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Susceptibility of Five Tomato Varieties to *Tuta absoluta* Infestation in Insecticide Treated Fields

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ABSTRACT

The susceptibility of five tomato cultivars (Hybrid Alissa, Hybrid Elbasha 1077, Hybrid Hadir, Hybrid H9780 and Fyrouz) grown in Egypt to *Tuta absoluta* infestation was studied during the summer of 2012 before and after insecticide treatments. Four insecticides (Tracer (spinosad), Agriflex (abamectin+ thiamethoxam), Alferde (metaflumizone) and Larifos (chlorpyrifos)) were applied at the recommended rates for management of *T. absoluta* on tomato crop. The results showed that tomato varieties, Fyrouz and H9780 were the most susceptible to *Tuta absoluta* infestation (71.6%) followed by hybrid Alissa, hybrid Hadir, and hybrid Elbasha 1077 whereas the infestation were 68.7, 67.4, and 62.5 %, respectively. There were no significant differences estimated among tomato varieties except Elbasha 1077. The results also showed that Tracer was the most effective insecticide in reducing *T. absoluta* infestation on all tomato varieties followed by Agriflex, Alferde and Larifos. Among three time intervals in 1st or 2nd sprays, no significant differences were reported between all tomato varieties in infestation reduction of *Tuta absoluta* after all insecticides treatments.

INTRODUCTION

Tomato is one of the most consumed vegetables in the world. In Egypt, tomato is one of the economic vegetables crops and the cultivated area is increasing from year to another. The tomato plant, *Solanum lycopersicum* Mill, is attacking by several serious diseases and pests (Spooner *et al.* 1993, Suinaga *et al.* 2003). Tomato crop in the Mediterranean Basin and in Europe has been recently affected by the exotic pest *Tuta absoluta.* The tomato leafminer, *T. absoluta*, is a native micro lepidopteron of South America (Torres *et al.*, 2001) and a major pest of tomato crop since its detection in the Mediterranean basin (Guenaoui, 2008). It was first recorded in Eastern Spain in late 2006 (Urbaneja *et al.*, 2007), then Morocco, Algeria, France, Greece, Malta, Egypt and other countries (Roditakis *et al.*, 2010, Mohammed, 2010). This pest has been responsible for losses of 80-100% in tomato plantations in both protected cultivation and open fields (Korycinska and Moran, 2009). In early 2010, *T. absoluta* was detected in Marsa Matrouh governorate, the western Egyptian border side to Libya. In mid-2010, the insecticide panel of the Ministry of Agriculture in Egypt reported its presence in other parts of the Delta valley (http://www.apc.gov.eg). Later, the pest was discovered to have rapidly spread in the upper and lower regions of Egypt (Mousa *et al.*, 2013). Therefore, it is very essential to control *T. absoluta* that attacks tomato plant starting from seedling till fruiting stages. The main method of crop management to control this insect is using insecticides. The use of insecticides as the only or main form of management may cause damage to the environment, harming to the health of rural workers and consumers, and increasing control costs (Souza and Reis 1999). The use of tomato cultivars resistant to the leafminer can be a viable alternative due to the high cost of spraying and the problems cited. One of the difficulties in obtaining a resistant variety is the low genetic variability that often prevents a breeding program.

The aim of the present study was to evaluate the susceptibility of some tomato varieties to *T. absoluta* infestation before and after insecticide treatments under Egyptian field conditions.

MATERIALS AND METHODS

Tomato varieties

Five tomato varieties (hybrid Alissa, hybrid Elbasha 1077, hybrid Hadir, hybrid H9780 and Fyrouz) represent the most popular cultivars grown in open field in Banger El-soker region, El Amreya, Alexandria, Egypt were cultivated. Cultivation and other agriculture practices commonly used in Egypt were applied. Tomato varieties were originated from China, except Fyrouz F1 originated from India. The purity of the tomato varieties were 99.9% and the germination percentage was about 85% and all seeds were treated with thiram fungicide.

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Insecticides

Four insecticides, Agriflex 18.6% SC, 240 ml/fed (abamectin 152.4 g/ L + thiamethoxam 33.2g/ L); Larifos 48% EC, 1 L/fed (chlorpyrifos); Tracer 24% SC, 30 ml/100 L water (spinosad); Alferde 24% SC, 100 ml/ 100 L water (metaflumizone), were supplied by Ministry of Agriculture, Egypt.

Field trials

The experiments were conducted to evaluate the susceptibility of the selected tomato varieties to *T. absoluta* infestation before and after insecticides treatment at flood irrigated field at Banger El-soker region, El Amreya, Alexandria, Egypt in season 2012. Transplanting of tomato varieties were done in the field on 15 May during summer cultivation season of 2012 after seeded in a greenhouse. The four insecticides were applied as foliar spray (first spray), the treatments were carried out after the appearance of *Tuta absoluta* infestation, and repeated again after 10 days (second spray) at recommended field rates using knapsack sprayer (CP3). The untreated plots were served as control. The experiments were arranged in a randomized complete block design with three replications having plot size of 42 m^2. The cultivated area was divided into 75 plots. Agronomic practices of irrigation, fertilizer, and herbicide were standard for tomato production to raise good crop. Ten plants were randomly examined from each plot for *Tuta absoluta* infestation. The percentages of infestation were determined before treatments and 3, 5, 10 days after treatments in treated and untreated plots. The reduction percentages of *Tuta absoluta* infestation were calculated as described by Henderson and Tilton (1955) using the following equation:

$$\% \text{ Reduction} = 1 - \frac{T_a \times C_b}{T_b \times C_a} \times 100$$

Where:

T_a and T_b: Number of infested plants in the treatments after and before application.

C_a and C_b: Number of infested plants in control after and before application.

Statistical analysis

Data were subjected to one-way analysis of variance, followed by student-Newman-Keuls test (cohort software Inc. 1985) to determine significant differences among the mean value at probability level of 0.05.

RESULTS AND DISCUSSION

Susceptibility of the selected tomato varieties to *Tuta absoluta* infestation in non-treated fields

Susceptibility of five tomato varieties, Hybrid Alissa, Hybrid Elbasha 1077, Hybrid Hadir, Fyrouz and Hybrid H9780, to *T. absoluta* infestation is shown in Table 1. The results revealed that there were no significant differences between all tomato varieties in *T. absoluta* infestation through 20 days. Hence Fyrouz was the most susceptible tomato variety during 10 days from observation, followed by hybrid H9780, hybrid Hadir, hybrid Alissa, and hybrid Elbasha 1077 whereas the infestation of 49.9, 49.1, 48.3, 47.5, and 41.7%, respectively. While in the following 10 days, H9780 was the most susceptible tomato variety followed by Fyrouz, hybrid Alissa, hybrid Hadir, and hybrid Elbasha 1077 whereas the infestation were 94.4, 93.3, 90.0, 86.6, and 83.3 %, respectively. Furthermore, during 20 days from observation, Fyrouz and H9780 were the most infested tomato varieties to *Tuta absoluta*. On the other hand there were significant differences between Elbasha 1077 on one side and Alissa, Fyrouz and H9780 on the other side. Generally the susceptibility of the cultivated tomato varieties was similar except for Elbasha 1077 which showed more tolerant to *T. absoluta* infestation.

Table 1. Percentages of *Tuta absoluta* infestation on non-treated five tomato varieties through 20 days

Period (Day)	Infestation (%) mean ± SE				
	Tomato variety				
	Alissa	Elbasha 1077	Hadir	Fyrouz	H9780
0	26.7±3.3[a]	23.3±3.3[a]	23.3±3.3[a]	23.3±3.3[a]	20.0±0.0[a]
3	53.3±3.3[a]	40.0±0.0[b]	43.3±3.3[ab]	56.7±3.3[a]	56.7±3.3[a]
5	53.3±3.3[a]	50.0±0.0[a]	56.6±3.3[a]	53.3±3.3[a]	60.0±0.0[a]
10	56.6±3.3[bc]	53.3±3.3[c]	70.0±0.0[a]	66.6±3.3[ab]	60.0±0.0[abc]
Mean	47.5[a]	41.7[a]	48.3[a]	49.9[a]	49.1[a]
13	76. 7±3.3[ab]	63. 3±3.3[b]	76. 7±3.3[ab]	80.0±0.0[ab]	86. 7±3.3[a]
15	93. 3±3.3[ab]	86.7±3.3[ab]	83. 3±3.3[b]	100.0±0.0[a]	96. 7±3.3[ab]
20	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]
Mean	90.0[a]	83.3[a]	86.6[a]	93.3[a]	94.4[a]
General mean	68.7[a]	62.5[b]	67.4[ab]	71.6[a]	71.6[a]

Values are mean ± SE, n= 3.
Mean having the same letter are not significantly different from each other in the same row ($P \leq 0.05$).

Susceptibility of the selected tomato varieties to *Tuta absoluta* infestation after insecticide treatments through two sprays

First spray

The reduction percentages of *Tuta absoluta* infestation on five tomato varieties, Alissa, Elbasha 1077, Hadir, Fyrouz and H9780, after three different time intervals from first spray with four insecticides, Tracer, Agriflex, Alferde and Larifos are shown in Table 2 and Figure 1. The results revealed that the tested insecticides reduced *T. absoluta* infestation. However, the reduction percentages of infestation varied with insecticide and tomato variety. The statistical analysis revealed non-significant differences between all tomato varieties in reduction percentages of *T. absoluta* infestation in Tracer treatment after 3, 5 and 10 days of the first spray. In Agriflex treatment, there were no significant differences between all tomato varieties after 3 days. Moreover, 5 days after Agriflex treatment, no significant differences were found between all tomato varieties except between Hadir and Fyrouz. Ten days after treatment, non- significant differences were observed between Alissa, Hadir and H9780 in reduction percentage of *T. absoluta* infestation in Agriflex treatment, while there were significant differences between Elbasha 1077 and Fyrouz in one side and other tomato varieties in other side. In Larifos treatment, non- significant differences were observed between all tomato varieties except for Alissa variety after 3 and 5 days of treatment. Three days following spraying with Alferde treatment, there were no significant differences between Alissa, Fyrouz and H9780, while there were significant differences in reduction percentage of *T. absoluta* between Elbasha 1077 and Hadir in one side and Alissa, Fyrouz and H9780 in other side. Five days after first spray, no significant differences were estimated between all tomato varieties. In addition, 10 days following 1st spray, no significant differences between Elbasha 1077, Hadir and H9780 while significant differences between Alissa and Fyrouz, in one side and other varieties in other side were recorded.

Second spray

The reduction percentages of *Tuta absoluta* infestation on five tomato varieties after three time intervals from second spray with the four insecticides, Tracer, Agriflex, Alferde and Larifos are shown in Table 3 and Figure1. All of the tested insecticides showed higher infestation reductions than those after first spray.

Three days after the second spray, the statistical analysis revealed non-significant differences between all tomato varieties in reduction percentages of *T. absoluta* infestation in Tracer and Larifos treatments. In Agriflex and Alferde treatments, there were no significant differences between all tomato varieties except for Elbasha 1077 and H9780, respectively. Five days after second spray, the statistical analysis showed non-significant differences between all tomato varieties in reduction percentages of *T. absoluta* infestation in Tracer, Agriflex and Larifos treatments. Moreover, no significant differences between all tomato varieties were observed except between Hadir and Elbasha 1077 and H9780, in Alferde treatment.

Table 2. Reduction percentages of *Tuta absoluta* infestation on tomato varieties after different time intervals of insecticide treatments (first spray)

Insecticide	Time after application (Day)	Reduction (%) mean ± SE				
		Tomato variety				
		Alissa	Elbasha	Hadir	Fyrouz	H9780
Tracer	3	91.6±8.6^{a}	87.6±12.2^{a}	100.0±0.0^{a}	93.3±6.6^{a}	91.4±4.8^{a}
	5	100.0±0.0^{a}	100.0±0.0^{a}	100.0±0.0^{a}	100.0±0.0^{a}	100.0±0.0^{a}
	10	100.0±0.0^{a}	100.0±0.0^{a}	100.0±0.0^{a}	100.0±0.0^{a}	100.0±0.0^{a}
Agriflex	3	83.3±1.6^{a}	88.2±5.9^{a}	93.3±6.6^{a}	81.4±9.8^{a}	63.1±1.8^{a}
	5	65.0±7.6^{ab}	70.0±5.7^{ab}	88.6±6.0^{a}	56.6±0.0^{b}	61.0±5.5^{ab}
	10	53.3±3.3^{a}	28.3±5.9^{b}	58.0±0.0^{a}	33.3±0.0^{b}	55.3±5.3^{a}
Alferde	3	82.1±9.5^{a}	53.5±6.7^{c}	60.0±0.0^{bc}	74.6±7.2^{ab}	84.3±1.1^{a}
	5	61.6±7.2^{a}	62.6±5.3^{a}	55.4±7.8^{a}	68.8±5.8^{a}	75.6±4.8^{a}
	10	21.0±2.6^{b}	48.1±1.0^{a}	48.0±4.9^{a}	33.8±6.8a^{b}	42.5±4.8^{a}
Larifos	3	77.0±4.7^{a}	54.1±4.0^{b}	43.3±3.3^{b}	53.3±5.9^{b}	53.3±1.6^{b}
	5	66.6±0.0^{a}	37.7±2.2^{b}	36.6±1.9^{b}	30.0±5.7^{b}	40.6±7.1^{b}

	10	21.4 ± 5.3^{ab}	40.0 ± 0.0^{a}	29.0 ± 8.0^{ab}	17.0 ± 0.0^{b}	33.3 ± 0.0^{ab}

Values are mean ± SE, n= 3.
Mean having the same letter are not significantly different from each other in the same row ($P \leq 0.05$).

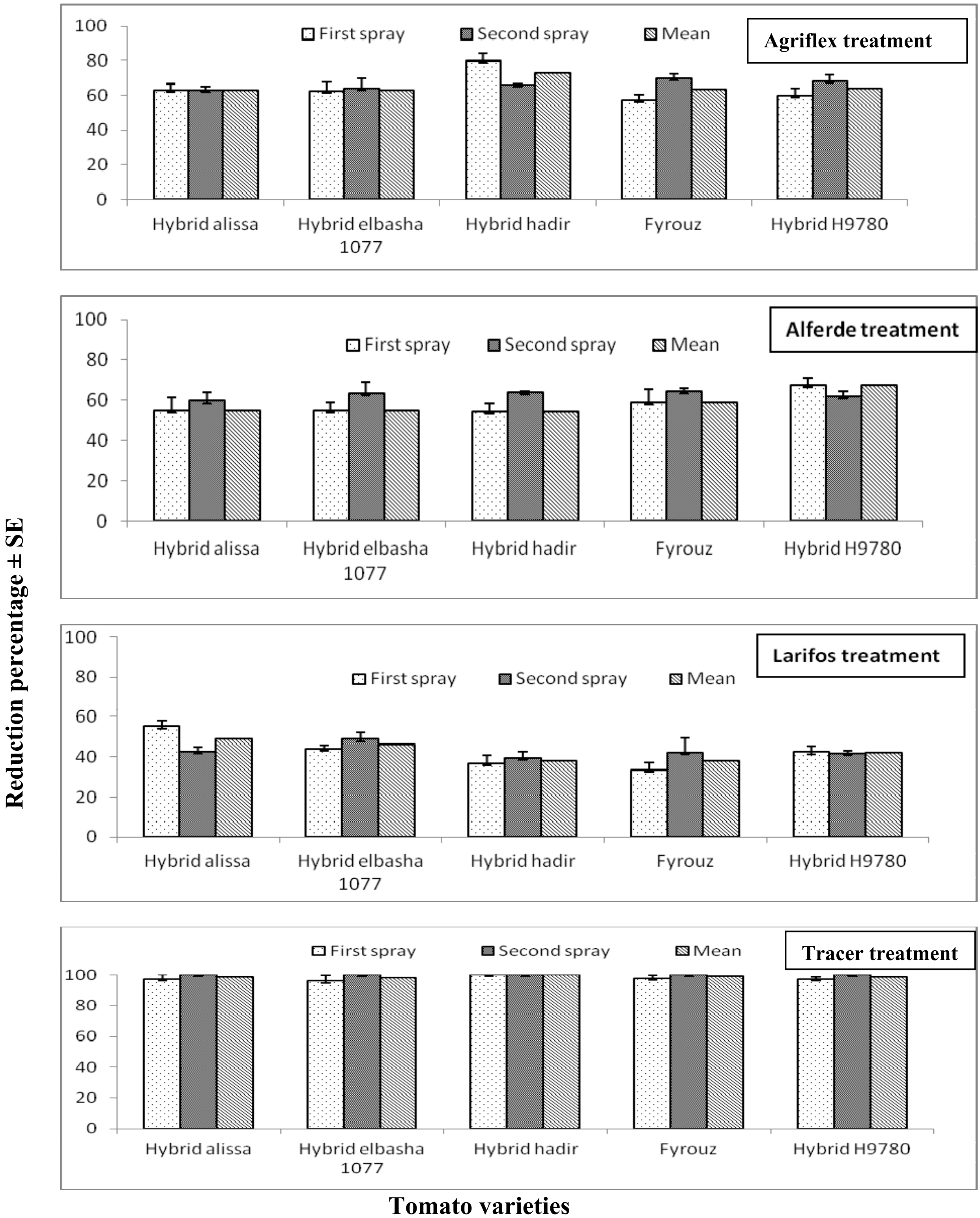

Figure 1. Reduction percentage of *Tuta absoluta* infestation on tomato varieties after two sprays of insecticides.

Table 3. Reduction percentages of *Tuta absoluta* infestation on tomato varieties after different time intervals of insecticide treatments (second spray)

Insecticide	Time after application (Day)	Reduction (%) mean ± SE				
		Tomato variety				
		Alissa	Elbasha	Hadir	Fyrouz	H9780
Tracer	3	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]
	5	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]
	10	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]	100.0±0.0[a]
Agriflex	3	100.0±0.0[a]	80.6±10.0[b]	100.0±0.0[a]	100.0±0.0[a]	88.3±5.9[ab]
	5	70.5±2.4[a]	70.0±1.1[a]	68.1±1.8[a]	70.5±3.3[a]	74.1±4.6[a]
	10	17.5±4.3[b]	40.5±7.7[a]	30.0±0.0[ab]	39.3±5.1[a]	41.6±1.6[a]
Alferde	3	90.0±5.7[ab]	83.3±9.5[ab]	100.0±0.0[a]	100.0±0.0[a]	72.2±3.2[b]
	5	64.8±5.2[ab]	72.3±2.5[a]	61.5±1.4[b]	71.0±0.5[ab]	75.6±2.9[a]
	10	24.0±2.2[b]	34.6±4.6[ab]	30.0±0.0[ab]	23.0±4.0[b]	38.3±1.6[a]
Larifos	3	66.5±0.8[a]	71.4±3.1[a]	54.0±1.9[a]	58.3±11.6[a]	65.0±1.5[a]
	5	45.5±1.7[a]	46.5±5.0[a]	45.8±5.0[a]	43.5±6.7[a]	48.3±2.0[a]
	10	15.6±4.6[a]	28.0±2.9[a]	18.3±3.3[a]	24.6±4.3[a]	11.6±1.6[a]

Values are mean ± SE, n= 3.
Mean having the same letter are not significantly different from each other in the same row ($P \leq 0.05$).

Ten days after second spray, the statistical analysis revealed non-significant differences between all tomato varieties in reduction percentages of *T. absoluta* infestation in Tracer and Larifos treatments. In Agriflex and Alferde treatments, no significant differences were observed between all tomato varieties except for Alissa and H9780, respectively.

The susceptibility of tomato varieties to *T. absoluta* infestation showed variation between tomato cultivars. The variation in the *T. absoluta* infestation between the five tomato cultivars might depend on many factors, for instance morphological characters of plant parts; leave and leaflets shape and dense, leaves hair, shape and size of fruits and thickness of fruits. Also, the physiology and biochemistry of plants attributed to differences in leaf volatile compounds. Based on oviposition bioassays, Proffit *et al.* (2011) demonstrated that *T. absoluta* females laid more eggs in response to Santa Clara and Carmen as compared to Aromata variety. The same authors found that overall leaf volatile composition of Aromata differed significantly from Santa Clara and Carmen, due to differences in proportions of minor compounds and due to the absence of several compounds, mostly terpenes, in Aromata. Furthermore, previous studies pointed out that tomato cultivars showed differences in susceptibility to *T. absoluta* infestation, after quantifying symptoms and damages caused by this pest on leaves of three different tomato cultivars (Bogorini *et al*. 2003; Oliveira *et al*. 2009).

De oliveira *et al.* (2012) examined the resistance of improved tomato strains rich in 2-tridecanone (2-TD), zingiberene (ZGB) and acyl sugars (AA) to the tomato moth, *T. absoluta.* They reported that TOM-622 (rich in 2-TD), ZGB-703 (rich in ZGB), and TOM-687 (rich in AA) showed significant reductions in the oviposition rate of the tomato moth, damage to the plants, injury to the leaflets, and the percentage of leaflets attacked in comparison with the control strains (TOM-584 and TOM-679). Gianfagna *et al.* (1992) observed that low insolation and high temperatures affect the density of glandular trichomes by decreasing the production of substances conferring resistance to insects, as reported by other authors (Knodel-Montz *et al*. 1985; Weston *et al.* 1989; Snyder *et al*. 1998). Suinaga *et al*. (1999) demonstrated that heptadecane was the principal compound associated with reduced number and viability of *T. absoluta* eggs in *L. peruvianum*. Maluf *et al* (1997) indicated that 2-tridecanone mediates resistance to *T. absoluta* in the interspecific cross and acts as both an ovipositioning and feeding deterrent for this insect.

In conclusion, our results indicated that Tracer was the most effective insecticide for controlling *T. absoluta*, followed by Agriflex, Alferde and Larifos. These findings suggest the possibility of use Tracer for chemical control of *T. absoluta* under the field conditions or incorporate this insecticide in IPM program to control *T. absoluta* on tomato. Elbasha 1077 was the least susceptible tomato variety to *T. absoluta* infestation followed by Hadir, Alissa, H9780 and Fyrouz. In addition, further study is needed on the physiology and biochemistry of tomato varieties, shoots and sap to verify the variation between different tomato varieties, and use that as tool to correlate that with *T. absoluta* infestation.

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الملخص العربي

حساسية خمسة أصناف من الطماطم للإصابة بحشرة التوتا أبسليوتا فى الحقول المعاملة بالمبيدات الحشرية

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تم دراسة حساسية خمس أصناف من الطماطم التي تنمو تحت الظروف المصرية للإصابة بحشرة التوتا ابسليوتا وهم (اليسا هجين، الباشا ١٠٧٧هجين، هدير هجين، ٩٧٨٠ هـ- هجين، فيروز) خلال صيف ٢٠١٢ قبل وبعد المعاملة بالمبيدات الحشرية. تم تطبيق أربعة مبيدات حشرية على محصول الطماطم لمكافحة التوتا ابسليوتا وهم التريسر(اسبينوساد)، الأجريفليكس (أبامكتين+ ثياميثوكسام)، الفيردي(ميتافلوميزون)واللاريفوس (كلوربيرفوس). أظهرت النتائج أن صنف فيروز و ٩٧٨٠ هـ- هجين كانتا أكثر أصناف الطماطم حساسية للإصابة بالتوتا ابسليوتا (نسبة الإصابة ٧١.٦%) يليهما الهجن اليسا، هدير والباشا ١٠٧٧ حيث بلغت نسب الإصابة (٦٨.٧، ٦٧.٤ و٦٢.٥% على التوالي) ولم يظهر التحليل الإحصائي لنسب الإصابة بالحشرة أى فروق معنوية بين الإصناف ما عدا صنف الباشا ١٠٧٧. كما أظهرت النتائج أن مبيد التريسر كان أكثر المبيدات كفاءة في خفض الإصابة بالحشرة في جميع أصناف الطماطم يليه مبيد الأجريفلكس والفيردي واللاريفوس. كما أظهرت النتائج عدم وجود فروق معنوية في نسب الخفض في الإ صابة بين أصناف الطماطم بعد معاملات المبيدات خلال ثلاث فترات من أي من رشتي المبيدات التي تم تطبيقها.