Soil Tests - Getting the Most from Your Investment

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Most farmers think that a soil test will tell them how much fertilizer to use. Sure, its pretty simple, isn't it? Go out in late winter, collect some dirt, send it in and voila, you will know exactly how much of the right fertilizers to apply to have great yields.

Unfortunately, it is not that simple. Soil tests can be useful tools but they are not precision instruments that guarantee a certain response. Many people don't realize that a soil test is NOT absolute calculation of all available nutrients in the soil. In reality, a soil test is a rough approximation of the nutrients that may be available to a growing plant under normal growing conditions. Whether the plants actually get the nutrients they need from that soil depends on many factors including the weather, especially the temperature and moisture levels, activity of soil organic matter and microbes, the soil tilth and compaction, previous cropping history, the species of crop and the weed pressure.

Soil test results are highly dependent on the method of chemical extraction. That is why different labs will come up with different results. There is no absolute right way to simulate the availability of nutrients. Different extraction techniques all have validity, but some methods may be more useful than others in a particular situation.

Researchers at the Rodale Institute in the 1980's took one sample of soil and sent it off to 70 different labs . . . and got 70 very different results. Indeed, the pH of the sample ranged from 4.7 to 6.9 with lime recommendations ranging from 0 to 7 tons per acre! Readings and recommendations for NPK and micronutrients were equally variable. It is not uncommon for labs to liberally recommend 'insurance' or excessive fertilizer that may not be necessary and may not be correlated with any crop response data.

Few soil testing labs are familiar with organic conditions and most will usually provide recommendations that are inappropriate and not particularly useful to your situation. Once you find a lab that seems to give results consistent with the way your crops are growing, it is a better idea to compare results year to year from that lab than to try a different lab each year. It is also a good idea to calibrate any lab's results to your own farm by taking a soil test from one of your best producing and most manageable fields. This will give you an approximation what a good soil test from that lab should look like, and give you a better idea of what you might want to see on your other fields.

It is useful to get information on CEC, soil organic matter and % base saturation for cations such as potassium, calcium, and magnesium, as well as micronutrient levels. For organic farmers, base saturation is a more useful measurement than pH. pH rates the percent of hydrogen ions as compared to the percent of other cations in the soil - the lower the pH, the higher the number of H+ ions. In contrast, base saturation tells us which actual cations, especially Ca and Mg, are present and in what relative quantity. If we're going to apply materials to adjust cations, we'd better know where we're

starting and monitor how much change we are making, because excess cations can be just as much of a problem as deficiencies. William Albrecht pointed out that the real reason for liming is to provide necessary cations, not to decrease acidity. We need the soil to be slightly acidic for good nutrient availability.

Soil Test Sampling

Taking an accurate soil is somewhat of an art, but certainly there are right and wrong ways to do it. Often it is most cost effective to contract with someone who has been trained in taking soil tests, but if you want to take your own, you need to learn how.

As a general guideline, you should take 15-20 soil cores from a field to make a composite sample that can adequately represent a 5-10 acre area. If the soil is unusually non-uniform, you will need to take more core, or make separate composite samples from smaller areas that represents certain characteristics (i.e. a knoll or low spot). If there are small non-representative areas in a field and you don't intend to handle them as a separate samples, avoid sampling from them entirely so you don't skew the results for the rest of the field. A good quality soil probe that takes a core the correct depth and width is important.

After taking the cores, mix them thoroughly in a bucket. Some labs will want wet samples, some will want air dried samples. Depending on how they do their tests, this may make a huge difference in the results. Make sure you know what your lab wants and handle the samples accordingly. In any case, if samples need to be air dried, do so immediately, don't let damp samples sit around in a closed container for awhile and then dry them because microbial and chemical changes in the soil will distort the results.

Most people take their soil tests during the winter because it is more convenient and the fields are not covered with crops. However, the time of year that a soil test is pulled can make a significant difference. We had a SARE grant in 1999 and 2000, conducting soil tests on 6 fields every six weeks for 2 years to see if there were seasonal fluctuations in nutrient availability. In general, most nutrients stayed fairly constant throughout the year, but there was a major fluctuation in phosphorus. This is hardly surprising since as organic farmers, most of our available phosphorus is tied directly to level of microbial activity. In our fields, a soil test taken in the winter showed low levels of phosphorus, while soil tests taken in the same field in late spring and summer when the microbes were really active showed high levels of phosphorus. Using the winter reading to plan soil amendments might very well have resulted in over-application of phosphorus.

Interpreting a Soil Test

Conventional crop advisors use standard 'response curves' to recommend fertility amendments based on soil test results. These are derived from experiments correlating increased yield to increasing fertilizer application. By estimating where your soil is on the curve, the advisor predicts how much more fertilizer should be applied to achieve higher yields. If your soil reads 'low' on the curve, you are likely to see more dramatic increases than if it already reads 'medium' or 'high', since in those cases, fertility may not be limiting plant performance appreciably. Unfortunately almost all of these standard curves are based on chemical fertilizer and chemically treated soil conditions, and therefore have limited applicability to an organic farm or the fertility amendments we use.

In the organic system, we must interpret soil test results differently and consider them in light of our two main types of amendments. The large corrective treatments, such as lime, gypsum, manure, rock dust and compost, are applied to correct imbalances in the soil, not really in the crop plants. Generally, we try to apply these products to a growing cover crop the year before the crop is planted to 'feed the soil', our goal is not actually to 'feed the plants'. This is to promote soil conditions that will allow healthy crop growth and that favor crop growth over weed growth. By putting these materials onto cover crops, we allow time and biological activity to convert the nutrient salts and insoluble materials into biologically available and stable molecules that will be released to the following crop. It is important to remember that nature prefers gentle changes. Making big changes in one element can easily create imbalances in other elements. If your soil needs 4 tons of lime, it is much better to apply no more than 2 tons per year rather than putting it all on at once. This prevents high Ca or high pH shock to microbes in a small area of the soil.

The other type of organic amendment is a starter fertilizer that will directly feed the young crop seedlings. Starter fertilizers generally are based on well-matured compost containing small amounts of readily available nitrogen, phosphorus and micronutrients to correct specific deficiencies. Starters should be banded where the roots of small seedlings can benefit from the higher fertility. We generally only use starter fertilizers only on our more valuable row crops, like corn and vegetables.

We feel it is equally important for organic farmers to consider soil fertility as a critical piece in successful cultural weed control. Many of us in New York have found that on soils with a CEC above 8, a 7:1 (% base saturation) calcium:magnesium ratio is best for both weed control and crop plant growth. This is equivalent to approximately 11:1 or 12:1 Ca:Mg if measured in pounds or parts per million. This particular ratio appears to be a key factor regulating weed population size and strength. When magnesium levels are high relative to calcium levels, increased weed populations and soil compaction and crusting are more likely to result. Many prevalent weed species, such as foxtail and summer annual grasses, thrive in hard compacted soils that are often also low in calcium and high in magnesium. For this reason, weed control can be often improved by calcium amendments that do not add extra magnesium. However, different weed species will be favored in a soil that is excessively high in calcium. A correct balance between the two minerals is needed.

Unproductive, hard, high knobs on our farm are usually very high in P and K and have excessive magnesium with very low calcium levels. It really pays to test such areas separately and correct imbalances. Often yields from areas like this can be raised dramatically by simply liming and/or using gypsum.

Phosphorus can be tested for with several different tests, each of which measure a different portion of the phosphorus in the soil that will be available to plants. An acid extraction technique, such as a strong Bray extraction (P2), estimates the potentially available cations over the entire growing season while a weak acid extraction method, such as a weak Bray extraction (P1), estimates what nutrients are available to the plant immediately. If the weak Bray test reads low, using a starter fertilizer with phosphorus may be profitable. Although microbial activity has a tendency to release

phosphorus naturally over the growing season, such activity may be slow in a typical spring under cold wet conditions. Since seedlings need to absorb phosphorus early and translocate it around the plant as needed, it is important to have ample phosphorus available at planting.

A typical soil test

A soil test taken on one of our fields in June 2000 showed that organic matter= 3.2%, Phosphorus P1=12 (low), Phosphorus P2=3 (med), pH=6.8, CEC=9.1, and the base saturations were 1.9% K, 18.1% Mg, 77.1% Ca, 2.9% H. Sulfur = 5ppm (low), Zn = 2.7 ppm (med), Mn = 65 ppm (very hi), Fe = 42 ppm (high), Cu = 2.4 ppm (hi), and B = 0.5 ppm (low). The lab that performed this test was A&L East.

Our experience has shown that we can get excellent yields on fields testing like this one as long as the Ca and Mg levels are adequate. The high Ca and Mg mask some P and K that does not show in these soil test extractions but are made available by biological activity in the soil. A clover cover crop was plowed down before the crop was planted. This clover residue, both from the fall before and the spring, contained about 30 lb/A P, 200 lb/A K, and 300 lb/A N, but it had not been plowed before the soil test was taken and therefore was not reflected in the soil test results. Rock phosphate had been applied to this field several years before, resulting in the good P2 reading and adequate P levels. The first thing we notice on this soil test is that while the Ca level is good, Mg is too high. This field is somewhat crusty and tends to have more foxtail and summer annuals which are typical of elevated Mg conditions. To adjust the Ca:Mg ratio and to add needed sulfur, we applied 800 lb/A gypsum. We used a starter fertilizer which contained enough Zn and B to address the documented deficiencies and about 4 lb/A N, 8 lb/A P, and 8 lb/A K. While this is only a fraction of what the chemical fertilizer consultant would have recommended, we got good yields on red kidney beans that year and on spelt and snap beans in the 2 years since. We credit the high level of biological activity in this soil to provide most of nutrients that the crops need.

"If it ain't broke, don't fix it"

When determining whether you need to make major fertility corrections, it is important to look at your crops and weeds and consider your cropping plans. We are able to get away with using relatively little purchased inputs because of the clover plowdown, our crop rotations and other practices that raise organic matter and return nutrients to the soil. Even with the low numbers on the soil test described above, we know that this field has been producing well and therefore it is not really in need for major attention. We try not to get too hung up on soil test numbers, but if one element is significantly low or is dropping, then we try to be aware of it and watch the crop more closely. When the crops, weeds and the soil test indicate there is a fertility problem, then address it but go slow, don't try to correct everything in one year.