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Communities of nematodes in cereal fields following sugar beet

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Summary

The nematodes communities of cereals divided into two groups (spring cereals, winter wheat), with sugar beet as a preceding crop, were studied in the Slovak Republic in 2002.
The mean number of nematodes/500 g of soil were 292.5 ± 198.4 in spring cereals, while in winter wheat it reached 327.8 ± 208.4. Plant feeders were dominant trophic groups in both cereals groups (45.4 ± 16.5 %, respectively 48.9 ± 13.9 %). Bacterial feeders were subdominant trophic groups followed by fungal feeders, omnivores and predators. Values of Maturity Index (MI) varied from 2.36 ± 0.31 to 2.53 ± 0.31, Plant Parasite Index values were balanced in the both groups of cereals and PPI/MI ratio as well as F/B ratio was higher in spring cereals.

Key words: nematode communities; spring cereals; winter wheat; trophic groups; Slovak Republic

Introduction

Soil and plant nematode communities in agriculture soils are influenced by various biological, physical and chemical factors as plant species, soil type, climatic condition, pH, and also by the different human activities such as tillage, crop rotation, fertilisation and use of pesticides.
Modification of those factors can result in falling of some indigenous nematode species population below the detection levels, while other indigenous or introduced species successfully exploit the modified ecosystem. Nematode diversity tends to by the greatest in the ecosystems with the least disturbance, and bacterial feeders make the greatest contribution to the decomposer food in more intensively managed ecosystems (Yeates, 1999).
The changes of nematode community structures were presented in some recent works from the agroecosystems with annual cropping systems (Freckman and Ettema, 1993; Yeates and Bird, 1994; McSorley and Frederic, 1996; Neher, 1999; Ivezić *et al.*, 2000, Valocká *et al.*, 2001)
In our previous paper we studied a structure of nematode communities in sugar beet growing areas of the Slovak Republic (Renčo and Valocká, 2002).
In this study the nematode community structures are analyzed from cereals succeeding by sugar beet in crop rotation.

Material and Methods

Nematode communities structure were studied in 2002 in 28 localities with cereals (Fig. 1). Localities were divided into two groups:
A – spring cereals (oat and barley) with sugar beet as preceding crop in 2001 (14 sites),
B – winter wheat with cereals as a preceding crop in 2001 and sugar beet in 2000 (Tab.2).
Soil samples were collected twice per year (in June and September) at the depth of 20 cm, nematodes were isolated

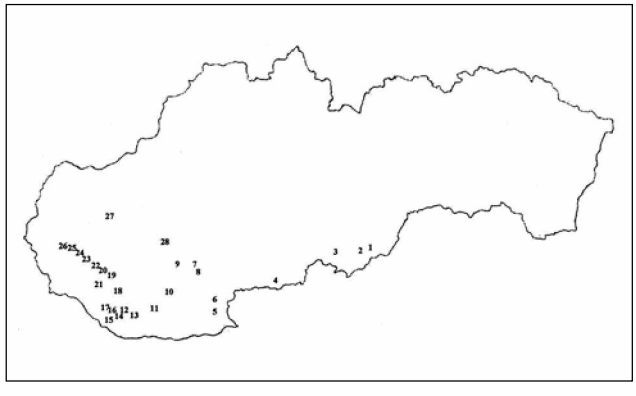

Fig 1. The localities of the samples collection in the Slovak Republic

1 – Martinová; 2 – Bottovo, 3 – Fiľakovské Kováče; 4 – Kosihy nad Ipľom; 5 – Čata; 6 – Hronovce; 7 – Kálna nad Hronom; 8 – Tekovský Hrádok; 9 – Lúčnica nad Žitavou; 10 – Bánov; 11 – Komoča; 12 – Dropie; 13 – Okoč; 14 – Dolný Štál; 15 – Pataš; 16 – Vrakúň; 17 – Trhová Hradská; 18 – Jahodná; 19 – Košúty; 20 – Sládkovičovo; 21 – Nový Dvor; 22 – Pusté Uľany; 23 – Čataj; 24 – Báhoň; 25 – Vištuk; 26 – Budmerice; 27 – Nižná; 28 – Beladice

by the Cobb sieving method (lit.) with final extracting using a Bermann funel from 500 g of composite soil samples. Nematodes were determinated to genera and divided into five trophic groups based on the classification system of Yeates *et al.* (1993) – bacterial feeders, fungal feeders, plant feeders, omnivores and predators.

Frequency and mean population density of soil and plant nematodes (Tab.1) as well as following indices were used for nematode communities evaluation (Tab.2):

Mean number of nematodes/500 g of soil; percentage proportion of trophic groups;

Maturity Index: $MI = \Sigma\, v_i\, f_i$

where v_i is c-p value of taxon (1 – 5) and f_i frequency of a taxon in the sample (Bongers, 1990) (for non parasitic nematodes); Plant Parasite Index (PPI): calculated by a similar formula (for plant parasitic nematodes) (Bongers, 1990); PPI/MI ratio: proportion of Plant Parasite Index to Maturity Index (Bongers & Karthals, 1995); F/B ratio: proportion of fungal to bacterial feeders.

Results

Altogether 42 genera of nematodes were identified in cereals, were sugar beet was a preceding crop. The number of nematodes /500g of soil were 292.5 ± 198.4 on the „A" sites (spring cereals), while 327.8 ± 208.4 on the „ B" sites (winter wheat) (Tab 3).

Plant feeders were dominant trophic groups with the proportion of 45.4 ± 16.5 % on A and 48.9 ± 13.9 % on B sites. The highest frequency of occurrence (100 %) as well as the highest population density (89.9 ± 116.9/500 g of soil) belong to parasitic nematodes *Tylenchorhynchus s.l.* and *Tylenchus s.l.* (96.4 %, respectively 34.7 ± 24.9/500 g of soil) (Tab.1).

Proportion of bacterial feeders was higher at the „A" sites (28.8 ± 10.9 %) than at „B" (24.6 ±7.2 %). The genus *Rhabditis* showed the highest frequency of occurrence as well as population density (100 %, respectively 35.1 ± 14.9 /500 g of soil). As well numerous genera were *Eucephalobus* and *Acrobeloides* with 89.2 resp. 82.1 proportion of occurrence.

Fungal feeders averaged 13.1 ± 9.2 % of nematode fauna at spring cereals and 10.1 ± 5.2 % at winter wheat with the most frequently occured nematodes of genera *Aphelechus* and *Nothotylenchus* (89.2 %)

Omnivores represented 10.1 ± 6.1 % at A and 13.9 ± 8.2 % at B sites. The most abundant genera were *Eudorylaimus* and *Dorylaimus* with 96.4 resp. 85.7 % frequency of occurrence.

Predators were the least abundant trophic groups with mean proportion 2.3 ± 1.9 % at A and 2.3 ± 3.2 % at B sites. The most frequently were genus *Mylonchulus* (53.2 %) proportion with total groups.

Values of MI reached 2.36 ± 0.31 in spring cereals and 2.53 ± 0.31 in winter wheat. PPI values were similar at both groups of cereals (2.57 ± 0.23, respectively 2.56 ± 0.22) Values of PPI/MI ratio as well as F/B ratio were higher in spring cereals than in winter wheat.

Table 1. Frequency and mean population density (specimens 500 g of soil) of soil and plant nematodes in cereals localities of the Slovak Republic (n = 28)

Genus	c – p value	Number of positive localities	Frequency %	Mean population density mean ± S.D.
Bacterial feeders				
Acrobeles	2	6	21.4	1.8 ± 0.6
Acrobeloides	2	23	82.1	16.1 ± 17.6
Alaimus	4	15	53.5	3.8 ± 3.5
Anaplectus	2	18	64.2	8.1 ± 5.3
Aulolaimus	3	2	7.1	1.0
Bastiania	3	2	7.1	2.0
Cephalobus	2	22	78.5	26.7 ± 22.1
Eucephalobus	2	25	89.2	20.8 ± 21.8
Chiloplacus	2	17	60.7	13.4 ± 11.0
Panagrolaimus	1	16	57.1	5.8 ± 5.0
Plectus	2	18	64.2	8.8 ± 6.3
Rhabditis	1	28	100.0	35.1 ± 14.9
Fungal feeders				
Aphelenchoides	2	21	75.0	9.6 ± 9.3
Aphelenchus	2	25	89.2	11.3 ± 12.1
Boleodorus	2	16	57.1	5.9 ± 3.9
Diphtherophora	3	7	25.0	2.5 ± 1.2
Ditylenchus	2	14	50.0	4.8 ± 2.7
Hexatylus	2	2	7.1	1.5 ± 0.5
Nothotylenchus	2	25	89.2	8.3 ± 5.6
Paraphelenchus	2	2	7.1	3.0 ± 1.0
Tylencholaimus	4	5	17.8	2.0 ± 0.6
Plant feeders				
Coslenchus	2	23	82.1	22.8 ± 50.0
Helicotylenchus	3	11	39.2	9.1 ± 6.8
Heterodera	3	8	28.5	2.7 ± 0.9
Paratylenchus	2	18	64.5	4.5 ± 4.6
Pratylenchus	3	21	75.0	17.5 ± 27.0
Tylenchorhynchus s. l.	3	28	100.0	89.9 ± 116.9
Tylenchus s.l.	2	27	96.4	34.7 ± 24.9
Omnivores				
Aporcelaimus	5	2	7.1	1.5 ± 0.5
Axonchium	4	1	3.5	1.0
Dorylaimus	4	24	85.7	16.5 ± 10.6
Eudorylaimus	4	27	96.4	22.9 ± 32.1
Mesodorylaimus	5	8	28.5	3.6 ± 3.1
Oxydirus	4	4	14.2	1.2 ± 0.4
Paraxonchium	4	1	3.5	1.0
Predators				
Anatonchus	4	4	14.2	1.5 ± 0.5
Clarkus	4	11	39.2	3.4 ± 2.1
Discolaimium	5	2	7.1	5.5 ± 4.5
Discolaimus	5	5	17.8	1.8 ± 1.1
Mylonchulus	4	15	53.2	4.2 ± 4.2
Nygolaimus	5	10	35.7	3.2 ± 2.7
Tripyla	3	1	3.5	1.0

Table 2. Nematode community structure at 28 cereals sites in the Slovak Republic

No. locality	crop	Indices n	B	M	F	O	P	MI	PPI	MI/PPI	F/B
1 +	oat	433	25.0	12.2	49.6	9.0	4.1	2.49	2.79	1.12	0.49
2 +	oat	266	17.3	24.8	47.7	6.4	3.7	2.37	2.55	1.07	1.43
3 +	oat	116	28.4	31.1	35.3	5.2	0	2.02	2.31	1.14	1.09
4 -	w. wheat	231	20.3	7.4	55.1	11.2	8.0	2.70	2.70	1.00	0.36
5 -	w. wheat	577	14.2	4.0	70.0	11.6	0.2	2.69	2.26	0.84	0.28
6 -	w. wheat	359	41.5	13.4	33.4	10.0	1.7	2.29	2.69	1.17	0.32
7 -	w. wheat	570	28.6	6.0	27.0	37.2	1.2	3.03	2.35	0.77	0.20
8 +	oat	389	29.8	2.6	47.8	14.1	5.6	2.81	2.31	0.82	0.08
9 -	w. wheat	387	22.0	4.9	59.1	10.8	3.1	2.68	2.56	0.95	0.22
10 +	barley	361	28.8	6.4	44.6	18.3	1.9	2.79	2.51	0.89	0.22
11 +	barley	831	19.6	6.6	64.7	8.4	0.6	2.51	2.85	1.13	0.33
12 -	w. wheat	358	31.2	10.4	29.4	28.9	0	2.78	2.20	0.79	0.33
13 +	barley	289	52.6	13.1	10.1	20.1	4.1	2.50	2.20	0.88	0.25
14 -	w. wheat	231	22.5	6.9	52.8	13.0	4.8	2.82	2.85	1.01	0.30
15 +	oat	116	32.7	12.1	31.1	19.8	4.3	2.67	2.94	1.10	0.36
16 -	w. wheat	199	31.6	12.6	49.2	6.5	0	1.91	2.71	1.41	0.39
17 -	w. wheat	891	16.8	5.2	70.9	7.1	0	2.21	2.88	1.30	0.30
18 +	oat	129	14.7	32.5	48.0	4.7	0	2.22	2.56	1.15	2.21
19 +	oat	173	26.1	9.8	62.9	0	1.2	1.68	2.78	1.65	0.37
20 -	w. wheat	264	26.9	3.8	60.2	8.3	0.8	2.18	2.82	1.29	0.14
21 -	w. wheat	232	18.1	17.3	53.0	11.6	0	2.40	2.53	1.05	0.95
22 -	w. wheat	187	16.2	18.2	53.4	10.2	0	2.43	2.37	0.97	1.00
23 +	oat	112	33.9	12.5	42.0	11.6	0	2.29	2.42	1.05	0.36
24 +	barley	107	35.5	7.5	38.3	14.0	4.7	2.62	2.56	0.97	0.21
25 +	barley	247	46.5	10.5	32.4	8.5	2.1	2.03	2.37	1.16	0.22
26 -	w. wheat	120	31.7	18.3	31.6	15.8	2.5	2.43	2.31	0.95	0.57
27 +	oat	526	12.7	2.9	82.1	2.1	0.2	2.05	2.93	1.42	0.22
28 -	w. wheat	121	21.5	14.1	40.5	13.2	10.7	2.98	2.71	0.90	0.65

+– spring cereals; – – preceding crop sugar beet (A); - winter wheat – preceding crop cereals, followed by sugar beet (B); n – number of nematodes

Table 3. Mean values of nematode communities structure at spring cereals (A) and winter wheat (B)

Indices	A	B	Total
Mean number of nematodes /500g	292.5 ± 198.4	327.8 ± 208.4	310.5 ± 204.2
Bacterial feeders	28.8 ± 10.9	24.6 ± 7.2	26.8 ± 9.5
Fungal feeders	13.1 ± 9.2	10.1 ± 5.2	11.7 ± 7.6
Plant feeders	45.4 ± 16.5	48.9 ± 13.9	11.7 ± 7.6
Omnivores	10.1 ± 6.1	13.9 ± 8.2	12.1 ± 7.5
Predators	2.3 ± 1.9	2.3 ± 3.2	2.3 ± 2.6
MI	2.36 ± 0.31	2.53 ± 0.31	2.44 ± 0.32
PPI	2.57 ± 0.23	2.56 ± 0.22	2.57 ± 0.22
PPI/MI	1.11 ± 0.20	1.02 ± 0.18	1.06 ± 0.20
F/B	0.56 ± 0.58	0.42 ± 0.25	0.49 ± 0.45

Discussion

The results showed the structure of plant and soil nematodes communities in cereals with sugar beet as a preceding crop. In cereals there was found the least number of nematode 42 genera and mean number of nematodes on 500 g of soil (310.5 specimens) than found Renčo and Valocká, 2002 in sugar beet (51, respectively 401.3 specimens)
Our results on nematode communities structure in cereals were comparable with the results presented by Yeates and

Bird (1994), Ivezić *et al.* (2000) and Valocká *et al.* (2001). The mentioned authors found plant feeders as dominant trophic groups in cereals followed by bacterial feeders. On the other hand in another annual cropping systems presented by Freekman and Etema (1993), McSroley and Frederick (1996) Renčo and Valocká (2002) bacterial feeders were dominant trophic groups.

There are some differences in the structure of nematode communities in sugar beet and its followed cereals. While nematode communities of sugar beet were characterized by a high proportion of bacterial feeders (36.9 %) Renčo and Valocká (2002), succeeded cereals showed lower proportion of this trophic groups (28.8 % in the first year and 24.6 % in the second year after sugar beet). Proportion of plant feeders increased successively from 33.8 % in sugar beet to 45.5 % in the first year and 48.9 % in the second year.

The Maturity Index was developed as a measure of environmental disturbance of terrestrial ecosystems (Bongers, 1990). Its higher value reflects less disturbed sites. Our Mi values were lover than those in cereals fields (Valocká *et al.*, 2001) but comparable or higher than those Renčo and Valocká (2002) in sugar beet and Freckman & Ettema (1993) and Yeates & Bird (1994) in annual cropping systems.

Recent studies referred to an inverse relationship between MI and PPI (Bongers & Korthals, 1995; Bongers *et al.*, 1997). According to these authors, this ratio increases gradually from natural habitats (up to 0.9) to intensively managed agricultural systems, where effects of slight nutrient disturbance are indicated by value of to 1.2. Our PPI/MI values varied from 1.02 at „B“ to 1.11 at „A“ sites and it was generally higher than in cereals (Valocká *et al.*, 2001) and comparable or higher with Renčo & Valocká (2002) in sugar beet.

F/B ratio values in our study were comparable or lower with those Valocká *et al.* (2001) and Freckman & Ettema (1993) in annual cropping system, but higher than those McSorley and Frederick (1996)

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