Original scientific paper

Free-living and plant parasitic nematodes under conventional tillage and no-tillage treatments in wheat and soybean

Ivana Majić, Marija Ivezić, Miro Stošić, Danijel Jug, Mirjana Brmež, Ankica Sarajlić

Josip Juraj Strossmayer University of Osijek, Faculty of Agriculture in Osijek, Kralja Petra Svačića 1d, Osijek, Croatia (imajic@pfos.hr)

Abstract

Any disturbance of soil can affect nematode community and total abundance. Tillage practices are considered as main disturbance to soil that may bring to the changes in nematode trophic structure. The aim of this preliminary study is to evaluate effect of conventional tillage and no-tillage treatments on nematode community in wheat and soybean. A split plot field experiment was conducted in 2008, in Darda, Croatia. Sampling for nematodes was done in May 2008, in wheat and soybean under conventional tillage and no-tillage treatment. Nematodes were separated to the trophic groups and plant parasitic genera were identified. The most abundant plant parasitic genus in all treatments was *Tylenchorhynchus* Tillage treatments did not have significant effect on nematode trophic structure and on biodiversity of genera of plant parasitic nematodes. This study proved beneficial role of nematode community in conventional tillage and no-tillage regimes, whereas overall effect of nematodes was postitive in terms of mineralisation of organic matter.

Keywords: Trophic structure, *Tylenchorhynchus*, tillage, mineralization

Introduction

Nematodes are abundant and diverse invertebrates (Yeates and Bongers, 1999). Trophic structure of nematode community is a functional classifcation that reveals how each group affects the soil food web (Freckman and Caswell, 1985). According to their feeding habit, nematodes can be grouped into five major trophic groups: bacterivorous, fungivorous, plant parasites, predators and omnivorous (Yeates et al., 1993). Plant parasitic nematodes are direct herbivory, while bacterivorous and fungivorous graze on decomposer microbes and enhance nutrient mineralization (Griffits, 1994; Ferris et al., 2004). Omnivorous nematodes feed on more than one type of food material, while predatory nematodes feed on nematodes and other invertebrates in the soil (Grewal et al., 2005).

Any disturbance of soil can affect nematode community and total abundance (Briar et al., 2007). Species that pass one or more stages of their life cycle in the soil are directly affected by tillage. Tillage practices are considered as main disturbance to soil which causes the relocation of plant residue and soil organic matter, change of microbial activity and population as well as nematode trophic structure. The species composition of the soil microbial community is directly affected by reduced tillage since retention of soil moisture and soil temperature is modified and this environment may be more antagonistic to pathogens due to competition effects (Krupinsky et al., 2002; Cook, 1990). Bailey and Lazarovits (2003) report that tillage treatments may change inoculum density of a pathogen and its ability to survive.

Plant parasitic nematodes were found in greater populations in conventionally tilled field plots than in no-till plots (Stinner and Crossely, 1982). However, different studies report

greater population of plant parasitic nematodes in no-tillage treatments as to conventional tillage in soybean and maize (Alby et al., 1983; Caveness, 1979). Baird and Bernard (1984) found no significant differences in overall diversity and dominance among treatments and trophic groups in experiment with tillage treatments in soybean-wheat cropping. Okada et al. (2002) found that the overall effect in no tillage and conventional tillage differences was not clear, except for omnivores and plant parasitic genus *Meloidogyne.*

The aim of this preliminary study is to evaluate effect of conventional tillage and no-tillage treatments on nematode community in wheat and soybean.

Material and methods

A split plot field experiment was conducted in 2008 in Darda, Croatia (45°37′34″N, 18°41′33″E). The soil type was pseudogley. The experiment was set in area of 8 ha, with plots of 540 m^2 and subplots of 180 m^2. Plots of wheat (cultivar Srpanjka) and soybean (cultivar Podravka 95) were four times replicated and imposed on eight different tillage treatments, and three nitrogen fertilization levels. However, in this study soil cores were taken from two tillage treatments (conventional tillage (CT) and no-tillage) and with fertilization of 150 kg N ha^{-1} for wheat and 70 kg N ha^{-1} for soybean. In CT the soil was plowed, disked, and rotary tilled before planting. In NT the soil remained undisturbed. Pesticides were used in both treatments as required, mainly herbicides and rodenticide.

Sampling for nematodes was conducted on 8th May 2008. Extraction of nematodes from a 100 ml subsample of soil was processed following the Erlenmeyer method (Seinhorst, 1956). Nematodes were counted and separated according to their feeding habit to five trophic groups (Yeates et al., 1993): bacterivorous (B), plant parasites (PP), fungivorous (F), omnivorous (O) and predators (P). Plan parasitic nematodes were identified to the genus level according to Bongers (1994). Ratio B+F/PP was used to indicate the decomposition pathway (Wasilewska, 1994). The data were log(n+1) transformed prior ANOVA. Means were spearated by Tukey test ($P<0,05$) (SAS Institute Inc., 2000).

Results and discussion

Effect of tillage treatments on nematode trophic structure and total number of nematodes is shown in Table 1. Bacterivorous nematodes and plant parasites were the most dominant trophic groups, while no predators were detected. These results are expected as previously it has been reported (Freckman and Caswell, 1985). Omnivorous and predatory nematodes have been shown to decrease due to intensive cultivation (Bouwman and Zwart,1994: Wardle et al., 1995), Minoshima et al. (2007) did not find this results, and it was not the case in this study.

No significant differences were observed among the treatments, except for total number of nematodes in soybean. In soybean, in CT, significantly more nematodes were observed: 322,50 in 100 ml of soil, while in NT 185,00, respectively. The difference occurred since abundance of bacterivorous nematodes in CT in soybean was greater than in NT.

In CT, bacterial and fungal abundance is greater due to faster decomposition of crop residues, which provides more feeding sites and chance for reproduction and growth of bacterivorus and fungivorous nematodes. Tillage increases bacterial dominance of the microbial community and favor r-type organisms (Lenz and Eisenbeis, 2000) and that emphasize the need for more indepth analysis of bacterivorous nematodes and analysis based on colonizer-persister groups (Fiscus and Neher, 2002). Parmelee and Alston (1986) reported greater abundance of bacterivorous nematodes in CT compared to NT plots over an annual cycle, whereas fungivorous nematodes were more abundant in NT plots during the dry summer cropping season, but more numerous in CT during winters. Stinner and Crossley (1982) did

not find significant differences in CT and NT for total numbers of nematodes and free living nematodes, however group of plant parasites were significantly different among the treatments.

Table 1. Mean number of nematodes according to the nematode feeding habit in soybean and wheat for conventional tillage (CT) and no-tillage (NT)

Culture	Tillage	Trophic group					B
		PP	B	F	O	Total	+F/PP
Wheat	NT	67.50a	302.50a	32.50a	30.00a	432.50a	4.96a
	CT	65.00a	215.00a	10.00a	40.00a	330.00a	3.46a
Soybean	NT	40.00a	82.50a	32.50a	40.00a	185.00b	2.88a
	CT	80.00a	145.00a	57.50a	40.00a	322.50a	2.53a

Values in columns followed by the same letter are not significantly different (P<0,05)

Similar results are achieved between the crops; however bacterivorous nematodes occurred in greater abundance in wheat. Since bacterivorous and fungivorous nematodes in soil ecosystems are important in the decomposition of organic matter and recycling of nutrients, ratio B +F/PP was used to reveal decomposition pathway (Wasilewska, 1994). Values of decomposition pathway ratio greater then 1 indicate overall positive effect of nematode community in soils, whilst lower values indicate negative effect, and dominance of plant parasitic nematodes (Table 1). The least negative effect of nematode community was observed in wheat in NT treatment (4,96 ratio value). No significant differences were determined between the treatments for this index. Since all treatments had greater abundance of bacterivorous than fungivorous nematodes, the bacterial decomposition pathway seems to have dominated in all treatments.

Plant parasitic nematodes were the second most abundant group in nematode community.

Table 2. Mean number of plant parasitic nematodes for conventional tillage (CT) and no-tillage (NT)

Rod	NT	CT
*Ditylenchus**	5.00a	6.25a
*Filenchus**	15.00a	15.00a
Heterodera	1.25a	0a
Paratylenchus	0a	1.25a
Pratylenchus	16.25a	7.50a
Scutylenchus	0a	1.25a
Tylenchorhynchus	30.00a	17.50a
*Tylenchus**	5.00a	5.00a

Values in rows followed by the same letter are not significantly different (P<0,05)
*Not obligate plant parasites

In Table 2, eight plant parasitic genera were identified, among which three genera are not obligate plant parasites but also may feed on fungi (*Filenchus, Ditylenchus* and *Tylenchus*) (Ferris and Bongers, 2006). The most abundant plant parasitic genus in all treatments was *Tylenchorhynchus* (stunt nematodes), and no significant differences were determined between the the treatments for plant parasitic genera. Stunt nematodes feed on epidermal cells and root hairs mostly in the cell elongation region, and may cause roots to thicken and decay. Griffin (1996) reported *Tylenchorhynchus acutus* reduced growth of wheat. However, many species of stunt nematodes even in high populations do not cause economically important damages wheat and other crops.

Conclusions

This was preliminary research that provided an opportunity to compare the effects of conventional tillage and no-tillage on nematode community. Tillage practices did not have impact on nematode community regarding trophic structure and plant parasitic nematodes biodiversity. However, effect of tillage treatments was observed for total number of nematodes in soybean. The differences in results of various studies indicate that the tillage treatments should be further investigated to elucidate impact on nematode community. This study proved beneficial role of nematode community in conventional tillage and no-tillage regimes, whereas overall effect of nematodes was positive in terms of mineralization of organic matter.

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