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LABORATORY EVALUATION OF THE EFFECTIVENESS OF THE BIOLOGICAL DRUG ENTOLEK K PLANTECO® ON DIFFERENT SPECIES OF PEST INSECTS OF FODDER CROPS

Tursynkulov A.M.[1], researcher, PhD-student
askhat_t-26@mail.ru,https://orcid.org/0000-0003-1108-8506
Amangeldikyzy Z.[2]**,** PhD doctor
zako_89@mail.ru,https://orcid.org/0000-0002-8701-6819
Gabdulov M. A.[2]candidate of technical sciences, associate professor
madigabdulov@mail.ru, https://orcid.org/0000-0002-1818-5272
Temreshev I.I.[1], leading researcher, candidate of biological sciences
temreshev76@mail.ru, https://orcid.org/0000-0003-0004-4399
Makezhanov A.M.[1], researcher
makezhanov81@mail.ru; https://orcid.org/0000-0002-9951-3425
Kozhabaeva G.E.[1], researcher
luch.78@mail.ru, https://orcid.org/0000-0002-8622-2848

"*Kazakh SRI of Plant Protection and Quarantine named after Zh. Zhiembayev" LLP, Almaty city, Republic of Kazakhstan*
[2] *– NJSC «West Kazakhstan Agrarian and Technical University named after Zhangir khan», Uralskcity, Republic of Kazakhstan*

Annotation. The article presents the data on the results of laboratory tests of effectiveness of the biological drug Entolek K Planteco® on different species of insect pests of fodder crops. The authors used the following pest species as test-objects - imago of *Eurydema ornata*(Linnaeus, 1758) (Heteroptera, Pentatomidae), larvae of *Tettigonia viridissima*(Linnaeus, 1758) (Orthoptera, Tettigoniidae), larvae and adults of *Anacanthotermes ahngerianus* Jacobson, 1904 (Blattodea, Hodotermitidae), adults of *Oxythyrea cinctella* (Schaum, 1841) (Coleoptera, Scarabaeidae), caterpillars of *Pieris rapae* (Linnaeus, 1758) (Lepidoptera, Pieridae). Of the pest arthropods tested, the most resistant to the effects of Entolek K Planteco® were the adults of *O. cinctella* - the death of insects reached 100% in 15 minutes after treatment. The same resistance was shown by *E. ornata*. The larvae of *T. viridissima* showed average resistance - 7 minutes. *A. ahngerianus* and *P. rapae* were the most susceptible to the preparation - 99-100% of insects died 5 minutes after treatment. This difference is largely due to the thickness of the chitinous cover of the insects used as test objects. Based on this, we can say that the Entolek K Planteco® can be used with the greatest effectiveness against insect pests with thin covers or in the younger age of larval stage when they are the least resistant. Also, it may be better used against agricultural pests with thick chitinous covers (beetles, adult bugs, etc.) by increasing the concentration. Based on the results of the studies, Planteco® Entolek K can be used against various pests, which are quite numerous on the crops of fodder crops. Analysis of the obtained results showed that after 7-15 minutes (depending on the pest species), the drug efficiency reaches 99-100%. This efficiency is good enough for a biological preparation and will allow to obtain organic products of fodder crops, and then livestock, containing no toxic residues.

Keywords: Entolek K Planteco®, biodrugs, pest insects, fodder crops, organic farming.

Introduction. The use of biological preparations in plant protection is one of the main components in the conduct of organic agriculture and organic production. However, many agricultural producers are skeptical about the possibility of their use, because a significant drawback of most biological preparations used against a variety of agricultural pests in the Republic of Kazakhstan is a slow action. In this regard, as well as to determine the range of pests

- potential objects of application, a laboratory evaluation of the effectiveness of the drug is necessary. We have previously conducted similar studies for the biological drug Aktarofit [1].

Since the line of preparations used for organic farming can not be limited to only one name, there is a need to expand it. For this purpose, we chose Entolek K Planteco® - a biological preparation based on the anamorphic ascomycete *Akanthomyces lecanii* (Zimm.) Spatafora et al., 2017 (= *Lecanicillium lecanii* (Zimm.) Zare & W. Gams, 2001) with a total titer of 1.8*109 CFU/ml, and products of its metabolism, produced by «Trading House Biopreparat» LLC, Russian Federation. The choice of the preparation was based on the fact that it has already proven itself in foreign practice [2-17], and it was successfully tested by us on other species of insect pests on various crops [18-20].

Material and methods. The authors used as test objects different species of harmful insects from different orders - adults of the shiled bug*Eurydema ornata* (Linnaeus, 1758) (Heteroptera, Pentatomidae), larvae of the great green bush-cricket *Tettigonia viridissima* (Linnaeus, 1758) (Orthoptera, Tettigoniidae), larvae and adults of the big transcaspian termite *Anacanthotermes ahngerianus* Jacobson, 1904 (Blattodea, Hodotermitidae), imago of the chafer beetle*Oxythyrea cinctella* (Schaum, 1841) (Coleoptera, Scarabaeidae), caterpillars of the small cabbage white*Pieris rapae* (Linnaeus, 1758) (Lepidoptera, Pieridae). The choice of objects was based on the fact that these insects are one of the mass pest species in the studied areas of forage crops. Termites were also selected due to the fact that there is no biological control agent safe for humans and domestic animals in the Republic of Kazakhstan.

Bed bugs, grasshoppers, beetles and caterpillars of lenticels were caught in the nature by the authors of the article using mowing with a net and manual collection in the area of rape and other fodder crops of "Baiserke-Agro" LLP. The specimens of big trans-caspian termite were collected in the nature in the vicinity of Kentau city of Turkestan region. Accordingly, experiments on the first species of insect pests were carried out in the laboratory of Baiserke-Agro LLP in Almaty Region, and on termites - in Turkestan Region, where the preparation was transferred according to the verbal agreement between the executors. 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 suspension. After that, the solution was applied to the bottom of Petri dishes or a 1 L plastic cage for the experimental group using a sprayer, while water was used for the control group. 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. For each group of test insects, 4 replicates of 20 specimens in each group were carried out.

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

The treated insects were placed in a clean Petri dish or a plastic cup and checked on the following days after contact with the preparation, in case survivors were found.

Research results. Insect pests used as test objects in our experiments are shown in Figures 1-5. The following results (Tables 1-5) show that 1% solution of Entolek K Planteco® has 99-100 % efficacy against all pest species used in the laboratory experiments.

Figure 1 – Shiled bug Eurydema ornata.

Figure 2 – Larvae of the great green bush-cricket Tettigonia viridissima.

Figure 3 – Big transcaspian termite Anacanthotermes ahngerianus, larvae (light exemlar) and adults (dark exemlar).

Fig. 4 – Chafer beetle Oxythyrea cinctella.

Figure 5 – Caterpillars of small cabbage white *Pieris rapae.*

As can be seen from the data in Table 1, individuals of the schield bug *Eurydema ornata* in the experimental version were completely killed in 15 minutes after treatment with Entolek K Planteco®.

Table 1 – Test results of Entolek K Planteco® on the schield bug *Eurydema ornate*

Repeatability (20 exemlar)	Experiment					Control				
	3 min	5 min	7 min	10 min	15 min	3 min	7 min	10 min	15 min	20 min
1	5	4	2	2	0	10	10	10	10	10
2	5	4	3	2	0	10	10	10	10	10
3	6	3	2	1	0	10	10	10	10	10
4	6	4	3	2	0	10	10	10	10	10

The larvae of great green bush-cricket *Tettigonia viridissima* were 99-100 % dead in 7 minutes after treatment (Table 2).

Table 2 – Test results of Entolek K Planteco® on great green bush-cricket larvae Tettigonia viridissima

Repeatability (20 exemlar)	Experiment					Control				
	3 min	7 min	10 min	15 min	20 min	3 min	7 min	10 min	15 min	20 min
1	2	1	1	0	0	20	20	20	20	20
2	1	1	0	0	0	20	20	20	20	20
3	1	0	0	0	0	20	20	20	20	20
4	2	1	0	0	0	20	20	20	20	20

Larvae and adults of the big transcaspian termite *Anacanthotermes ahngerianus* were even less resistant than the 2 previous insect species. Their 100 % mortality occurred 5 minutes after Planteco® treatment with Entolek K (Table 3).

Table 3 – Test results of Entolek K Planteco® on larvae and adults of the big transcaspian termite *Anacanthotermes ahngerianus*

Repeatability (20 exemlar)	Experiment					Control				
	3 min	7 min	10 min	15 min	20 min	3 min	7 min	10 min	15 min	20 min
1	2	0	0	0	0	20	20	20	20	20
2	3	1	0	0	0	20	20	20	20	20
3	2	0	0	0	0	20	20	20	20	20
4	2	0	0	0	0	20	20	20	20	20

Data on the efficacy of Entolek K Planteco® against the shingles beetle are given in Table 4. The authors noted that the adult beetles detected the agitation stage almost immediately after contact with the preparation, but died only 15 minutes after treatment.

Table 4 – Results of the Planteco® Entolek K test on imago of chafer beetle*Oxythyrea cinctella*

Repeatability (20 exemlar)	Experiment					Control				
	3 min	7 min	10 min	15 min	20 min	3 min	7 min	10 min	15 min	20 min
1	6	2	1	1	0	10	10	10	10	10
2	5	3	3	2	0	10	10	10	10	10
3	6	3	2	1	0	10	10	10	10	10
4	6	3	2	2	0	10	10	10	10	10

Caterpillars of small cabbage white *Pieris rapae* as well as larvae and adults of the big transcaspian termite *Anacanthotermes ahngerianus* proved to be hardly resistant to the effect of Planteco®. Their 100 % mortality occurred 5 minutes after the treatment (Table 5).

Table 5 – Test results of Entolek K Planteco® on caterpillars of small cabbage white *Pieris rapae.*

Repeatability (20 exemlar)	Experiment					Control				
	3 min	7 min	10 min	15 min	20 min	3 min	7 min	10 min	15 min	20 min
1	11	1	0	0	0	20	20	20	20	20
2	7	0	0	0	0	20	20	20	20	20
3	10	0	0	0	0	20	20	20	20	20
4	9	0	0	0	0	20	20	20	20	20

Conclusion. As can be seen from the results obtained, the greatest resistance to the effects of Entolek K Planteco® from the tested pest arthropods was possessed by adults of the shingle bug *Oxythyrea cinctella*, whose elimination reached 100% in 15 minutes after treatment. The same relative resistance to the action of the preparation was shown by the dissolved bug *Eurydema ornata*. The larvae of the green grasshopper *Tettigonia viridissima* showed average resistance of 7 minutes. Larvae and adults of the big Trans-Caspian termite *Anacanthotermes*

ahngerianus and caterpillars of small cabbage white *Pieris rapae* were the most susceptible to the drug: 99-100% of insects died 5 minutes after treatment. This difference is largely due to the thickness of the chitinous cover of the insects used as test objects. As is known, chitin is a polysaccharide that is chemically stable, inert, and can be preserved for hundreds of thousands of years (this is proved by paleoentomological materials). Due to these qualities, the chitinous cover serves as a barrier to the penetration of foreign substances into the insect's body, including the active substances of various drugs. Of the test objects selected by the authors, the girdle has the toughest and hardest covers that protect it long enough from the effects of Planteco® components of Entolek K. It should be noted that this species also shows considerable resistance to various chemicals. The painted bug also has relatively thick and hard covers. In green grasshopper, especially in the larvae of younger and middle ages, chitin is much softer than in the previous two species. Termites and caterpillars of the turnip moth are very soft and delicate insects whose covers are highly permeable. The cover is somewhat denser in adults of termites and caterpillars of older ages, as the data in the 2nd repeat of the experiment on termites (Table 3) and in the 1st repeat of the experiment on turnip moth caterpillars (Table 5) show. In these variants, mortality was somewhat slower in individuals of these age groups. In field tests against other insect pests Entolek K Planteco® showed high efficacy primarily against insects with soft covers - naked caterpillars of painted lady *Vanessa cardui* (Linnaeus, 1758), wild or southern moth *Euxoa conspicua* (Hübner, 1824), Old World bollworm*Helicoverpa armigera* (Hübner, 1805), marbled clover *Heliothis viriplaca* (Hufnagel, 1766) and yellow-banded blister beetles *Lytta togata* Fischer von Waldheim, 1844 [-]. Based on this, we can say that the biological preparation Entolek K Planteco® can be used with the greatest effectiveness against insect pests with thin covers or in the younger ages of larval stage when they are the least resistant. It may also be better used against agricultural pests with thick chitinous coatings (beetles, adult bed bugs, etc.) by increasing the concentration. This issue should be investigated further in field trials.

Findings. Based on the results of the studies, Planteco® Entolek K can be used against various pests, which are quite numerous on the crops of fodder crops. The analysis of the obtained results showed that on the 7th-15th minute (depending on the pest species) after treatment, the effectiveness of the preparation reaches 99-100 %. This efficiency is good enough for a biological preparation and will make it possible to obtain organic products of fodder crops and then livestock without toxic residues. Since no waiting period is required for biological preparations like for chemical pesticides, it can be used immediately before harvesting, when it is impossible to use chemicals. It is important that Entolek K Planteco® is effective against termites, which in the southern and southwestern regions of Kazakhstan harm not only crops, but residential and public facilities. Being a biological preparation, safe for humans and warm-blooded animals, it can be used in termite control in domestic conditions. For this purpose in the future it is necessary to test Entolek K Planteco® in the field conditions to establish the effectiveness of the preparation in the production environment and its use as an element of organic farming.

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ЭНТОЛЕКК PLANTECO® БИОЛОГИЯЛЫҚ ПРЕПАРАТЫНЫҢ ЖЕМ-ШӨП ДАҚЫЛДАРЫНЫҢ ӘР ТҮРЛІ ЖӘНДІКТЕР ЗИЯНКЕСТЕРІНЕ ТИІМДІЛІГІН ЗЕРТХАНАЛЫҚ ЖАҒДАЙДА БАҒАЛАУ

Турсынкулов А.М.[1], докторант
Амангелдіқызы З.[2], PhD
Габдулов М.А.[2],ауыл шаруашылығы ғылымдарының кандидаты.
Темрешев И.И.[1], биология ғылымдарының кандидаты
Макежанов А.М.[1], ғылыми қызметкер
Кожабаева Г.Е.[1], ғылыми қызметкер

[1]*"Ж. Жиембаев атындағы Қазақ өсімдіктерді қорғау және карантин ҒЗИ" ЖШС, Алматы қ., Қазақстан Республикасы*
[2]*Жәңгір хан атындағы Батыс Қазақстан аграрлық-техникалық университеті, Орал қ., Қазақстан Республикасы*

Аңдатпа. Мақалада жемдік дақылдардың әртүрлі жәндіктер зиянкестеріне Энтолек К Planteco® биологиялық препаратының тиімділігін зертханалық сынау нәтижелері туралы деректер келтіріледі. Авторлар тест нысандары ретінде зиянды жәндіктердің келесі түрлерін қолданды- Eurydema ornata безендірілген ересек қоңызы (Linnaeus, 1758) (Heteroptera, Pentatomidae), жасыл шегіртке личинкалары Tettigonia viridissima (Linnaeus, 1758) (Orthoptera, Tettigoniidae), үлкен Транскаспий термитінің личинкалары мен имаго Anacanthotermes ahngerianus Jacobson, 1904 (blattodea, Hodotermitidae), oxythyrea cinctella (Schaum, 1841) (Coleoptera, Scarabaeidae), Pieris rapae (Linnaeus, 1758) (Lepidoptera, Pieridae) белянка көбелегінің құрттары. Сыналған зиянды артроподтардың ішінен Энтолек К Planteco®-ның әсеріне ең жоғары қарсылыққа *O.cinctella* қоңызының имаго ие болды-өңдеуден кейін 15 минуттан кейін жәндіктердің өлімі 100% - ға жетті. Дәл осындай тұрақтылықты *E. ornata* қатесі көрсетті. *T. viridissima* жасыл шегіртке личинкалары орташа тұрақтылықты көрсетті - 7 минут. *A. ahngerianus* термиттің дернәсілдері мен имагосы және *P. rapae* құрттары препараттың әсеріне ең сезімтал болып шықты - өңдеуден кейін 5 минуттан кейін жәндіктердің 99-100% қайтыс болды. Мұндай айырмашылық көбінесе сынақ нысаны ретінде қолданылатын жәндіктердің хитин жамылғысының қалыңдығына байланысты. Осыған сүйене отырып, Энтолек К Planteco® биологиялық препаратын жіңішке жабыны бар жәндіктер зиянкестеріне қарсы неғұрлым тиімділікпен не олар ең аз төзімді болған кезде дернәсіл сатысының кіші жасында пайдалануға болады деп айтуға болады. Сондай-ақ, концентрацияны арттыра отырып, қалың хитинді жабындары бар ауылшаруашылық зиянкестеріне (қоңыздар, ересектер және т.б.) қарсы қолданған дұрыс. Жүргізілген зерттеулердің нәтижелеріне сүйене отырып, Энтолек К Planteco® препаратты жемшөп дақылдарының егістіктерінде көп кездесетін әртүрлі зиянкестерге қарсы қолдануға болады. Алынған нәтижелерді талдау өңдеуден кейін 7-15-минутта (зиянкестердің түріне байланысты) препараттың тиімділігі 99-100% - ға жететінін

көрсетті. Мұндай тиімділік биологиялық препарат үшін жеткілікті жақсы болып табылады және жемдік өсімдік шаруашылығының органикалық өнімін, содан кейін құрамында уытты қалдықтары жоқ мал шаруашылығын алуға мүмкіндік береді.

Кілт сөздер: Entolec K Planteco®, биологиялық өнімдер, жәндік зиянкестер, мал азықтық дақылдар, органикалық егіншілік.

ЛАБОРАТОРНАЯ ОЦЕНКА ЭФФЕКТИВНОСТИ БИОЛОГИЧЕСКОГО ПРЕПАРАТА ЭНТОЛЕК К PLANTECO® В ОТНОШЕНИИ РАЗЛИЧНЫХ ВИДОВ НАСЕКОМЫХ-ВРЕДИТЕЛЕЙ КОРМОВЫХ КУЛЬТУР

Турсынкулов А.М.[1]докторант
Амангелдіқызы З. [2] PhD
Габдулов М.А.[2]кандидат сельскохозяйственных наук
Темрешев И.И.[1], кандидат биологических наук
Макежанов А.М.[1], научный сотрудник
Кожабаева Г.Е.[1], научный сотрудник

[1]*ТОО"Казахский НИИ защиты и карантина растений имени Ж.Жиембаева», г.Алматы, Республика Казахстан*
[2]*Западно Казахстансикй аграрно-технический университет имени Жангир хана, г.Уралск, Республика Казахстан*

Аннотация. В статье приводятся данные о результатах лабораторных испытаний эффективности биологического препарата Энтолек К Planteco® на разных видах насекомых-вредителей кормовых культур. В качестве тест-объектов авторами использовались следующие виды вредных насекомых – имаго разукрашенного клопа Eurydema ornata (Linnaeus, 1758) (Heteroptera, Pentatomidae), личинки зеленого кузнечика Tettigonia viridissima (Linnaeus, 1758) (Orthoptera, Tettigoniidae), личинки и имаго большого закаспийского термита Anacanthotermes ahngerianus Jacobson, 1904 (Blattodea, Hodotermitidae), имаго жука олёнки опоясанной Oxythyrea cinctella (Schaum, 1841) (Coleoptera, Scarabaeidae), гусеницы бабочки репной белянки Pieris rapae (Linnaeus, 1758) (Lepidoptera, Pieridae). Наибольшей устойчивостью к воздействию Энтолек К Planteco® из протестированных вредных членистоногих обладали имаго жука O. cinctella – гибель насекомых достигала 100 % через 15 минут после обработки. Такую же устойчивость показал клоп E. ornata. Личинки зеленого кузнечика T. viridissima показали среднюю устойчивость – 7 минут. Личинки и имаго термита A. ahngerianus и гусеницы P. rapae оказались наиболее восприимчивы к воздействию препарата – через 5 минут после обработки гибло 99-100 % насекомых. Подобное различие во многом связано с толщиной хитинового покрова насекомых, использованных в качестве тест-объектов. Исходя из этого, можно говорить о том, что биологический препарат Энтолек К Planteco® возможно использовать с наибольшей эффективностью против насекомых-вредителей с тонкими покровами либо в младших возрастах личиночной стадии, когда они наименее устойчивы. Также, возможно его лучше применять против вредителей сельского хозяйства с толстыми хитиновыми покровами (жуки, имаго клопов и т.п.), увеличив концентрацию. Исходя из результатов проведенных исследований, препарат Энтолек К Planteco® можно использовать против различных вредителей, которых на посевах кормовых культур встречается достаточно много. Анализ полученных результатов показал, что на 7-15-й минуте (в зависимости от вида вредителя) после обработки эффективность препарата достигает 99-100 %. Такая эффективность является достаточно хорошей для биологического препарата и позволит получать органическую продукцию кормового растениеводства, а затем и животноводства, не содержащую токсических остатков

Ключевые слова: Энтолек К Плантеко®, биопрепараты, насекомые-вредители, кормовые культуры, органическое земледелие.