Lime: Not All It's Cracked Up To Be

Inconsistencies challenge the proper use of lime.

■ By Jim Ruen, contributing editor

If you think lime is boring, think again. Although lime has long been shown to affect soil productivity, a recent meeting involving key members of the U.S. Department of Agriculture, academia and lime industry identified serious questions, concerns and significant opportunities related to liming material evaluation.

Adding annual pH testing and more predictable lime applications based on how these materials react in soil may boost soil health and productivity, which could mean more sales of product and services for full-service ag retailers and agronomists. However, better liming may reduce the need for applied nutrients. Of course, from a grower, environmental and regulatory relief standpoint, that is good news. Taken as a whole, the discussion raises the question, "Do we fully understand how liming materials are reacting in the soil and exactly how they are impacting soil health and associated processes?"

"We've got target pH for maximum yields figured out," said Andrew Hoiberg, Ph.D., director of research and development, Calcium Products. "We brought USDA and Iowa State University researchers together with the lime industry to lay out inconsistencies that exist in how materials are evaluated and what that could mean for agriculture moving forward."

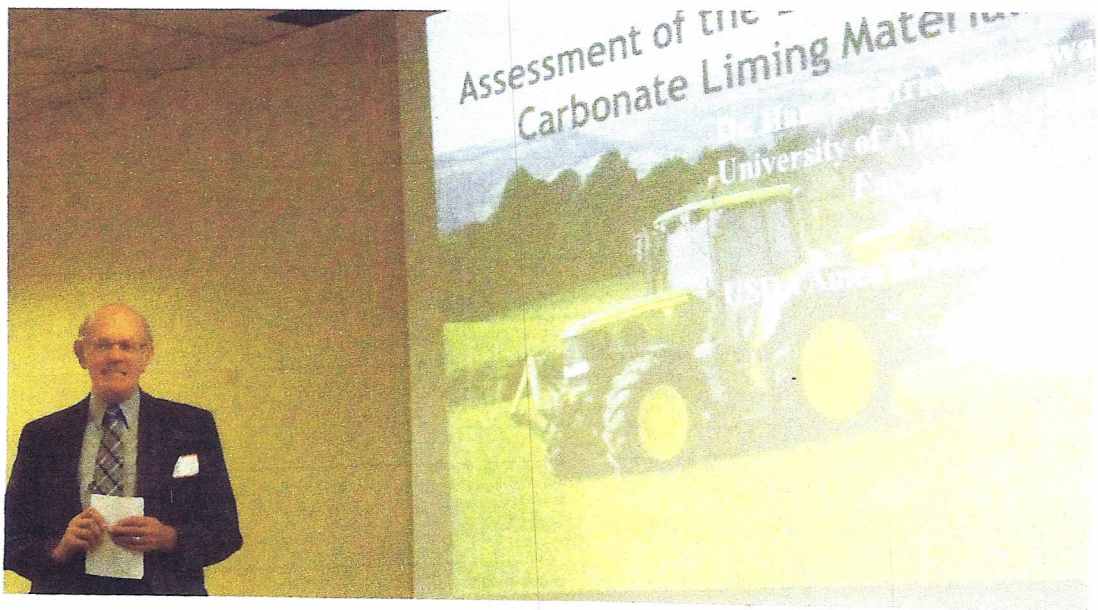
Those inconsistencies start with state lime laws that follow 39 different ways to grade lime and 19 ways to define it. At the same time, there are inconsistencies simply with putting together a liming recommendation. The process seems simple. Test the soil for pH. Test the lime for calcium carbonate ($CaCO_3$) equivalent. Apply enough lime to equal the recommended rate of 100 percent calcium carbonate equivalent (CCE) needed to raise the pH to the desired level.

Unfortunately, once you get past the soil test and prescribing a target pH, the process starts to fall apart. Rather, it doesn't always fall into solution, soil solution that is. It turns out that not only is reactivity (rate at which the lime dissolves in soil solution) for different types of lime poorly understood, reactivity based on particle size raises further questions.

"The CCE test is very accurate at describing the potential a liming material has to effect pH change, but it uses hydrochloric acid, a very strong acid that may not reflect the actual capacity of a material to react in weaker soil solutions," explained Hoiberg.

VARIANCES IN LIME'S REACTIVITY

Dan Olk, Ph.D., research soil scientist, USDA-ARS National Laboratory for Agriculture and the Environment, pointed out that past research has shown calcitic limestone to be relatively more reactive and raises pH more quickly compared to dolomitic limestone. However, the established HCl test for determining CCE gives additional neutralizing power to



Hans-Siegfried Grunwaldt, Ph.D., lectured on how limestone is measured in Europe.

dolomitic materials despite these findings. Dolomitic limestone works fine as a liming material provided it is processed properly, and it is desired for soils deficient in magnesium.

Europe has placed a much greater emphasis on lime evaluation. Conference presenter Hans-Siegfried Grunwaldt, Ph.D., University of Applied Sciences, Faculty Agriculture, Kiel/Germany, described differentiation based on reactivity. After extensive research in Europe, common lime sources are now broken up by source material, quality and reactivity, and must contain information that growers and retailers can use to determine how it will behave in soil.

If this isn't enough to consider, particulate size (measured in mesh) also impacts reactivity, yet variations in state requirements for mesh size to determine a fineness factor are dramatic. Hoiberg pointed out that Iowa uses 4- and 8-mesh particle sizes in their calculation, and nine others also use 8-mesh as part of their fineness factor (though most include finer material also); yet a substantial body of research suggests that particles larger than 10- (and some suggest 20-mesh) have no pH changing value. Many states don't include anything finer than 60-mesh in calculating the fineness factor. Research suggests that as the mesh size increases/particle size decreases, the speed and the level of pH change increases dramatically.

Gudrun Mahrt, Columbia River Carbonates, AGRO, described this range in reactivity, with particles passing a 100-mesh screen as having 100 percent reactivity in the soil within six months and particles between 20-mesh and 60-mesh reacting about 50 percent during the first year.

"What it may indicate is that in states that use coarser mesh fractions in determining the fineness factor, people have not been applying enough lime," said Hoiberg. "Some of these coarse particles are not reacting in the soil, while the fines do. The rate of and completeness of reactivity in soil are poorly understood."

Hoiberg suggested that as both are better understood application rates will likely be adjusted accordingly, as under German law. Grunwaldt reported that minimum particle sizes are defined by source and $CaCO_3$ content. A 5-mesh chalk with 97 percent $CaCO_3$ is allowed, while a hard limestone with only 70 percent $CaCO_3$ requires a minimum 48-mesh to be considered reactive enough to perform as expected based on reactivity testing. While higher quality, finer particles may prove to have a premium value in many scenarios, there may be some situations where a slower reactivity will prove beneficial. Grunwaldt described just that with high reactive limes prescribed for heavy soils, large amounts of low reacting dolomites for sandy loam soils and slower reacting limes for sandy, organic soils and pastures. What all presenters agreed on at the meeting was that much additional research is needed.

FIELD EVALUATIONS NEEDED

One of the things likely to change even before completing new research is how lime is applied. Hoiberg pointed to the potential with precision ag technology. Grid soil sampling has long shown the tremendous variability of pH and other soil characteristics within a field. He suggested that the tried and true method of broadcasting a flat rate of lime across a field once every three to five years might not provide optimal results.

Jerry Hatfield, Ph.D., Agricultural Research Service, discussed the importance improved measurements of limestone has for agriculture.

He advised retailers, crop consultants and growers to begin field evaluations with enhanced awareness of source and fineness, while doing strip trials, annual soil testing and variable rate applications. "The more people get involved and the more data we can collect from on-farm trials on different rates and liming materials over different soil conditions, the better," he said.

Even if crop yields seem unaffected, things like nutrient availability may be impacted in ways not yet understood. Hoiberg pointed out that while crops seem fairly adaptable to a range of pH, the range for yield may not fully encompass the right pH for full nutrient uptake and availability to plants.

"Without testing pH on a yearly basis, it is hard to determine exactly how fast and completely the liming material is changing pH, and how long the reaction is lasting" said Hoiberg. "There may be a lot of soils that are under limed. Given that everything from biological activity to nutrient availability is governed by pH, the implications are big for overall soil health, which governs how well crops perform, and even bigger for nutrient management strategies."

5 R'S FOR LIME

Mahrt suggested that the 4Rs of right source, right rate, right time and right placement be applied to lime as it has been to fertilizer. Hoiberg suggested that the right pH should be the fifth R when it comes to responsible fertilizer use. Lime needs and deserves more attention in the research lab, in the field and in the regulatory area.

"Our ultimate goals from this meeting are to better understand reactivity of liming materials in a wide range of soils, and how source, purity and fineness affect this reactivity. To achieve this, much research is needed evaluating the different reactivity tests, followed by soil incubations in a lab setting, and finally attempting to correlate in the field, where it really matters," said Hoiberg. "We need to gain industry support for this research that will make necessary changes to the scoring system to fully inform growers about the product they're buying. Ultimately, we want to elevate liming materials to equal footing with other farming inputs and establish a nationwide standardization system." AG