

Current Occurrence and Geographical Distribution of *Heterodera avenae* Wollenweber 1924 in the Slovak Republic

MAREK RENČO

Parasitological Institute, Slovak Academy of Sciences, Košice, Slovak Republic

Abstract

RENČO M. (2005): **Current occurrence and distribution of *Heterodera avenae* in the Slovak Republic.** Plant Protect. Sci., **41**: 80–85.

During 2003 and 2004 the occurrence and distribution of *Heterodera avenae* (Woll.) in the cereal growing areas of the Slovak Republic was studied. 188 soil samples from 27 districts throughout the country were analysed; *Heterodera avenae* was present in 56.4% of the samples, at an incidence of 2–81 cysts in 100 g soil. At 87 localities the incidence of the parasite was low, at 15 it was medium, and high at 4 localities.

Keywords: *Heterodera avenae* (Woll.); occurrence; Slovak Republic; cereal cyst nematodes

The cereal cyst nematodes, *Heterodera* spp., are pests of cereal crops and their occurrence in Europe has been known for many years (RIVOAL & COOK 1993; EVANS & ROWE 1998). They often cause great yield losses (RITTER 1982; DROPKIN 1989). This group of nematodes forms a complex of species referred to as the “*Heterodera avenae*-complex” which includes *H. avenae* Wollenweber 1924 (cereal cyst nematode), *H. bifenestra* Cooper 1955, *H. mani* Matthews 1971, *H. iri* Matthews 1971, *H. hordecalis* Andersson 1975, *H. latipons* Franklin 1969 and *H. filipjevi* Stelter 1984. Symptoms of damage by cyst nematodes in cereals are usually shown as patches of pale and stunted plants. The effects on the aerial parts of plants are identical with symptoms of severe nitrogen and other mineral deficiencies. Plants attacked by the nematodes wilt readily in dry weather, as a consequence of damage to the root system.

Studies of the occurrence and distribution *Heterodera avenae* were done by SABOVÁ *et al.* (1977, 1988a) and VALOCKÁ *et al.* (1993b), of the ontogeny under experimental conditions by SABOVÁ *et al.* (1985b, c), pathotypes by SABOVÁ *et al.* (1988b, 1990, 1991) and VALOCKÁ *et al.* (1994, 1995), and of the damage and host specificity of *H. avenae* on cereal varieties grown in the Czech and Slovak Republic by SABOVÁ *et al.* (1981, 1985a, 1986, 1989). At those times, *H. avenae* was found in approximately 60% of the cereal growing areas of Czechoslovakia, and 10% of them were infested above the economic threshold. In other countries the yield losses due to this nematode are, for example, 15 to 20% in wheat in Pakistan (MAQBOOL 1988); 40 to 92% in wheat and 17 to 77% in barley in Saudi Arabia (IBRAHIM *et al.* 1999); and 20% in barley and 23 to 50% in wheat in Australia (MEAGHER 1972).

Supported by the Scientific Grant Agency VEGA, Grant No. 2/1021/21.

The problem was sufficiently important to require characterisation of *H. avenae* pathotypes in Czechoslovakia. The first study on this aspect was done by SABOVÁ *et al.* (1988b), who tested four *H. avenae* populations and showed the predominance of pathotype C (Ha 12). Several pathotypes of *H. avenae* have been found in Europe, for example, the two pathotypes Ha51 and Ha11 occur in Norway (ROSLANGEN 1998).

The aim of this work was to determine the current occurrence of *Heterodera avenae* in Slovakia at localities where a higher occurrence of it had been observed during previous studies (SABOVÁ *et al.* 1977; VALOCKÁ *et al.* 1993b) and to compare the new data with previous ones.

MATERIAL AND METHODS

The survey of the occurrence and geographical distribution of *Heterodera avenae sensu stricto* in the Slovak Republic was performed during 2003 and 2004. In the cereal growing areas of Slovakia, 188 soil samples were collected from the rhizosphere of cereals (115 in winter wheat, 41 in winter barley, 18 in spring barley, 10 in oat and 4 in rye) at a depth of 15–20 cm, 2 weeks before harvest. One basic sample (500 g of soil) was obtained from an area of 10 × 10 m by 10 randomised soil collections. Average samples (200 g) were obtained by mixing two basic samples. The samples were slowly dried in a laboratory and cysts were extracted from 100 g of soil by using the flotation method (SABOVÁ & VALOCKÁ 1980). The species to which the cysts belonged were identified morphologically by the original descriptions of cysts and second stage larvae development (MULVEY 1972; WOUTS & WEISHER 1977). The population densities of *H. avenae* were evaluated as low if

there were less than 14 cysts/100 g soil, as medium for 14 to 40 cysts/100 g, and high for more than 40 cysts/100 g soil.

RESULTS

The current occurrence and geographical distribution of *H. avenae* in the Slovak Republic is presented in Table 1. The incidence of cysts ranged from 2 to 81 cysts in 100 g of soil. In the area with more intensive cultivation of cereals in Western Slovakia, 111 localities were investigated, with a medium abundance of occurrence at 53.1%. The abundance varied from 25 to 100% (district of Senica). The highest incidence was found in district Zlaté Moravce (81 cysts/100 g soil), which also showed the highest average number of cysts per locality (29.6 cysts). The lowest abundance was in the district of Pezinok, although the incidence was relatively high (23 cysts/100 g soil). Only in district Piešťany was no *H. avenae* found.

In the Central area of the Slovak Republic, 64 localities were investigated with an abundance of 54.6%. The areas with the most infested soil were in district Nové Mesto nad Váhom (abundance 100%, intensity 36 cysts/100 g soil, mean number of cysts 19.2). There were relatively high abundance and incidence also in district Veľký Krtíš (75.2%; 20 cysts/100 g soil). Low incidence of the parasite was observed in districts Myjava and Žiar nad Hronom (25%; 2 cysts/100 g soil).

In Eastern Slovakia the two districts Košice and Rožňava were investigated. A higher incidence was found in district Košice (87.5%; 30 cysts/100 g soil).

The occurrence of *H. avenae* in the Slovak Republic is presented in Figure 1. The results showed that 106 out of a total of 188 localities (56.4%) were

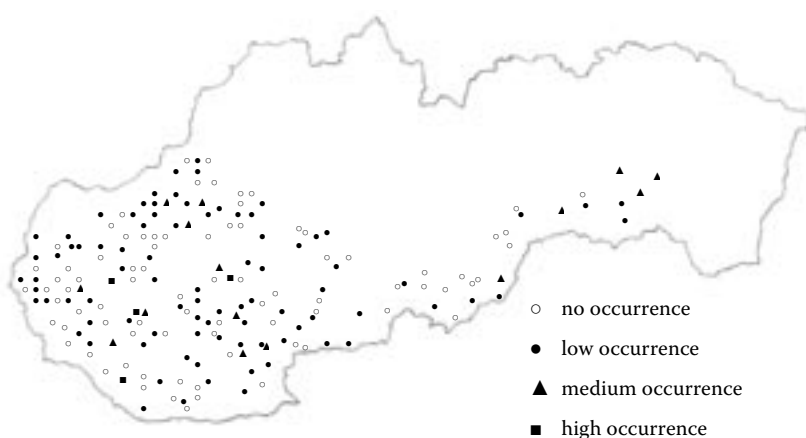


Figure 1. Intensity of occurrence of *Heterodera avenae* at individual localities of the Slovak Republic

Table 1. Occurrence of *Heterodera avenae* in the Slovak Republic

District	Number of localities	Percentage of positive localities in the district	Highest number of viable cysts/100 g soil	Mean number of viable cysts/100 g soil	Average number larvae/eggs in cysts	Average number viable larvae/eggs	Viability of cysts (%)
Bratislava	6	33.3	13	4.6 ± 2.1	5.1 ± 0.8/72.3 ± 23.6	4.2 ± 0.6/33.4 ± 5.6	48.6
Dunajská Streda	11	45.5	53	11.4 ± 4.8	9.8 ± 4.5/140.8 ± 35.4	7.8 ± 1.1/103.6 ± 25.4	73.9
Galanta	7	57.2	43	21.6 ± 20.8	12 ± 2.5/142.6 ± 20.8	4.9 ± 1.5/72.3 ± 2.8	49.9
Komárno	7	28.6	3	1.5 ± 1.5	2.8 ± 0.3/79.5 ± 12.4	1.2 ± 0.6/60.2 ± 15.9	75.3
Levice	18	66.6	29	13.8 ± 13.6	18.9 ± 3.6/183.2 ± 45.5	10.3 ± 2.4/160.3 ± 35.8	84.3
Malacky	9	66.6	10	5.3 ± 4.6	2.9 ± 0.5/92.6 ± 10.8	2.3 ± 0.2/53.2 ± 5.1	58.1
Nitra	8	75.0	8	7.2 ± 0.5	6.3 ± 1.4/150.9 ± 23.8	4.1 ± 0.5/120.3 ± 14.7	79.1
Nové Zámky	9	55.5	8	3.7 ± 4.2	8.3 ± 2.4/109.3 ± 5.6	3.6 ± 1.0/50.8 ± 8.4	46.3
Piešťany	3	0	0	0	0	0	0
Pezinok	8	25.0	23	12.8 ± 10.3	4.5 ± 0.9/138.9 ± 54.8	1.3 ± 0.3/62.1 ± 15.4	44.2
Senec	3	66.6	12	5.2 ± 4.6	10.4 ± 3.4/78.9 ± 11.4	5.4 ± 0.5/43.5 ± 20.1	54.8
Senica	6	100.0	9	8.3 ± 0.6	2.9 ± 0.3/150.3 ± 25.7	2.3 ± 0.6/109.8 ± 13.8	73.8
Topoľčany	8	50.0	4	1.5 ± 0.5	2.0 ± 0.2/105.3 ± 14.6	1.0 ± 0.2/52.2 ± 10.3	49.7
Trnava	10	50.0	42	15.3 ± 8.8	12.3 ± 2.0/192.8 ± 41.1	6.2 ± 0.5/124.6 ± 34.6	63.3
Zlaté Moravce	6	66.6	81	29.6 ± 25.2	29.8 ± 8.6/183.8 ± 22.7	14.1 ± 5.7/150.4 ± 20.7	77.3
Krupina	4	50.0	4	2.3 ± 0.8	0/52.3 ± 12.4	0/18.9 ± 2.2	36.1
Lučenec	5	40.0	6	1.8 ± 0.6	2.6 ± 0.5/101.3 ± 15.8	0.9 ± 0.2/43.8 ± 5.8	42.4
Myjava	4	25.0	2	1.5 ± 0.5	1.3 ± 0.4/122.8 ± 9.4	0.5 ± 0.1/32.9 ± 4.5	26.9
Nové Mesto nad V.	12	100.0	36	19.2 ± 18.4	17.3 ± 3.7/164.4 ± 31.4	12.2 ± 2.1/109.8 ± 16.3	66.7
Partizánske	4	50.0	5	5.0 ± 0.5	2.1 ± 0.5/70.3 ± 10.2	1.0 ± 0.2/18.8 ± 1.4	27.2
Rimavská Sobota	8	37.5	15	6.2 ± 5.9	1.9 ± 0.6/128.8 ± 15.2	1.0 ± 0.2/35.6 ± 3.5	28.1
Trenčín	7	42.8	10	4.8 ± 4.3	1.2 ± 0.3/85.9 ± 11.6	0.5 ± 0.1/33.9 ± 8.7	39.9
Veľký Krtíš	4	75.0	20	5.9 ± 4.5	15.0 ± 3.5/148.2 ± 23.8	12.1 ± 3.9/90.3 ± 25.4	62.7
Žiar nad Hronom	4	25.0	2	2.0 ± 0.0	1.7 ± 0.2/90.8 ± 16.7	0.8 ± 0.2/18.4 ± 1.6	20.7
Zvolen	4	50.0	6	3.0 ± 2.5	1.0 ± 0.4/90.3 ± 12.7	1.0 ± 0.2/33.9 ± 2.5	38.2
Košice	8	87.5	30	12.2 ± 10.3	3.0 ± 0.7/111.8 ± 19.2	2.0 ± 0.5/22.6 ± 2.6	21.4
Rožňava	5	60.0	5	2.6 ± 2.4	1.3 ± 0.4/80.2 ± 13.5	0.4 ± 0.03/20.9 ± 4.2	26.3
Sum	188	–	–	8.1 ± 7.1	7.1 ± 7.0/115.8 ± 42.7	4.1 ± 4.2/63.4 ± 43.3	48.7

positive. A low occurrence of the parasite was detected in 87 localities, a medium occurrence in 15, and 4 localities showed a high occurrence (i.e. in the districts Trnava, Dunajská Streda, Galanta and Zlaté Moravce).

The most cultivated crop in the cereal growing areas of Slovakia is winter wheat, followed by spring barley, oat and rye. Abundance and incidence of *H. avenae* was highest in soil with wheat (66.1%, resp. 81 cysts/100 g soil, with a mean number of

Table 2. The abundance and incidence of *Heterodera avenae* in cereals

Cereal	Number of samples	Number of positive samples	Highest number of viable cysts/100 g soil	Mean number of viable cysts/100 g soil	Percentage of positive localities
Winter wheat	115	76	81	24.9	66.1
Winter barley	41	18	23	9.3	43.9
Spring barley	18	7	5	1.8	38.8
Oat	10	5	39	21.6	50.0
Rye	4	0	0	0	0
Total	188	106	–	–	–

cysts of 24.9/100 g soil). A high abundance and incidence was also observed in fields with oat (50%, resp. 39 cysts, with an average number of cysts of 21.6/100 g soil).

The mean number of viable eggs and larvae in cysts, and the viability of *H. avenae* cysts found in individual districts of the Slovak Republic is given in Table 1. Average viability of the cysts was 48.7%; the highest viability was found in district Levice (84.3%), viability of cysts up to 70% was found in districts Dunajská Streda, Komárno, Nitra, Senica and Zlaté Moravce. A 100% abundance of parasite occurrence was found in district Nové Mesto nad Váhom, with cysts viability of 66.7%. The lowest level of cyst viability was found in districts Žiar nad Hronom (20.7%) and Košice (21.4%), even though district Košice showed the second highest prevalence of *H. avenae*.

DISCUSSION

The aim of the present study was to determine the current prevalence, incidence and distribution of *Heterodera avenae* in the cereal growing areas of the Slovak Republic and to compare the obtained data with the results of SABOVÁ *et al.* (1977) and VALOCKÁ *et al.* (1993b).

The present results showed that the occurrence of *Heterodera avenae* in the cereal growing areas of Slovakia is 56.4%, that is less than the 60% reported by SABOVÁ *et al.* (1977), but similar to the results of VALOCKÁ *et al.* (1993b) at 56%. In 46.2% of the localities there was a low incidence of the parasite, while in 1977 that level was 52.4% and in 1993 it was 51%. In 7.9% of the localities there was a medium occurrence, in 1977 it was so in 5.0%, and in 1993 in 6.2%. A high occurrence of

the parasite was found in 2.1% of the localities, in 1977 in 2.9%, and in 1993 in 2.1% of them. The highest prevalences now were in districts Senica (100%), Nové Mesto nad Váhom (100%) and Košice (87.5%), while in the previous study they were highest in districts Galanta (100%), Považská Bystrica (70%) and Poprad (70%). Incidence was lower in the present (2–81 cysts/100 g soil) than in the previous study (4–193 cysts/100 g soil).

Our study did not focus on ontogeny, pathotypes, host specificity, number of viable cysts and yield losses. Such matters were studied by SABOVÁ *et al.* from 1985 to 1995. The life cycle of *H. avenae* in our conditions were 56 d in oat. On winter wheat, autumn and spring invasion L2 was detected. The autumn invasion occurred 12 d after sowing at a soil temperature of 11.5–14.5°C and persisted until the time the soil froze. The spring invasion started in March at a soil temperature of 2.5–4.5°C. The life cycle from the spring invasion to the appearance of white cysts lasted for 84 d in 1981 and for 63 d in 1982 in winter wheat. The order of susceptibility of cereals to *H. avenae* was the following: oat – spring barley – spring wheat – winter wheat – rye – winter barley.

SABOVÁ *et al.* (1988b) reported that only the one pathotype C (Ha 12) of *H. avenae* occurred in the Slovak and Czech Republic. Consecutively, VALOCKÁ *et al.* (1993a) studied the response of 85 cereal cultivars (25 winter wheat, 35 spring barley, 25 oat) to this pathotype. A low to very low degree of susceptibility to it was found in 10 winter wheat cultivars, 35 spring barley cultivars and 6 oat cultivars, representing genetic resources for cereal breeding in the Czech and Slovak Republic. The following year the study of the response continued on 30 new cultivars of winter wheat and 90 culti-

vars of spring barley. Only one cultivar of winter wheat was considered as resistant (Ignaz) with a low degree of susceptibility, but 55 cultivars of spring barley were rated as resistant with a low to very low degree of susceptibility. It is assumed that a high multiplication of the cereal cyst nematode on winter wheat cultivars presents a risk for high initial infestation of subsequent cereals in a crop rotation, as stressed by VALOCKÁ *et al.* (1994).

Our results demonstrate the fact that occurrence and geographical distribution of *H. avenae* in the Slovak Republic has not changed, although the incidence is slightly lower than found earlier by SABOVÁ *et al.* (1977). Most cysts of the parasite were found at localities of Western Slovakia. In this part of Slovakia, cereals are often grown as a monoculture. An easily crumbling and friable soil creates good conditions for development and reproduction of *H. avenae*. The intensity of the occurrence of *Heterodera avenae* cysts depends on the type of cereals, type of soil and climatic conditions of the area. The growing of cereals as a monoculture has resulted in an increasing population of *H. avenae*.

Seventeen cyst nematode species are known to occur in the Slovak Republic (STURHAN & LIŠKOVÁ 2004). They were found in different ecosystems (*Heterodera avenae* Wollenweber 1924; *H. carotae* Jones 1950; *H. galeopsidis* Goffart 1936; *H. humuli* Filipjev 1935; *H. schachtii* Schmidt 1871; *H. iri* Mathews 1971; *H. bifenestra* Cooper 1955; *H. cruciferae* Franklin 1945; *H. hordecalis* Anderson 1975; *H. mani* Mathews 1971; *H. ripae* Subbotin, Sturhan, Rumpfenhorst and Moens 2003; *H. salixophila* Kirjanova 1969; *H. trifolii* Goffart 1932; *H. urticae* Cooper 1955; *Globodera rostochiensis* Wollenweber 1923; *G. achilleae* Golden et Klindic 1973; *Punctodera stonei* Brzeski 1998). Only *Heterodera avenae* has been found on cereals in the Slovak Republic up to the present. In the Czech Republic also *H. latipons* was detected (SABOVÁ *et al.* 1988c). It is assumed, that new species of cereal cyst nematodes may be found in cereals in the future.

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Received for publication February 21, 2005

Accepted after corrections April 28, 2005

Abstrakt

RENČO M. (2005): **Súčasný výskyt a distribúcia *Heterodera avenae* na Slovensku.** Plant Protect. Sci., **41**: 80–85.

V rokoch 2003 a 2004 bol študovaný výskyt a rozšírenie *Heterodera avenae* (Woll.) v obilninárskych oblastiach na Slovensku. Celkovo sme vyšetrili 188 vzoriek z 27 okresov Slovenska, zistili sme 56,4% výskyt *Heterodera avenae*, pri incidencii výskytu 2–81 cýst na 100 g pôdy. Na 87 lokalitách bol zistený nízky výskyt parazita, na 15 stredný a na 4 lokalitách bol výskyt vysoký.

Kľúčové slová: *Heterodera avenae* (Woll.); výskyt; Slovenská republika; cysty nematód na obilninách

Corresponding author:

Ing. MAREK RENČO, Ph.D., Parazitologický ústav SAV, Hlinkova 3, 040 01 Košice, Slovenská republika
tel.: + 421 55 622 27 87, fax: + 421 55 633 14 14, e-mail: renco@saske.sk
