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Understanding Soil Biology

Rob Dunn, P.Ag. Cropping System Specialist, FarmWise Inc., Lethbridge, AB

Having a basic knowledge of soil biological diversity, along with how that diversity is affected by our farming practices, is important for understanding soil health management. Soil Biology of the Canadian Prairies is an excellent reference describing the organism types, functional roles and how they are impacted by farm management practices.¹

Soil organisms are usually classified based on size into either fauna or microorganisms. Common fauna range from microscopic hair-like worms called nematodes to larger earthworms with numerous other types including insect larvae, beetles, ants, spiders and springtails (mites). Depending on the species, soil fauna can feed on organic debris, plant material or bacteria, fungi and other soil fauna.

Figure 1. Insect larva, mite and nematode, 40 X magnification (from *Soil Biology of the Canadian Prairies*).



Soil microorganisms can only be seen with a microscope with the major groups including bacteria, actinomycetes, fungi, algae and protozoa. Some are especially important for agriculture like the legume associated nitrogen (N) fixers and arbuscular mycorrhizae (AM) fungi. AM fungi form a symbiotic relationship with plant roots, mobilizing plant available nutrients in exchange for carbohydrate – especially important for phosphorus, copper and zinc

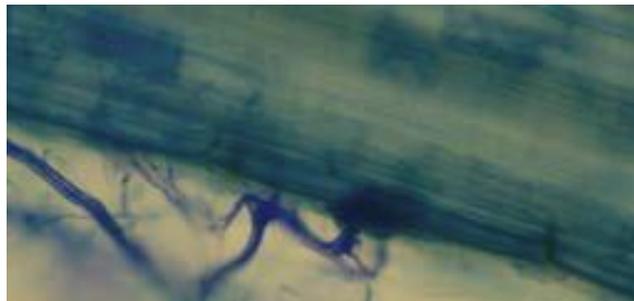
¹ Lupwayi, N., Hamel, C., Tollefson, T. Soil Biology of the Canadian Prairies. Prairie Soils and Crop Journal. Saskatchewan Soil Conservation Association. Volume 3. 2010. <http://www.prairiesoilsandcrops.ca/articles/volume-3-3-print.pdf>

uptake. AM fungi have also been shown to protect plants from soil borne pathogens. One gram of top soil can contain 100 metres of AM fungal hyphae.²

Scientists are just beginning to understand the role of dark septate endophytes (DSE), soil fungi that can be found within many of our plant roots, often associated with AM fungi. They may be important for plants to access nutrients from organic pools, for improved plant tolerance to pathogen attack, drought, heat, and grazing stresses, and may influence plant community dynamics³.

While various bacteria and fungi species have a primary role for organic matter decomposition and nutrient cycling, soil fauna have an indirect affect through their feeding activity, fragmenting and partially digesting plant materials to help accelerate decomposition. These interactions help to distribute nutrients and build soil structure. In particular, AM fungi play an important role with soil particle aggregation through the excretion of glomalin, a sticky glue like substance that is resistant to breakdown.

Figure 2. AM fungi in an alfalfa root (from *Soil Biology of the Canadian Prairies*).



Microorganisms are also important for other reasons, like degrading agrochemicals and pollutants that could otherwise harm plants or contaminate water supplies. Soils with diverse soil microbial communities often have fewer pest problems because of biological control through things like predation and antibiotic production.

Farming practices will influence soil biology with the most diverse and plentiful microbial communities associated with higher crop diversity, low soil disturbance and a surface mulch to maintain topsoil moisture. Microorganisms will respond to carbon inputs from increased crop yields or organic amendments like manure with the ideal situation to maintain a living mulch. Brassica species like canola do not associate with AM fungi and will affect their prevalence in soils. Fertilizers applied at recommended rates for crop or forage production do not usually affect soil organisms and generally have positive effects. Excessive residual soil P can suppress symbiotic formation of AM fungi with plant roots and too much soil N will reduce nodulation or N-fixation by

² Leake, J.R., Johnson, D., Donnelly, D.P., Muckle, G.E., Boddy, L. and Read, D.J. 2004. Networks of power and influence: the role of mycorrhizal mycelium in controlling plant communities and agroecosystem functioning. *Can. J. Bot.* 82: 1016-1045.

³ Mandyam, K. and Jumpponen, A. 2005. Seeking the elusive function of the root-colonising dark septate endophytic fungi. *Studies in Mycol.* 53: 173-189.



ARECA Soil Health Initiative

This article is part of a series to promote better understanding of our agricultural soil resources along with practices that can influence soil health.

rhizobium bacteria. Pesticides do affect both soil fauna and microorganisms with some documented shifts associated with herbicide, insecticide or fungicide use patterns. Populations within healthy soils are more resilient and can quickly recover, for example with insecticide injury to soil fauna.

In summary, healthy soils are comprised of a highly diverse population community of organisms having complex interrelationships with each other and plants. They provide many important functions related to decomposition, nutrient cycling, nutrient uptake and plant health (to name a few). Practices that reduce soil disturbance, maintain cover, increase plant diversity and increase carbon inputs will benefit soil biology and improve soil health.