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# Understanding Plant Nutrition: Limestone, Calcium And Magnesium

Argo and Fisher take a microscope to the details that can help growers make informed decisions on nutrients.

by **BILL ARGO, PH.D., PAUL FISHER, PH.D. and JINSHENG HUANG, PH.D.**

**T**HE reason for adding limestone to a container media, besides pH control, is to supply calcium and, depending on the limestone, magnesium. In this article, we will discuss the nutrient content of different types of limestone and how limestone influences calcium and magnesium nutrition.

## Limestone Nutrient Content

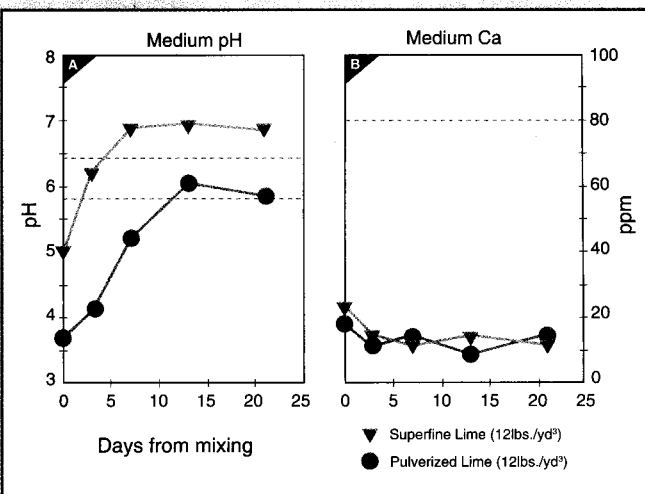
There are four types of carbonate-based limestone that are available. Calcite is pure calcium carbonate ( $\text{CaCO}_3$ , 40 percent Ca). Calcitic lime is composed of mostly  $\text{CaCO}_3$  (> 30 percent Ca) with some  $\text{MgCO}_3$  (<5 percent Mg). Dolomitic lime contains less  $\text{CaCO}_3$  (<30 percent Ca) and more  $\text{MgCO}_3$  (>5 percent) than calcitic lime. Finally, dolomite also contains  $\text{CaCO}_3$  and  $\text{MgCO}_3$ , but at a specific ratio of 22 percent Ca to 13 percent Mg.

Calcium hydroxide ( $\text{Ca}(\text{OH})_2$ ), also known as hydrated lime, or calcium magnesium hydroxide ( $\text{CaMg}(\text{OH})_4$ ), also known as dolomitic hydrated lime, are sometimes used as a fast reacting liming source because they will react quickly and leave no residual. Calcium hydroxide contains approximately 54 percent Ca, while calcium magnesium hydroxide contains about 30 percent Ca and 18 percent Mg.

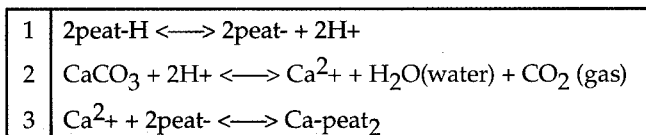
Sometimes the calcium and magnesium content of the limestone is listed as CaO or MgO on the label. To convert CaO to actual Ca, multiply the CaO value by 0.71. To convert MgO to actual Mg, multiply the MgO value by 0.6.

## Reactive Lime And Calcium

Reactive lime is that fraction of the incorporated limestone that causes the media pH to increase initially after mixing. When limestone is incorporated into a media, the important reactions that occur are:



**Figure 1. pH change over time (A) and medium calcium concentrations (B) measured in a limestone amended peat medium. The two limestones were from the same source, but ground to either a pulverized (65 percent passing a 150µm (100 mesh) screen) or superfine (65 percent passing a 75µm (200 mesh) screen) designation. Minimum acceptable concentrations for calcium with the saturated media extract is 80 ppm. Research by Bill Argo and John Biernbaum.**



After the peat and lime are done reacting and the equilibrium pH is reached, the peat is less acidic and contains calcium on its exchange sites. When limestone is suggested as a source of calcium for the plant, it is usually the exchangeable calcium left over from the reactive lime fraction.

Research at Michigan State University tested the effect that a dolomitic limestone had on pH and calcium concentrations for the first four weeks after mixing (Figure 1). It was shown that the reactive fraction of the limestone had little effect on root-medium calcium concentrations, even as the limestone continued to react.

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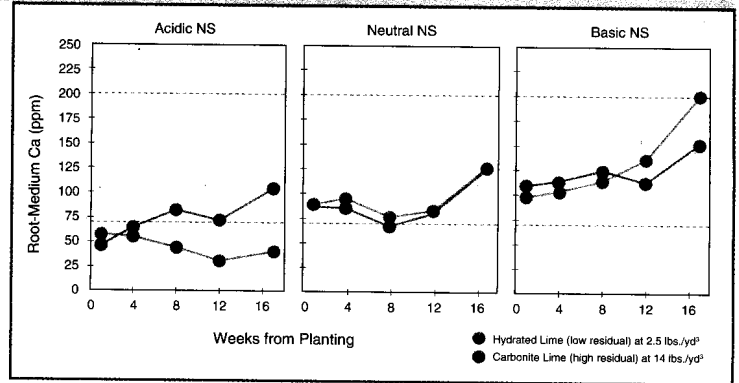
Figure 2. Root-medium calcium concentrations of Impatiens grown in the same peat/perlite medium containing one of two types of lime, and grown with three nutrient solutions between weeks one and 17. The dotted lines represent the recommended acceptable range for the saturated media extract. Research by Bill Argo and John Biernbaum.

It appears that once the calcium from the reactive limestone is bound to the peat, it is not released back into the soil solution under most conditions. Since nutrients must be soluble to be taken up by the plant, the bound calcium does not influence calcium nutrition, either in the short term (mixing to stable pH) or the long term (stable pH till the end of the crop). It also may explain the reason that cation exchange capacity of a limed peat has minimal influence on pH buffering.

Residual Lime And Calcium

Just like with pH buffering, it's the residual lime fraction that influences calcium buffering. Figures 2 and 3 show the results from an experiment at Michigan State University in which the same peat/perlite media was prepared using two different types of lime. The low-residual treatment contained a hydrated lime, which reacted quickly and completely, leaving no residual. The high-residual lime treatment contained a dolomitic lime with a large residual fraction. Impatiens were grown for 17 weeks in both media using one of three fertilizer solutions.

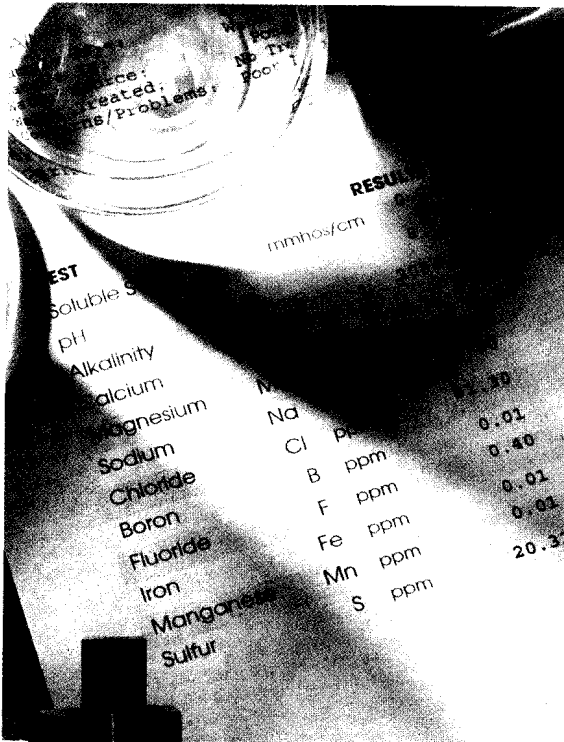
The acidic nutrient solution (NS) was composed of water with 20 ppm alkalinity and a fertilizer containing 50 percent NH4-N:50 percent NO3-N. The neutral NS was composed of water with 120 ppm alkalinity and a fertilizer containing 25



percent NH4-N:75 percent NO3-N. The basic NS was composed of water with 120 ppm alkalinity and a fertilizer with 3 percent NH4-N:97 percent NO3-N. The calcium concentrations also differed between the fertilizer solutions with the acidic NS containing 15 ppm Ca, the neutral NS containing 50 ppm Ca and the basic NS containing 150 ppm Ca.

When the acidic NS was used, both media and shoot-tissue calcium concentrations were significantly higher in plants grown in media containing the high residual lime fraction compared to those grown in the media without the residual lime (Figures 2 and 3).

However, when less acidic fertilizer solutions were used,



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## PLANT NUTRITION

### LIMESTONE, CALCIUM & MAGNESIUM

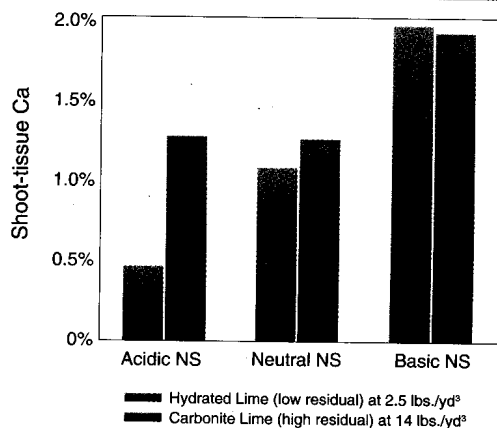
there was little difference in the media or shoot-tissue calcium concentrations of plants grown in the two media.

These results suggest that the residual lime contained in the medium after the equilibrium pH was reached did not, in itself, buffer the root-medium Ca concentrations. Instead, the increase in root-medium and shoot-tissue Ca

resulted from the reaction of the acidic NS with the residual lime. Decreasing the acidity of the fertilizer solution, either by reducing the amount of  $\text{NH}_4\text{-N}$  in the fertilizer or by increasing the alkalinity of the water, almost completely negated the residual lime as a calcium source.

### Magnesium

The effect that limestone has



**Figure 3. The effect of the concentration of applied calcium from the nutrient solution on the shoot-tissue calcium of impatiens grown in two root media containing either hydrated lime with small residual fraction or a dolomitic lime with a high residual fraction. Research by Bill Argo and John Biernbaum.**

with magnesium nutrition follows the same pattern as with calcium.

The reactive lime fraction did not influence magnesium concentrations in the media, even as the limestone continued to react. While the residual lime fraction was a source of magnesium under acidic conditions, reducing the acidity of the fertilizer solution negated the residual lime as a magnesium source.

The chemistry of the limestone will also influence magnesium nutrition. The research presented in this article used a dolomitic lime. Other lime sources can contain less magnesium (and more calcium). It would be expected that using a limestone with a lower percentage of magnesium would further reduce the limestone as a magnesium source.

Limestone can be an important source of calcium and magnesium for a crop, but it may not be a consistent source because it is not available under all conditions. In addition to limestone, starter fertilizers are often incorporated into media in order to get consistent concentration of both macronutrients and micronutrients at time of planting. In next month's article, we will discuss sources for starter fertilizers and their persistence in the media over time. **GG**

**About the authors:** Bill Argo ([bargo@blackmoreco.com](mailto:bargo@blackmoreco.com)) is technical manager at the Blackmore Company, Paul Fisher ([pfisher@ufl.edu](mailto:pfisher@ufl.edu)) is an Associate Professor and Extension Specialist in the Environmental Horticulture Department at the University of Florida, and Jinsheng Huang ([huangj@ufl.edu](mailto:huangj@ufl.edu)) is a research scientist in the Environmental Horticulture Department at the University of Florida.



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