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Effect of living mulches on soil biodiversity in an organic apple orchard

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Abstract

A trial testing different living mulch species (lady's mantle, peppermint, wild strawberry, etc.) was established in 2019 in an organic apple orchard. The effect on belowground microbial activity and biodiversity together with nematodes biodiversity was assessed. In particular, peppermint and lady's mantle improved the microbial activity, but any tested living mulch significantly affected the microbial diversity. On the other hand, highly structured nematode communities were found in the soil covered with living mulches, which indicate a positive effect on soil food web condition. The highest biodiversity of soil nematodes population was observed with peppermint.

Keywords: Living Mulch, Soil Nematodes, Soil Biodiversity, Microbial Activity

Introduction

Organic management is based on practices that are expected to enhance biodiversity. However, specialization of intensive organic orchards has resulted in a conventional-like approach, with increased use of external inputs, which impact on soil biodiversity can be limited. On the other hand, enhancing the functional biodiversity of both above and below ground communities can be pursued by modifying the orchard cropping system, e.g. by using living mulches.

Material and Methods

A trial was established in 8-year old organic apple orchard (cv. Gala on M9 rootstock) to assess the impact of living mulch species grown understory on the orchard soil biodiversity. The orchard was drip irrigated and fertilized with dry bovine manure and stillage, for a total of 12 g N/tree. Several living mulch species were tested to maintain the soil on the tree row: pumpkin, violet, lady's mantle, peppermint. Soil samples for microbial and nematodes analyses were collected in spring and autumn. Microbial activity (AWCD) and biodiversity (Weaver-Shaonn Index) were estimated using Biolog EcoPlates.The nematodes were extracted from 250 ml of fresh soil using Oostenbrink elutriator method (van Bezooijen, 2006). The characteristics of the nematode communities were described by: share of trophic groups described by Yeates et al. (1993) and Maturity Index (Bongers, 1990). The Maturity Index was calculated according to nematode taxon's allocation to the colonizer (c)–persister (p) scale based on their perceived life history strategy (Bongers, 1990; Yeates, 2003).

Results and Discussion

Microbial activity defined by AWCD has been visibly influenced by certain living mulches (Table 1). The most interesting results were obtained for lady's mantle, which improved the microbial activity after first and third season of trial. Also mint was able to influence the microbial activity but to a lesser extent. None of tested living mulches was able to significantly improve the microbial diversity. Nevertheless, PCA results based on raw Biolog data shows that the observed changes can be also dependent on climatic conditions and characteristics of each season, as the samples from one sampling point cluster together (Figure 1A).

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Table 1. Microbial activity and biodiversity of selected treatments.

Living mulch	AWCD (activity)			Weaver-Shannon Index (biodiversity)		
	Spring 2020	Autumn 2020	Autumn 2021	Spring 2020	Autumn 2020	Autumn 2021
Lady's mantle	2.03 a	0.52 b	1.64 a	1.27 a	3.18 a	3.26 a
Peppermint	1.94 ab	0.63 a	1.39 b	1.28 a	3.35 a	3.17 a
Control	1.77 b	0.53 b	1.33 b	1.29 a	3.28 a	3.20 a

On the other hand, the nematodes community structure seemed to be more influenced by the living mulch species than climatic conditions during each season (Figure 1B). Nonetheless, herbivores, fungivores and bacterivores were always the most abundant three trophic groups (data not shown).

Now the effort is being laid to better understand the tri-trophic relationship between living mulch, soil microbiome and belowground fauna diversity and the long-term effect of living mulch species to the orchard environment.

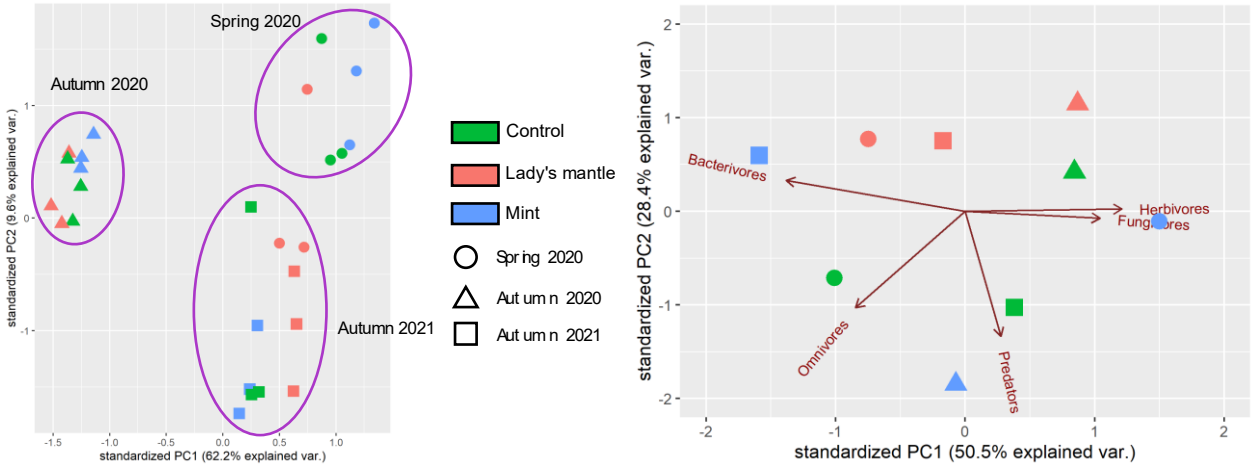

Figure 1. Visualization of PCA based on raw results from Biolog EcoPlates after 72h of incubation (A), abundance of different trophic groups of nematodes community (B).

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