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KAZIMIERZ ŻUKOWSKI, CECYLIA BAJAN [1], *ELŻBIETA POPOWSKA-NOWAK* [1]

EVALUATION OF EFFECT OF *METARHIZIUM ANISOPLIAE* ON REDUCTION OF NUMBERS OF *BLATTELLA GERMANICA L.*

OCENA WPŁYWU GRZYBA METARHIZIUM ANISOPLIAE NA REDUKCJĘ LICZEBNOŚCI *BLATTELLA GERMANICA L.*

National Institute of Hygiene
Department of Control of Biological Contamination
00–791 Warszawa, ul. Chocimska 24
Head: dr *K. Kanclerski*

[1] Institute of Ecology PAS
Department of Agrocenology
Head: prof. dr hab. *C. Bajan*

Estimates were given of effectiveness of infestation of B. germanica L. by M. anisopliae strains originating from different regions of Poland. The investigated strains caused high mortality among experimental insects. Especially effective in reducing numbers of B. germanica were strains Browsk and Pruszyn, which even at a low density of spores caused high mortality of the test insects.

INTRODUCTION

Various species of insecticidal fungi form known biological factors which play a substantial role in reducing harmful insects. These fungi due to their significance are the best investigated group. Most useful species were found in genera: *Beauveria, Metarhizium, Paecilomyces*, although they have been encountered in many other taxonomic groups such as: *Aschersonia, Aegerita, Fusarium, Hirsutella, Sorosprella etc.* Susceptibility of insects to various fungal species or strains is differentiated and it depends on many factors such as: humidity, temperature or even insects sex. Relationships between fungi and insects is multifold. Many species of fungi coexists with insects supplying them food. On dead insect tissues saprophytic fungi develop. A number of fungi are obligatory parasites of insects. They causes lethal disease known as mycoses. Finally fungi as microbioinsecticides were used as early as in the second half of 19 century.

Among biological factors used for controlling harmful insects some viruses, protozoans and fungi should be mentioned. Many of them were included in preparation proved to be useful biological means to control harmful insects. Up to know these preparations contain viruses which caused nuclear polyedroses, bacteria which caused bacterioses, eg. *Bacillus thuringiensis var. kurstaki* – killing *Lepidoptera larvae or B. thuringiensis var. israelenis* – lethal to mosquitos and other insects. Other preparation

has been registered halding some protozoans, eg. *Nosema locustae* or fungi, eg. *Hirsutella thompsoni* lethal for mites living on citrus plants and *Lagenidium giganteum* – a parasite of mosquito larvae.

Preparations based on insecticidal fungi such *Beauveria bassiana, Metarhizium anisopliae, Verticillium lecanii*, are being produced besides USA in such countries as former Czechoslovakia, Switzerland or China. In Poland on the basis conidial fungi: *B. bassiana* and *V. lecanii* an industrial production of biopreparation has been elaborated. Methods were patented (Patent No 288661, 1993, No 169335, 1996). *M. anisopliae* is a factor which caused so-called green muscardine disease name such on account of green coloration of hyphae.

The aim of these investigations was to determine pathogenic properties of chosen strains of *M. anisopliae* against *B. germanica* L. as well as to estimate their usefulness for controlling the numbers of these insects.

MATERIALS AND METHODS

Experiment were carried out on cockroach, *B. germanica* L. with various strains of *M. anisopliae* (Metsch). Strains of *M. anisopliae* were taken from Department of Agrocenology, Institute of Ecology, PAS. Five strains of M. anisopliae were investigated. Separate strains of *M. anisopliae* were introduced to the insects together with food mixture LSK used to feed laboratory animals. Each strain of fungi was added to food at 3 germ concentrations. Simultaneously water was supplied. Each glass container was suplemented with strip of filter paper accordion-pleated with width about 7 cm.

Experiments were conducted in weck jars at ambient temperatures on adults of both sexes of cockroach. The experimental insects originated from the culture run in the National Institute of Hygiene.

A total 1620 cockroaches of both sexes: 1350 nourished on food with admixture of fungus *M. anisopliae* with different germ density and 270 individuals used as the control were employed in the experiment.

RESULTS

Mortality of cockroaches feeding on food contaminated with fungus *M. anisopliae* derived from differend regions of Poland are presented in Table 1. The results thus obtained proved the high pathogenecity of these strains. During 30 days of experiment, at lowest density of fungus germs in food, mortality of females ranged 30 – 80% that of males: 59 – 85%. At the highets germ concentrations, on the other hand, mortality of cockroaches was higher: 58 – 90% in females, and 68 – 95% in males. After 50 days of experiment the mortality increased to 60 – 99% in females and 80 – 100% in males. In the control insects mortality was always low – 5%. Out of strains tested B strains of *M. anisopliae* from *Browsk* showed high pathogenecity. This strain even at the lowest density of spores showed high mortality in the two period of investigation (Tab. 1). Strain M of *M. anisopliae* deserved also attention. It showed high activity at all spore densities during the two experiments (Tab. I). At the lowest density of spores after 30 days of experiment it caused 80% mortality in females and 85% in males. At the highest spores densities the mortality of insects reached 90% in both sexes. After 50 days these values were still higher. It should be stressed thad the densities of spores

of strain M used were more than 9 times higher as compared with those used for *Browsk* strain (Tab. I).

Table I. Mortality of *B. germanica L.* (%) fed with food contaminated with various strains of fungus *Metarhizium anisopliae*.

No.	Strain *Metarhizium anisopliae*	Spore density 10^6 in food	% mortality after: 30 days females	30 days males	50 days females	50 days males	K (%)
1.	*M. anisopliae* B_1	24	65	70	78	80	5
		48	60	75	83	90	
		72	63	78	99	99	
2.	*M. anisopliae* B_2	70	30	58	68	80	
		140	55	70	73	80	
		210	58	68	78	83	
3.	*M. anisopliae* M	220	80	85	90	100	
		440	80	70	90	85	
		660	90	90	95	100	
4.	*M. anisopliae* ZP_1	50	35	65	60	90	
		100	50	50	80	95	
		150	85	95	95	100	
5.	*M. anisopliae* ZP_2	230	45	60	90	90	
		460	75	80	95	100	
		690	70	90	80	100	

1) B_1 – Browsk
2) B_2 – Brynek
3) M – Pruszyn
4) ZP_1 – Złoty Potok
5) ZP_2 – Złoty Potok
K – control

Pathogenecity of the two strains of fungus derived from Złoty Potok (ZP_1, ZP_2) was diversified. Strains ZP_1 causes highest mortality only when the food was treated with the highest amount of its germs, whereas strain ZP_2 caused the highest mortality both when average and the highest dose of spores was added to the food.

After elapse of 50 days mortality of insects increased considerably (Tab. I).

DISCUSSION OF RESULTS

The effect of different densities of *M. anisopliae* on cockroaches is presented in Table 1. These data point to a high effectiveness of the fungus against the insect tested.

Among examined strains some differences were found in the level of pathogenicity against cockroaches. The differences became perceivable when the lower density of spores of these strains was added to the insect food. Strains from localities Brynek and Złoty Potok (ZP_1 and ZP_2) caused lower mortality after 30 days of experiment

(30, 35 and 45%) as compared with strains derived from Browsk (B_1), *Pruszyn* (M), these strains caused 65 and 80% mortality (Tab. I).

Males treated with the same strains as females turned to be more susceptible after 30 days of treatment. Their mortality amounted to 58, 65 and 60% of strains from Brynek (B_2), Złoty Potok (ZP_1, ZP_2), respectively, and from Browsk (B_1) and Pruszyn (M) such mortality amounted to 70 and 85%, respectively. The obtained results after 30 and 50 days of experiments prove that the strains B_1 (from Browsk) and M (from Pruszyn) are most useful for controlling the cockroaches of all strains investigated.

Experiments with entomopathogenic fungi and harmful insects have been conducted earlier. Under the laboratory condition the pathogenic properties of several strains of *Beauweria bassiana* and *Pacilomyces farinosus* against cockroaches (*B. germanica L.*) were investigated [9,10]. The findings suggest that properly chosen strain of *B. bassiana* can control the numbers of *B. germanica.* Trial was also made to evaluate the entomopathogenity of *Paecilomyces farinosus* against the cockroaches [10]. The laboratory results point to the fact that pathogenicity against cockroaches is diversified depending on strains. Out of 10 strains of *P. farinosus* tested three caused high mortality amontg insects tested. Diversified pathogenicity found that mortality of test insects depended on strain, spore density and insect sex. This differentiation of pathogenicity of entomopathogenic fungi (*B. bassiana* and *P. farinosus*) against cockroaches was also corroborated by results of investigations carried out both strains of *M. anisopliae.* Pathogenicity of various species of fungi can be affected by different factors (eg. substratum type, temperature, humidity, etc). *Bajan* and *Kmitowa* [2] reported that entomopathogenic fungi can undergo various alteration leading to formation of groups, forms or strains *etc.*, more or less aggressive and pathogenic. The authors draw attention to taking into account this phenomenon when examining the usefulness of species of entomopathogenic fungi for biological control. Our studies on *B. bassiana*, *P. farinosus* [9, 10] and *M. anisopliae* seem to confirm this opinion. Among strains of species just mentioned, these were some which even at a low density of spores yielded high mortality of the test insects, and on the contrary, high density of spores of some strain caused low mortality of insects tested under the some experimental conditions. This phenomenon can result from vulnerability or resistance of insects against the fungal strain applied. *Bajan* and *Kmitowa* [2] reported that the observed differences in *P. farinosus* strains such as growth rate, spore formation time, amount of spores produced it and their pathogenicity against various developmental stages of Colorado beetle can be manifestation of appearance of different forms or morpho- physiological races or different biotypes of *P. farinosus.*

Entomopathogenic *B. bassiana* is already used for production of biopreparation to protect forest against *Dendrolimus sp.* [5] or to control a pest, *Hylobius abietis.* It was found that during 8 years of storage in the form of powder, *B. bassiana* has lost only 50% of its activity [8]. The Polish preparation based on *B. bassiana* spores have maintained viability in 50% after 3 years of storage at a temperature of 4°C (Bajan *et al.* [3]). In our southern neighbours, similarly as in Poland technology was elaborated to produce biopreparation based on spores of *B. bassiana* and *V. lecanii* to control the Colorado beetle and orchard and greenhouse pests [3, 6, 9]. We hawe also information on producing preparation with the use of spores of *B. brongniartii* in Switzerland [1].

In the Great Britain [4] liquid substratum was used to produce biopreparation based on conidial spores of *M. flavoviride.*

It should be underlined that the entomopathogenic fungi are more and more often used to control the plant pests. The best solution should be using the already elaborated technology of production of biological preparation, which could be successfully competitive with chemical insecticidal substances against harmful insects [3].

CONCLUSIONS

The obtained results pertain to vulnerability of cockroaches (*B. germanica L.*) to various strains of *M. anisopliae.* The indicate that:

1. effectiveness of tested strains of *M. anisopliae* against cockroach is high.
2. most pathogenic to cockroaches were strains M and Browsk of *M. anisopliae.*
3. *M. anisopliae* brings about the highest mortality of cockroaches in comparison with *B. bassiana* and *P. farinosus* hitherto examined.

K. Żukowski, C. Bajan, E. Popowska-Nowak

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Summary

Effectivenes of infestation *B. germanica L.* with strains of *M. anisopliae* originating from different regions of Poland. The tested strains have caused high mortality of the test insect. Especially effective in reduction were strains *Browsk* and *Pruszyn*, which even at relatively low spore density caused high mortality of examinated insects.

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Streszczenie

Oceniono skuteczność porażania *B. germanica L.* przez szczepy grzyba *M. anisopliae* pochodzące z różnych okolic Polski. Testowane szczepy powodowały dużą śmiertelność wśród doświadczalnych owadów. Szczególnie skuteczne w redukcji liczebności badanych populacji prusaków były szczepy *Browsk* i *Pruszyn*, które nawet przy stosunkowo niskiej gęstości zarodników grzyba wywoływały wysoką śmiertelność wśród doświadczalnych owadów.

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