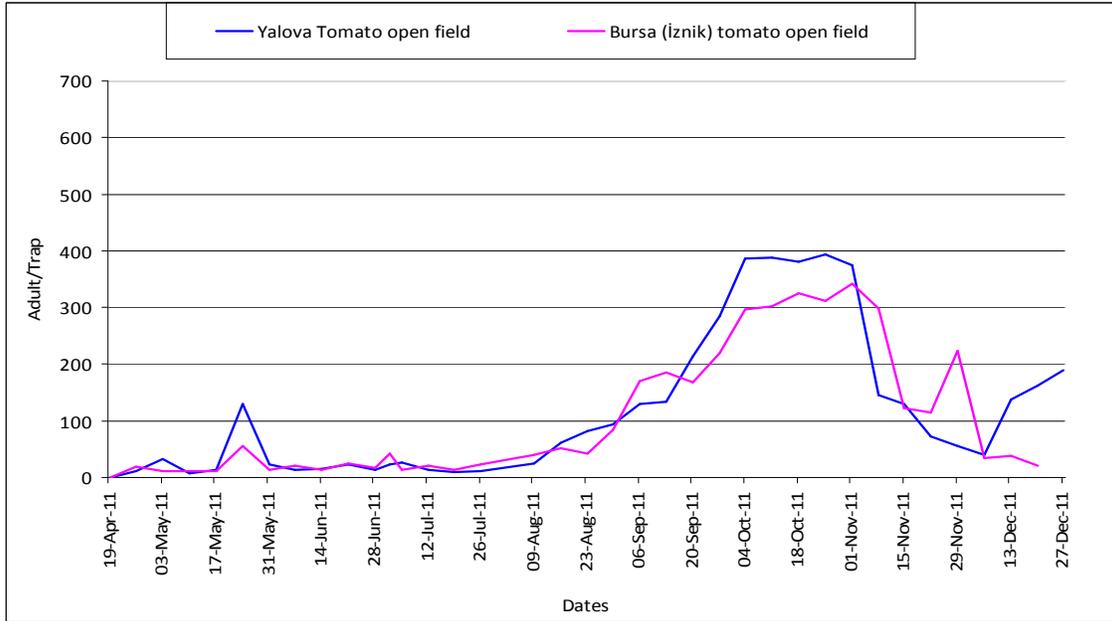


Figure 1. Adult population fluctuation of Tomato leaf miner (*Tuta absoluta*) in Yalova and Bursa (İznik) provinces in 2011.

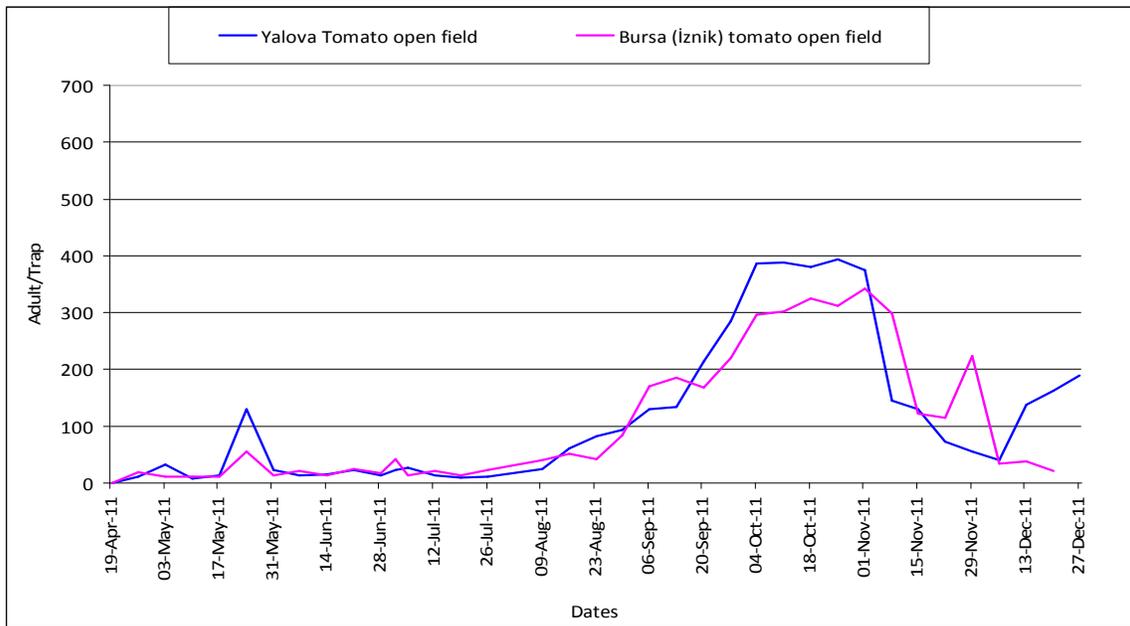


Figure 2. Adult population fluctuation of Tomato leaf miner (*Tuta absoluta*) in Yalova and Bursa (İznik) provinces in 2012.

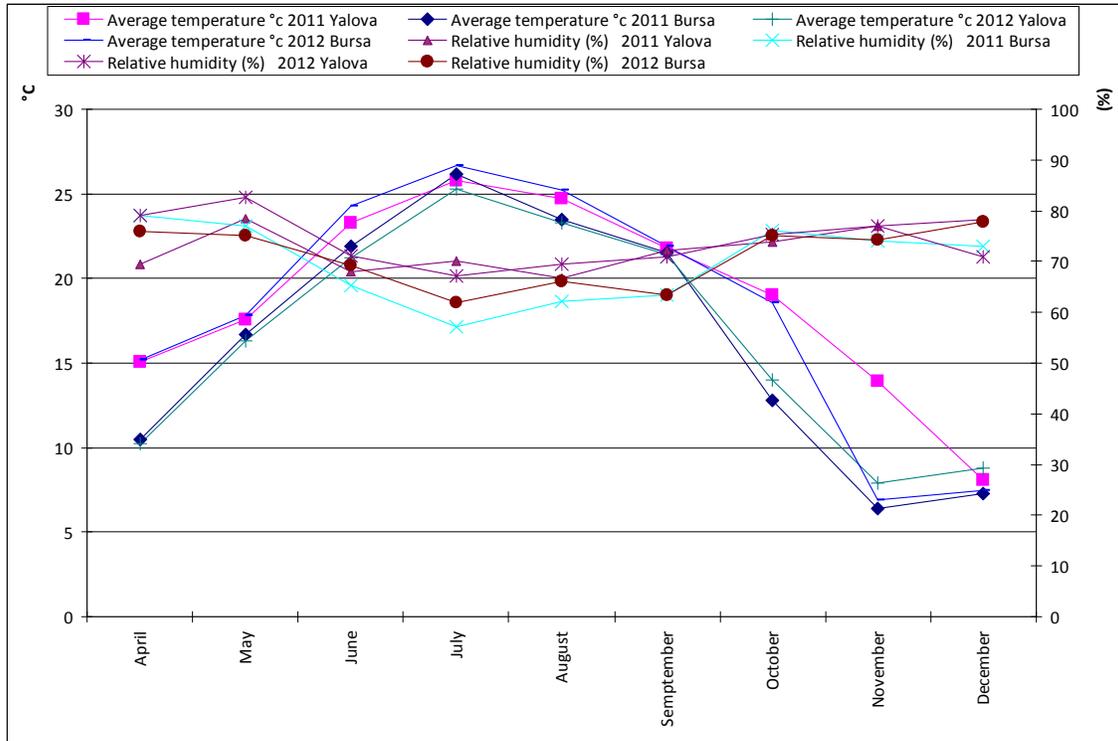


Figure 3. Data of average temperature °C and relative humidity (%) pertaining to Yalova and Bursa (İzник)

### Provinces

Initially, male adults were caught to the delta traps in Yalova and Bursa (İzник) in 2011 and 2012 as 2 and 5 individuals; 32 and 12 individuals respectively.

When first adults were captured in Yalova and Bursa (İzник) in 2011 and 2012 daily relative humidity and average temperature data were 15.4 °C and 78%, 19°C and 85%; 18.3°C and 80% 20.2 °C and 81% (Figure 3) respectively. The maximum male adult capturing of this pest in trap in 2011 and 2012 were occurred as 394 and 621 individuals per trap in Yalova on 25 October and on 25 September respectively. Likewise, the maximum male adult capturing of this pest in Bursa (İzник) in 2011 and 2012 were occurred as 342 and 405 individuals per trap on 01 November and on 02 October respectively. While male adult population density from April to August was found fewer than 150 individuals per trap, this density from at the end of August to at the end of December was found above the 150 individuals per trap in both years. Adults were captured to trap from the end of April or the beginning of May to the end of December, in both years.

### Discussion

As a result of this study, it was determined that tomato leaf miner spread in all tomato locations in each province of the South Marmara

Region. Studies conducted on this pest in Turkey reveals that it was appeared in Aegean region for first time in 2009 (Kılıç, 2010) and then was detected in Mediterranean, South-East Anatolia, Central Anatolia and Aegean Regions up to now (Karut et al. 2011, Tatlı and Göçmen 2011, Ünlü 2011, Mamay and Yanık 2012, Portakaldalı et al. 2013).

Infestations occurred by this pest to tomato plants were detected almost everywhere of studied areas, except in a few tomato fields. Even though it was detected in every location, its infestation rates were significantly low level when adult population intensity was compared and they varied between 1-10% in areas of the industrial tomato production and fresh tomato areas in late season (June-November). On the other hand, Mamay and Yanık (2012) indicated that infestation rates were 100% on tomato in two open fields in Şanlıurfa province of the South-East Region. Tomato leaf miner has become a threaten pest in tomato production all over world. Furthermore, Desneux et al. (2010) reported that this pest can cause up to 80-100 % yield losses in tomato crops if no control measures are taken. In fact, it can be assumed this pest was under the economic damage threshold (2 female or 26 larvae per plant reported by Bajonero et al., 2008) in the South Marmara Region due to very low fruit damage and infestation rates. But it should be

pointed out that open field tomato cultivation in this region is done under contractual cultivation and control measures against all diseases and pests are applied regularly from seedling planting till harvest in accordance with the contractual cultivation rules. During that periods, control measures, especially chemicals applied against *T. absoluta* and the Cotton bollworm, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) could be a reason for low infestation rates and population densities during May–August period in both industrial tomato and fresh tomato production areas. Also, due to the implementation of control measures regularly, fruit damage of the industrial tomato was not observed. But, fruit damage on fresh tomatoes was observed and varied between 3% and 5% (Table3). Damage rates on fresh tomatoes were very low due to chemical control which was applied regularly. On the other hand, Karut et al. (2011) indicated that fruit damage of tomato in greenhouses in Mersin provinces of Mediterranean Region reached a maximum of 38.4% per plant.

As for population monitoring studies, the obtained findings were similar to findings of Mamay and Yanik (2012), Portakaldalı et al. (2013) in terms of duration and emergence time of adults during all the seasons but, there were differences in peak numbers, while peak numbers were 370 adults per trap in Şanlıurfa province (Mamay and Yanik (2012), and 708 adults per trap in Adana province (Portakaldalı et al. 2013) in this study were 621 adult per trap in Yalova and 405 adult per trap in Bursa provinces respectively. Furthermore, Filho et al. (2000) reported that highly attractive traps with triene acetate caught about 869 males per trap in Brazil. All these findings indicated that population fluctuations and maximum male adult numbers of *T. absoluta* were varied depending on the climatic conditions of different locations. While adult population density was under 150 male adults per trap from April to August, that density was about 330 male adults per trap as average from the end of August to the end of December in both years. As mentioned on the rates of infestation and fruit damage, the reason for increasing of adult population after August is that control methods applied under contractual cultivation ruler during growing period were left after product harvesting and crop residues were not removed by growers.

### Conclusion

All tomato locations except a few tomato fields was infested by *T. absoluta*, infestation and fruit damage rates were lower than other region due to control measures applied against all pests in accordance with contractual cultivation sanctions regularly from seedling period until tomato was

harvested. Male adult population has been increasing rapidly after end of the August because contractual cultivation sanctions applied during growing period were left after harvest and crop residues were not removed. For these reason, pest population was increased and caused damage to tomato fruits in late season fresh tomato production areas.

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