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**INFLUENCE OF TEMPERATURE ON EFFECTIVENESS
OF PATHOGENIC FUNGI FOR CONTROL OF WESTERN
FLOWER THRIPS *Frankliniella occidentalis* (PERGANDE)
(*THYSANOPTERA: THRIPIDAE*)**

**WPLYW TEMPERATURY NA SKUTECZNOŚĆ GRZYBÓW
PASOŻYTNICZYCH W ZWALCZANIU WCIORNASTKA ZACHODNIEGO
Frankliniella occidentalis (PERGANDE) (*THYSANOPTERA: THRIPIDAE*)**

Abstract: *Frankliniella occidentalis* is the most damaging pest of protected cucumbers in Poland and reliable control measures are required that are compatible with other components in the Integrated Pest Management programme. Successful control of this pest is very difficult to achieve due to life cycle where some stages are not available to the insecticides. In practice, entomopathogenic fungi are mostly used in control of insect pest of greenhouse crops because environmental factors such as temperature and humidity are optimal for their development and efficacy. Entomopathogenic fungi are able to have a major role in the regulation of insect populations in greenhouse conditions. The study shows efficacy of following pathogenic fungi: *Paecilomyces lilacinus*, *Beauveria bassiana* and *Acremonium* sp depending on temperatures. The fungus *Beauveria bassiana* was effective against larvae and adults of *F. occidentalis* when applied at the temperature of 25 °C. *Acremonium* sp. was more effective against western flower thrips at higher temperatures.

Keywords: pathogenic fungi, temperature, *Frankliniella occidentalis*

For many years entomopathogenic fungi have been applied in the biological control of the most severe greenhouse pests, such as aphids, mites, greenhouse whiteflies and western flower thrips. However, their efficacy depends upon several abiotic factors and therefore, results are not always satisfactory [1, 2]. In Poland only one bioinsecticide is available based on fungus *Isaria fumosorosea* (old name – *Paecilomyces fumosoroseus*). When applied together with the parasitoid *Encarsia formosa* it can sufficiently decrease populations of the whitefly [3, 4].

The main objective of the research was to evaluate the influence of temperature on pathogenicity of the Polish strain of three species of pathogenic fungi such as: *Paecilomyces lilacinus*, *Beauveria bassiana*, *Acremonium* sp. at different stages of *Frankliniella occidentalis*.

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Materials and methods

Experiments were carried out in laboratory conditions. *P. lilacinus*, *Acremonium* sp. and *B. bassiana* were applied as a suspension of conidia. Spore suspensions were prepared by harvesting spores grown on PDA by washing the cultures with tap water plus Triton X-100 (0.05 %). The spores were collected from a 12-day-old fungus culture grown on potato-dextrose-agar medium (PDA). Spores were harvested by adding 20 cm³ of sterile distilled water and scraped off with a sterile cell scraper and then homogenized in a glass homogenizer. The concentration of conidial suspension was subsequently adjusted to 10⁸ conidia cm⁻³ using a Gorjaev haemocytometer. The isolates were maintained in a collection at the Department of Biological Control and Quarantine, Institute of Plant Protection – PIB, Poznan, Poland.

In laboratory tests, 10 individuals of different stages of western flower thrips were placed on bean leaves covered with moistened filter paper in Petri dishes (9 cm diam.). These leaves were sprayed with a spore suspension in sterile water at a concentration of 10⁸/cm³ with Triton X-100. The dishes were preserved during tests at 20 °C, 25 °C and 30 °C temperatures. Observations were conducted 2, 5 and 7 days after a treatment and each time the number of live and dead pest individuals were recorded. The degree of fungal infection was evaluated under a microscope.

There was one Petri dish with bean leaves with 10 individual stages of thrips per treatment, with 5 replications.

Data were analyzed by ANOVA after angle transformation. The differences were examined with the Tukey's test at $p < 0.05$.

Results and discussion

P. lilacinus was most successful when applied against soil stages of *Frankliniella occidentalis*, this fungus caused about 70 percentage of mortality. No effect of tested temperatures was observed on effectiveness *P. lilacinus* for control soil stages of western flower thrips. This fungus is effective against different species of plant pathogenic nematodes, and mainly infects eggs and females [5, 6]. In Poland, a domestic strain of this fungus species was investigated as a potential biological agent against root-knot nematodes in greenhouses [7]. There is no information in the literature about using *P. lilacinus* against *F. occidentalis*. Our results showed that *P. lilacinus* could also be recommended for control of thrips.

Table 1

Mean percentage mortality (\pm sd) of soil stages of *Frankliniella occidentalis*, on *P. lilacinus* treated and control in different temperatures

Treatment	Mortality [%]		
	20 °C	25 °C	30 °C
1. <i>P. lilacinus</i>	68 \pm 4.8 b	72 \pm 8.2 b	70 \pm 6.4 b
2. Control	0 \pm 0.0 a	0 \pm 0.0 a	0 \pm 0.0 a

Means marked by the same letter in each column are not significantly different, $p < 0.05$, Tukey's test)

Table 2

Mean percentage mortality (\pm sd) of larvae (L1) of *Frankliniella occidentalis*, on *Acremonium* sp. and *B. bassiana* treated and control in different temperatures (7 days observation).

Treatment	Mortality [%]		
	20 °C	25 °C	30 °C
1. <i>B. bassiana</i>	38 \pm 4.6 b	84 \pm 8.8 c	40 \pm 4.6 b
2. <i>Acremonium</i> sp.	48 \pm 4.4 b	52 \pm 10.2 b	84 \pm 2.8 c
3. Control	4 \pm 0.8 a	4 \pm 0.2 a	2 \pm 0.8 a

Means marked by the same letter in each column are not significantly different, $p < 0.05$, Tukey's test)

Table 3

Mean percentage mortality (\pm sd) of larvae (L2) of *Frankliniella occidentalis*, on *Acremonium* sp. and *B. bassiana* treated and control in different temperatures (7 days observation).

Treatment	Mortality [%]		
	20 °C	25 °C	30 °C
1. <i>B. bassiana</i>	52 \pm 4.2 c	80 \pm 6.2 c	60 \pm 2.2 b
2. <i>Acremonium</i> sp.	32 \pm 2.0 b	42 \pm 2.4 b	76 \pm 4.4 c
3. Control	2 \pm 0.4 a	4 \pm 1.0 a	2 \pm 0.2 a

Means marked by the same letter in each column are not significantly different, $p < 0.05$, Tukey's test)

Generally, the greatest mortality of larvae *F. occidentalis* was obtained with *Acremonium* sp. (84 % and 76 %) at the temperature of 30 °C. If the temperature increases, the mortality of different stages will also increase. This isolate was isolated from *Trialeurodes vaporariorum* in Palm House in Poznan. The effect of temperature was recorded for fungus *B. bassiana*, where larvae and adults of *F. occidentalis* mortality was significantly greater at 25 °C than at 20 °C and 30 °C. The fungus caused 92 % mortality of adults 7 days after application (Fig. 1). Other authors also examined the efficacy of *B. bassiana* strain. They obtained similar results [8, 9].

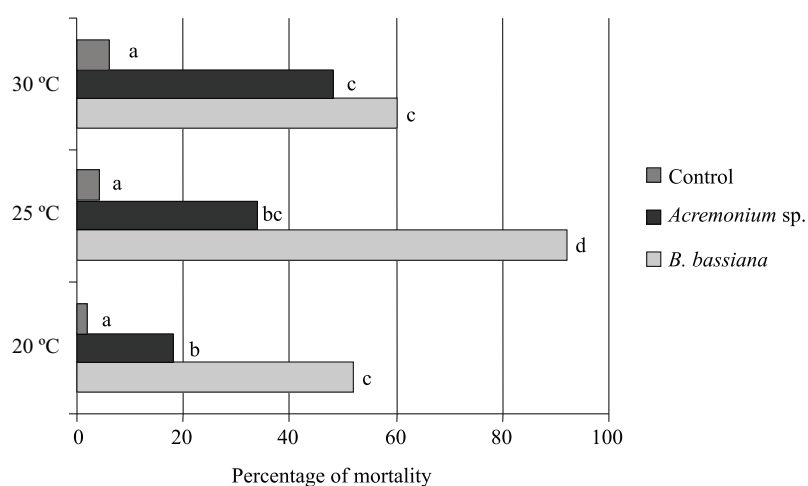


Fig. 1. Mean percentage mortality of *Frankliniella occidentalis* adults on *Acremonium* sp. and *B. bassiana* treated and control (7 days observation).

Microbiological control of arthropod pests using entomopathogenic fungi is not a new idea. In practice, entomopathogenic fungi are mostly used in control of insect pests of greenhouse crops because environmental factors such as temperature and humidity are optimal for their development and efficacy. However, application of natural enemies and entomopathogenic nematodes is still the most common biological control method. Chemical products are applied in cases of failure of the biological methods or their insufficient effect. According to the Polish Act on Plant Protection issued on December 18th 2003, biological methods should be used prior to any application of chemical products. Thus, biological control is a priority in plant protection, and *P. lilacinus*, *B. bassiana*, *Acremonium* sp. seem to be excellent candidates to be used in greenhouse biocontrol programs. The pathogenic fungi are good alternative for control pests in greenhouse crops.

Conclusions

1. The fungus *P. lilacinus* was effective against prepupal and pupal stages of *Frankliniella occidentalis* when applied at different temperatures, from 20 °C to 30 °C. This is the first report on efficacy of this fungus in western flower thrips control in Poland or anywhere else.
2. *B. bassiana* was the greatest pathogenic to L1-L2 larvae and adults of western flower thrips when fungus was applied at the temperature of 25 °C and *Acremonium* sp. was more effective at temperature 30 °C.

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**WPLYW TEMPERATURY NA SKUTECZNOŚĆ GRZYBÓW PASOŻYTNICZYCH
W ZWALCZANIU WCIORNASTKA ZACHODNIEGO *Frankliniella occidentalis* (PERGANDE)
(THYSANOPTERA: THRIPIDAE)**

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Abstrakt: Wciornastek zachodni (*Frankliniella occidentalis*) należy do najgroźniejszych szkodników występujących w uprawach szklarniowych. Zwalczenie tego szkodnika za pomocą środków chemicznych i entomofagów nie rozwiązało problemów z jego występowaniem w uprawach szklarniowych. W doświadczeniach laboratoryjnych przebadano wpływ temperatury 20 °C, 25 °C i 30 °C na skuteczność trzech gatunków grzybów pasożytniczych: *Paecilomyces lilacinus*, *Beauveria bassiana* i *Acremonium* sp. w ograniczaniu liczebności różnych stadiów rozwojowych wciornastka zachodniego. Doświadczenia wykazały, że powyższe temperatury nie mają wpływu na skuteczność grzyba *P. lilacinus* w zwalczaniu szkodnika. Inna sytuacja wystąpiła w przypadku grzyba *B. bassiana*, gdzie optymalną temperaturą dla jego stosowania okazała się temperatura 25 °C, natomiast dla grzyba *Acremonium* sp. stwierdzono, że wraz ze wzrostem temperatury wzrasta skuteczność tego gatunku w zwalczaniu wciornastka zachodniego.

Słowa kluczowe: grzyby pasożytnicze, temperatura, *Frankliniella occidentalis*