The Analysis

Agronomic Information From

Spectrum Analytic Inc.

Summer 2011

This spring has been another very challenging planting time in Ohio as well as parts of Indiana, Michigan and Pennsylvania. During April and May, rainfall was much above normal and temperatures were below normal. As of this writing the National Agricultural Statistics Service report released on May 31, 2011 in Ohio corn planting was 19% complete compared to the 4 year average of 93% complete. Indiana 59% planted, Pennsylvania 61% planted, Michigan 67% planted, Kentucky 75% planted while Illinois and Iowa were 94% and 99% completed. Illinois and Iowa are the only states that are average; all others are 30% to 80% behind their 4 year average. Soybean planting is near normal in Iowa and Illinois while other states are behind 30% to 60% of the past 4 years. I may have missed your area in the evaluation, if so I am sorry because I know there have been other isolated areas.

Our online soil and plant submittal continues to grow. We started the service with soil in 2007 and it has been so widely accepted we have added plant, manure, turf and ornamental, manure, feed, lime, water and greenhouse media. We have made it so nitrogen soil testing can be completed on line. If you only need a nitrate test be sure to check the NO_3 box. If you want both ammonium and nitrate, under PKG you will need to specify N1. On line submittal helps speed data entry at our end and also improves accuracy by eliminating retyping information. If you have not tried it, why not sign up for a user name and password and join the others that are enjoying the ease of on line submittal.

Crop scouting is just around the corner, this is a great time to take plant tissue samples and see how well the current fertility program is working for your growers. Soil analysis tells approximately how much of each nutrient is available to the crop while a plant tissue analysis confirms what nutrient in the crop is normal and which may low or high. With the cost of fertilizer inputs this is a way to evaluate that the crop is getting a sufficient amount of plant food. Hidden hunger can cause yield loss before visual symptoms are detected. We have included an article with some helpful reminders on taking plant samples. See our website for complete details on how to take a proper sample.

Have a safe and enjoyable summer.

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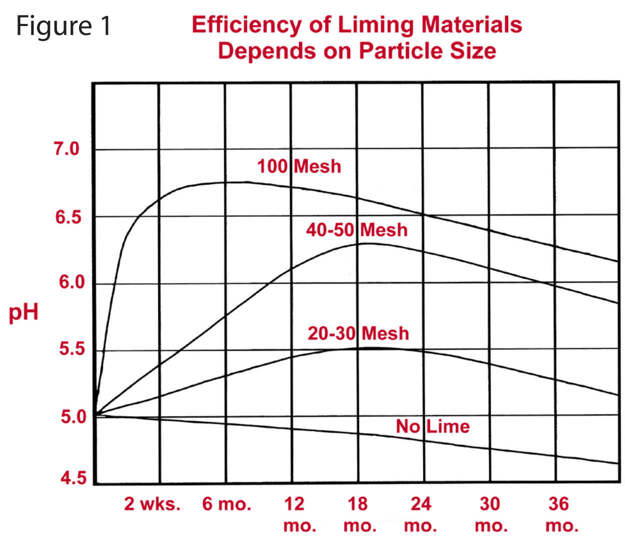
What's Inside...

Lime Movement in the Soil

By Bill Urbanowicz

Since the beginning of researching lime applications to soil, agronomists have known lime does not move readily through the soil profile. Liming materials are made up of products such as calcium and magnesium oxides, calcium and magnesium hydroxides, calcium and magnesium carbonates and calcium and magnesium silicates. Other lime sources include marl, fly ash from coal burning power generating plants, sludge from water treatment plants, lime or flue dust from cement manufacturing, pulp mill lime, carbide lime, acetylene lime, packinghouse lime, and so on. It is not the purpose of this article to discuss the differences or effectiveness of the different liming materials.

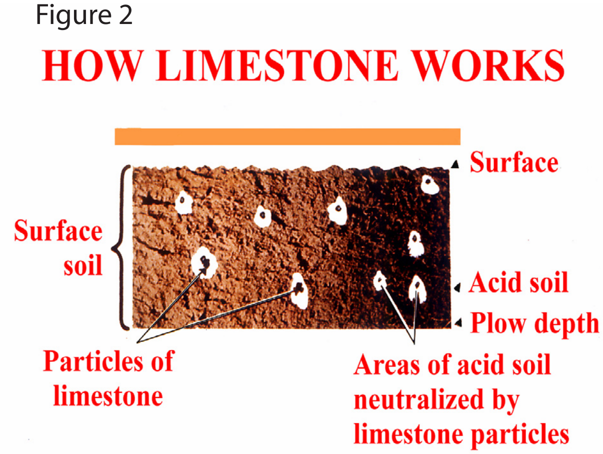
Figure 1



Lime products are not highly water soluble and do not readily move through the soil profile compared to many of the fertilizer products that people are familiar with in daily material use. One of the things that can help make lime more reactive in the soil is the fineness of grind. The finer the grind of material the more lime particles that will come into contact with the acidic soil in order to neutralize the soil acidity. Figure 1 illustrates the amount of time based on the fineness of grind that it takes liming materials to change the soil pH. When a 100-mesh lime product was applied it reacted very quickly in the first 2 weeks. As the material was ground coarser (20-30 mesh) the reaction time took longer, increasing to approximately 18 months.

Figure 2 is work that shows how much soil around the liming particle is neutralized. In this experiment lime was mixed with a soil and put between two pieces of glass in order to study the area around the liming particle that neutralized the acidity. It is only the area immediately surrounding the lime granule that is neutralized. This area is not much larger than 2 times the size of the lime particle. Once the lime particle neutralized the acidity around it, the particle must be physically moved to come into contact with more acidic soil to neutralize again. The process continues until the particle no longer has any neutralizing capability. This illustration helps to understand why having more finely ground lime particles they will come into contact with more acid soil than a larger more coarsely ground product.

Figure 2



Several years ago, Penn State University published a research project on how much time is needed for lime to neutralize soil deeper in the soil in a no-till field. In this study, a constant rate and application times were investigated. Figure 3 shows the annual segmented soil pH changes when lime was surface applied at 6,000 lbs/acre surface every third year. The initial pH of the "plow layer" was 5.1 and the top 2" was 4.5.

As the chart shows, the initial lime application in 1985 affected the soil pH as deep as 6". However, the main benefit was found in only the top 2". We don't know whether this soil was sand, loam or clay, and we don't know what the CEC was, so we can't draw conclusions related to these factors. The results do show, however, that the lower

2/3 of the plow-layer took up to 10 years to come to the same pH as the top 2" under this program.

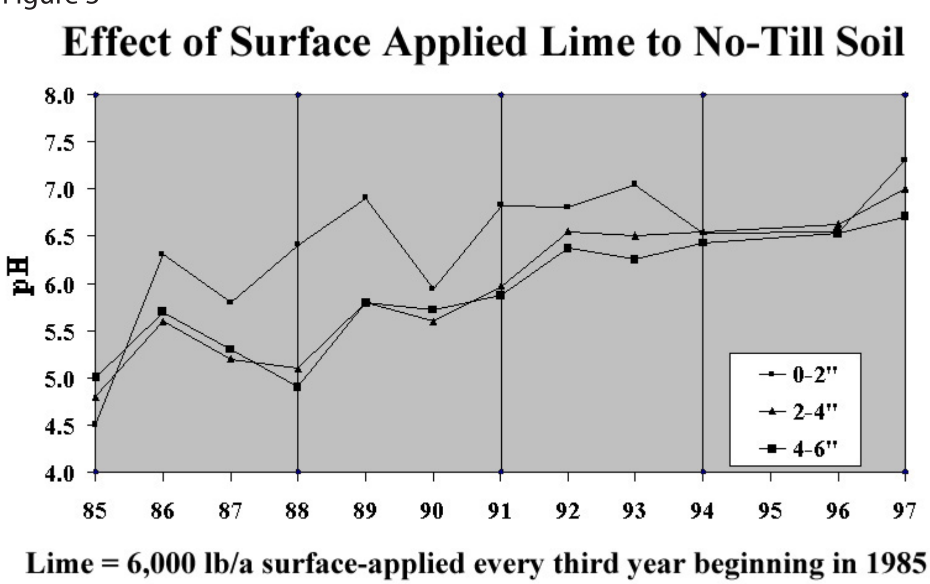
When no till became more popular and widespread, agronomists recommended two separate soil samples be taken. The top 2" to monitor the soil pH changes due to the acid forming nitrogen fertilizers that were broadcast across the soil surface. The idea being to correct the soil pH before it moved deeper in the soil profile and affecting root growth and nutrient availability deeper in the soil profile. They also recommended to continue taking the 0-6 2/3" depth for the other crop nutrients. This practice never caught on or became widely accepted, and only the regular depth sample was taken. Then growers began to notice dramatic drops in their soil pH levels, at the same time noticing that when lime was applied they were not seeing increases in soil pH levels like they did when they moldboard plowed. The previous illustrations should have helped to explain why the soil pH levels deeper were not being changed.

The moldboard plow was and still is the best implement available to mix lime with soil. The entire furrow slice is turned and the soil is inverted or at least turned 125°. With no till farming the moldboard plow has become a tool of the past. There is very little scientific research that has been done looking at modern implements to study soil inversion or incorporation. Back in the 1960's to 1980's there was work done looking at implements for herbicide incorporation. This is the only work that is available. For chemical incorporation it was found the disc would mix the top 3-4" of soil. The power rototill was one of the best that would mix the top 5-6" of soil. This implement took a high amount of horsepower to make it work correctly and was extremely slow. The C-shank field cultivator would mix the top ½ of whatever the operating depth is and the S-shank field cultivator would go a little deeper at 2/3 to ¾ of whatever the operating depth is of the implement. Rolling baskets, spike harrows will mix the top ½ to 2" of soil and a rotary hoe will mix the top ½" (depending on soil conditions). Chisel plows and deep rippers do not mix the soil, their design is to fracture the soil below the soil surface and actually try to do only a minimal disturbance of the surface residue. The chisel plow with a twisted shank will do a small amount of mixing, but this is small and only where the shank is run.

Modern vertical tillage equipment also lacks the capability of doing any kind of soil mixing. The purpose of this equipment is to help cut surface residue into smaller pieces at a high speed and at the same time do some amount of soil penetration. The penetration that is done is much like that done with a shank, except it is a smaller amount of soil disturbance. Field work shows an increase in soil bulk density in the area of disturbance, but this area is not mixing soil which is needed to redistribute lime in the soil profile. Any small amount of redistribution that is done would also only be done in the top few inches of the soil and a narrow band that is not deeper in the profile where the soil will likely be more acidic and need the limestone.

What options does this leave; the best option is the same one that was recommended 40 years ago when no till first started. Get your soil ready. Make sure the soil is adequately drained. Remove any soil compaction. Make sure the soil P, K levels and soil pH are at the recommended levels for crops to be grown in the rotation. Most importantly, monitor the soil pH in the top 2 inches of the soil and maintain the soil pH with the recommended rates of lime for that top 2 inches. Do not let the soil become too acidic in the subsoil.

Figure 3



Plant Analysis

By Bill Urbanowicz

With high commodity prices and high input costs, soil and plant analysis are still the best ways to monitor the growing crop and make good sound decisions on what fertilizers to recommend. Many people take soil samples on a regular basis, in order to recommend what fertilizer products for growers to apply. How many of you have been approached by growers asking, "Do I need to apply that much fertilizer," or "Am I applying the correct fertilizer for the crop that I am growing." Or how about when the grower is cutting the rate on the amount of fertilizer that has been recommended, or even some growers going the extreme and not applying any fertilizer at all. Then during the growing season when you are out scouting the field the crop may not look as good as it should, or the grower brings you in a plant and asks what is wrong with the plant. Plant analysis is a tool that has been in your toolbox of diagnostics for many years. It is often under utilized and is one of the best ways to monitor the fertility program that is being prescribed.

The biggest thing to keep in mind when doing a plant analysis is: 1) be sure to send enough plant material. This is probably the single biggest problem that occurs at the lab. We are not the CSI laboratory that takes 1 drop of blood and can give you a hundred different analyzes. We need a least a softball (double fist full, or a pint) of plant material. This will ensure that the lab has sufficient material after the tissue is dried and that you will also have a representative sample of the crop being sampled. 2) Getting the correct part of the plant at the proper stage of growth. We do not need a full stalk of corn when the crop is at green silk stage, only the ear leaf is required. Be sure to get the most recently mature leaf as specified, older leaves will have changed nutrient composition and younger leaves still have unstable chemistry for good analytical results. 3) Fill out the paper work as fully as possible so the agronomist can help make a useful interpretation that will be meaningful to those that are looking at the results. Many labs only supply the analytical values that were found in the plant analysis. To my knowledge Spectrum Analytic is the only that lab that has an agronomist that is trained in interpreting plant analysis looking at each sample. There are many interactions that can occur between plant nutrients and many outside factors such as soil moisture, temperature, compaction, soil type, fertilizer applications that can affect plant development and nutrient interactions. The DRIS (Diagnosis and Recommendation Integrated System) was set up to help in the interpretation of some nutrient interactions, however it cannot think like a human brain and make a user friendly evaluation like a trained agronomist. See our website for a complete guide on how to take a good plant sample.

Keep in mind that a plant analysis is reporting a nutrient concentration based on the amount of dry matter at the time the sample is collected. If you send in leaves that are from the lower or older portion of the plant then there will be a different concentration of nutrients than what has been researched and the standards developed for the most recently mature leaf. Also if you send a leaf that is only recently come out, the chemistry is not stable in that part of the plant, therefore you will get a result that will also not be useful for interpretation.

Plant analyzes can be used for several purposes. The most common use is in making comparisons of normal and abnormal areas in a field. In most cases this type of test is used to see if the problem may be nutrient related. In general when used for this purpose the crop has already been hurt and the application of any material is more of a rescue case. However these results can be used for future crop planning because if the nutrient is low in one crop it will likely be low in the next crop unless corrected. With plant analysis the levels that are found cannot be directly related to making a recommendation as far as how much of a given nutrient needs applied to get that nutrient into the normal range. However that brings us to the next use of plant analysis. Orchard, vineyards, and Christmas tree growers use plant analysis to confirm that the nutrients they are applying are getting into the crop so as not to have any low levels. With the perennial plants we mark indicator plants that will act as our check for the response of nutrients being applied. This can also be done with annual crops, say for instance the grower takes a plant analysis for wheat when it comes out of dormancy and the report is

How Does One pH Compare To Another?

Dr. T. Scott Murrell, Northcentral Director, IPNI

Soil pH. It is one of the most important chemical properties that affect nutrient interactions in soils and plants. It is, however, one of the most misunderstood measurements, particularly when comparing one pH value to another.

A question that is often asked is, "How many times more acid is one pH than another?" This question is not so straightforward to answer, because pH is not on a linear scale, like a ruler. Instead, it is on a negative log scale. Soils that are higher in acidity actually have smaller pH values, thanks to the negative log scale. The pH scale goes from 0 to 14. The 0 end of the scale is more acid. The 14 end is basic, and a pH of 7 is neutral, dividing acidic from basic. So we know that a pH of 5.8 is more acid than a pH of 6.6. But how many more times acid is it?

To get at the answer to this question, we must first recognize that pH is a transformed measure of the concentration of acid. To find out "how many more times acid" one pH value is than another, we have to do some mathematical manipulations to get us out of the negative log scale and back to a linear scale where such comparisons make sense.

The table below was developed from these mathematical manipulations and is provided to allow you to quickly determine how many times more acid a lower pH value is than a higher one. To use the table, take the higher pH value and subtract the lower one. Look up the difference in the table, under the heading "pH difference." Then look at the corresponding number in the column to the right labeled "Times more acid." Using our example, we want to compare pH 5.8 and 6.6. We take the higher value and subtract the lower one: 6.6 – 5.8 = 0.8. When we look up 0.8 in the table, we get 6.3. So the lower pH of 5.8 is 6.3 times more acid than the higher pH of 6.6. Using this table, you can easily determine how two pH values compare to one another, up to a difference of 3 pH units. For a more complete set of units, visit *http://nanc.ipni.net/articles/NANC0022-EN*.

pH difference	Times more acid	pH difference	Times more acid	pH difference	Times more acid
0.1	1.3	1.1	13	2.1	126
0.2	1.6	1.2	16	2.2	158
0.3	2.0	1.3	20	2.3	200
0.4	2.5	1.4	25	2.4	251
0.5	3.2	1.5	32	2.5	316
0.6	4.0	1.6	40	2.6	398
0.7	5.0	1.7	50	2.7	501
0.8	6.3	1.8	63	2.8	631
0.9	7.9	1.9	79	2.9	794
1.0	10.0	2.0	100	3.0	1000

Plant Analysis (cont)

reporting low levels of boron and copper. The grower can make an application of boron and copper and take another plant analysis later in the season and confirm that the amounts of the nutrients applied were sufficient for the plant. A third use for plant analysis is to confirm that the fertility program being applied is supplying the crop with the correct balance of the needed nutrients. Many times these samples are taken just prior to grain fill initiation. If you are doing grid soil testing, this can be another way to confirm to the grower that program is working to supply the crop with its fertility needs.

If you have any questions on plant analysis, see our website for complete information or give us a call at the lab.

Soil Compaction Hurts Nutrient Use Efficiency

By Scott Anderson

The spring of 2011 forced many growers to plant and do other field work in excessively wet soil. This situation can have a negative and possibly multi-year impact on nutrient use efficiency in those fields.

A newsletter article is not nearly enough space to go into all of the details about the cause and effects of soil compaction, but we thought that a few points related to crop nutrition could be mentioned. While soil compaction comes in several different forms, with today's reduced tillage, wheel track compaction is probably the most widespread concern.

Various sources have reported yield losses due to soil compaction of from 10% to 50% in many crops. The amount of yield loss caused by soil compaction is hard to predict, but the losses would be worse in conditions where compaction is combined with other problems like poor soil fertility, late planting, weed and insect problems, or generally poor growing environment. Besides reducing yields, soil compaction also reduces soil health and environmental quality.

A given volume of soil should be made up of or contain about 50% soil material and 50% pore space. About half of the pore space should contain water. This "ideal" condition would result in a soil composed of 50% solid soil material (sand, silt, clay and organic matter), 25% water, and 25% air. When soil is compacted, it reduces the percentage of pore space in the soil volume. This not only reduces the amount of soil space available to hold the needed air and water, it also means that any water added to the soil can more quickly saturate the smaller amount of empty pore space.

Penn State University lists the following as some of the effects of soil compaction.

- Compacted soil is dense and has low porosity. Compaction preferentially compresses large pores, which are very important for water and air movement in the soil. Infiltration is then reduced and erosion is increased.
- Compaction causes an increase in the soil's penetration resistance. There is little root penetration in soil above 300 psi (pounds per square inch), except if there are cracks and macropores in the soil that can be followed by plant roots.
- More energy is expended when tilling compacted soil.
- Compacted soil is a harsher environment for soil organisms, especially earthworms, to live in.
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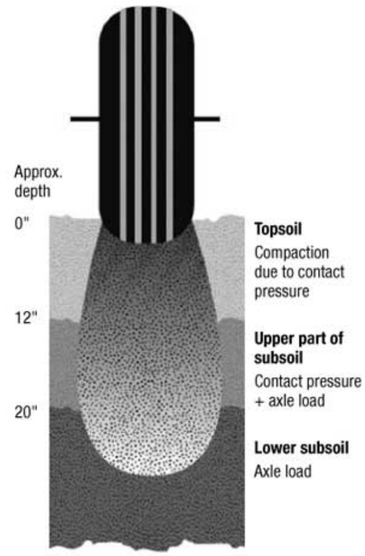
Figure 1.1-5. Topsoil compaction is caused by contact pressure, whereas lower subsoil compaction is caused by axle load.



Compaction affects nutrient uptake. Denitrification rates can increase in compacted soil due to limited aeration. Manure ammonia volatilization losses have been found to increase when liquid manure is surface applied to compacted soils because of reduced infiltration. Phosphorus and potassium uptake

SOIL COMPACTION REDUCES P UPTAKE BY CORN

Soil texture	Bulk density g/cm³	P in shoots %	P uptake mg/pot
Loamy sand	1.30	0.59	63.7
	1.60	0.44	47.5
	1.90	0.33	12.2
Silt loam	1.10	0.41	–
	1.35	0.35	–
	1.60	0.28	–
Silty clay	1.10	0.55	78.1
	1.35	0.41	48.4
	1.50	0.34	29.6

Higher soil bulk density indicates a higherdegree of compaction.

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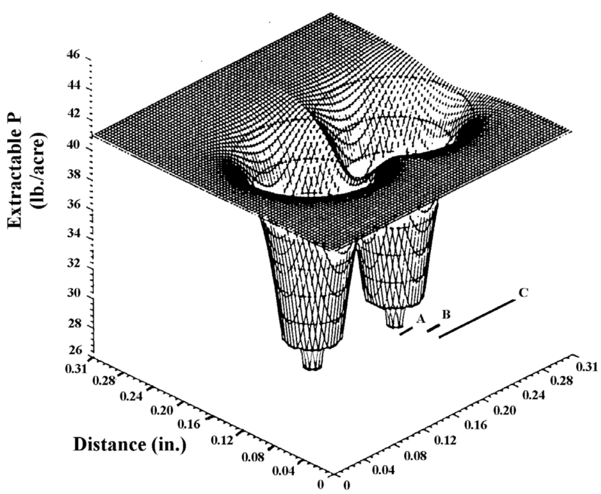
can be reduced if root growth is inhibited.

Soil compaction typically has

PROFILE OF EXTRACTABLE P AROUND TWO CORN ROOTS



A = Root Cylinder (approx. 0.02" or 1/42")
B = Root Hair Cylinder (approx. 0.02" or 1/42")
C = Maximum Depletion Zone (approx. 0.10" or 1/10")

a more detrimental effect on the uptake of the less mobile nutrients. Unfortunately, this group includes most of the cation nutrients (those with a positive charge). However, as mentioned above, even nitrate nitrogen (the anion NO_3^-) is affected by increased chances for loss through denitrification.

Phosphorous moves very little in most soils. Because of this, plants will quickly deplete the soil of soluble P immediately around each root. To avoid P deficiency, the soil solution must either be frequently recharged from the soil reserves, or the plant root must grow into a new area of the soil.

When neither of these possibilities is adequate, the plant suffers from P shortage. This is one of the reasons that we see leaf samples with P deficiency on soils with an adequate P soil test.

A corn study illustrates the very limited amount of soil that the root has access to (left). In this study, the researchers found that roots could extract P from a cylinder of soil no more than 1/10th of an inch around each root-hair. This thin volume of soil can be rapidly depleted of soluble P and if the root cannot physically push into new soil due to compaction, it quickly runs out of available P, regardless of the soil P test.

Soil air is important to plant growth. Roots need oxygen to function properly. A few plants adapted to flooded soil conditions, such as rice, are able to transport oxygen from the above ground plant parts to the roots, but most cannot transport enough oxygen to the roots to support proper root function and growth. When soil is compacted, the pore space is reduced. When this happens, it takes less additional water to completely saturate the reduced soil pore space. This reduces the free oxygen (gaseous O_2) in the soil.

A typical soil should contain 20% or more free oxygen (O_2) in the soil atmosphere. Soil with poor aeration, due to compaction may have as low as 0.2% O_2. This can reduce P uptake by as much as 50%. The same condition also limits the amount of O_2 available to soil bacteria and other organisms. Some of these soil bacteria are able to get their needed O_2 by other means. One of these other means is taking the oxygen from soil nitrate-N (NO_3-N). This is called denitrification and when it happens the NO_3-N is converted to gaseous N (N_2), which is unavailable to plants and is lost from the soil. This leads to N deficiency, even when adequate fertilizer N was applied.

These are only a few of the problems caused by soil compaction. And since wheel track compaction occurs below normal tillage depths, it normally lasts for multiple seasons. It is not always possible to completely prevent soil compaction, but growers should take all possible steps to minimize this problem.

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