Bioinoculants and organic amendments affect nematode diversity in apple orchards

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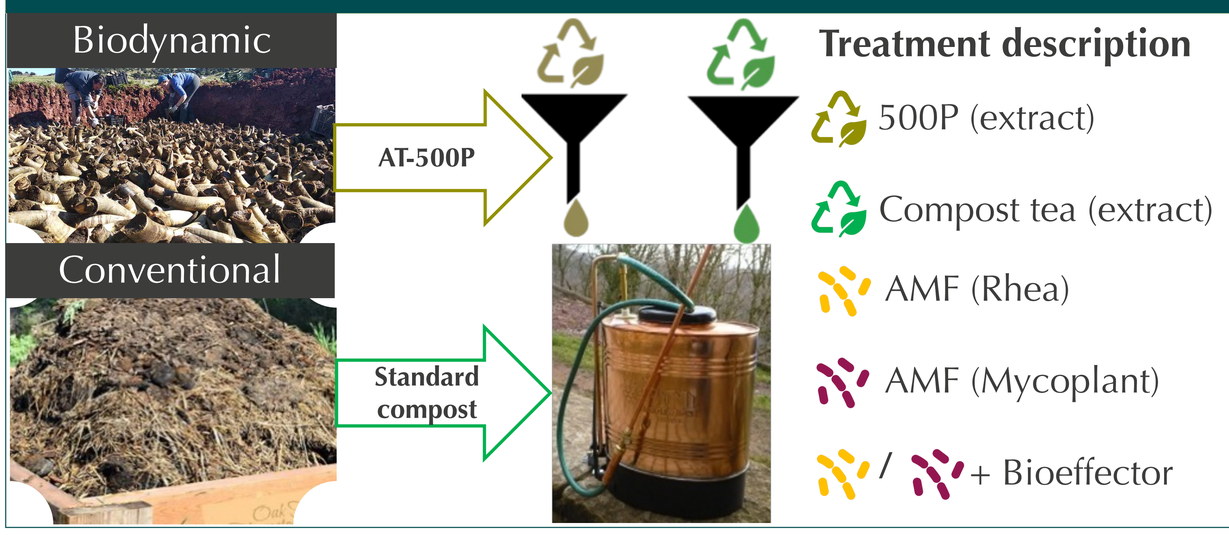
INTRODUCTION

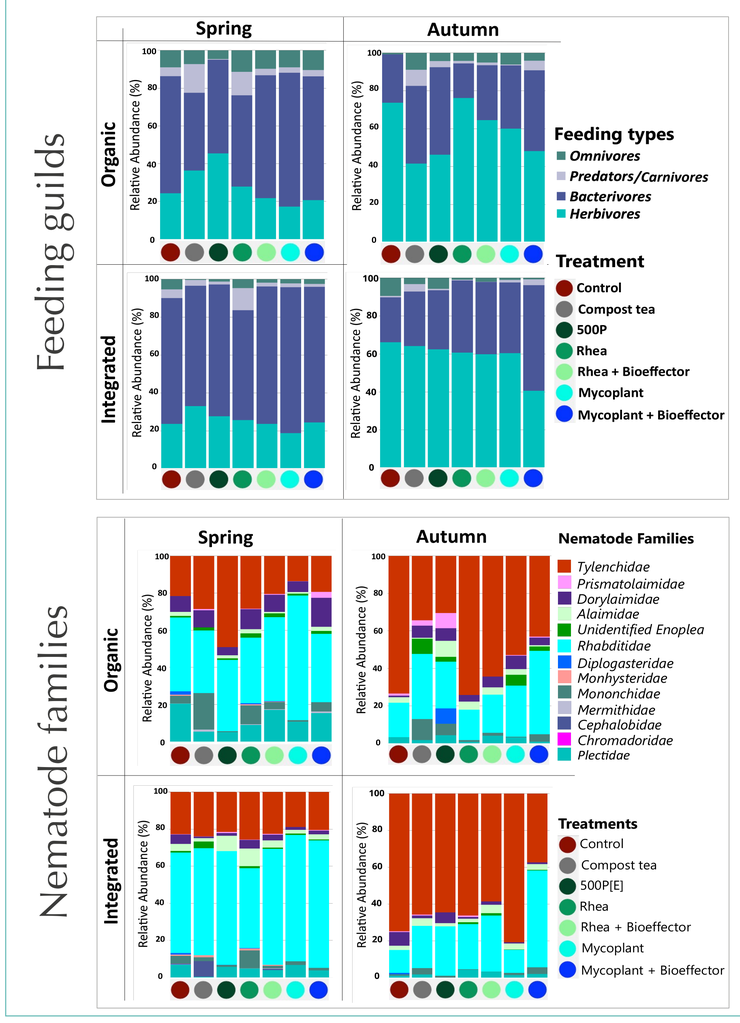
Nematodes are crucial members of the soil food web. For instance, free-living nematodes (i.e., bacterivores, fungivores, predators, and omnivores) accelerate organic matter decomposition and mineralization. Owing to their versatile lifestyles, nematode community analysis is evolving as a powerful bioindicator of soil conditions and in predicting the structural and functional attributes of the soil food web. This study used 18S rDNA metabarcoding of nematode fauna to assess the impact of bioinoculants and organic amendment extracts (i.e., compost tea, and biodynamic manure : 500P) on the soil nematode assemblages and functional structure in apple orchards over the two sampling times.

MATERIALS AND METHODS



Nematode composition:

- Seasonal variations in nematode guilds were consistent across orchards and were driven by a few dominant families.



The influence of bioinoculants and bioextracts on the nematode diversity:

- Sampling time significantly influenced ($P<0.0001$) the nematode richness, evenness, and phylogenetic diversity (PD).
- In both orchards, a higher diversity was seen during spring as compared to autumn.
- Treatment significantly affected the nematode richness and PD during spring for the two orchards (**Table 1**).
- A significant reduction in nematode PD was seen for 500P treatment in the organic orchard, also for treatments (compost tea and 500P extracts, Mycoplant, Mycoplant +, and Rhea +) in the integrated orchard.

Treatment	Diversity index	Control	Compost tea (500)	500P	Mycoplant	Mycoplant +	Rhea	Rhea +	ANOVA/Kruskal-Wallis
Orchard	Organic								
Spring	Richness	33.8 ± 6.1^{ab}	16.5 ± 4.7^{abc}	10.8 ± 1.0^{c}	16.0 ± 5.0^{ac}	21.2 ± 8.6^{abc}	37.5 ± 7.9^{b}	28.8 ± 7.5^{abc}	KW: P = 0.002 (KW)
	Pielou's evenness	0.9 ± 0.1	0.9 ± 0.1	0.8 ± 0.1	0.9 ± 0.1	1.0 ± 0.0	0.9 ± 0.0	0.9 ± 0.1	KW: $P = 0.144$
	Faith's PD	2.1 ± 0.2^{bc}	1.4 ± 0.2^{ab}	1.1 ± 0.1^{a}	1.4 ± 0.3^{ab}	1.6 ± 0.4^{abc}	2.2 ± 0.1^{bc}	2.3 ± 0.7^{c}	A: P = 0.0004
Autumn	Richness	7.0 ± 0.1	12.0 ± 0.0	9.5 ± 0.7	11.8 ± 4.2	12.0 ± 3.0	9.0 ± 0.1	6.8 ± 4.0	KW: $P = 0.295$
	Pielou's evenness	0.7 ± 0.1	0.9 ± 0.0	0.9 ± 0.1	0.7 ± 0.3	0.9 ± 0.1	0.4 ± 0.1	0.6 ± 0.3	KW: $P = 0.240$
	Faith's PD	0.6 ± 0.1	1.3 ± 0.1	0.8 ± 0.3	1.2 ± 0.3	1.1 ± 0.2	0.9 ± 0.3	0.8 ± 0.5	A: $P = 0.478$
	Integrated								
Spring	Richness	33.2 ± 5.7	13.2 ± 3.9	13.8 ± 1.7	15.2 ± 2.4	16.5 ± 6.5	34.0 ± 7.7	16.2 ± 8.5	KW: $P = 0.013$
	Pielou's evenness	0.9 ± 0.0	0.8 ± 0.1	0.8 ± 0.1	0.9 ± 0.0	0.7 ± 0.2	0.8 ± 0.1	0.9 ± 0.1	KW: $P = 0.729$
	Faith's PD	2.2 ± 0.1^{c}	1.1 ± 0.2^{a}	1.3 ± 0.1^{a}	1.4 ± 0.2^{ab}	1.5 ± 0.3^{ab}	1.9 ± 0.3^{bc}	1.5 ± 0.4^{ab}	A: P = 0.0002
Autumn	Richness	11.0 ± 2.7	11.0 ± 4.4	6.7 ± 2.5	13.8 ± 4.9	14.3 ± 0.6	12.8 ± 6.7	13.0 ± 3.6	KW: $P = 0.354$
	Pielou's evenness	0.5 ± 0.3	0.6 ± 0.1	0.7 ± 0.2	0.6 ± 0.2	0.8 ± 0.1	0.7 ± 0.2	0.7 ± 0.3	KW: $P = 0.815$
	Faith's PD	1.2 ± 0.4	0.9 ± 0.3	0.9 ± 0.2	1.2 ± 0.4	1.4 ± 0.1	1.1 ± 0.5	1.3 ± 0.3	A: $P = 0.501$

Table 1: Diversity indices (richness, Shannon index, Pielou's evenness, and Faith's Phylogenetic diversity index). ANOVA (A) and Kruskal Wallis (KW) were employed for testing statistical differences. Values shown are mean ± standard deviation (n = 4).

- **Beta diversity:** A significant effect of treatment on the nematode community composition was majorly seen during spring, both in organic and integrated orchards.

CONCLUSION

Season is a key driver of numerous soil processes including plant primary productivity. This effect also underscored the observed dynamics in diversity and composition of orchard nematode communities. The dynamics in soil nematode functional guilds can be anticipated through the identification of dominant nematode taxa at family or genus level. The treatment effect was majorly seen during spring, highlighting the potential effect of bioinoculants and organic bioextracts on the soil nematodes. Through the lens of nematodes, and by using DNA metabarcoding approaches, we can measure the potential ecological state of our agroecosystems.

Other work/s under the same project and author/s:

We showed that biodynamic manures contained a higher bacterial diversity in comparison to conventional compost, were specific for each production site, but all contain potentially plant-beneficial bacterial genera.

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