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SOIL BIOLOGY – *Not Cornstalks* – IS THE REAL CHALLENGE

BY JILL CLAPPERTON

In agriculture, medicine, and other fields it is common to identify something as a problem when it is really just a symptom, as illustrated by Daniel Davidson's October 2014 article entitled "Cornstalks Present Big Challenges."

Corn stalks break down slowly when soil biology is not optimal. Inadequate soil biology is the problem. Slow residue cycling is just the symptom.

Optimizing soil biology begins with practices that portray and promote soil as a habitat. Tillage is one of the most detrimental practices affecting soil health. It collapses the soil lattice structure with all its maze of soil pores, cuts up the carbon and micronutrient trading network of the mycorrhizal fungi, destroys the infrastructure of the soil habitat, and turns the microarthropods, that are responsible for much of the decomposition for woody stalks, upside down.

The use of tillage also selects for only the organisms that can function in a dysfunctional unsustainable system.

Inappropriate, excessive, or prophylactic use of fungicides, insecticides, and nematicides can also significantly affect the ability of the soil to function in a way that benefits soil and plant health. Fungi are one of the most important organisms responsible for breaking down woody residues like corn stalks. They gain access to the corn stalks from the holes in the stalks made by insects, and soil microartropods – like mites and collembola that chew on the dead and dying corn stalks. Bt technology can actually be beneficial when it leads to the reduced use of insecticide. An insecticide takes out pests but also kills insect predators and those that begin the residue decomposition process.

In order to fully realize the benefits of a functioning soil agroecosystem you need to maintain the soil habitat and feed the inhabitants a quality diet. If you want to optimize performance, then like athletes, you need to give your soil a performance-based, high protein, balanced carbon diet. Both above- and below-ground residues are the food (source of energy and nutrients) that drives soil ecosystem functions. So Dr. Davidson's article was correct to discourage the removal of residue.

Corn stalks are very high in carbon but low in nitrogen (protein). This makes them good as an energy source but they cannot be "eaten" unless something provides the nitrogen. This means the rate of cornstalks being cycled will depend on the amount of soil biology AND the amount of protein. The best way to provide high protein material is through the use of crop rotations and/or cover crops. For continuous corn systems, annual, and in some cases perennial, cover-crops need to be used. Tillage increases residue decay rates because it supplies nitrogen by decomposing (mining) stable organic material and gassing off carbon dioxide while leaving nitrogen behind. This nitrogen is then used by organisms to help them decompose the high carbon-content residue. The net amount of stable organic matter that remains in the soil is actually less than the amount mined by the tillage because some nitrogen is lost as nitrous oxides in the process.

Tillage has detrimental effects on soil structure, water infiltration rates, and ecosystem processes but it is especially destructive to soil biology. Species like earthworms, mycorrhizal fungi, many of the beneficial ground beetles, and the mites that start the residue degradation processes tolerate almost no disturbance of surface residue and soil. Nightcrawlers (deep burrowing earthworms) live in permanent burrows. Destroying these burrows and the middens (food stores) that are placed over the burrows means they cannot survive in tilled systems. In continuous corn systems it is common to find whole leaves being pulled into nightcrawler burrows as soon as they fall.

Photo courtesy of Jill Clapperton

Adult earthworms and earthworm eggs, also known as cocoons.

The above-ground residues are essential to insulate the soil from increasing and decreasing diurnal and seasonal temperatures. Insulating soils allow the biology to function for a much longer period during the cool months of the year. In well insulated no-till soils, earthworms will be working after the snow flies and as long as the soil remains above freezing.

Placing the residues in contact with soil biota is a legitimate technique if it can be done without movement from the field due to wind or rainfall events. Chopping corn heads increases the amount of residue moving in the field, leading to bare spots and then piles in the field. Residue non-uniformity can lead to greater patchiness of activity, and makes the field difficult to seed. Harvesting in a manner that leaves the stalks more intact and erect while crushing the outer layer of stalk provides the best scenario for continuous corn. Totally flattening the residue will increase wind speed at the soil surface and lead to increases in soil temperature fluctuations.

It has been well documented that having a green growing plant will increase the decomposition of woody materials, reduce diseases in the next year, maintain soil biological activity longer in the season, and increase N and C mineralization or nutrient recycling. The use of cover crops especially legumes like hairy vetch, clovers, and field peas are obvious choices to increase the amount of nitrogen in the system. These can be mixed with grasses like annual ryegrass, cereal rye, or oats to provide more high nitrogen biomass. Brassica species are low in fiber (carbon), scavenge existing nitrogen, produce large leaves to raise the humidity in the canopy, and grow late into the fall. Most importantly brassicas stimulate the growth and activity of soil animals further stimulating decomposition, mineralization, and overall microbial activity. The act of drilling cover crops can disrupt the residue cover a bit but the subsequent plant growth will keep it stable on the field. Using alfalfa as a perennial cover-crop or clovers as companions in continuous corn are promising techniques.

Annual plants probably work best as cover crops in the central and southern parts of the U.S. Corn Belt because there is more time at moderate temperatures for the soil biota to function between corn crops. Areas farther north require more creativity to extend the time of biologically active soils. High-boy seed distributors, aerial seeding, and clay seed balls show promise towards being able to establish cover crops before the corn comes off. Livestock grazing is probably one of the oldest and most economical techniques for extending the "soil biology" season. The rumen of a cow maintains an ideal temperature to cycle high carbon residue if it is mixed with a source of protein. Appropriate (controlled) grazing by livestock provides an excellent method of processing residue in continuous corn systems, and turns the cover crop into an economical forage crop. Protein can be supplied by the cover crop or through supplementation with DDGs, soybean meal, or other protein sources. One common trick is to use high-protein cover crops grown in adjacent fields in conjunction with corn stalks to supply the balanced diet.

It is critical to recognize that corn stalks are not the problem: they are a critical solution. If we maintain the habitat and feed the below-ground organisms or soil biota a balanced diet they will in turn act to build better soil structure, recycle nutrients from both the above-ground and root residues, making our soils more productive and profitable.

ABOUT THE AUTHOR

Photo courtesy of The Furrow, Larry Reichenberger

Jill Clapperton (PhD) is the Principal Scientist and Co-founder of Rhizoterra Inc. She is a well-known researcher, international lecturer and advocate for practices that promote soil health. At the 2014 National No-Till Conference, Jill received the Syngenta No-Till Innovator for Research and Education Award, she is also the recipient of the Environment Canada Patricia Roberts-Pichette Award for enthusiastic leadership and education in environmental monitoring and assessment. Rhizoterra believes that soil must be managed as a habitat, and that healthy soil grows healthy plants, promotes water quality, and grows a bounty of nutritious food.

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