Bolstering the Soil Environment—Nematodes

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To promote tree growth in a new orchard, a holistic approach to the health of the soil environment should be adopted. As a nematologist, my interest might tend to focus on the plant-parasitic nematode worms that may suppress early root growth. It would be a mistake, however, to become too narrowly focused on just the pathogens in the soil. As a scientist, my concern probably should be to determine which elements of the soil environment could prevent successful establishment and which can promote soil health, i.e., a balanced sustainable ecology.

In thinking about the soil environment, we can regard soil-inhabiting organisms conceptually as a multi-branched and interwoven food-web rather than the older ecological notion of a food-chain. Within such a food-web in a healthy soil, we can expect to find the total biomass made up of bacterial biomass (75-94%), earthworms (0-18%), protozoans (5-6%), fungal biomass (<1%) and nematodes (0.25%). Plant-parasitic nematodes are normally only about 10% of the total nematode biomass, with the rest being saprophytes, bacterivores, fungivores, and predators which attack soil fauna including the plant parasites. Plant-parasitic nematodes can be indicators of poor soil health. If the plant-parasitic nematodes become much more numerous than the average 10%, this expansion indicates an ecological situation which is no longer sustainable and which will progress toward plant disease.

The non-parasitic nematodes (saprophytes, bacterivores, fungivores, predators) and particularly the bacterivores aid in the mineralization process of soil carbon (C) and nitrogen (N). Organic soil amendments, such as poultry manure and straw or papermill waste, can be used to balance the soil C:N ratio to a range of 12:1 to 20:1. When the C:N ratio is within that range, the organic amendments function as a control to plant-parasitic nematodes. The reason is thought to be partly the release of ammonia, but other mechanisms may also be active. In the nitrification process from manure through ammonia to nitrate nitrogen, a series of flushes of growth of differing bacterial species takes place. Besides the possible release of antibiotics which might affect plant-parasites, each flush provides food for bacterivorous nematodes, which in turn are spatial competitors of the plant-parasites. The non-parasitic nematode groups are apparently less sensitive to the nematicidal activity of the C:N balance.

Chemical fumigation with commercial products can damage this food-web, causing long-term harm by killing off much of the soil biomass, which in turn reduces the metabolism of amended organic matter. Consequently, if chemical fumigation must be used to reverse an imbalance of plant-parasites, growers should use as benign a product as possible and ensure that the fumigant is placed where needed by using an applicator that treats only the tree row. Treatment to the depth of root establishment is also important. When establishing a new orchard, the use of nematode-suppressive plants such as Tagetes marigolds or Rudbeckia sp. (black-eyed susan) in the row and suppressive grasses seeded between rows prior to tree-planting may be sufficient to avoid the need for chemical fumigation.

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