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Efficacy of some plant essential oils against cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae) under laboratory conditions

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***Abstract*- The cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae) is one of the most injurious pests of fruits, vegetables and ornamental plants worldwide, both outdoor and indoor. The purpose of the current study was to investigate the insecticidal activity of six essential oils against the pest under laboratory conditions. The tested formulations are based on: coriander (*Coriandrum sativum* L.) oil, lavender (*Lavandula spica* L.) oil, fennel (*Foeniculum vulgare* Mill.) oil, oregano (*Origanum vulgare* L.) oil, juniper (*Juniperus communis* L.) oil and clove (*Syzygium aromaticum* (L.)) oil prepared as ready to use plant protection products. The products were created at the University of Food Technologies, Plovdiv, Bulgaria. Chemical product Karate Zeon® at 0.03% (Lambda-cyhalothrin) was included as a standard. The mortality of pest was evaluated 24 hours after treatment. All of tested essential oils shown a strong insecticidal activity against cotton aphid. The preparations on the base of *Syzygium aromaticum* and *Origanum vulgare* essentials oils deserves attention due to the fact, the LD_{50} according to the tested insect is very close to the used standard Karate Zeon®.**

***Keywords*: *Aphis gossypii, Coriandrum sativum, Lavandula spica, Foeniculum vulgare, Origanum vulgare, Juniperus communis, Syzygium aromaticum*, plant oils.**

I. INTRODUCTION

The cotton aphid, *Aphis gossypii* Glover, is a polyphagous pest, major pest of cultivated plants in the families Cucurbitaceae, Rutaceae and Malvaceae, and of Citrus trees. It is one of the most injurious pests of fruits, vegetables and ornamental plants worldwide, both outdoor and indoor. Nymphs and adults feed on the underside of leaves, sucking nutrients from the plant. The foliage may become chlorotic and die prematurely [1].

Currently, the main method of control of this pest is through application of pesticides which is mostly accompanied by the resistance of the pest against pesticides. In organic systems, however, the use of synthetic insecticides is not allowed, increasing the difficulty of controlling this pest. Recently, botanical insecticides have long been considered as acceptable alternatives to synthetic chemical insecticides for pest management as they have low persistence in the environment and little mammalian toxicity [2]; [3]; [4]; [5]; [6]. Recent studies have indicated how various essential oil efficient against pests on plants. Most of the studies reported great potentials of the essential oils to control pests particularly in the greenhouse and in field [3]; [5]; [7]; [8]; [9].

The aphids have a particular importance as serious pests. The essential oils with their novel, highly bioactive compounds can be very well used as effective insecticides [5] and thus should be considered seriously for control of the aphids. Recently which information has been accumulated about the potential of essential oils in control of aphids and several studies reported usefulness applications.

Tunç and Şahinkaya [8] found that essential oils of cumin (*Cuminum cyminum* L.), anise (*Pimpinella anisium* L.), oregano (*Origanum syriacum var. bevanii* L.) and eucalyptus (*Eucalyptus camaldulensis* Dehn.) were effective as fumigants against the cotton aphid (*Aphis gossypii* Glover).

Tomova *et al.* [9] tested the biological activity of essential oil volatiles obtained from *Tagetes minuta* L. against aphid species, *Acyrthosiphon pisum* (Harris), *M. persicae, Aulacorthum solani* (Kaltenbach) and found that *T. minuta* oil volatiles significantly have reduced the reproduction potential of the tested species.

Jaastad [10] showed that rapeseed oil significantly reduced damage by black cherry aphid, *Myzus cerasi* (Fabricius).

Görür *et al.* [11] demonstrated adverse effects of Thymus, Veronica and Agrimonia essential oils on cabbage aphid. Particularly Thymus oil application resulted in significant decrease in fecundity and increase in mortality rate.

Digilio *et al.* [6] tested aphicidial activity of some essential oils extracted from twelve Mediterranean plants against the pea aphid, *A. pisum* and green peach aphid, *Myzus persicae* (Sulzer). Anise, fennel and basil essential oils resulted in high mortality, even applied at low doses. Activity was dose-dependent.

Işık *et al.* [12] investigated the aphidicidial activities of seven essential oils (*Juniperus excelsa* M. Bieb., *Juniperus oxycedrus* L., *Foeniculum vulgare* Miller, *Pimpinella anisum* L., *Rosmarinus officinalis* L., *Juglans regia* L. and *Laurus nobilis* L.) against cabbage aphid, *Brevicoryne brassicae* (Hemiptera: Aphididae) under laboratory conditions. Applications of each tested essential oil significantly reduced the reproduction potential of the cabbage aphid and resulted in higher mortality.

Górski and Tomczak [13] tested the efficacy of natural essential oils, such as basil oil (*Ocimum basilicum*), citronella oil (*Cymbopogon winterianus* Jowitt), eucalyptus oil (*Eucalyptus globulus*), juniper oil (*Juniperus communis*) and patchouli oil (*Pogostemon patchouli*), in the control of foxglove aphid (*Aulacorthum solani* Kalt.) occurring on eggplant. After application of citronella oil and patchouli oil at a concentration of 0.05 and 0.10% and juniper oil at 0.10%, 100% mortality of the pest was recorded 24 hours after treatment.

In the study of Jiang *et al.* [14], essential oils from different parts (leaves, twigs and seeds) of *Cinnamomum camphora* L. Presl. were investigated for their chemical composition, and insecticidal and repellent activities against the cotton aphid. In the contact toxicity assay, the three essential oils of leaves, twigs and seeds exhibited a strong insecticidal activity against cotton aphids. In the repellent assay, the highest repellent rate was found in the seed essential oil after 24 hours of treatment. Linalool was found to be a significant contributor to the insecticidal and repellent activities. The results indicate that the essential oils of *C. camphora* might have the potential to be developed into a natural insecticide or repellent for controlling cotton aphids.

In this aspect, the aim of the current study is to investigate the aphidicidial activity of six essential oils against cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae) under laboratory conditions.

II. Material And Methods

Natural colonies of nymphs and wingless adults of cotton aphid, feeding on leaves of cucumber were used.

The tested active substances (plant oils) are not directly soluble in water. For the purposes of agriculture a special formulation was prepared that was soluble in water. The formulation procedures included saponification of active substances and its emulsification. Saponification procedure - mixture of coconut oil, potassium hydroxide and water was heated up to 50° C and stirred in a mixer at a rotation speed of 1 500 min-1. After soap preparation active substances and glycerin were added. The mixture was re-heated to 40° C and stirred in a mixer at a rotation speed of 1500 min-1. The active substances, such as essential oil, were prepared in a laboratory steam atmospheric hydro-distillation unit with volume 30 l. The only reagent used for essential oil production was water. The production procedure includes loading of raw material in perforated bottom basket, exposure of the raw material to superheated water steam and evaporation of volatile compounds, condensing of water steam and volatile compounds by means of cooling, decanting of oil (volatile compounds) from distillate by means of density differences, removal of decanted oils, dewatering of oils by potassium sulphate, and filtration of oils.

The individuals were placed on the layer of filter paper soaked with tested insecticide in 10 cm high plastic caps (5 cm diameter of the bottom). Each variant was implemented with three replicates with 10 aphids in each repetition. The

variants were treated with tested concentrations of products and the control was treated with water. As standard variant was used Karate Zeon® on the base of lambda-cyhalothrin produced by Syngenta at 0.03 % (v/v) concentration. The number of surviving individuals was recorded on the 24 hours after the treatment. The efficacy was estimated according to Henderson and Tilton formula [15]. Ten different concentrations were tested to be determined LC_{05} (NOEL), LC_{25} (LOAEL) LC_{50} and LC_{90}. The received data from conducted tests were statistically manipulated with R language for statistical computing [16] and drc R language package [17].

III. Results And Discussion

The figure below show the Dose – Response Modeling for tested products.

The received toxicological data are:

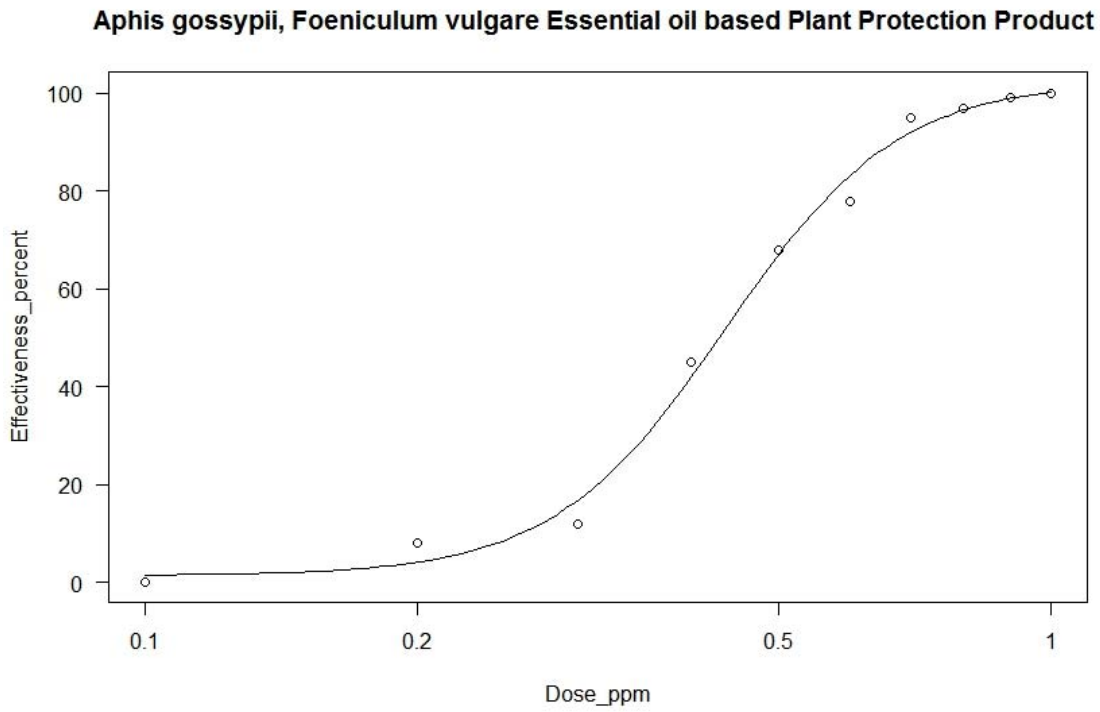

Figure 1. Dose - Response Modeling for *Foeniculum vulgare* Essential oil based Plant Protection Product.

- NOAEL = 0.22 % (m/v)
- LOAEL = 0.34 % (m/v)
- LD_{50} = 0.43 % (m/v)
- LD_{90} = 0.70 % (m/v)

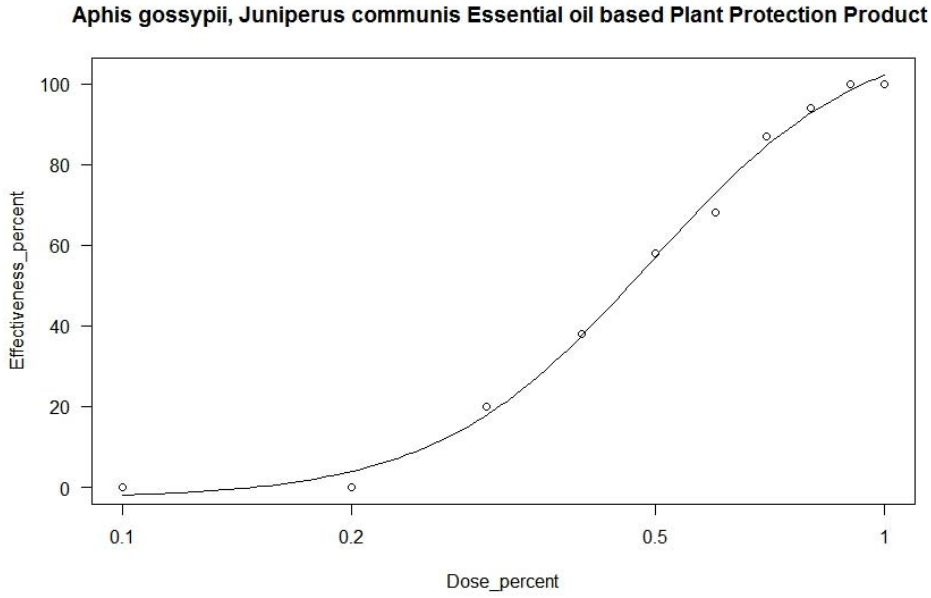

Figure 2. Dose - Response Modeling for *Juniperus communis* Essential oil based Plant Protection Product.

- NOAEL = 0.19 % (m/v)
- LOAEL = 0.34 % (m/v)
- LD_{50} = 0.49 % (m/v)
- LD_{90} = 0.99 % (m/v)

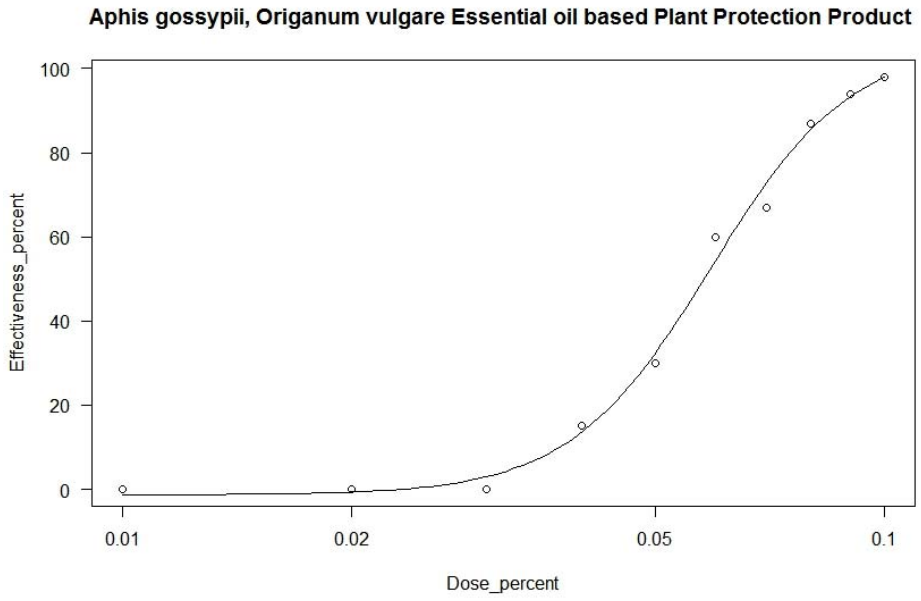

Figure 3. Dose - Response Modeling for *Origanum vulgare* Essential oil based Plant Protection Product.

- NOAEL = 0.03 % (m/v)
- LOAEL = 0.046 % (m/v)
- LD_{50} = 0.059 % (m/v)
- LD_{90} = 0.09 % (m/v)

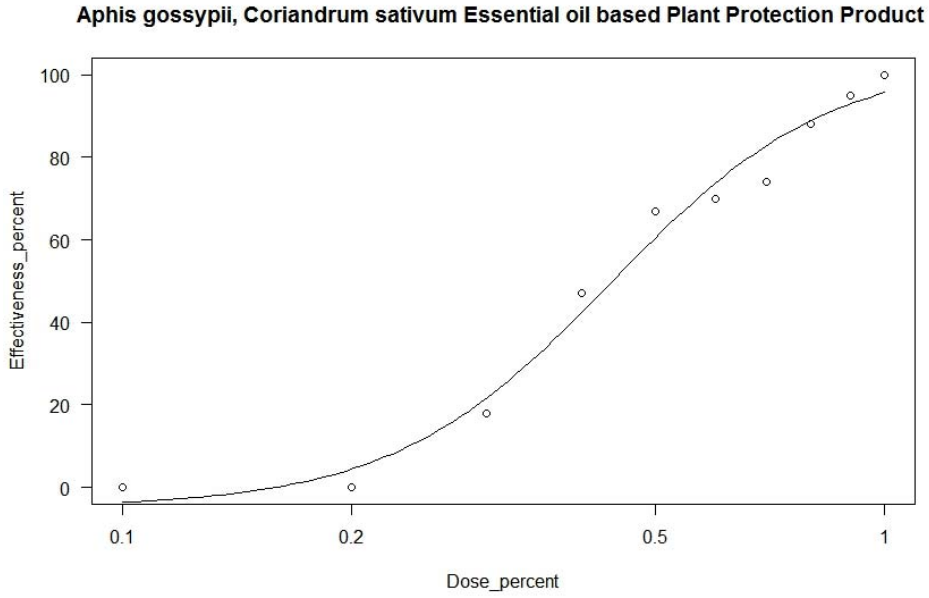

Figure 4. Dose - Response Modeling for *Coriandrum sativum* Essential oil based Plant Protection Product.

- NOAEL = 0.16 % (m/v)
- LOAEL = 0.30 % (m/v)
- LD_{50} = 0.43 % (m/v)
- LD_{90} = 0.90 % (m/v)

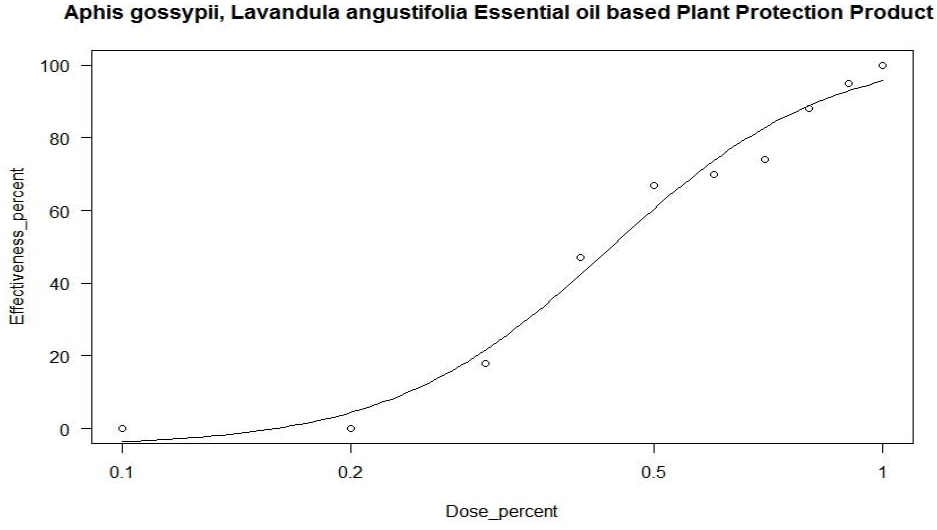

Figure 5. Dose - Response Modeling for *Lavandula angustifolia* Essential oil based Plant Protection Product.

- NOAEL = 0.35 % (m/v)
- LOAEL = 0.44 % (m/v)
- LD_{50} = 0.51% (m/v)
- LD_{90} = 0.69 % (m/v)

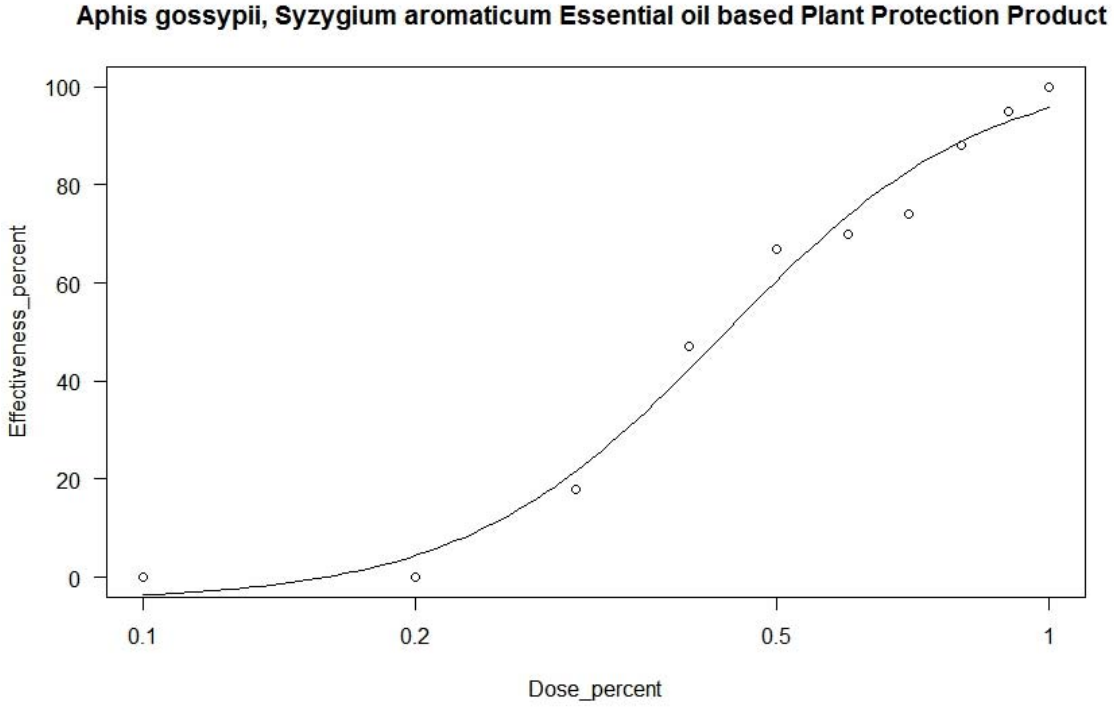

Figure 6. Dose - Response Modeling for *Syzygium aromaticum* Essential oil based Plant Protection Product.

- NOAEL = 0.018 % (m/v)
- LOAEL = 0.032 % (m/v)
- LD_{50} = 0.045% (m/v)
- LD_{90} = 0.087 % (m/v)

From conducted trials clearly can be seen the strong insecticidal action of the tested formulations completely comparable to the commercial synthetically insecticides on the market. The preparations on the base of *Syzygium aromaticum* and *Origanum vulgare* essentials oils deserves attention due to the fact, the LD_{50} according to the tested insect is very close to the used standard Karate Zeon®. This results show the enormous potential such kind plant protection products to be evaluated under real field conditions and introduced as naturally friendly pesticides in organic and commercial agriculture.

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