Pesticide Effects on Soil Biology: Part I

by Jill Clapperton

SCIENCE

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Editors' Note: Jill Clapperton, PhD (Plant Ecophysiology), is one of only a handful of soil ecology scientists in the world. Formerly with Agri-Food Canada at Lethbridge, AB, she is now a freelance consultant in her "new life" in Montana. Her business is named Earthspirit Land Resource Consulting, earthspiritconsulting@gmail.com.

One of the biggest criticisms against no-till farming is the use of herbicides to control weeds. How many times have we all heard: "I just don't like all those chemicals that farmers use, and don't no-till farmers use far more chemicals anyways? And doesn't that sterilise the soil?" So let's look at how herbicides, fungicides, and insecticides affect the soil biology. This is the first in a series of articles addressing the question of how agricultural practices affect soil biological properties and soil ecology functions.

In this first article, I will discuss the effects of pesticides on soil micro-flora, and on the rhizosphere (the microbiologically active portion of the soil near plant roots), and how these effects can be managed. This article looks especially at the primary producers and the early-stage decomposers in a soil food web: bacteria and fungi. In future articles, I will address interactions between pesticides and the soil fauna ('animals,' such as predatory or scavenging protozoa, nematodes, mites, collembola, enchytraeids, earthworms, spiders, and beetles), and the influence of transgenic (GMO) crops on the soil biota (all organisms that live in the soil) and ecosystem processes.[1]

Photo by Kris Nichols, USDA-ARS.

Cyanobacteria from grassland soil in central North Dakota.

Before we begin, all of us should be clear on some key background information: First, what happens in the rhizosphere drives most of what happens biologically in the soil. Secondly, it is the organic material (in both quality and quantity) that feeds the soil biota, and the term 'soil organic material' includes the plant roots and root exudates (carbon-containing compounds that leak from roots). Lastly, undisturbed soil allows the biota to build a stable and continuous soil pore network, establish an interactive community, and provide key functions, such as C, N, P, and S mineralisation and nitrogen fixing that we rely on to grow nutritious foods.

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The disclaimer for these articles is that much is yet to be discovered. Science has a limited understanding of the abundance and diversity of organisms in the soil, let alone trying to figure out all the biological interactions that unite the soil's chemical and physical properties for 'soil health.' We know a lot about how pesticides influence the target, and even some of the effects on plants and other aboveground organisms that are not the targets of pesticides. But we don't know much about how pesticides interact with soils and soil organisms, and there's far greater species diversity belowground than aboveground. The following article is a summary of my understanding on how pesticides affect the soil biota, and how that could affect soil ecosystem function specifically in a no-tillage system.

[1] *Editors: The grouping of organisms into fauna and flora is a bit arbitrary at times, e.g., protozoa somewhat blur the distinction between animal and plant, while fungi are actually more closely related to animals than to green plants, and the greatest single distinction of all these life forms is prokaryote (bacterial & archaean) versus eukaryote (cells with mitochondria and a true nucleus). Protozoa are single-celled eukaryotes; all multicellular species are comprised of eukaryotic cells.*