

Seasonal effects on the population dynamics of soil nematodes in a maize field

Vplyv sezóny na populačnú dynamiku nematód v poraste kukurice

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ABSTRACT

A study on the seasonal changes of nematode population was conducted during period of May to September, 2011 in maize field Komoča in Slovak Republic. A total of 37 nematode species from 32 genera were found. The identified nematode species belonged mainly to the orders Dorylaimida Pearse, 1942, Tylenchida Thorne, 1949 and Rhabditida Chitwood, 1933. Dominant species were *Acrobeloides nanus* (de Man, 1880), *Cephalobus persegnis* Bastian, 1865 and *Eucephalobus striatus* (Bastian, 1865). Dominance of many species changed during the season. In May it was found dominance of *Rhabditis* spp. (almost 80 % of total nematodofauna) but this dominance dropped during the season. On the other hand, dominance of *C. persegnis*, *Aphelenchoides minimus*, *Bitylenchus dubius* increased during the season. Nematode species *C. persegnis*, *E. striatus*, *Filenchus vulgaris* and *Mylonchulus brachyuris* had a frequency of occurrence over 90%. The highest abundance of nematodes was found in May and the lowest abundance was found in September.

KEYWORDS: nematodes, seasonal effects, population dynamics, *Zea mays*

ABSTRAKT

Sezónne zmeny spoločenstiev pôdnych nematód boli študované v poraste kukurice od mája do septembra, 2011 na lokalite Komoča, Slovensko. Celkovo bolo identifikovaných 37 druhov pôdnych nematód, ktoré patrili do 32 rodov. Najviac identifikovaných druhov patrilo do radov Dorylaimida Pearse, 1942, Tylenchida Thorne, 1949 a Rhabditida Chitwood, 1933.. Na skúmanej lokalite dominovali druhy *Acrobeloides nanus* (de Man, 1880), *Cephalobus persegnis* Bastian, 1865 and *Eucephalobus striatus* (Bastian, 1865). Dominancia viacerých druhov sa počas sezóny menila. Rod *Rhabditis* v máji tvoril takmer 80% z celkovej nematodofauny ale táto výrazna dominancia klesla počas sezóny na približne 8%. Naopak dominancia druhov *C. persegnis*, *Aphelenchoides minimus*, *Bitylenchus dubius* počas sezóny stúpala. Frekvencia výskytu nad 90% sa zistila pri druhoch *C. persegnis*, *E. striatus*,

Filenchus vulgaris a *Mylonchulus brachyuris*. Najvyššia priemerná abundancia nematód bola zaznamenaná v mesiaci máj naopak najnižšia v septembri.

KLÚČOVÉ SLOVÁ: Nematoda, sezónne zmeny, *Zea mays*

DETAILNÝ ABSTRAKT

Pôdne nematódy (Nematoda – hlístice) patria k najjednoduchším mnohobunkovom, ktoré sú významnou zložkou všetkých ekosystémov (Andrássy, 1984). Svojou samotnou početnosťou a rôznorodosťou zastúpenia druhov sú významnou súčasťou pôdy. Cieľom práce bolo zistiť zastúpenie voľne žijúcich pôdnych a parazitických nematód rastlín, ich abundanciu, dominanciu a frekvenciu výskytu a zároveň zachytiť ich zmeny v sezónnej dynamike v poraste kukurice siatej (*Zea mays*).

Priemerné pôdne vzorky boli odoberané počas piatich mesiacov máj – september 2011. Bolo vybraných 5 stanovišť pričom na každom stanovišti bola priemerná vzorka zmiešaná z 5 odberov odobratých z plochy cca 10x10 m. Nematódy boli izolované zo 100 g premiešanej priemernej vzorky pomocou Baermannovej lievikovej metódy, fixované roztokom FAA (Southey, 1986) a následne identifikované z trvalých glycerínových preparátov. Na identifikáciu boli použité identifikačné kľúče: Meyl (1961), Brzeski (1998), Loof (1999), Siddiqi (2000) a Andrássy (1984, 2005, 2007, 2009).

Počas sledovaného obdobia piatich mesiacov bolo z 5 968 izolovaných jedincov identifikovaných 37 druhov patriacich do 32 rodov voľne žijúcich pôdnych a parazitických nematód rastlín. Najviac identifikovaných druhov patrilo do radov Dorylaimida (9) Tylenchida (8) a Rhabditida (6). Priemerná abundancia nematód v 100 g pôdnej vzorky bola 238.7, pričom priemerná abundancia v jednotlivých mesiacoch kolísala od 322 jedincov/100g pôdy v máji po 146 jedincov /100g pôdy v septembri. Ako eudominantné ($D > 10\%$) druhy boli zaznamenané *Acrobeloides nanus* and *Cephalobus persegnis* a tiež rod *Rhabditis* spp. Dominantným druhom bol *Eucephalobus striatus* ($D = 5 - 10\%$). Dominancia jednotlivých identifikovaných druhov sa počas sezóny výrazne menila. Napríklad pri druhoch *C. persegnis*, *Aphelenchoides minimus*, *Bitylenchus dubius* dominancia stúpala počas sezóny. Pri druhoch *A. nanus*, *Filenchus vulgaris* a *Doryllium zeelandicum* bola zistená výrazna dominancia v júli. Frekvencia výskytu nad 90% sa zistila pri druhoch *C. persegnis*, *E. striatus*, *F. vulgaris* a *Mylonchulus brachyuris*. Niektoré druhy, napr. *Plectus longicaudatus*, *Aglenchus agricola* *Coomansus parvus* a *Eudorylaimus iners* boli zaznamenané len v máji a v ďalších mesiacoch ich výskyt nebol zaznamenaný.

INTRODUCTION

On the rhizosphere on the maize occur nematodes of various ecological groups; from free living up to specific plant parasites. Plant parasitic nematodes can directly influence and reduce plant crop. Besides them, many free living nematode species with different influence and function in soil can be found. Valocká et al. (1986) found gradual increase of plant parasitic nematodes in the course of consecutive grain growing and more stable seasonal dynamic of plant parasitic nematodes or free living nematodes. Hassan et al. (2009) studied seasonal nematode population density on maize and provided reached peak of nematode population in the soil in June – July

and the decline gradually from July to August and from December to March. A seasonal change on occurrence of soil nematodes in maize field has been documented with focus on specific plant parasites species, e.g. by Lawrence et al. (2007) study host status evaluations of *Rotylenchulus reniformis* associated with the *Gossypium hirsutum-Zea mays* rotation system, by Adegbite (2011) study reaction of maize (*Zea mays* L.) varieties to infestation with root-knot nematode, *Meloidogyne incognita* under field conditions. The objective of this investigation was to obtain information about seasonal fluctuation of the nematode population in maize field in southwest region of Slovakia.

MATERIAL AND METHODS

The study was undertaken in maize field at Komoča (47°58'N; 18°02'E) in southwest region of Slovakia situated in warm area with temperate and moderately humid winter. Average daily temperature in January is under -2°C, average daily temperature in July achieve 20-21°C. Mean annual precipitation total is 500-550 mm. The locality is characterized by calcareous fluvisols associated with gleyic and arenic calcareous fluvisols from carbonate alluvial segments. During the period of investigation (May – September 2011) the temperature was in the range of 16.7 – 21.6°C and rainfall in the range of 15.4 – 83.7 mm. (Tab. 1). Maize hybrid Realli CS (Causade Semences) was used in the experiment.

Sampling was carried out in 2011 during five months on following dates: May 4; June 8; July 6; August 3; and September 5. Five stands (100 m²) were selected for investigating the nematode communities. A bulked sample consisted of five subsamples collected at a depth of 15 cm at each stand on individual sampling dates. Nematodes were isolated from 100 g of mixed soil samples using the Baermann method, fixed in FAA solution (Southey, 1986) and evaluated on permanent glycerine slides. The nematodes were microscopically identified and allocated to the genus level using the keys by Meyl (1961), Brzeski (1998), Loof (1999), Siddiqi (2000) and Andrassy (1984, 2005, 2007, 2009). The nematode species were allocated to the trophic groups according to data on feeding habits by Yeates *et al.* (1993) as follows: bacteriovores (B), fungivores (F), root-fungal feeders (RFF), plant parasites (PP), predators (P), omnivores (O). The nematode species were characterised as eudominant at $D > 10\%$, dominant at $D = 5 - 10\%$, subdominant at $D = 2 - 5\%$ and recedent at $D < 2\%$ (Losos *et al.*, 1984).

Table 1 Mean monthly temperature and sum of precipitations in May – September, 2011 at the locality Hurbanovo (data provided by Slovak Hydrometeorological Institute).
Tabuľka 1 Priemerná mesačná teplota a suma zrážok počas mesiacov máj – september, 2011 na lokalite Hurbanovo (údaje poskytol Slovenský hydrometeorologický ústav).

	May	June	July	August	September
Mean monthly temperature	16.7	20.7	20.3	21.6	18.4
Mean monthly precipitation	24.6	63.0	83.7	22.4	15.4

RESULTS AND DISCUSSION

From a total of 5968 nematode specimens that were isolated, 37 nematode species and 32 genera were identified during vegetation period (Table 2). The majority of identified nematodes species belonged to the orders Dorylaimida (9), Tylenchida (8) and Rhabditida (6).

The mean abundance of nematodes in 100 g of soil sample was 239. Mean abundance during season fluctuated from maximum 322 individuals /100 g soil in May to minimum 146 individuals /100 g soil in September. Valocká et al. (1986) found the highest numbers of nematodes in May, but she found yearly minimum in August. The population dynamics of nematodes in winter wheat has been carried out by Bramez et al. (2004). They showed that the total number of nematodes was the highest in April and the lowest in October. Population of plant parasitic nematodes was the highest in autumn and it decreased during the spring and the winter period. In the maize field, Hassan et al. (2009) found the highest mean nematode population density 250 individuals/200 g of soil in July and 65 individuals /200 g of soil in August.

In our study, the eudominant ($D > 10\%$) genera were bacterial feeding nematodes *Rhabditis* spp., *Acrobeloides nanus* and *Cephalobus persegnis*. Dominant species ($D = 5-10\%$) was *Eucephalobus striatus*. Dominance of many species changed during the season rapidly. Genus *Rhabditis* was markedly eudominant in May and represented almost 80 % of all nematodes, but in September or July its abundance achieved only 8.5 % or 7.8 % of total nematode fauna. Renčo et al. (2010) found the highest abundance of *Rhabditis* in hop-field in June and Venette and Ferris (1997) observed the increase of bacterial feeding nematodes at higher temperature. On the other hand, dominance of *C. persegnis*, *Aphelenchoides minimus*, *Bitylenchus dubius* increased during the season. Species *Acrobeloides nanus*, *Filenchus vulgaris* and *Doryllium zeelandicum* had the highest dominance in July.

Plant parasitic nematodes were represented by only six species that included *Bitylenchus dubius*, *Doryllium zeelandicum*, *Pratylenchus pratensis*, *Pratylenchoides crenicauda*, *Trichodorus primitivus* and *Helicotylenchus digonicus*. This number is lower compared to those observed in maize field by Talwana et al. (2008). These authors found 12 plant parasitic species with predominance of *Pratylenchus zaeae*. Similarly Kornobis (1981) found dominant *Pratylenchus neglectus* in maize field in Poland. Evans et al. (1993) found *Pratylenchus* spp. to be most frequently associated with poor growth of maize. Dominant plant parasitic species in our maize field was *Bitylenchus dubius* and dominance of this species during the season increased from 0.7 % in May to 6.7 % in September from total nematode fauna. Kornobis (1981) listed this species as the second the most frequently presented and abundant species in maize field in Poland. Control of *B. dubius*, which multiplied four fold in untreated plots, increased maize dry matter yields in England by up to 37 % (Williams and Beane, 1984).

Frequency of occurrence over 90% in all investigated samples was recorded for species *C. persegnis*, *Eucephalobus striatus*, *F. vulgaris* and *Mylonchulus brachyuris*. Occurrence of these species is very common in agroecosystems and natural forest and grassland in Slovakia (Lišková and Čerevková, 2011). Some species e.g.

Plectus longicaudatus, *Aglencus agricola*, *Coomansus parvus* and *Eudorylaimus iners* were recorded only in May and during the following months their occurrence was not recorded.

Table 2 Communities of nematodes in maize field identified during period May-September 2011 at Komoča locality, A – abundance, D – dominance in %, F – frequency of occurrence in %, TG – trophic groups: B - bacterial feeders, F - fungal feeders, RFF - rootfungal feeders, PP - plant parasites, O - omnivores, P -predators. Tabuľka 2 Spoločenstvá nematód v poraste kukurice identifikovaných počas piatich mesiacov máj až September 2011 na lokalite Komoča, A – abundancia, D % - dominancia v %, F – frekvencia výskytu v %, TG – trofické skupiny: B – baktériofágy, F – mykofágy, RFF – fyto-mykofágy, PP – parazity rastlín, O – omnifágy, P – predátory.

TG	Nematode species	Dominance % (n=5)					Mean (n=25)		
		V.	VI.	VII.	VIII.	IX.	A	D%	F%
	ARAEOLAIMIDA								
B	<i>Plectus longicaudatus</i> Butschli 1873	0.4	-	-	-	-	0.24	0.1	4
B	<i>Plectus parvus</i> Bastian 1865	1.0	1.6	0.6	0.5	-	1.76	0.74	48
	RHABDITIDA								
B	<i>Cephalobus persegnis</i> Bastian 1865	0.7	9.2	13.9	14.3	19.7	24.92	10.44	96
B	<i>Eucephalobus striatus</i> (Bastian 1865)	2.2	19.9	11.7	9.9	10.7	23.4	9.8	96
B	<i>Acrobeloides nanus</i> (de Man 1880)	0.3	18.0	27.3	22.0	19.3	38.84	16.27	84
B	<i>Chiloplacus propinquus</i> (de Man 1921)	0.4	0.7	-	0.1	0.3	0.68	0.28	20
B	<i>Cervidellus vexilliger</i> (de Man 1880)	0.9	0.4	0.8	0.1	0.7	1.36	0.57	36
B	<i>Panagrolaimus rigidus</i> (A. Schneider 1866)	1.2	-	0.3	0.3	0.1	1.16	0.49	40
B	<i>Rhabditis</i> spp.	78.2	9.7	7.8	9.5	8.5	65.88	27.6	100
	APHELENCHIDA								
F	<i>Aphelenchus avenae</i> Bastian 1865	1.1	4.8	1.3	1.7	-	4.12	1.73	72
F	<i>Aphelenchoides composticola</i> Franklin 1957	0.6	2.4	3.7	3.3	4.2	6.32	2.65	80
F	<i>Aphelenchoides minimus</i> Meyl 1953	1.6	6.3	3.6	5.8	8.2	11.0	4.61	80
F	<i>Aphelenchoides ritzemabosi</i> (Schwartz 1911)	0.9	5.1	3.8	4.3	2.7	7.72	3.23	84
	TYLENCHIDA								
RFF	<i>Aglencus agricola</i> (de Man 1884)	0.5	-	-	-	-	0.32	0.13	4
RFF	<i>Filenchus vulgaris</i> (Brzeski, 1963)	1.7	6.3	10.4	5.6	6.3	13.6	5.7	96
RFF	<i>Basiria gracilis</i> (Thorne 1949)	-	-	-	6.3	1.8	4.4	1.84	28
RFF	<i>Malenchus exiguus</i> (Massey 1969)	-	0.1	-	-	-	0.04	0.02	4
PP	<i>Bitylenchus dubius</i> (Butschlii 1873)	0.7	5.6	3.7	4.2	6.7	8.72	3.65	80
PP	<i>Pratylenchus pratensis</i> (de Man 1880)	0.1	-	-	0.5	0.4	0.48	0.2	20
PP	<i>Pratylenchoides crenicauda</i> Winslow 1958	0.1	0.7	-	-	-	0.28	0.12	12
PP	<i>Helicotylenchus digonicus</i> Perry 1959	0.1	-	-	-	-	0.04	0.02	4
	ENOPLIDA								
B	<i>Prismatolaimus dolichurus</i> de Man 1880	-	-	-	0.1	2.7	0.88	0.37	24
	ALAIMIDA								
B	<i>Alaimus primitivus</i> de Man 1880	0.4	0.2	0.6	0.8	0.3	1.16	0.49	40
	DIPHTHEROPHORIDA								
O	<i>Diphtherophora communis</i> de Man 1880	-	-	-	0.1	-	0.04	0.02	4
PP	<i>Trichodorus primitivus</i> (de Man 1880)	-	-	0.3	0.1	-	0.2	0.08	8
	MONONCHIDA								
P	<i>Coomansus parvus</i> (de Man 1880)	0.1	-	-	-	-	0.04	0.02	4
P	<i>Mylonchulus brachyuris</i> (Butschli 1873)	2.2	1.0	1.4	1.4	1.8	3.84	1.61	92

P	<i>Prionchulus muscorum</i> (Dujardin 1845) DORYLAIMIDA	0.6	-	-	0.1	1.6	0.96	0.4	24
O	<i>Mesodorylaimus bastiani</i> (Butschli 1873)	-	-	0.1	-	-	0.04	0.02	4
O	<i>Mesodorylaimus centrocercus</i> (de Man 1880)	-	0.4	-	-	-	0.16	0.07	4
O	<i>Crassolabium ettersbergense</i> (de Man, 1885)	2.4	2.0	2.0	3.3	2.2	5.88	2.46	84
O	<i>Dorydorella pratensis</i> (de Man 1880)	0.6	3.6	3.0	3.8	0.4	5.6	2.35	72
O	<i>Eudorylaimus carteri</i> (Bastian 1865)	0.1	0.6	0.1	0.3	0.1	0.48	0.2	32
O	<i>Eudorylaimus iners</i> (Bastian 1865)	0.1	-	-	-	-	0.08	0.03	4
O	<i>Aporcelaimellus obtusicaudatus</i> (Bastian 1865)	0.7	1.0	0.3	0.9	0.8	1.76	0.74	64
O	<i>Enchodelus macrodorus</i> (de Man 1880)	-	-	0.4	0.1	0.4	0.4	0.17	24
PP	<i>Doryllium zeelandicum</i> (de Man 1876)	0.2	0.2	2.9	0.5	-	1.92	0.8	40
Total abundance		322	179.6	237.6	308.2	146.2	238.7		

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