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PHOSPHORUS AND SOIL HEALTH

Soil health has elicited interest from many. The idea of looking at the soil as a living system with physical, chemical, and biological aspects of its functioning engages imaginations of crop producers and consumers alike. Policymakers and extension educators have particularly linked onto soil health as a key attribute in reduction strategies for phosphorus (P) loss. Are their expectations warranted?

> *"It can't be assumed that more nutrient cycling, on its own, means less nutrient loss."*

The importance of maintaining good physical structure in soil is well known. Producers and soil experts have long appreciated the importance of a soil's capacities to let rainwater enter the profile, to retain that water in a tension range available to plants, and to remain in aggregate forms resistant to erosion. While these properties are not new, they are still important to managing P loss—and good crop yields. Major practices influencing the physical attributes of the soil include returning adequate amounts of crop residue to the soil, managing tillage to conserve soil organic matter, and avoiding compaction by staying off the land when it is too wet.

The chemical aspect of soil health has also been valued for a long time. Producers sample soils to test for the availability of a wide array of chemical constituents of the soil. A healthy soil needs levels of nutrients that support the full potential of plant growth, since plants are the primary producers of the organic materials that feed the biology of the soil. Soil bacteria, fungi, protozoa, nematodes, arthropods, and earthworms all feed on material derived from plants.

The biological aspect is likely the "newest" area of soil health. Tests that measure how rapidly a soil emits carbon dioxide give an indication of how much activity the available organic materials in a soil can support. Such tests, however, need to be interpreted with care. Owing to the very biodegradability being measured by the test, such materials do not last long in the soil, and the test would be expected to give very different results depending on the composition of crop residues and the weather conditions encountered since the last additions of fresh organic matter.



NRCS-USDA photo

In biological nutrient cycling, one organism dies, and another feeds on its contents. A fungus secretes enzymes that break down old plant tissue, bacteria



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in turn digest the fungus, and higher organisms feed on them both, in turn excreting unneeded nutrients. Each time, carbon dioxide is released, total organic matter declines, and the amounts of each nutrient in the mineral form increase. Membranes and cell walls of microbial organisms are disrupted, and the contents of the cells—including the soluble phosphate stored in the vacuole—are often released into the soil. Each time a nutrient cycles, it goes through release as well as re-absorption. Some of it is prone to loss before another organism can take it up. It can’t be assumed that more nutrient cycling, on its own, means less nutrient loss. Synchrony of release with re-absorption is likely the most important attribute for minimizing nutrient loss.

Soil health is a concept worthy of attention. The practices it encourages—cover crops, conservation tillage, crop rotation, and more—go a long way towards preventing soil degradation. These practices are essential to averting the worst cases of P loss. Some of the latest loading reduction targets, however—particularly those aimed at reducing losses of dissolved phosphate—may not be met through soil health alone, and definitely require attention to nutrient application placement and timing as well.

Many studies, dating back decades, document that in conservation tillage systems—as the top inch or two of soil enriches in soil organic matter, biological activity and nutrients—concentrations and often loads of dissolved P in runoff increase. Soil conservation should be practiced with care. It can’t be used as an excuse to leave P fertilizer or manure on the surface of the soil. The optimum combination of tillage and fertilizer placement practices is likely to be specific to soil and landscape, and in many areas, requires continuing research.



Tom Bruulsema/IPNI photo

Strip-till implement for placement of granular fertilizers 4 to 6 inches below the soil surface, with minimal disturbance of crop residue.

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