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INVESTIGATIONS ON THE CONTROL OF *Sphaerolecanium prunastri* F. (*Homoptera*, *Coccinea*) BY ENTOMOPATHOGENIC NEMATODES UNDER CONTAMINATED CONDITIONS

BADANIA NAD WPŁYWEM NICIENI ENTOMOPATOGENNYCH NA *Sphaerolecanium prunastri* F. (*Homoptera*, *Coccinea*) W WARUNKACH ZANIECZYSZCZEŃ KOMUNIKACYJNYCH

Abstract: Scale insects (*Coccinea*) are the primary pests of fruit, ornamental and forest trees worldwide. Losses made by scale insects consist in sucking assimilates and causing pathological histological changes. Scale insects are controlled with many methods, most often with chemical insecticides. Biopreparations based on entomopathogenic nematodes may be an alternative way. The effect of nematodes *Heterorhabditidae* and *Steinernematidae* on globose scale fungi was studied under laboratory conditions but they were collected from the combustion gases area near a PKS bus station. Invasive larvae of the nematodes *H. megidis*, *H. bacteripphora*, *S. affinis*, *S. feltiae*, *S. carpocapsae* were used for experiments. *H. megidis* caused 53 % insect mortality and appeared to be most effective. Nematodes of the family *Steinernematidae* were not able to penetrate the body of the globose scale.

Keywords: entomopathogenic nematodes**,** globose scale**,** scale insects, anthropogenic pollution

Scale insects (*Coccinea*) belong to the order *Homoptera*. They are primary pests of fruit as well as ornamental and forest trees worldwide. Losses brought by these insects consist in taking up assimilates and triggering pathological histological changes in plants. They are also the virus disease vectors and large amounts of honeydew excreted by these insects become a medium for fungi [1].

Many methods are used to control scale insects; most popular are the chemical method with the use of insecticides. Zolone, Owadofos, Anthio, Lannante 20L, Ultracid 40 EC are the insecticides now recommended for this purpose [2].

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Insecticides are the means of great efficiency which cause rapid extinction of pests; they are, however, toxic and mutagenic. The substances are easily dispersed in the environment by air and water. Many of them have long waiting periods which means long persistence in soil and a pose threat to the environment. Moreover, chemicals may accumulate in plants and finally reach consumers as dangerous residues tending to accumulate in human blood, fat tissues and milk. There are premises to expect that pesticides are responsible for carcinogenic changes [3]. Common phenomenon of resistance to increasing doses of pesticides observed in many pests is another negative consequence of their application. Moreover, the use of pesticides is harmful to beneficial insects and may deform plant anatomy and physiology [2].

Now, due to a general trend of abandoning chemical pest control, alternative methods are being explored. Such methods include environment friendly biological methods. Pheromone traps with juvenile hormones are used to control scale insects. Their action consists in hampering fertility and growth of insects [4]. The number of scale insects is also controlled by the introduction of predators and parasitoids [1].

In the presented study an attempt was made to check the sensitivity of the globose scale (*Sphaerolecanium prunastri*) collected from the combustion gases contaminated environment, to entomopathogenic nematodes *Steinernematidae* and *Heterorhabditidae*. There is no data on the entomopathogenic nematodes – scale insects system in the world literature so it seems reasonable to check the sensitivity of the latter to selected species of entomopathogenic nematodes.

Material and methods

The globose scale insects were taken for experiments from twigs of a host tree (plum tree) growing on the grounds of a bus station. Trees constantly affected by exhausts from buses were heavily infested by the insects. Twigs were cut into small pieces (ca 9 cm) with several to several dozen insects (larvae of the second growth stage) on each.

Invasive larvae of entomopathogenic nematodes were taken from constant laboratory culture of the Department of Zoology. Larvae are kept in a fridge at a temperature of 4 ^{o}C. Every two months the culture is renewed to maintain uniform pathogenic properties.

Twigs with globose scales were placed in small test tubes with water to maintain viability of the plant and insects. Test tubes were sealed with cotton wool and paraffin. Such prepared twigs with insects were placed in Petri dishes lined with double layer of filter paper. Invasive larvae of a given nematode species at a dose of 4 thousand invasive larvae per 1 cm^3 of water were introduced to Petri dishes. The dishes were then sealed with paraffin and placed in a thermostated chamber at a temperature of 25 ^{o}C.

Five nematode species: *Heterorhabditis megidis*, *Heterorhabditis bacteriophora*, *Steinernema feltiae*, *Steinernema affinis*, *Steinernema carpocapsae* were used in the experiment. Globose scale larvae treated with water devoid of nematodes were the control sample. Mortality of the larvae was checked during 6 days. Dead insects were dissected in order to test whether nematodes were the reason of their death.

Results and discussion

Performed experiments allowed for estimating mortality of the globose scale *Sphaerolecanium prunastri*. Results (Table 1) indicate that the highest mortality of the larvae (95 % as compared with 45 % in the control) was caused by the nematode *H. bacteriophora*. High mortality of the globose scale larvae (Table 2) was a result of the presence of hymenopteran larvae of the family *Chalcidoidae* in their body. As known from the literature [5] most frequent species of *Chalcidoidae* grown from the body of the globose scale were: *Discodes* spp., *Microterys hortulanus*, *Coccophagus lyciminia*. Other literature data [6] indicate a high degree of infection (up to 90 %) in larvae of the II growth stage of the globose scale by *Chalcidoidae*. The latter play a role of superparasites. The larvae of the globose scale are small organisms (1–4 mm) [7]. *Chalcidoidae* present in their bodies make penetration of the second potential parasite impossible.

Table 1

Mortality of the globose scale caused by entomopathogenic nematodes [%]

Nematode species	Mean	SD	Control
H. megidis	88	0.14	86
H. bacteriophora	95	0.05	45
S. affinis	89	0.05	80
S. feltiae	71	0.02	70
S. carpocapsae	69	0.03	70

Table 2

Mortality of the globose scale caused by the presence of *Chalcidoidae* [%]

Nematode species	Mean	SD
H. megidis	19	0.05
H. bacteriophora	73	0.05
S. affinis	60	0.07
S. feltiae	56	0.08
S. carpocapsae	62	0.07

Table 3

The extensity of invasion of the globose scale
by entomopathogenic nematodes [%]

Nematode species	Mean	SD
H. megidis	53	0.17
H. bacteriophora	3	0.05
S. affinis	0	0
S. feltiae	0	0
S. carpocapsae	0	0

The extensity of invasion of the globose scale larvae by nematodes is presented in Table 3. The data demonstrate that only the *H. megidis* nematode was able to penetrate and infest the body of the globose scale. The extensity of infection of the insects' larvae was 53 %. The presence of developing nematode population in the insects' body was never found when *Steinernematidae* were used in the experiment. Probably tough body structures did not allow nematodes to penetrate to the insect interior. *Heterorhabditidae* possess a cuticular tooth in the anterior part of their body which enables them to penetrate the globose scale [8].

Conclusions

1. Entomopathogenic nematodes of the family *Steinernematidae* (*S. affinis*, *S. carpocapsae*, *S. feltiae*) do not penetrate the body of the globose scale collected from the combustion gases contaminated environment.
2. The globose scale (*Sphaerolecanium prunastri*) is sensitive to nematodes of the family *Heterorhabditidae*.
3. The globose scale infected by hymenopterans (*Chalcidoidae*) is not attractive to entomopathogenic nematodes.

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Abstrakt: Czerwce (*Coccinea*) w skali światowej zajmują pierwsze miejsce jako szkodniki drzew owocowych, ozdobnych, leśnych i innych. Szkody przez nie powodowane polegają na pobieraniu asymilatów i wywoływaniu u roślin patologicznych zmian histologicznych. Czerwce zwalcza się wieloma metodami, z których najczęściej stosowane są środki chemiczne – insektycydy. Alternatywą dla nich mogą być biopreparaty z wykorzystaniem nicieni entomopatogennych. W warunkach laboratoryjnych zbadano wpływ nicieni *Heterorhabditidae i Steinernematidae* na misecznika tarniowego pozyskanego z terenów zanieczyszczonych spalinami komunikacyjnymi. Do doświadczeń użyto larw inwazyjnych nicieni *H. megidis*, *H. bacteriophora*, *S. affinis*, *S. feltiae*, *S. carpocapsae*. Najskuteczniejszy okazał się *H. megidis*, który spowodował 53-procentową śmiertelność owadów. Nicienie *Steinernematidae* nie wykazują zdolności penetracji do ciała miseczników.

Słowa kluczowe: nicienie entomopatogenne, misecznik tarniowy, czerwce, zanieczyszczenia antropogenne