SOIL BIOLOGY UNDER CONSERVATION TILLAGE

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INTERPRETIVE SUMMARY

Soil biota comprise a wide array of organisms which spend all or part of their life cycle in soil. Taxonomically, they include hundreds of thousands of species representing 11 animal phyla and all known types of microorganisms; morphologically, they range in size from less than one micrometer (bacteria) to several centimeters in diameter and up to 1.5 m in length (the giant Australian earthworm). In most agricultural soils the diversity of soil biota is higher under conservation management than under intensive cultivation.

Soil biota influence soil processes through 1) effects on soil structure; 2) effects on organic matter dynamics and nutrient cycling; and 3) in the case of soil fauna, effects on microbial activity. Structural effects are most obvious from larger animals, such as earthworms and ants, and include casting which can enhance soil aggregation, and burrowing which can increase soil porosity, water infiltration and aeration; soil fungi and plant roots also contribute to aggregate and pore formation. Organic matter and nutrient transformations are carried out via enzymatic processes by soil microbes (principally bacteria and fungi), but are influenced by soil animals through fragmentation, redistribution and microbial inoculation of organic residues, and increased turnover of microbial biomass.

Tillage impacts soil biota 1) directly by changing the relative abundance and vertical distribution of organisms; and 2) indirectly by altering microhabitat conditions and the distribution and availability of organic matter. Compared to soil biota under no-tillage, those in plowed soils tend to be smaller in size, capable of rapid reproduction and dispersal, display a lower degree of food and habitat specificity and a higher metabolic rate. These differences in species composition may alter the trophic structure of detritus food webs. Data from sites on the Georgia Piedmont and elsewhere show that no-tillage management favors food webs dominated by fungi and fungal-feeding soil animals, and high abundances of earthworms. In contrast, food webs in plowed soils show greater importance of bacteria and bacterial-feeding fauna, such as protozoa and bacteriophagous nematodes, which colonize buried residues. As a consequence of these altered biotic communities, residue decomposition, organic matter mineralization, and nutrient release rates tend to be higher in plowed than in no-till soils.

The idea of soil biotic 'husbandry' offers interesting possibilities for soil management. Examples include 1) increasing soil biodiversity through reduced tillage, cover cropping, maintenance of surface residues, and/or addition of organic amendments; and 2) optimizing soil biological activity through residue management to accelerate or slow residue decomposition, or to enhance nutrient immobilization or mineralization.