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THE EFFECT OF ALTERNATIVE TREATMENT METHODS ON THE EVOLUTION OF THE *PHILAENUS SPUMARIUS* POPULATION IN GOOSEBERRY CULTIVATION

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Abstract

Philaenus spumarius is a polyphagous insect that attacks hundreds of plant species. Initially, it was considered harmless to crops. However, it is now classified as a highly harmful insect because it serves as a vector for polyphagous pathogens - such as Xylella fastidiosa and Phytoplasma solani - which have caused significant damage to Vitaceae, Oleaceae, Rutaceae, Rosaceae, and Solanaceae crops across Europe.
The attacking capacity of Philaenus spumarius is influenced by factors such as the tolerance of the plant variety, the phenological phase at the time of the attack, climatic conditions, and the type of treatment applied.
Field studies conducted on the gooseberry varieties Invicta, Captivator, and Hinnonmaki Red revealed that Philaenus spumarius prefers Hinnonmaki Red. Treatments using Mentha pulegium, Urtica dioica, Thymus serpyllum, and Mentha piperita had varying effects on Philaenus spumarius specimens.
The research was carried out under field conditions.

Key words: *goosberry, Philaenus spumarius, polyphagous pathogens, vector insect, treatment.*

INTRODUCTION

Philaenus spumarius is a polyphagous insect from the order Homoptera, family Aphrophoidae. It damages plants directly by sap absorption and indirectly through the transmission of diseases.
Philaenus spumarius has a wide distribution in the northern hemisphere (Figure 1).

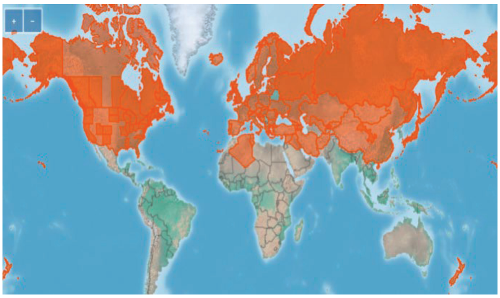

Figure 1. Distribution map of *Philaenus spumarius* (CABI PlantWise Plus, 2022)

In Europe, it was considered not to be a significant pest until it was discovered that it is an important vector of pathogens (Germinara et al., 2017). For this reason, there is limited data on the biology and ecology of *Philaenus spumarius* (Cornara et al., 2018).
Currently, the insect is classified as a serious pest (CABI PlantWise Plus, 2022).
The most important pathogen transmitted is *Xylella fastidiosa*. The bacterium attacks 696 plant species from 88 families (European Food Safety Authority, 2024). *Xylella fastidiosa* causes Pierce's disease in grapevines (PD), the rapid decline syndrome in olives (OQDS), almond leaf scorch (ALS), citrus variegated chlorosis (CVC), and others. The bacterium has caused significant losses in Spain, Italy, Portugal, Germany, France, Israel, Greece, Turkey (Godefroid et al., 2021).
Xylella fastidiosa colonizes the xylem, affects sap transport, and can cause plant death. Currently, there is no effective treatment for plants affected by this bacterium (Godefroid et al., 2021).
Philaenus spumarius also transmits *Phytoplasma solani*, a phytoplasma that causes the disease called stolbur (CABI PlantWise Plus, 2022).
Phytoplasma solani is also found in the scientific literature under the names *Candidatus Phytoplasma solani* and *Stolbur phytoplasma*

(Quaglino, 2017). The pathogen affects plants from the Solanaceae family, but also grapevines (CABI PlantWise Plus, 2022; Quaglino F., 2017).

Philaenus spumarius is a univoltine insect, although in some areas of Greece, it may be bivoltine (Yurtsever, 2000).

In spring, the female *Philaenus spumarius* lays 350-450 eggs in groups of 10-20, in protective foam. The larvae go through five developmental stages. Nymphs surround themselves with protective secretion. Under laboratory conditions, the larval stage lasts 50 days. The development from egg to adult takes place at a GDD of 700-800°C, a sum of temperatures above 5°C (Yurtsever S., 2000).

The color morphism of *Philaenus spumarius* is influenced by climatic factors, as well as by the habitat in relation to altitude (Boucelham et al., 1988).

Research on how substances influence the antennal movements of *Philaenus spumarius* has shown that both sexes respond most actively to octanal, 2-octanol, 2-decanone, (E)-2-hexenyl acetate, and vanillin, depending on the concentration of the substance (Germinara et al., 2017), as well as to α-pinene (Anastasaki et al., 2021). Additionally, the antennae of female *Philaenus spumarius* responded to camphor, limonene, 4-methyl octane, and sabinene (Anastasaki et al., 2021). The studies mentioned were not conducted under field conditions and specifically refer to antennal sensitivity, without indicating how the substance is perceived, whether attractant or repellent.

Some of these substances are found in the composition of plants used in alternative treatments: *Urtica dioica*, *Mentha piperita*, *Thymus serpyllum*, and *Mentha pulegium*.

The pedoclimatic conditions in which the plant grows influence its composition, specifically the substances it contains and their percentage.

Alimoddin et al. (2024) indicated in their article that *Urtica dioica* contains vanillic acid, but did not specify the percentage in its composition. The plant analyzed was grown under the pedoclimatic conditions of India, Kalaburagi district.

In Romania, Dâmbovița County, *Urtica dioica* contains camphor 0.27% (Ilieș et al., 2012).

Mentha piperita contains α-pinene 0.32% and sabinene 0.26% in Iran (Motamedi M. et al., 2012). In Morocco (Chraibi M. et al., 2017), *Mentha piperita* contains: limonene 3.01%, sabinene 1.38%, and α-pinene 0.32%. The cultivar 'Kristinika' contains in Italy (Camele et al., 2021): limonene 4.32% and α-pinene 0.47%. In Spain, *Mentha piperita* contains limonene 0.78% and α-pinene 0.38%, while in Pakistan, it contains limonene 7.58%, α-pinene 3.53%, and sabinene 0.19% (Gholamipourfard et al., 2021).

Mentha pulegium contains limonene 4.293% and α-pinene 0.509% in Algeria (Boukhebti H. et al., 2011). Eftekhari indicated in his 2021 paper that *Mentha pulegium* contains vanillic acid, but did not specify the environment in which the plant was cultivated or the percentage in its composition.

MATERIALS AND METHODS

The research was conducted in the southern part of Romania, at the experimental field in the commune of Domnești, Ilfov County. It was established in 2021, in an area where there are no longer any gooseberry crops.

The experiment was carried out between 2021 and 2024, with three varieties of gooseberries: *Invicta*, *Captivator*, and *Hinnonmaki red*, in five treatment variants with three repetitions, each repetition having 3 plants.

The treatment variants used were infusions of: *Urtica dioica*, *Mentha piperita*, *Thymus serpyllum*, and *Mentha pulegium*. The treatments were applied monthly, from April to July. One row was left as a control.

In order not to diminish the biological reserve of insects, no treatment with horticultural oil or insecticides was applied during the vegetative rest period.

To achieve the proposed goal and objectives, the following general working methods were used: documentary study at the national and international level regarding the current knowledge on the research topic, data analysis and synthesis, field observations in the experimental field, identification of pests, preparation of infusions, comparison, and experimentation.

RESULTS AND DISCUSSIONS

In the period 2021-2022, no specimens of *Philaenus spumarius* or specific foam were observed in the experimental field.

In 2023, *Philaenus spumarius* entered the crop field from the eastern and western edges. Foam was observed on only five gooseberry specimens.

In 2024, foam from *Philaenus spumarius* was observed on 19 gooseberry specimens, of which: 2 gooseberries treated with *Urtica dioica*, 6 gooseberries treated with *Mentha piperita*, 5 gooseberries treated with *Thymus serpyllum*, 2 gooseberries treated with *Mentha pulegium*, and 4 control gooseberries.

In Figure 2 here are images taken under the Mustools G 1200 digital microscope of the foam of *Philaenus spumarius*.

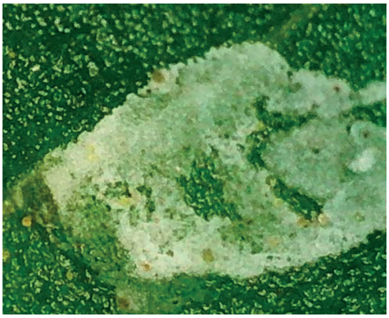

Figure 2. Microscope view of *Philaenus spumarius* foam (10.05.2024) (Source: original)

The gooseberry shrubs treated with *Thymus serpyllum* and *Mentha pulegium* were more attacked than the control specimens (Figure 3).

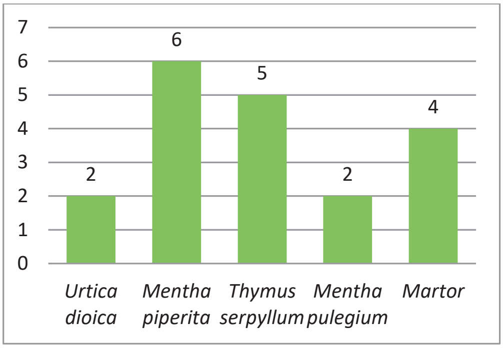

Figure 3 Number of gooseberries on which *Philaenus spumarius* foam was observed, without breakdown by variety, in 2024

The *Hinnonmaki red* variety is the most sensitive to *Philaenus spumarius*, while the *Invicta* variety is the most resistant (Figure 4).

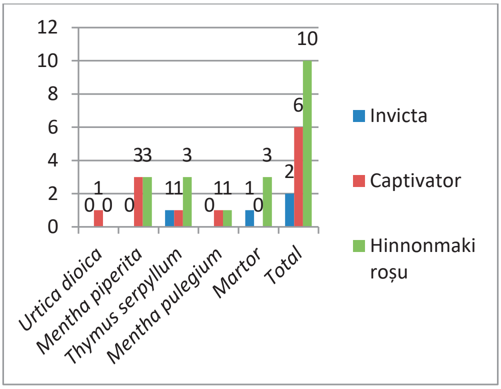

Figure 4. The way *Philaenus spumarius* attacked gooseberry varieties in 2024, depending on the applied treatment

Research conducted by Anastasaki et al. (2021) and Germinara et al. (2017) was not done in the field. It revealed that *Philaenus spumarius* shows olfactory antennal sensitivity to certain compounds, but without specifying how the insect's behavior manifests in response to these compounds.

The substances mentioned in the studies are: octanal, 2-octanol, 2-decanon, (E)-2-hexenyl acetate, vanillin, α-pinene, camphor, limonene, 4-methyl octane, and sabinene.

For the infusions used in the experiment, no laboratory analyses were made in 2023 and 2024.

Thymus serpyllum had an attractive effect on *Philaenus spumarius*.

Nikolić et al. (2014) present the substances found in *Thymus serpyllum*. Correlated with the studies on the substances to which *Philaenus spumarius* shows antennal olfactory sensitivity, it can be observed that *Thymus serpyllum* contains the following substances that influence the behavior of *Philaenus spumarius*: α-pinene, sabinene, and camphor. In natural field conditions, the combination of these substances had an attractive effect. It is specified that the substances and their percentages in *Thymus serpyllum* are determined for plants grown in the pedoclimatic conditions of Serbia.

For *Mentha pulegium* and *Mentha piperita* used in this research, laboratory analyses were performed at the Applied Chemistry laboratory of the Chemistry Faculty at the Polytechnic University of Bucharest in 2019.

Mentha pulegium had a repellent effect. In the case of *Mentha pulegium*, the only substance found in its composition and noted in the studies is octanol, with a percentage of 2.41%. Although the percentage of substances known to influence the olfactory sensitivity of *Philaenus spumarius* is low, the gooseberry shrubs treated with *Mentha pulegium* were not preferred. It is mentioned that, based on field observations, *Mentha pulegium* creates stress in the gooseberry shrubs, which influences their physiology. In this context, it could be deduced that *Philaenus spumarius* prefers plants with favorable physiology. Future studies will confirm or disprove this assumption. Furthermore, it is possible that *Mentha pulegium* contains other substances with repellent characteristics that have not been identified so far.

Mentha piperita had an attractive effect. In the case of *Mentha piperita*, the substances that were determined to affect the antennal olfactory sensitivity are in very small percentages: limonene (0.09%) and octanol (0.21%). Even though the percentage of limonene and octanol is very low (0.3% of the total components), the number of gooseberries attacked by *Philaenus spumarius* was higher than that of the control gooseberries. The effect of other substances in the composition, for which no specialized studies have been found, cannot be specified.

Urtica dioica had a repellent effect. In the article published by Alimoddin et al. (2024), it is mentioned that *Urtica dioica* contains, among other substances, vanillic acid, without specifying the percentage in the composition. The *Urtica dioica* analyzed was grown under the pedoclimatic conditions of India. In the article by Ilieș et al. (2012), it is mentioned that, among other substances, *Urtica dioica* contains camphor at a concentration of 0.27%. The plant analyzed by Ilieș et al. grew under the pedoclimatic conditions of Romania, Dâmbovița County.

Vanillic acid was not found in the composition of *Mentha* spp. and *Thymus serpyllum*, which suggests that vanillic acid may have a repellent potential. The amount of camphor in *Urtica dioica* indicated in Ilieș's study (0.27%) is lower than the amount of camphor in *Thymus serpyllum* as indicated by Nikolić (0.7%).

For the other substances contained in the infusions used in the treatment, no information was found in the published articles on how they may influence or not influence the behavior of *Philaenus spumarius*.

It cannot be specified how the other substances in the composition influence the positive or negative effect of the substances individually determined in laboratory conditions. The studies on antennal sensitivity do not mention whether experiments were conducted with substances known to have insecticidal or insect-repelling effects (e.g., carvacrol, cineole, etc.) and how *Philaenus spumarius* might have been influenced or not influenced by them.

CONCLUSIONS

The results of the research conducted on gooseberry could be applied to other plants attacked by *Philaenus spumarius*.

Since *Philaenus spumarius* overwinters as an egg, it is important to carry out treatments during the vegetative rest period to reduce the biological reserve.

Philaenus spumarius is more difficult to control because the adults are mobile, and the larvae are protected by a protective foam. In addition, the pest has a highly developed sense of smell.

International research on the antennal sensitivity of *Philaenus spumarius*:

- has been done on a limited number of individual substances;
- has not been conducted under field conditions.

The infusions/decoctions/macerations from plants used in practice contain a set of substances that may have a synergistic effect.

This study was conducted in the experimental field, not in the laboratory. The conclusions of the research reflect the impact of treatments with *Urtica dioica*, *Mentha piperita*, *Thymus serpyllum*, and *Mentha pulegium* on the behavior of *Philaenus spumarius* in its natural environment.

It can be concluded that:

- the treatment with *Urtica dioica* had a repellent effect - only one specimen from the

Captivator variety repetition had foam from *Philaenus spumarius*, and no specimens from the Invicta and Hinnonmaki red varieties had foam;

- the treatment with *Thymus serpyllum* had an attractive effect in the case of the Hinnonmaki red variety, while in the case of the Invicta and Captivator varieties, only one repetition was found with *Philaenus spumarius*;
- the treatment with *Mentha pulegium* had a repellent effect – only one specimen from the repetitions of the Captivator and Hinnonmaki red varieties had foam from *Philaenus spumarius*.
- all repetitions of the Hinnonmaki red and Captivator varieties treated with *Mentha piperita* were found with *Philaenus spumarius*;
- the Hinnonmaki red variety is preferred more by *Philaenus spumarius* than the Invicta and Captivator varieties;
- the most resistant variety to the attack of *Philaenus spumarius* is Invicta.

Considering the major impact that *Philaenus spumarius* has as an insect-vector for dangerous pathogens of economically and socially important crops for European countries, and the mobilization of scientists by the European Food Safety Authority, research on *Philaenus spumarius* will undoubtedly be expanded in the future.

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