JOURNAL OF PLANT PROTECTION RESEARCH Vol. 51, No. 1 (2011)
DOI: 10.2478/v10045-011-0012-1

PARASITIC NEMATODES ON POLISH TULIP PLANTATIONS

Aneta Chałańska[1]*, *Andrzej Skwiercz*[2]

[1] The Institute of Holticulture, Pomologiczna 18, 96-100 Skierniewice, Poland
[2] The Warmińsko-Mazurski University, Prawocheńskiego 17, 10-722 Olsztyn, Poland

Received: July 16, 2010
Accepted: December 13, 2010

Abstract: Soil samples were collected from 10 plantations of tulip. The most often found plant-parasitic nematode was *Pratylenchus neglectus*, of which 80 species were found. But *P. neglectus* was usually not over 10% of the individuals in the samples.
Among ectoparasitic nematodes, the most often found was *Bitylenchus dubius*. The occurrence of *Bitylenchus dubius* was not dependent on the acidity of the soil. Facultative parasites were the most numerous group, especially *Filenchus vulgaris* and *Basiria graminophila*. The plant-parasitic nematode populations which occurred on plantations of tulip did not cause severe damage.

Key words: plant-parasitic nematodes, tulip

INTRODUCTION

There are 1 000–1 200 ha of plantations of bulb plants in Poland (Jabłońska 2006). During the last ten years the plantations of bulb plants have doubled (Hetman and Jabłońska 1997). In 2004, noted reproduction of tulip bulbs has taken place on 64% of that area (Wróblewska 2007). Monoculture and home-made bulbs used for planting can have an increased plant parasitic nematode population density. High quality planting material includes the cost of growing fungicides, nematicides, and more intensive cultivation or allowing for less of a yield.

The survey provided on tulip plantations was aimed at a quantitative analysis of the quality of the population density of plant parasitic nematode species in various soil environments.

MATERIALS AND METHODS

Location of survey

Soil samples from the rhizosphere of tulips were collected from 10 plantations during the 2005–2006 season. Sixty per cent of the samples were collected from the north-central area of Poland. Type of soil and its acidity were noted (Table 5).

From each plantation, 5 soil samples of 200 g each were collected. Samples were taken from the vicinity of plant rhizospheres from a depth of 5–30 cm. Nematodes were extracted by the Oostenbrink method, killed by heat and preserved in 5% formalin. Permanent slides were prepared by the Seinhorst rapid method, for examination under high magnification.

Keys for species identification were used as follows: Goodey (1963), Decreamer (1980), Baranovskaya (1981), Cen Qi-Wen *et al*. (1997), Brzeski (1998). Species structure on plantations were analyzed by the species dominance index – D and occurrence constancy index – C (Kasprzak end Niedbała 1981). The nematode similarity was described on the base of the Jaccard similarity coefficient (Jaccard 1912).

Five classes of domination we used:
1. E (eudominants) – number of species constitute 10% or more of all the species of nematodes in samples.
2. D (dominants) – 5.01–10%.
3. SD (subdominants) – 2.01–2%.
4. R (recedents) – 1.01–2%.
5. SR (subrecedents) – below 1%.

There were 3 trophic group, using the classification by Yeates *et al*. (1993), established for classification of the nematode species obtained during the survey: endoparasitic nematodes (1), ektoparasitic nematodes (2), facultative parasitic nematodes (3).

RESULTS

There were 80 species of plant parasitic nematodes found during the survey on the tulip plantations (Table 1–3). Most of the species of nematodes were found in Jankowo Gdańskie (34) and Gdańsk (29). A minimal amount were found in Nikielkowo (9 species).

Endoparasitic nematodes (Table 1)

The most frequent species were *Pratylenchus neglectus* (C = 30%, D < 10%) in alkaline soils. They made up under 10% of the total nematodes specimens in samples. Nine species of *Pratylenchus* (also *P. penetrans*) were obtained on tulip plantations.

*Corresponding address:
aneta.chalanska@instad.pl

Table 1. The species dominance index (D) and the occurrence constancy index (C) of the endoparasitic nematodes on 10 tulip plantations

Nematode species	The occurrence constancy index (C)	Plantations									
		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
		the species dominance index (D)									
Pratylenchus neglectus	29.1	R	SD	E	–	SR	–	D	D	–	SR
P. thornei	12.7	–	–	D	–	–	–	SD	D	–	SD
P. crenatus	5.4	–	SD	R	–	–	–	–	–	–	–
P. fallax	5.4	–	SR	–	–	–	–	–	SD	SD	–
P. flakkensis	3.6	–	–	–	–	–	–	–	–	SD	SR
Pratylenchus sp.	3.6	–	SR	SR	–	–	–	–	–	–	–
P. penetrans	1.8	–	–	–	–	–	–	–	–	–	R
P. pratensis	1.8	–	R	–	–	–	–	–	–	–	–
P. pseudopratensis	1.8	–	–	SR	–	–	–	–	–	–	–

E – eudominants; D – dominants; SD – subdominants; R – recedents; SR – subrecedents;
I. – Chrzypsko Wielkie; II. – Gdańsk Wieniec; III. – Jankowo Gdańskie; IV. – Jantar; V. – Radunica; VI. – Mokry Dwór; VII. – Tujsk; VIII. – Grębałów; IX. – Nikielkowo; X. – Skierniewice

Table 2. The species dominance index (D) and the occurrence constancy index (C) of the ectoparasitic nematodes on 10 tulip plantations

Nematode species	The occurrence constancy index (C)	Plantations									
		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
		the species dominance index (D)									
Bitylenchus dubius	23.6	E	–	–	–	SR	–	–	R	E	E
Geocenamus nanus	21.8	D	SR	D	–	–	–	R	SD	–	R
G. nothus	18.2	R	D	SD	R	–	–	SD	–	R	–
Helicotylenchus varicaudatus	14.5	–	R	SD	D	–	–	E	–	SD	–
Merlinius sp.	12.7	E	SR	–	–	–	–	SR	D	–	R
H. pseudorobustus	10.9	–	SR	–	E	–	–	SR	–	–	–
H. candensis	9.1	–	–	SR	E	–	–	–	–	–	SR
Rotylenchus robustus	9.1	–	R	–	D	–	–	D	–	–	SR
H. vulgaris	7.3	–	–	SD	–	SR	–	E	–	–	–
Longidorus leptocephalus	5.4	–	–	–	–	–	–	–	–	E	–
Trichodorus primitivus	5.4	–	–	SD	–	–	–	–	–	–	–
Tylenchorhynchus maximus	5.4	D	–	–	–	R	–	–	–	–	R
Cephalenchus hexalineatus	3.6	–	–	–	–	–	SD	SD	–	–	–
Geocenamus. microdorus	3.6	–	R	SR	—	–	–	–	–	–	–
G. tenuidens	3.6	–	–	–	–	–	–	SD	–	–	SR
Paratylenchus microdorus	3.6	–	R	–	–	SR	–	–	–	–	–
Rotylenchus capitatus	3.6	–	–	SR	–	–	D	–	–	–	–
R. pumilus	3.6	–	–	–	–	–	–	R	–	–	–
Trichodorus viruliferus	3.6	SD	–	–	–	–	–	R	–	–	–
Aphelenchoides subtenuis	1.8	–	SR	–	–	–	–	–	–	–	–
G. brevidens	1.8	–	–	R	–	–	–	–	–	–	–
G. tartuensis	1.8	–	–	–	–	–	–	–	–	D	–
H. digonicus	1.8	–	–	SR	–	–	–	–	–	–	–
Longidorus sp.	1.8	–	–	–	–	–	–	–	–	–	SR
Mesocriconema curvatum	1.8	R	–	–	–	–	–	–	–	–	–
Paratylenchus bukowiensis	1.8	–	–	–	–	–	–	–	–	–	R
P. nanus	1.8	–	–	–	–	–	–	–	–	–	SR
P. similis	1.8	–	SD	–	–	–	–	–	–	–	–
P. veruculatus	1.8	–	–	R	–	–	–	–	–	–	–
Rotylenchus sp.	1.8	–	–	–	–	–	–	–	–	–	SR
Trichodorus sp.	1.8	R	–	–	–	–	–	–	–	–	–
Bitylenchus sp.	1.8	–	–	–	–	–	–	–	–	–	SR

Expalanation: see table 1

Table 3. The species dominance index (D) and the occurrence constancy index (C) of the facultative nematodes on 10 tulip plantations

Nematode species	The occurrence constancy index (C)	Plantations									
		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
		the species dominance index (D)									
Filenchus vulgaris	36.4	–	E	E	E	SR	D	D	D	–	E
Basiria graminophila	30.9	–	D	SD	D	E	SD	E	E	–	SR
Filenchus sp.	18.2	–	D	SD	–	SD	–	–	–	–	R
F. thornei	18.2	–	D	SD	D	–	SR	E	–	–	E
Paraphelenchus sp.	18.2	–	SR	R	R	–	E	–	SD	–	SD
Aphelenchus avenae	14.5	SD	–	SR	R	–	SR	–	–	SD	E
Aphelenchoides sp.	12.7	–	R	–	–	R	SD	–	SD	–	SR
B. gracilis	12.7	–	R	D	–	–	–	SD	E	–	–
F. sandneri	12.7	–	–	SR	–	SR	SD	E	D	–	–
Boleodorus tylactus	10.9	–	SR	SR	–	E	SR	–	–	–	–
Coslenchus oligogyrus	10.9	–	SD	SD	–	–	SD	–	–	–	–
F. discrepans	9.1	–	D	–	–	SD	D	–	–	–	–
F. misellus	9.1	SD	–	R	SD	–	–	–	–	–	–
Malenchus neosulcus	9.1	–	–	R	–	E	D	–	–	–	E
Coslenchus alatinatus	7.3	–	SR	SD	–	–	–	–	SD	–	–
Anomyctus xenurus	5.4	D	–	–	–	–	–	–	–	–	–
Aphelenchoides limberi	5.4	–	–	–	–	–	SD	–	–	–	R
Irantylenchus vicinus	5.4	–	–	–	SD	SD	–	–	–	–	SD
B. duplexa	5.4	–	SR	–	R	–	–	–	D	–	–
Ditylenchus sp.	5.4	R	R	–	–	–	SR	–	–	–	–
Aglenchus agricola	3.6	–	–	SD	–	–	SD	–	–	–	–
A. tuzeti	3.6	–	R	–	–	–	–	SD	–	–	–
B. obscura	3.6	–	–	SR	SD	–	–	–	–	–	–
B. clavicaudatus	3.6	–	–	–	R	–	SD	–	–	–	–
C. areolatus	3.6	–	R	SR	–	–	–	–	–	–	–
C. costatus	3.6	–	–	R	–	–	–	–	D	–	–
Ditylenchus acutus	3.6	SR	SD	–	–	–	–	–	–	–	–
D. adasi	3.6	–	R	–	–	R	–	–	–	–	–
D. clarus	3.6	R	–	–	–	–	–	SR	–	–	–
D. equalis	3.6	–	D	–	–	SD	–	–	–	–	–
D. myceliophagus	3.6	–	SR	–	–	–	SD	–	–	–	–
F. facultativus	3.6	–	–	–	–	D	–	–	–	–	–
Psilenchus hilarulus	3.6	–	–	–	–	SD	–	SD	–	–	–
Trophurus imperialis	3.6	–	–	–	–	–	E	–	–	–	–
Amplimerlinius globigerus	1.8	–	–	–	–	–	D	–	–	–	–
A. daubichaensis	1.8	–	–	–	SD	–	–	–	–	–	–
A. haquei	1.8	–	–	–	R	–	–	–	–	–	–
Lelenchus leptosoma	1.8	–	–	–	D	–	–	–	–	–	–
Basiria sp.	1.8	–	–	–	–	SR	–	–	–	–	–
B. tumida	1.8	–	–	–	–	R	–	–	–	–	–
D. kheirii	1.8	–	–	R	–	–	–	–	–	–	–
D. longimatricalis	1.8	–	–	–	–	SD	–	–	–	–	–
D. medians	1.8	D	–	–	–	–	–	–	–	–	–
F. fragariae	1.8	–	–	SR	–	–	–	–	–	–	–
Neopsilenchus magnidens	1.8	–	–	–	–	D	–	–	–	–	–
Paraphelenchus myceliophthorus	1.8	–	–	–	–	–	–	–	–	R	–
Paratrophurus bursifer	1.8	–	–	–	–	–	SD	–	–	–	–
Paratrophurus hungaricus	1.8	–	–	–	–	–	SD	–	–	–	–
Psilenchus terxtremus	1.8	–	–	SR	–	–	–	–	–	–	–
Tylenchus elegans	1.8	–	–	–	–	–	SD	–	–	–	–

Explanation: see table 1

Table 4. The similarity of the fauna based on the Jaccard similarity coefficient

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
I. Chrzypsko Wielkie	–									
II. Gdańsk Wieniec	10.5	–								
III. Jankowo Gdańskie	11.9	28.6	–							
IV. Jantar	10.7	20.5	23.8	–						
V. Radunica	10.3	20.0	15.2	8.8	–					
VI. Mokry Dwór	3.1	19.5	25.6	18.7	18.2	–				
VII. Tujsk	19.2	30.5	26.8	24.1	19.3	11.8	–			
VIII. Grębałów	13.0	27.3	27.0	14.8	18.5	13.8	29.2	–		
IX. Nikielkowo	15.8	8.6	7.5	12.5	3.8	3.6	8.0	10.0	–	
X. Skierniewice	17.9	6.5	22.7	26.7	21.9	21.2	26.7	26.9	11.5	–

Table.5. Location characteristics

Distinct	Locality	Coordinates of the UTM square	pH soil	Type of soil
Wielkopolskie	Chrzypsko Wielkie	WU83	6.3	P/fawn soils
Pomorskie	Gdańsk Wieniec	CF42	6.9	M/the alluwial soils
Pomorskie	Jankowo Gdańskie	CF41	7.1	B/the brown soils
Pomorskie	Jantar	CF72	5.9	M/the alluwial soils
Pomorskie	Radunica	CF41	7.7	M/the alluwial soils
Pomorskie	Mokry Dwór	CF51	6.8	M/the alluwial soils
Pomorskie	Tujsk	CF71	7.4	M/the alluwial soils
Małopolskie	Grębałów	DA35	7.1	B/the brown soils
Warmińsko-mazurskie	Nikielkowo	DE76	5.3	P/the fawn soils
Łódzkie	Skierniewice	DC45	7.0	P/the fawn soils

M – the allwial soils, B – the brown soils, P – the fawn soils

Ektoparasitic nematodes (Table 2)

Bitylenchus dubius was the most frequently obtained and it was found in each type of soil (Skwiercz 1989). From the genus *Geocenamus* (6 species), *G. nanus* (C = 21.8) and *G. nothus* (C = 18.2) were found to be specific to the tulip. Semiectoparasitic nematodes from the genus *Helicotylenchus*, were represented by 5 species. The genus *Rotylenchus* was represented by 4 species. There were also 5 species from the genus *Paratylenchus* and nematode viruses vectors from the genus *Trichodorus* and *Longidorus leptocephalus*.

Similarity of nematode species on the tulip plantations was 3.1–29.0%. More similarity was obtained on the soil pH = 7.0–7.7 (Table 4).

Facultative parasitic nematodes (Table 3)

This was the most numerous group. The occurrence of C (constancy index) was consistently above 30% which was affirmed for *Filenchus vulgaris* and the *Basiria graminophila* (Table 1). These species were often found in great numbers. Their numbers did not depend on the kind of soil, and the pH of the soil.

DISCUSSION

Occurrence and population density of facultative parasitic nematodes were independent of soil type and its pH. These findings correspond with the observations of Brzeski (1998).

Occurrence of species belonging to the genus *Pratylenchus* depended on the pH of the soil. In the presence of host plants, the optimal pH of the soil for the *Pratylenchus* species was 5.0–7.3 (Castillo et Vovlas 2007). However, *P. crenatus* build a maximal population density in natural peat soils with a pH 6.5–8.0 (Skwiercz 1989a). *P. negletus* was frequently obtained when the soil pH was up to 6.5 (Szczygieł *et al*. 1969; Szczygieł and Zepp 2004) which corresponds with the results from the tulip plantations.

P. penetrans, was a more important pest of several plants (Christie 1959; Boer *et al*. 2005) as a recedent species in tulip plantations due to the high level of pH (above 6.5). A decrease in the population density in such high levels of pH was observed earlier by Castillo and Volvas (2007).

Ektoparasite nematodes from the *Belonolaimidae* family preferred acid soils (Szczygieł and Zepp 2004). In contrast Szczygieł *et al*. (1969), Skwiercz (1989a) and Dobies (2004) noted, that *B. dubius* had a preference for alkaline soils.

That results show that not only chemical properties are deciduous on the nematode population growth in soil (Wallace 1971; Skwiercz 1989a).

Tulip plantations can be infested by plant viruses transmitted by nematodes. During the survey, 2 species of the genus *Trichodorus* which transmitted tobraviruses such as TRV, nepoviruses (eg. TBRV) which was transmitted by two species of *Longidorus* and *Trichodorus primitivus*, were obtained (Asjes 1974; Taylor and Robertson 1974; Skwiercz 1987). These species were noted near rhizosphere of tulip in cultivated brown soils and *T. viruliferus* in fawn soils which corresponded with the findings of Szczygieł and Zepp (2004). Findings of high population density of *Longidorus leptocephalus* in acid soil are in agreement with the observations of Szczygieł *et al*. (1983) and Szczygieł and Zepp (2004).

To sum up this discussion, the following conclusions can be made: Tulip plantations on fertile soils with a pH of 6.9–7.1 are characterized by numerous plant parasitic nematode populations.

The limited survey so far showed that more detailed studies of plant parasitic nematodes in the rhizosphere of ornamental plants should to be undertaken.

ACKNOWLEDGEMENTS

This work was undertaken as part of a project WND-POIG.01.03.01-00-133/09 provided by the Museum and Institute of Zoology, the Polish Academy of Science, Warsaw.

REFERENCES

Asjes C.J. 1974. Soil-borne virus diseases in ornamental bulbous crops and their control in the Netherlands. Agric. Environ. 1: 303–315.

Baranovskaya I.A. 1981. Plant and Soil Nematodes (Aphelenchoididae and Seinuridae). Nauka, Moskwa, 234 pp.

Boer M., Ende E., Os G., Bijman V., Werd R. 2005. Integrated management of soil-borne diseases in flower bulb production. Acta Hort. 673: 73–78.

Brzeski M.W. 1998. Nematodes of Tylenchida in Poland and Temperate Europe. MiIZ PAN, Warszawa, 395 pp.

Cen Qi-Wen, Hooper D.J., Loof P.A.A., Xu Jianhna. 1997. A revised polytonous key for the identification of species of the genus Longidorus Micoletzky (Nematoda: Dorylaimida). Fundam. Appl. Nematol. 20 (1): 15–28.

Christie J.R. 1959. Plant Nematodes. Their Bionomics and Control. Agricultural Experiment Station, University of Florida, Gainesville, Florida, 256 pp.

Castillo P., Volvas N. 2007. Pratylenchus (Nematoda: *Pratylenchidae*): Diagnosis, Biology, Pathogenicity and Management. Brill, Leiden-Boston, 529 pp.

Decreamer W. 1980. Systematics of the *Trichodoridae* (Nematoda) with the keys to their species. Revue Nematol. 3 (1): 81–99.

Dobies T. 2004. Nicienie-pasożyty roślin (Nematoda, Tylenchida, Dorylaimida) szkółek leśnych. Acta Sci. Pol. Silv. Colendar. Rar. Ind. Lignar. 3 (2): 33–48.

Goodey J.B.1963. Soil and Freshwater Nematodes. Methuen & CO LTD, London, 544 pp.

Hetman J., Jabłońska L. 1997. Kierunki rozwoju produkcji roślin ozdobnych w Polsce na progu XXI wieku. Mat. Konf. „Strategia rozwoju polskiego ogrodnictwa do 2010 roku". AR Lublin, 11–12 XII 1997: 45–59.

Jabłońska L. 2006. Społeczno-ekonomiczne uwarunkowania rozwoju polskiego kwiaciarstwa. Zesz. Probl. Post. Nauk Rol. 510: 203–211.

Jaccard P. 1912. The distribution of flora in the alpine zone. New Phytol. 11: 37–50.

Kasprzak K., Niedbała W. 1981. Wskaźniki biocenotyczne stosowane przy porządkowaniu I analizie danych w badaniach ilościowych. p. 397–416. In: "Metody Stosowane w Zologii Gleby" (M. Górny, L. Grum, eds.). Wyd. Naukowe PWN, Warszawa, 483 pp.

Skwiercz A.T. 1987. Nicienie – pasożyty roślin i ich rola w kompleksowych chorobach drzew i krzewów. Sylvian 6: 29–35

Skwiercz A.T. 1989. Plant parasitic nematodes in the peat soils in Poland. Part I. Biocenotic analyse. Roczn. Nauk. Roln. Seria E – Ochrona Roślin 19 (1/2): 91–99.

Skwiercz A.T. 1989a. Plant parasitic nematodes in the peat soils in Poland. Part II. Frequency of occurrence and population density in different chemical properties of peat. Roczn. Nauk Roln. Seria E – Ochrona Roślin 19 (1/2): 101–111.

Szczygieł A., Gondek J., Karaś W. 1969. Występowanie pasożytniczych nicieni w szkółkach drzew owocowych w Polsce Południowej. Acta Agraria et Silvestria IX/1: 99–119.

Szczygieł A., Słowik K., Soroka A. 1983. Effect of soil pH on host-parasite relationship of three plant-parasitic nematodes and strawberry plants. Zesz. Probl. Post. Nauk Rol. 278: 95–103.

Szczygieł A., Zepp A. 2004. The association of plant parasitic nematodes with fruit crops in Poland as related to some soil properties. Frag. Faunist. 47 (1): 7–33.

Taylor C.E., Robertson W.M. 1974. Acquisition, retention and transmission of viruses by nematodes. p. 253–276. In: "Nematode Vectors of Plant Viruses" (F. Lamberti, C.E. Taylor, J.W. Steinhorst, eds.). Plenum Press, London and New York, 451 pp.

Wallace H.R. 1971. Abiotic influences in the soil environment. p. 257–280. In: "Plant Parasitic Nematodes" (B.M. Zuckerman, W.F. Mai, R.A. Rodhe, eds.). Vol. I. Academic Press, New York and London, 345 pp.

Wróblewska W. 2007. Rynek materiału wyjściowego ozdobnych roślin cebulowych i bulwiastych w Polsce i Holandii. Biul. SPORC 20: 3–10.

Yeates G.W., Bongers T., de Goede R.G.M., Freckman D.W., Georgieva S.S. 1993. Feeding habits in soil nematode families and genera – an outline for soil ecologists. J. Nematol. 25: 315–331.

POLISH SUMMARY

NICIENIE PASOŻYTNICZE NA PLANTACJACH TULIPANA W POLSCE

W latach 2005–2006 zebrano materiał z 10 plantacji tulipana na terenie województwa pomorskiego (6) oraz z jednej w województwie warmińsko-mazurskim, łódzkim, małopolskim i wielkopolskim. Na każdej plantacji określono pH gleby i jej rodzaj. Z każdej plantacji pobrano losowo 5 prób gleby po 200 g. Strukturę gatunkową nematofauny na poszczególnych plantacjach określono współczynnikiem dominacji – D i stałością występowania – C, a podobieństwo gatunkowe między plantacjami określono za pomocą formuły Jaccarda.

Ogółem stwierdzono 80 gatunków nicieni z 29 rodzajów, przy czym najwięcej gatunków odnotowano w Jankowie Gdańskim (34) i Gdańsku (29), a najmniej w Nikielkowie (9). Najczęściej notowanym obligatoryjnym pasożytem roślin był *Pratylenchus neglectus*, dla którego stałość występowania C była bliska 30%. Wśród ektopasożytów najczęściej stwierdzano *Bitylenchus dubius*. Podobieństwo faunistyczne wahało się dla poszczególnych plantacji od 3,1 do 29,2%. Najbogatszą faunę nicieni i największy stopień podobieństwa wykazywały plantacje założone na glebach żyznych o odczynie zasadowym 7,0–7,7. Na plantacjach o najniższym odczynie pH 5,3–6,1, występowało najmniej gatunków nicieni i wskaźniki podobieństwa faunistycznego były najniższe.