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I. I. Temreshev[1], A. M. Uspanov[1], A. B. Yeszhanov[2], A. M. Kenzhegaliev[1], A. M. Makezhanov[1], B. B. Bolatbekova[1]

[1]LLP Zh. Zhiembaev Kazakh Research Institute of Plant Protection and Quarantine, Ministry of Agriculture of Republic of Kazakhstan, Almaty, Kazakhstan,
[2]M. Aikimbaev Kazakh Scientific Center for Quarantine and Zoonotic Diseases, Almaty, Kazakhstan.
E-mail: temreshev76@mail.ru, u_alibek@mail.ru, aidyn.eszhanov@gmail.com, arnur_1992@mail.ru, Makezhanov.arman@bk.ru, bolatbekova_beikhan@mail.ru

ABOUT THE RESULTS OF LABORATORY TESTS OF THE BIOLOGICAL DRUG ACTHAROPHYT ON DIFFERENT SPECIES OF ARTHROPOD PESTS

Abstract. The article presents data on laboratory testing of the efficacy of the Actarofit, a new biotechnological insectoacaricide of contact action, from a group of avermectins against several species of pest arthropods from different orders - an imagines of a painted bug *Eurydemaornata*(Linnaeus, 1758) (Hemiptera, Heteroptera, Pentatomidae), great green bush-cricketlarvae *Tettigoniaviridissima*(Linnaeus, 1758) (Orthoptera, Tettigoniidae), larvae of*Gomphomastaxclavata* (Ostroumov, 1881) (Orthoptera, Eumastacidae)and *Chorthippusapricarius* (Linnaeus, 1758) (Orthoptera, Acrididae),imago of healer-beetle*Ulomoidesdermestoides*(Fairmaire, 1893) (Coleoptera, Tenebrionidae), wax moth caterpillars *Galleria mellonella*(Linnaeus, 1758) (Lepidoptera, Pyralidae), as well as blood sucking ixodid tick *Haemaphysalispunctata*Canestrini and Fanzago, 1877 (Acari, Ixodida, Ixodidae).The most resistant to the effects of Actarofit among the tested pest arthropods are the painted bug *Eurydemaornata* (Linnaeus, 1758), the wax moth caterpillars *Galleria mellonella* (Linnaeus, 1758) and the healer-beetle*Ulomoidesdermestoides* (Fairmaire, 1893). The larvae of the great green bush-cricket *Tettigoniaviridissima*(Linnaeus, 1758), *Gomphomastaxclavata* (Ostroumov, 1881) and *Chorthippusapricarius* (Linnaeus, 1758), as well as the imago of the blood-sucking ixodid tick, *Haemaphysalispunctata*Canestrini and Fanzago, 1877, were the most susceptible to drug effect. Possibly this difference is largely linked with the thickness of the chitinous cover of the studied objects, which to some extent protects them from the effects of Actarofit. Based on the obtained results, it can be said that the biological drug Actarofit may be used for treatment against the wax moth, but with measures to prevent application of the drug on imago and larvae of bees. It can also be used against various pests of agriculture, and some bloodsucking arthropods. But it should always be taken into account that the sensitivity of the pest object to the drug action.

Key words: Aktarofit, avermectins, biological drug, pest arthropods, insects, blood-sucking ticks, protective measures, ecologization, agriculture.

Introduction. Modern methods of pest control in agriculture are still widely used chemical insecticides. This is mainly due to the fact that the widespread use of chemical insecticides due to economic necessity, and today biological control methods, are less effective comparing to chemical means of protection. High impact speed and efficacy are their advantage. Despite this, pest insects are often able to produce resistance to insecticides, which is expressed in changes in cover permeability, detoxification and changes in sensitivity to insecticides. The undoubted disadvantage of chemical insecticides is also the impact on non-target species of arthropods, as well as accumulation in the soil, plant and animal tissues. As a result of the increasing use of chemicals in plant protection, an enormous amount of various chemical compounds enter the environment. There is evidence that pesticides used in agriculture are able to act as mutagens, causing cytotoxic and negative genetic effects [1-3, 7-9, 22]. Biological drugs, in particular, neurotoxic compounds such as avermectins, can serve as an alternative means of environmentally friendly plant protection. Avermectins - antibiotics, insecticides, acaricides and nematicides with a 16-membered macrocyclic lactone ring, referring to macrolides, are a product of the vital activity of actinomycetes *Streptomyces avermitilis* (ex Burget al., 1979) Kim and Goodfellow, 2002 (syn. *Streptomyces avermectinius* Takahashi et al., 2002).

In 1984, their synthetic forms were obtained. The principle of action is that they stimulate the release of gamma-aminobutyric acid (GABA) from the nerve endings and increase the connection of GABA with receptor sites on the postsynaptic membrane of muscle cells. This leads to blocking the transmission of nerve impulses, resulting in paralysis and death. The effectiveness of avermectins is very dependent on temperature, for example, when it decreases from 24 to 17°C, toxicity to spider mites decreases by 7.6 times, and when increased to 32°C, it increases by 4.8 times.A big advantage of avermectins is their low toxicity to mammals and humans, non-toxicity to earthworms, as well as to plants, rapid decomposition under the action of sunlight without the formation of toxic residues. Avermectins are not absorbed by the roots of plants from the soil and do not accumulate in them [10-21, 23, 24]. The authors asked about the possibility of using avermectins against various pests of agriculture in the Republic of Kazakhstan. For this purpose, Aktarofit was chosen - a new biotechnological insectoacaricide of contact action for the destruction of pests of agricultural, ornamental, forest and fruit crops (produced by "Enzim", Ukraine). The active basis of the drug is a complex of natural avermectins of groups B1 and B2, at a concentration of 0.2%. The introduction of such drugs is fully consistent with the tasks of transfer and technology adaptation and improving the environmental friendliness and competitiveness of Kazakhstan's agricultural products, set by the President of the Republic of Kazakhstan N.A. Nazarbayev in his annual message to the people in 2018.

Material and methods. As a model object, we used various species of pest arthropods from different orders - imago of a painted-bug *Eurydemaornata* (Linnaeus, 1758) (Hemiptera, Heteroptera, Pentatomidae), great green bush-cricketlarvae *Tettigoniaviridissima* (Linnaeus, 1758) (Orthoptera, Tettigoniidae), berry grasshopper larvae *Gomphomastaxclavata* (Ostroumov, 1881) (Orthoptera, Eumastacidae) and *Chorthippusapricarius* (Linnaeus, 1758) (Orthoptera, Acrididae), healer-beetle imago *Ulomoidesdermestoides* (Fairmaire, 1893) (Coleoptera, Tenebrionidae), great wax moth caterpillars *Galleria mellonella* (Linnaeus, 1758) (Lepidoptera, Pyralidae), as well as the bloodsucking ixodid tick *Haemaphysalispunctata* Canestrini and Fanzago, 1877 (Acari, Ixodida, Ixodidae).All insects, except for the last two species, were captured in nature with the help of a butterfly net and manual collection by employees of LLP Zh. Zhiembaev KazRIPPQ. The healer-beetle and the great wax moth were artificially bred under laboratory conditions in the insect of the M. Aykimbaev KSCQZD. Accordingly, experiments on species taken in nature were made in the laboratory of biotechnology of LLP Zh. Zhiembaev KazRIPPQ, while over artificially bred - at the insectary of the M. Aykimbaev KSCQZD, where the drug was transferred according to the oral agreement between the performers. The drug was diluted by us in a concentration of 1%, at a ratio of 400 ml of ordinary running water with the addition of 4 ml of avermectin. After this, the solution was applied to the bottom of Petri dishes or a plastic glass with a volume of 1 liter for the experimental group, while for the control groupwater was used. Exposure for both experimental and control groups was 1, 2 and 5 minutes. The exposure for the control group was the same time with the addition of water. It should be noted that for each group of tested insects, 3 replications were carried out.

In order to calculate the average time after which the full immobilization of pests occurs upon contact with the drug, time was counted on a stopwatch, immediately after the insect was treated.

The treated insects were placed in a clean Petri dish or plastic cup and checked on the following days after contact with the drug, in case of any surviving individuals could be found.

Research results. The pests used for the experiments are shown in figures 1-7. Below (tables 1-6) are the results from which it is clear that 1% solution of the drug Actarofit has 100% effectiveness against all species of pest arthropods used in the laboratory experiment.

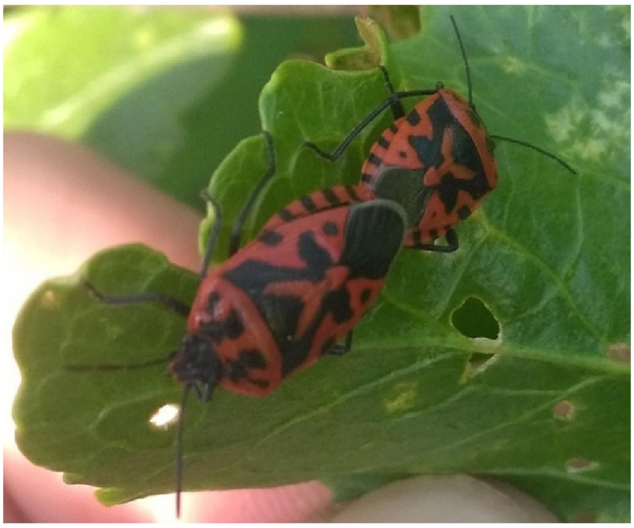

Figure 1 –
The painted bug *Eurydemaornata* (Linnaeus, 1758)

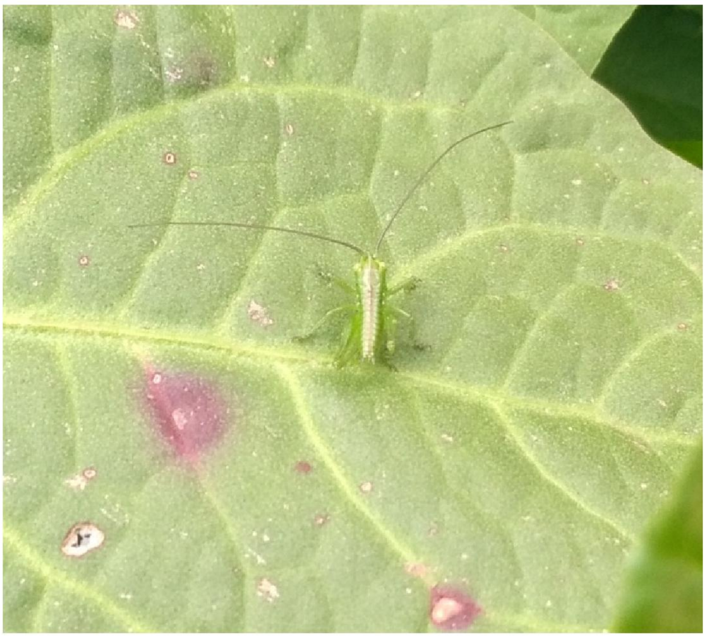

Figure 2 –
The larva of the great green bush-cricket
Tettigoniaviridissima (Linnaeus, 1758)

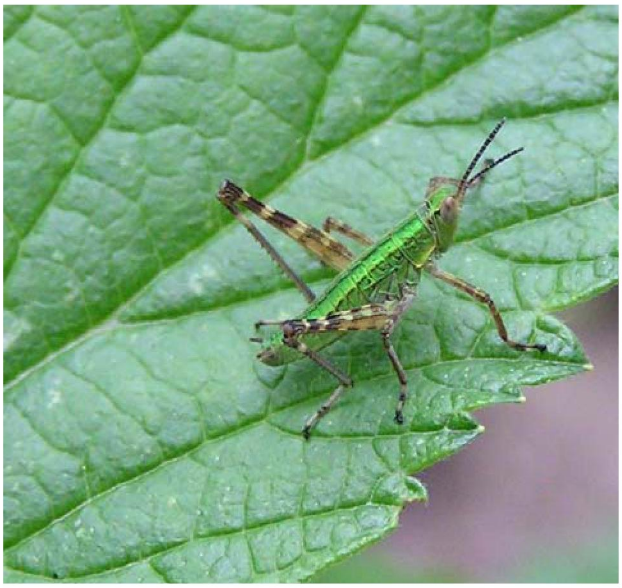

Figure 3 –
The larva of *Gomphomastaxclavata* (Ostroumov, 1881)

Figure 4 –
The larva of *Chorthippusapricarius* (Linnaeus, 1758)

Figure 5 –
Healer-beetle *Ulomoidesdermestoides* (Fairmaire, 1893)

Figure 6 –
Great wax moth *Galleria mellonella* (Linnaeus, 1758)

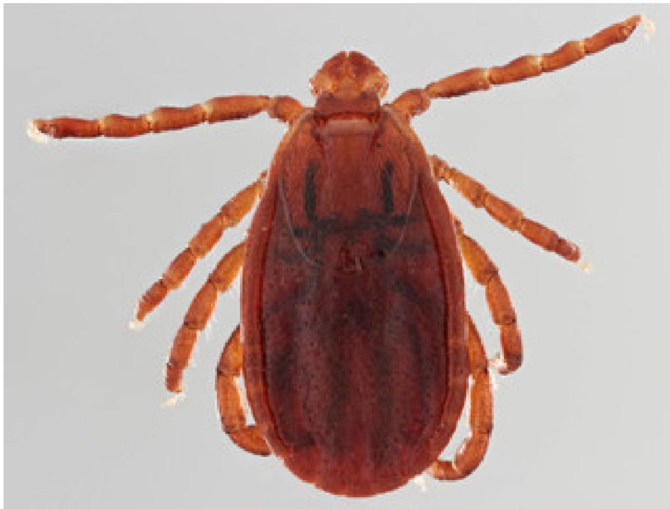

Figure 7 –
Bloodsucking ixodic tick *Haemaphysalispunctata* Canestrini and Fanzago, 1877

As can be seen from the data in Table 1, the painted bug *Eurydemaornata* (Linnaeus, 1758) – a pest of cruciferous crops, died completely 20 minutes after the treatment with Aktarofit.

Table 1 – The results of the test of Acarofit on the painted bug *Eurydemaornata* (Linnaeus, 1758)

Date	Experiment					Control				
	3 min	7 min	10 min	15 min	20 min	3 min	7 min	10 min	15 min	20 min
16.05.2019	8	4	3	2	0	10	10	10	10	10
17.05.2019	0	0	0	0	0	10	10	10	10	10

100% of a great green bush-cricket larvae *Tettigoniaviridissima* (Linnaeus, 1758) a multiple eating pest died 15 minutes after treatment.

Table 2 – The results of the test of Aktarofit on the great green bush-cricketlarvae *Tettigoniaviridissima* (Linnaeus, 1758)

Date	Experiment					Control				
	3 min	7 min	10 min	15 min	20 min	3 min	7 min	10 min	15 min	20 min
16.05.2019	6	4	2	1	0	10	10	10	10	10
17.05.2019	0	0	0	0	0	10	10	10	10	10

Larvae of berry grasshopper *Gomphomastaxclavata* (Ostroumov, 1881) and *Chorthippusapricarius* (Linnaeus, 1758) (Orthoptera, Acrididae) - a pest of fruit crops and medicinal plants, were even less resistant than the previous 2 insect species. Their 100% death occurred 10 minutes after the treatment with Aktarofit (table 3).

Table 3 – Results of the test of Aktarofit on the *Gomphomastaxclavata* larvae (Ostroumov, 1881) and *Chorthippusapricarius* (Linnaeus, 1758) (Orthoptera, Acrididae)

Date	Experiment			Control		
	3 min	7 min	10 min	3 min	7 min	10 min
16.05.2019	4	2	0	10	10	10
17.05.2019	0	0	0	10	10	10

Data on the efficacy of Acarofit against the wax moth - a pest of beekeeping [4], and the healer-beetle, a pest of stocks, are given in tables 4, 5. We found that the average time beforethe total immobilization of the wax moth larvae was 228.02 seconds, the maximum 405.82 seconds, and a minimum 104.26 seconds. While the same indicator for the imago of the healer-beetle was 36.86 seconds, 68.18 seconds, and 25.04 seconds respectively. Differences were found in the reactivity of both species for the drug, it was found that the imago beetles had the stage of excitation almost immediately after they were in contact with the drug, while the wax moth larvae reacted much later (about 1 minute). Probably, the differences in sensitivity and time before the total immobilization occurs consisted in the species specific resistance of insects, as well as their body weight. However, this aspect was not studied by us in this study.

Table 4 – Results of the test of Avermectin on the great wax moth caterpillars *Galleria mellonella* (Linnaeus, 1758)

Date	Experiment			Control		
	1 minute	2 minutes	5 minutes	1 minute	2 minutes	5 minutes
16.04.2019	3	3	3	3	3	3
17.04.2019	0	0	0	3	3	3
	Experiment			Control		
	1 minute	2 minutes	5 minutes	1 minute	2 minutes	5 minutes
17.04.2019	3	3	3	3	3	3
18.04.2019	0	0	0	3	3	3
	Experiment			Control		
	1 minute	2 minutes	5 minutes	1 minute	2 minutes	5 minutes
18.04.2019	3	3	3	3	3	3
19.04.2019	0	0	0	3	3	3

Table 5 – The results of the test of Aktarofit on the imago of the healer-beetle *Ulomoidesdermestoides* (Fairmaire, 1893)

Date	Experiment			Control		
	1 minute	2 minutes	5 minutes	1 minute	2 minutes	5 minutes
16.04.2019	5	5	5	5	5	5
17.04.2019	0	0	0	5	5	5
	Experiment			Control		
	1 minute	2 minutes	5 minutes	1 minute	2 minutes	5 minutes
17.04.2019	5	5	5	5	5	5
18.04.2019	0	0	0	5	5	5
	Experiment			Control		
	1 minute	2 minutes	5 minutes	1 minute	2 minutes	5 minutes
18.04.2019	5	5	5	5	5	5
19.04.2019	0	0	0	5	5	5

100% of blood-sucking ixodic tick *Haemaphysalispunctata*Canestrini and Fanzago, 1877 died 10 minutes after treatment with Actarofit(Table 6).

Table 6 – The results of the test of Aktarofit
on the blood-sucking ixodic tick *Haemaphysalispunctata* Canestrini and Fanzago, 1877

Date	Experiment			Control		
	3 min	7 min	10 min	3 min	7 min	10 min
16.05.2019	2	1	0	3	3	3
17.05.2019	0	0	0	0	0	0

Discussion of research results. As can be seen from the obtained results, the painted bug *Eurydemaornata* (Linnaeus, 1758), the great wax mothcaterpillar *Galleria mellonella* (Linnaeus, 1758) and the healer beetle *Ulomoidesdermestoides* (Fairmaire, 1893) have the greatest resistance to the effects of Actarofitfrom tested pest arthropods. The larvae of the great green bush-cricket *Tettigoniaviridissima* (Linnaeus, 1758), *Gomphomastaxclavata* (Ostroumov, 1881) and *Chorthippusapricarius* (Linnaeus, 1758), as well as the imago of the blood-sucking ixodic tick *Haemaphysalispunctata* Canestrini and Fanzago, 1877 proved to be most susceptible to the effects of the drug. It can be assumed that this difference is largely due to the thickness of the chitinous cover of the studied objects, which to some extent protects them from the effects of Actarofit. Based on the results obtained, it can be said that the biological drug Actarofit may be used for treatment against the wax moth, but with measures to prevent the ingestion of the drug on the imago and the larvae of bees. Also, it can be used against various pests of agriculture, and some bloodsucking arthropods. But, the sensitivity of the harmful object to the action of the drugshould be taken into account.

Findings. Thus, the drug from the group of avermectins Actarofit can be used against various pests, for example, true bags, which are found quite a lot on food crops [5, 6]. In addition, the high efficacy of this biological drug against the blood-sucking ixodic tick, *Haemaphysalispunctata* Canestrini and Fanzago, 1877, is of great interest. This species is a grazing three host parasite. Imago feed on mammals (several dozen species), larvae and nymphs can also feed on birds and reptiles. The vector of causative agents of Qfever, Crimean hemorrhagic fever, tick-borne encephalitis, tularemia, Lyme disease, etc., which is of great sanitary and epidemiological importance. Therefore, the effect of Aktarofit on this tick is important not only in the field of plant protection, but also to ensure epidemiological well-being.

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І. И. Темрешев[1], А. М. Успанов[1], А. Б. Есжанов[2],
А. М. Кенжегалиев[1], А. М. Макежанов[1], Б. Б. Болатбекова[1]

[1]ҚР АШМ ТОО Ж. Жиембаев атындағы
Қазақ өсімдік қорғау және карантин ғылыми зерттеу институты, Алматы, Қазақстан,
[2]М. Айқымбаев атындағы Қазақ зооноздық және карантиндік инфекциялар ғылыми орталығы,
Алматы, Қазақстан

АКТАРОФИТ БИОЛОГИЯЛЫҚ ПРЕПАРАТЫНЫҢ ӘРТҮРЛІ ЗИЯНДЫ АРТРОПОДТАРҒА АРНАЛҒАН ЗЕРТХАНАЛЫҚ ЗЕРТТЕУЛЕРІНІҢ НӘТИЖЕЛЕРІ ТУРАЛЫ

Аннотация. Мақалада әр түрлі отрядтардан зиянды буынаяқтылардың бірнеше түріне қарсы авермектиндер тобынан контактілі әсер ететін жаңа биотехнологиялық инсектоакарицид - Актарофит тиімділігін зертханалық тестілеу бойынша деректер келтіріледі – қандала *Eurydema ornata* (Linnaeus, 1758) (Hemiptera, Heteroptera, Pentatomidae), *Tettigonia viridissima* (Linnaeus, 1758) (Orthoptera, Tettigoniidae), *Gomphomastax clavata* (Ostroumov, 1881) (Orthoptera, Eumastacidae) және қоңыр саяқ шегіртке *Chorthippus apricarius* (Linnaeus, 1758) (Orthoptera, Acrididae), *Ulomoides dermestoides* (Fairmaire, 1893) (Coleoptera, tenebrionidae), *Galleria mellonella* (Linnaeus, 1758) (Lepidoptera, Pyralidae), сондай-ақ қан сорғыш иксод кенесінде *Haemaphysalis punctata* Canestrini and Fanzago, 1877 (Acari, Ixodida, Ixodidae). Сыналған зиянды буынаяқтардан Актарофит әсеріне ең жоғары төзімділікке боялған қандала *Eurydema ornata* (Linnaeus, 1758), *Galleria mellonella* (Linnaeus, 1758) және *Ulomoides dermestoides* (fairmaire, 1893) балауыздары ие. Құрттар жасыл шекшек *Tettigonia viridissima* (Linnaeus, 1758), жидек биелер *Gomphomastax clavata* (Ostroumov, 1881) және қоңыр керек *Chorthippus apricarius* (Linnaeus, 1758), сондай-ақ имаго кровососущего иксодового кене *Haemaphysalis punctata* Canestrini and Fanzago, 1877 қалсаңыз, ең сезімтал әсеріне препарат. Мұндай айырмашылық көбінесе зерттелетін объектілердің хитин жабынының қалыңдығына байланысты болуы мүмкін, ол оларды Актарофиттің әсерінен қорғайды. Алынған нәтижелерді негізге ала отырып, биологиялық Актарофит препаратын балауыз балына қарсы өңдеу үшін пайдалануға болады, бірақ препараттың имаго мен бал араларының личинкаларына түсуінің алдын алу жөніндегі шаралармен бірге. Сондай-ақ оны ауыл шаруашылығының әртүрлі зиянкестеріне және кейбір қан соратын буынаяқтыларға қарсы қолдануға болады. Бірақ бұл ретте зиянды объектінің препараттың әсеріне сезімталдығын міндетті түрде ескеру керек.

Түйін сөздер: Актарофит, авермектиндер, биологиялық препарат, зиянды буынаяқтылар, жәндіктер, қан соратын кенелер, қорғау шаралары, экологизация, ауыл шаруашылығы.

И. И. Темрешев[1], А. М. Успанов[1], А. Б. Есжанов[2],
А. М. Кенжегалиев[1], А. М. Макежанов[1], Б. Б. Болатбекова[1]

[1]ТОО Казахский научно-исследовательский институт защиты и карантина растений
им. Ж. Жиембаева МСХ РК, Алматы, Казахстан,
[2]Казахский научный центр зоонозных и карантинных инфекций им. М. Айкимбаева, Алматы, Казахстан

О РЕЗУЛЬТАТАХ ЛАБОРАТОРНЫХ ИСПЫТАНИЙ БИОЛОГИЧЕСКОГО ПРЕПАРАТА АКТАРОФИТ НА РАЗЛИЧНЫХ ВИДАХ ВРЕДНЫХ ЧЛЕНИСТОНОГИХ

Аннотация. В статье приводятся данные по лабораторному тестированию эффективности Актарофита – нового биотехнологического инсектоакарицида контактного действия из группы авермектинов против нескольких видов вредных членистоногих из разных отрядов – имаго разукрашенного клопа *Eurydemaornata* (Linnaeus, 1758) (Hemiptera, Heteroptera, Pentatomidae), личинок зеленого кузнечика *Tettigoniaviridissima* (Linnaeus, 1758) (Orthoptera, Tettigoniidae), личинок ягодной кобылки *Gomphomastaxclavata* (Ostroumov, 1881) (Orthoptera, Eumastacidae) и бурого конька *Chorthippusapricarius* (Linnaeus, 1758) (Orthoptera, Acrididae), имаго чернотелки жука-знахаря *Ulomoidesdermestoides* (Fairmaire, 1893) (Coleoptera, Tenebrionidae), гусениц большой восковой моли *Galleriamellonella* (Linnaeus, 1758) (Lepidoptera, Pyralidae), а также на кровососущем иксодовом клеще *Haemaphysalispunctata* Canestriniand Fanzago, 1877 (Acari, Ixodida, Ixodidae) наибольшей устойчивостью к воздействию Актарофита из протестированных вредных членистоногих обладают разукрашенный клоп *Eurydemaornata* (Linnaeus, 1758), гусеницы большой восковой моли *Galleriamellonella* (Linnaeus, 1758) и жук-знахарь *Ulomoidesdermestoides* (Fairmaire, 1893). Личинки зеленого кузнечика *Tettigoniaviridissima* (Linnaeus, 1758),ягодной кобылки *Gomphomastaxclavata* (Ostroumov, 1881) и бурого конька *Chorthippusapricarius* (Linnaeus, 1758), а также имаго кровососущего иксодового клеща *Haemaphysalispunctata* Canestriniand Fanzago, 1877 оказались наиболее восприимчивы к воздействию препарата. Возможно, что подобное различие во многом связано с толщиной хитинового покрова исследуемых объектов, которое в какой-то мере защищает их от воздействия Актарофита. Исходя из полученных результатов, можно говорить о том, что биологический препарат Актарофит возможно использовать для обработки против восковой моли, однако с мерами по предупреждению попадания препарата на имаго и личинок пчел. Также его можно применять против различных вредителей сельского хозяйства, и некоторых кровососущих членистоногих. Но при этом следует обязательно учитывать чувствительность вредного объекта к действию препарата.

Ключевые слова: Актарофит, авермектины, биологический препарат, вредные членистоногие, насекомые, кровососущие клещи, защитные мероприятия, экологизация, сельское хозяйство.

Information about authors:

Temreshev I. I., LLP Zh. Zhiembaev Kazakh Research Institute of Plant Protection and Quarantine, Ministry of Agriculture of Republic of Kazakhstan, Almaty, Kazakhstan; temreshev76@mail.ru; https://orcid.org/0000-0003-0004-4399

Uspanov A. M., LLP Zh. Zhiembaev Kazakh Research Institute of Plant Protection and Quarantine, Ministry of Agriculture of Republic of Kazakhstan, Almaty, Kazakhstan; u_alibek@mail.ru; https://orcid.org/0000-0001-7122-8596

Yeszhanov A. B., M. Aikimbaev Kazakh Scientific Center for Quarantine and Zoonotic Diseases, Almaty, Kazakhstan; aidyn.eszhanov@gmail.com; https://orcid.org/0000-0001-6572-5668

Kenzhegaliev A. M., LLP Zh. Zhiembaev Kazakh Research Institute of Plant Protection and Quarantine, Ministry of Agriculture of Republic of Kazakhstan, Almaty, Kazakhstan; arnur_1992@mail.ru; https://orcid.org/0000-0002-0308-222X

Makezhanov A. M., LLP Zh. Zhiembaev Kazakh Research Institute of Plant Protection and Quarantine, Ministry of Agriculture of Republic of Kazakhstan, Almaty, Kazakhstan; Makezhanov.arman@bk.ru; https://orcid.org/0000-0003-1587-1979

Bolatbekova B. B., LLP Zh. Zhiembaev Kazakh Research Institute of Plant Protection and Quarantine, Ministry of Agriculture of Republic of Kazakhstan, Almaty, Kazakhstan; bolatbekova_beikhan@mail.ru; https://orcid.org/0000-0001-5924-493X

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