

# Repellent Effect of Herb Extracts on the Population of Wingless Green Peach Aphid, *Myzus persicae* Sulzer (Hemiptera: Aphididae)

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## Abstract

Investigation of the repellent and insecticidal effects of 8 kinds of herb extracts (chives, dokudami, eucalyptus, lavender, peppermint, cherry sage, sweet pepper and tansy) against wingless green peach aphids were conducted in laboratory and field test.

In laboratory repellent tests, 20 aphids were placed between a radish leaf and filter paper for 16 h and aphids on radish leaf were calculated. In laboratory insecticide tests, 20 aphids were placed on a radish leaf treated with herb extract, and live aphids were counted after 16 h. In field tests, the number of aphids that propagated on radish leaves treated with each herb extract was assessed every 3 days.

In the laboratory, dokudami, tansy and sweet pepper extracts repelled aphids, while chives, sweet pepper and tansy extracts killed them. In particular, sweet pepper and tansy extracts proved to be a potent insecticide against aphids.

In the field test, the results found that extracts from dokudami, cherry sage and lavender had repellent effect on aphids. In particular, dokudami extract was a highly effective repellent against aphids. These findings suggest that dokudami extract can be used to control wingless green peach aphids in the field.

**Keywords:** *Myzus persicae* Sulzer, Reproductive inhibition, Herb extracts, Dokudami

## 1. Introduction

The intensive use of chemical pesticides and fertilizers has resulted in environmental pollution, adverse effects on human health, natural biological control disruption and pesticide resistant increase. As consumer concerns in the safety of food and agricultural products has risen in recent years, producers are increasingly focused on pesticide-free and organic farming that satisfied the need of human health and the environment protection. In Japan, about 600 agricultural pesticides have been included in the Positive List since its introduction in 2006. This list details the maximum limits of chemical residues permissible in food products. Without the use of chemicals, however, crops are threatened by the disease and insect damage (Perry *et al.*, 1998; Isman, 2006). Consequently, herb extracts are increasing attracting attention as the botanical insecticides (Tripathi *et al.*, 2009;

Farooq *et al.*, 2010; Schrader *et al.*, 2010).

The wingless green peach aphid (*Myzus persicae* Sulzer) is a major polyphagous pest, infecting about 100 plant species and transmitting a multitude of viral diseases worldwide, including those of solanaceae, fabaceae and brassicaceae (Feng and Isman, 1995; Hori, 1998). The aphid is a multiple reproductive pest which is difficult to be suppressed in green houses and fields (Hori and Harada, 1995). In previous studies, Hori (1996; 1999a) reported that peppermint, thyme, garlic and onion oil strongly repel *M. persicae* and that the volatile constituents of essential oils of garlic and onion may inhibit *M. persicae* from settling on plants. Moreover, Hori (1999c) suggests that polyphagous aphids such as *M. persicae* have a tendency to locate their host plants medium mainly by visual cue, avoiding the odors of some non-host plants. Thus, the olfactory behavior of aphids against host plant odors is related to host proximity.

Repellency tests were carried out using alate aphids because non-alate virus-transmitting aphids can spread disease widely. However, apterous aphids propagate throughout the year. To date, there are only a few studies on the repellent and insecticidal activity of herb extracts on aphids (Hori and Harada, 1995; Hori, 1999a; 1999b).

The goal of this study was to develop a biological pesticide alternative to chemical insecticide for future use. Specific objective was to assess the repellent effects of 8 kinds of herb extracts (chives, dokudami, eucalyptus, lavender, peppermint, cherry sage, sweet pepper and tansy) from companion plants against wingless green peach aphids.

## 2. Materials and Methods

### 2.1 Insect

Wingless green peach aphids (*M. persicae* Sulzer) were collected around the Prefectural University of Hiroshima and were reared on radish plants at 25 °C under a L16:D8 photoperiod in an incubator until reaching 1.8–2.0 mm in length after which they were used in the experiments.

### 2.2 Plant

Radish ‘Comet’ (*Raphanus sativus* var. *sativus*) was purchased from Takii Seed Co. (Kyoto, Japan), seeded in black polyethylene pods and grown for 15 days.

### 2.3 Herbs

Peppermint (*Mentha piperita* L.), cherry sage (*Salvia microphylla* L.), dokudami (*Houttuynia cordata* L.), sweet pepper (*Capsicum annuum* L.), eucalyptus (*Eucalyptus globules* L.), lavender (*Lavandula intermedia* L. ‘Super sapphire blue’), chives (*Allium schoenoprasum* L.) and tansy (*Tanacetum vulgare* L.) were used. Peppermint, cherry sage, sweet pepper, lavender and chive seedlings were purchased from Miyoshi garden. Tansy seedlings were obtained from the Herb Garden of the Prefectural University of Hiroshima. Dokudami was collected around the Prefectural University of Hiroshima. Eucalyptus seeds were purchased from Chugoku Seed Co. Ltd. (Shobara, Japan).

### 2.4 Herb Extracts

Fresh herb leaves (10 g) were homogenized with 40 ml of 50% EtOH for 24 h and filtered to obtain a herb extract. The control was 25% EtOH solution. Each herb extract was added to a spreading agent (Dain®, Sumitomo Chemical Co. Ltd., Osaka, Japan). The extractions of each herb were performed in three replications.

### 2.5 Laboratory Repellent Test

Optimum growth conditions for the green peach aphid (25 °C, D8:L16) were set in a climate-controlled chamber. Then, 20 aphids were placed on filter paper and 0.5 ml of herb extract was applied to a radish leaf. Aphids were calculated to move on the radish leaf after 16 h. Experiments for each extract were performed in ten replications.

### 2.6 Laboratory Pesticide Test

Experimental conditions were the same as those for the repellent experiment. Twenty aphids were placed on radish leaves in a petri dish and 0.5 ml of each herb extract was applied. Live aphids were counted after 16 h. Experiments for each extract were performed in ten replications.

### 2.7 Field Test

Radish seedlings for the field test were seeded in 12-cm diameter pots on October 1 and were harvested on November 3, 2009. The dorsal and ventral leaf surfaces of radish seedlings (4 leaves) were coated with 2 ml of herb extract diluted 2-fold with water and control solution (25% EtOH) once every 3 days. Aphid source plants were propagated in other plant pots. Four pots of each herb extract were placed around one aphid-infested radish

pot (Fig. 1). The total number of aphids on each radish plant was calculated from day 1 to day 21. Experiments for each extract were performed in four replications.

### 2.8 Statistical Analysis

Statistical differences between treatments were assessed using ANOVA, followed by Tukey-Kramer honestly significant difference (HSD) comparison ( $P < 0.05$ ).

## 3. Results

The repellent effect of each herb extract on *M. persicae* in laboratory is shown in Fig. 2A. Dokudami, tansy and sweet pepper extracts had a significantly high repellent effect.

The insecticidal effect of each herb extract on *M. persicae* in laboratory is shown in Fig. 2B. Tansy, sweet pepper, dokudami and chives, in particular, tansy extracts had a high insecticidal effect against aphids.

The number of *M. persicae* on radish leaves coated with herb extract in the field is shown in Table 1. The number of aphids on leaves treated with different herb extracts and the control was equal until day 13, but changed after day 16. Dokudami extract significantly prevented and completely repelled an increase in aphids by day 21. Lavender extract significantly prevented an increase of aphids the number at day 16. Cherry sage extract repelled aphids from day 16. Peppermint extract increased the number of aphids at day 16, but decreased the number from day 19. These results show that dokudami extract had the highest repellency, followed by sage and lavender extracts.

## 4. Discussion

The present findings suggest that chives extract may contain insecticidal compounds. *Aphis fabae* Scopoli living on plants of the Brassicaceae family has been shown to be repelled by tansy extract (Nottingham, et al., 1991). *M. persicae*, on the other hand, is known as a major aphid species that attacks Capsicum spp. (Weintraub, 2007). In the present study, *M. persicae* was repelled and killed by sweet pepper extracts in the closed space such as a laboratory. To date, there are no studies on repellent and insecticidal activity of tansy and sweet pepper extract against *M. persicae*. These results indicate that tansy and sweet pepper extracts are effective for repelling *M. persicae* in the laboratory.

The extracts that prevented an increase in aphids in the field—dokudami, cherry sage and lavender—were different from the effective extracts in the laboratory. We compared the repellent effect between laboratory and field tests. In the laboratory, which is a closed system; pest behavior and food selection is impossible. In contrast, the field is an open system, and pest behavior and food selection is possible; therefore, pests can seek out places with a rich food supply if food quality in a particular location is poor. In addition, *M. persicae* aphids use visual cues such as plant size, shape and color to search for host plants, with non-host plant odor serving only as an avoidance measure (Hori, 1999c). There was no significant difference between each herb extract and the control until day 13, because it was assumed that aphids entered the larval stage when they colonized the radish after moving from the source plant. From day 13, dokudami, cherry sage and lavender extracts continued to prevent an aphid increase, indicating their potential to protect against aphid damage.

Peppermint extract had an immediate effect on reproductive inhibition of aphids, since although peppermint extract increased the number of aphids at 16 day, it significantly decreased the number thereafter. Hori (1996) described that mint inhibited the sucking ability of aphids but did not repel them. The mint extract treatment inhibited the sucking activity of aphids causing them to move on to other host plants, likely because the host plant odor was masked by the mint extract.

The chives extract had a slow reproductive inhibiting effect since the number of aphids increased rapidly at day 16 and dramatically decreased from day 19 to day 21. Hori and Harada (1995) suggested that compounds in Allium genus plants play a role in repelling aphids. However, the reason that their data are not concomitant with ours was likely attributed to the use of a solvent which could not extract the repellent from the chives in our study.

Of all the herbs, dokudami extract resulted in the lowest number of aphids throughout the field test period and proved to be a strong repellent against *M. persicae*. This result supports the finding that aphids did not settle on dokudami plants (Hori and Harada, 1995). Hori and Komatsu (1997) propose that components in essential oil have either a repellent or attractant effect on insects and that these compounds have various functions such as masking host plant odors.

In the future, we plan to identify repellent and insecticidal compounds in dokudami, tansy and sweet pepper and to elucidate their respective repellent and insecticidal mechanisms.

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Table 1. Number of aphids on radish leaves sprayed with herb extracts in the field

Plant materials	the number of aphid on leaves (average $\pm$ standard deviation)										
	1days <sup>z</sup>	4days	7days	10days	13days	16days	19days	21days			
eucalyptus	1.5 $\pm$ 2.1 a <sup>y</sup>	1.0 $\pm$ 0.7 a	1.5 $\pm$ 1.1 a	2.8 $\pm$ 2.6 a	1.8 $\pm$ 1.9 a	34.5 $\pm$ 1.5 b	139.0 $\pm$ 7.5 a	163.0 $\pm$ 0.0 a			
dokudami	3.8 $\pm$ 4.2 a	2.5 $\pm$ 1.5 a	0.5 $\pm$ 0.5 a	1.0 $\pm$ 0.0 a	9.7 $\pm$ 6.3 a	3.5 $\pm$ 1.5 b	9.0 $\pm$ 9.0 b	0.0 $\pm$ 0.0 b			
cherry sage	1.0 $\pm$ 1.0 a	3.5 $\pm$ 3.5 a	2.5 $\pm$ 2.1 a	3.8 $\pm$ 2.9 a	2.3 $\pm$ 2.8 a	7.3 $\pm$ 8.2 b	13.5 $\pm$ 8.3 b	13.5 $\pm$ 7.2 b			
tansy	1.5 $\pm$ 1.5 a	1.0 $\pm$ 1.7 a	2.5 $\pm$ 1.8 a	4.0 $\pm$ 1.9 a	2.0 $\pm$ 1.2 a	133.3 $\pm$ 81.5 a	69.0 $\pm$ 14.7 a	36.0 $\pm$ 20.2 a			
sweet pepper	0.5 $\pm$ 0.5 a	1.5 $\pm$ 1.5 a	1.3 $\pm$ 1.3 a	11.0 $\pm$ 6.5 a	11.7 $\pm$ 11.6 a	58.0 $\pm$ 25.9 a	126.5 $\pm$ 22.5 a	7.0 $\pm$ 6.0 b			
chives	2.8 $\pm$ 3.1 a	3.5 $\pm$ 5.5 a	4.0 $\pm$ 4.1 a	6.3 $\pm$ 4.2 a	15.8 $\pm$ 12.3 a	127.3 $\pm$ 67.4 a	120.3 $\pm$ 4.0 a	24.0 $\pm$ 20.0 a			
peppermint	1.3 $\pm$ 1.1 a	2.5 $\pm$ 3.3 a	2.0 $\pm$ 0.7 a	5.8 $\pm$ 6.5 a	4.3 $\pm$ 6.3 a	56.8 $\pm$ 40.7 a	14.5 $\pm$ 9.0 b	15.8 $\pm$ 9.4 b			
lavender	1.3 $\pm$ 1.1 a	1.3 $\pm$ 0.8 a	3.3 $\pm$ 3.0 a	10.5 $\pm$ 13.1 a	4.3 $\pm$ 5.7 a	13.5 $\pm$ 9.5 b	20.7 $\pm$ 12.9 b	11.5 $\pm$ 11.9 b			
control	0.5 $\pm$ 0.9 a	2.5 $\pm$ 2.6 a	1.5 $\pm$ 0.9 a	3.5 $\pm$ 2.7 a	8.0 $\pm$ 8.0 a	124.0 $\pm$ 14.0 a	156.0 $\pm$ 34.0 a	89.5 $\pm$ 9.5 a			

<sup>z</sup> Days after paked aphid source plant.

<sup>y</sup> Different letters indicate a difference significant at the 5% level by Turkey-Kramer test among plant materials (n=5).

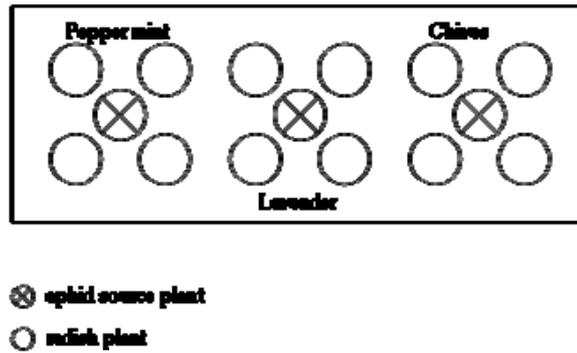


Figure 1. Layout of radish plants and aphid source plants in the field

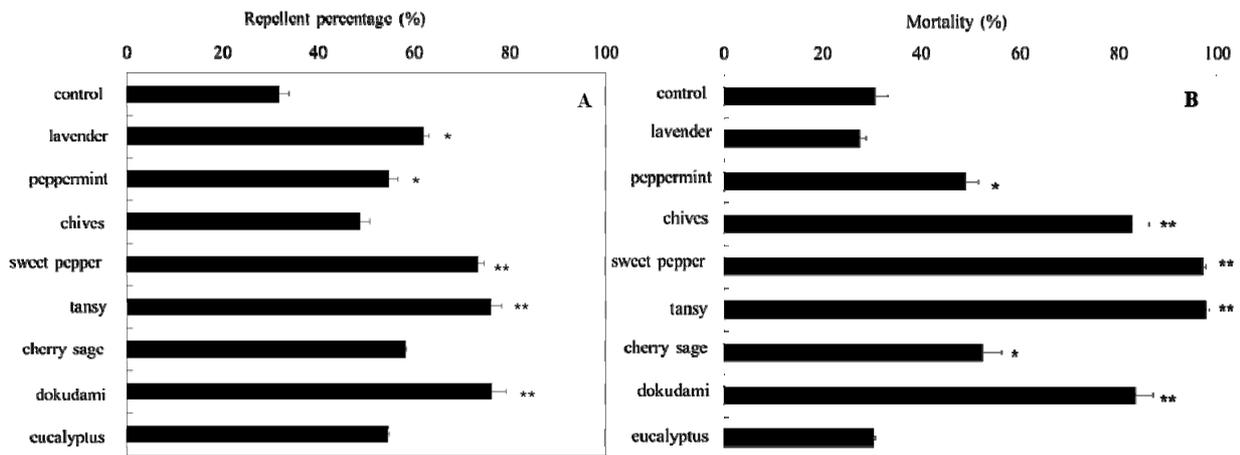


Figure 2. Repellent (A) and pesticide (B) effect of 8 kinds of herb extracts on *M. persicae* in the laboratory.

\*Significant difference by the Tukey-Kramer test (\* $P < 0.05$ , \*\* $P < 0.01$ ). Error bars represent standard deviation of mean (n=10)