SOIL ORGANIC MATTER

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George has presented to you some questions; I'm going to take a slightly different approach. I'm going to make some statements and let you challenge them. This will accomplish the same thing.

Jack asked me to address my comments to organic matter, cover crops, and tillage. When I thought of these three things, I came to the conclusion that they really all revolve around organic matter. In essence then, this is what I'll talk about. I'll discuss what they have to do with tillage as we go along.

Since we seem to be taking a historical approach this morning, organic matter was once the heart and soul of the soil. In fact, it was known as the food of the soil, or the food of the plants that grew in the soil. Then the inorganic chemists came along and said, "Well, you are really just a bunch of blind idiots. Really what you are doing when you put this organic matter in the soil is that you are providing the nitrogen, the phosphorus, the potash, the calcium, the magnesium, etc. that the plants need. All you have to do, really, is to apply these in mineral form and it is a lot cheaper and a lot less bulky, and you will get the same results." Some swung completely to the other end then, and we've really had some rather disasterous results. So, it depends on how it is thrown back; most of us have an appreciation of the fact that organic matter is important to our soil. We might want to raise the question of "why" and so I thought that with the assistance of a few slides, I'd discuss some of these points.

1. Nursery soil organic matter sources

There are primarily three things: cover crops, fresh organic residues, and composts.

(a) Cover crops: This is green manures, or green crops. It's growing some crop on the land hoping to provide some organic matter.

(b) Fresh organic residues: This is bringing organic matter to the area that did not grow there.

(c) Composts: Bringing organic matter to the nursery, composting it, and then applying it to the soil.

In a few cases and under certain situations, some people grow cover crops and them compost it before putting it back into the soil. This is where organic matter comes from--now, where does it go?

2. Nursery soil organic matter losses

We lose organic matter to three different routes.

(a) Oxidation: A nursery soil that is tilled, opened, and exposed by just the natural biological activity in the soil is going to break down the organic matter. It is a constant decomposition. This is not bad. The organisms that do this decomposition, a great number of them, benefit us from other ways and so we want this biological activity in the soil.

(b) Erosion: Wind or water erosion cause loss of organic matter. Although we try to avoid this as much as possible, the nursery soil is opened and exposed and we do get some of this.

(c) Removal with seedlings: There is a considerable quantity of the organic matter (that we work so hard to put back into the soil) that we turn right around and haul off attached to the roots of the seedlings. I'll show you a couple of slides on this and show you how it works.

3. Physical and chemical advantages of organic matter in nursery soil

(a) Improved aggregation in the structures of the soil; this is important to the tillage aspects.

(b) Tillage: One expects this to fall right along in this line.

(c) Penetration of water into the soil and moisture retention: This goes across the board to almost all soil types--makes no difference if its a sandy or clay soil. With good

structure, as far as wind and water are concerned, we reduce erosion. If we have good tilth, we reduce lifting damage. There's nothing worse than to work throughout the season to grow a good crop of seedlings and then tear the roots up getting them out of the soil.

(d) Organic matter as the reservoir of nitrogen and phosphorus: Practically all the nitrogen that we have in the soil will be taking the place of mineral fertilizer as we add it in the form of organic material (protein). As much as three-fourths of our phosphorus often times will be in the organic matter. The organic matter serves to hold nutrients against leaching and here I'm speaking of the physical cation exchange properities of the organic matter. If you have a very coarse sand, you know that the potassium and other calamines will leach unless you get a good amount of organic matter in the soil to hold them.

(e) The last thing I have listed is the buffering action of the soil: A soil that is low in organic matter, unless it is really loaded with clay, which in turn makes a very poor nursery soil, has a low buffering capacity. This means that whatever cultural operations you undertake will, quite likely, change the pH of the soil and the soil that is buffed-up will be protected against this. Also, in this way the organic matter will tend to absorb and take out of circulation some of the overdoses of pesticides that we occasionally have.

4. Biological influences of organic matter in nursery soil

We said that the organic matter served as a reservoir for the nitrogen and phosphorus, but if it stays in the reservoir it's not going to do the seedlings much good. We must have biological activity in the soil, breaking down this organic matter and mineralizing the nitrogen and phosphorus, so that the seedlings can get it. Also, this organic matter serves as a food source for non-synthetic fixing organisms in the soil.

(a) I have listed here the increase in the phosphorus and potash availability to provide organic matter to the saprophytic organics in the soil. They, in turn, attack the primary minerals in the soil and release the potassium and phosphorus. There are at least two lines in the country right now working on this very problem with seedlings. It turns out to be that a considerable amount of phosphorus and potash can be liberated if sufficient material (organic matter) is present for the organisms.

(b) Pathogen suppression: This is a difficult bound, as Jim knows much more than I. There have been well documented cases where proper organic matter in sufficient quantities will result in growth of antagonistic organisms in the soil, which will suppress certain of our root pathogens.

(c) Root regulator production: There is also the possibility that root growth can be stimulated by the production of hormones which are produced in the soil by these active microbes.

5. Cover crops, organic residues, and composts

We are all interested in getting the organic matter into the soil and this corn crop certainly does supply organic matter to the soil--there's no doubt about that. It also provides the nurseryman with a little extra cash because the corn is harvested before the crop is turned under. Present day cover crops vary considerably. Jack mentioned earlier some of the early ones and they still have a place. Certainly, soybeans are used quite commonly as a cover crop. I would like to call your attention to watching a new cover crop, which is just now being tried. This is pigonpeas, and is a legume and grows almost as large as corn in one season. I've been assured by the people who are trying it that it will not turn out to be another Kudzu. It does produce a lot of organic matter and they say it absolutely will not overwinter in the United States. It has to be planted each year--the seed will not stay. So, this is one we'll want to watch and I don't recommend that anyone run home and plant his whole nursery in pigonpeas right away.

Now, in the terms of organic amendments, the fresh or composted material. A little data here (slides) from work with sawdust, both fresh and composted. The application rate was the same (40 yards per acre).

We looked at the growth of Jack pine in terms of stem diameter and the weight of the composted material. Notice the larger seedlings, especially the tops are much larger. Four hundred milligram top weight for the composted material versus only 60 for the fresh sawdust. This was undoubtedly due to nitrogen problems. In the soil without any sawdust, the top was only 140. Now everyone worries about whether we're growing large tops and no root systems--so we look at the ratio. We find that the ratio most suitable would be the composted material. We not only have stimulated top growth but we have even mare stimulated root growth. We have very fibrous root systems on the seedlings.

Now, let's put this fresh sawdust in the soil ahead of our cover crop. At this particular time we were working with clover and these three pictures represent: (a) no sawdust added to the soil, (b) fresh sawdust, and (c) composted material.

As any good compost should, this had been pretty well spiked with mineral fertilizer. I don't want to imply that it's just rotten sawdust--it's not; but the fresh sawdust, even with the legume cover crop, did reduce the amount of organic matter that we were able to put into the soil.

The question is raised--if we grow a cover crop, do we increase the organic matter content of the soil? Obviously, when we looked at that corn field a moment or two ago, you know that when the corn was turned under, there was some additional organic matter in the soil, at least for awhile. The question has been raised repeatedly, so I'll show you some data from test work. Sudan grass was turned under in the soil and it had already been tagged with some traces of carbon and nitrogen; thus we knew where the resulting carbon and nitrogen came from. For the soil alone (without Sudan grass) one can see about 19 milligrams of CO_2 to 1.4 of nitrogen. When the Sudan grass was added, the minerals jumped tremendously but here the thing that caught our attention was that the carbon dioxide dissolved from the soil came primarily from the native organic matter rather than the grass. The grass only served as a root primer. It started the microbes working furiously in the soil and, actually, as an indirect result of this, we had less organic matter in the soil than we had to begin with. The same sort of picture appeared with nitrogen. Adding the grass to the soil resulted in the mineralization of more of the native soil nitrogen. This is not bad, but it does bring out the fact that we have to keep adding all the time.

6. Soil organic matter and root pruning

Let's think now about the tilth of the soil. The organic matter that we have in the soil is important. Here we see the undercutting during root pruning. Very often following root pruning, we have a little wilt. This wilt is not too bad and if we can get water back on there, recovery will be quite fast. If we don't have enough organic matter to give us the good structure we need in the soil, we will not get good water penetration and we will have some bad results from the root pruning.

One purpose for root pruning is to stimulate the lateral root growth and we find that a good fibrous root system can be promoted by root pruning if we have good organic matter in the soil; one that will give us good structure and good tilth.

7. Soil organic matter and mycorhizae

One of the things we have to know is how the electroscopic mycorhizae works. We find that one of the things these critters do accomplish is that the fungus that lives in association with the root is able to turn around and be a saprophyte in the soil and attack the organic matter directly--bringing the nitrogen, phosphorus, etc., right to the plant. This slide shows some organic matter that couldn't even be washed off the mycorhizae roots. It shows how much organic matter these mycorhizae fungi will attack and hang on to, if it is there.

8. Soil organic matter and lifting of stock

When lifting time comes we run into one of the most critical things as far as organic matter is concerned. We must have our soil in good, pliable, easily worked up condition; otherwise, we will damage the root system which we are trying to grow. Therefore, it behooves us to pay attention to the structure of the soil and this is done by paying attention to the organic matter.

I think that we can say that our cover crops may give us some organic matter in the soil and promote structure, but will not give us a large increase in organic matter. Some of the fresh organic residues that we use will go further towards actually increasing the organic matter content--such things as sawdust, sewage sludge which some of you probably have access to, peat moss, hammermilled cones from the seed extractory, or anything like this that will stay around in the soil longer are good. These hard materials will not serve as a large food source for the organisms in the soil, but will definitely give us the physical properities we want. We can say, I think, that if we have the time and facilities, certain advantages can be gained from compost. But, compost does present an additional challenge in the terms of effort. I'm not going to say whether I promote compost or not.

I think that we all agree that maintenance of organic matter in the soil is most important.