Effects of plant volatiles on the feeding and oviposition of *Thrips tabaci*

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Abstract: The influence was determined of essential oils and their volatile constituents from plant species within the *Lamiaceae* on the feeding activity and reproduction of adult female onion thrips, *Thrips tabaci*, using leaf disc bioassays at several concentrations. Application of the essential oil of marjoram, *Origanum majorana*, at 1% and 0.1% concentration interfered with the feeding activity of onion thrips females and reduced oviposition. Furthermore, oil of rosemary *Rosmarinum officinalis*, at 1% concentration resulted in decreased feeding damage. The monoterpene 1,8-cineole at both concentrations reduced oviposition rate by about 30%. Assessment of the biological activity of volatile plant chemicals against *Thrips tabaci* will contribute to the development of antifeedants and oviposition deterrents for use in both biological and integrated pest management strategies.

Introduction

The onion thrips, *Thrips tabaci*, is a serious pest in field cultures of leek in Austria (Kahrer, 1998). Thrips adults and larvae feed on green leaf parts, which become disfigured by white and silvery feeding marks (Crüger, 1991). Allelochemicals, such as essential oils, are part of the chemical defence system of plants against herbivores (Rice and Coats, 1994). As essential oils from plant species within the *Lamiaceae* family and their volatile main compounds have previously been demonstrated to be behaviourally active against several insect pests (eg. Isman, 2000), we selected the essential oils of *Origanum majorana*, *Rosmarinus officinalis* and *Salvia officinalis* and their monoterpene constituents, terpinen-4-ol and 1,8-cineole, for evaluating their antifeedant and oviposition deterrent properties against the onion thrips.

Material and Methods

Analysis of the essential oils showed the proportion of their main compounds – the monoterpenes terpinen-4-ol and 1,8-cineole (Table 1). *T. tabaci* was reared in the laboratory using the bean-pod method, modified from Loomans and Murai (1997). For the assessment of the antifeedant and insecticidal properties of the volatiles against *T. tabaci* females leaf disc bioassays were conducted as previously described by Koschier et al. (2002). For assessment of the oviposition rate on treated (no-choice test) or the oviposition preference for treated or untreated leaf discs (dual-choice test), respectively, 2d-old females were singly allowed to oviposit on the leaf discs for 24 hours. After this time the number of eggs on the leaf discs was recorded. Thrips rearing and all bioassay units were maintained in climate chambers at 25 ± 1°C and 65 ± 5% relative humidity with a photoperiod of L16:D8.

	Marjoram	Sage	Rosemary
terpinen-4-ol	22.5	0.5	1.2
1,8-cineole	0.0	15.5	50.8

Table 1. Relative percentage of volatile compounds in the respective essential oil detected on GC-MS.

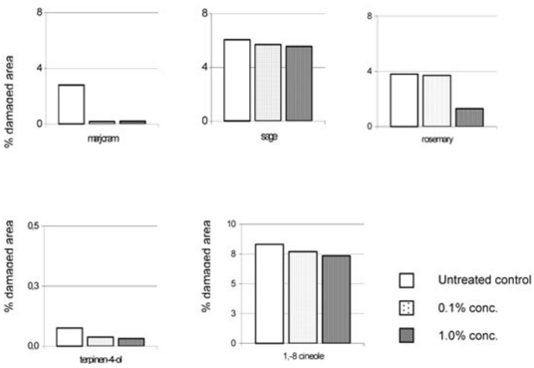

Figure 1a – 1e. Feeding damage (% damaged area on leek leaf discs) caused by *T. tabaci*.

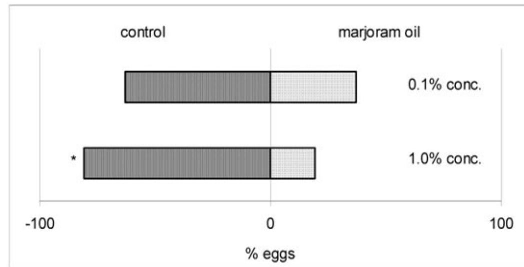

Figure 2. Oviposition preference (% eggs) of *T. tabaci* females for leaf discs treated with marjoram oil or untreated control leaf discs. Significance level for *P* (H_0: *P*=50%) is ≤ 0.05 (*), binomial test.

	Marjoram	**Sage**	**Rosemary**	**Terpinen-4-ol**	**1,8-cineole**
	% effectiveness (Abbott)				
0.1 conc.	0.0	0.0	1.6	8.9	3.3
1.0 conc.	8.5	3.3	1.6	16.1	1.7

Table 2. Insecticidal effects of plant volatiles on *T. tabaci*.

	Marjoram	**Sage**	**Rosemary**	**Terpinen-4-ol**	**1,8-cineole**
	Percentage of eggs relative to untreated control				
0.1 conc.	46.2	74.8	73.4	85.0	67.5
1.0 conc.	53.7	76.3	107.9	82.5	67.5

Table 3. Effects of plant volatiles on oviposition rate of adult *T. tabaci* females.

Results and Discussion

Our results demonstrate that essential oils from plants within the *Lamiaceae* family and their monoterpene main constituents interfere with the feeding and egg-laying activity of *T. tabaci* on leek.

Application of the essential oil of marjoram at 1.0% and 0.1% concentration showed clear antifeedant activity against *T. tabaci* (Figure 1a) and reduced the oviposition rate by half compared to the untreated control (Table 3). In dual-choice bioassays females clearly preferred to lay their eggs in untreated leaf discs (Figure 2). In all bioassays, thrips responses to terpinen-4-ol were very low. We conclude that testing of other constituents of marjoram oil might reveal the component responsible for the deterrent properties of marjoram oil.

Rosemary essential oil inhibited the feeding activity of the thrips solely at 1% concentration (Figure 1c). This oil has been demonstrated to be particularly active against aphids (e.g., Hori, 1999). Sage oil (Figure 1b) as well as both monoterpenes (Figures 1d and 1e) did not significantly affect thrips feeding activity, though application of 1,8-cineole led to a clear decrease of the oviposition rate by about one third compared to the untreated control (Table 3).

Generally, all volatiles tested showed low insecticidal effects, only marjoram oil and terpinen-4-ol caused somewhat higher mortalities of *T. tabaci* (Table 2). Therefore we assume that the reduction of the feeding damage as a result of marjoram oil and terpinen-4-ol to some extent might have been caused by their toxicity to the thrips. Rice and Coats (1994) point out that sublethal effects such as reduction of feeding or oviposition on a plant caused by volatile plant chemicals may be even more important than acute toxicity to herbivores.

Especially on leek plants, economic damage is caused by feeding of adults and high numbers of larvae of *T. tabaci* on green plant parts (Crüger, 1991). Further experiments in the greenhouse and in the field will show if the inhibitory effects of plant volatiles may be included in biological and/or integrated crop protection programmes and contribute to prevent qualitative crop losses in the future.

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