Understanding Lime

Improving crop production through better soil management

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Importance of soil pH and controlling soil acidity

Managing soil acidity is part of farming in Iowa. Soils farmed in Iowa range from too acidic to too alkaline for optimal crop growth. In general, agricultural soils become more acidic with normal farming practices and will benefit from the application of lime, which increases soil pH.

Despite the investment many growers make in liming, not everyone fully understands all of the aspects involved with managing soil pH for optimal profit. This publication was created to help explain the different aspects of proper soil pH management. It deals with multiple components, including an explanation of soil pH, how to determine whether your soils need lime, the different sources of lime and related materials now available, and other general questions.

Maintaining soil pH using lime is considered one of the basic fundamentals of soil nutrient management. Most corn and soybean fields in Iowa receive lime on a regular basis. Despite this, many growers still have questions about the basics of monitoring their soils and maintaining a pH level that helps them optimize management of other soil nutrients.

Iowa is fortunate to have ample supplies of lime readily available at a relatively low cost. With today’s higher market prices for both corn and beans, any management of soil pH that can optimize nutrient availability and uptake by crops has increased value.

Soil pH is a measure of the acidity of the soil solution. The amount of acidity in soils impacts many different components of crop management. Significant problems can arise if soil pH is too low or too high. Soil testing provides a very reliable means of determining the amount of acidity present. But we need more information than a test provides to fix pH problems.

If pH is out of balance, it can affect the microorganisms present in the soil, which in turn can impact crop performance and profitability. Soil pH also affects the availability of various macro and micronutrients. Since nutrients differ in their availability at different pH levels, a change in pH may increase the availability of one nutrient, but decrease the availability of another. Soil pH can also affect other factors, such as the effectiveness of some soil-applied herbicides.

While there are good methods for determining whether your soils need lime, determining what to do to bring about the desired change is less obvious.
Soil pH

Simply stated, soil pH is a measure of the hydrogen ion concentration in the soil solution (the combination of all the various components that make up the soil), with 7 on the pH scale being neither acidic nor alkaline. The higher the hydrogen ion concentration, the lower the soil pH and the greater the soil acidity.

Acidity is usually reported as pH, which is the negative log of the hydrogen ion concentration and has a scale of 0-14. Typically, soil pH in Iowa ranges from 4.5 to 8.3. For optimal corn and soybean yields, Iowa State University-Extension recommends a pH of 6 to 6.5.

It is important to recognize that pH is a logarithmic scale, meaning each one-unit increment in pH equals a ten-fold change in acidity. This means that soil with a pH of 6.0 has ten times the hydrogen ion concentration as a soil with a pH of 7.0. If the pH is 5.0, the hydrogen ion concentration is 100 times greater than in a soil with a pH of 7.0, and the concentration at pH 4.0 is 1000 times more than at pH 7.0.

Increasing amounts of hydrogen ions in the soil (increasing acidity) should be of great concern for any farmer. As hydrogen increases in the soil (and, correspondingly, as the pH level declines), availability of required nutrients can be dramatically altered. It's not likely that such a change would occur rapidly, but over time it can have a big impact on growing crops.

Hydrogen atom

Electron

Proton

Hydrogen ions are formed when the electron in the hydrogen atom splits off, leaving just the proton. This occurs naturally. Hydrogen ions are found in all acid solutions.

Hydrogen ion

Electron

(H^+) = acidity

Acidity is usually reported using the pH scale of 0-14. pH is defined as the negative log of the hydrogen (H) ion concentration. A pH of 7 is neutral, 0 the most acid, and 14 the most alkaline.

- pH 6 = 10X the acidity of pH 7
- pH 5 = 100X the acidity of pH 7
- pH 4 = 1000X the acidity of pH 7
- pH 3 = 10,000X the acidity of pH 7
Why is soil pH important?

Managing soil acidity in corn and soybean production can improve productivity for a number of reasons.

While lime can supply calcium and/or magnesium (depending on the source of lime), we should understand that the main reason to apply limestone is the effect it has on the free hydrogen ions in the soil. The goal is to neutralize the excess hydrogen ions in the soil thereby preventing a buildup of hydrogen which can impact other components of the soil system. When we mix liming materials into the biological system we call soil, it leads to certain biological and chemical actions that raise the pH of the mixture. In addition to the effect it has on soil biology, the pH level may also affect the availability of other nutrients and the longevity of other crop inputs, such as certain herbicides.

Soil biology

Modern row crop production depends on many biological processes that occur in the soil. Some soil microorganisms work best at one pH level, while others prefer a different level. Because the mix of microorganisms is different from field to field, and even from one area to another within fields, there is no single pH level that is optimal for all fields or all microorganisms.

Nutrient availability

Nutrient availability can be an issue at extreme pH levels – either too high or too low. In both cases, yields can be affected. Nutrient imbalances that develop in acidic soils can have a toxic effect that limits productivity or destroys the plant. In some instances, it can result in grain or forage so nutritionally imbalanced that it is not suitable for livestock feed.

The figure (below left) shows the relative availability of different nutrients as affected by soil pH. From this we can see that there’s no one specific number that we can shoot for with soil pH that will make all nutrients optimally available.

Looking closely, however, you can see there is a general range in which most nutrients are sufficiently available for most crops. While there are clear economic differences in availability of some nutrients, the most pronounced effects occur when there is either a severe nutrient tie-up or when there’s excessive release of some nutrients that leads to a toxic level in the plants.

An example of an excessive release of a nutrient caused by soil pH, although not frequent in Iowa, is the increasing rate of aluminum release as soil pH drops below 5.0. While trace aluminum is found in most soils, it takes a more acidic soil for aluminum to become readily available. This occurs more frequently in warmer areas that receive higher amounts of rainfall.

At the other extreme, nutrient tie-up, involving phosphorus and iron, are prevalent in Iowa, especially on soils where high pH is caused by accumulation of calcareous minerals that are dissolved in surface water and redeposited in the top few inches of soil in lower, poorly drained areas of fields. Soybeans growing in these "calcareous" soil areas may turn yellow, a classic sign of iron deficiency. It generally takes a pH of 8.0 or higher to create this condition, but it occurs regularly in the Des Moines Lobe region in the central and north central part of the state. Symptoms of pH-induced iron deficiency usually disappear within a week or so, as soybean roots extend below the higher pH soil at the surface. Even so, this early deficiency can have a significant impact on yield.

Herbicide effectiveness

Some soil-applied herbicides can be affected by soil pH, since the microorganisms that break down these herbicides work better at a certain pH level. In Iowa this is more likely to affect products like atrazine, which are broken down more slowly in higher pH soils. This can lead to a carryover of the herbicide into the next season which might be fine if you’re planting corn after corn, but may not be so good in a corn-soybean rotation.
Why do soils become more acidic over time?

The changes in soil pH growers might observe over a lifetime are in fact largely due to management decisions and practices used. While most people are familiar with the benefits of applying lime to increase soil pH, most are not aware that many production practices we use in Iowa can lead to an increase in soil acidity (reduced pH).

The predominant factors leading to increased soil acidity (reduced soil pH) are the breakdown of ammonium-based nitrogen fertilizers and soil organic matter or manure, and the mix of nutrients removed from the soil by crops.

This means that the single most important practice in corn production - applying nitrogen fertilizer - leads to reduced soil pH.

Nitrogen fertilizers that contain ammonium or urea (dry urea, UAN liquid (28% and 32%), MAP, DAP, and anhydrous ammonia) undergo a soil transformation in which ammonium is converted to nitrate. This process, called nitrification, releases hydrogen ions into the soil solution, thereby increasing soil acidity. The chemical reaction is illustrated by this equation, with the resulting free hydrogen shown in red:

\[ \text{NH}_4^+ + 2\text{O}_2 \rightarrow 2\text{H}^+ + \text{NO}_3^- + \text{H}_2\text{O} \]

To illustrate how nitrogen sources affect soil pH, the following table shows the amount of lime required to neutralize free hydrogen ions released into the soil during nitrification.

<table>
<thead>
<tr>
<th>Nitrogen Source</th>
<th>Composition</th>
<th>Lime required (lb CaCO$_3$/lb N applied)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAP (NH$_4$)$_2$HPO$_4$</td>
<td>18-46-0</td>
<td>3.6</td>
</tr>
<tr>
<td>Map NH$_4$H$_2$PO$_4$</td>
<td>11-52-0</td>
<td>5.4</td>
</tr>
<tr>
<td>Ammonium sulfate (NH$_4$)$_2$SO$_4$</td>
<td>21-0-0-24</td>
<td>5.4</td>
</tr>
<tr>
<td>Urea CO(NH$_2$)$_2$</td>
<td>46-0-0</td>
<td>1.8</td>
</tr>
<tr>
<td>UAN NH$_4$NO$_3$·CO(NH$_2$)$_2$</td>
<td>28-0-0</td>
<td>1.8</td>
</tr>
<tr>
<td>Anhydrous Ammonia NH$_3$</td>
<td>82-0-0</td>
<td>1.8</td>
</tr>
</tbody>
</table>

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**Crop nutrient uptake**

Because the soil solution is a chemical system, there is a balance of charge in the soil. In the nutrients they use, crops take up basic cations (positively charged particles). Maintaining the charge balance in the soil requires replacement of these ions. Adding lime – calcium carbonate (CaCO$_3$) – can do that. The table below shows the amount of lime needed to rebalance the soil charge after production of various crops. Remember that yield and removal of plant material from the field are factors in this – since higher yields remove more nutrients from the soil, creating a greater imbalance. Note the much higher liming requirements for forage crops.
What do you use to correct soil pH?

As previously stated, we need to maintain soil pH at 6.0 to 6.5 in order to grow corn and soybeans in Iowa. While there are a number of ways to alter soil pH, the product most people rely on for this is lime, or aglime.

The strict chemical definition of lime is calcium oxide (CaO). But in a more general sense for agriculture, liming materials can also include calcium hydroxide (CaOH) and calcium carbonate (CaCO₃). All three of these will neutralize acidity. The most commonly used liming material is CaCO₃.

It's the carbonate portion rather than the calcium that reacts with hydrogen ions in the soil to reduce soil acidity. The following equation shows how this works:

\[ \text{CaCO}_3 + 2\text{H}^+ = \text{Ca}^{2+} + \text{CO}_2 + \text{H}_2\text{O} \]

Basic terms and materials

Agricultural liming material. Material that can contain calcium and/or magnesium in forms capable of reducing soil acidity.

Calcareaus. An adjective describing a material that is composed partly or mainly of calcium carbonate. In other words, it contains lime or is chalky.

Calcium carbonate (CaCO₃). A compound consisting of calcium combined with carbonate. It occurs in nature as limestone, marble, chalk, marl, shell, and other similar materials.

Calcite (CaCO₃). Crystalline form of calcium carbonate. Pure calcite is 100% calcium carbonate – and contains 40% calcium.

Calcitic limestone. The term is widely used to refer to agricultural limestone with high calcium content. It is mainly calcium carbonate, but may also contain small amounts of magnesium. This term is not restrictive, and it is often confused with calcite, which is a crystalline form.

Calcium carbonate equivalent (CCE). Expression of the acid neutralizing capacity of the carbonate relative to that of pure calcium carbonate. The value for pure calcite is 100% and for pure dolomite is 108.5%. CCE’s of most limestones vary in these percentages due to impurities in the rock and the fact that the commercially available limestone is usually composed of mixtures of calcite dolomite rather than either compound in its pure form.

Calcium oxide (CaO). A lime form derived from calcium carbonate, also known as quicklime or burned lime. This product does not occur naturally. It is produced by burning calcium carbonate (CaCO₃), which removes CO₂, leaving only CaO.

Calcium hydroxide (Ca(OH)₂). An alkaline form of lime often used to treat sewage and septic systems. This product is capable of quickly raising pH to 11. (Also called hydrated, slaked or slack lime).

Dolomite. A rock or mineral in which the calcium-to-magnesium ratio is greater than 50% magnesium.

Dolomitic limestone. Limestone that contains less magnesium than dolomite, but more than calcitic limestone.

Effective calcium carbonate equivalent (ECCE). Expression of the aglime effectiveness based on the combined effect of purity (CCE) and fineness, with a negative adjustment for moisture content.

Gypsum. Hydrated form of calcium sulfate (CaSO₄). Supplies calcium and sulfur to the soil but is neutral rather than alkaline, so it does not correct soil acidity. It is not considered a liming material.

<table>
<thead>
<tr>
<th>Material</th>
<th>Formula</th>
<th>% CCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure calcitic limestone</td>
<td>CaCO₃</td>
<td>100</td>
</tr>
<tr>
<td>Dolomitic limestone</td>
<td>(Ca, Mg)CO₃</td>
<td>109</td>
</tr>
<tr>
<td>Calcium oxide; lime; burned, lump or unslaked lime; quick lime</td>
<td>CaO</td>
<td>179</td>
</tr>
<tr>
<td>Calcium hydroxide; hydrated, slaked or builders lime.</td>
<td>Ca(OH)₂</td>
<td>136</td>
</tr>
</tbody>
</table>
How soon will limestone fix a pH problem?

From a practical perspective, application of carbonates is the preferred tool for raising a low soil pH in farm fields. The two main factors determining how quickly lime will neutralize an acid soil are the amount of carbonate in the material and how quickly it will react to neutralize acid in the soil.

The amount of carbonate (chemical make-up) in a liming product is easy to calculate based on its chemical composition. This is usually reported as a percentage equivalent to pure calcium carbonate. On soil test reports, you'll see this as the calcium carbonate equivalency, or simply CCE.

The second component is how quickly the carbonates will go into the soil solution to affect its acidity. This is largely a function of the surface area of the particles. This is currently reported as the “effective calcium carbonate equivalent” or ECCE.

We know limestone is a good building material that can last for decades - even centuries. The difference between the stones in the 100+ year-old Iowa church on the right and what you actually apply to your farm fields is largely one of particle size and surface-to-volume ratio. The large "particle size" and low surface-to-volume ratio of the limestone blocks in the church allow almost no impact on the soil around it. Grinding that same stone into a fine powder greatly increases the surface-to-volume ratio, allowing it to react more quickly with soil acids.

Iowa Legislative Code (see box at bottom of page) requires ECCE to be calculated as a function of the particle size, measured by passing through three sizes. Figure 1 (right) shows expected reaction times from various particle sizes.

However, as pointed out, particle size is only one factor in surface area. Because of their smoother surface, calcite crystals have less surface area than a product like marl when both are ground to the same screen size. Note the differences in surface area in these highly magnified photos of two different limestone products, both ground to the same particle size.

The particles of the material on the right have a much rougher edge than those of the product on the left, giving them more overall surface area. Because of this, it will react with acids in the soil faster and change pH more quickly.

**Iowa Lime Code**

21-43.31(201A) Determination of ECCE. Agricultural liming material or specialty limestone offered for sale, sold or otherwise distributed in this state shall be analyzed on the basis of the number of pounds of effective calcium carbonate equivalent per ton, using the method set forth in this rule.

43.31(1) A fineness factor shall be determined as follows:
   a. Multiply the percent of the total material passing the number 4 sieve by one-tenth.
   b. Multiply the percent of the total material passing the number 8 sieve by three-tenths.
   c. Multiply the percent of the total material passing the number 60 sieve by six-tenths. Add the results obtained from paragraph “a,” “b” and “c” of this subrule to obtain the fineness factor.

43.31(2) Multiply the fineness factor obtained by using the method in subrule 43.31(1) by the percent of calcium carbonate equivalent in the material to obtain the percent of ECCE.

43.31(3) The percent of ECCE obtained in subrule 43.31(2) shall be reduced by the percent of moisture contained in the sample.

43.31(4) Multiply 2,000 pounds by the percent ECCE obtained in subrule 43.31(3) to determine the number of pounds of ECCE per ton of agricultural liming material or specialty limestone.
Determining the amount of lime needed

The decision to add or not add lime to a field requires two different measurements, both made by a qualified soil testing laboratory.

The first step is measuring soil acidity (pH). The pH level represents the active acidity in the soil, which directly affects the plant roots, bacteria, and other important factions of the soil solution. If a soil test indicates there is too much acidity in the soil (pH is too low), you'll need to apply lime.

Before you can decide how much lime is needed, you first need to know how soils will react to the addition of lime. For this, you'll need an assessment of the soil's buffer pH, which is a measure of the reserve acidity that can be released from the soil. This tells you how difficult it will be to change the pH of the soil.

The buffer pH is helpful only after you've determined that lime is needed. It's used to determine how much lime must be applied in order to hit the desired target pH.

Several factors affect the buffer pH of a soil, but in general, the higher the amounts of clay and organic matter in the soil, the more free hydrogen ions the soil can hold. The more holding capacity for hydrogen ions, the greater the reserve acidity of the soil. And the higher the reserve acidity, the lower the buffer pH level of the soil. As the buffer pH value becomes lower, the quantity of lime required to adjust the soil pH increases.

Measuring Buffer pH

Buffer pH is measured using a weak base solution that has a pH of 7.5. A known amount of the buffer solution is added to the soil and the pH is measured after a period of time. The more the solution decreases from the original 7.5 pH, the more stored acidity there is in the soil sample,

The analogy of water in a well may help distinguish the difference between pH and buffer pH. The depth to the water is somewhat analogous to the soil pH level, and the drawdown capacity of the well is analogous to the buffer pH.

The table on the left shows Iowa State University’s most recent recommendations on how much coarse aglime to apply, based on buffer pH, tillage depth, and target pH.

<table>
<thead>
<tr>
<th>Buffer pH</th>
<th>2 inch</th>
<th>3 inch</th>
<th>6 inch</th>
<th>8 inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH 6.5</td>
<td>pH 6.9</td>
<td>pH 6.5</td>
<td>pH 6.9</td>
<td>pH 6.5</td>
</tr>
<tr>
<td>7.0</td>
<td>0</td>
<td>400</td>
<td>0</td>
<td>600</td>
</tr>
<tr>
<td>6.9</td>
<td>0</td>
<td>600</td>
<td>0</td>
<td>1,000</td>
</tr>
<tr>
<td>6.8</td>
<td>200</td>
<td>900</td>
<td>300</td>
<td>1,400</td>
</tr>
<tr>
<td>6.7</td>
<td>400</td>
<td>1,200</td>
<td>700</td>
<td>1,800</td>
</tr>
<tr>
<td>6.6</td>
<td>700</td>
<td>1,500</td>
<td>1,100</td>
<td>2,200</td>
</tr>
<tr>
<td>6.5</td>
<td>900</td>
<td>1,700</td>
<td>1,400</td>
<td>2,600</td>
</tr>
<tr>
<td>6.4</td>
<td>1,200</td>
<td>2,000</td>
<td>1,800</td>
<td>3,000</td>
</tr>
<tr>
<td>6.3</td>
<td>1,400</td>
<td>2,300</td>
<td>2,100</td>
<td>3,400</td>
</tr>
<tr>
<td>6.2</td>
<td>1,700</td>
<td>2,600</td>
<td>2,500</td>
<td>3,900</td>
</tr>
<tr>
<td>6.1</td>
<td>1,900</td>
<td>2,800</td>
<td>2,900</td>
<td>4,300</td>
</tr>
<tr>
<td>6.0</td>
<td>2,200</td>
<td>3,100</td>
<td>3,200</td>
<td>4,700</td>
</tr>
<tr>
<td>5.9</td>
<td>2,400</td>
<td>3,400</td>
<td>3,600</td>
<td>5,100</td>
</tr>
<tr>
<td>5.8</td>
<td>2,600</td>
<td>3,700</td>
<td>4,000</td>
<td>5,500</td>
</tr>
<tr>
<td>5.7</td>
<td>2,900</td>
<td>3,900</td>
<td>4,300</td>
<td>5,900</td>
</tr>
</tbody>
</table>

*Soil pH 6.9 is recommended for alfalfa. Soil pH 6.5 is considered to be sufficient for corn and soybean. Because of high pH subsoils in the Clarion-Nicollet-Webster, Galva-Primmghar-Sac, Moody, Ida-Monona, Marshall, and Luton-Onawa-Salix soil associations, soil pH 6.0 is considered sufficient for corn and soybean grown in these soil associations, but when liming is required, lime to soil pH 6.5. Soil pH 6.0 is sufficient for grass pastures and grass hayland.
Know what you're applying

As you learned in the previous pages, not all liming materials are the same. You need to know the composition of the liming material before you can predict how much acidity it can neutralize and how quickly it will react with the soil. When you have both of these factors, you can make a decision on the economic value of various liming agents. A standardized method is used to report the Effective Calcium Carbonate Equivalent (ECCE) for each liming material sold for ag use in Iowa.

From the discussion on page 6, you can see the neutralizing power of the liming materials is expressed as a relative comparison to pure calcium carbonate. This is done by a laboratory and is a straightforward analysis. For the sake of this exercise, let’s assume the liming material has a CCE rating of 92%.

Then we look at the particle size, based on the Iowa Legislative rule using three particle sizes. While the particle size does influence how fast the reaction will occur, it is not the only factor. Although many European countries now use actual sample incubation assessments of the product rather than particle size to predict the reaction time for a liming product, we still rely on particle size in Iowa. An example analysis, which we call the Total Fineness Efficiency, would look like this:

<table>
<thead>
<tr>
<th>% of Particles Passing</th>
<th>Fineness Factor</th>
<th>Percent Available Based on Fineness</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-mesh</td>
<td>100</td>
<td>0.1</td>
</tr>
<tr>
<td>8-mesh</td>
<td>80</td>
<td>0.3</td>
</tr>
<tr>
<td>60-mesh</td>
<td>60</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Total Fineness Efficiency = 70

Using the CCE rating and the Total Fineness Efficiency rating, along with a moisture correction, we can finally calculate the ECCE of the liming material:

\[
\text{Effective Calcium Carbonate Equivalent (ECCE):} \quad \text{(Total Fineness Efficiency ÷ 100)} \times \left(\%\text{CCE ÷ 100}\right) \times \left([100 - \%\text{Moisture}] ÷ 100\right) \times 2000 = \text{ECCE}
\]

Example:

\[
(70 ÷ 100) \times (92 ÷ 100) \times ([100 - 2] ÷ 100) \times 2000 = 1,260 \text{ ECCE}
\]
Living with high pH soils

Some soils in parts of Iowa and elsewhere in the upper Midwest are naturally high in pH (alkaline). Some soils have documented pH levels as high as 8.3. Excesses of calcium, magnesium, potassium or sodium can create alkaline (high pH) conditions.

The most notable of these locally are the calcareous "prairie potholes" found particularly in the Des Moines Lobe geographic area of central and north central Iowa. In extreme cases, these soils can be one third calcium carbonate (CaCO₃) by volume.

An extremely high soil pH can dramatically limit soybean yield. While amendments like elemental sulfur (S) or sulfuric acid can help to lower the pH (increase acidity), this is not an economically viable solution for most alkaline soils. To make a pH change, you must dissolve the CaCO₃ that is native to these soils. It would take 68 tons of concentrated sulfuric acid per acre to dissolve just 1% of CaCO₃ in the top 7 in. of the soil. If you're dealing with the extreme case mentioned earlier, that means that for the risk and cost involved in putting 68 tons per acre of dangerous acid on your field, you'd reduce the CaCO₃ content from 33% to 32%. At that level, it's highly unlikely that you'd see any significant improvement in crop yields.

The two aerial images below show a field with a high pH level at different times of the year, with the photo on the left being early in the season and the one on the right later in the year. Soil pH in Area 1, marked on both photos, was in the "normal" range. Area 2 is a calcareous region of the field.

A check of soybean height in each of these areas showed that plants in the normal soils in Area 1 averaged about 41 in. tall, while those in Area 2 were only 9 in. tall. The correlation to yield is obvious.

High soil pH can cut yields and encourage soybean cyst nematode activity. This analysis of performance of SCN susceptible varieties showed that relative yields were lower as pH increased.

What do we see in Iowa?

Nearly 1000 Iowa corn and soybean fields were involved in a statewide nutrient testing program last year. This was the beginning year of a project to quantify a baseline for nutrient levels.

Current Iowa State University soil pH recommendations suggest maintaining a pH of 6.5 for row crop production in the state, but only just over half of the soil samples collected were in that range. More than 20% of the samples tested at 6.0 or below for pH.

Our current sampling methods for soil pH look only at a shallow depth. And these “current” recommendations are 30 years old. Soybean checkoff-funded research conducted at ISU in the 1990’s documented a lack of yield response when current soil testing methods resulted in soil pH readings as low as 5.5 when the subsoil was calcareous.

The Iowa Soybean Association has used checkoff dollars to fund soil ISU pH research for five years and is currently awaiting a final analysis and data summary that will permit growers to make a more informed decision about the economics of liming. At this time, there is no recent data available that permits a more adequate economic analysis than we’ve used for the past several decades. This new information is needed in order to be able to make a better decision about the use of lime. One thing we do know from years of looking at soil variation through the On-Farm Network® is that spatial variability is not always conducive to collecting soil samples from 2.5-acre grids laid out on most fields.

**Current Iowa State University soil pH recommendations**

- **Corn and Soybeans:** pH 6.5 Sufficient for most soils  
  (pH 6.0 Sufficient for fields with high pH subsoil)
- **Alfalfa:** pH 6.9 Sufficient
- **Grass Pastures:** pH 6.0 Sufficient
Points to remember on managing pH

1. Iowa soils used for feed and grain production become more acidic over time, so they should be monitored for pH levels.

2. Nitrogen fertilizers (especially ammonium forms) are a big source of free hydrogen ions, which add to soil acidity.

3. Some soils naturally have a high pH and do not need lime. This is also true for lower depths of the soil.

4. pH is a measure of the soil’s acidity or alkalinity. It can affect many other factors in the soil, such as nutrient availability, biological activity and herbicide effectiveness.

5. There is no optimal pH for all crops. Current Iowa State University recommendations for target pH are higher for alfalfa than for corn and soybeans. Recommended pH level for grass pastures is lower than for row crops.

6. pH seldom changes rapidly from one crop year to the next, but over time, it can change significantly if not monitored and corrected routinely.

7. Testing soil for pH level is the recommended method for determining whether lime is needed.

8. Buffer pH, calculated during soil testing, is used to determine how much lime is needed to raise the pH to the recommended level.

9. There are significant differences in the quality of lime, so you should understand what you are buying.

10. Lime sold for ag purposes is defined by a rule under the Iowa legislative Code. This code sets the standard for comparing different lime sources with varying particle sizes and compositions.

11. Depth of tillage is important when determining the amount of lime to add.

12. In general, liming materials that are more finely ground are more reactive, but these can be more difficult to spread. Some lime products are pelletized to combine the fine particle size with a processing that allows better coverage of the field during spreading.

13. Current liming recommendations are not exact and have not been updated in Iowa for more than 20 years. They also do not factor in recent economic changes, including product and application costs, the value of the crop(s) produced and the economic tradeoff or advantage from maintaining soil pH at a level different from the current recommendation.

14. There can be a big difference in price between various liming materials being sold in the state.

15. Common sense should be exercised when reviewing test results and making management decisions.

For more information, see also
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