Potency of some vegetable oils on control tomato leaf miner *Tuta absoluta* M.

By

Sawsan S. Moawad, Ibrahim M.A. Ebadah and Youssef A. Mahmoud
Pests and Plant Protection Department, National Research center, Cairo, Egypt

Abstract

The experiments were carried out to test three vegetable oils namely (*Prunus dulcis, Prunus amygdalus var amara,* and *Moringa olifera*) against *T. absoluta* under laboratory and field conditions. The results indicated that the most effective oils on eggs hatchability was *P. dulcis* followed by *P. amygdalus* var amara compare to untreated eggs. All of tested oils were depressed percentage of pupation to larvae which penetrated and feed on treat leaflets. The last larval instar also affect by oils treatment. On other view, the two sequential sprays of tested oils to infested tomato leaves were recorded larval mortality and reduction in infestation and deposited eggs especially in treatment by *Prunus dulcis* and *Prunus amygdalus* under field conditions. application of the tested oils saved some protection to tomato fruits against *tuta absoluta* and that lead to high production rate of tomato crop.

Key word: tomato leaf miner- egg hatch-larval mortality-infestation rate- crop production.

Acknowledgment

The authors are grateful to the National Research Centre (NRC) for the financial support of this research under the project (number 13050121).

Introduction

Tuta absoluta (Meyrick) is belonging to family (Gelechidae) and had a great economic important as pest in a number countries. In last decade, it was recorded real threaten to several countries in Latin America and the Mediterranean basin (EPPO, 2011). Its primary host is tomato, although potato,common bean and various wild solanaceous plants are also suitable hosts. The tomato leaf miner is characterized by a higher production potential. Each female maylayupto260 creamycoloureggsand10-12generations can be produced each year (EPPO, 2005). Itlives on and in the leaves, stems,and flowers and also in the fruit of tomatoes and can causeup to100%crop destruction. This pestis crossing borders and decreased quality of tomato production in both protected and openfields.

Pests like *T.bsoluta*, with high reproduction capacity and short generation cycle, are at higher risk of developing resistance to insecticides (Silva et al., 2011). This risk increases significantly when management of the pest reliesexclusively on chemical control with a limited number ofeffective insecticides available. The search for novel pest control products from plants continues to grow, but not always with clear outcomes and benefits (Isman and Grieneisen, 2013). However, there are many candidate plant species with known pesticidal properties where much is already known about their chemistry and efficacy under laboratory conditions that could be rapidly developed in to new products (Stevenson et al., 2017). Isman (2017) has argued that increasing farmer use of natural pesticides needs research directed at the practical application of such products under complex agro-ecological conditions, particularly understanding how different pesticidal plant species perform when applied to different crops under different growing conditions. Furthermore, their effects against target and non-target species, safe use and overall socio-economic and agro-ecological benefits need work (Moawad and Ebadah 2019). Only through their evaluation under field conditions can the evidence for more widespread adoption of natural pest control products be found, particularly as natural compounds are often not as effective as current synthetic pesticides (Casida, 1980). Using unrefined plant extracts for pest control has several advantages in terms of preventing the development of insecticide resistance due to the usual presence of several bio-active compounds, their low persistence in the environment and their generally low cost of use, particularly for smallholder farmers with limited income (Angioni et al., 2005; Caboni et al., 2006; Isman, 2008). However, disadvantages include variable efficacy, and low toxicity and persistence against target pests, which is partly due to the rapid breakdown of bio-active compounds, for example through photodegradation, and due to such extracts easily washing off when it rains. Consumers and policy makers are demanding reduced synthetic inputs in food production, and practices that support agro-ecological intensification and pesticidal plant products may be well suited to this vision (Grzywacz et al., 2014; Sola et al., 2014; Pavela, 2016).

The present study were tried to find other materials from nature sources to help the farmers to face problem of target pest.

Materials and Methods

The testes were done to evaluate three types of natural oils namely (*Prunus dulcis, Prunus amygdalus var amara*, and *Moringa olifera*) which were obtained from Emtinan Company Egypt. The preparation of tested oils concentration 10% was followed methods (Katoune et al., 2011 and Moawad and Sadek, 2018). 10% oil concentration was prepared by dissolved 10 ml of tested oil in 80 ml distilled water + 8 ml Arabic gum (20%) + 2 ml tween (20%) with add two drop from glycerin.

I- Laboratory Test:

I.1.Insect rearing: To test oils on immature stages of *T. absoluta* (eggs and larvae) the infested tomato leaves were collected from field to start rearing. The larvae were reared and maintained on tomato leaves, cultivated in plastic pots inside a glass cage (50x 50x100cm3). The culture was provided by infested tomato leaves harboring T. absoluta pre-imagine stages collected from the field for isolation of eggs or outer larvae and pupae to maintain it. Newly emerged adults were collected and transferred to another glass cage (50x50x50 cm3) containing untreated plastic pots of tomato. The experiments were carried out on the 1st generation of tomato leaf miner

I.2 Treatment of egg stage: Leaves from the maintained culture were examined under Stereo-binocular to isolate deposited eggs by fine brush and keeping them in a Petri-dish. Eggs of one day old were used in the experiments. The tested oils was sprayed on eggs and let till dry. Each test was used 30 eggs and it was replicated five times. Percentages of reduction in eggs atchability were calculated as follows:

Reduction of eggs hatchability % = a – b/a x 100

Where; a= number of eggs hatched in the control.

b= number of eggs hatched in the treatment.

I.3. Treatment of larval stages: Couples of males and females were placed in glass tubes (10 cm.) for egg deposition and for facilitating obtain of 1st instar larvae. While other larval stages (3rd and 4th instar) were collected directly from the infested tomato leaves. In case of exposure

1st instar to treatment was investigated leaves daily to calculated penetration percentage and follow up till record pupation %.

On other target the treatment of last larval stage (3rd and 4th) was observed and recorded their mortality and pupation %. Mortality % in all treatments was corrected by Abbott's formula (Abbott, 1925).

Mortality % = (T - C) / (100 – C) x 100

Where: T=Mortality in the treatment C= Mortality in the control

II- Green house evaluation: The present study was carried out in a plastic green house (9 x 40 m^2) in reclaimed desert sandy soil in National Research farm, Egypt and cultivated with tomato variety at winter plantation. The greenhouse area 300 m^2 was randomly divided into five experimental blocks, each block (5 rows, 7 plants/ row i.e. 35 plants/block) was specified for each treatment and two block were specified for the control +additive and control (without any treatment). The whole tested area was followed normal agricultural practices. Each block was divided to three replicates. Each one was sprayed twice interval time by tested oil. The first spraying was done after one month while second one was done after two months of tomato plantation. Tested oils were sprayed by using a manual sprayer (10 litter / plot). To evaluate the effect of tested oils on population of *T. absoluta* the randomly sample were collected from each replicate before spraying followed by subsequently samples after spraying (5,7,10,and 15 days). Examination of tomato leaflets were done under stereomicroscope to count number of deposited eggs and tunnel were targeted to calculate the reduction percentage in insect population. The reduction percentage of population density of *T. absoluta* was calculated according Henderson and Tilton (1955) equation as follows:

R % = 1 - (no. of individuals in control before treatment X no. of individuals in treatment after treatment / no. of individuals in control after treatment X no. of individuals in treatment before treatment) X100

To evaluate the effect of treatments on crop production and infestation percentage of tomato fruits were done once for first spray (by let 100 plant without 2nd spraying) and other one for 2nd spray by pick up the whole fruits to investigate and weight.

III. Statistical analysis: All data were subjected to analysis of variance (ANOVA) and the means were compared by LSD test at 0.05 levels, using SAS computer program (SAS, 2009).

Results

I- Effect of tested oils on different stages of *T. absoluta* under laboratory condition:

I.1 on Eggs stage: Fig.1 showed that the most effective oils on eggs hatchability was *P. dulcis* followed by *P. amygdalus* var amara compare to untreated eggs. From examination unhatched eggs were noticed that the eggs development completed but lose ability to hatch.

I.2. on 1st larval stage: the penetration percentage of 1st instar larvae to treated leaflets by spray with *P. amygdalus* var amara or *P. dulcis*was recorded moderate effect but the most of penetrated larvae to treated leaflets hadn't ability to complete their maturity.So, all of tested oils were depressed percentage of pupation to 3.1 and 8.3 % in case sprayed by *P. amygdalus* var amara and *P. dulcis* while *Moringa oleifera* were recoded 37.5% compare to control was record 96% pupation.

I.3. on last larval instar: the data at Fig 2 illustrated that the highest mortality percentage was recorded in case of treatment by *P.amygdalus* var amara followed by *P. dulcis* compare to untreated one were recorded zero mortality percentage.

II- Effect of tested oils on control *T. absoluta* infestation under green house:

II.1. on larval mortality: Data in Table 3 gave indication around the efficacy of two sequential sprays of tested oils on the percentage of larval mortality under greenhouse condition. 1st spray by *P. amygdalus* var amara and *P. dulcis* caused larval mortality reach to more than 70% but treatment by *M. oleifera* was recorded 34.9% mortality. 2nd spray was nearly recorded the same effect.

II.2. on infestation rate:

Data in Table (4) indicated that *Prunus dulcis* and *Prunus amygdalus* oils gave the highest percent reduction in infestation rate among tested oils through the whole period of application. In some cases this percent reached up to 90% as in 7th day after treatment, it recorded 95.5% and 92.043%, respectively, also after ten days post treatment, it recorded 92.4% and 92.04% for two

tested oils, respectively. On the other hand application of morenga oil caused least percent reduction in infestation rate especially after two weeks of application (14.23). In the second spray, the percent reduction in infestation rate still high for both *prunus dulcis* and Prunus amygdalus oils. It is noticed that for morenga oil the percent reduction in infestation was higher in the 2nd spray than in the 1st one through the whole period of application.

II.3. on egg deposition

The egg deposition was determined by the number of deposited eggs on 50 tomato leaflets. The highest percent reduction in the number of deposited eggs was recorded after 6 days of 1st spray with *Prunus dulcis* oil (991.2%) and 88.6% after two weeks of 1st spray. For *prunus amygdalus* oil the highest percent reduction (86.7%) was recorded after ten days of 1st spray. In the 2nd spray the percent reduction in the egg deposition still high through the whole period of application. It recorded 85.1% and 80.9% after seven days of application for both *Prunus dulcis* and *Prunus amygdalus*oils, respectively. The previous data indicated that all tested oils had a deterrent effect against *Tuta absoluta*. This effect was more obvious in recording only 4 eggs on 50 tomato leaflets in relation to 85 eggs\ 50 leaflets in the control. The degrees of deterrent effect differ among the tested oils, both *Prunus dulcis* and *Prunus amygdalus* oils had more deterrent effect than moringa oil. This is means that the tested oils saved different degrees of protection for tomato plant against *Tuta absoluta*.

II.4. on the fruit infestation

Application of the tested oils saved some protection to tomato fruits against *tuta absoluta*. Table (6) showed that although the less degree of tomato fruit protection against *Tuta absoluta* as a result of application of the tested oils, percent reduction in fruit infestation ranged from 18.35% to 22.3% but it considered respected protection especially in relation to fruit infestation in the untreated control, it reached to 71.7%. This protection effect of the tested oils for tomato fruit against *Tuta absoluta* reflected on the yield (crop weight), it recorded 14.4kg to 15.5kg\35 tomato plant by applying the oils in relation to 9.2kg\35 tomato plants in the untreated control.

Discussion

Most of vegetable oils and plant extract are known to have toxic effects on insect pest population (Gaby, 2000). Literatures have been documented several studies where, extracts, isolated compounds, plant oils or mixture products have been evaluated against many agriculture insect pests (Rosell et al., 2008). Our results indicated that all tested vegetable oils exhibited

ovicidal effect especially *Prunus dulcis* and *Prunus amygdalus var amara* oils where they caused approximately complete unhatched treated eggs. Orland et al., 2017 recorded the ovicidal effect of citrus peel oil on the eggs of *T. absoluta* where the highest egg mortality was achieved in the sweet orange emulsion treatment.

On the larval stage all tested vegetable oils have drastic effect on the *T. absoluta* larvae. Percent of larval penetration into the tomato leaves was severely affected especially with application of *Prunus dulcis*and *Prunus amygdalus var amara* oils. Also, the two tested oils have the highest and extended larvicidal effect among the tested oils, they caused more than 70% larval mortality till 7th and 10th day after application. These results are in agreement with that obtained by several authors. Moreno et al., 2011 found that the crud extract of *Acmella oleracea* has larvicidal effect and can be used to control *T. absoluta*. Our results suggested that both eggs and larvae of *T. absoluta* are highly susceptible to the tested vegetable oils. Many previous studies used botanical materials to control the larvae of *T. absoluta*. Nadia et al., 2014 reported that application of neem seed extracts and gatropha seed extract resulted in larval mortalities ranged between 33% - 46% and 23% - 48.5%, respectively and higher larval mortality, up to 100% was obtained after 4 days of application. Nilahyane et al., 2012 recorded varying toxicity levels of seven plant extracts against *T. absoluta* larvae.

Our results indicated that there is a high reduction in infestation rate of tomato leaves by *T. absoluta* larvae, approximately complete reduction by larval infestation was recorded at 7th and 10th day after application of *Prunus dulcis* oil, however, this reduction was extended till two weeks after application.

In relation to the oviposition deterrence, the control of *T. absoluta* by preventing egg deposition on plant tissues is a potentially very attractive approach in order to avoid increasing pest population on tomato fields. However, there is still little knowledge on the activity of natural products about this aspect.

Our results suggested a deterrent effect of the tested oils against *T. absoluta* adults as expressed by percent reduction in the deposited eggs. The lowest number of deposited eggs was recorded by application of *Prunus dulcis* and *Prunus amygdalus var amara* oils accompanied by high yield of crop production. A literature survey revealed that some works on the oviposition deterrence of *T. absoluta* have been conducted using aqueous extracts of *Nerium oleander* , *Olea europea* , *Laurus nobilis* (Natour and Karrom 2017), EOs of *Azadirachta indica* (Tomé et al.

2013), *Tanacetum vulgare, T. parthenium, Aleo vera, Melaleuca alternifolia and Juglans regia* (Erdogan 2019) in laboratory, EOs of *Ocimum gratissimum* and *O. basilicum* (Yarou et al. 2017) in fight tunnels, and aqueous extracts of *Allium sativum* and *Cymbopogon citratus*, EOs of *Eucalyptus spp., Ruta graveolens, O. basilicum and Pimpinella anisum*(Hussein et al. 2015) in field conditions.

Finally, the control of *T. absoluta* by using the vegetable oils on tomato plant is a potentially very attractive approach in order to avoid increasing pest population in tomato fields so, the results of our study provide a scientific contribution for the use of vegetable oils to control *Tuta absoluta* specially inside the greenhouse.

References

Angioni, A., Dedola, F., Minelli, E. V., Barra, A., Cabras, P., and Caboni, P. (2005). Residues and half-life times of pyrethrins on peaches after field treatments. J. Agric. Food Chem. 53, 4059–4063. doi: 10.1021/jf0477999

Caboni, P., Sarais, G., Angioni, A., Garcia, A. J., Lai, F., Dedola, F., et al. (2006). Residues and persistence of neem formulations on strawberry after field treatment. J. Agric. Food Chem. 54, 10026–10032. doi: 10.1021/jf062461v

Casida, J. E. (1980). Pyrethrum flowers and pyrethroid insecticides. Environ. Health Perspect. 34, 189–202.

Silva, G. A, Picanço, M.C, Bacci, L, Crespo, A.L.B., Rosado,J.F.,Guedes, R.N.C.,(2011): Controlfailure likelihood andspatialdependence ofinsecticide resistance in the tomato pinworm, *Tuta absoluta*.Pest Management Science DOI,10.1002,ps.2131

EPPO,(2011). Tuta absoluta continues to spread around the Mediterranean Basin. EPPO

Reporting Service, 4(071): 4-5.

EPPO, (2005). EPPO data sheets on quarantine pests. *Tuta absoluta*. EPPO bulletin, 35: 434-435.

Erdogan P (2019). Oviposition deterrent activities of some plant extracts against tomato leaf miner, *Tuta Absoluta* Meyrick (Lepidoptera: Gelechiidae). J BacterMyc Open Access 7(6):139–142. https://doi.org/10.15406/jbmoa.2019.07.00259

Gaby S. (2000). Natural Crop Protection in the Tropics. 2nd Enlarged and Revised edition. Margraf Verlag Press 502 PP.

Grzywacz, D., Stevenson, P. C., Mushobozi, W. L., Belmain, S. R., and Wilson, K. (2014). The use of indigenous ecological resources for pest control in Africa. Food Secur. 6, 71–86. doi: 10.1007/s12571-013-0313-5

Hussein NM, Hussein MI, Gadel Hak SH, Shaalan HS, Hammad MA (2015). Effect of two plant extracts and four aromatic oils on *Tuta absoluta* population and productivity of tomato cultivar gold stone. Nat Sci 12:108–118. https://doi.org/10.21608/jppp.2015. 74529

Isman, M. B. (2008). Botanical insecticides: for richer, for poorer. Pest Manag. Sci. 64, 8–11. doi: 10.1002/ps.1470

Isman, M. B., and Grieneisen, M. L. (2013). Botanical insecticide research: many publications, limited useful data. Trends Plant Sci. 19, 140–145. doi: 10.1016/j.tplants.2013.11.005

Isman, M. B. (2017). Bridging the gap: moving botanical insecticides from the laboratory to the farm. Ind. Crops Prod. 110, 10–14. doi: 10.1016/j.indcrop.2017.07.012

Moawad, S. and Ebadah, I.M.,(2019). Evaluation of botanical oils in management the population of okra sucking pests and their predators. J. ent. Res., 43 (3): 247-252

Moreno S. C., Carvalho G. A., Picanco M. C, Morais E.GF and R. M Pereira. (2011). Bioactivity of compounds from Acmella oleracea against Tuta absoluta (Meyrick) (Lepidoptera: Gelechiidae) and selectivity to two non – target species. Society of Chemical Industry. Pest Manag Sci 2012; 68:389 -393.

Nadia, E. M. K., Awad, K. T., and Mohammed, E. E. M.(2014). Effects of Botanical Extracts of Neem (*Azadirachta indica*) and Jatropha (*Jatropha curcus*) on Eggs and Larvae of Tomato Leaf Miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). Persian Gulf Crop Protection 3 (3): 41-6

Natour M, Karrom M (2017). The effect study of oviposition deterrent of some plant aqueous extracts of moth tomato females *Tuta absoluta* (Meyrick), (Lepidoptera: Gelechiidae). J King Abdulaziz Univ - Sci 29(2):77–85

Nilahyane, A., Bouharroud, R., Hormatallah, A., and Taadaouit, N. A. (2012). Larvicidal Effect of Plant Extracts on Tuta absoluta (Lepidoptera: Gelechiidae). IOBC-WRPS Bulletin 80: 305-10.

Orlando C, Asma C, Michele R, Gaetano S, Kaouthar G, Agatino R, Lorena M, Patrizia D, Cristina S, Nicolas D, Antonio B, Lucia Z, Vincenzo P (2017). Citrus peel essential oil nanformulation to control the tomato borer, *Tuta absoluta*: chemical properties and biological activity. Scientific Rep 7: 1-10. DOI:10.1038/s41598-017-13413-0

Pavela, R. (2016). History, presence and perspective of using plant extracts as commercial botanical insecticides and farm products for protection against insects-a review. Plant Prot. Sci. 52, 229–241. doi: 10.17221/31/2016-PPS

Rosell G., Quero C., Coll J. and Guerrero A. (2008). Biorational insecticides in pest management. Journal of Pesticide Science; 33:103–21.

Sola, P., Mvumi, B. M., Ogendo, J. O., Mponda, O., Kamanula, J. F., Nyirenda, S. P., et al. (2014). Botanical pesticide production, trade and regulatory mechanisms in sub-Saharan Africa: making a case for plant-based pesticidal products. Food Secur. 6, 369–384. doi: 10.1007/s12571-014-0343-7

Stevenson, P. C., Isman, M. B., and Belmain, S. R. (2017). Pesticidal plants in Africa: a global vision of new biological control products from local uses. Ind. Crops Prod. 110, 2–9. doi: 10.1016/j.indcrop.2017.08.034

Tomé HVV, Martins JC, Corrêa AS, Galdino TVS et al (2013). Azadirachtin avoidance by larvae and adult females of the tomato leaf miner, *Tuta absoluta*. Crop Prot 46:63–69. https://doi.org/10. 1016/j.cropro.2012.12.021

Yarou BB, Bawin T, Boullis A, Heukin S et al (2017). Oviposition deterrent activity of basil plants and their essentials oils against *Tuta absoluta* (Lepidoptera: Gelechiidae). Environ Sci Pollut Res 25:29880–29888. https://doi.org/10.1007/s11356-017-9795-6