

Earwigs - pests of honey bees *Apis mellifera*

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Received: 17.10.2020. Accepted 25.11.2020

The two experiments studied the use of mavrik (fluvalinate) to protect honey bees from earwigs on apiary, located in the South of the Tyumen region. For this purpose, sheets of dense cardboard in size of 300x200x1 mm were prepared, containing 240, 480 and 960 mg of fluvalinate. The first experiment was conducted in June during the appearance of earwigs on the apiary, where 12 hives without bees were selected, which were divided into 4 equal groups (3 experiment and 1 control). To attract the earwigs in each hive, 6 selected frames were placed, which were covered with insulation material. In the first experimental group, 1 sheet with 240 mg of fluvalinate was attached to the bottom of each hive from the outside, as well as on the inner surface of the roof. In the second and third groups, the same was done, using sheets containing 480 and 960 mg of the active substance. In control, sheets without the agent were used. Within two weeks every 2-3 days, the hives were inspected, particular attention was paid to the presence of earwigs and waste of their vital activity in hives. The second experiment was carried out at the end of August, for which 12 bee colonies were identified, in which the earwigs were registered. In each of the six experiment colonies 1 packet (480 mg of fluvalinate) was placed on the inner surface of the hive roof, into the space between the cushion and the canvas, and on the bottom of the hive from the outside. In the control colonies (6) similar sheets were installed without the agent. All colonies were examined twice at an interval of 5 days. It was found that after 12 days in hives containing sheets with 240 mg of fluvalinate, single earwigs were found only on the bottom, in the other experimental groups no earwigs were found. In the control group, the earwigs were detected on honey combs, insulation material. In the second experiment, when inspecting experiment bee colonies 5 days after hives' treatment, no earwigs were found, in control colonies pests and traces of their vital activity were found. Thus, the use of cardboard sheets containing 480 mg of fluvalinate and placed on the bottom on the outside and inner surface of the hive roof prevents the penetration of earwigs into colonies of honey bees when they appear on a apiary. Additional installation of sheets with fluvalinate between insulation and intra-hive canvas (ceiling) helps to remove earwigs out of hives when they are found in colonies of bees.

Key words: honey bee colonies, earwigs, mavrik (fluvalinate), efficiency.

Introduction

Earwigs are insects in the *Dermaptera* order characterized by chewing mouth parts, incomplete transformation, membranous wings folded under short leathery forewings (tegmina), and the abdomen, which extends far beyond the wings and often, though not always, ends in a pair of tick-shaped unarthroated appendages called cerci. Earwigs are common in the Americas, Europe, Asia, Australia, New Zealand, Africa, the Falkland Islands, etc. (Lamb, 1975; Lamb & Wellington, 1975; Choat, 2001). In the territory of the former USSR 26 species of earwigs are found throughout the European part of Russia, as well as in Western Siberia, Kazakhstan, Turkmenistan, Transcaucasia (Batuev et al. 1991). Earwigs exercise a night lifestyle and usually hide in small clefts in plant material, stones and trees. As nymphs and adults, they can withstand a wide range of temperatures and humidity levels and can survive for long periods without food. Economic relations between countries contribute to the spread of earwigs in different regions of the world.

Earwigs are polyphages and cause significant damage to crops, particularly vegetables, flowers and stone fruit crop. The damage is mainly caused by the nutrition of adult insect individuals on leaves, stems of vegetables. Sometimes the earwigs penetrate inside crops, such as cabbage and cauliflower, or feed on seedling and young plants. Earwigs can affect a wide variety of fruits, with damage of stone fruit crops such as cherries, nectarines, peaches and apricots are more common compared to damage of apples and pears. Animal food includes insects, spiders, ticks and protozoa (Crumb et al., 1941; Buxton & Madge 1976). Aphids predominate among the insects eaten (Carroll et al., 1985; Mueller et al., 1988).

Honey bees are harmed by common earwigs - *Forficula auricularia* Linnaeus, garden earwigs - *Forficula tomis*- and coastal earwigs - *Labidura riparia* Pallas, 1773. In bee colonies, these insects can occur throughout the beekeeping period, but active penetration into hives is observed in the second half of summer and autumn, especially in cool and rainy weather. A mass cluster of earwigs can be observed at the bottom of the hive from the outside, as well as on the inside of the hive cover, in the insulation material, crevices, and on honeycomb, where they feed on honey and perg, contaminating their surface with the

products of vital activity, attack sick adult bees, spoil brood (Buysson, 1900; Grobov et al.1987; <http://MAAREC.cas.psu.edu>, 2000). Earwigs bring pathogens of American and European foulbrood (Batuev et al., 1991) into bee colonies. In the study of earwigs collected under hives, *Forficula auricularia* showed five types of viruses that cause infections in bees: black queen cell virus (BQCV), deformed wing virus (DWW), Israeli acute paralysis virus (IAPV), Kashmir-Virus (KBV) and sack brood virus (SBV), (Levitt et al.,2013; Yañez et.al, 2020). Common earwigs (European earwigs, *Dermaptera*, *Forficulidae*, *Forficula*) is the most numerous and invasive species among the earwigs (fig.1).



Fig. 1. Common earwigs (*Forficula auricularia*)

In order to prevent the penetration of earwigs into the colonies of bees, hives are placed in dry locations, grass needs to be periodically mowed down. The legs of the hive stands are lubricated with thick grease. During strong attacks of earwigs the hives are changed, the insulation material needs to be dried. Pests are removed and killed. On the apiaries, traps of two boards connected with a twine are laid out around the hives. Between the boards peels of apples, dried fruits, crumbs of wax debris, and dead bees are placed. Once a week traps are carried away from hives, cleaned, pests get killed (Grobov & Lihotin, 2003). The pheromone composition "Apimil" is proposed as a bait for earwigs. The agent is used in Russia to attract and capture swarm. As a result of the research, the authors concluded that "Apimil" can be used as a highly effective bait to attract earwigs into traps (Ishmuratova et al.,2002). The main disadvantage of the methods described above is their low efficiency.

Insectoacaricide mavric is well known, it is an aquatic emulsion containing 24% of tau fluvalinate. The agent is designed to protect a large number of crops from a complex of pests from various classes: *lepidopterous insects* (*Lepidoptera*), chafers (*Coleoptera*), dipterans (*Diptera*), bedbugs (*Heteroptera*), iniwinged (*Homoptera*), orthopterous insects (*Orthoptera*), ticks (*Acarina*) (<http://www.pesticity.ru/pesticide/mavrik>). Fluvalinate - (*RS*)- α -cyano-3-phenoxybenzyl *N*-(2-chloro- α , α , α -trifluoro-*p*-tolyl)-*DL*-valinate is a cyanopyrethroid insectoacaricide, moderately dangerous for mammals and bees (3 hazard class), and therefore the active substance is also used in veterinary medicine for the development of formulative forms of acaricides intended for the control of ticks *Varroa destructor* - pathogen of varroatosis of bees. The aim of our research was to study the possibility of using maverick (fluvalinate) to protect bee families from earwigs.

Materials and Methods

Experiments were carried out on a bee yard located in the Tyumen district of the South of the Tyumen region. Before the beginning of the research sheets with fluvalinate were prepared as follows: measure the necessary the amount of mavric, add tap water to 20 ml, mix the liquid was thoroughly. Sheets of dense cardboard were cut to size 300x200x1 mm. The obtained water emulsion impregnated evenly the cardboard on both sides. After drying, the sheets were placed in plastic bags having 10 holes with a diameter of 5 mm on each side. The number of initial substances and their ratios are shown in table 1.

Table 1. Initial substances and their quantity for the manufacture of cardboard sheets

№	Mavrik (ml)	Water (ml)	Fluvalinate content (mg/sheet)
1	1	19	240
2	2	18	480
3	4	16	960

The first experiment was carried out in June during the appearance of the earwigs on the apiary. 12 hives without bees were selected for the research purpose, which were divided into 4 equal groups (3 experiment and 1 reference). To attract earwigs, 6 rejected nesting frames were placed in each hive with remnants of honey and perg, hives were covered with canvases, as well as with insulating upper and side cushions. In the first experimental group, 1 sheet was attached to the bottom of each hive from the outside (fig. 2), as well as on the inner surface of the roof - 1 sheet with the agent containing 240 mg of fluvalinate (fig. 3). In the second and the third group the same was done, using sheets containing 480 and 960 mg of active substance respectively. In the reference hive, sheets without the agent were installed. For two weeks every 2-3 days, hives were opened, attention was paid to the presence of earwigs and traces of vital activities directly on the frames, canvases, hive covers, walls and bottom of hives (Domatskaya & Domatsky, 2020).

**Fig. 2.** Installation of the agent at the bottom of the hive from the outside**Fig. 3.** Placement of the agent on the inner surface of the hive

The second experiment was conducted at the end of August. During the inspection, 12 bee colonies were selected, in which earwigs were found on hive roofs, canvases, as well as in a bee's nest. Into each of the six experiment bee families 1 packet (480 mg of fluvalinate) was placed on the inner surface of the hive roof, into the space between the cushion and the canvas (fig. 4), and on the bottom of the hive from the outside. In the reference families similar sheets were installed without the agent. All colonies were examined twice at an interval of 5 days.

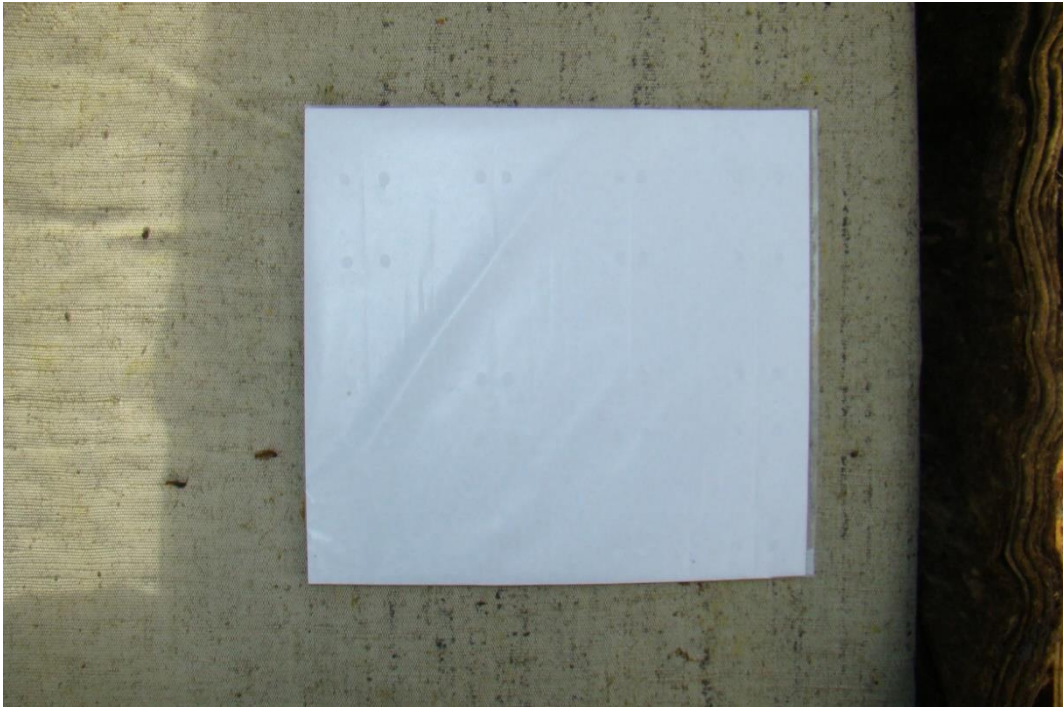


Fig. 4. Placement of a sheet with the agent on an intra-hive canvas (top view)

Results and Discussion

The results of the first experiment showed that after 12 days in hives containing sheets with 240 mg of fluvalinate single earwigs were found only on the bottom. In the second and third experimental groups, the earwigs were not registered. In the reference group, the earwigs were detected on honeycombs, hive's walls, and insulation material. In the second experiment, when inspecting experiment bee colonies 5 days after hives' treatment, no earwigs were found, in control colonies pests and traces of their vital activity (Fig. 5) were found.



Fig. 5. Earwigs on intra-hive canvas

The results obtained confirm that the use of cardboard sheets containing 480 mg of fluvalinate and placed on the bottom on the outside and inner surface of the hive roof prevents the penetration of earwigs into colonies of honey bees when they appear on apiary. Additional application of sheets with fluvalinate between insulation and intra-hive canvas (ceiling) helps to remove earwigs out of hives when they are found in colonies of bees. The proposed method of protecting honey bees from earwigs is highly effective and excludes contact of the agent with bee products.

Conclusion

During the research, we obtained positive results on the use of mavrik (fluvalinate) to protect honey bees from earwigs. In order to obtain more objective data on the proposed above the method needs to expand research on the effectiveness of the agent, the timing and multiplicity of its use, environmental safety for bees and bee products.

Acknowledgements

The article was prepared with the financial support of Federal Agency for Scientific Organizations of Russia within the framework of the topics of the FNI No 0371-2018-0041 "Monitoring of the most common, new and returning diseases of honey bees" and the Program for fundamental research of RAS (AAAA-A18 -118020690242-7).

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Citation:

Domatsky, A.N., Domatskaya, T.F. (2020). Earwigs - pests of honey bees *Apis mellifera*. *Ukrainian Journal of Ecology*, 10(6), 103-107.



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