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Analysis of the soil food web structure under grass and grass-clover

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ABSTRACT

The below ground biodiversity of soil organisms plays an important role in the functioning of the soil ecosystem, and consequently the above ground plant production. The objective of this study is to investigate the effect of grass or grass-clover in combination with fertilisation on the soil food web structure.

In 2003 a fertilisation trial on grass and grass clover was sampled for soil organisms. Data were agglomerated in seven trophic groups, and classified by means of TWINSPAN.

TWINSPAN clearly distinguished three main soil food web structures:
Type 1: Grass plots with a high biomass of bacteria and fungi;
Type 2: Grass-clover plots with a high biomass of earthworms;
Type 3: Grass and grass-clover plots, that received relatively high fertilisation, with a high number of nematodes.

Results suggest a microbial oriented soil food web for grass and an earthworm oriented soil food web for grass-clover.

Keywords: soil food web, soil biology, grass-clover, grass, fertilisation

INTRODUCTION

The below ground biodiversity of soil organisms plays an important role in the functioning of the soil ecosystem, and consequently the efficiency of the above ground plant production on dairy farms. However, for farmers soil biology remains a black box. It is difficult to interpret the soil biology and to identify management measures to improve it. In an ongoing research project the effect of different management measures on soil life are measured. The objective of this study is to investigate the effect of grass and grass-clover in combination with fertilisation on the soil food web structure.

MATERIALS AND METHODS

A fertilisation trial on grass (*Lolium perenne*) and grass clover (*Lolium perenne* and *Trifolium repens*) was established in 2001. In October 2003 different subplots were sampled for soil organisms. The subplots consisted of grass and grass-clover plots with three manure treatments: no manure, deep litter manure and slurry. The deep litter manure and slurry was applied at three nitrogen levels: 40, 80 and 120 kg total N ha^{-1}. Soil life records included densities of fungi, bacteria, nematodes and earthworms. Data were agglomerated in seven trophic groups, and standardised to the group maximum. The combinations of these trophic groups for the different plots were classified by means of TWINSPAN (Hill, 1979).

RESULTS

In the set of data TWINSPAN clearly distinguished three main soil food web structures in which grass or grass clover was a very discriminating factor (Table 1). These soil food web structures can be described as follows:
Type 1: Grass plots with a high biomass of bacteria and fungi;
Type 2: Grass-clover plots with a high biomass of earthworms;
Type 3: Grass and grass-clover plots, that received a relatively high fertilisation, with a high number of nematodes.

Table 1. Classification of soil foodweb structures under grass and grass-clover plots with different fertilisation.

			Charactersitics plots					Average quantities (see key)						
Type	n grass plots	n grass-clover plots	N-total kg ha^{-1} slurry	Total DM t ha^{-1}	Clover DM t ha^{-1}	SOM%	pH-KCl	Bacteria	Fungi	Nem hf	Nem pf	Nem bf	Nem mp	Earthworm
1	6	2	40	8.1	2.3	5.1	4.7	97	39	1	26	14	3	78
2	0	7	46	11.1	5.6	5.1	4.4	70	30	2	24	14	2	186
3	3	7	68	9.8	4.3	5.1	4.5	83	24	3	33	36	2	112

Key table: SOM=Soil Organic Matter, Bacteria (µg C g^{-1} soil), Fungi (µg C g^{-1} soil), Nem=nematodes (number g^{-1} soil), hf=hyphal-feeding, pf=plant-feeding, bf=bacteria-feeding; mp=micropredator; Earthworms (g m^{-2}).

In Figure 1 and 2 the difference between the two extreme soil food web structures type 1 and 2 is visualised. Type 1 is more dominated by bacteria and fungi, while type 2 is more dominated by earthworms.

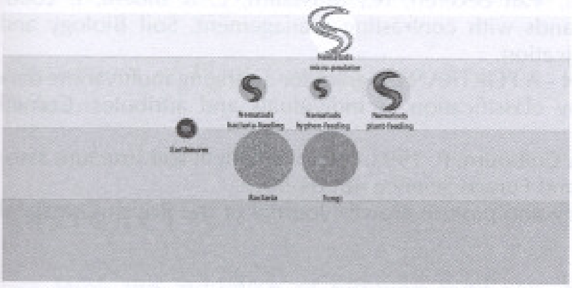

Figure 1.
A visual representation of a soil food web structure of grass plots with a high biomass of bacteria and fungi (type 1).

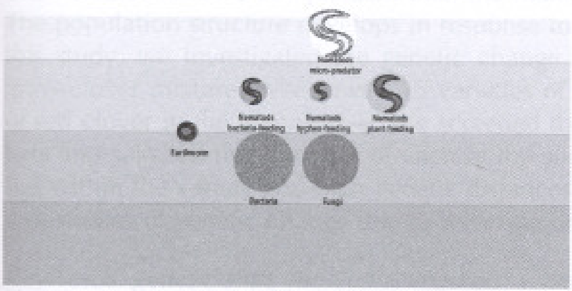

Figure 2.
A visual representation of a soil food web structure of grass-clover plots with a high biomass of earthworms (type 2).

DISCUSSION AND CONCLUSIONS

Our results suggest a microbial oriented soil food web for grass and an earthworm oriented soil food web for grass-clover. More earthworms under grass-clover have also been found in other studies (Baars, 2002 and Sears, 1950). A possible explanation is the availability of organic matter with a low C/N-ratio produced by clover. This high substrate quality could be expected to lead also to a higher bacterial biomass. However bacteria were 50% lower under grass-clover plots compared to grass plots (De Vries et al., accepted for publication). This aspect will be further investigated.

Since earthworms play an important role in soil structure building, sowing of clover can have an indirect positive effect on soil structure, beside the direct positive effect on soil properties (Mytton, 1993). Therefore sowing of clover could be a management measure for farmers not only for nitrogen fixation but also to improve other important aspects of the soil ecosystem functioning.

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