

## **No Till Notes: Soil Food Web**

By Mark Watson, Panhandle No Till Educator

In the past several articles I have talked about diverse mixtures of forage crops and grain crops. We know diverse crop rotations have the benefit of breaking up persistent weed and disease cycles. I've also talked about how diverse forage crops seem to improve overall forage, and the possibility that even diverse mixtures in our grain crops may increase the yield of these crops.

By using no till crop production systems we are improving the organic matter of the soil. When we add to the no till system more diversity we are also improving the soil micro organism population. With a combination of diverse crop rotations and improved organic matter we are improving our soil food web and this is very important when considering the overall health of the soil we work with.

I'm beginning to understand some of the workings of this complex system know as the soil food web. The soil food web is the community of soil organisms living all or part of their lives in the soil. I gained a better understanding of this soil food web when we attended the forage workshop in Burleigh County, North Dakota. The NRCS staff and local producers in Burleigh County are concentrating on improving the soil food web in their soils and are seeing some dramatic results.

Jay Fuhrer sent me a booklet entitled Soil Biology Primer which is an introductory book to the soil food web. This booklet was published by the Soil and Water Conservation Society in cooperation with the USDA Natural Resources Conservation Service. I would encourage everyone to obtain a copy of this booklet by visiting your local NRCS office or going to the following website, <http://soils.usda.gov/sqi/> and click on soil biology where this book is available online.

In my next article I will talk more about the soil food web, why it is important to production agriculture, and some of the results producers in North Dakota are seeing from improving their soil food web and their soil.

## **Soil Food Web II**

The soil food web is a complex system of soil organisms that are a key element in determining the overall health of the soil we work with and how this soil will perform for us in production agriculture. The soil food web is an integral part of how our soils perform as far as nutrient cycling, soil aggregation, water infiltration, water holding capacity, the breakdown of pesticides, storing of nutrients, fixing nitrogen from the atmosphere, and controlling some crop pests. The soil food web is the livelihood of our soil, yet we don't understand or pay much attention to this important part of our soil in production agriculture. The overall health of the soil food web is dependent upon our soil management practices. With no till and diverse cropping rotations we can improve the soil food web in our soil.

My simple farmer's version of the soil food web is organic matter, plant roots, and crop residue feed these soil organisms. The soil organisms decompose the organic matter and crop residue and release nutrients available to the plants we grow. Primarily the

bacteria and fungi are the decomposers of organic matter. The bacteria and fungi are also an important food source for protozoa and nematodes. The protozoa and nematodes are predators in the soil food web. The bacteria and fungi are higher in nitrogen than the protozoa and nematodes, so protozoa and nematodes excrete excess nitrogen during the digestive process and this excess nitrogen becomes available to the plants we grow. The more bacteria and fungi we can produce through our soil management practices, the more the protozoa and nematodes will eat, and the more nutrients that will be available for crop production.

As we improve our soil management practices by incorporating no till systems into our crop production practices and diversify our cropping rotations, we can influence the overall soil food web in our soils. As the food web improves, our overall soil health and the performance of our soil in crop production will also improve.

### **Soil Food Web III**

What are the practical applications for improving the soil food web and overall soil health in production agriculture? I want to try and answer this question by sharing some results a producer in Burleigh County, North Dakota shared with me on his farm. Gabe Brown has been an integral part of the team of producers and NRCS staff who have been exploring the possibilities of improved soil health in production agriculture.

Gabe had a field on his farm that had grown 2 years of forage crops for cattle grazing. Prior to this the field had produced winter triticale. Gabe has been improving the soils on his farm over the past 10 years by growing forages along with grain crops in a no till production system. During this time he has had diverse mixtures of forages and has also improved the organic matter of his soil.

On this particular field Gabe had soil tests taken prior to planting the corn crop he intended to grow. The soil test showed he had 14 lbs. of total N in a 3 foot sample. Gabe had also sent a soil sample to have his soil food web analyzed. The soil food web assay analyzes the total amount of bacteria, fungi, and protozoa and nematodes in the soil along with other soil health indicators. The food web analysis indicated he would have 200+ lbs./acre potential supply of available nitrogen. This supply of nitrogen would in part be the mineralization of nitrogen which is available through the soil food web. The nitrogen would be a slow release of nitrogen during the growing season. The benefit of this type of nitrogen release is this nitrogen isn't readily available for leaching in its current state in the soil.

Gabe's goal was to produce 100 bushels of dry land corn. The soil sample recommended 100 lbs. of nitrogen be applied for this yield goal. Gabe decided to conduct an experiment and fertilized half the field and applied no fertilizer to the other half of the field. He combined and weighed each half of the field and found the yields to be identical. His soil food web analysis indicated he had plenty of available nitrogen to produce the corn crop and he saw no response from fertilizing the other half of the field.

By improving the soil health along with the soil food web in his soil Gabe feels he will require little if any fertilizer to produce crops on his farm. Imagine the economic return if we could reduce the amount of fertilizer we require to produce crops here in Western Nebraska. I feel we need to look more closely at our soil management practices

and see what we can do to improve the overall soil health with the soils we work with. Improving the soil food web in our soil will result in healthier soils and an improved bottom line.

## **Soil Food Web IV**

When we look at adding diversity into our crop rotations whether by adding cover crops after a short season crop like winter wheat, adding diverse crop mixtures into a growing cash crop, or adding forages into our crop rotations, an important consideration is what crop to grow to address the resource concerns of our soil. We need to look at the concerns we have in our soil, and try to add crops that will address these concerns.

Many of our soils have more than one concern, so mixtures of these cover crops will address more than one problem in the field. If for example we feel a particular field has soil compaction, we need to look at adding a deep tap root crop like the turnips or oil seed radishes. Another deep rooted crop would be sunflower. If this field also has excess nutrients such as nitrogen, these deep rooted crops will also pick up this excess nitrogen and store it in plant matter rather than let the excess nitrogen leach deeper into the soil where it may be lost for crop production.

If the field has poor infiltration these deep rooted crops will provide waterways for moisture to drain into the soil. We can also add residue to the soil surface to improve water infiltration. By planting high carbon to nitrogen ratio crops such as wheat, millet, oats, triticale, or barley we can add residue to the soil surface. These crops will also produce fibrous roots which will increase the organic matter of the soil. If a field is low in nitrogen, it will prove beneficial to add a legume mixture to the cover crop mix to fix nitrogen into the soil.

By addressing the resource concerns of the soil we typically wind up with a diverse crop mixture which will enhance the soil microorganism population. This in turn is beneficial to the soil by increasing the aggregation of the soil, improving soil structure. The soil microorganisms provide the glue which holds soil particles together. This process improves the aggregation, which increases water infiltration into the soil, along with the water holding capacity of the soil.

I hope I have given you food for thought on how you can improve the management of the soil in your farming operation. The soil food web is a complex system that immediately improves as our soil management improves. I think we have a long way to go in understanding the possibilities of improving the performance of our soils by improving our soil management. I also think the benefits to production agriculture will be significant as we improve our soils.

## **Food for the Soil Web**

By Jon Stika.....

The Soil Food Web is a complex association of organisms responsible for breaking down crop residues and cycling plant-available nutrients in the soil. Every

organism has something that it eats...or someone who it is eaten by. But what is the original source of food that keeps the Soil Food Web alive and functioning?

Working backward, all the energy that powers the Food Web comes from the same place the majority of the energy on earth comes from; the Sun. The energy from the Sun is captured through photosynthesis by green plants, and then transmitted to the Soil Food Web by several pathways.

The easiest source of food for soil microbes to eat is the sugar exuded through the roots of living plants. Plants direct the orchestra of the Soil Food Web to provide what the plant needs, when it needs it. Living plants do their best to maintain a rhizosphere, an area of concentrated microbial activity close to the root, to supply the plants nutritional needs.

The rhizosphere is a busy place because that is where the microbial food is exuded by the root to attract and feed the microbes that will make nutrients (and other compounds) available at the root-soil interface where the plant can take them up. Since living roots provide the easiest source of food for soil microbes, growing long season crops or a cover crop following a short season crop, will feed the foundation species of the Soil Food Web as much as possible during the growing season.

The next easiest food source for soil microbes to utilize is dead plant roots that can be decomposed by soil microbes. This source of food is fairly easy for soil microbes to break down because recently dead roots have a fairly high moisture content and moderate carbon: nitrogen ratio. While the sugars exuded from living roots might be compared to cake and cookies, dead roots would be like bread...not as tasty as cake and cookies, but still relatively easy to eat.

Following dead roots on the menu of soil microbes is above-ground crop residues: straw, chaff, husks, stalks, flowers and leaves. These materials usually have a higher carbon: nitrogen ratio and lower moisture content which make them a little more difficult for soil microbes to break down and "eat". Above ground residues first need to be shredded into smaller pieces for soil microbes to have a crack at decomposing them. Shredding is the work of soil microarthropods such as: mites, springtails, woodlice, earwigs, beetles and ants. These microarthropods need well aggregated soil and plant residues on the soil surface for their habitat. Fungi are also capable of breaking down large pieces of plant residues into smaller pieces, but do not work as quickly as microarthropods.

When root exudates, dead roots, or plant residues are not available, soil microbes will feed on other soil organic matter. While soil organic matter contains what soil microbes need to survive, it is not easy for them to make a living eating soil organic matter. If the soil is managed in a way where soil organic matter is the only source of food, the quality and quantity of soil organic matter may suffer. In the old wheat and tilled summer fallow system, soil organic matter declined as carbon was lost from the system from bacteria eating organic matter in a wasteful manner; respiring more than they contributed to the soil.

Healthy soil is dependent upon how well the Soil Food Web is fed. Providing plenty of easily accessible food to soil microbes will help them cycle nutrients that plants need to grow. Sugars from living plant roots, recently dead plant roots, crop residues and soil organic matter all feed the many and varied members of the Soil

Food Web. While the mission statement of the Natural Resources Conservation Service is “helping people help the land”, a farmer’s mission statement might be; “helping microbes help the plants” by providing soil microbes with the best habitat possible; including food.