

BEHAVIOUR OF THE INSECT SPECIES *SITOPHILUS GRANARIUS* L. (COLEOPTERA: CURCULIONIDAE) IN THE PRESENCE OF VOLATILE THYME OIL

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Abstract: Interaction between pest insects in warehouses and food source is based essentially on a series of biochemical stimuli at the level of the chemo-olfactory species system. Feeding behaviour of the harmful population is registered in the genetic code of pest species and ethologically translates by interacting at the biochemical and metabolic level. The present study tested the behaviour of species *Sitophilus granarius* L., grown under controlled conditions in a number of generations on wheat grains to an ecological biocontrol product, obtained from *Thymus vulgaris* L., plants, biologically active against a number of insect species. Insect behaviour has been tested in two different stages in controlled conditions, in the first phase was tested the reaction of the insect against three volatile oils settling strong repellent nature of the active ingredient derived from *Th. vulgaris* plants, later settling reaction to the essential thyme oil in experimental pots that simulate the environmental conditions in warehouses. The results indicate that in low doses in the stored product, the essential oil of thyme induce of the individuals of the harmful population disruption of the rhythm of feeding and changing motility which allows a closer and faster contact with the organic product based on diatomaceous earth.

Key words: grain storage, volatile essential oil, *Sitophilus granarius*

INTRODUCTION

Studies related to the response of insect species in the feeding process face of certain emissions of volatile plant oils dates back a long time with the development of two key disciplines, plant physiology and biochemistry. Complex interplay between phytophagous insects and host species is the result of a long and continuous evolutionary process. If we do not take into account individual cases of mutualism seems that any tendency toward parallel development should be limited to the development of defence mechanisms of the plant and to counter these adjustments by insects. Through this simple vision, the interrelationships between plants and insects were divided into two directions: the choice of host species of insect or plant resistance against insects. These two classic directions, essentially each an extreme absolutizes of a highly complicated process, and although essentially proved wrong, allowed to define two essential processes on the physiology and biochemistry interrelation host plant - phytophagous insects.

The first area developed by Thorsteinson (1960) led to defining the mechanism of fagostimulant choice of host by insect and the two helped to define by Painter (1951, 1958) the mechanism of plant resistance to insects. After a period of relative stagnation in studies with a more fundamental theory, recent research (Gerber et al., 2005; Turlings & Ton, 2006; Manole, 2008; Bruce et al., 2010; Dudareva et al., 2011) had formulated a new concept that unifies two seemingly antagonistic processes that define the chemo-olfactory communication

system of individuals of the two populations. This interest is reflected in numerous studies with interdisciplinary character (behavioural, chemical, biochemical, physiological and genetic) whose joint effort enabled the understanding of the mechanism of selective pressure, the environmental consequences as ways of handling and control of important stored grain pest.

The present study is a preliminary research based on the concept of the behaviour of the insect *Sitophilus granarius* to volatile oils emissions of plants. The objective and the purpose of the research were to understand the behaviour of the stored grain pest under the essential volatile oils influence to be used in biological control combined with organic insecticide (diatomaceous earth type).

MATERIALS AND METHODS

Biological material

There were used for testing, adult individuals of the species *S. granarius* growth under controlled conditions in ICDPP Bucharest biobase for insects mass rearing. Essential oils extracted from *Thymus vulgaris* L., *Thuja occidentalis* L. and *Origanum vulgare* L., what were delivered from ICECHIM Bucharest in commercial preparations.

Experimental design - phase I: testing repellent effect of the three oils (against *S. granarius* adults) with and without food

To estimate the repellent effect of these essential oils against individuals of the species *S. granarius*, the bioassay test had carried out in Petri dish on filter paper rings. The essential oils in amount of 1 μ l were added in a experimental variant and compared with untreated control (distilled water) with 3 replicate each. In the Petri dishes 10g of wheat grains were placed on filter paper rings with the drop of oil in the center and 10 adult specimens of *S. granarius* were introduced on each Petri dish. In the first phase, the laboratory conditions were: $t^{\circ} = 25 \pm 20^{\circ}\text{C}$, UR% = 70%.

Experimental design - phase II

The behaviour of *S. granarius* individuals was tested in special vessels by simulating the conditions of grain unit (Figure 1). The experimental device shows in the figure 1 was build from transparent plastic with roofed cardboard simulating one stored grain cells unit. The cells were connected with a special plastic tube giving the possibility to insects transfer from each to another. One variant with three repetitions with essential oil of *Thymus vulgaris* was compared to an untreated control. Observations were carried out at intervals of 12, 24, 48 and 72 hours after the essential oil introduction. The simulation conditions of the warehouse were $t^{\circ} = 20 \pm 10^{\circ}\text{C}$, UR% = 47%.

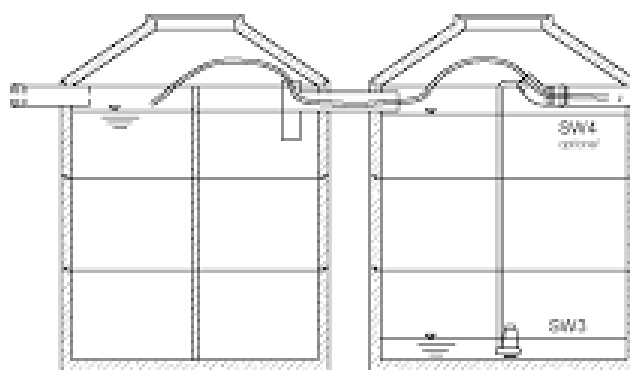


Figure 1. The device for simulation the conditions of grain warehouse

RESULTS AND DISCUSSIONS

The effect of volatile oils on individuals of *S. granarius* in laboratory conditions

In the first phase, the behaviour of individuals of *S. granarius* was tested on three essential oils (Table 1). The values in the table show that from the 3 essential oils tested, 72 hours after administration, the thyme oil had a strong repellent effect against the 10 specimens of insects. In the variant with thyme oil, the insect had leaving food and oil paper ring, interrupting the feeding process.

Table 1. The effect of volatile oils on the *S. granarius* individuals in laboratory conditions

Product	Repellent effect on <i>S. granarius</i> individuals			
	12 hours	24 hours	48 hours	72 hours
Thyme oil	10	4	3	0
Thuja oil	10	8	8	5
Oregano oil	10	10	9	9
Untreated control	10	10	10	10

Compared to the other two oils tested and untreated control, the repellent effect was significantly manifested for individuals of *S. granarius* in the case of thyme oil. For this reason the thyme oil was selected for testing in phase II under simulated warehouse. In the conditions described above for phase II, and without the introduction of food, insects behaviour was video monitored to track their movement to biochemical stimuli (Figure 2, a and b). The *S. granarius* response to the biochemical stimuli caused a repellent reaction, insects movement was disorderly and continued till exhaustion (Figure 2, b) compared to the untreated control, where the insect has three stops and a coordinated shift in foraging (Figure 2, a).

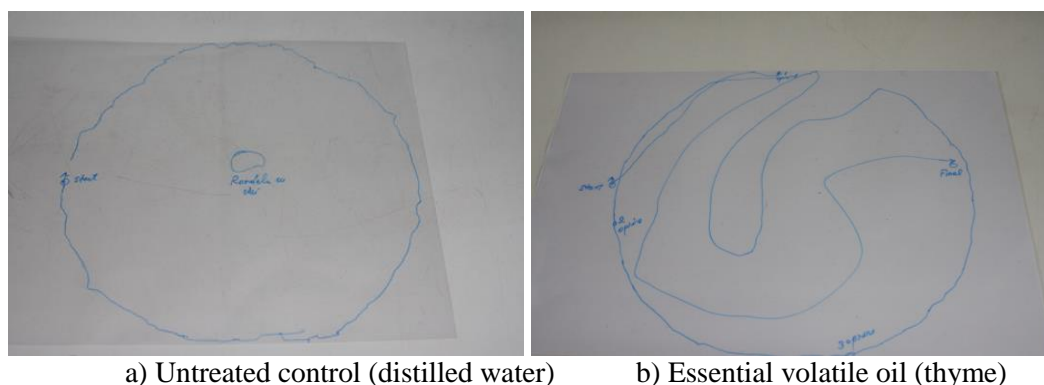


Figure 2. Thyme essential oil influence on the behaviour of individuals of *S. granarius*

The effect of volatile oils on individuals of *S. granarius* under simulated grain warehouse

Figure 3 shows the effect of volatile oil from *Th. vulgaris* in experimental vessels (Figure 1) simulating the conditions in the warehouse. The graph shows that the powerful repellent effect of volatile oil induce a behaviour of insect motility stimulating feeding search interruption in the essential thyme oil bioassay compared with untreated control after 72 hours after oil administration. The *S. granarius* adults had moved from the oil source by leaving the chamber and passing through the connecting tube in chamber 2, while the vessel 2 does not contain food, grains of wheat. After the essential thyme oil source removal the insects regain the chamber and start feeding on the wheat grains.

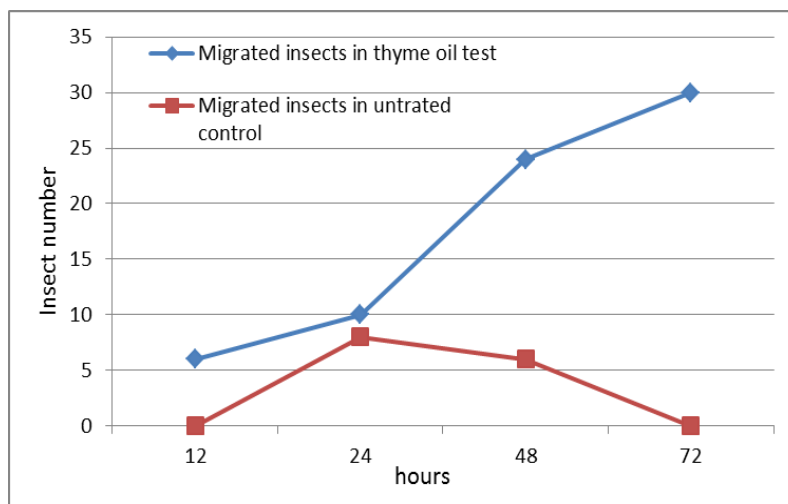


Figure 3. Repellent effect of essential oil of thyme against *S. granarius* under simulated warehouse conditions

CONCLUSIONS

In the preliminary study conducted in laboratory conditions has been tested insect behaviour of *S. granarius* to three oils, individuals of this species exhibit a strong repellent reaction to oil from *Thymus vulgaris*.

The combined use of essential oils with attractant or repellent effect, with organic insecticide of the mineral type, such as diatomaceous earth, to harmful species from stored grain units can be a useful method to prevent the attack of these species.

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