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Zhumatayeva U.T*[1]., Duisembekov B.A[2]., Begalieva A.M[3].,
Sabdenova U.O[4]., Yerkekulova K.K.[5]

*[1]Kazakh National Agrarian Research University, c. Almaty, Kazakhstan, *doni_uli@mail.ru,*
[2]Agropark «Ontustik», Almaty region, Kazakhstan,
[3]SKU named after M. Auezov, c. Shymkent,
[4]Kazakh National Pedagogical University named after Abay, Almaty, Kazakhstan
[5]South Kazakhstan Medical Academy, c. Shymkent

SCREENING OF COLLECTION STRAINS (COLLECTIONS) OF ENTOMOPATHOGENIC FUNGI AGAINST ASIAN LOCUSTS FOR SIGNS OF VIRULENCE

Abstract

The article provides a preliminary screening of Asian locust larvae aged 2-3 years for the virulence of 25 isolates isolated from insects belonging to different systematic groups of fungi *Beauveria bassiana*. Five of the 25 strains showed high biological activity against larvae, (BCo1-14, BSc1-15, BSc2-15, BTr1-16, BPit-16) reaching a mortality rate of 90-100% 21 days after inoculation. The strains that have the best effect on the level and rate of mortality of the host organism are - BCo1-14, BSc1-15, BSc2-15, BTr1-16, BPit-16. The greatest biological activity was observed in the BSc1-15 strain, as the mortality rate of test organisms was only 100% within 15 days of exposure. The lowest activity was shown by the BCi_4-14 strain in the range of 35.0-62.5%. At the same time, the mortality rate of Asian locust larvae in the control variant (without treatment) for 21 days was 15.0±2.88%. Thus, the proportion of highly toxic forms (80-100% lethality) in the total number of studied strains was not more than 44%, and the proportion of mildly toxic forms (less than 80% activity) was 56%.

Keywords: entomopathogen, virulent, *Beauveria bassiana,* strain, crop, *Locusta migratoria migratoria* L., conidia, fungi, screening.

Introduction

Locusts, especially herbivores, one of the most harmful groups of multi-element pest crops [1]. Kazakhstan has 270 locust species. 15-20 species pose a high risk to crops and fields [2].

Asian locusts are one of the most dangerous locusts in Kazakhstan (*Locusta migratoria migratoria* L.). During periods of mass reproduction, they can cause enormous damage, incomparable to the damage caused by other pests. In 1999, locusts destroyed only 220,000 hectares of crops in Kazakhstan, costing $15 million. In 2000, the area treated with insecticides was 8.0 mln. hectares, which is 9 times more than the average long-term cultivation of previous years [3]. Currently, only chemical insecticides are used in the CIS for locust control. However, widespread use of pesticides is known to have a number of important deficiencies, the most important of which are the emergence of persistent pest populations and environmental pollution [4].

In this regard, the alternative environmentally friendly plant protection methods should be sought. One such method of suppressing harmful phytophages is microbiological protection. The microbiological method plays an important role in the development of such methods [5, 6].

Research aimed at developing technologies for the production of biological drugs is relevant for Kazakhstan, but the production and use of fungicides in Kazakhstan is not yet widespread, but they have been able to effectively regulate the number of pests [3, 4, 7]. At present, there are almost no local drugs in the country that are highly effective against pests based on entomopathogenic strains [8]. Thus, the development of highly effective biological sources, optimization of their development and use is one of the prerequisites for the widespread introduction of entomopathogenic microorganisms in plant protection practices in Kazakhstan and provides eco-friendly agricultural products, which is one of the key components of national health and safety.

In connection with the above, the purpose of our study was to explore the possibility of using entomopathogenic hypomicets to control the number of Asian locusts in south-eastern Kazakhstan.

Research materials and methods

Virulence assessment experiments used 25 strains of entomopathogenic fungus belonging to the genus *Beauveria bassiana*, isolated from pathological material collected in 2009-2016 by the staff of the Biotechnology Laboratory of the Kazakh Research Institute of Plant Protection and Quarantine named after Zh. Zhiembayev in different climatic zones of Kazakhstan and Kyrgyzstan (**table 1**).

The Biotechnology Laboratory of the Kazakh Research Institute for Plant Protection and Quarantine named after Zh. Zhiembayev carried out an assessment of the biological activity of *B. bassiana* strains against Asian locust larvae *Locusta migratoria migratoria* L. (Orthoptera: Acrididae) at the age of 2-3 years (**table 2**).

To test *B. bassiana* strains, 2-3 young larvae of Asian locusts from the Bakanas district and Balkhash district of Almaty province were collected.

Table 1. *B. bassiana* strains used in experiments to assess the biological activity of Asian locusts

No.	Strain name	Selected object	Location, year
	1	2	3
Mountainous area			
1	BLe_2-13	*Lepidoptera*	Almaty region, Sarkan district, Dzungarian Alatau (1400-1500 m above sea level), July 25, 2013
2	$BCol_1$-13	*Coleoptera*	Almaty region, Sarkan district, Dzungarian Alatau (1200-1500 m above sea level), 2013
3	BP_1-13	*Pentotamidae*	Almaty region, Sarkan district, Dzungarian Alatau (1200-1500 m above sea level), July 25, 2013
4	BEL-13	*Elateridae*	Almaty region, Sarkan district, Dzungarian Alatau (1200-1500 m above sea level), July 25, 2013
5	BCh-13	*Chriysomelidae*	Almaty region, Sarkan district, Dzungarian Alatau (1200-1500 m above sea level), July 25, 2013
6	BLe_1-14	*Lepidoptera*	Kostanay, forest-steppe landscape, Tobol River, June 22, 2014
7	BCo_1-14	*Coleoptera*	Kostanay, forest-steppe landscape, Tobol River, June 22, 2014
8	BCi_1-14	*Cicadellidae*	North Kazakhstan region, Kostanay, Tobol River, June 2014
9	BCi_2-14	*Cicadellidae*	North Kazakhstan region, Kostanay, Tobol River, June 2014
10	BCi_4-14	*Cicadellidae*	North Kazakhstan region, Kostanay, Tobol River, June 2014
11	BSc_1-15	*Scolytidae (Ips hauseri)*	Medeu Ili-Alatau at an altitude of 1200-1500 m above sea level, 2015
12	BSc_2-15	*Scolytidae (Ips hauseri)*	Medeu Ili-Alatau at an altitude of 1200-1500 m above sea level, 2015
13	BSc_7-15	*Scolytidae (Ips hauseri)*	Medeu Ili-Alatau at an altitude of 1200-1500 m above sea level, 2015
14	BSc_8-15	*Scolytidae (Ips hauseri)*	Medeu Ili-Alatau at an altitude of 1200-1500 m above sea level, 2015
15	BSc_{10}-15	*Scolytidae (Ips hauseri)*	Medeu Ili-Alatau at an altitude of 1200-1500 m above sea level, 2015
16	BOr_1-16	*Orthotomicus suturalis*	Kyrgyz Republic, June 2015

17	BSc_1-16	*Ips hauseri*	Kyrgyz Republic, June 2015
18	BTr_1-16	*Trypodendron cirratum*	Kyrgyz Republic, June 2015
19	BPit-16	*Pityogenes spesivtsev*	Kyrgyz Republic, June 2015
20	BP_1-16	*Pentotamidae*	Kyrgyz Republic, June 2015
Steppe area			
21	$BCa_{2(m)}$-09	*Carabidae*	South Kazakhstan region, Makhtaral district, Yessentayev village, June 30, 2009
22	$BCa_{3(m)}$-09	*Carabidae*	South Kazakhstan region, Makhtaral district, Yessentayev village, June 30, 2009
23	$BCo_{2(к)}$-09	*Coleoptera*	Zhambyl region, Kordai district, June 2009
24	BScar-09	*Scarabidae*	Zhambyl region, Kordai district, July 2009
25	BHy-09	*Hymenoptera*	Zhambyl region, Kordai district, July 2009

Locust cultivation. In order to obtain a large number of conidia of locust, the cultivation of locust was carried out in a surface culture on a Petri dish, Saburo artificially modified solid nutrient medium at a temperature of 25-30^{o}C. The composition of Saburo nutrient medium consists of the following components (g / l) consist of: peptone - 10,0; glucose - 10,0; maltose - 10,0; yeast extract - 5,0; agar-agar - 16,0; water – 1 liter [9-12].

Autoclaving mode - 0.8 atm. 30 min.

Pure growth of entomopathogenic fungi were obtained by repeated inoculation (**Fig. 1**). Most spore isolates were obtained according to standard methods.

After 7-14 days of mass formation of conidial spores, conidia were carefully removed from the culture with a sterile spatula. The fungus spores were then placed in a thermostat at a temperature of 25-30°C and dried.

After drying the conidia mass, the standard method was used to calculate the pathogen titer under the Goryaev chamber (**Fig. 2**) [9-14].

The obtained biomaterial was stored in a refrigerator at a temperature of 3-5^{o}C.

Results and discussion

The research was conducted in the summer at the biotechnology laboratory of the Kazakh Research Institute for Plant Protection and Quarantine.

According to the virulence of 25 strains of the fungus *B. bassiana* isolated from dead bodies found in different systematic groups and in different regions (Almaty region, Sarkan district, Dzungarian Alatau (1400-1500 m); Kostanay region, forest-steppe landscape, Tobol River; North Kazakhstan region, Kostanay city, Tobol river; Medeu Ili-Alatau at an altitude of 1200-1500 m; South Kazakhstan, Makhtaral district, steppe landscape; Zhambyl region, Kordai district, steppe landscape; Kyrgyz Republic) the first screening of larvae of L. *migratoria* L. 2-3 years of age was carried out and virulence was determined.

Figure 1. Inoculation of strains in a solid medium modified by Saburo and strains grown at a temperature of 25^{o}C.

Evaluation of the biological activity of fungi in the laboratory was carried out by the standard method in a plastic container, and a climatic chamber. The larvae of test insects were placed on 10 trees in each glass. It is a plastic glass with a volume of 1000 ml. The infestation of larvae with entomopathogenic fungi was carried out by submerging 2 ml of the suspension on 10 trees. The controlled larvae were treated with distilled water. If several inoculum concentrations are assessed at the same time, low-titer versions are processed first. The experiment was laid out with four replication.

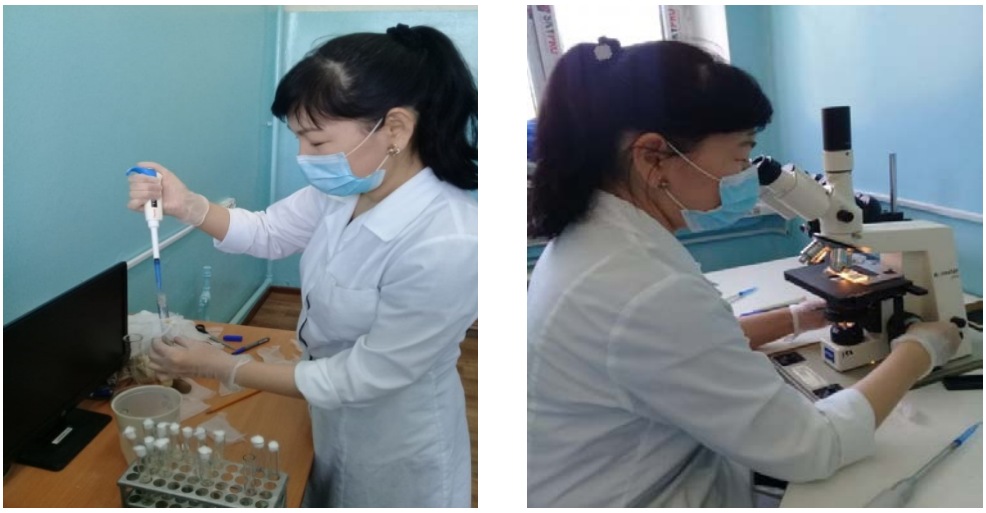


Figure 2. Preparation of a suspension of fungal conidia for locust infestation and calculation of the number of titers.

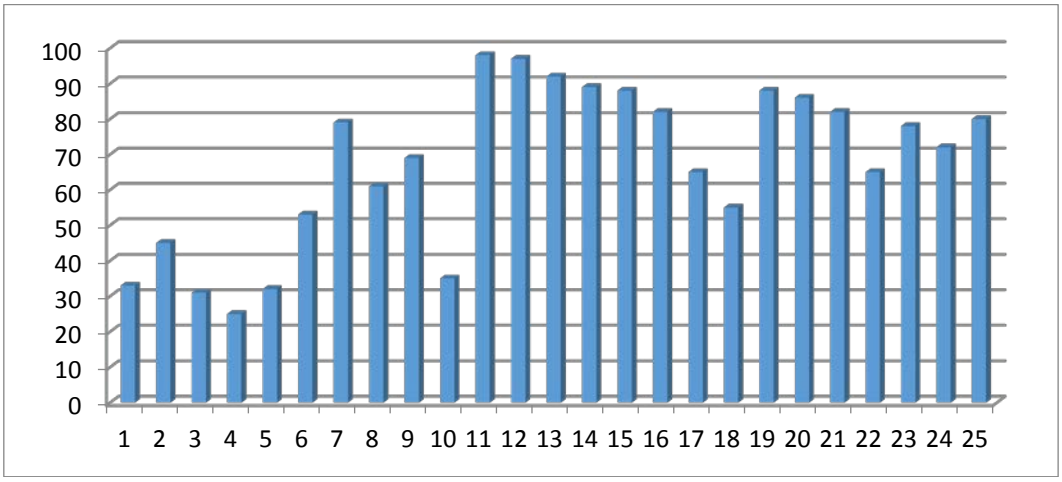
For 21 days after inoculation, the glasses were inspected daily, all dead trees were removed, and food was changed as needed (**figure 3**). Further, to determine the cause of death of dead trees and the level of mycelium growth in them, they were placed in a glass, humid chamber (Petri dish with a filter soaked in water) (**figure 4**). The results of the study showed that among the dead trees in the humid chamber, the mycelium covered the dead ones under the influence of fungi (**figure 5**).

Figure 3. Feeding and accounting of experimental Asian locusts.

Figure 4. Placing dead trees in a humid chamber.

Figure 5. Suppression of mycosis by locusts placed in a humid chamber.

The level of 100% suppression of dead Asian locust trees by fungal mycelium was not observed in any test strains. Maximum growth of mycelium was observed in strain BSc_1-15 (97%), and minimal growth was observed in strain BEL-13 (25%). In other strains, the proportion of dead trees covered with mycelium varied from 31 to 92% (**figure 6**).



1-BLe_2-13; 2-$BCol_1$-13; 3-BP_1-13; 4-BEL-13; 5-BCh-13; 6-BLe_1-14; 7-BCo_1-14; 8-BCi_1-14; 9-BCi_2-14; 10-BCi_4-14; 11-BSc_1-15; 12-BSc_2-15; 13-BSc_7-15; 14-BSc_8-15; 15-BSc_{10}-15; 16-BOr_1-16; 17-BSc_1-16; 18-BTr_1-16; 19-BPit-16; 20-BP_1-16; 21-$BCa_{2(m)}$-09; 22-$BCa_{3(m)}$-09; 23-$BCo_{2(к)}$-09; 24-BScar-09; 25-BHy-09

Figure 6. Extent of mycelium suppression of dead Asian locust trees after infection with a fungus strain *B. bassiana.*

Statistical analisis was carried out by the method of analysis of variance using the application software package «Sigma STAT 32», «Sigma Plot 32» and with the help of Excel spreadsheets.

At the first stage of laboratory experiments, the biological activity of *L. migratoria L.* 2-3-year-old larvae was determined due to the timing of infection of 25 strains of fungi belonging to the genus *B. bassiana* (**table 2**).

Table 2. Dynamics of biological activity of strains belonging to the genus *B. bassiana* to larvae of *L. migratoria L*. 2-3 years old (Almaty, Laboratory of Biotechnology, KazNIIS, 2019)

Strain	Title	Lethality%. days after infection				
		5	9	13	17	21
BLe2-13	$5x10^7$	42.5±11.0	52.5±8.5	62.5±12.5	67.5±8.5	72.5±9.4
	$1x10^7$	35.0±6.45	40.5±9.5	55.0±6.4	75.2±8.2	82.5±7.5
	$5x10^6$	15.0±6.45	25.0±9.2	52.5±13.1	67.5±13.1	75.0±104
	$1x10^6$	12.5±4.78	20.0±7.07	20.0±7.07	25.2±3.4	30.0±5.7
BCol1-13	$5x10^7$	35.0±6.45	52.5±8.5	75.0±11.9	77.5±11.08	85.0±12.0
	$1x10^7$	45.0±10.4	57.5±15.4	62.5±13.1	65.0±11.07	75.0±10.5
	$5x10^6$	22.5±4.7	25.0±2.8	27.5±4.7	32.5±6.2	37.5±2.5
	$1x10^6$	12.5 ±2.5	20.0±4.0	25.0±8.66	30.0±4.8	37.5±7.5
BP1-13	$5x10^7$	42.5±2.5	62.5±7.5	72.5 ±11	75.0±5.2	80.0±7.2
	$1x10^7$	27.5±7.5	37.5±6.2	57.5±13.1	67.5±6.2	77.5±13.1
	$5x10^6$	17.5±6.2	25.0±2.8	27.5±4.7	32.5±2.5	40.0±6.2
	$1x10^6$	15.0±5.0	20.0±7.07	25.0±8.6	30.0±12.2	35.0±2.88
BEL-13	$5x10^7$	25.0±6.4	37.5±6.2	47.5 ±4.7	62.5±10.8	70.0±10.3
	$1x10^7$	32.5±8.5	37.5±9.4	45.0±4.8	55.0±5.0	62.5±13.1
	$5x10^6$	15.0±5.0	30.0±6.3	40.0±7.2	50.0±10.0	55.0±5.0
	$1x10^6$	10.0±4.08	22.5±7.5	25.0±8.6	30.0±4.08	37.5±6.2
BCh-13	$5x10^7$	15.0±5.0	47.5±11.8	65.0±14.4	75.5±16.2	80.0±12.2
	$1x10^7$	30.0±10.8	43.1±7.2	65.0±11.9	67.5±12.5	75.0±16.2
	$5x10^6$	20.0±4.08	37.5±6.2	47.5±11	57.5±7.5	62.5±7.5
	$1x10^6$	15.0±5.0	27.5±8.5	47.5±11	52.5±4.6	70.0±7.07
BLe1-14	$5x10^7$	37.5 ±10.3	57.5±20.1	82.5±4.7	90.0±4.08	100
	$1x10^7$	35.0±2.8	52.4±9.4	80.0±10.8	85.0±11.8	95.0±5.0
	$5x10^6$	30.0±9.12	35.0±9.5	40.0±6.2	50.0±6.5	62.5±7.5
	$1x10^6$	7.5±4.78	25.5±13.2	37.5±9.4	45.0±4.3	55.0±5.0
BCo1-14	$5x10^7$	50.0±4.08	70.0±4.08	85.0±5.0	95.2±10.3	100
	$1x10^7$	27.5±7.5	37.5±6.2	50.0±8.1	60.0±9.1	90.0±5.77
	$5x10^6$	20.0±4.08	22.5±2.5	30.0±9.1	40.0±7.07	55.0±5.0
	$1x10^6$	5.0±5.0	7.5±4.7	27.5±2.5	35.0±4.03	45.0±6.4
BCi1-14	$5x10^7$	62.5±7.5	68.5 ±2.5	82.5 ±6.2	97.0±10.02	100
	$1x10^7$	35.0±6.4	47.5±8.2	55.0±8.6	70.0±7.07	85.0±9.5
	$5x10^6$	17.5±8.5	27.5±11	40.0±5.2	47.5±11.3	62.5±7.5
	$1x10^6$	17.5±8.5	17.5±6.2	22.5±2.5	30.0±4.08	42.5±7.5
BCi2-14	$5x10^7$	35.0±6.45	70.0±7.07	82.5 ±2.5	85.0±2.8	100
	$1x10^7$	30.0±9.1	57.5±7.5	62.5±7.5	75.0±14.2	90.0±5.77
	$5x10^6$	17.5±6.29	22.5±8.5	32.5±13.1	45.0±8.6	67.5±11.1
	$1x10^6$	7.5±4.78	20.0±7.7	30.0±4.08	35.0±6.4	55.0±5.0
BCi4-14	$5x10^7$	35.0±11.9	43.5±6.2	52.5±7.5	57.5±8.53	62.5±7.5
	$1x10^7$	25.0±5.0	42.5±6.5	50.0±10.8	55.5±8.5	75.0±8.7
	$5x10^6$	5.0 ±5.0	12.5±6.2	22.5±10.3	27.5±10.3	45.0±8.2
	$1x10^6$	7.5±4.7	10.0±4.0	15.0±8.2	25.0±10.4	35.0±2.88
BSc1-15	$5x10^7$	52.5±19.7	97.5±2.5	100	100	100
	$1x10^7$	32.5±8.5	87.5±7.5	100	100	100
	$5x10^6$	25.0±8.6	92.5±4.7	100	100	100
	$1x10^6$	17.5±2.5	40.0±8.1	87.5±4.7	100	100

BSc2-15	$5x10^7$	35.0±14.4	80.0±10.8	100	100	100
	$1x10^7$	32.5±9.4	65.0±12	100	100	100
	$5x10^6$	30.0±7.07	50.0±10	95.0±5.0	100	100
	$1x10^6$	17.5±4.7	20.0±5.7	40.0±7.07	60.0±40.8	92.5±7.5
BSc7-15	$5x10^7$	45.0±6.4	80.0±10.8	97.5±7.07	100	100
	$1x10^7$	22.5±6.29	65.0±11.9	75.0±18.4	90.5±4.08	100
	$5x10^6$	20.0±7.07	50.0±10	60.0±8.4	82.5±17.5	100
	$1x10^6$	15.0±5.0	20.0±5.7	35.0±8.6	52.5±7.5	75.0±8.66
BSc8-15	$5x10^7$	40.0±9.1	80.0±8.1	92.5±4.7	100	100
	$1x10^7$	25.0±10.4	50.0±8.2	80.0±9.1	100	100
	$5x10^6$	22.5±10.3	40.5±8.6	72.5±6.2	92.5±7.5	100
	$1x10^6$	22.5±2.5	27.5±11	32.5±9.4	42.5±4.78	65.2±7.07
BSc10-15	$5x10^7$	50.0±10.8	80.0±9.1	90.0±2.8	92.5 ±4.78	100
	$1x10^7$	17.5±6.2	55.0±10.4	85.0±4.08	90.0±4.08	100
	$5x10^6$	20.0±8.1	35.0±2.8	40.0±5.2	60.2±4.08	75.0±8.66
	$1x10^6$	15.0±6.4	25.0±2.8	35.0±2.8	42.5±4.78	67.5±8.09
BOr1-16	$5x10^7$	32.5±2.5	77.5±6.2	95.0±5.0	100	100
	$1x10^7$	30.0 ±7.07	55.0±2.8	62.5±10.8	87.5±7.5	92.5±7.5
	$5x10^6$	30.0±13.2	37.5±5.7	57.5±7.2	82.5±6.8	90.0±5.77
	$1x10^6$	17.5±2.5	27.5±8.5	32.5±4.7	52.5±8.53	70.0±9.2
BSc1-16	$5x10^7$	40.0±9.1	45.0±6.2	70.0±8.1	80.0±4.08	92.5±7.5
	$1x10^7$	40.0±9.1	45.5±8.1	67.5±11	80.0±7.07	95.0±5.0
	$5x10^6$	35.0±12.5	40.2±8.6	45.0±8.2	55.0±6.4	60.0±8.14
	$1x10^6$	33.5±8.5	35.0±8.6	42.5±7.07	50.0±17.3	57.5±7.1
BTr1-16	$5x10^7$	57.5±6.2	92.5±7.5	100	100	100
	$1x10^7$	57.5 ±13.7	97.5±2.5	100	100	100
	$5x10^6$	30.0±8.1	92.5±4.7	100	100	100
	$1x10^6$	27.5±4.7	45.0±9.5	67.5±4.7	90.0±5.72	100
BPit-16	$5x10^7$	46.0±14.0	95.0±2.8	100	100	100
	$1x10^7$	25.0±13.2	55.0±8.6	70.0±7.07	80.0±6.31	95.0±5.0
	$5x10^6$	22.5 ±8.5	30.0±9.1	45.2±5.2	52.5±4.78	75.0±8.07
	$1x10^6$	37.5±2.5	42.5±4.7	50.0±7.07	75.0±6.45	92.5±7.5
BP1-16	$5x10^7$	37.5±2.5	52.5±7.5	57.5±10.3	90.0±5.77	100
	$1x10^7$	22.5±7.5	47.5 ±8.5	52.5±7.2	77.5±6.29	100
	$5x10^6$	40.0±9.1	62.5±14.3	77.5±14.3	85.0±15.0	85.0±15.0
	$1x10^6$	30.0±7.07	37.5±8.5	40.0±8.1	50.0±4.08	57.5±2.5
BCO2-09	$5x10^7$	47.5±10.3	72.5±8.5	85.0±2.8	87.5±4.7	92.5±4.7
	$1x10^7$	20.0±4.0	50.0±4.0	62.5±2.5	72.5±7.5	87.5±2.5
	$5x10^6$	12.5±2.5	25.0±9.5	37.5±6.2	52.5±8.5	60.0±7.0
	$1x10^6$	25.0±2.8	32.5±6.2	37.5±4.7	52.5±8.5	57.5±7.5
BHy-09	$5x10^7$	32.5±6.2	32.5±6.2	57.5±4.7	82.5±7.5	92.5±4.7
	$1x10^7$	22.5±7.5	47.5±11.0	67.5±4.7	87.5±4.7	90.0±5.7
	$5x10^6$	37.5±7.5	47.5±7.5	60.0±10.8	72.5±4.7	80.0±4.0
	$1x10^6$	25.0±10.4	32.5±9.4	37.5±8.5	47.5±4.7	57.5±2.5
BScar-09	$5x10^7$	27.5±11.8	57.5±17.5	75.0±15.5	90.0±5.7	95.0±5.0
	$1x10^7$	10.0±4.0	32.5±7.5	60.0±8.1	75.0±8.6	80.0±11.5
	$5x10^6$	20.0±9.1	37.5±16.5	57.5±14.3	67.5±14.9	75.0±11.9
	$1x10^6$	12.5±4.7	25.0±8.6	40.0±10.8	55.0±6.4	65.0±10.4
BCa2(m)-09	$5x10^7$	35.0±6.4	52.5±11.0	77.5±4.7	90.0±7.0	90.0±7.0
	$1x10^7$	17.5±8.5	37.5±6.2	55.0±6.4	80.0±4.0	85.0±5.0
	$5x10^6$	42.5±7.5	57.5±7.5	75.0±6.4	82.5±8.5	82.5±8.5
	$1x10^6$	10.0±4.0	20.0±4.0	22.5±2.5	57.5±17.0	62.5±16.5
BCa3(m)-09	$5x10^7$	40.0±9.1	60.0±7.0	82.5±2.5	82.5±2.5	95.0±5.0
	$1x10^7$	20.0±4.0	30.0±8.1	42.5±4.7	65.0±14.4	75.0±15.5
	$5x10^6$	27.5±2.8	50.0±4.9	60.0±5.9	67.5±6.8	67.5±7.4

	$1x10^6$	15.0±5.0	27.5±2.5	32.5±4.7	37.5±4.7	50.0±7.0
Control		0.0	0.0	2.5±2.5	7.5±4.78	15.0±2.88
LSD_{05}		22.2	24.1	23.8	24.4	25.9

25 strains (20 strains - mountainous zone and 5 strains - steppe zone) were selected from the laboratory collection to determine the virulence of the strains. One of the most important elements in the development of technology for the use of biologicals is the determination of the optimal titer of the suspension of the pathogen. We experimented with these four titres $1x10^6$, $5x10^6$, $1x10^7$, $5x10^7$. In our experiment, the infestation was carried out by immersing the fungi in a suspension of fungal conidia.

The first screening of larvae of Asian locusts aged 2-3 years was carried out on the virulence of isolates of fungi belonging to the genus *B. bassiana* isolated from different systematic groups of insects.

Strains have a slight variability due to their virulent properties. The final mortality rate in 13 strains of titres $1x10^7$ and $5x10^7$ was 100%. Strains BCo1-14, BSc1-15 BSc2-15 and BTr1-16, BPit-16 showed a high rate of death of the host organism at the maximum titer. In these variants, the mortality of Asian locusts was 50-90% in one week after infection with a concentration of $5x10^7$ working suspension, reached 85-100% in 13 days, and 100% in 21 days. Other strains showed different activity depending on the titers (**table 2**). The results of the study showed that the optimal number of titers is $5x10^7$.

In five fungal cultures (BCO_1-14, BSC_1-15, BSC_2-15, BTr_1-16, BPit-16), at 21 days after inoculation, the mortality rate of the larvae reached 90-100%, indicating high biological activity against the larvae. The onset of 100% mortality (LT_{100}) of *L. migratoria* L. larvae aged 2-3 under the influence of B. bassiana fungi strains occurred mainly on the 11th day after inoculation. (**table 3**).

Table 3. Period of 100% death of L. *migratoria* L. larvae at age 2-3 under the influence of *B. bassiana* fungus strains (Laboratory experiment, 2019)

Strain	LT_{100} in the title, day			
	$1x10^6$	$5x10^6$	$1x10^7$	$5x10^7$
BLe1-14	-	-	-	21
BCo1-14	-	-	-	21
BCi1-14	-	-	-	21
BCi2-14	-	-	-	21
BSc1-15	15	13	13	11
BSc2-15	-	15	13	13
BSc7-15	-	19	19	15
BSc8-15	-	19	17	15
BSc10-15	-	-	21	19
BOr1-16	-	-	-	15
BTr1-16	19	13	11	11
BPit-16	-	-	-	15
BP1-16	-	-	21	19

In conclusion, the host was the best influence on the level and mortality of the body and showed peculiarities among the strains BCo_1-14, BSc_1-15, BSc_2-15, BTr_1-16, BPit-16. The highest biological activity was observed in the BSc1-15 strain on the 15th day, and the mortality rate of test-borne organisms was 100%. BCi_4-14 strain showed the lowest activity in the range of 35,0-62,5%. In addition, the mortality rate of Asian locust larvae at 21 days of control (unprocessed) was 15,0±2,88%. Thus, the proportion of forms with high virulence (mortality of 80-100 per cent) of the total studied fungal strains was not more than 44 per cent, and the proportion of weak virulent forms (activity of less than 80 per cent) was 56 per cent. It should be noted that most entomopathogenic anamorphic ascomyces are non-specialized species [15]. Therefore, if a particular strain exhibits

high biological activity for one type of pest, it can be said to have a high virulence for other species of phytophages [16].

Conclusion

Strains of fungi belonging to the Kazakh family Beauveria showed heterogeneity in virulence to Asian locusts. Of the 25 cultures tested, 44% of strains showed high virulence and 56% showed low virulence. In the control version (without treatment) the mortality rate of larvae did not exceed 15%. Thus, 5 strains of fungi with high biological activity in the control of L. migratoria L. were selected: BCo_1-14, BSc_1-15, BSc_2-15, BTr_1-16, BPit-16. In the future, on the basis of these selected strains, semi-drug forms will be prepared for production and laboratory experiments will be conducted.

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Жуматаева У.Т*[1]., Дуйсембеков Б.А[2]., Бегалиева А.М[3].,
Сабденова У.О[4]., Еркекулова К.К.[5]

*[1]Казахский национальный аграрный исследовательский университет, г. Алматы, Казахтан, *doni_uli@mail.ru*
[2]Agropark «Ontustik», Алматинская обл, Казахтан,
[3] ЮКУ имени М.Ауэзова, г. Шымкент, Казахтан,
[4]Казахского национального педагогического университета имени Абая, г. Алматы, Казахтан,
[5]Южно Казахстанская медицинская академия, г. Шымкент, Казахтан,

СКРИНИНГ КОЛЛЕКЦИОННЫХ ШТАММОВ (КОЛЛЕКЦИЙ) ЭНТОМОПАТОГЕННЫХ ГРИБОВ ПРОТИВ АЗИАТСКОЙ САРАНЧИ ПО ПРИЗНАКАМ ВИРУЛЕНТНОСТИ

Аннотация

В статье проведен первичный скрининг личинок азиатской саранчи в возрасте 2-3 лет по признакам вирулентности 25 изолятов, выделенных из насекомых, относящихся к различным систематическим группам грибов *Beauveria bassiana*. Из 25 штаммов пять штаммов в течение 21 суток (BCo1-14, BSc1-15, BSc2-15, BTr1-16, BPit-16) после завершения процесса инокуляции показали высокую биологическую активность против личинок, достигнув 90-100% летальности. Штаммы BCo1-14, BSc1-15, BSc2-15, BTr1-16, BPit-16, которые лучше всего повлияли на уровень и скорость летального исхода организма хозяина, а наибольшая биологическая активность наблюдалась у штамма BSc1-15, так как уровень летальности тест-насекомых после заражения составил всего 15 суток 100%. Наименьшую активность показал штамм BCi_4-14 в пределах 35,0-62,5%. В то же время уровень смертности личинок азиатских саранчовых в контрольном варианте (без обработки) за 21 сутки наблюдался 15,0±2,88%. Таким образом установлено что доля форм обладающих высокой вирулентностью (летальность 80-100%), от общего количества исследуемых штаммов не превышала 44%, а а доля слабых вирулентных форм (активность ниже 80%) составлял 56%.

Ключевые слова: энтомопатоген, вирулентность, *Beauveria bassiana*, штамм, культура, *Locusta migratoria migratoria* L., конидия, грибы, скрининг.

Сабденова У.О[4]., Еркекулова К.К.[5]

*[1]Қазақ ұлттық аграрлық зерттеу университеті, Алматы қ., Қазақстан, *doni_uli@mail.ru,*
[2] Agropark «Ontustik», Алматы обл., Қазақстан
[3]М.Әуезов атындағы ОҚУ, Шымкент қ., Қазақстан
[4]Абай атындағы Қазақ ұлттық педагогикалық университеті, Алматы қ., Қазақстан
[5]Оңтүстік Қазақстан медицина академиясы, Шымкент қ., Қазақстан

АЗИЯЛЫҚ ШЕГІРТКЕЛЕРГЕ ҚАРСЫ ЭНТОМОПАТОГЕНДІ САҢЫРАУҚҰЛАҚТАРДЫҢ КОЛЛЕКЦИЯЛЫҚ ШТАММДАРЫН (ТОПТАМАСЫН) ВИРУЛЕНТТІЛІК БЕЛГІЛЕРІ БОЙЫНША СКРИНИНГТЕУ

Аңдатпа

Мақалада *Beauveria bassiana* саңырауқұлағының әртүрлі систематикалық топтарына жататын бунақденелілерден бөлініп алынған 25 изоляттарының уыттылық белгілері бойынша азиялық шегірткесінің 2-3 жас шамасындағы дернәсілдеріне алқашқы скрининг жасалды. 25 штаммның ішінен бес штаммы 21 тәулікте (BCo1-14, BSc1-15, BSc2-15, BTr1-16, BPit-16) инокуляция процесі аяқталған соң, дернәсілдердің өлім деңгейі 90-100% жетіп, оларға қарсы жоғары биологиялық белсенділік көрсетті. Ие организмнің өлімге ұшырау деңгейі мен жылдамдығы бойынша ең жақсы әсер еткен штаммдар - BCo1-14, BSc1-15, BSc2-15, BTr1-16, BPit-16. Ал ең жоғарғы биологиялық белсенділік BSc1-15 штаммында байқалды, себебі залалданғаннан соң бар-жоғы 15-тәулікте тест-бунақденелілердің өлу деңгейі 100% құрады. Ең төменгі белсенділікті BCi_4-14 штаммы 35,0-62,5% аралығында көрсетті. Бақылау нұсқасындағы (өңдеусіз) азиялық шегіртке дернәсілдерінің 21-тәулікте өлу деңгейі 15,0±2,88% байқалды. Осылайша зерттеуге алынған штаммдардың жалпы санынан жоғары уыттылыққа (өлуі 80-100%) ие формаларының үлесі 44%-дан аспады, ал әлсіз уытты формаларының меншікті салмағы (белсенділігі 80%-дан төмен) 56%-ды құрағандығы анықталды.

Кілт сөздер: энтомопатоген, уыттылық, *Beauveria bassiana*, штамм, культура, *Locusta migratoria migratoria* L., конидия, саңырауқұлақ, скрининг.