Why do organic farmers need to keep good nematodes in their soil?

Koon-Hui Wang

When farmers are adding organic matters to the soil, organic residues must be decomposed to release nutrients for plant to uptake. Decomposition of organic matter in a soil can be divided into two channels, a faster bacterial channel and a slower fungal-based channel. Soil ecosystem types and nutrient forms (e.g., Carbon to Nitrogen ratios or C:N ratios) determine the predominant decomposition channels (Ingham et al., 1983). Although bacteria and fungi are the primary decomposers in the soil food web (Fig. 1), these microbes also can immobilize inorganic nutrients in the soil (Ingham et al., 1983), making nutrients unavailable for plants to uptake. As an extension of these decomposition channels, when the bacterivorous and fungivorous nematodes graze on these microbes, they give off CO_2 and NH_4^+ and other nitrogenous compounds, affecting C and N mineralization directly (Ingham et al., 1983). Indirectly, nematodes can disseminate microbial propagules throughout the soil, which advances the colonization of substrates and mineralization of nutrients. Nematode metabolites may also stimulate specific bacterial growth by releasing growth-limiting nutrients (such as N and vitamins). However, overgrazing of bacterial or fungal populations by nematodes can result in a reduction of the overall activity of these decomposers. Fortunately, in the hierarchy of the soil food web, generalist predators (such as the omnivorous and predatory nematodes) prey on these bacterivorous and fungivorous nematodes (Fig. 1), improving nutrient cycling and allowing more nutrients to be released (Yeates and Wardle, 1996).

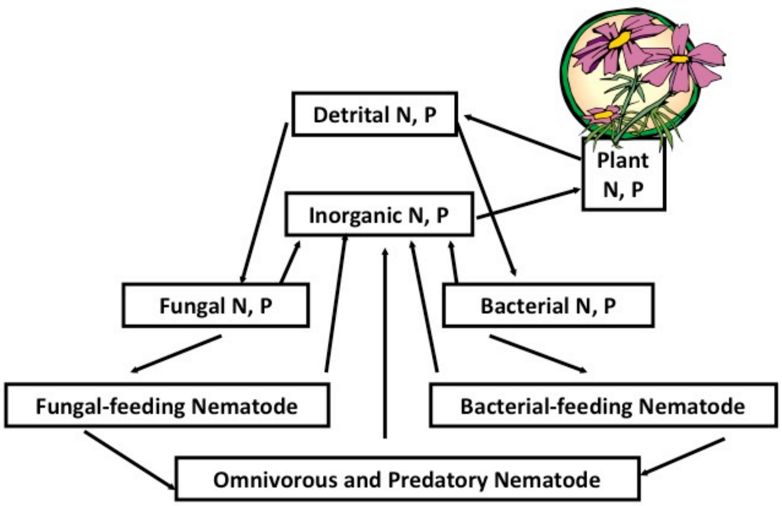

Fig. 1. Roles of beneficial free-living nematodes in soil nutrient cycling (modified from Ingham *et al.*, 1985).

Therefore, free-living nematodes (Fig. 2) play important roles in soil nutrient cycling. Nematode excretion may contribute up to 19% of soluble N in soil (Neher, 2001). This is due to the fact that nematodes (C:N ratio of 8-12) have a lower N content than the bacteria (C:N ratio of 3-4) they consume (Wasilewska and Bienkowski, 1985). In addition, the growth efficiency of nematodes (< 25%) is smaller than those of the bacteria (> 30%) (Hunt et al., 1987). Therefore, nematodes excrete a majority of both the assimilated C and N that they consumed from the bacteria. Bacteria, on the other hand, usually respire most of the assimilated C, but immobilized most of the assimilated N. Therefore the contribution made by nematodes to N mineralization (making N available to plants) is relatively high compared to bacteria in soil ecosystems.

Besides contributing to N mineralization, the abundance of many free-living nematodes, especially bacterivorous, omnivorous, and predatory nematodes, also were found to correlate with concentrations of many other soil nutrients in a fallow field (Wang et al., 2004), suggesting the possibility of nematodes mineralizing many other soil nutrients.

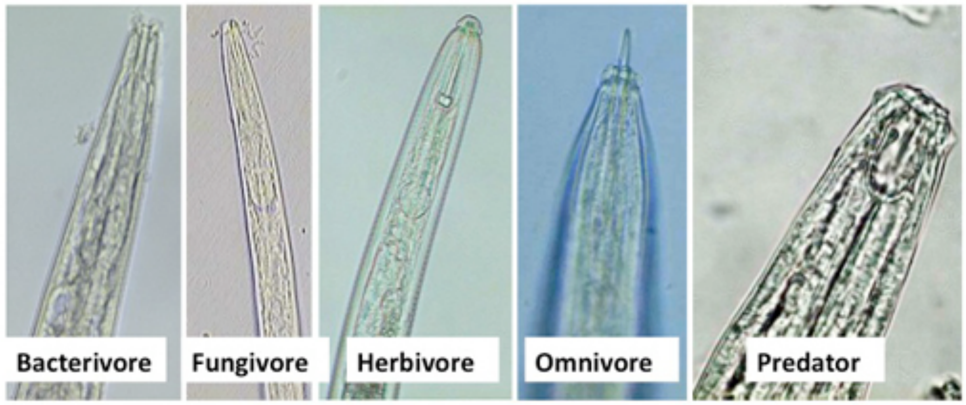

Fig. 2. Bacterivorous, fungivorous, omnivorous and predatory nematodes are beneficial nematodes in volved in soil nutrient cycling. Whereas herbivorous nematodes are plant-parasitic nematodes infecting plant crops.

Adding organic amendments to the soil, growing cover crops as green manure, covering soil with organic mulch, and practicing conservation tillage are various methods to enhance population densities of beneficial free-living nematodes in the soil. A case study on how to grow cover crop in a strip-till cover cropping system resulted in significant enhancement of beneficial nematodes in the soil in a Hawaiian vegetable farming system can be found at http://www.ctahr.hawaii.edu/sustainag/Downloads/2010_APS_khwang2-small.pdf (Wang et al., 2010).

FMI: Dr. Koon-Hui Wang, Email: koonhui@hawaii.edu

Selected References

Freckman, D. W. 1988. Bacterivorous nematodes and organic-matter decomposition. Agr. Ecosyst. Environ. 24:195-217.

Hunt, H. W., Coleman, D. C., Ingham, E. R., Elliott, E. T., Moore, J. C., Rose, S. L., Reid, C. P. P., and Morley, C. R. 1987. The detrital foodweb in a shortgrass prairie. Biol. Fertil. Soils 3:57-68.

Ingham, R. E., Trofymow, J. A., Ingham, E. R., and Coleman, D. C. 1985. Interactions of bacteria, fungi, and their nematode grazers: Effects on nutrient cycling and plant growth. Ecol. Monogr. 55:119-140.

Neher, D. 2001. Role of nematodes in soil health and their use as indicators. J. Nematol. 33:161-168

Yeates, G. W., and D. A. Wardle. 1996. Nematodes as predators and prey: relationships to biological control and soil processes. Pedobiologia 40:43-50.

Wang, K.-H., R. McSorley, R. N. Gallaher. 2004. Relationship of soil management history and nutrient status to nematode community structure. Nematropica 34: 83-95.

Wang, K.-H., C.R.R. Hooks, S. P. Marahatta, R. Manandhar. 2010. Use of a strip-till cover crop system to manipulate above and below ground organisms in cucurbit plantings. Meeting of the American Phytopathological Society (APS) at Charlette, NC. Aug 2010.

Wasilewska, L., and P. Bienkowski. 1985. Experimental study on the occurrence and activity of soil nematodes in decomposition of plant material. Pedobiologia 28:41-57.