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The roles of nematodes in nitrogen and phosphorous availability, plant uptake and growth in organically amended soils

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Several studies have shown that soil biota contributes significantly to the crucial ecosystem functions and services such as organic matter decomposition and nutrient cycling. The contribution of each group of soil organisms may vary depending primarily on their feeding behavior. The magnitude of the ecosystem services by the biota may also depend on the interactions amongst the soil biota groups and their surrounding environment, for instance, biochemical characteristics of the externally added organic material. However, only a few studies considered these interactions concurrently. Here, we investigated the effects of fauna-microbe-plant interactions on organic matter decomposition and nutrient cycling by applying different organic materials spanning a range of C:N ratios and presumed N availability. Nematodes were selected as model fauna because they are the most abundant soil metazoans that have a diversified feeding strategy and interact very intimately with microbes, other fauna, and plants.

A series of incubation experiments were conducted in bare and planted microcosms under controlled conditions using fresh soil collected from an agricultural field and defaunated by gamma irradiation. In the first experiment without plants, the defaunated soil cores were either left unamended (UNA) or received lignin-rich low N compost (COI), N-rich compost (COV), fresh manure (MAN) or chopped clover (CLO). The entire free-living soil nematode community was extracted from unirradiated fresh soil and reinoculated into half of the soil cores that had been defaunated by gamma irradiation. Two treatments: with (+Nem) and without (-Nem) nematodes were compared for soil nitrogen and phosphorus availability, plant uptake, and PLFA signatures over time during a 105-days incubation. The same experimental setup was used to investigate further the CLO amendment in the presence of plants (rye grass was used as a model plant). Nematodes were extracted and assigned to feeding groups, and their contribution was calculated by simple differences between +Nem and Nem treatments.

Nematode reinoculation generally increased the amount of N mineralized from the amendment in bare microcosms, the maximal mineralization being greater and occurring earlier for amendments with high bioavailable N (CLO and COV). Nematode reinoculation also clearly stimulated nitrification in all amendments. The abundance of both bacteria and fungi increased the most with MAN and CLO amendments which have the lowest C:N. In planted microcosms, nematodes increased net N mineralization and P availability by +25 and +23% respectively in CLO amended microcosms. Dry plant biomass and total PLFA concentration were also significantly higher during most of the incubation periods in +Nem compared to -Nem in CLO amended microcosms. Our results show that different functional groups of nematodes collectively exert significant influence on OM decomposition, nutrient availability and plant growth.