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Factors affecting *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) infesting some tomato hybrids throughout summer season in Assiut Governorate, Upper Egypt

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Abstract

An area of about half acre was cultivated with tomato (*Lycopersicon esculentum* Mill) in 2012 summer season. Obtained data indicated that the infestation began when the plant aged one month. Infestation with *T. absoluta* reached the maximum number of 50 and 28 larvae per 10 leaves on hybrids of H6 and H7, respectively. The infestation was then decreased gradually until the end of the season. The relative efficiency of the plant age factor was found 25% out of about 90%. Data indicated also that mirid bugs seemed to be responsible for about 14% of the variability of the infestation with *T. absoluta* larvae. Mirid bugs occupied the second rank of the rating sort. Both hybrids, (H6 and H7) showed similar effect of maximum temperature on larval infestation. Rating sort of co-efficient of determination revealed that the air temperature ranked the fourth factor. However, air temperature was found to be responsible for about 9% and 10% of the variability of larval infestation between the two hybrids H6 and H7, respectively. The maximum relative humidity took the lowest level. The statistical analysis indicated that the coefficient of determination of soil temperature and larvae of *T. absoluta* infesting H6 and H7 was about 10% and 17%, respectively. Results of the present investigation clearly show that plant age (Rate 1) may be the key factor as it had a small simple correlation despite RH (Rate8) approximately had a similar simple correlation. These reversed evidences, prove that the simple correlation is not enough to determine the potency of an independent factor unless it correlate with other factors. Thus, multi-coefficient analysis is highly recommended in such cases.

Key words: Multi factors analysis, *T. absoluta*, H6, H7 tomato varieties.

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Introduction

Tomato *Lycopersicon esculentum* Mill is one of the most important crops in many parts of the world particularly in Egypt. It is consumed as a fresh table tomato and as an essential raw material for a variety of food processing industries. Tomatoes are grown in both greenhouses and in open fields. The tomato leaf-miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is a serious pest of both open fields and greenhouses. It is a South America species (Giordano & Silva, 1999) and recently became an alime species in Europe subsequently spread throughout the Mediterranean Basin (EPPO, 2011). This pest was first recorded from eastern Spain in late 2006 (Urbaneja et al., 2007) then Morocco, Algeria, France, Greece, Malta, Egypt and other countries (Roditakis et al., 2010). *T. absoluta* has invaded Egypt through Marsa Mtrooh Governorate near the Libyan border in 2009. In 2010, it was reached Giza, and then well established in all Governorates of Egypt, reaching to the border and north part of Sudan in June 2011 (Temerak, 2011). Tomato trade and, active flight or passive movement by wind current are the main mechanisms of the current spread of this pest (Desneux et al., 2010). Adults of *T. absoluta* usually lay eggs on the underside of leaves and on stems. After hatching, young larvae penetrate leaves, aerial fruits or stems, on which they feed and develop, thus creating conspicuous mines which may be invaded later by secondary pathogens, leading to fruit rot (EPPO, 2005) and thereby directly reducing crop value and causing significant yield losses of up to 100% if it is not controlled. So, *Tuta absoluta* is an economically significant pest of tomatoes that is currently undergoing a rapid expansion in its geographical distribution (Desneux *et al.* 2010). Many factors (biotic and climatic factors) affecting the population fluctuation of this pest either directly or indirectly, e.g. plant age, mirid bugs, air temperature, relative humidity and soil temperature. The present work is carried out to clarify the relationship between *T. absoluta* infesting tomato varieties and some factors that may have an autocorrelation among them.

Materials and methods

Area of study: An area of approximately half acre was cultivated with tomato at the Experimental Farm of Plant Protection Department, Faculty of Agriculture, Assiut University, Assiut, Egypt. The normal agricultural practices were performed with no insecticidal treatments during the study period. In summer plantations the seedlings were transplanted on February 23, 2012.

Tomato varieties: Two tomato hybrids were used in this study. Both hybrids Nirouz (TH99806) and Nirouz (TH99807) (H6 and H7) were used for summer plantations.

Sampling method: Direct count method was followed. Throughout summer season, 5 leaves randomly selected from the nonadjacent plants from each plot. Each leaf was picked carefully and sealed separately in a polyethylene bag. Samples were examined in the laboratory under stereomicroscope for counting the number of tomato leaf mines (eggs, larvae and tunnels). The mean numbers of larvae, tunnels and plant age were calculated and recorded. Meteorological data were obtained from Meteorological Station Experimental Farm, Faculty of Agriculture, Assiut University.

Statistical analysis: Data were subjected to simple, partial, and multiple correlations by the Advanced Statistical Analysis Package (ASAP)[R] (Darwish et al., 2012).

Results and Discussion

Data illustrated in Figure (1) indicate that the infestation began when the plant aged one month and reached its maximum number of 50 and 28 larvae per 10 leaves of the hybrids H6 and H7, respectively**.** The infestation was decrease gradually until the end of the season where it reached about 12 and 9 larvae per 10 tomato leaves of the hybrids H6 and H7, respectively**.** From the previous data, it seemed that the variety H6 was more susceptible to infestation with *T. absoluta* than the variety H7 however, it is clear that the two hybrids behaved in a parallel manner.

Relative efficiency of the independent factors affecting the infestation with *T. absoluta* larvae: The relationship between *T. absoluta* infestation and the independent factors were shown in Table (1) and illustrated in Fig. (2).

Plant age

H6 hybrid: It was found that plant age has a coefficient of determination of about 20% out of about 70% total efficiency (8 variables). This reasoning indicates that 20% of the variability of the infestation was due to the plant age of H6 hybrid. The rating sort showed that the plant age ranked the first (Table 1).

H7 hybrid: In respective to H7 hybrid, it was found that the plant age also occupied the first rank with a relative efficiency for about 25% out of about 90% total efficiency (8 variables). This testimony indicates that plant age was responsible for 25% of the infestation variability of *T. absoluta* larvae. It is well known that the older plant leaves are not suitable for feeding habits and spawning behavior for most of phytophagous insects. The rate of egg exclusion, proportion of females, the larval period and mortality appeared to be affected by plant age. A higher proportion of females, mortality of larvae and length of the larval period were obtained with older plants of *Lycopersicon hirsutum* f. glabratum while the rate of egg exclusion was higher in case of *L. hirsutum* young plants aged 3 months (Leite et al., 2001).

Mirid bugs

H6 hybrid: Data in Table (1) and Figure (2) showed that mirid bugs seemed to be responsible for about 14% of the variability in the infestation with *T. absoluta* larvae. Mirid bugs ranked the second in the rating sort.

H7 hybrid: The obtained data of the Mirid bugs were also responsible for 15% of the variability of infestation with *T. absoluta* larvae (Table 1 and Fig.2). They occupied the third rank in rating sort and may be one of the key factors limiting the infestation. Mirid bugs were used as a biological control agent of the *T absoluta*. Both the egg parasitoid and predatory bug were released alone and in combination. Several species of predaceous bugs 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* egg and larval stages. The predatory mirid bug *Nesidiocoris tenuis* Reuter is a zoophytophagous predator which commonly appears in horticultural crops and natural vegetation in the Mediterranean basin. This predator is augmentative released and conserved against whiteflies *Bemesia* spp and *Tuta absoluta* in tomato crops. Once established in the crop *N. tenuis* is also able to regulate populations of other pests such as thrips, mites and some lepidopterans (Greco, 1993).

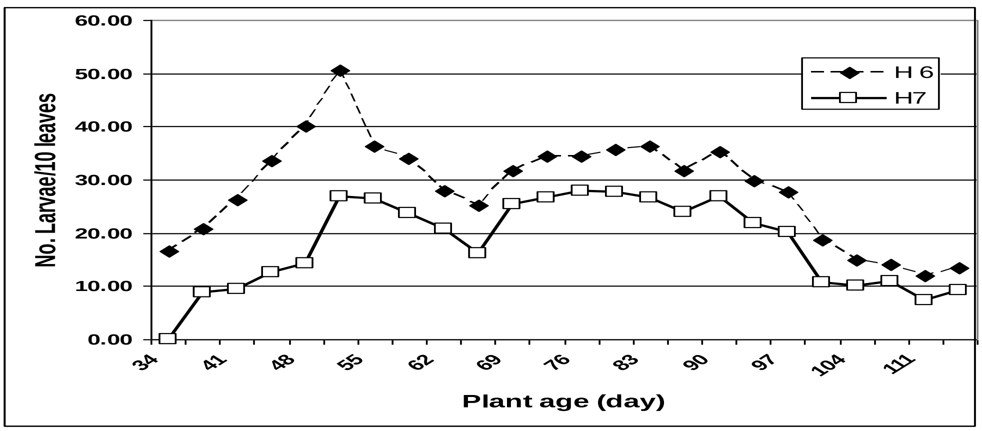

Figure 1. Fluctuation of *T. absoluta* larvae infesting two tomato hybrids H6 and H7, through 2012 summer season.

Air temperature and humidity: In both hybrids (H6 and H7), the effect of maximum temperature on larval infestation came in the same level. Co-efficient of determination indicated that the air temperature was responsible for about 9% and 10% of the variability of the larval infestation for hybrids H6 and H7, respectively. Relative humidity seemed to have less effect on larvae infesting tomato leaves and fruits. The maximum relative humidity was found to be responsible for about 1.7% and 7% of the variability of larvae infesting H6 and H7, respectively. This substantiation is logic where adults of *T. absoluta* usually lay eggs on the underside of leaves and on the stems, after hatching, young larvae penetrate leaves, aerial fruits or stems, on which they feed and develop, thus creating conspicuous mines through which larvae feed and develop far from the effect of relative humidity of its microclimate.

Table 1: Factors affecting fluctuation of *T. absoluta* larvae through 2012 summer season.

Independent factors			H6 Simple correlation	H6 Relative Efficiency	H6 Rating	H7 Simple correlation	H7 Relative Efficiency	H7 Rating
Plant age			-0.262	20.148	1	0.166	25.182	1
Mirid bug			0.496**	14.260	2	0.505	15.212	3
Weather records	Temperature	Max.	-0.154	8.720	4	0.291	10.005	4
		Min.	0.357*	7.960	5	0.085	6.431	6
	R.H.	Max.	0.254	1.680	8	0.031	7.110	5
		Min.	0.015	3.920	6	-0.347	1.243	8
	Soil temperature(5cm)	Max.	0.251	10.234	3	-0.173	17.340	2
		Min.	0.168	3.980	7	-0.263	6.190	7
Multiple correlation R			0.8420**			0.9428**		
Co-efficient of determination R2			0.709			0.889		

* Significant at 5%, ** Significant at 1%

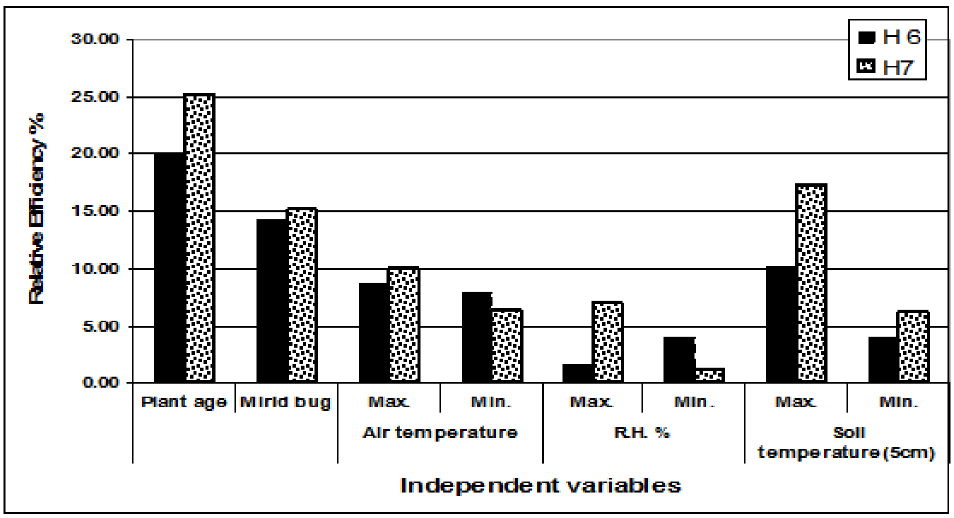

Figure 2. Relative efficiency of some independent factors affecting *T. absoluta* larvae infesting H6 and H7 tomato hybrids through 2012 summer season.

Soil temperature: The statistical analysis indicated that the relative efficiency of soil temperature was about 10.23% and 17.34% for hybrids H6 and H7, respectively. These considerable values may be attributed to the direct effect of soil temperature on the pupae subsequently, on the number of emerged females and number of laid eggs. The activity of crop pests living in soil is influenced by soil temperature conditions (Greco, 1993). Moreover, the soil temperature has an indirect effect on tomato plants. Decreasing soil temperatures progressively reduce tomato plant growth rates. Temperatures above the optimum have less impact until reaching the maximum when growth ceased. Root growth of plants also requires favorable temperature conditions. Better root growth improves the size of the root system and its capacity to provide the above ground parts of the plant with water and nutrients, subsequently the nutrients requirement to *T. absoluta* larvae. It is clear from Table (1) that plant age appeared to be the key factor (Rate 1), showing a small simple correlation although RH variable (Rate 8) had the same simple correlation. These reversed evidences, prove that the simple correlation is not enough to determine the potency of an independent factor unless it correlate with other factors. Thus, multi-coefficient analysis is highly recommended in such cases (Darwish et al., 2012).

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