Pharmacognosy Communications
Volume 3 | Issue 1 | Jan–Mar 2013
www.phcogcommn.org

Research Article

Repellence and Anti-oviposition Activities of Plant Products on Greenhouse Whitefly

Mahsa Dehghani[a,b], Ahmadi Kamal*,[a]

[a]*Department of Plant Protection, Faculty of Agriculture, Shahid Bahonar University of Kerman, Kerman, Iran*
[b]*Member of Young Researchers Society, Shahid Bahonar University of Kerman, Kerman, Iran*

ABSTRACT: **Introduction:** The greenhouse whitefly, *Trialeurodes vaporariorum* Westwood (Homoptera: Aleyrodidae), is an important cosmopolitan pest of many crops. **Methods:** The present study investigated the repellent and anti-oviposition activities of plant products from *Achillea millefolium* and *Thymus vulgaris* against this pest in greenhouse conditions. Cucumber plants were sprayed with the chemicals at 40 µl/ml concentration and control plants were treated with distilled water. Also, the essential oil of *A. millefolium* at the same volume (5 ml) was sprayed on the special filter paper (2 × 4 cm) attached at the petiole plant. Four treated plants and four control plants were placed randomly in to a cage. Three days after spraying, approximately 250 whitefly adults were released into the cages. Then three and six days after infesting, the number of eggs and adults were recorded. Each experiment was repeated two times at the same greenhouse condition. **Results:** The results revealed that all plant products affected the oviposition and tropism behaviors of greenhouse whitefly. Amongst the different treatments, the highest anti-oviposition effect was calculated by aqueous extracts of *T. vulgaris* (62.87%) six days after treated. Moreover, the aqueous extract of *A. millefolium* had the highest repellent effect (52.54%) six days after treatment. Also, the compare repellent activity of the chemicals on greenhouse whitefly adults indicated the highest repellent effect was evaluated by the essential oil of *A. millefolium* (48.07%) nine days after treatment. **Conclusion:** These results showed that *A. millefolium* and *T. vulgaris* had relatively long lasting repellent and anti-oviposition activities on the adults of the greenhouse whitefly.

KEYWORDS: *Achillea millefolium*, anti-oviposition activities, greenhouse whitefly, repellent activity, *Thymus vulgaris*

INTRODUCTION

Trialeurodes vaporariorum (Westwood) is a polyphagous insect pest responsible for high economic damages in many crops. They damage by secreting honeydew, which leads to growth of sooty mold fungi, and this affect the process of the plant physiology.[1] Also, they transmit plant viruses.[2] The intensive usage of chemical insecticides to control whitefly has also eliminated the natural enemies of whitefly and has led to increase tolerance or the development of insect resistance to pesticides.[3] However, the potential hazards for mammals from synthetic insecticides has caused to a search for new classes of insecticides with lower mammalian toxicity and a lower persistence in the environment in integrated management program.[4]

*Correspondence
Ahmadi Kamal
Department of Plant Protection, Faculty of Agriculture,
Shahid Bahonar University of Kerman, Kerman, Iran
E- mail: kam_ahmadi@yahoo.com
DOI: 10.5530/pc.2013.1.8

The application of botanical products to control agricultural pests can adversely affect the environment and requirements for safer means of pest management have become critical. Also, these products are now emerging as one of the prime means to protect crops and the environment from pesticide pollution.[5] The essential oils or other plant derived chemicals as potential sources of many common spices plants have also been evaluated for their repellent and insecticidal activities.[6] For example, Kordan et al.[7] found the deterrent properties of *Achillea millefolium* L. against *Sitophilus granaris* L. and *Tribolium castaneum* Herbest. Ateyyat et al.[8] studied the effect of *A. biebersteinii* L. on adults of sweet potato whitefly, *Bemisia tabaci* Genn. The medicinal plants, *Artemisia annua* L. and *A. millefolium* have been reported deterrence activities against *Pieris rapae* L.[9]

Beside essential oils, repellent potential of certain plant extracts such as thyme oil and some of its effective substances are known from the work of other authors. For example, Park et al[10] determined the repellent effectiveness of five monoterpenes (carvacrol, p-cymene, linalool,α terpinene and thymol) derived from the essential oil of *Thymus* sp. against the mosquito *Culex pipiens* pallens. The essential oils obtained from *T. vulgaris* L., *Satureja hortensis* L. and *T. satureioides* Boiss. Plants were investigated for repellent and anti-oviposition effects of the mosquito larvae *C. quinquefasciatus* Say.[11] In the another study, the activities of the essential oil of *T. vulgaris* and *Mentha piperita* were evaluated by fatalities percentage of greenhouse whitefly (*T. vaporariorum*).[12] Pavela and Herda[13] investigated the repellent and anti-oviposition activities of pongam oil against the adults of the common greenhouse whitefly *T. vaporariorum*.

This paper describes a greenhouse study to assess the potential of essential oils and aqueous extracts for use as repellents. Repellent and anti-oviposition activities of essential oils and aqueous extracts from *A. millefolium* and *T. vulgaris* were assessed against the greenhouse whitefly (*T. vaporariorum*) adults.

MATERIALS AND METHODS

Rearing of insect and host plant

Cultures of greenhouse whiteflies *T. vaporariorum* were collected from tobacco, *Nicotiana tabacum* (L.) and tomato, *Solanum lycopersicum* (L.) in the greenhouse of the faculty of agriculture in Shahid Bahonar University of Kerman, Kerman, Iran. They were reared on cucumber plants, cv. Negin in 80 × 60 × 60 cm fine cloth cages in greenhouse condition (6 × 4 m) located on the Agriculture Research and Natural Resource Center of Kerman (ARNRCK), Kerman, Iran. Adults used in the experiments were collected from this colony with a hand aspirator.

For use in bioassays, when the seedlings cucumber reached to 4–5 cm height with two leaves, they were transplanted into plastic pots (15 cm diameter and 16 cm height) and allowed to reach at least five fully expanded leaves (approximately 4–5 weeks old).

Preparation of plant products

The aromatic plants of *A. millefolium* L. (leaves and flowers) and *T. vulgaris* L. (leaves) were derived from areas of Kerman province, Iran [(Baft, Kerman, Iran: 29°14'00.18"N 56°36'07.70"E, 2271 m (altitude)]. The essential oils of the dry plant were extracted by steam or hydrodistillation using a Clevenger-apparatus. In each case, 100 g of the plant material was boiled in 500 ml of distilled water for 4 hours. The aqueous extract (aqueous portion) was separated from the essential oil (oily phase). For the short time, all the chemicals were stored at 4°C until required.[14–15]

Procedure of the experiments

The repellence and anti-oviposition activities of plant products were performed in greenhouse condition in Agriculture Research and Natural Resource Center of Kerman (ARNRCK), Kerman, Iran. Cucumber plants as host plant were sprayed with extracts at 40 µl/ml concentration and control plants were treated with distilled water. Also, the essential oil of *A. millefolium* at same volume (5 ml) (for avoid the phytotoxicity effect on the cucumber plant) were applied on Whatman of filter paper (2 × 4 cm) attached to the petiole of cucumber plants.

The four treated plants and four control plants were placed randomly in a double row of plants with 18 cm spacing between and within rows in each cabin of the experiment in 80 × 60 × 60 cm fine cloth cages as block design experiment. Three days after spraying with the plant products, approximately 250 whitefly adults were released into the cage. Three and six days after releasing greenhouse whitefly, the number of eggs and adults on detached cucumber leaves at similar areas were counted. Two cages as replicates were used for each treatment. The percent effectiveness of repellency (ER) or anti-oviposition index for the plant products was calculated by the formula:

$$ER = [(C - T)/(C + T)] \times 100$$ [16]

Where ER = percent effectiveness of repellency; C = number of eggs or adults in control treatment; T= number of eggs or adults in plant derived treatment.

Statistical analysis

Statistical comparison among the ER and anti-oviposition index of aromatic plants were conducted using a one-way analysis of variance (ANOVA) followed by a Tukey's Test ($P < 0.05$) (Stat Plus version 4.9, 2007, Croydon, UK).

RESULTS

Anti-oviposition effects

Results of the anti-oviposition effectiveness of *A. millefolium* and *T. vulgaris* are shown in Figure 1. All the aromatic plants selected showed anti-oviposition activity.

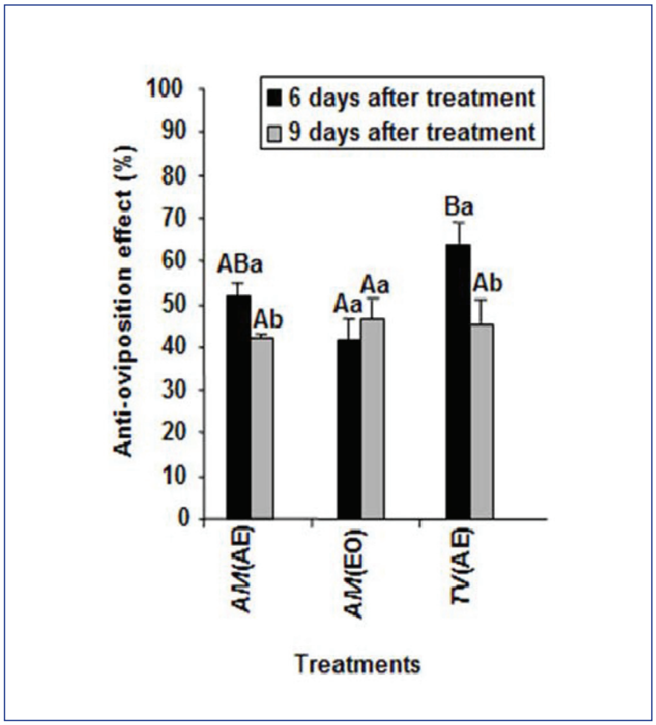

Figure 1: Anti-oviposition activity (mean ± SE) of various plant essential oils and aqueous extracts against greenhouse whitefly *Trialeurodes vaporariorum*. [*AM: Achillea millefolium, TV: Thymus vulgaris*, AE (aqueous extracts), EO (essential oil). Bars with different small letters indicate significant differences days within the same plant derived chemical. Bars with different upper case letters indicate significant differences between the plant derived chemical within the same time periods at (P ≤ 0.05) (one-way ANOVA)].

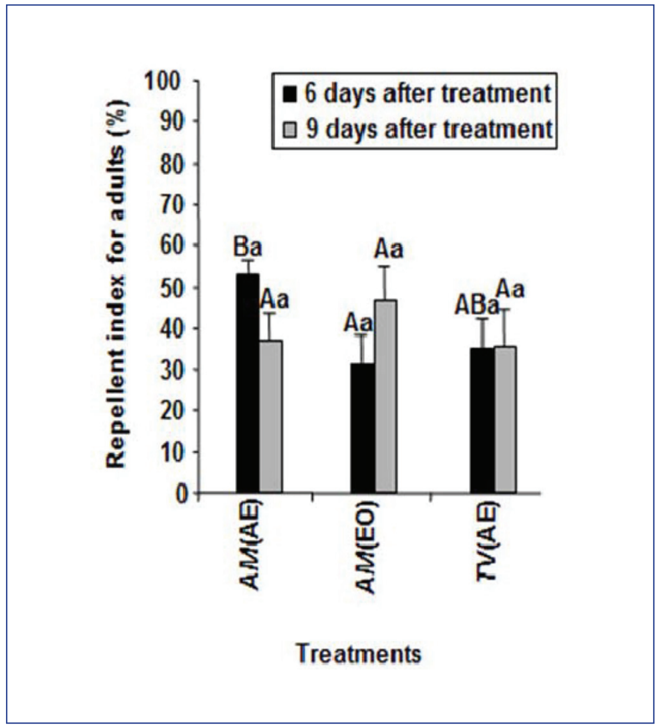

Figure 2: Repellent activity (mean percentage ± SE) of various plant essential oils and aqueous extracts against greenhouse whitefly *Trialeurodes vaporariorum*. [*AM: Achillea millefolium, TV: Thymus vulgaris*, AE (aqueous extracts), EO (essential oil). Bars with different small letters indicate significant differences days within the same plant derived chemical. Bars with different upper case letters indicate significant differences between the plant derived chemical within the same time periods at (P ≤ 0.05) (one-way ANOVA)].

Among different treatments, the highest anti-oviposition activity on greenhouse whitefly 6 days after treated was caused by aqueous extracts of *T. vulgaris* [(62.87% ± 4.81) (mean ± SE)] that was significantly different from the effect of essential oil of *A. millefolium* ($P < 0.005$).

The Essential oil obtained from *A. millefolium* had the highest anti-oviposition effect on *T. vaporariorum* after 9 days (49.33% ± 5.07) and the aqueous extracts of *A. millefolium* had the lowest (41.80% ± 0.96). Among different plant products there were no significant differences in the anti-oviposition index 9 days after treatment ($P < 0.05$).

Repellent activities

Repellent activities for all compounds, 6 and 9 days after treated, revealed in Figure 2. Six days after treated, the aqueous extracts of *A. millefolium* indicated the highest repellence effect (52.54% ± 3.55), while essential oil of *A. millefolium* had the lowest (32.47% ± 6.16). The repellent effect caused by all plant products after 9 days ranged from 35.69% to 48.07% in aqueous extract of *T. vulgaris* and essential oil of *A. millefolium* treatments, respectively. There were no significant differences among aqueous extract and essential oil of *A. millefolium* as well as *T. vulgaris* treatments ($P < 0.05$).

In addition, there were significant differences between 6 and 9 days after treated in anti-oviposition activity obtained from aqueous extract of *A. millefolium* and aqueous extract of *T. vulgaris* ($P < 0.05$). Also, to compare repellence activity of all aromatic plants selected between 6 and 9 days after treated had no significant differences ($P < 0.05$).

DISCUSSION

The selected aromatic plants of *A. millefolium* and *T. vulgaris* showed high repellence and anti-oviposition effectiveness on the adults of greenhouse whiteflies. Nevertheless, our research revealed that these plants in the spraying bioassay may successfully control this aggressive pest because of their high volatility, repellent efficacy and safety.[17] Different parts of plants contain a complex of chemicals with unique biological activity[18] which is thought to be due to toxins and secondary metabolites, which act as attractants or deterrents.[7] Positive results for deterrent activity of these plants were obtained against various pests.[10, 11, 19] The results of our study are mostly in the agreement with the results of other investigators. Pavela[11] has demonstrated that concentrations of 0.01% and 0.005% *T. vulgaris* were most effective at repelling mosquito larvae *C. quinquefasciatus* with about 99.8 and 62.3% repellence respectively. Moreover, the essential oils made of *S. hortensis, T. vulgaris* and *T. satureoides* offer a high potential for the control of *C. quinquefasciatus* as new safety larvicides in the environment. Hasheminia et al.[9] proved that the deterrent effect of *Artemisia annua* L. and *A. millefolium* L. on small cabbage *Pieris rapae* L. were 29.82% and 44.18%, respectively. In the another study, Kordan et al.[7] assessed that *A. millefolium* can have a high deterrence effect in protecting stored products from *S. granaris* L. and *T. castaneum* Herbest. Al-Mazra'awi and Ateyyat[20] have reported that plant extracts of *Urtica pilulifera* L. and *T. capitatus* L. had repellent effecst against *B. tabaci* adults.

Some authors also studied the toxicity effect of these plant derived chemicals on the pests. For example, the persistency of larvicidal affects of some essential oils under different conditions against *Aedes aegypti* larvae. Some oils (for example thyme oil (*T. vulgaris*)) stayed effective under certain conditions until the last test and their toxicity remained a long time after preparation.[21] The present study demonstrates a high potential for using the aromatic plants *A. millefolium* and *T. vulgaris* as repellent and anti ovipositional activity against greenhouse whitefly. This may lead to new and more effective strategies to prevent and control this aggressive pest. The high activity of these plants could be used as an active ingredient in the preparation of natural insect repellents or as bio-insecticides. Some of the compounds tested could find a place in integrated pest management programs (IPM), especially where the emphasis is on environmental and food safety and on replacing the more dangerous and toxic insecticides.

ACKNOWLEDGEMENTS

The authors thank Hadi Zohdi at Agriculture Research and Natural Resource Center of Kerman, Iran for his help and support.

REFERENCES

1. Bi JL, Toscano NC, Ballmer GR. Seasonal Population dynamics of the Greenhouse Whitefly *Trialeurodes vaporariorum* on Oxnard area. Department of Entomology, University of California, Riverside, CA 92521, 2001.
2. Mutwiwa UN, Tantau HJ. Suitability of a UV Lamp for Trapping the Greenhouse Whitefly *Trialeurodes vaprariorum* Westwood (Homoptera: Aleyrodidae), Agricultural Engineering International. CIGRE J. 2005 Sept; Vol. VII. Manuscript BC 05 004.
3. Morales FJ, Anderson PK. The emergence and dissemination of whitefly transmitted geminiviruses in Latin America brief review. Arch Virol 2001; 146:415–441.
4. Regnault-Roger C, Hamraoui A. Efficiency of plants from the south of France used as traditional protectants of *Phaseolus vulgaris* L. against its bruchid *Acanthoscelides obtectus* (Say). J Stored Prod Res 1993; 29:259–264.
5. Prakash A, Rao J. Botanical Pesticides in Agriculture. Boca Raton, FL, USA: CRC Press, Inc., 2000 Corporate Bld, N.W; 1997.
6. Tripathi AK, Prajapati V, Aggrawal KK, Khanuja SPS, Kumar S. Repellency and toxicity of oil from *Artemisia annua* to certain stored product Beetles. J Econ Entomol 2000a; 93:43–47.
7. Kordan B, Ciepielewska D, Nietupski M. Deterrent activity of plant powders on grain weevil (*Sitophilus granarius* L.) and red flour beetle (*Tribolium castaneum* Herbst.). Polish J Nat Sci 2003; 14:265–272.
8. Ateyyat MA, Al-Mazra'awi M, AbuRjai T, Shatnawi MA. Aqueous extracts of some medicinal plants are as toxic as Imidacloprid to the sweet potato whitefly, *Bemisia tabaci*. J Insect Sci 2009; 9(15):1–6.
9. Hasheminia S, Jalali Sendi J, Talebi Jahromi K, Moharramipour S. The effects of *Artemisia annua* L. and *Achillea millefolium* L. crude leaf extracts on the toxicity, development, feeding efficiency and chemical activities of small cabbage *Pieris rapae* L. (Lepidoptera: Pieridae). Pestic Biochem Phys 2011; 99(3):244–249.
10. Park BS, Choi WS, Kim JH, Kim KH, Lee SE. Monoterpenes from thyme (*Thymus vulgaris*) as potential mosquito repellents. J Am Mosq Control Assoc 2005; 21:80–87.
11. Pavela R. Larvicidal property of essential oils against *Culex quinquefasciatus* Say (Diptera: Culicidae). Ind Crop Prod 2009; 30: 311–315.
12. Aroiee H, Mosapoor S, Karimzadeh H. Control of greenhouse whitefly (*Trialeurodes vaporariorum*) by Thyme and Peppermint. KMITL Sci J 2005; 5(2):511–514.
13. Pavela R, Herda G. Repellent effects of pongam oil on settlement and oviposition of the common greenhouse whitefly, *Trialeurodes vaporariorum* on *chrysanthemum*. J Insect Sci 2007; 14:219–224.
14. Tawatsin A, Asavadachanukorn P, Thavara U, Wongsinkongman P, Bansidhi J, Boonruad T, et al. Repellency of essential oils extracted from plants in Thailand against four mosquito vectors (Diptera: Culicidae) and oviposition deterrent effects against *Aedes aegypti* (Diptera: Culicidae). Southeast Asian J Trop Med Public Health 2006; 37(5):915–931.
15. Traboulsi AF, El-Haj S, Tueni M, Taoubi K, Abi Nader N, Mrad A. Repellency and toxicity of aromatic plant extracts against the mosquito *Culex pipiens* molestus (Diptera: Culicidae). Pest Manag Sci 2005; 61: 597–604.
16. Pascual-Villalobos MJ, Robledo A. Screening for antiinsect activity in Mediterranean plants. Ind Crop Prod 1998; 8:183–194.
17. Farnsworth NR, Bingel AS. Natural products and plant drugs with pharmacological, biological or therapeutic activity. Berlin: Springer Verlag; 1977.
18. Fisher PR. The role of gaseous metabolites in phototaxis by *Dictyostelium discoideum* slugs. FEMS Microbiol Letters 1991; 77:117–120.
19. Pavela R. Insecticidal activity of certain medicinal plants. Fitoterapia 2004; 17:745–749.
20. Al-mazra'aw MS, Ateyyat M. Insecticidal and repellent activities of medicinal plant extracts against the sweet potato whitefly, *Bemisia tabaci* (Hom.: Aleyrodidae) and its parasitoid *Eretmocerus mundus* (Hym.: Aphelinidae). J Pestic Sci 2009; 82:149–154.
21. Amer A, Mehlhorn H. Persistency of larvicidal effects of plant oil extracts under different storage conditions. Parasitol Res 2006; 99:473–477.