

Repellent and insecticidal effect of the invasive plant *Melilotus officinalis* (L.) Pall. on *Tenebrio molitor* L.

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Abstract. The repellent and insecticidal effect of invasive alien plant *Melilotus officinalis* L. on *Tenebrio molitor* L. in a laboratory experiment were studied. The repellent activity of the dry crushed aboveground part of *M. officinalis*, added to oatmeal and spring wheat, was studied in relation to the larvae of *T. molitor*. The best repellent effect of *M. officinalis* was observed in relation to *T. molitor* larvae when added to oatmeal. The insecticidal activity of an aqueous extract of the aboveground part of *M. officinalis* was studied on larvae and imago of *T. molitor*. A pronounced insecticidal effect of *M. officinalis* on the imago *T. molitor* was established in the absence of an effect on the larvae.

1 Introduction

In the context of agricultural pest control, botanical pesticides are best suited for use in the production of organic food in industrialized countries, but can play a much larger role in the production and post-harvest protection of food in developing countries [1]. Studies on the usefulness and effectiveness of invasive alien plants as insecticides for plants are few [2, 3].

Melilotus officinalis (L.) Pall., known as yellow sweetclover, a plant belonging to the Fabaceae family, is widely used in medicine and agriculture. At the same time, yellow clover is a weed and invasive plant in Siberia [4].

There is a single information about the repellent activity of *M. officinalis*. Antifeedant property and average toxicity ($LC_{50} = 5.6$ mcg/ml) of methanol extract of sweet clover for *Spodoptera littoralis* larvae were demonstrated [5]. The aboveground part of *M. officinalis* is poisonous and contains various chemicals, secondary plant metabolites and biological active substances: coumarines and their derivatives, flavonoides, melilotin, essential oil, saponins, derivatives of purine, phenol-carbon acids, phenol triterpene compounds, nitrogen compounds, amino-acids, tannins fatty-like substances, macro- and micro-elements [6].

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2 Material and methods

The repellent activity of *M. officinalis* in relation to the larvae of *Tenebrio molitor* was determined in an experiment on the free choice of food. During experiments, 50 g of oatmeal or 50 g of wheat grain (control) and 50 g of oatmeal or 50 g of spring wheat grain with 2% dry crushed aboveground part of yellow clover were placed in cotton bags loosely tied (experiment). The bags were placed in a circle in a plastic basin with a volume of 20 liters. Middle-aged (37-60 mg) larvae were released into the center of the pelvis at the rate of 10 larvae per bag. The basin was covered with a cloth from above and removed into the darkness. After 7 days, the larvae were counted inside each pouch. The experiment was carried out in 3-4 repetitions. The index of repellent activity was calculated according to Wang et al. [7].

For an experiment to determine the insecticidal activity of plant mixtures on the mortality of imago and larvae *T. molitor* an aqueous extract of *M. officinalis* was used.

The oatmeal was soaked in distilled water (control) and an aqueous extract of *M. officinalis* (experiment) for 30 seconds. Then the soaked oatmeal was dried to an absolutely dry state in a drying box. The prepared oatmeal (10 g) was placed in 6 plastic containers with a volume of 250 ml (3 control and 3 experimental), carrots as a source of moisture and 10 imago or 10 larvae of *T. molitor* were launched into each container.

Statistical processing was carried out using the Statistica 10.0 software package and the Microsoft Excel program. The significance of the differences was assessed using the nonparametric Mann-Whitney test ($p < 0.05$).

3 Results

The repellent effect of yellow clover was studied on larvae of *T. molitor*.

In the variant with oatmeal as a food substrate with the addition of *M. officinalis*, a repellent effect was observed against insects larvae (repellent activity index = 50%) with a significance level of 81%, which indicates an average repellent effect of yellow clover on larvae of *T. molitor*.

The use of spring wheat as a food substrate with the addition of yellow sweetclover had a weak repellent effect against larvae of *T. molitor* (repellent activity index = 10%).

Thus, the greater repellent activity of the yellow clover against the larvae was noted when using food more preferable for *T. molitor* as a food substrate.

Thus, the degree of repellent action of *M. officinalis* depends on the food substrate to which dry plant material was added. Thus, the addition of *M. officinalis* to a more preferred food substrate (oatmeal) had a more pronounced repellent effect on larvae of *T. molitor* compared to less preferred food (spring wheat).

The insecticidal activity of *M. officinalis* was studied on imago and larvae of *T. molitor*, which were kept on oatmeal moistened with an aqueous extract of yellow clover.

In the experiment with the imago, the death of insects in the experimental group began from 29 days, while in the control group – from 49 days (Fig.). A significant difference in mortality between the experiment and the control was noted from 45 days to 89 days (from 30 % to 47 %). By the end of the experiment (day 89), the mortality rate in the control was 10%, while in the experimental group it was 57%.

Thus, the content of imago *T. molitor* on oatmeal soaked with extracts from *M. officinalis* led to a significant difference in mortality between the control and experimental groups (47% at the end of the experiment).

Thus, *M. officinalis* has an insecticidal effect on the imago of *T. molitor*.

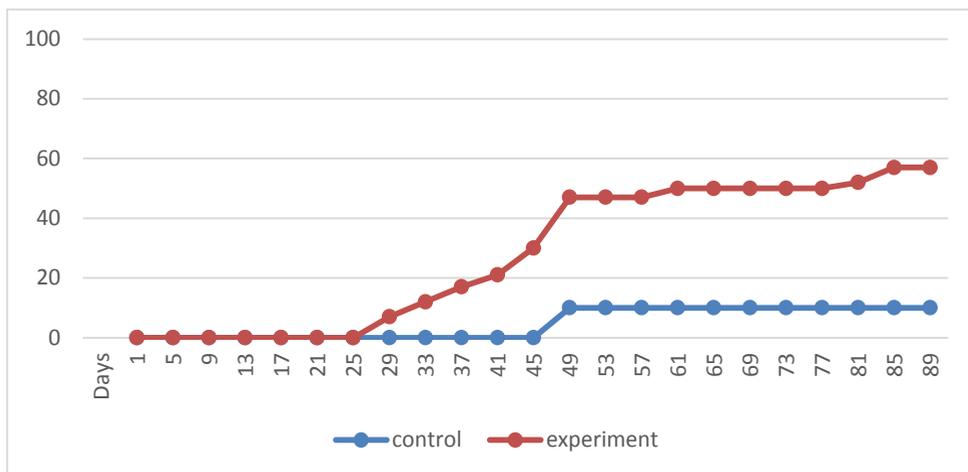


Fig. Dynamics of *Tenebrio molitor* imago mortality (%) when kept on oatmeal moistened with an aqueous extract from the *Melilotus officinalis*

When studying the insecticidal activity of *M. officinalis* against to the larvae of *T. molitor* and their subsequent development, data were obtained on the 95th day of the experiment (Table).

Table. Influence of larval conditions on oatmeal moistened with extract *Melilotus officinalis* on the viability of *Tenebrio molitor*

Groups	Surviving larvae (95 days)	Death at larval stage	Pupation	Surviving pupae (95 days)	Death at pupal stage	Born imago	Death at imago stage
Control	83%	13%	4%	–	–	4%	–
Experiment	37%	10%	53%	10%	–	43%	3%

As can be seen from the table, yellow clover helps to accelerate the transition of larvae to the subsequent stages of development.

Thus, *Melilotus officinalis* has insecticidal activity on imago of *Tenebrio molitor*. The content of *T. molitor* larvae on a substrate with yellow clover extract has practically no effect on the mortality of the insects at all subsequent stages of development.

It is possible that the repellent and insecticidal effect of *M. officinalis* on *T. molitor* is due to the presence of biologically active substances, in particular essential oils, coumarin and its derivatives in the composition of *M. officinalis*.

Thus, the degree of repellent action of *M. officinalis* depends on the food substrate to which dry plant material was added. The degree of insecticidal activity of *M. officinalis* in relation to *T. molitor* depends on the stage of development of the insect.

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