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THE EFFECT OF ORGANIC FERTILIZERS ON FUNGI PARASITIZATION OF BEET CYST NEMATODE (*HETERODERA SCHACHTII* SCHMIDT) EGGS IN SUGAR BEET CULTIVATED IN A THREE YEARS ROTATION

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Abstract. In 1997-1998 the effect of manure, straw and mustard on fungi parasitization of eggs of beet cyst nematode in three years sugar beet rotation was investigated. The highest eggs parasitization by fungi was observed inside cysts from plots with spring barley cultivation and sugar beet as a forecrop. Straw fertilizer favored more fungi parasitization than manure. Three species of nematophagous fungi were isolated from eggs: *Cylindrocarpon destructans*, *Paecilomyces lilacinus* and *Verticillium chlamydosporium*.

Key words: sugar beet nematode, nematophagous fungi, fertilizers

I. INTRODUCTION

Sugar beet cyst nematode (*Heterodera schachtii* Schmidt) is the most significant pest of sugar beet plants. Its direct and indirect noxiousness or harmfulness do not fully appear in every field every year (Banaszak 1997). There are many factors that can have an influence on this nematode: spring weather, seeding data, selection of herbicides, zoocides crust and soil born nematopathogenic fungi. The important role of fungi in reducing sugar beet nematode population is well known (Banaszak et al. 1990; Crump and Kerry 1986; Kerry and Mullen 1981; Kerry 1988; Morgan-Jones et al. 1986; Sosnowska 1996). In spite of many papers, this subject still required more explanations and new experiments to understand this role. Supposing changes in technology of sugar beet cultivation, especially in organic fertilization will have the effect on pathogenic fungi development in sugar beet nematode population.

The purpose of these experiments was to evaluate the effect of organic fertilizers on fungi parasitization of beet cyst nematode eggs population. There were several factors evaluated during spring, summer and autumn time like:
- manure as a fertilizer – traditional technology of sugar beet cultivation,
- post yield fertilizer – mustard as a plants against nematode (was left during winter time without ploughing for moulting),
- straw as a fertilizer – come from forecrop before sugar beet in plant rotation.

All factors were included in three years sugar beet rotation, which is added in agriculture practice in many regions of sugar beet cultivation in Poland.

II. MATERIALS AND METHODS

Trials were conducted in 1997-1998 in Experimental Station in Koniczynka near Toruń on brown soils. Soil samples were taken from plots with 100 m^2 size and were replicated four times. Sugar beet were cultivated from 1992 in a three year rotation. Manure come from swine and used in dose 40 t/ha. Mustard cultivar Salvo was sowing in dose 20 kg/ha. Straw fertilizer was winter wheat as a forecrop which was cut with special machine and then fertilized by urea.

Soil samples were taken from fields with sugar beet cultivation and with spring barley as a post crop after sugar beet. From each sample 200 g of soil was weigh, washed with water on sieve and filtered to received cysts. Surface of cysts were washed several times in sterile water. Than transferred to sterile distilled water containing 0.05% of streptomycin sulfate. Samples were incubated for 2-3 days at 22°C and 10 randomly chosen cysts from each samples (40 cysts) were disrupt and fungi parasitization was estimated under a microscope. To facilitate identification some eggs were transferred to Petri dishes with potato dextrose agar (PDA) to allow fungi to grow and sporulate.

Analysis of variance with Tukey's multiple comparison tests was used to determine differences.

III. RESULTS AND DISCUSSION

In 1997 we determined a small amount of cysts and different percent of fungi parasitization in soil samples taken from plots of sugar beet cultivated after 2 years break (in 1995 spring barley was cultivated, in 1996 winter wheat was a crop). In spring the highest eggs mortality was observed inside cysts from plots with mustard moulting – 42%, in summer inside cysts from plots fertilized by manure – 45% and in autumn inside cysts from plots fertilized with straw – 32% (Fig. 1). In 1997 also higher amound of cysts was observed in samples taken from plots of spring barley crop and sugar beet as a forecrop than in samples taken from plots of sugar beet cultivation. There were 102 cysts in 200 g of soil samples as compared with 30 cysts. Clear differences were observed in eggs parasitization by fungi on plots where sugar beet was a forecrop and also an influence of type of fertilizers was noticed. There was higher eggs mortality on plots fertilized with straw and mustard than on plots fertilized with manure (Fig. 2). Fungi parasitization of eggs was 34% higher in spring in cysts from plots fertilized with straw than from plots fertilized with manure (45% higher of parasitization in summer, and 40% higher of parasitization more in autumn) (Fig. 2). While on the contrary fungi parasitization of eggs from plots with mustard as moulting crop was 15% higher in spring time than in cysts from plots fertilized with manure (44% higher of parasitization in summer, and 40% higher of parasitization in autumn). Results were significantly different at 5% (Fig. 2). When sugar beet was cultivated differences in eggs parasitization was not so clear when spring barley was cultivated. It is connected with sugar beet nematode life cycle when sugar beet plant emanated special extracts which influences nematode development, and number of eggs inside the cysts is less than inside cysts when spring barley is cultivated.

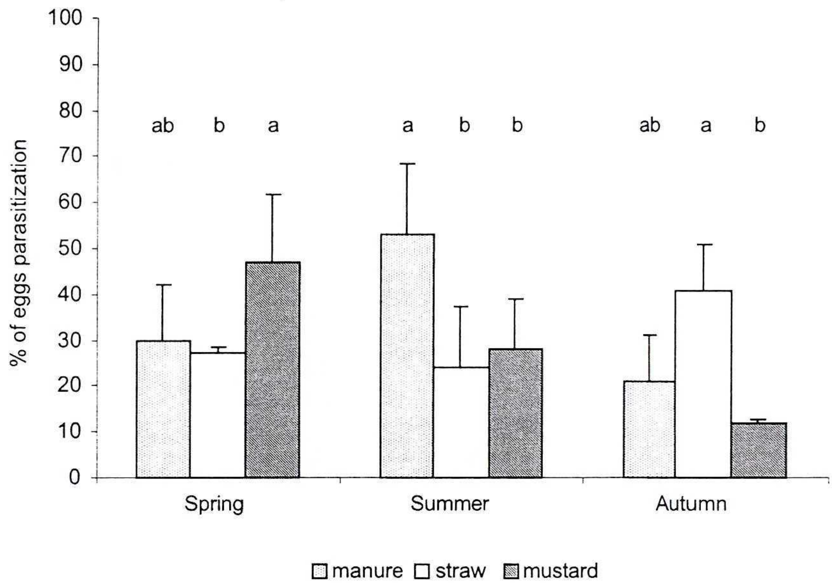

Fig. 1. Infection of *H. schachtii* eggs with fungi from plots with sugar beet cultivation and spring barley as a forecrop (1997).
Different letters above the bars indicate significant differences ($P < 0.05$) between treatments

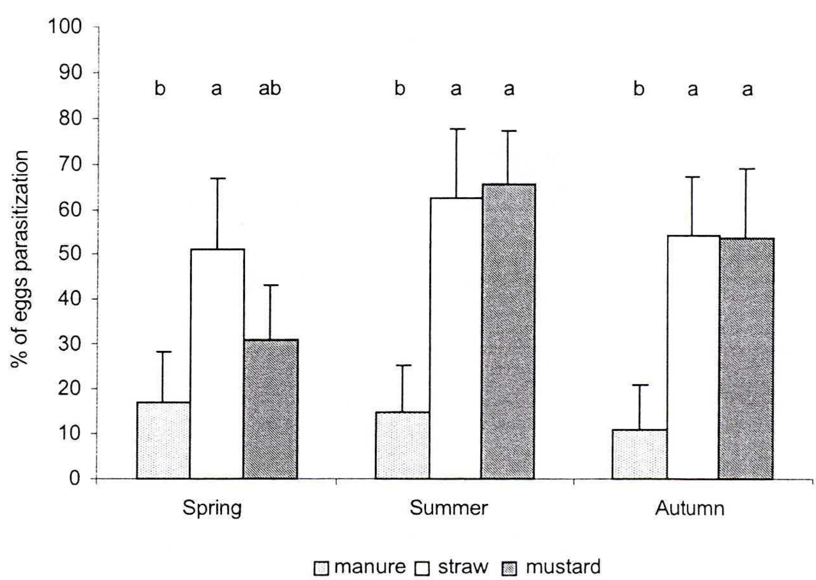

Fig. 2. Infection of *H. schachtii* eggs with fungi from plots with spring barley cultivation and sugar beet as a forecrop (1997).
Different letters above the bars indicate significant differences ($P < 0.05$) between treatments

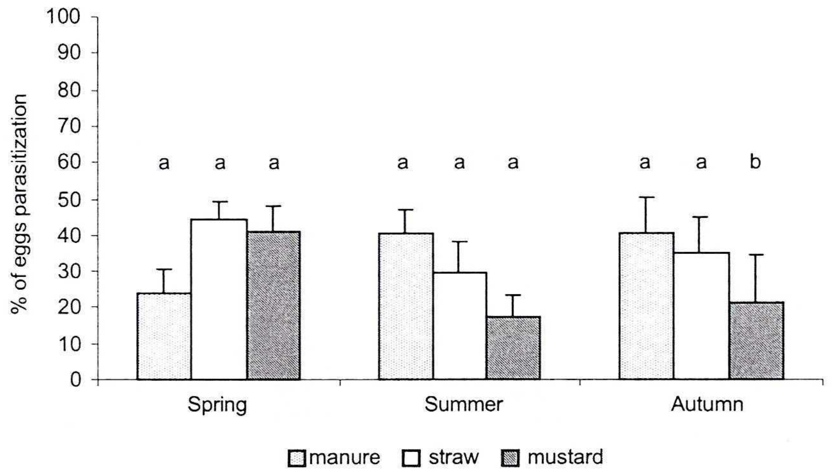

Fig. 3. Infection of *H. schachtii* eggs with fungi from plots with sugar beet cultivation and spring barley as a forecrop (1998).
Different letters above the bars indicate significant differences ($P < 0.05$) between treatments

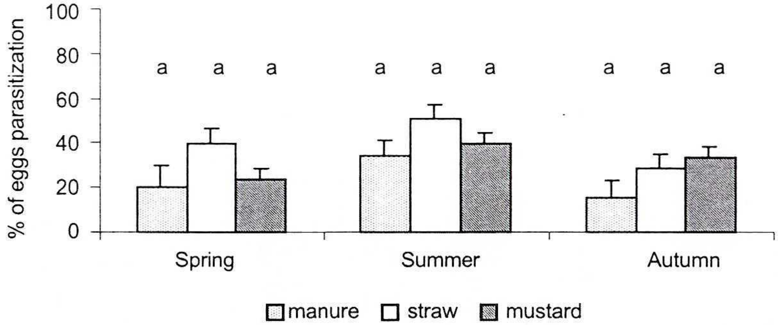

Fig. 4. Infection of *H. schachtii* eggs with fungi from plots with spring barley cultivation and sugar beet as a forecrop (1998).
Different letters above the bars indicate significant differences ($P < 0.05$) between treatments

In 1997 more than ten fungi species were isolated from eggs of *H. schachtii*. *Fusarium* species dominated. *F. oxysporum* was the most often isolated specimen and also it occurred on all plots during vegetative season. During spring time two species of nematophagous fungi were isolated from eggs from plots fertilized with straw. There were *Cylindrocarpon destructands* and *Verticillium chlamydosporium*. On plots with mustard moulting these species did not occur at this time but fungi from *Gliocladium* and *Trichoderma* species were isolated. In spring *C. destructans*, *Verticillium* spp. and *Gliocladium* spp. were isolated from eggs from plots fertilized with manure. *V. chlamydosporium* did not occurs on this plots in spring.

In summer *Paecilomyces lilacinus*, *Scopulariopsis* spp. and *Verticillium* spp. were additionally isolated from eggs obtained from plots fertilized with straw. *V. chlamydosporium* was only isolated from samples taken in autumn from eggs obtained from plots fertilized with manure and mustard. Results showed that three species of nematophagous fungi *C. destructans, P. lilacinus* and *V. chlamydosporium* were isolated from eggs from plots fertilized with straw. *P. lilacinus* was not isolated from plots fertilized with manure. Presumably these three species decreased cyst beet nematode population on plots fertilized with straw in Koniczynka, where higher fungi infection on eggs inside cysts was observed. There was a correlation between fungi parasitization of eggs and number of cysts in samples. The number of cysts was smaller on plots fertilized with straw than with manure. For example, in spring we observed 37 cyst in samples taken from plots fertilized with straw whereas 102 cyst were evaluated in samples taken from plots fertilized with manure. In summer there was 9 cyst in samples taken from plots fertilized with straw and 46 cyst in samples taken from plots fertilized with manure.

Our results showed that straw was the good base and the medium for nematophagous fungi and enriched soil with fungi species which did not occurred on manure.

Already Jones in 1956 wrote about influence of plants, soil and parasites on cysts beet population (Jones 1956). Brzeski and Sandner later in 1974 wrote that organic matter from plants stimulated fungi growth, but manure did not. Our observations in Koniczynka confirm these conclusions, although mode of action of fertilizers on fungi is not clear and results of experiments are incompatible. Duddington et al. (1956) wrote that there is not interaction between organic matter and soil fungi and he observed that cyst beet nematode population decreased but the reason was due to increasing of microflora and fauna in soil with organic matter and increasing of oxygen competition between this components. As he observed it decreased larvae hatching from cysts.

Nicolay at al. (1990) experiments showed an increase in pathogenic fungi activity on *H. schachtii* eggs in natural conditions on straw and manure. However extract from mustard and radish reduced growth of *Verticillium chlamydosporium* in vitro tests. Hoffman-Hergarten et al. (1993) did not observed any influence of mustard and straw from barley on trapping fungi *Arthrobotrys* spp., whereas in Russia (Galimzynova et al. 1990) the best growth of *Deuteromycotina* fungi was observed during first stage of decomposition of straw from wheat, pea and manure.

In 1998 we also obserwed higher fungi parasitization on eggs from cysts of *H. schachtii* from plots fertilized with straw then with manure on fields in Koniczynka. However there were not significantly different at 5% as it was in previous year. The highest eggs parasitization was observed on plots with sugar beet cultivation after two years break fertilized in spring with straw, and in summer, and in autumn fertilized with manure (Fig. 3). As in previous year we obserwed the highest eggs parasitization in cysts from plots with spring barley cultivated after sugar beet crop fertilized with straw. In contrast the lowest eggs parasitization was observed in cysts from plots fertilized with manure (Fig. 4). Mean values were not significantly different at 5%. The same fungi species were isolated in 1998 as in 1997.

The experiments conducted in 1997-1998 on Koniczynka fields showed that nematophagous fungi reduced cyst beet nematode population. Different type of fertilizer affecetd fungi effectiveness. The trend toward increasing eggs parasitization by fungi in cysts from fields with straw fertilizer was observed. This occur mainly on plots with barley crop cultivation after sugar beet as a forecrop in 3 years rotation. In addition more amount of nematophagous fungi that decreased cysts population was observed on these plots as compared with plots fertilized with manure.

Intensive research on straw fertilization began in West Europe in the 1960's (Misterski 1963). At this time plowing small grain stubbles and straw was not common in agricultural production in Poland. Also there was hardly any research conducted. Unquestionable is importance of straw fertilization as compared to manure. The straw fertilizer benefits farm economicly. Straw has a positive effect on organic matter and nutrients balance in soil (Schonberger 1995; Kuszelewski 1970), and on microfauna and flora development (Misterski 1963). Maybe these straw properties favoured soil fungi development and caused fungi species diversity that decreased cyst beet nematode population on fields in Koniczynka. Experiments are still being conducted. Also editional tests are being carried out on influence of soil extracts from different fertilizers on nematophagous fungi species.

IV. CONCLUSIONS

1. The highest eggs parasitization by fungi was observed in 1997-1998 inside cysts from plots with sugar beet as well as from plots with spring barley cultivation. It reached 60% of eggs mortality in summer.
2. Straw fertilizer and mustard favored more fungi parasitization of *Heterodera schachtii* eggs than manure as a fertilizer in spring and in autumn when spring barley was cultivated and sugar beet was as a forecrop.
3. Three species of nematophagous fungi were isolated from eggs in cysts from plots fertilized with straw: *Cylindrocarpon destructans*, *Paecilomyces lilacinus* and *Verticillium chlamydosporium*. *P. lilacinus* did not occur on plots fertilized with manure and mustard. *V. chlamydosporium* occurred occasionally on these plots.

V. LITERATURE

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WPŁYW NAWOŻENIA ORGANICZNEGO NA SPASOŻYTOWANIE JAJ MĄTWIKA BURAKOWEGO (*HETERODERA SCHACHTII*) PRZEZ GRZYBY W TRZYLETNICH ROTACJACH UPRAWY BURAKA CUKROWEGO

STRESZCZENIE

W latach 1997-1998 na polach Rolniczego Zakładu Doświadczalnego w Koniczynce pod Toruniem badano stopień spasożytowania jaj mątwika burakowego przez grzyby w zależności od nawożenia pól słomą, gorczycą i obornikiem, podczas uprawy buraka cukrowego w 3-letniej rotacji. Największe spasożytowanie jaj przez grzyby obserwowano na poletkach, na których uprawiano jęczmień jary w rok po uprawie buraka cukrowego. Spasożytowanie jaj było ponadto większe na poletkach nawożonych słomą niż na poletkach nawożonych obornikiem. Na poletkach, na których uprawiano burak cukrowy spasożytowanie jaj nie było już istotnie uzależnione od rodzaju nawożenia, co jest związane z cyklem rozwojowym szkodnika.

Izolowano trzy gatunki grzybów nicieniobójczych, które redukowały liczebność populacji szkodnika na polu. Były to: *Cylindrocarpon destructans*, *Paecilomyces lilacinus* i *Verticillium chlamydosporium*.

Book Review

Duveiller E., Dubin H.J., Reeves J., McNab A. (rds.) 1998. Helminthosporium Blight of Wheat: Spot Blotch and Tan Spot. CIMMYT, UCL, BADC, Mexico 376 pp. ISBN 970-648-001-3.

This book presents the Proceedings of an International Workshop held by CIMMYT at its headquarters in El Batan, Mexico from 9 to 14 February, 1997. The workshop was co-sponsored by the Belgian Administration for Development and Catolique University of Louvain, Belgium and attended by 54 specialists from 21 countries, including China, Russian Federation, Uzbekistan and Hungary.

This workshop was a response to increasing incidence of helminthosporium blight of wheat: spot blotch, caused by *Bipolaris sorokiniana*, and tan spot, caused by *Pyrenophora tritici-repentis*. Fifty seven papers were presented at the workshop covering the following topics: pathogen variability, disease scoring, effect of cropping practices, chemical and cultural control, breeding strategy and multilocation testing.

Out of several positive outcomes of this workshop is clearing of nomenclature used for *Helminthosporium* spp. fungi causing leaf blight. H. Maraite (Belgium) presented a clear overview on evolution of nomenclature of *Helminthosporium sativum* Pammel, King & Bakke to *Cochliobolus sativus* (Ito& Kurib.) Drechsler ex Dastur, anamorph *Bipolaris sorokiniana* (Sac.) Shoem, and *Helminthosporium tritici-repentis* Drechsler to *Pyrenophora tritici-repentis* (Died.) Drechsler, anamorph *Drechslera tritici-repentis* (Died.) Shoem.

Jerzy J. Lipa

Ustinov, I.D., Movchan O.M., Kudina Zh.D. 1995. Karantin Roslin: 1 – Karantinni Szkidniki [Plant Quarantine: 1 – Quarantine Pests]. Iris, Kiev, 416 pp. ISBN 5-7707-8165-3. (In Ukrainian)

This well illustrated handbook is addressed to quarantine inspectors who, at the border inspection of plants or plant derived goods, must quickly and properly identify the organisms with quarantine status. The book is also very useful for academic teachers as an excellent source of information for lectures but particularly for laboratory exercises.

Chapter 1 "Biological and organizational principles of plant quarantine: short theoretical overview" (p. 4-43) provides basic information on legal regulations of plant quarantine in Ukraine, explains several definitions and contains a list of quarantine organisms consisting three categories of pests: not present in Ukraine – 61 species, present but with limited distribution – 21, and potentially dangerous requiring monitoring – 83 species. Among 165 organisms are: 68 insects, 3 nematodes, 16 fungi, 16 viruses, 10 bacteria and 52 weeds.

Chapter 2 "Detailed information on quarantine pests (identification, inspection methods)" (p. 44-416) is arranged in several subchapters dealing with taxonomic groups: *Homoptera, Thysanoptera, Coleoptera, Lepidoptera, Diptera*. The text is arranged for self-learning; there are several technical questions and reader is expected to answer them.

This chapter contains descriptions of individual quarantine pests supported with drawings, tables identification keys and references. For this reason the book is more useful than other books on similar subject.

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