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Oviposition deterrent activities of some plant extracts against tomato leaf miner, *Tuta Absoluta* meyrick (Lepidoptera: *Gelehiidae*)

Abstract

Tuta absoluta Meyrick (Lep.:Gelechiidae) is a very serious pest worldwide, causing damage to tomatoes. In this study, the oviposition deterrence efficacy of extracts obtained from *Tanacetum vulgare L.* (Asteracea), *Tanacetum parthenium L.* (Asteracea), *Aleo vera* (L) (Liliaceae), *Melaleuca alternifolia* (Maiden&Betce)(Myrtaceae) and *Juglans regia* L. (Juglandecae) on *Tuta absoluta* Meyrick (Lep.:*Gelechiidae*) was investigated. Eggs laid daily were placed in Petri dishes and observed until pupa. After larvae become pupae were distinguished male or females using a stereomicroscope. After that, two male and one female were released within cage to couple during 24h. Adults were put into cages containing with extract treated plant. The experiment was replicated four times including control. Daily monitoring was conducted for fourteen days and the total number of eggs was recorded. According to the results obtained, the extract of *T. parthenium* showed the highest deterrence effect (98.29%) at the highest concentration (20%). The extracts of *T. vulgare* and *A. vera,* were the deterrence effect 95.43% and 94.68% in the same concentration respectively. It was reported that the deterrence effect of Gamatol, fungatol and *J. regia* were 92.54%, 86.52% and 79.94% at the highest concentration respectively. The percent oviposition deterrence was 89.37% at Neem Azal T/S. The percent oviposition deterrence increased with increase in concentration of plant materials.

Keywords: *Tuta absoluta*, antimicrobial, tomatoes, gammatol, flavonoids, plant material, botanical insecticides, fungi

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Introduction

Tomato *(Lycopersicon esculentum* Mill.), which has a very important place in human nutrition, is cultivated almost everywhere in the world. Tomato is grown in almost every region of Turkey. It is an important export product for Turkey. In tomato cultivation, *Liriomyza spp*. (Burgess) (Diptera: Agromyziidae), *Tetranychus* spp. (Acarina: Tetranychidae), *Aphis* spp. *Thrips* spp. (Thysanoptera: Thripidae) are identified as significant pests.[1] Tomato exclusion of host plants of *T. absoluta* are potatoes, eggplants, pepino, artichokes, beans and tobacco.[2] *T. absoluta*, which has high reproductive power, gives 10-12 offspring per year under suitable conditions (in Mediterranean climate) and completes one off in 30-35 days. One female leaves 260 eggs during her life.[3] The larvae are damaged in all parts of the tomato plant except the root, especially in the leaf and in every phenological period. In addition, the fungi and bacteria enter the galleries and make fruit unusable. Tomato moth reduces the quality of the product in tomatoes grown in greenhouses and outdoors and causes high (50-100%) product loss in heavily contaminated areas.[4] When *T. absoluta* was determined in Turkey in 2009, this pest has become the main pest in the provinces where tomato is grown. *T. absoluta* caused high rate of product losses and adversely affected tomato exports. Insecticide is used extensively to control *T. absoluta*. The widespread use of insecticides has improved resistance to *T. absoulta,* and their toxicity endangers health farm operators, animals and food consumers. Because of the negative effects of pesticides, scientists have focused on different methods to control pests. The researcher has reviewed the use of plant compounds such as essential oils, flavonoids, alkaloids having anti-insect effects. Plant compounds effect on insects in different ways, namely insecticide, repellents, anti feeding, oviposition deterrence and growth retardants. Botanical insecticides effect only target insects, not destroy natural enemies and provide residue free food and safe environment.

Tea tree, *M. alternifolia* is a native to Australia. Tea tree oil has antimicrobial and anti-inflammatory properties.[5] *J. regia* is a cosmopolitan tree species, and its leaves are used for medicinal purpose. The kernels contain a wide variety of flavonoids, phenolic acids and related polyphenols, which have good antioxidant, anti-atherogenic, anti-inflammatory and anti-mutagenic properties.[6] Feverfew, *T. parthenium* is a medicinal plant traditionally used for the treatment of fevers, migraine headaches, rheumatoid arthritis, stomachaches, toothaches, insect bites, infertility, and problems with menstruation and labor during childbirth.[7] *T. vulgare* is a perennial herb that has been used to treat multiple ailments. Regional variability of the chemical composition of *T. vulgare* essential oils is well-known.[8] *A. vera* is one of the most important medicinal plant capable of withstanding harsh environmental conditions such as lack of water and high temperatures.[9] The aim of study to determine oviposition deterrent effect the extracts of *M. alternifolia* (Gammatol and Fungatol), *T. parthenium T. vulgare, A. vera* and *J. regia* on *T absoluta.*

Material and methods

Tomato leaf miner culture

T. absoluta was collected as larvae from tomato greenhouses in Ankara. The collected larvae of *T. absoluta* were placed in the cage (50x50x30 cm) with tomato plant. Newly emerged adults were transferred into another cage containing tomato plant. Tomato plant used in this study was grown in greenhouse. The joker variety tomato was used in stock culture of *T. absoluta* and the experiments.

Plant extracts

The plants *T. parthenium T. vulgare* were collected during 2016 in around Ankara province. Both plants were collected while actively growing at the flowering stage. The leaves, flowers and stems of the plants were used to obtain the extract. Only the leaves of *J. regia* plant were used. *A. vera* was grown in plots at room conditions. Gammatol and Fungatol obtained from *M. alternifolia* were supplied from Australia. Neem Azal T/S used as positive control was purchased from the company.

Preparing the crude extracts

Plant material were cut at level and whole plant was used for extraction. Than plant material were allowed to dry in laboratory conditions. Oven-dried leaves were ground to a fine powder. For extraction, 200g of powdered plant materials and 400 mL of ethanol (80%) were added to the dried powder for 72 hours. The above mixture placed into Sox let for 5-6 hrs. After filtering through a Bucher funnel and Whatman No.1 filter paper, the extracts were concentrated under low pressure using rotary evaporator (50-60℃). Crude extract was keep at 4 ℃ in glass vials to be used as stock plant extract.

Oviposition deterrent assay

Daily laid eggs were placed in petri dishes (3cm) containing leaves tomato plant. Per dishes, one egg was placed, and eggs were observed daily until pupa. Individuals were distinguished male or females using a stereomicroscope on the pupa stage. After that two male and one female were released within a cage (15x15x10 cm) lined with tulle without tomato plant to couple during 24h. After 24h, adults were placed into cages containing tomato plants with extract treated. The experiment was replicated four times including control. Daily monitoring was conducted for fourteen days and the total number of eggs was recorded. For these tests, one female and two males were released within cage (30cm×30cm×30cm) and allowed to mate. After that, the extracted plant was left into the cage. The applications of the extract were sprayed using a small hand sprayer. Two concentrations were prepared by using distilled water to obtain concentrations of 5%, 10% and 20%. Control treatments were used distillated water; experiments were conducted with four replications. The experiment was completely randomized and counts were performed daily for 14days. After 24h, the number of eggs deposited in each plant was counted and recorded.

Statistical analysis

The obtained results were submitted to a variance analysis and the mean values were compared by Duncan's test (P = 0.05) calculated by the program SPSS 20.6.

Percent oviposition deterrent effect (PODE) was calculated according to the following method.

$$PODE = \frac{\text{NE in control - NE in treated}}{\text{NE in control}} \times 100$$

Index of egg laying (IE) was calculated according to the following method.

$$IE = \frac{\text{NE in control - NE in treatment}}{\text{NE in control+ NE in treatment}} \times 100$$

Where NE is the number of eggs laid.

Results and discussion

The data obtained from the experiment are shown in Table 1. According to Table 1, the highest index of egg laying was at concentrations 10% and 20% extract of *T. vulgare.* This value fallowed the extract of extract of *A. vera*. The smallest index of egg laying was the concentration at 0.50% extract of Gamma-T-ol. The increased index of egg laying depending on concentrations. Statistical analysis showed importance differences between the concentrations. Accordingly, the highest concentrations *T. vulgare* (10%, 20%) *T.parthenium* (20%), *A.vera* (10%, 20%), Gammatol (2.00%), Fungatol (3.50) and Neem Azal T/S were in the same groups (F=1.423; p=0.05). The largest oviposition deterrent effect was at the highest concentrations (10%, 20%) extract of T. vulgare while the smallest oviposition deterrent effect was at 0.50% extract of Gammatol. It was determined that statistical analysis showed the highest concentrations *T. vulgare* (10%, 20%) *T.parthenium* (20%), *A.vera* (10%, 20%), Gammatol (2.00%), Fungatol (3.50) and Neem Azal T/S formed in the same group (F=35.148; p=0.05) (Table 2).

Table 1 Plants used in ovposition effect on *Tuta absoluta*

Scientific name	Family name	Tissue used
Tanacetum parthenium L	Asteracea	Flawers, leaves, buds
Tanacetum vulgare L.	Asteracea	Flawers, leaves, buds
Aleo vera (L.)	Liliaceae	Leaves
Juglans regia L.	Juglandecae	Leaves

Table 2 Index of egg laying and percent ovicidal percent oviposition deterrent effect of some plants crude extracts against *Tuta absoluta* eggs

Treatment	Concentrations (%)	Index of egg laying (%)	Oviposition deterrent effect (%)
Gammatol	0.50	16.95±0.263d	28.63±0.363 c
	1.00	56.70±0.535bc	69.28±0.341 b
	2.00	79.10±0.327ab	92.54±0.181a
Fungatol	1.25	22.42±0.285c	35.50±0.342c
	2.50	55.90±0.565bc	69.69±0.214b
	3.50	76.30±0.327b	86.52±0.131a
Aleo vera	5	58.94±0.379bc	73.90±0.312b
	10	79.93±0.456ab	86.75±0.157a
	20	91.39±0.251a	94.68±0.123a
Juglans regia	5	23.02±0.298c	33.43±0.331c
	10	49.33±0.218c	65.62±0.254bc
	20	67.29±0.281b	79.94±0.37 8b

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Table Continues...

Treatment	Concentrations (%)	Index of egg laying (%)	Oviposition deterrent effect (%)
Tanacetum vulgare	5	58.68±0.341bc	72.87±0.298b
	10	87.87±0.263a	92.62±0.189a
	20	91.47±0.143a	95.43±0.154a
Tanacetum parthenium	5	70.87±0.135ab	74.05±0.231b
	10	76.59±0.148ab	91.46±0.194a
	20	96.77±0.189a	98.29±0.191a
Neem Azal T/S	0.05	88.98±0.211a	89.37±0.231a

*Means within rows followed by the same uppercase letter are not significantly different (Duncun's multiple range test)

This study investigates the oviposition deterrent effect of the extracts of *M. alternifolia* (Gammatol and Fungatol), *T. parthenium T. vulgare, A. vera* and *J. regia* on *T absoluta.* The all extracts were found to have strong oviposition deterrent effect on *T absoluta.* Especially *T. parthenium* and *T. vulgare* showed that the highest oviposition deterrent effect on *T. absoluta.* There is no literature about the extract of these extracts effect on *T. absoluta.* This study is the first record to determine oviposition deterrent effect on *T. absoluta.* There are studies which conducted by using different plant extracts. For example, Barthelemy et al.[10] revealed that the extracts of *Ocimum gratissimum* L. and *O. basilicum* L. (*Lamiaceae*) significantly reduced *T. absoluta* oviposition behavior on tomato plant. Azadirachtin caused decrease of egg-laying capacity of *T. absoluta*.[11] On the contrary, it was revealed that the number of eggs laid by *T. absoluta* females on the treated leaves did not differ significantly from the control, with the exception of leaves treated with zeolits.[12] *T. parthenium* and *T. vulgare* are medicinal plants. There are many studies on the effect of *T. parthenium* and *T. vulgare* extracts on other insects. Goldstain & Hahn[13] revealed that aqueous the extract *T. vulgare* reduced feeding on cabbage leaf disks on *Pieris rapae* L. The same study was determined that aqueous the extract *T. vulgare* extract found that the insect lay less eggs than the control. The extracts of *T. parthenium* had antinociceptive and anti-inflammatory effects without altering the normal behavior of the mice and rats.[14] Erdogan & Yıldırım[15] reported that extracts of *T. parthenium* had the highest mortality effect on *M. persicae* the highest concentration (12%). The extract of pyrethrum consists of many organic substances such as pirethrin, which exhibited insecticidal properties. Pirethrin was used as insecticide since ancient times. Particularly, pirethrin was used to control *Thrips* spp. and *Aphids spp*.

Tea tree oil has been used to control agricultural pests since the past. Halbert revealed that tea tree oil has toxic and repellent effect on pests. Bayindir et al.[16] reported that Gammatol had insecticidal effect on *T. absoluta*. The same authors revealed that the commercial production named Gammatol and Gammatol plus neem showed negative effective on reproductively and development of *M. persicae.* In addition, Liao et al.[17] revealed that *M. alternifolia* essential oil was shown to possess the fumigant toxicity against *Sitophilus zeamais* (Motsch) [Coleoptera: Curculionidae] and the same oils was the most effective compound for fumigant toxicity. The same study it was determined that terpinen-4-ol was the most effective compound for fumigant toxicity against *S. zeamais.* In another study, the extracts obtained from tea tree and named Gammatol and Fungatol showed the highest toxic effect on *M. persicae, Aphis gossypii* Glover, *Tetranychus urticae* Koch[18,19] *J. regia* has good antioxidant, anti-atherogenic, anti-inflammatory and anti-mutagenic properties.[6] Leaf extract of *J. regia* has both insecticidal, bactericidal and antimicrobial properties.[20] Erdogan and Yilmaz[21] reported that the extract of walnut leaves showed the highest rate acaricidal effect on *Tetranychus urticae* Koch ((Acari: *Tetranychidae*). It was determined that walnut leaf extract had both contact and systemic effect on *Tetranychus cinnabarinus* (Boisd) and *Tetranychus viennensis* Zacher (Acari: Tetranychidae). *A. vera* is one of the most important medicinal plants, including enzymes, choline, amino acids, sugars, minerals, metabolic and phenolic compounds.[22] There a few study effect on extract of *A. vera* on insects. For example, Sarwar[23] reported that extract of *A. vera* showed the highest effect on larva of *Musca domestica*. In addition, extract of *A. vera* had repellent effect *Sitophilus oryzae* L. In another study, it was revealed that the extract of *A. vera* showed the highest mortality rate on *Sitotrage cerealella* L. Lep.:*Gelechiidae*). Zhang et al.[24] reported that the extracts *A. vera* coused strong acaricidal and repellent effect on *Tetranychus cinnabarinus* Boisduval (Acarina:*Tetranychidae*).[25]

Conclusion

It was determined that the oviposition deterrent effect of extracts of *T. vulgare, T.parthenium*, *A.vera*, Gammatol and Fungatol showed on *T. absoluta.* This study is the first report about oviposition deterrent of some extracts (*T. vulgare, T.parthenium*, *A.vera*, Gammatol and Fungatol) on *T. absolta.* According to the results of this study, these plant extracts may be used to control *T. absoluta.* Further study is needed to identify the active component of these plant extracts responsible for insecticidal activities under controlled and field conditions.

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Conflicts of interest

The author declares that there is no conflict of interest.

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