Soil Education Course Chapter 3 FAQ

Session #11: Protozoa

1. **Q: Is it possible to get 100% self-sustaining soil?**

A: Yes, of course! We see it all the time in nature.

2. **Q: Is there any connection between high ciliate populations and E. coli?**

A: I have no idea, I've never noticed a trend in that direction. We don't test soil for E. coli very often, and usually when we test a compost that has high levels of E. coli, it usually doesn't have any protozoa in it at all. It's a very interesting thing. So, unless it's a worm casting, and sometimes there'll be high levels of ciliates and E. coli, but those are really unusual and unique kinds of things.

3. **Q: Mineralization is what occurs when a predator eats a fungus or bacteria, and excretes a soluble compound, or what is not needed? What is the rest of that process?**

A: Right. That's a part of the mineralization process. The rest is what happens to that soluble nutrient after it's been released. So, the whole mineralization process is what happens to the nutrients in order for them to get to a plant: from collection, to predation, to release, and conversion. So mineralization is the whole process. And the predation step is the release of soluble nutrients in that step, in that mineralization process. And then the pH, oxygen level, and conditions in the root system converted into another form.

4. **Q: How does excess nitrogen get stored?**

A: So, that's the whole beauty of the cycle. The bacteria and fungi, as they're collecting the nutrients (especially the bacteria) they're storing all that nitrogen in their bodies as protein, and when they get eaten and it gets released, those same organisms (or similar organisms) will go in and collect if the plant isn't taking it up.

And again, it depends on so many variables, but in a healthy system basically the biology stores all that nitrogen and that's what we really want. It is mostly stored in microbiology. There is some storage of nitrogen in the organic material. There's some really complex processes going on with the different forms of carbon, and how it relates to the nitrogen.

Some of that nitrogen will be stored in the plant material that hasn't been fully decomposed.But for the most part, the viable portion of nitrogen is going to be in the bacteria. And of course, the protozoa too, have some nitrogen.

5. **Q: Therefore, how long do the nutrients last within the microbiology?**

A: Indefinitely, as long as you keep the conditions good, that cycle is an indefinite cycle. Bacteria can't really die. they'll reproduce and split, and they don't actually die. Just 1 becomes 2, and they continue storing that protein. So it's an indefinite storage potential, as long as that system is alive and functioning. It's the same concept, when we're talking about fungi and radiation, and it's sequestering the radiation, that process will continue as long as the fungi lives. It'll keep holding onto it, but as soon as the fungi dies, or it gets killed, I guess the same thing. Well, either eaten or it dies. Then, the radiation would get released. And if the microorganisms are there to grab it again, then it can stay in the cycle forever.

Protozoa Pun:

Amy Amoeba and Cybil Cilia saw Fred Flagella whip himself into a frenzy as he ate a plate of Proteobacteria. A gram negative feast.

Session #12: Nematodes

1. **Q: So you already sort of answered my question, which was going to be, how does one manage to lower the population of root feeders? And I think your answer was a nice, diverse food web and good management practices (don't over till, don't kill the fungi). Do you have anything else to add to that?**

A: It's all about the stress on the plant, so the less stress you can put on the plant, the better. We need to make sure it gets everything it needs to reduce the *conditions* in which nematodes will express themselves. Think about how we grow corn in the midwest: There's a tremendous amount of stress. Just the fertility practices alone puts a tremendous amount of stress on those plants, because, sure, they can absorb the salt through their root system, but there are other ways that they prefer to eat. So, the answer is to reduce the stress. The best way to do that, in my opinion, of course I'm biased, is to fix the soil. So utilizing compost, introducing diversity, minimizing disturbance, and minimizing the things which disrupt the function.

2. **Q: How long does it take for the fungi to consume the nematode? How often do they "feed" ?**

A: I have no idea! I think they will feed whenever they get the opportunity. It probably varies a lot. And as far as I'm concerned, once that nematode is captured by the fungi, it's finished. It probably varies on the nematode/fungi relationship as well (what type of fungi versus what type of nematode you have).

3. **Q: Are there different nematodes in the soil environments that are dominated by woody or grass landscapes?**

A: So what we tend to find is because nematode populations are relatively speaking, very low, overall, in every system we expect there to be a relatively decent balance. If you think of bacterial feeders and fungal feeders, and think about bacterial and fungal dominance, I would expect that there might be more bacterial feeding nematodes in like a grassland than you would find in the forest. But in a forest system, there is such a diversity that it wouldn't surprise me if it was more equal.

That's one area where nobody really knows for sure what the population distribution should be of the nematodes. Nobody has studied that that I know of, I haven't seen any research that supports the answer to that question. If anybody finds it, always feel free to send it to us. I'm always reading scientific papers and stuff that people send us, and say, "Hey, look at this." And we always read it, and it always adds something to the body of knowledge.

4. **Q: What microscope magnification would be best to see the diverse microorganisms in a soil sample?**

A: We use anywhere from 100 to 400 to even 1000x magnification, depending on what we're looking at. Our microscopes are the same magnification of microscopes that you could buy online -- You can buy a $1000 microscope that has 1000x magnification. The problem is the quality of those optics. It's really hard to see anything with it. When we're looking at these organisms, 400x is about the right magnification. What you're really looking for when you're trying to do a really good job of looking at these organisms, is **resolution**. So our objective lens, just the 40 X objectives, cost more than most microscopes you can buy online. So that's why our microscopes cost $20,000 because the **light source** and the **optics** are incredibly high quality. The higher the resolution, the more you can see, and the better you see it. But with a $1000 scope, you can see a good amount just at home.

Session #13: Different Testing Methods

1. **Q: I always struggled to get an understanding of the CEC test. Could you expand on that? (i.e. What's going on physically, the benefits of that test, etc.)**

A: CEC is "cation exchange capacity." The particles of the soil are positively and negatively charged, and the nutrients of the soil are positively and negatively charged. They cling to the surfaces of that particulate matter. For example, a sandy soil has a low CEC because there's not a lot of surface area -- sand is really big and it's not very well charged. But clay soil has a huge amount of surface area, and a huge amount of charge, so your CEC is going to be really high. There are limitations here because if you have a heavy clay soil, it may be harder to get that nutrient off of the clay into the soil. That's why so many people spend so much money trying to get the pH balanced to flocculate the clays, and make those nutrients available. There are a lot of factors to take into account here. Essentially, it is the nutrients that are on the surface of the soil particles, and the conditions in the soil. How much of those things that you need to add are dependent on a lot of other factors. Usually, that information is used to determine how to apply a chemical or salt based fertilizers, because they're not taking into account the biological processes. So, if your CEC and calcium are a little low, they recommend adding tons of calcium to the soil, tons of lime or gypsum, depending on the circumstances. Whereas we wouldn't recommend that when we take the biological components into consideration.

2. **Q: At a very basic level, someone should be looking at chemical and biological testing at the beginning of the season pre-plant to make assessments, and then tissue testing during the season to see if things are going well?**

A: Yes, and then also in the fall, after harvest, to see what condition the soil is in after the growing season. Then you'll see what you need to do to help the soil through the winter, post-harvest. Most people test one or the other, but if you're aggressive about it: test in the spring *and* fall and then also monitor tissue and sap throughout the season.

3. **Q: There's an article posted on your website from Anthony Michaels about biological farming, he's not an organic farmer, but he wants to use the biological method... And he talked about a wide range of minerals. I assume he's talking about the micros, not the macros, right?**

A: NPK, calcium, and magnesium are kind of the macros, and then we have micronutrients which are things like iron, boron, sulfur, molybdenum, & manganese. Then there's trace minerals, of which, there are about 70 more. Trace minerals are really hard to test for. You can do it, but it gets expensive. The longer the list, the more expensive the testing. When we're looking at "plant available nutrients" we're looking at macro- and micro- nutrients.

4. **Q: Is there a preferred type of micronutrient or does it matter?**

A: It depends on the plant. Some plants really need molybdenum for certain things and you'll know it if they're deficient. Other plants really need boron, or sometimes iron is important. With the plant available nutrients test, we are only looking at maybe 17 parameters. They are all important. The nice thing is the tools that we have available are fairly broad spectrum. But, if you're putting out compost, you are getting a lot of things in there. Fish also brings a lot of different things to the table-- if you're using things like kelp and a little bit of lime. Sea minerals are also a real popular tool, and that has all of the macro, micro, and trace nutrients.

5. **Q: For TCEC and base saturation, what are your thoughts on the Albrecht Model?**

A: I don't have enough experience directly working with the model (other than I do believe the Calcium to Magnesium ratio is more important than the NPK). Overall, from what I know so far, I agree with it.

It is still chemistry farming, and calling it biological farming. I think that the calcium to Magnesium ratio is probably much wider than what is in Albrecht's writings. 7:1 is the main thing, but I've seen it work just fine as 10:1 or 12:1. And even as low as 4 or 5:1. But I think overall, his approach is correct. The thing about some of these alternatives is... Albrecht's model is supposed to be a biological model. And a lot of the biological farming models are, they're not actually based on biology, they are based on a different perspective of the nutrients. So it's still a chemistry test, it's still chemistry farming that's *maybe* a bit more biologically friendly. They're still measuring chemistry and calling it biological, when really we should be measuring biology, and supporting it with chemistry testing -- if you're going to be a biological farmer. I like Albrecht's stuff, I think he has a lot of good insights.

Session #14: Understanding Your Earthfort Test Results

1. **Q: What QC measures do you have?**

A: We have a specialized technician that comes in annually and calibrates everything and cleans all of our equipment microscopes to the scales, the autoclave, the incubator, drying oven, and all of that is quality checked and calibrated on an annual basis. Internally, we do a quality control check every 100 samples, at every 100th assay, every 100th dry weight measurement, to have a quality control chart between the technicians and double check everything. Active and total fungi, nematodes, protozoa and cross-training. Our lab technician has been doing this for over 20 years, and there are a few other labs around the world that do what we do.

Also, we have internal quality control, like cross checking work with the nematodes. But unfortunately, we don't yet have external quality control. We do occasionally do some cross collaboration with some of the other labs, but because they're international, it can be a little tricky to get samples back and forth. We're doing data entry, putting the reports together, and we are double checking all the results all the time. There's some air traffic as well that we have built into the database to catch potential errors.

2. **Q: Do you do microorganism counts before drying your sample? Also, because you are measuring dry weight, should my sample be drier rather than moist?**

A: We measure the soil's biology when the sample is fresh. When we dry it out, it kills a lot of the biology, as it's a very destructive test. For some of these tests, we have to do it in isolation from other tests. The dry weight portion is specifically to determine the dry weight. We use fresh material to measure the actual organisms. Here's the thing about dry weight. The higher the dry weight number, the less moisture is in the soil, and the lower the dry weight number of horrible extruders in the soil. It really depends on your climate and plant. When I work with, for example, the desert or south-west, (we have a lot of customers in Arizona, New Mexico, and Southern California) I take into consideration that they're in a drier climate and that there might be an extra heat factor. I've seen healthy soils with as high as 95% dry weight -- only 5% moisture, but those are sandy soils that are well irrigated. They don't hold onto water, but they're trying to constantly add water to the system that helps keep the roots. Some organisms are so fascinating.

3. **Q: If you find the perfect compost, how long will it stay that way? (Do you get as much as you can or is there a "shelf life"?)**

A: That is a really good question because it's highly variable. It depends on a lot but what I've seen is that a stable, mature, compost will stay that way and improve with age usually for a few years. So, even bagged material can be good for a couple years. That's why they can get away with bagging, putting it on a pallet, and shipping it out to Garden centers. If you go to Home Depot or Lowe's or someplace like that, chances are that material is 1 to 2 year old compost. So, it's very fresh, but yes. If you store it properly, it can mature quite a while, and in some cases it'll even improve. We'll cover this in the compost session.

4. **Q: If I buy compost, can I request a test?**

A: I don't know what the context of this question is, but when you purchase from us, we'll give you the most current test result, as we test everything. We do quality control of the products, so if you buy something from us and it has biology, it will be tested, and we will provide those results to you.

5. **Q: Because you are measuring dry weight, should my sample be drier rather than moist?**

A: I don't understand that question. We measure it as it comes out of the ground so you don't do anything to that sample. We just test it as it comes, we'll figure out the dry weight because what we're really measuring is, we're taking the moisture away from it to interpret the solid better.

6. **Q: Just curious if you can go into more detail about how the plant nutrient test could be more robust?**

A: I think what we've been discussing with the agronomists in the current paradigm of chemistry testing is that different parts of the country because of the soil type require different methods of extraction. But, I think that that works for CEC. So that's what we're discussing: whether or not the cation exchange capacity types of tests need to be regionally specific, or soil-type specific. Whereas, I think, with the plant's available nutrients, we're looking at some saturated pepper paste methods. And, Forget, when there was another one that the guys that microterra, we're talking about, but they've, we've done The testing, are actually expecting the results from them. They compare what we've been doing with the plant available nutrients, comparing it to what they do. And they're discussing what they have available and seeing if we can find out more. I don't know if robust is the right word, but just more accurate and more compatible with the biological. We are always pushing that. Why is our niche retesting to be life focused, as well as our biology testing. It's an ongoing thing.

Session #15: Report Interpretation

1. **Q: What is meant by the term "biomass"?**

A: The weight of the organisms in the soil. The measurement of microorganisms/gram of soil. Fungal biomass is calculated from the length and width of hyphae and the number of bacteria is converted to volume. The unit of measurement in micrograms (one millionth of a gram), reported as µg.

2. **Q: What role does electrical conductivity play in growing?**

A: Electrical conductivity has also to do with soluble salts, which is the ability of the soil solution to exchange ions. So, it's part of the ionic exchange of the biochemistry of the soil.

3. **Q: Does the high Phosphate amount limit the benefits of Mycorrhizal Fungi?**

A: These levels are not high enough to have a negative impact on the mycorrhizal. You need to be in the tens of thousands. And it's also when you look at the research online because I

know there's a lot of research that says that high phosphate levels or phosphate fertilizer limit mycorrhizal fungi. Those are based on Cation Exchange Capacity (CEC). They are using a higher extracted level and they're also basing it on salt-based fertilizers.

4. **Q: Are there visual indicators that your soil structure is off?**

A: There are some things that you can look at. Probably the best thing is to just get a penetrometer. Other things you can watch for is puddling, so if it rains and the water just sits there on the surface, that is an infiltration problem. That's a structural issue. You can dig it up and look at the aggregation. But that's a lot of work.

5. **Q: For an annual plant, what is the best time to test to react meaningfully?**

A: The nice thing about biology is that it is always working. If you test in the fall and you say, "OK, what's going on after this season? What do I need to do to help that soil get prepared for the plants I want to grow over winter, or through the winter. Or, you test in the spring just a few weeks before you're going to plant it... You could either test after you plant it, just do what you're going to do, get it in the ground, then test, and see what else you might do to help the whole system.

I don't think that there's a clear answer for that... I think it is best to test whenever it's meaningful to you, where the information will help you make the proper decision. Testing will help you make good decisions, if you're not sure what to do. Test so that you can get some ideas of what needs to be corrected. I wish it was more formulaic, but there's no one answer.