JOURNAL OF PLANT PROTECTION RESEARCH
Vol. 48, No. 2 (2008)

POPULATION DYNAMICS OF SUGAR-BEET CYST NEMATODE (*HETERODERA SCHACHTII*) ON SPRING AND WINTER OILSEED RAPE CROPS

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Received: 22 April, 2008
Accepted: 02 June, 2008

Abstract: The influence of spring as well as winter oilseed rape on the change in population density of *H. schachtii* was investigated in microplot experiment in the years 2002–2005. The spring oilseed rape caused the increase of nematode population (P_f/P_i were 1.31–1.79), in contrast to winter oilseed rape where the population distinctly decreased (P_f/P_i were 0.49–0.59). No statistically important differences between winter oilseed rape crops and fallow were observed. Comparative observations of the life cycle were carried out in pot experiments outdoors. On spring oilseed rape only one generation was completed. The development of the second generation was interrupted because of crop harvesting. In winter oilseed rape J_3 and J_4 occurred in roots in the autumn where they probably did not overwinter, except of the years 2006–2007. In the spring there was a second emergence of larvae and adult females were observed in June and July. The development of the second generation was interrupted because of harvesting. In winter oilseed rape sown in the spring one generation was completed.

Key words: cyst nematode, *Heterodera schachtii*, spring oilseed rape, winter oilseed rape, population density, life cycle

INTRODUCTION

In 1935 H. Goffart already noticed the development of *Heterodera schachtii* (Schmidt 1871) females on winter oilseed rape crops (*Brassica napus* var. *arvensis* f. *biennis*), a completion of this process depended on a sowing time (Decker 1969). Later numerous authors confirmed possibilities of sugar-beet cyst nematode development on both winter and spring oilseed rape. Due to the lack of evidence of negative impact of oilseed rape plants on *H. schachtii* development there was no survey regarding this

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issue in the way that would allow to evaluate changes in sugar-beet cyst nematode population density in the soil. Available data have suggested that effect of oilseed rape plants on density of sugar-beet cyst nematode is not apparent and the population density might either increase or decrease under certain conditions (Evans and Russell 1993; Dobosz 2001). There are less reliable data about the effect of spring oilseed rape plants on sugar-beet nematode population. Results from the conducted trials showed that the population of *H. schachtii* on these plants increased but in lesser extent (Kornobis and Dobosz 2003).

The increase of acreage of oilseed rape crops over last years resulted in introduction of sugar-beet cyst nematode to the fields where sugar beet is grown. *H. schachtii* is known since XIX century as a pest of economic importance of sugar beet and thus it became significant to carry out a quantitative evaluation of its population on the fields with oilseed rape and sugar beet rotation.

MATERIALS AND METHODS

All experiments were carried out at the Institute of Plant Protection in Poznań. Changes in population density of *H. schachtii* (eggs and larvae in cysts in soil) were assessed on micro-plots (1m^2 each) naturally infested with the nematode. The randomized block with four replications was the experiment design. The following plant species were included in the studies: sugar beet Janina cultivar, spring oilseed rape Likosom cultivar, winter oilseed rape Bor cultivar. No plant were grown on control plots. Sugar beet and oilseed rape plants were cultivated (planted and harvested) according to standard crop recommendations. For the purpose of the experiment winter oilseed rape was also sown in the spring.

P_i value was estimated for the samples collected directly before planting and P_f two weeks after harvest. From each plot 10 randomly selected samples were taken with a soil auger of 20 cm length and 2.5 cm in diameter. The collected soil samples were combined in one and next eight samples of 25 cm^3 were taken to form a final sample of 200 cm^3. The cysts were rinsed using the floatation method, then selected from a filter under a microscope and broken with a Seinhorst drill. The released larvae and eggs were counted.

Observations of development of particular developmental stages of nematodes in plant roots were conducted in the pot experiment set up in containers (5 dm^3 each) in four replications. The containers were put into a ground and filled with soil naturally infested with *H. schachtii*. The same cultivars of oilseed rape as in the micro-plot experiment were used. Sowing dates were typical for crop recommendations. In addition to a standard oilseed rape planting, winter oilseed rape was sown in the spring, like oilseed rape was. The observations were performed on the samples collected in mid-month. The root system was removed from the containers and rinsed. The collected nematodes were stained with an acid fuchsin solution in lactoglycerol. The particular growth stages were screened and counted under a microscope.

Data from microplot experiment was subjected to the variance analysis (ANOVA) and Fisher test at $p = 0.05$. Data from pot experiments was transformed according to $\ln (x + 1)$ formula and analysed with Tukey's test at $p = 0.05$.

RESULTS

The largest increase of *H. schachtii* population was recorded by 2.54–4.35 times in the growing season on the micro-plots with sugar beet plants. The nematode population increased on the micro-plots with the spring oilseed rape plants however, this increase was clearly smaller (P_f/P_i were 1.31–1.79; respectively). The population density of nematodes decreased on the plots with winter oilseed rape plants and did not differ from the decline registered in a fallow (Table 1).

Table 1. The influence of cropping of various host plants and fallow on population density of *H. schachtii* in the soil in micro-plot experiment

	Value of P_f / Pi		
	Year of experiment		
	2003	2004	2005
Sugar beet		2. 54 b	4. 35 a
Spring rape	1. 49 c	1. 31 c	1. 79 c
Winter rape*	0. 59 d	0. 49 d	0. 55 d
fallow	0. 56 d	0. 57 d	0. 52 d

* plants grown in the previous year

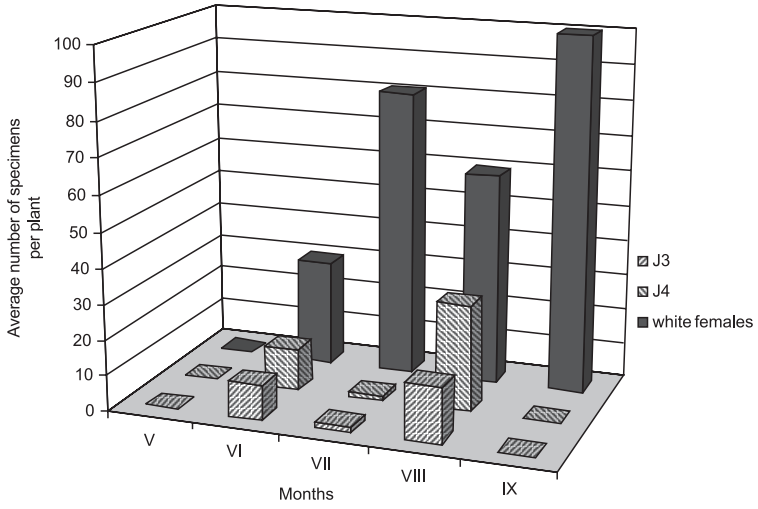

Fig. 1. Number of individuals of *H. schachtii* in sugar beet roots in the pot experiment in 2003

Presented in the table values of P_f/P_i describe total quantitative changes taking place in *H. schachtii* population in various conditions. Observations performed during the growing season in the pot experiment provided important information regarding nematode population density.

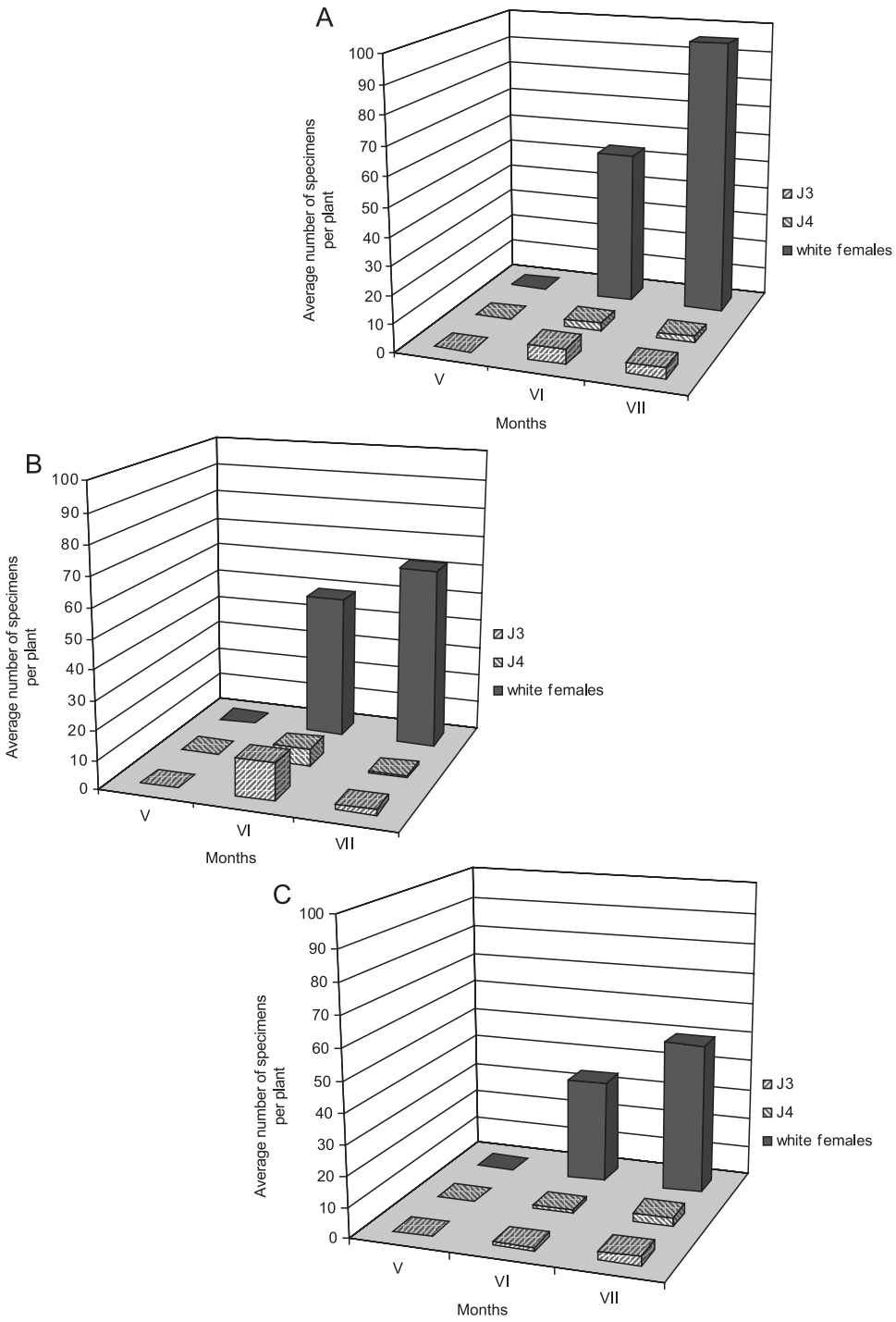

Fig. 2. Number of individuals of *H. schachtii* in roots of spring oilseed rape plants in the pot experiment in 2003 (A), 2004 (B) and 2005 (C)

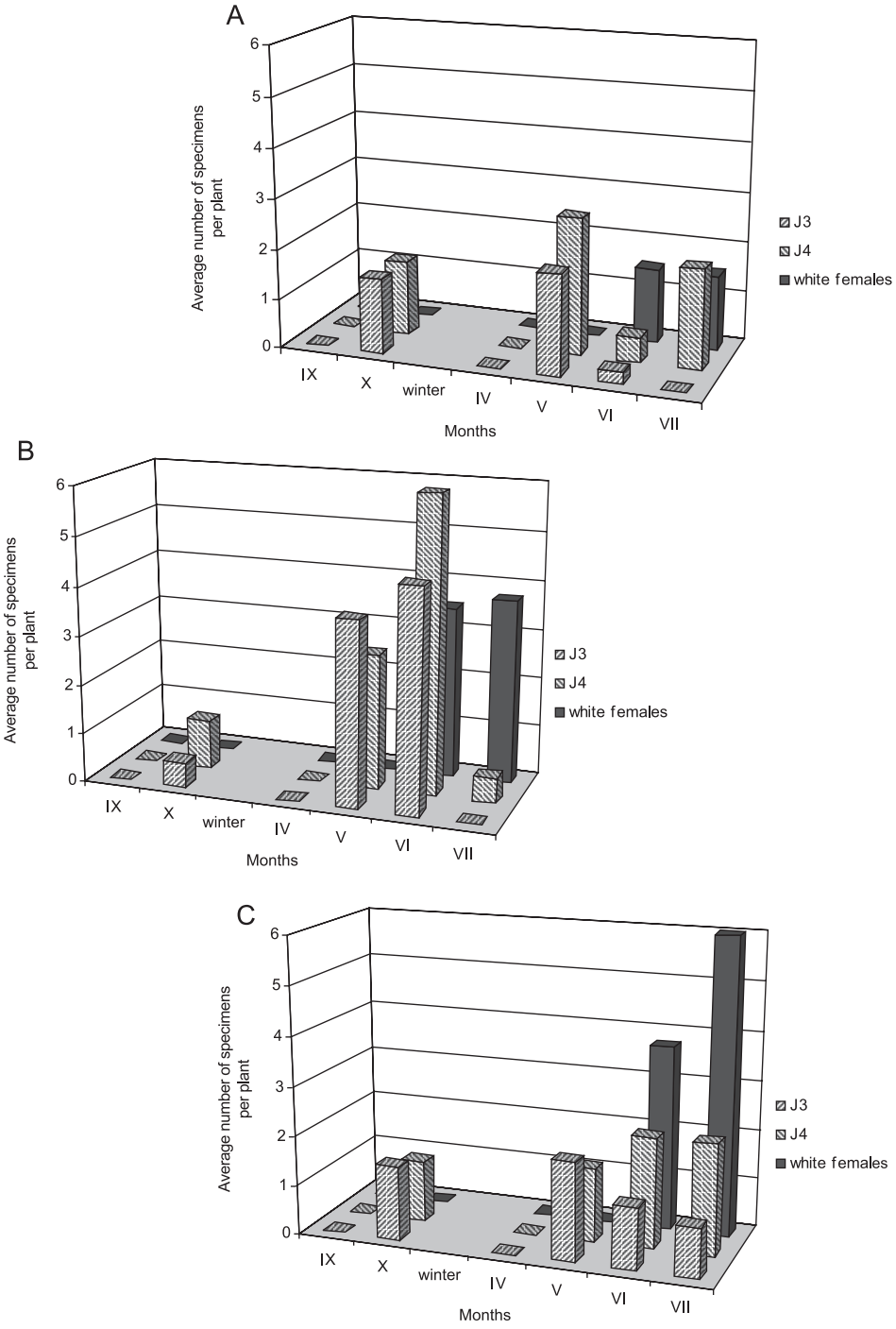

Fig. 3. Number of individuals of *H. schachtii* in roots of winter oilseed rape plants in the pot experiment in 2002–3 (A), 2003–4 (B), 2004–5 (C) and 2005–6 (D)

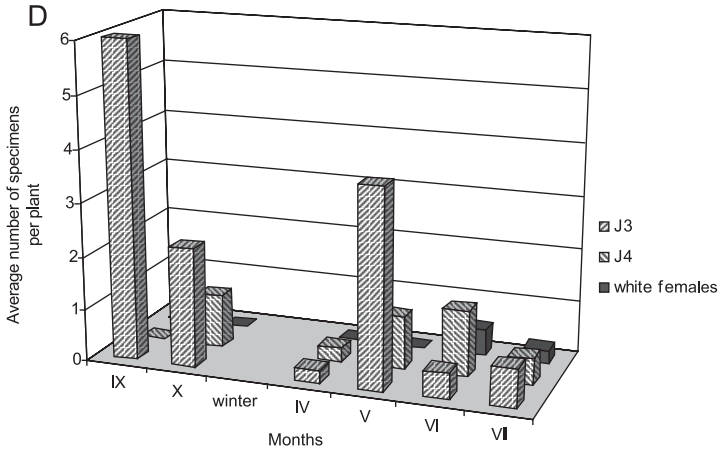

Fig. 3. Number of individuals of *H. schachtii* in roots of winter oilseed rape plants in the pot experiment in 2002–3 (A), 2003–4 (B), 2004–5 (C) and 2005–6 (D)

The data from the pot experiment with sugar beet plants in 2003 showed that *H. schachtii* population formed two generations and it resulted in dynamic changes of all studied developmental stages (Fig. 1). Because the results conformed with the data from the literature these experiments were not repeated. Based on them we assumed that the applied methods were correct.

Population of *H. schachtii* developed only one generation on spring oilseed rape as the plants were harvested according to agrotechnical dates of cultivation and a second generation had no conditions to develop (Fig. 2).

The development of *H. schachtii* was different on winter oilseed rape plants sown at a standard dates. The larval J_3 and J_4 stages occurred already on roots in the autumn following the plant sowing. In 2006 specimens at J_3 stage were found in roots in September. These stages were recorded only once in April of 2007 and this suggested that the larvae could overwinter. In other years of the study larvae were not observed in April despite their presence in October. Numerous larvae were again found in May and this indicated that they emerged in the spring from cysts remaining in the soil. Mature females appeared always in June and July (Fig. 3). The development of next generation was impossible due to the harvest time of winter oilseed rape.

The nematodes developed only one generation on winter oilseed rape plants sown in the spring (Fig. 4). Farmers will not be growing winter oilseed rape in the spring however, for the purpose of study it was interesting to learn that the population of *H. schachtii* developed the same as on spring oilseed rape plants. It may be concluded that the most important role is not played by this plant species but the season of a year and environmental conditions.

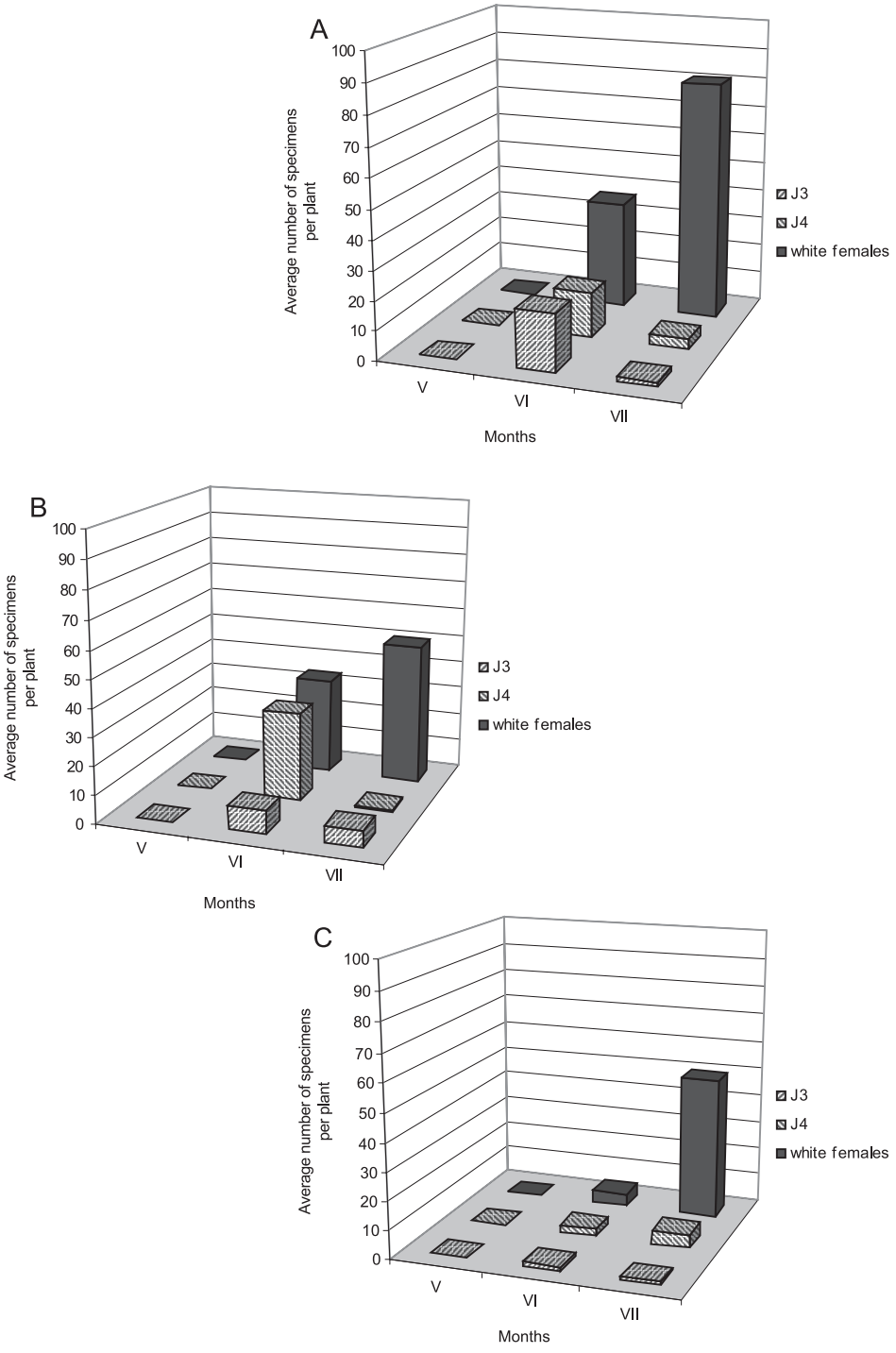

Fig. 4. Number of individuals of *H. schachtii* in roots of winter oilseed rape plants sown in the spring in the pot experiment in 2003 (A), 2004 (B) and 2005 (C)

DISCUSSION

The presented results and literature data allow to improve the knowledge regarding the population density of sugar-beet cyst nematode.

Based on our results and the literature data we can conclude that the spring oilseed rape crop plays the role in an increasing of *H. schachtii* population density. However, the role of winter oilseed rape crop is not so clear. Goffart in 1935 already reported that under German climatic and geographic conditions the development of new egg generation in cysts was observed at the beginning of October when oilseed rape plants were sown at the beginning of August. Decker (1969) recorded that when oilseed rape plants were sown at the beginning of September there were no changes in nematode population density. The results from the micro-plot trials carried out in Rothamsted, England, showed that cultivation of winter oilseed rape plants caused some increase of *H. schachtii* population but on the contrary Evans and Russel (1993) published different data showing a decrease of nematode population under the same conditions. It cannot be excluded that the increase of population density resulted from the completion of development of larvae that infested roots in the fall, but these changes could also result from the larval development of individuals infesting roots in the spring. These differences might be due to the length of the winter that is significantly warmer and shorter in England than in Poland. The data from the trials with winter oilseed rape plants sown according to agrotechnical dates suitable to Polish climatic conditions indicate that there was no full development of larvae to female stage that infested roots in the fall. We cannot eliminate a hypothesis that there was no development of larvae into male stage but it seems to have no effect on population density of nematodes.

Generally it may be concluded, that the cultivation of spring oilseed rape increases the population density of *H. schachtii* in the soil and it might be harmful to a subsequent crop such as sugar beet planted on the same field. As far as winter oilseed rape plants are considered there is no evidence that cultivation of this crop will affect the nematode population.

ACNOWLEDGEMENTS

This research was supported by grant 2 PO6 R 08426. The authors thank Jolanta Matuszczak for technical assistance.

REFERENCES

Decker H. 1969. Phytonematologie Berlin. VEB Deutscher Landwirtschaftsverlag, 526 pp.

Dobosz R. 2001. Winter rape and sugar beet nematode, *Heterodera schachtii.* Prog. Plant Protection/ Post. Ochr. Roślin 41: 193–195.

Evans K., Russell M.D. 1993. The population dynamics in microplots of brassica and beet cyst nematodes in rotations which include oilseed rape. Nematologica 39: 411–414.

Kornobis S., Dobosz R. 2003. Population dynamics of sugar beet nematode on oilseed rape – a critical outlook, based on empirical data. Prog. Plant Protection/ Post. Ochr. Roślin 43: 208–211.

Schmidt A. 1871. Über den Rüben- Nematoden (*Heterodera schachtii A.S.*) Z. Ver Ruben Zucker Industr. Zolliver 21: 1–19.

POLISH SUMMARY

DYNAMIKA POPULACJI MĄTWIKA BURAKOWEGO (*HETERODERA SCHACHTII*) NA RZEPAKU JARYM I RZEPAKU OZIMYM

Wpływ uprawy rzepaku jarego i ozimego na zmiany zagęszczenia populacji *H. schachtii* badano w doświadczeniu mikropoletkowym w latach 2002–2005. W glebie z uprawą rzepaku jarego zagęszczenie populacji nicienia wyraźnie wzrosło (P_f/P_i wynosiło 1,31–1,79) przeciwieństwie do uprawy rzepaku ozimego, w której spadło (P_f/P_i od 0,49 do 0,59) nie różniąc się istotnie od spadku obserwowanego na ugorze. Porównawcze obserwacje cyklu rozwojowego przeprowadzono w doświadczeniu wazonowym. Na rzepaku jarym *H. schachtii* wykształcił tylko jedno pełne pokolenie rocznie gdyż rozwój drugiego pokolenia przewały żniwa. W uprawie rzepaku ozimego larwy J_3 i J_4 pojawiły się w korzeniach już jesienią lecz z wyjątkiem lat 2006–7 nie przeżyły zimy. Drugi pojaw tych stadiów obserwowano w maju następnego roku, a dojrzałe samice w czerwcu i lipcu. Rozwój drugiego pokolenia przerwały żniwa. Na rzepaku ozimym wysianym wiosną również rozwinęło się jedno pokolenie *H. schachtii*.