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Short Paper

Population development of the tomato moth *Tuta absoluta* (Lepidoptera: Gelechiidae) in greenhouse tomato in Biskra, Algeria

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Abstract: The objective was to study the population development of *Tuta absoluta* (Meyrick, 1917) on tomato in greenhouse conditions at Droh. The trial assessed the occurrence of *T. absoluta* adults from the month of October to May in traps; a low numbers is noted. The high numbers recorded (170 adults/greenhouse) are caught at the end of crop cycle. The mean number of capture is 22 adults/ week/ trap. Regarding the other developmental stages, immatures of *T. absoluta* are also very low mainly at the beginning of the crop season. The highest numbers of immature stages recorded is: 36 eggs per 30 leaves on 19 April 2012, 14 larvae 19 April and 3 May 2012. One pupa is recorded on 17 November 2011 and 26 January 2012. During the survey, no natural enemies are detected on the different developmental stages of *T. absoluta*.

Keywords: Tomato borer, protected crops, infestation levels, North Africa

Introduction

Tomato *Lycopersicon esculentum* Miller, occupies a privileged position in vegetable production sector in the world and in Algeria. It is the most popular vegetable with widespread growing areas both in open fields and in greenhouses. The climatic conditions in Algeria are very favourable for production of a highly profitable crop. Its cultivation has undergone a major expansion in the Sahara region and mainly in Ziban (Biskra). Biskra is classified the first producer of early vegetables nationally (DSA, 2009).

Greenhouse crops are more susceptible to fungal and viral diseases and also to pest attacks due to the high humidity and temperature. Infestation can occur on aerial parts and/or roots in an isolated manner or generalized. The main pests of tomato are nematodes, insects or other arthropods (Lange and Bronson, 1981). The moth *Tuta absoluta* (Meyrick) has been regarded as a major pest and most devastating to tomato crops in South America since 1960s (Garcia and Espul, 1982; Barrientos *et al*., 1998; Miranda *et al*., 1998). According to Haji *et al*. (1988) and Torres *et al*. (2001), in severely infested fields, the plants are affected at any stage of development and the losses can reach up to 100% (França, 1993). It is characterized by a high reproductive potential (Lopes-Filho, 1990; Castelo-Branco, 1992). The main host of the pest is tomato but it can also develop on other solanaceous plants. Although *T. absoluta* prefers tomato plant, according to Vargas (1970), Campos (1976) and Desneux *et al*. (2010) it can also feed, develop and reproduce on other solanaceous crops, such as eggplant *Solanum melongena* (L.), potato *S. tuberosum* (L.), pepper *S. muricatum* (Aiton) and tobaco *Nicotiana*

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tabacum (L.), as well as non- solanaceous crop plants. Other plant species were reported as alternative hosts since its introduction in Europe. It was listed on *Physalis peruviana* (L.), *Phaseolus vulgaris* (L.), *Lycium* spp. and *Malva* spp. (Tropea Garzia *et al*., 2012).

Tuta absoluta is a pest with great potential of dispersion related primarily to its biological characteristics, acclimatization capacity and also due to trade exchanges (Desneux *et al*., 2010). According to Guenaoui (2008), *T. absoluta* was reported for the first time in Western Algeria in March 2008. Since then, it has spread in areas where tomato is cultivated (Guenaoui, 2008), including several locations at Biskra (Allache and Demnati, 2012; Allache *et al*., 2012). Actually, it is considered the most important pest of tomato in the Mediterranean countries, Middle East, Eastern, Central and Western Europe as well as North Africa (Van Der Straten *et al*., 2011; Caparros *et al*., 2012; Tropea-Garzia *et al*., 2012). *Tuta absoluta* has become the most important pest of tomato crops in Algeria since 2008 (Badaoui *et al*., 2010; Gacemi and Guenaoui, 2012).

Hence, the objective of this work was to monitor the population development of *T. absoluta* in greenhouse tomatoes at Droh (Biskra) during 2011/2012 farming season.

Materials and Methods

Experimental field

The study was conducted in a greenhouse of 400 m^2 surface area cultivated with tomato “Sahara” cultivar. The study area is located at Droh (east of Biskra). The crop was planted on 2 October 2011.

Sampling method

Two monitoring methods were applied to study the population fluctuations of *T. absoluta* (Allache and Demnati, 2012; Allache *et al*., 2012). Two sex pheromone traps were placed in the greenhouse to catch adults. A random sampling of leaves taken on the upper level of the plant (30 leaves per week) for counting eggs, larvae and pupae was made. Traps were installed at the beginning of the growing cycle and the leaf samplings started on 10th November 2011 and finished on 3rd May 2012. After observation under binocular scope, sampled leaves were placed in boxes (at room temperature of ≈25°C) to allow development of live larvae or pupae and at the same time the emergence of potential parasitoids. The population monitoring of *T. absoluta* was conducted in the greenhouse for the entire duration of tomato crop growth period. The occurrence of spider mites and fungal diseases on tomato crops are often subject to chemical controls.

Statistical analysis

The data obtained, i.e. the number of adults captured in traps and of immature insects counted on leaves were square root transformed (x + 0.5) before analysis to homogenize data. One-way ANOVA procedure was used to test differences per month and confirm if development of numbers (dependent variables) were significant during crop cycle (independent variable) either in *T. absoluta* adults and immature at 5% level of significance using Statistica 6.1 Statsoft, Inc.1984-2003.

Results

The first flight of adult moth was detected at the end of October (27 October 2011). The evolution of the different pest stages is shown in Figures 1 and 2.

Captured adults varied markedly during the survey. However catches were significant at the end of the crop cycle. The total number of adults caught totalled 1270 individuals. Adults were present throughout all tomato crop cycle. According to statistical analysis, the development of the number of adults during the growing season was highly significant ($F = 7.95$, $df = 7$, $p = 0.0001$). Eighty two individuals were caught at the beginning of sampling (27 October 2011). The adult numbers ranged from 5 to 48 individuals between 3 November 2011 and 1 March 2012. Then, between 8 March 2012 up to end of crop growing season, the number of adults increased (Fig. 1). So, the trend of captures indicated the presence of six major peaks. The first peak was noted on 27 October 2011 (82 adults captured); the second on 7 December 2011 (48 individuals); the third on 8 March 2012 (88 individuals), the fourth on 22 March 2012 (112 individuals), the fifth on 5 April 2012 (132 individuals) and finally the sixth on 26 April 2012 with 170 individuals trapped. According to figure 1, *T. absoluta* developed six generations during the tomato growing cycle in greenhouse at Droh.

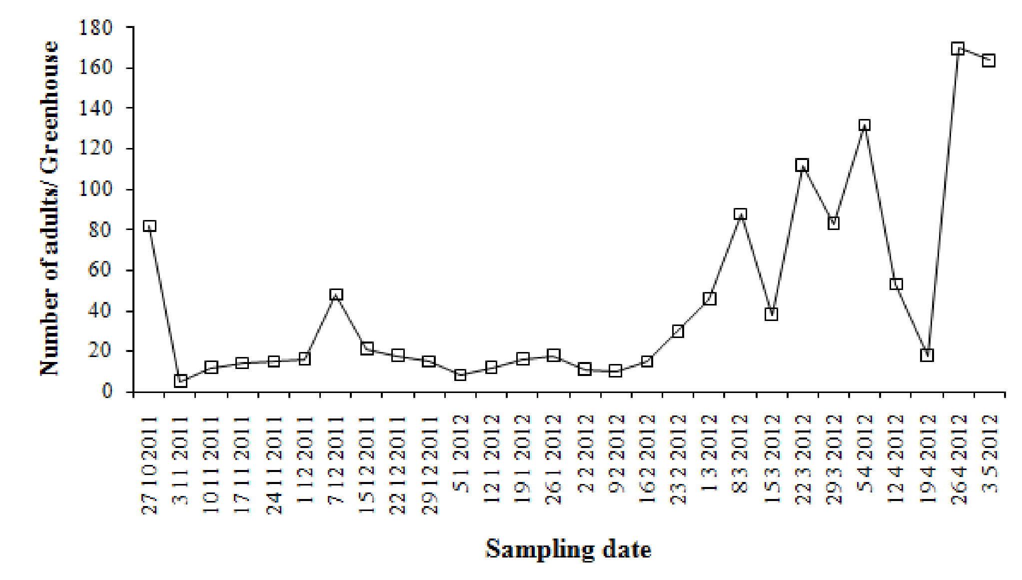

Figure 1 Fluctuation of *Tuta absoluta* adults in tomato greenhouse at Biskra.

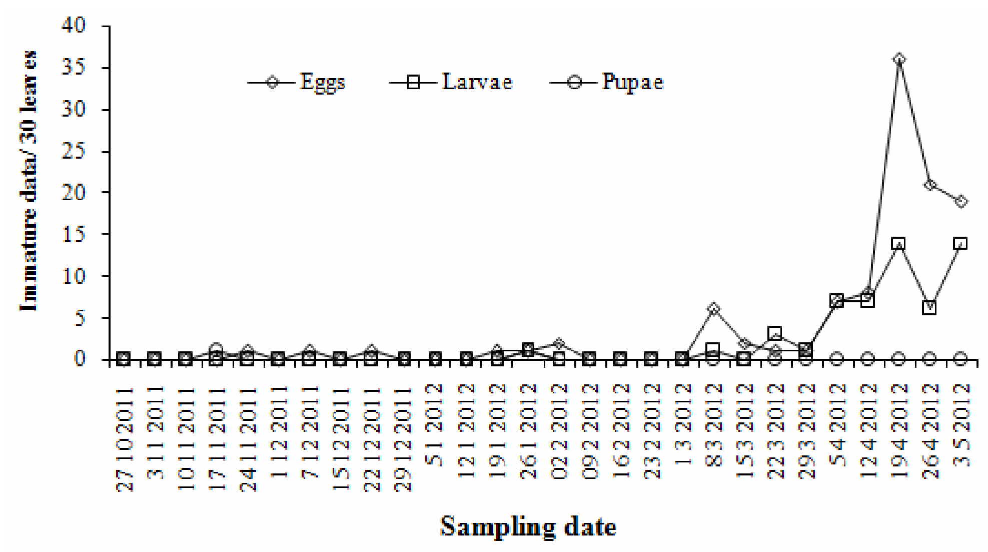

Figure 2 Fluctuation of *Tuta absoluta* immature stages on tomato crop in greenhouse at Biskra.

Regarding the eggs, a regular presence on leaves was observed only from 8 March 2012. Recorded numbers were very low, as shown in Figure 2. However, the highest number of eggs (36 eggs) was registered almost at the end of the crop cycle on 19 April 2012. The development of the number of eggs was highly significant (F = 11.26, df = 7, p = 0.0000). During the study, neither predators nor any parasitoids of eggs of *T. absoluta* were detected.

The trend of the density of larvae is illustrated in Figure 2. According to statistical analysis, the development of larvae is very highly significant (F = 31.26, df = 7, p = 0.0000). An absence of larvae is observed up to 8 March 2012. Regular occurrence is noted from 22 March 2012. The number of larvae sampled remained very low. However, the maximum number was reported at the end of crop cycle (14 larvae). However, there was no predation or parasitism of larvae observed in the study site.

A total absence of pupae was observed except for two samples collected on 17 November 2011 and 26 January 2012, when only one pupa was reported (Fig. 2). No pupae enemies were observed during this study.

Discussion

As previously reported by Allache and Demnati (2012) and Allache *et al*. (2012), the leaf miner *T. absoluta* is found only on tomato at Bouchagroune, Sidi Okba and Biskra. The same is observed at Droh. According to population development data, it is noticed that *T. absoluta* is present on all tomato growing stages. Adult flights began in late October while at Bouchagroune they started flying in November and at Biskra and Sidi Okba in December (Allache and Demnati, 2012; Allache *et al*., 2012).

The number of catches is low in this study compared to those reported by Allache and Demnati (2012) at Sidi Okba and Bouchagroune (Biskra) and Allache *et al*. (2012) at Biskra even, at the same period. Salas (2007) recorded in 2001 a total catch of 7041 individuals in Venezuela. The low numbers are probably due to the greenhouse isolation, the preceding crop in addition to the location of Droh, which is not a suitable area for greenhouse cultivation. The catches increased and became very significant at the end of growing season. The present results confirm those of Lacordaire and Feuvrier (2010), Allache and Demnati (2012), Allache *et al*. (2012) and Cocco *et al*. (2013). Leite *et al*. (2004) noticed that attacks of *T. absoluta* are very severe towards crop cycle end. The intensity of adult catches is due to the rise in temperature (Lacordaire and Feuvrier, 2010). The removal of preceding crop is crucial in reducing the leaf miner infestation (Leite *et al*., 2004) and the risk of attack for the new crop.

According to the curve, six generations in greenhouse tomato is recorded in the present study. However, three generations is reported in Turkey on potato by Unlu (2012) and at Biskra on tomato greenhouse by Allache *et al*. (2012). After Lebdi-Grissa *et al*. (2010), *T. absoluta* completed four generations on the same crop in greenhouse in Tunisia. In Italy up to nine generations per year were observed, while in Spain it has been estimated that the pest could complete up to 13 generations (Tropea-Garzia *et al*., 2012). Whereas, in South America it can reach 12 generations depending on climatic conditions (Barrientos *et al*., 1998).

According to Torres *et al*. (2001), eggs are laid on all parts of the plant, although the leaves are the preferred egg-laying substrate. It is noted that number of eggs is very low during the whole study period. This number increased during the last three weeks of the study with a maximum recorded on 19 April 2012 (36 eggs). This number is far from that recorded by Allache and Demnati (2012) at Bouchagroune (59 eggs) and Sidi Okba (55 eggs); while Allache *et al*. (2012) noted a low number of eggs (30 eggs) at Biskra on tomato. Pereyra and Sanchez (2006) registered an average fecundity of 132.78 on tomato and 97.73 on potato. The observations made during this work showed that eggs are deposited on the lower leaf surface of tomato, as indicated by Coelho and França (1987).

Reading the curve of larval stage, an absence of larvae is noted during the first sampling period and low numbers are recorded during the last weeks of the study. This may be due to low egg hatch (Allache *et al*., 2012) and natural mortality which can reach 58.7% (Miranda *et al*., 1998). Leite *et al*. (2004) stated that terpenes affected the pest oviposition. Schultz (1983) explained that heterogeneity in foliage quality between leaves' level is constraining for insects, making the foliage of high quality hard to find and forcing them to move frequently to search for good quality food which may explain the difference in spatial and temporal distribution of populations. The absence of larvae can be caused by insecticide use; then larvae can leave their galleries (Lacordaire and Feuvrier, 2010). Torres *et al*. (2001) also reported that natural larval mortality is high. Only two pupae were observed during the study, while Allache and Demnati (2012) recorded 13 and 12 pupae at Bouchagroune and Sidi Okba. The lack of pupae may be due to the sampling procedure which does not take into account the pupae fallen on the ground or to low occurrence of larvae due to chemical control (Allache *et al*., 2012), their viability and nutritional quality of plant (Torres *et al*., 2001). It can also be explained by pupation which can take place in the soil (Lebdi-Grissa *et al*., 2010). According to Coelho and França (1987), the percentage of pupation of larvae in the leaves, stems and fruits are low.

Tuta absoluta has become a major pest in Southern Europe and North African countries. In South America, the leaf miner development is limited by a large cohort of predators and parasitoids at its different developmental stages (Desneux *et al*., 2010). Several predators and parasitoids are recorded spontaneously attacking *T. absoluta* in tomato crops in Europe and North Africa (Urbaneja *et al*., 2012; Biondi *et al*., 2013a, b; Zappala *et al*., 2013; Abbes *et al*., 2014). Conversely, a total lack of natural enemies in tomato greenhouse at Droh is noticed. It can be explained by the excessive pesticide use by the farmers or by the recent introduction of the pest in the area. Allache and Demnati (2012) and Allache *et al*. (2012) also recorded a defect in parasitism and predation at Bouchagroune, Sidi Okba and Biskra. According to Miranda *et al*. (2005), the use of pesticides severely affects the natural enemies' population and can compromise biological control services (Balzan and Moonen, 2012) as already reported for several natural enemies (Biondi *et al*., 2012; 2013). However, in Mitidja (Algiers), Mahdi *et al*. (2011) noted the occurrence of two bug species, *Nesidiocoris tenuis* Reuter and *Macrolophus caliginosus* Wagner (Hemiptera, Miridae) and a parasitic wasp (Hymenoptera, Eulophidae); a third species is mentioned by Boualem *et al*. (2012), *Dicyphus errans* Wolff at Mostaganem (littoral west of Algeria). According to these authors, *N. tenuis* has a significant effect in regulating the population of *T. absoluta*. Several authors reported that indigenous mirid predators have been already successfully employed in *T. absoluta* integrated pest management programs (Calvo *et al*., 2012; Bueno *et al*., 2013; Zappala *et al*., 2012; Chailleux *et al*., 2013; Molla *et al*., 2014).

It would be interesting to extend such studies to other localities in order to search for potential indigenous antagonists of this pest, and to reduce the pesticides use by incorporating other non-polluting means to protect and help antagonistic organism to settle down.

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رشد جمعیت شب‌پره مینوز گوجه‌فرنگی *Tuta absoluta* (Lepidoptera: Gelechiidae) در گلخانه گوجه‌فرنگی بیسکرا، الجزیره

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چکیده: هدف از این مطالعه بررسی رشد جمعیت شب‌پره مینوز گوجه‌فرنگی *Tuta absoluta* (Meyrick, 1917) در شرایط گلخانه در شهر دروه می‌باشد. در این آزمایش میزان شکار حشرات کامل توتا در تله از مهر ماه تا اردیبهشت مورد بررسی قرار گرفت که تعدادشان خیلی کم بود. اما تعداد زیادی حشرات کامل (۱۷۰ حشره) در زمان برداشت محصول شکار شد. به‌طور متوسط تعداد ۲۲ حشره کامل در هر تله ثبت شد. در ابتدای فصل رشد تعداد حشرات نابالغ هم خیلی کم بود. بیش‌ترین تعداد حشرات نابالغ عبارت بودند از: ۳۶ تخم در ۱۹ آوریل ۲۰۱۲، ۱۴ لارو در ۱۹ آوریل و ۳ می ۲۰۱۲. یک شفیره در ۱۷ نوامبر ۲۰۱۱ و ۲۶ ژانویه ۲۰۱۲ به ثبت رسید. در طول این بررسی هیچ دشمن طبیعی مشاهده نشد.

واژگان کلیدی: کرم گوجه‌فرنگی (توتا)، گیاهان گلخانه‌ای، سطح آلودگی، شمال آفریقا