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Effect of mechanical disturbances on nematode communities in arable land

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Summary

Nematode communities were used as bioindicators of changes in agroecosystems caused by anthropogenic factors. The aim of this study was to examine the impact of plowing and harrowing on nematode communities structure in comparison to "no tillage" treatments. The effects of mechanical disturbing of nematodes were determined on four soil treatments. Differences in nematode community structure were compared between two tillage regimes: standard tillage and no tillage. Research was conducted in 2000, in Kneževo near Osijek. Plowing had impact on increasing of bacterivorous nematodes and decreasing of fungivorous nematodes. *Pratylenchus*, *Helicotylenchus* and *Tylenchus* were dominant plant-feeding nematodes in no tillage treatments, while in plowing treatments *Pratylenchus* and *Tylenchus* were dominant. Abundance of *Aphelenchoides* decreased significantly after plowing. Tillage affected nematode communities in the soil ecosystem by changing the trophic structure and gave a decreasing, but not statistically significant, trend in MI.

Key words: nematode communities; bioindicators; mechanical disturbances

Introduction

In numerous studies, nematode communities showed possibilities to be good indicators of different kind of disturbances in ecosystems. Some groups of nematodes can survive under disturbed environmental conditions, while others can not. There are differences in feeding behavior (Yeates *et al.*, 1993), and predominantly, omnivore and predators have great sensitivity to disturbances (Bongers *et al.*, 1991; Bongers *et al.*, 1995). Nematodes can be classified upon many different criteria, but the development of Maturity index (MI) (Bongers, 1990) presents a significantly advanced tool for predicting ecological processes in soil ecosystems. Above that, they play a great role in soil nutrient cycle, especially free-living nematodes (Ferris & Matute, 2003; Neher, 2001). For those reasons, nematode communities have potential to serve as very good biotic indicators of soil processes. Structure of nematode communities can reflect differences in agroecosystem conditions (Ivezic *et al.*, 2000), organic amendments (Goede, 1993; Goede & Dekker, 1993; Sohlenius & Wasilewska, 1984), heavy metal compounds (Korthals, 1997), soil tillage system (Hendrix *et al.*, 1986; Sohlenius *et al.*, 1987; Freckman & Ettema, 1993; Neher & Campbell, 1994), air pollution (Zullini & Peretti, 1986; Steiner, 1994 a, b, c) river pollution (Zullini, 1976), and different kind of environmental monitoring (Bongers & Ferris, 1999).

The objective of this investigation was to determine changes in nematode communities structure after human intervention or specific mechanical disturbances caused by tillage practices in eastern part of Croatia.

Materials and Methods

Research was conducted in 2000, in Kneževo near Osijek (45°32"N, 181°44"E), on caltic chernozem. The soil was a filty loam: pH (H_2O) = 8.6; pH (KCl) = 7.53; Al (P_2O_5) = 18.7 mg/100 g of soil; Al (K_2O) = 28.42 mg/100 g of soil; $CaCO_3$ = 2.12 and an organic content of 2.61 %. The arable treatments had been in place for at least 50 years before nematode sampling began, and all received similar fertilizers applications. The nematode communities were investigated on four different field treatments:

I. Treatment - arable land, without vegetation, no tillage regime. Treatment was predicted for corn, which should be sown in spring 2001. Previous culture was winter wheat, also in no tillage regime, harvested in July 2000. The no tillage regime involved sowing by direct drilling. In the sampling period, treatment was still without vegetation. First sampling was on 11th of October 2000, while second was on 6th of November 2000.
II. Treatment - arable land, without vegetation, standard tillage regimes. Treatment was predicted for corn which should be sown in spring 2001. The standard tillage regime included plowing to 30 cm and harrowing. Previous culture was winter wheat also in stan-

dard tillage regimes. In the sampling period, treatment was still without vegetation. Plowing and harrowing were done on 12nd of October 2000. First sampling was on 11th of October 2000 (before plowing), while second was on 6th of November 2000 (after plowing).

III. Treatment - arable land, winter wheat, no tillage regimes. Treatment was soil under the winter wheat. Previous culture was corn, also in no tillage regime, harvested in September 2000. The no tillage regime involved sowing by direct drilling. Sowing date was 18th of October. First sampling was on 11th of October 2000 (before sowing), while second was on 23th of November 2000 (after sowing).

IV. Treatment - arable land, winter wheat, standard regimes. Treatment was soil under the winter wheat. The wheat was sown on 18th of October 2000. Previous culture was corn, also in standard tillage regime, harvested in September 2000. Standard tillage regimes included plowing to 30 cm and harrowing. Plowing and harrowing were on 12nd of October 2000. First sampling was on 11th of October 2000 (before plowing and sowing), while second was on 23th of November 2000 (after plowing and sowing).

Sampling was done using a corer Ø 2 cm, to a depth of 20 cm. There were 4 replicate plots of each treatment. Nematodes were extracted from 100 g subsamples of soil by the Seinhorst method (Seinhorst, 1956), at the Faculty of Agriculture in Osijek, in Laboratory of Nematology. Identification was done by using keys of Bongers (1994), Mai and Lyon (1975) and Andrassy (1984, 1988, 1993). Total number of nematodes and number of genera were determined and compared between treatments and tillage regimes, as well as Maturity index (MI), Plant parasitic index (PPI) and PPI/MI (Bongers, 1990; Bongers *et al.* 1997). Trophic structure was determined according to Yeates *et al.*, 1993. The data were analyzed statistically, using ANOVA and LSD test on computer program Statistica by Vukadinović (Vukadinović, 1985; 1986).

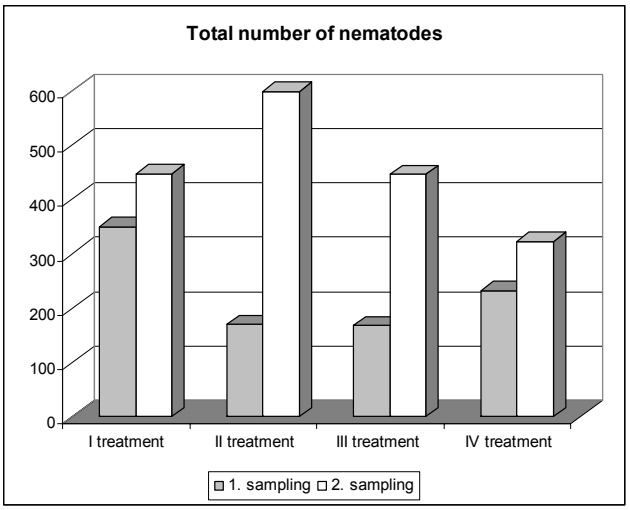

Fig. 1. Total number of nematodes in four different treatments in two sampling occasions

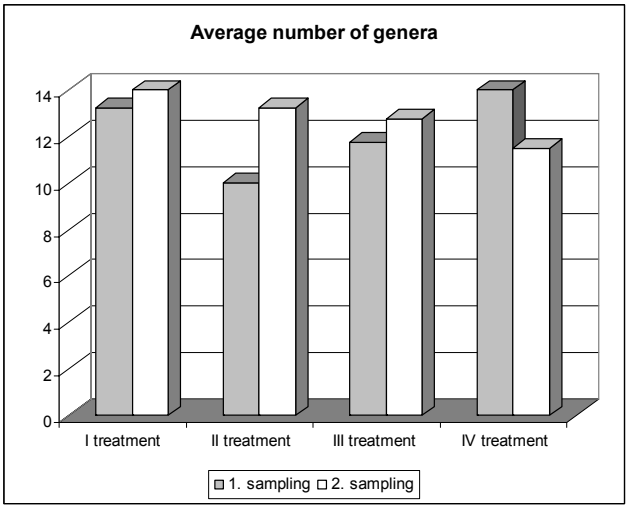

Fig. 2. Average number of genera occurred in each treatment on two sampling occasion

Results and Discussion

Nematode communities were studied in four different treatments, on two occasions. Minimum abundance of nematodes was 138 nematodes/100 g soils in II. treatment before plowing, while the maximum was 1037 nematodes/ 100 g of soil in the same treatment after plowing. Average abundance of nematodes in treatments is shown in Fig.1.

Total number of nematodes in all treatments increased after plowing and sowing, with nematodes from c-p group 1 increasing after disturbances. Statistically significant differences in total number of nematodes occurred between sampling periods, but not between treatments.

In this experiment 41 genus were determined. A checklist of genera is presented in Tab 1.

The average number of genera occurring in each treatment is shown in Fig. 2. In no tillage treatments there were no significant changes in the number of genera between the two sampling occasions. In treatment with standard tillage regimes (II. treatment), the number of genera increased a mean of 3 genera after plowing and sowing, while under wheat with standard tillage (IV. treatment) they decreased.

Pratylenchus, *Helicotylenchus* and *Tylenchus* were the dominant genera in no tillage treatments. In standard tillage treatments *Pratylenchus* and *Tylenchus* were dominant. *Aphelenchoides* decreased in number after plowing, while *Mesodorylaimus* (which is an omnivorous nematode and thus sensitive to disturbance) occurred in same number after mechanical disturbances. Fiscus & Neher (2002) found *Aphelenchus*, the most sensitive to direct effect of tillage. However they found *Epidorylaimus* and *Tylencholaimellus* tolerant, as well as *Anatonchus*, *Clarkus*, *Mylonchulus* and few others.

Trophic structure analyses showed similar patterns in all treatments investigated. Five trophic groups occurred (bacterivorous, fungivorous, plant-feeding nematodes, omnivo-

Table 1. Check list of genera occurring in the 4 treatments on each sampling occasion

Genus	I. Treatment		II. Treatment		III. Treatment		IV. Treatment	
	1. sampling	2. sampling	1. sampling	2. sampling	1. sampling	2. sampling	1. sampling	2. sampling
Acrobeles	-	-	-	-	+	+	-	-
Acrobeloides	+	+	+	+	+	-	-	+
Acrolobus	-	-	-	-	-	-	+	-
Alaimus	-	+	+	-	-	-	+	-
Aphelenchoides	+	+	+	+	+	+	+	+
Aphelenchus	+	+	+	+	+	+	+	+
Aporcelaimellus	-	-	-	-	-	-	-	+
Cephalobus	+	+	-	+	-	+	+	-
Chiloplacus	+	+	+	+	+	+	+	+
Diploscapter	+	+	+	+	-	+	+	+
Ditylenchus	+	+	+	+	+	+	+	+
Dorylaimidae	-	-	+	-	-	-	-	-
Dorylaimellus	-	-	-	-	+	-	-	-
Enchodelus	-	+	-	-	-	+	-	+
Eucephalobus	+	+	+	+	+	+	+	+
Eudorylaimus	-	+	-	-	-	+	-	+
Euteratocephalus	-	-	+	-	-	-	-	-
Filenchus	-	+	+	+	+	+	+	+
Helicotylenchus	-	+	+	+	+	+	+	+
Heterocephalobus	-	-	-	-	-	-	+	-
Heterodera	-	-	+	-	-	-	+	-
Malenchus	-	+	-	-	+	+	+	-
Mesodorylaimus	-	+	+	+	+	+	-	+
Metateratocephalus	+	-	-	-	-	-	-	-
Microdorylaimus	-	+	-	-	-	-	-	+
Monhystera	-	+	-	-	-	-	-	-
Mylonchulus	-	-	-	-	+	-	-	+
Panagrellus	-	-	-	-	-	+	-	+
Panagrobelus	-	+	-	-	-	-	-	-
Panagrolaimus	-	+	-	-	-	+	+	-
Paratylenchus	-	-	-	+	+	+	-	+
Plectus	-	-	+	+	+	-	+	+
Pratylenchus	+	+	+	+	+	+	+	+
Prismatolaimus	+	+	+	+	+	-	+	+
Psilenchus	+	-	-	-	-	-	-	-
Pungentus	-	-	-	-	-	-	+	-
Rhabditis	+	+	+	+		+	+	+
Rotylenchus	-	-	-	+	+	+	+	+
Tylencholaimellus	+	-	-	-	-	-	-	-
Tylenchorhynchus	+	+	+	+	+	+	+	+
Tylenchus	+	+	+	+	+	+	+	+

rous and predators). Plant - feeding nematodes were dominant in all treatments, before and after disturbance. Bacterial and fungal feeding nematodes were the next most abundant groups. Omnivorous nematodes were present at 0 – 4 % while predators were found in treatments III and IV with one specimen in each. Trophic structure presented in Fig. 3.

Plowing increased the proportion of bacterial feeding nematodes (treatments II and IV) and decreased plant feeding nematodes (treatment II). Similarly, Parmelee and Alston (1986) found greatest number of plant feeding nematodes in treatments with minimum tillage, contrary to treatments with standard tillage regimes.

Fungal feeding nematodes decreased in number after plowing, genus *Aphelenchoide* decreased significantly in number. Omnivores were present 0 – 1 %, except in I treatment (soil without vegetation with no tillage regimes) when they occurred 4 %.

Results of MI, PPI and PPI/MI analyses, average abundance, average genera richness, as well as statistic analyses are

Table 2. Average of MI, PPI, PPI/MI, total number of nematodes and number of genera in both sampling occasions with LSD test

Sampling occasion (A)	Treatments (B)	MI	PPI	PPI/MI	Total number of nematodes	Number of genera
1. sampling	I treatment	1.625	2.825	1.825	350	13
	II treatment	1.925	2.325	1.275	170	10
	III treatment	2.225	2.675	1.25	168	12
	IV treatment	1.9	2.625	1.45	232	14
Average 1 sampling occasion		1.919	2.613	1.45	230	12
2. sampling	I treatment	2.175	2.775	1.35	359	14
	II treatment	1.575	2.55	1.7	599	13
	III treatment	1.85	2.75	1.55	446	13
	IV treatment	1.875	2.9	1.6	323	12
Average 2 sampling occasion		1.869	2.744	1.55	432	13
LSD 5% (A)		n.s.	n.s.	0.9074	127.2928	n.s.
LSD 1% (A)		n.s.	n.s.	n.s.	n.s.	n.s.
LSD 5% (B)		n.s.	0.1116	n.s.	n.s.	n.s.
LSD 1% (B)		n.s.	0.1529	n.s.	n.s.	n.s.
LSD 5% (A*B)		0.3809	0.2566	0.2659	n.s.	2.9595
LSD 1% (A*B)		0.5922	n.s.	0.3809	n.s.	n.s.

n.s. – not statistically different; A – sampling occasion; B – treatments

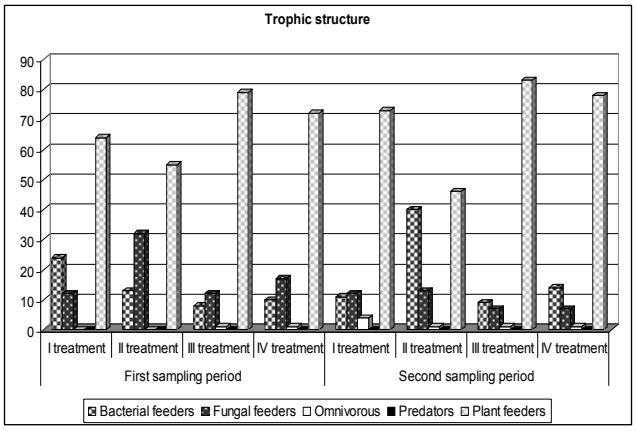

Fig. 3. Trophic structure in each sampling occasion

presented in Table 2.

The average MI index was affected by plowing, decreasing from 1.925 to 1.575 in II treatment, and from 1.9 to 1.875 in IV treatment. PPI also demonstrates the change in nematode communities by the increase in value after disturbance in treatments with standard tillage regimes. After plowing, in second sampling occasion PPI/MI showed the more disturbed environment in standard tillage regimes (1.7 in II. treatment and 1.6 in IV. treatment) in comparison to no tillage regimes (1.3 in I. treatment and 1.5 in III treatment). Although MI, PPI and PPI/MI do not show statistically significant differences among treatments and sampling occasions, the trends in them do represent an effective tool as distinguishing parameters in tillage regimes under our conditions. However, some authors obtain different results (Villenave *et al.*, 2001).

Conclusion

Plowing had an impact on the increase of bacterial feeding nematodes and on decrease of fungal feeding nematodes. *Pratylenchus*, *Helicotylenchus* and *Tylenchus* were dominant plant parasitic nematodes in no tillage treatments, while in plowing treatments *Pratylenchus* and *Tylenchus* were dominant. Genus *Aphelenchoides* decreased significantly after plowing. Effect of tillage did affect nematode communities in the soil ecosystem by changing the trophic structure and decreasing of MI.

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