Some Notes on the Occurrence of Plant Parasitic Nematodes on Fruit Trees in Slovakia

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Abstract

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Forty plant parasitic nematode species were identified in soil of fruit orchards in the southeastern and southwestern areas of the Danubian Lowlands and East Slovak Lowland, characterised by light sandy soil of riverine origin, locally combined with drift sand landscape. They were *Ditylenchus dipsaci*, *Helicotylenchus canadensis*, *H. digonicus*, *H. dihystera*, *H. multicinctus*, *Rotylenchus agnetis*, *R. fallorobustus*, *R. goodeyi*, *Rotylenchulus borealis*, *Pratylenchus crenatus*, *P. penetrans*, *P. pratensis*, *P. thornei*, *Zygotylenchus guevarai*, *Pratylenchoides laticauda*, *Meloidogyne hapla*, *Bitylenchus dubius*, *Tylenchorhynchus cylindricus*, *Merlinius nanus*, *Macroposthonia antipolitana*, *M. rustica*, *M. xenoplax*, *Paratylenchus bukowinensis*, *P. elachistus*, *P. nanus*, *P. projectus*, *Longidorus elongatus*, *L. euonymus*, *L. juvenilis*, unidentified *Longidorus* sp., *Xiphinema diversicaudatum*, *X. italiae*, *X. pachtaicum*, *X. taylori*, *X. vuittenezi*, *Trichodorus primitivus*, *T. sparsus*, *T. viruliferus*, *Paratrichodorus macrostylus* and *P. pachydermus*. Many of the observed species are phytopathologically important parasites of fruit trees and some are also vectors of plant viruses. The frequency of occurrence, dominance and abundance of individual species were determined.

Keywords: plant parasitic nematodes; fruit orchards; Slovakia

Many plant parasitic nematode species are important pests of fruit trees. They damage the plant by directly attacking roots and subsequently predisposing them to secondary infections by bacteria and fungi, by causing replant and preplant problems of orchards and also by transmission of plant viruses. The economically most important species belong to the genera *Criconemella*, *Meloidogyne*, *Pratylenchus*, *Longidorus*, *Xiphinema*, *Trichodorus* and *Paratrichodorus*, and are widely distributed in fruit orchards throughout the world (Nyczepir & Halbrendt 1993; Nyczepir & Becker 1998). Research on nematodes associated with fruit trees is focused on various aspects, including their occurrence and geographical distribution (Ivanova & Choleva 1999; Lamberti *et al.* 2001; Satya Kumar *et al.* 2003; Kumari 2004), their effects on fruit trees and rootstock susceptibility (Rubio-Cabetas *et al.* 1999; Gomez *et al.* 2000; Sasanelli *et al.* 1999, 2003, 2006), replant problems (Nyczepir & Becker 1998; Pacholak & Zydlik 2004), virus transmission (Taylor & Brown 1997; Kunz 2003) and control strategies (Nyczepir 1991; Greco *et al.* 1993; Kluepfel *et al.* 2002).

Longidorids, trichodorids and criconematids from Slovakia were previously studied on various plant species, including fruit trees (Lišková & Sturhan 1999; Lišková & Brown 2003; Lišková

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et al. 2004), but knowledge of the presence and distribution of other plant parasitic nematodes is still limited. The purpose of the present investigation was to carry out a survey of potentially dangerous nematode species occurring in the orchards of southeastern and southwestern Slovakia, where they are economically important due to an intensive production of fruit, mainly peaches and apricots.

MATERIAL AND METHODS

Research was focused on productive fruit orchards in the East Slovak Lowland and Danubian Lowland, characterised mostly by sandy soils of drift sand landscape and riverine plains (Figure 1). These areas are characterised by a warm and dry climate with a 10°C isotherm, 500–600 mm annual average rainfall, an altitude of 90–150 m and sandy soils derived from dune-sand or river-borne sediments. Average soil samples were taken from 31 orchards (nine apple, nine apricot, eight peach, three prune and two sweet cherry orchards), at a depth of 20–30 cm. Nematodes were isolated from 500 g of soil by modified Cobb's decanting and sieving technique (Cobb 1918). Isolated nematodes were fixed in FAA (80 parts distilled water, 60 parts 95% ethanol, 2.4 parts formalin, 1.6 parts acetic acid) (Johansen 1940), microscopically observed in permanent glycerine slides and taxonomically mostly classified after Siddiqi (2000). The number of positive localities, maximum and minimum abundance of individual nematode species (population density) in 500 g of soil, frequency of the occurrence – F % (proportion of positive localities from all localities investigated), and dominance – D % (proportion of total abundance of the individual nematode species from total abundance of plant parasitic nematodes) of nematode species were determined.

RESULTS AND DISCUSSION

The identified species, number of positive localities, minimum and maximum of abundance, frequency of occurrence and dominance of individual nematode species are presented in Table 1. Forty plant parasitic nematode species, nine of them endoparasites and 31 ectoparasites, were identified from the 31 fruit orchards studied.

The endoparasitic species were: *Ditylenchus dipsaci*, *Rotylenchulus borealis*, *Pratylenchus crenatus*, *P. penetrans*, *P. pratensis*, *P. thornei*, *Zygotylenchus guevarai*, *Pratylenchoides laticauda* and *Meloidogyne hapla*.

Root lesion nematodes, *Pratylenchus* spp., were observed in the rhizosphere of all sampled tree species. The most abundant and frequent species were *Pratylenchus pratensis* and *P. penetrans*, occurring with a frequency (F) of 52 and 48%, respectively. *Pratylenchus penetrans* is one of the most perilous pests in fruit orchards of temperate areas throughout the world (Decker 1969; Nyczepir & Becker 1998; Ivanova & Choleva 1999), although the other *Pratylenchus* are also phytopathologically significant. Generally, the damages caused by *Pratylenchus* spp. to the root system are growth reduction, darkening and necrotic lesions.

Juveniles of the root-knot nematode *Meloidogyne hapla* were observed in the soil from peach, apricot, plum and apple orchards. *M. hapla* is the *Meloidogyne* species most commonly occurring in European countries, and it is frequent also in Slovakia (Lišková & Sturhan 1998), mainly on carrot, parsley, parsnip and celery in private gardens, as well as in soil of meadows, in vegetation of river banks, forests and vineyards. *Meloidogyne incognita*, another economically important root-knot species, was recorded in Slovakia only in glasshouse conditions, but its presence could be

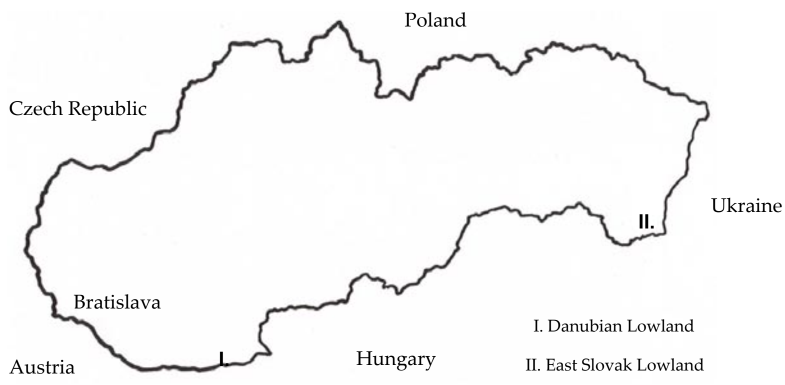

Figure 1. The regions of riverine plains in combination with drift sand landscape in the Slovak Republic

Table 1. Plant parasitic nematode species found in fruit orchards of the Danubian Lowland and East Slovak Lowland (Slovakia)

Nematode species	Number of positive localities	*Fruit orchards	Range of abundance in 500 g of soil	Dominance D (%)	Frequency F (%)
Ditylenchus dipsaci (Kühn, 1857) Filipjev, 1936	2	B, D	1–2	0.06	6.4
Helicotylenchus canadensis Waseem, 1961	2	A	5–78	1.65	6.4
Helicotylenchus digonicus Perry, in Perry, Darling & Thorne, 1959	7	A, B, C, D	2–258	5.94	22.6
Helicotylenchus dihystera (Cobb, 1893) Sher, 1961	1	C	197	3.91	3.2
Helicotylenchus multicinctus (Cobb, 1893) Golden, 1956	3	B, C	6–15	0.12	9.7
Rotylenchus agnetis Szczygiel, 1968	2	A, B	5–10	0.30	6.4
Rotylenchus fallorobustus Sher, 1965	5	A, B, D	3–9	0.40	16.1
Rotylenchus goodeyi Loof & Oostenbrink, 1958	1	A	5	0.10	3.2
Rotylenchulus borealis Loof & Oostenbrink, 1962	3	B	1–5	0.12	9.7
Pratylenchus crenatus Loof, 1960	3	B, C	4–35	1.25	9.7
Pratylenchus penetrans (Cobb, 1917) Filipjev & Schuurmans Stekhoven, 1941	15	A, B, C, D, E	2–92	5.18	48.4
Pratylenchus pratensis (de Man, 1880) Filipjev, 1936	16	A, B, C, D, E	2–107	5.14	51.6
Pratylenchus thornei Sher & Allen, 1953	3	B, C	4–35	1.01	9.7
Zygotylenchus guevarai (Tobar Jiménez, 1963) Braun & Loof, 1966	13	A, B, C, D, E	1–22	1.05	42.0
Pratylenchoides laticauda Braun & Loof, 1967	3	A, D,	3–75	2.38	9.7
Meloidogyne hapla Chitwood, 1949	6	A, B, C, D	2–12	0.58	19.3
Bitylenchus dubius (Bütschli, 1873) Filipjev, 1934	19	A, B, C, D, E	2–164	11.14	61.3
Tylenchorhynchus cylindricus Cobb, 1913	10	A, B, C, D	3–29	1.18	32.2
Merlinius nanus (Allen, 1955) Siddiqi, 1970	6	B, C, D	6–29	2.07	19.3
Macroposthonia antipolitana (de Guiran, 1963) De Grisse & Loof, 1965	4	B, C	2–3	0.20	12.9
Macroposthonia rustica (Micoletzky, 1915) De Grisse & Loof, 1965	1	B	3	0.06	3.2
Macroposthonia xenoplax (Raski, 1952) De Grisse & Loof, 1965	8	B, C, D, E	2–16	1.03	25.8
Paratylenchus bukowinensis Micoletzky, 1922	10	A, B, C, D	2–39	1.69	32.2
Paratylenchus elachistus Steiner, 1949	1	D	16	0.32	3.2
Paratylenchus nanus Cobb, 1923	1	B	3	0.06	3.2
Paratylenchus projectus Jenkins, 1956	1	C	6	0.12	3.2
Longidorus elongatus (de Man, 1876) Thorne & Swanger, 1936	2	A	7–76	1.65	6.4
Longidorus euonymus Mali & Hooper, 1973	1	B	3	0.06	3.2

Longidorus juvenilis Dalmasso, 1969	4	A, B, C, D	3–25	0.72	12.9
Longidorus sp.	3	B, C, D	2–58	1.27	9.7
Xiphinema diversicaudatum (Micoletzky, 1927) Thorne, 1939	1	D	2	0.04	3.2
Xiphinema italiae Meyl, 1953	2	A, B	3–4	0.14	6.4
Xiphinema pachtaicum (Tulaganov, 1938) Kirjanova, 1951	11	A, B, C, D, E	1–158	7.17	35.5
Xiphinema taylori Lamberti, Ciancio, Agostinelli & Coiro, 1991	11	A, B, C, D, E	2–257	9.31	35.5
Xiphinema vuittenezi Luc, Lima, Weischer & Flegg, 1964	17	A, B, C, D, E	2–216	16.40	54.8
Trichodorus primitivus (de Man, 1880) Micoletzky, 1922	9	A, B, C, D	2–55	3.02	29.0
Trichodorus sparsus Szczygiel, 1968	9	A, B, C,	2–79	4.37	29.0
Trichodorus viruliferus Hooper, 1963	9	A, B, C, E	2–139	6.08	29.0
Paratrichodorus macrostylus Popovici, 1990	7	B, C, E	2–30	1.51	22.6
Paratrichodorus pachydermus (Seinhorst, 1954) Siddiqi, 1974	4	A, B, C	4–6	0.34	7.6

*Fruit orchards with: A – apple (*Malus domestica* Borkh.); B – apricot (*Armeniaca vulgaris* Lam.); C – peach (*Persica vulgaris* Mill.); D – plum (*Prunus domestica* L.); E – sweet cherry (*Cerasus avium* (L.) Monch.)

hypothesised in open fields, especially in warm areas of southern regions, also as a consequence of climate changes. Trees infected by *Meloidogyne* spp. show a reduction of vigor and growth, early defoliation and also death in the case of heavy infestation of young plants. The extensive investigation on the resistance of fruit rootstocks to these nematodes (Nyczepir & Becker 1998; Sasanelli *et al.* 1997, 2006) demonstrates the importance of *Meloidogyne* spp. for the growth and yield of fruit trees.

The occurrence in Slovakia of other rare species of endoparasites, like *Rotylenchulus borealis* and *Zygotylenchus guevarai*, was also recorded. Till now *R. borealis* was known in Slovakia only in the rhizosphere of maize and pigweed (Lišková *et al.* 2002). In this survey the vermiform females of *R. borealis* were extracted from the rhizosphere of apricot trees only in soil infested by weeds. Therefore, it is not clear if the host of this species is the apricot or some herbaceous weeds. *Zygotylenchus guevarai* was previously observed in Slovakia only in the rhizosphere of grapevine (Sabová & Lišková 1974), but the present records on peach, apricot, sweet cherry, plum and apple from many sites indicate its larger geographical distribution in the country. This nematode species was found in association with grapevine in France, Germany and Hungary (Decker & Manninger 1976), with fruit trees and other plants in Turkey (Erdal *et al.* 2001), with faba bean in North Africa (Troccoli & Di Vito 2002), mostly in a warmer climate.

The 31 ectoparasitic species were: *Helicotylenchus canadensis*, *H. digonicus*, *H. dihystera*, *H. multicinctus*, *Rotylenchus agnetis*, *R. fallorobustus*, *R. goodeyi*, *Bitylenchus dubius*, *Tylenchorhynchus cylindricus*, *Merlinius nanus*, *Macroposthonia antipolitana*, *M. xenoplax*, *M. rustica*, *Paratylenchus bukowinensis*, *P. nanus*, *P. projectus*, *P. elachistus*, *Longidorus elongatus*, *L. uonymus*, *L. juvenilis*, one unidentified *Longidorus* species, *Xiphinema diversicaudatum*, *X. italiae*, *X. pachtaicum*, *X. taylori*, *X. vuittenezi*, *Trichodorus primitivus*, *T. sparsus*, *T. viruliferus*, *Paratrichodorus macrostylus* and *P. pachydermus*.

Longidorids and trichodorids are indisputably the most important ectoparasites, as beside the direct attack and damage on roots, some species are able to transmit plant viruses. Nine longidorid and five trichodorid species were observed in the investigated areas, and five of them are vectors of plant viruses.

Four *Longidorus* species were recorded, but in comparison with *Xiphinema* spp., they came only from a few localities (Table 1). Their abundance fluctuated within individual species and localities. Of phytopathological importance is the record of *L. elongatus*, vector of plant nepoviruses causing tomato black ring (Harrison *et al.* 1961) and raspberry ringspot (Taylor 1962) on fruit trees (Anonym 2001a, b). It was recorded at two localities and only from apple trees. *Longidorus euonymus*, originally described from spindle trees in Slovakia (Mali & Hooper 1974), was found in our investigation to be present also in other fruit orchards. Moreover, it was previously recorded also in cultivated soils with cereals, potatoes and vineyards, as well as in forests, always in light sandy soils of drift sand landscape or fluvial soils (Lišková & Brown 2003). Similarly, *L. juvenilis* was till now known only from vineyards in the riverine Danube plain with local drift sand landscape of southwestern Slovakia, whereas the present record from east Slovakia indicates a larger distribution of this species in the country, in association with light sandy soils. Further morphometrical studies are needed for the identification of another *Longidoru*s species recorded from three site. The present results confirmed the absence of *L. leptocephalus* in drift sand landscape areas, in spite of the very frequent occurrence of this species in fruit orchards of Slovakia as previously reported (Lišková & Brown 2003).

Five *Xiphinema* species were observed, with various frequency and abundance. *X. diversicaudatum* is phytopathologically important as a vector of arabis mosaic virus (Harrison & Cadman 1959; Jha & Posnette 1959, 1961) and strawberry latent ringspot virus (Lister 1964), with an ability to transmit these viruses to fruit trees (Anonym 2001a, b). It was recorded at one locality and only on plum, at an abundance of two specimens in 500 g of soil. *Xiphinema italiae*, vector of grapevine fanleaf virus (Cohn *et al.* 1970), was previously recorded from vineyards of drift sand landscape near the Danube in southwestern Slovakia. In the present investigation it was found in apricot orchards of the same area and, for the first time, in association with apples in soil derived from dune sand. The other three species, *X. pachtaicum*, *X. taylori* and *X. vuittenezi,* belong to the most widely distributed and most abundant species occurring in the sampled fruit orchards. The most frequent species is *X. vuittenezi* (F = 55%); it also has the highest dominance (D = 16%). Both *X. taylori* and *X. vuittenezi* are species with a very high abundance, in some cases more then 200 individuals in 500 g of soil. While *X. vuittenezi* is very often associated with viruses, it does not fulfill the criteria for the assessment of longidorid virus transmission (Trudgill *et al.* 1983; Taylor & Brown 1997). Similarly to *X. italiae*, *X. pachtaicum*, till now known only from the southwestern part of the country, was observed for the first time in eastern Slovakia, in peach and sweet cherry orchards.

Five trichodorid species, three *Trichodorus* spp. and two *Paratrichodorus* spp. were observed. A 9% frequency of occurrence was observed for *T. primitivus*, *T. sparsus* and *T. viruliferus*, and F = 23% and 8% for *P. macrostylus* and *P. pachydermus*, respectively. The abundance of trichodorids fluctuated from two to 139 specimens in 500 g of soil. *Trichodorus primitivus*, *T. viruliferus* and *P. pachydermus* are vectors of pea early browning virus (Hoof 1962; Gibbs & Harrison 1964; Hoof *et al.* 1966) and tobacco rattle virus (Sol *et al.* 1960; Sanger 1961). *Trichodorus primitivus*, *T. viruliferus*, *P. macrostylus* and *P. pachydermus* were previously found in Slovakia on various plants from a drift sand landscape and riverine plain characterised by sandy soils (Lišková & Sturhan 1999). In this study, *T. viruliferus* and *P. macrostylus* were for the first time recorded in the Danubian Lowland, whereas *P. macrostylus* was never before recorded in the rhizosphere of fruit trees. *Trichodorus sparsus* is very frequent in Slovakia, on various types of vegetation, mainly in forest ecosystems.

Among criconematids, three *Macroposthonia* spp. were observed: *M. antipolitana*, *M. rustica* and *M. xenoplax*, of which the last is the most frequent species (F = 26%, with an abundance of 2 to 16 specimens in 500 g of soil). According to previous investigations (Lišková *et al.* 2004), in Slovakia this species is symptomatic for light sandy soils of drift sand landscape or fluvial soils, on various plant species, especially grapevine, fruit and nut trees, but it occurs also in the rhizosphere of cereals, grassland and forests. *Macroposthonia antipolitana* and *M. rustica* were recorded sporadically and with very low abundance. Criconematids cause damage on roots, after initial normal tree growth they may contribute to chlorosis and wilting, as well as lead to occurrence of sudden death after blossoming (Ritchie & Zehr 1995). Numerous authors consider these nematodes responsible for replant problems in fruit orchards.

In addition, four *Helicotylenchus* spp., three *Rotylenchus* spp., one *Bitylenchus* sp., one *Tylenchorhynchus* sp., one *Merlinius* sp. and our *Paratylenchus* spp.

were observed. Of these, *Bitylenchus dubius* was the most frequent species (F = 61%, D = 11%, 2–164 specimens in 500 g of soil). *Paratylenchus* spp. are generally associated with various fruit species and may be responsible for damage to their root system (Nyczepir & Halbrendt 1993). In spite of the lack of information on the phytopathological importance of the other particular identified ectoparasites, all these nematodes may be considered as components of stress factors on trees.

In conclusion, the results of this investigation are relevant by enhancing the basic knowledge of plant parasitic nematodes in fruit orchards of Slovakia, in particular of species that are virus vectors. This knowledge could become essential for the assessment of future control and quarantine strategies.

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