Effects of Some Plant Extracts on *Aphis gossypii* Glover (Hemiptera: Aphididae) and *Bemisia tabaci* (Gennadius) Takahashi (Hemiptera: Aleyrodidae)

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ABSTRACT—*The study aimed to investigate the effects of the extracts derived from Satureja hortensis, Ocimum basilicum, Cassia angustifolia, Thevetia peruviana, Schinus molle, Melia azedarach on Aphis gossypii Glover. (Hemiptera: Aphididae), and Bemisia tabaci Genn. (Hemiptera: Aleyrodidae), which are major polyphagous pests. For this purpose, the extracts derived by water from these plants, which were dried and ground to fine powder. Then the extracts applied on A. gossypii and B. tabaci reared on cotton plants via a dipping method. Assessments were done according to counts made before application of extracts and at the 1st, 24th, 72nd and 168th HAA. The extract of T. peruviana with 30.69% had the highest effect on A. gossypii at the 1st HAA. The extract of O. basilicum with 40.67% had the highest effect on A. gossypii at the 24th HAA. None of plant extracts had a significant impact on A. gossypii at the 72nd and 168th HAA. The extract of C. angustifolia had the highest effect on B. tabaci with 50.78% at the 1st HAA. The percentage effects of the extract obtained from C. angustifolia on B. tabaci at the 24th and 72nd HAA were 49.50% and 50.97%, respectively. Consequently, the extracts of O. basilicum, C. angustifolia, T. peruviana were determined as hopeful according to results of the present study.*

Keywords—*Aphis gossypii*, *Bemisia tabaci*, plant extract, natural pesticide

1. INTRODUCTION

Nowadays, fulfilment of plant food requirements is still insufficient due to the continuation of the increase in the human population. However, one part of studies performed in order to increase the plant-based food production is about pesticide applications. Crop product loss in agriculture areas caused by biotic factors is estimated to be 35%, consisting of insect damage (14%), disease damage (12%) and weed damage (9%) (Özgür, 1995).

Although adverse effect of pesticides on human health and environment is known, they are more preferred in pest control for reasons such as getting result as soon as possible, less knowledge requirement and easy usage. Therefore, the interest of researchers shifted to studies which can be alternative to chemicals and less harmful on human health and environment. In this context, the use of biopesticides obtained from plant extracts has been raised.

Some plant extracts are well known to be effective on some agricultural pests. Low adverse impact of these preparations on human health and environment is due to the biological origin thereof has been reported (Suchmutterer, 1981). Erdoğan (2013) stated that the use of plant extracts against pests within the concept of integrated pest management, good agricultural practices and organic farming would be a significant improvement in terms of human and environment health.

A study of Sagheer et al. (2014) investigated the repellent effects of *Nigella sativa*, *Syzygium aromaticum* and *Trachyspermum ammi* on *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) by impregnating half-filter paper disc and at the concentrations of 5.0, 10.0, 15.0%. The results of this study demonstrated that these plant extracts has significant repellent effect on the pest. Based on the results of the study done by themselves, Yanar and Düzdemir (2012) concluded that Azadirachtin (10 $g.l^{-1}$), commercial eucalyptus oil (*Eucalyptus globulus* Labill.) (1.25% concentration) and methanol extract of *Melia azedarach* L. (Neem tree) (1.25% concentration) can be used to control *Acanthoscelides*

obtectus (Say.) (Coleoptera: Bruchidae) in integrated pest management programs to reduce the use of synthetic insecticides. Erdoğan and Toros (2005) studied on the effects of acetone, ethanol and methanol extracts of *M. azedarach* on larval development and pupae stage of *Leptinotarsa decemlineata* Say. (Coleoptera: Chrysomelidae). According to the results of this study, all of the extract applications, depending on the concentration increases, prolonged the development time and caused the high mortality at the larva and pupa stages of the pest. Also, it was reported in the study that the extract applications led to the formation of abnormal individuals, and the decrease in adult emergence and the fecundity of female adults.

Considering this situation, the study aimed to find out the effects of some plant extracts on *Aphis gossypii* Glover (Hemiptera: Aphididae) and *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae) which are major polyphagous pests, and determine promising plant extracts.

2. MATERIAL AND METHODS

2.1 Experiment materials

The main materials of the study are *Aphis gossypii* Glover. (Hemiptera: Aphididae), *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae) and plants in Table 1.

Table 1: Used plant organs and the ratio of triturated plant material per distilled water*

Plant name	Used plant organ	Triturated plant material per distilled water
Satureja hortensis	Leaf	0.1 $g.ml^{-1}$
Ocimum basilicum	Leaf	0.1 $g.ml^{-1}$
Cassia angustifolia	Leaf	0.1 $g.ml^{-1}$
Thevetia peruviana	Leaf	0.1 $g.ml^{-1}$
Schinus molle	Leaf	0.1 $g.ml^{-1}$
Melia azedarach	Fresh fruit**	0.25 $g.ml^{-1}$

*Surfactant (Tayowett®) in the ratio of 0.025% was added in the extracts for dispersion and adhesion prior to applications.
**60% of fruits were considered as seed.

2.2 Insect rearing

Primarily, a mixture of peat and soil in ratio of 1:1 was filled into 1.5 l plastic pots, and cotton seeds were sown in these pots, so that 2 seeds in each pot. After germination, the cotton plants reached the 2-3 leaf stage were infested with the pests. To that end, a plant infected with the pest was placed in a cage of 45x60x65 cm size, containing the clean plants. Thereby, the contamination of the pest was provided. This process was performed in a controlled climate room conditions at temperature 25±1ºC, relative humidity 60±10% and photoperiod 16:8 h., separately for *A. gossypii* and *B. tabaci*. When deemed necessary, new clean plants were added to replace died plants to ensure continuity of pest productions.

2.3 Preparation of plant extracts

Plant materials used in the experiment were collected from around Balcalı campus of Çukurova University in Adana, Turkey. To prepare extracts, all plant materials, except *M. azedarach* were previously divided into small pieces and dried in the shade. After the drying process, plant materials were crumbled and ground to a powder. Triturated plant material was added into the distilled water in an Erlenmeyer flask. As regards *M. azedarach*, fresh fruits of the plant, 60% of which were considered as seed were used to achieve extract. Next, the mixture in the Erlenmeyer flask was stirred for ca. 12 hours on a magnetic stirrer. Then, plant extracts were obtained by filtration the mixtures. Afterward, the obtained extracts were filled into glass jars covered with aluminum foil and placed in a refrigerator to be maintained.

2.4 Application of plant extracts

Each of Plant extracts were separately filled in to 1 l beakers and a surfactant (Tayowett®) in the ratio of 0.025% was added for dispersion and adhesion. Afterwards, applications were performed by submerging leaves infected with pest insect in the plant extracts, without separating from the plant. Distilled water was used as a control to compare with the

plant extracts. Assessments were done according to live individual counts at the 1st, 24th, 72nd and 168th HAA (Hours After Application). Aphids were checked if live or not, gently touching with the tip of the fine paintbrush.

2.5 Data analysis

The experiment was arranged in a completely randomized pot design with 5 replicates for each plant extract and distilled water. At the end of the experiment, percentage effects of the plant extracts were calculated according to mean number of live individual by Henderson-Tilton's formula (Henderson and Tilton, 1955), given below.

$$\text{Corrected \%} = 100 \text{ X} \left[1 - \frac{\text{N in T after application X N in Co before application}}{\text{N in T before application X N in Co after application)}}\right]$$

Where N is the mean "number of live individual", T is the mean "treated plot" and Co is the mean "control plot". Finally, arcsine square root transformation was applied to percentage data calculated by Henderson-Tilton's formula, and Tukey test was performed on these transformed data after One-Way ANOVA test, using SPSS® (Version 15.00, November 2006, SPSS Inc., Chicago, IL, USA.).

3. RESULTS AND DISCUSSION

Percentage effects of plant extracts derived from *Satureja hortensis*, *Ocimum basilicum*, *Cassia angustifolia*, *Thevetia peruviana*, *Schinus molle* and *Melia azedarach* on *Aphis gossypii* and *Bemisia tabaci* reared on cotton plant at the 1st, 24th, 72nd and 168th HAA according to the control were given in Figure 1-2.

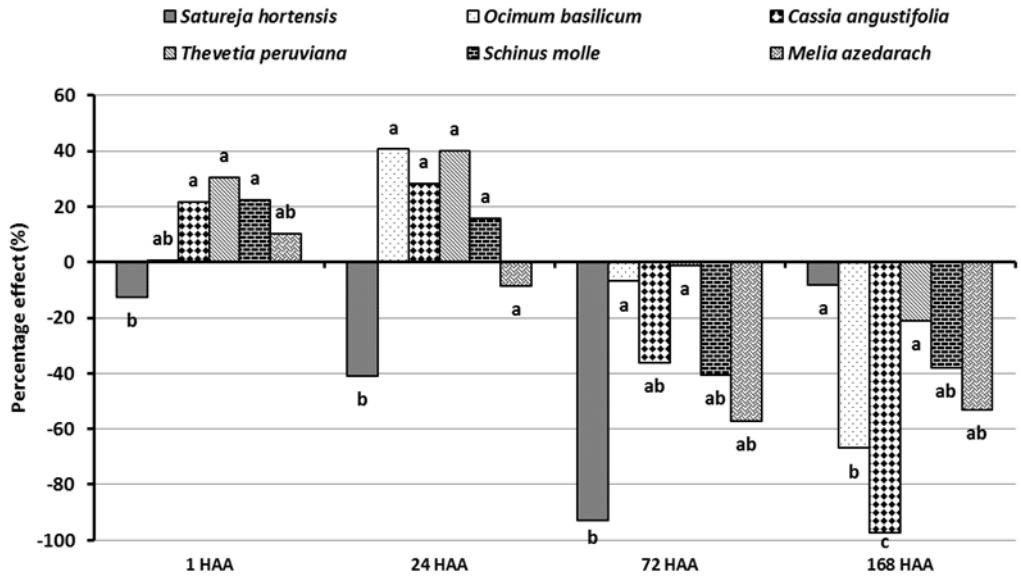

Figure 1: Percentage effects of plant extracts on *Aphis gossypii* at the 1st, 24th, 72nd and 168th hours after application (HAA). The untransformed values of data were given. Among vertical bars designated by the same letter at the same hour do not differ significantly (p>0.05; n=5) according to a Tukey test.

As seen in Figure 1, the plant extract with the highest percentage effect on *A. gossypii* at the 1st HAA was the extract derived from *T. peruviana* with 30.69%. The second highest effect on the pest was obtained from the extract of *S. molle* with 22.51%. The percentage effects of the extracts derived from *C. angustifolia* and *M. azedarach* on the pest were respectively 21.78% and 10.21% at the 1st HAA. The highest percentage effect on *A. gossypii* at the 24th HAA was showed by the plant extract derived from *O. basilicum* with 40.67%, followed by the extracts derived from *T. peruviana* with 40.00% and *C. angustifolia* with 28.28%. All plant extracts had no remarkable effect on the pest at the 72nd and 168th HAA.

Pavela et al. (2004) studied on the effects of low concentrations of azadirachtin, including 0.25, 0.05, 0.005, 0.0005 and 0.00005 mg/ml, on mortality, development time, longevity and fertility of cabbage aphid *Brevicoryne brassicae* L. (Hemiptera: Aphididae) in *Brassica napus* subsp. napus. The study noticed that mortality of the nymphs, especially during molting period, increased significantly with increasing concentrations of azadirachtin. Moreover, it was pointed out that the average longevity of cabbage aphid was reduced with increasing concentrations of azadirachtin and the time spent on feeding, and the fertility of aphids also decreased after azadirachtin applications. However, azadirachtin had no any impact on the development time of the immature stages of *B. brassicae*.

Erdoğan and Yıldırım (2013) investigated the effects of the extracts obtained from *Hyoscyamus niger* L. and *Achillea wilhelmsii* C. on *Myzus persicae* Sulzer (Hemiptera: Aphididae). The highest mortalities of the pest were determined at 12.0% concentrations of both extracts. The study indicated that the percentage effects of the extract derived from *A. wilhelmsii* on nymph and adult stages of *M. persicae* were 83.81% and 80.00% at 12.0% concentration, respectively. The percentage effects of the extract derived from *H. niger* on nymph and adult stages of the pest at the same concentration were found as 7.64% and 65.00%, respectively. It is also reported that there was no significant difference on the mortality between leaf dipping and direct leaf spraying method when compared. The study by Erdoğan and Yıldırım (2014) investigated the effect of the extract gained from *Veratrum album* L. on *M. persicae* at 1%, 3%, 6% and 12% concentrations applied separately in both dipping and spraying methods. According to the result of the study, the highest effect on both nymph and adult stages in leaf dipping method was obtained at 12% concentration with 67.16% and 85.71%, respectively. The highest effect in spraying method was also found at 12% concentration with 80.84%.

The plant extract with the highest percentage effect on *B. tabaci* at the 1st HAA was the extract of *C. angustifolia* with 50.78%, followed by the extract of *O. basilicum* with 14.55%. While the plant extract derived from *O. basilicum* has the percentage effect of 24.24% and 18.52% on B. tabaci at the 24th and 72nd HAA respectively, the percentage effects of the extract derived from *C. angustifolia* at the 24th and 72nd HAA were 49.50% and 50.97%,respectively.The extract of *T. peruviana* was effective on the pest with the rate of 9.40% and 16.04% at the 1st and 24th HAA, respectively (Figure 2).The study conducted by Kayahan and Çetin (2014) stated that the extract of *O. basilicum* had a partly impact on fecundity of *Callosobruchus maculatus* F. (Coleoptera: Bruchidae).

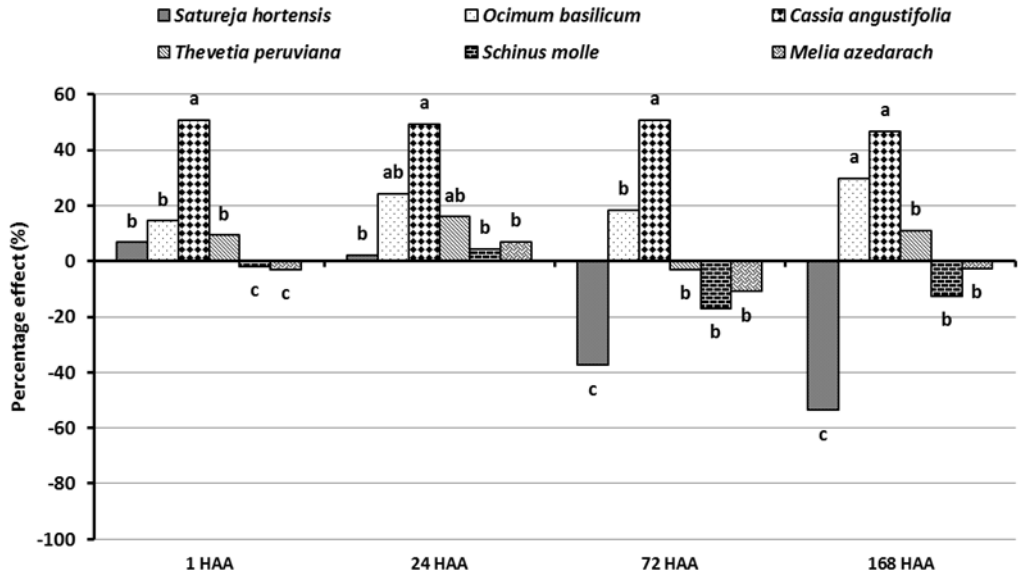

Figure 2: Percentage effects of plant extracts on *Bemisia tabaci* at the 1st, 24th, 72nd and 168th hours after application (HAA). The untransformed values of data were given. Among vertical bars designated by the same letter at the same hour do not differ significantly (p>0.05; n=5) according to a Tukey test.

According to the results of the present study, the extract derived from *M. azedarach* had low effect on *A. gossypii* and *B. tabaci*. The reason for this is believed that water used as the solvent could not provide sufficient solubility. Erdoğan (2013) reported that herbal insecticides are especially effective against larvae and nymphs of phytophagous insects, and therefore selective for parasitoids and many predators. Erdoğan (2013) also noted that Neem products might be mixed with some biopreparations such as *Bacillus thuringiensis*. The study on the use of compounds derived from the Neem tree as bioinsecticide compiled by Özger et al. (2013) clarified that Neem products have a very high potential to be used as biopesticide in integrated pest management. Madanlar et al. (2002) natural pesticides can be combined with sulfur

applications against red spider mites as well as releasing natural enemies in ecological farming. The pesticides with a short post-harvest period can also be applied when the pest populations are at a critical level to support the natural pesticides in integrated pest management programs.

Khan et al. (2013) explored the effects acetone based extracts of *Allium sativum* (Garlic), *Azadirachta indica* (Neem), *Citrus limon* (Lemon) and *Eucalyptus globules* (Safaida) on *Tribolium castaneum*. The highest contact toxicity on the pest was showed with the rate of 14.69% by the extract of *C. limon* at 15% concentration. The highest repellence effect with the rate of 82.96% was seen in the extract of *E. globules* at 15% concentration. According to the results of the study, the researchers reported that the correlation between the repellent effect and the concentration level of these plant extracts has the right proportions and also, these plant extracts are suitable for substitute of conventional synthetic insecticides for the management of *T. castaneum*. Hasan et al. (2014) prospected repellent effect of *Azadirachta indica* A. Juss. and *Glycyrrhiza glabra* L. to *Callosobruchus chinensis* L. (Coleoptera: Bruchidae). It is given in the results of this study that the highest repellency with 72.77% was achieved at 20% concentration of *A. indica*, and reported that *A. indica* is more repellent for *C. chinensis* when compared with *G. glabra*.

The results of the present study on effects of extracts on *A. gossypii* and *B. tabaci* demonstrated that the most effective extract on *A. gossypii* was the one derived from *T. peruviana* at the 1st HAA, the one derived from *O. basilicum* at the 24th HAA, and all plant extracts had no remarkable effect on the pest at the 72nd and 168th HAA (Figure 1). Also, the results showed that the extract derived from *C. angustifolia* was the most effective one among all on *B. tabaci* at the 1st, 24th, 72nd and 168th HAA (Figure 2).

Consequently, alternative methods in the control of agricultural pests, increasing demand for organic production, are becoming more interesting for researchers day by day. One of these alternative methods is to apply powder forms or extracts of plants on the pests. However, there are no many detailed studies on these plants. Seconder metabolites of plants such as phenols, terpenoids and many alkaloids can influence the behavior, longevity, development and reproduction of pests (Jacobson et al., 1984). Karakoç and Gökçe (2013) tested the antifeedant and stomach poison effects of extracts of *Humulus lupulus*, *Bifora radians*, *Xanthium strumarium*, *Rhododendron ponticum*, *Tanacetum mucroniferum*, *Delphinium consolida*, *Datura stramonium*, *Chrysanthemum segetum*, *Artemisia vulgaris* on *Spodoptera littoralis* (Lepidoptera: Noctuidae). The results of this study showed that all plant extracts used in the experiment has antifeedant effect on the pest. However, the extract derived from *D. consolida* was the most effective one among all extracts with the rate of 68.96%, followed by *C. segetum* (62.67%), *A. vulgaris* (61.09%) and *T. mucroniferum* (55.87%). The study also probed the relationship between dose and effect of the most active 4 plant extracts. The results of this dose-response experiments showed that antifeedant effects of these extracts were ranging from 68.91% to 82.20% at 2 mg.cm^{-2} doses. Pavela et al. (2004) stated that the effect of azadirachtin on *B. brassicae* was increased in direct proportion to the concentration thereof. The results of the study on the possibilities of controlling the pests with natural pesticides in vegetable greenhouses in İzmir of Madanlar et al. (2002) revealed that natural pesticides showed no difference in terms of controlling the pests from conventional pesticides, and also the obtained extrapolation from these results was that successful outcomes can be achieved by using natural pesticides with biological control and integrated pest management.

As a result of the present study investigated the effects of the extracts derived from *S. hortensis*, *O. basilicum*, *C. angustifolia*, *T. peruviana*, *S. molle*, *M. azedarach* on *A. gossypii* and *B. tabaci*, the extracts of *O. basilicum*, *C. angustifolia*, *T. peruviana* were determined as hopeful. Detailed studies on the effects of these extracts against the pests are believed to be useful. Last of all, studies in large-field studies will probably clearly demonstrate the efficacies of these extracts on the pests.

4. POTENTIAL CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

5. ACKNOWLEDGMENT

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