DOES AG-LIME NEED PARTICLES LARGER THAN 60-MESH TO MAINTAIN ELEVATED SOIL pH?

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Background. A common perception is that limestone applied to neutralize soil acidity must contain coarse particles for the lime to have a longer lasting effect on pH. The finer particle fraction of limestone in contact with soil acids reacts to completion more rapidly than coarser materials. Large particles take longer to dissolve. This experiment was done to compare the duration of pH change effected by coarse and fine lime materials.

Research Findings. Ag-grade (ECCE 62) and fine (ECCE 100) limestones from the same source were applied at rates of 0, 1, and 2 tons/acre each year in 1988, 1991, and 1992 to 9 x 15 ft plots in a randomized complete block experimental design. No additional limestone was applied from 1992 to 2000. Test crops overseeded into Coastal bermudagrass included rose clover in 1989-1991, crimson clover and alfalfa in 1992, alfalfa in 1993-1995, and ryegrass in 1996-1999. Nitrogen fertilizer was applied for the grasses at rates up to 80 lb/acre per cutting. Soil samples were collected annually to monitor pH (1:2 soil to water). Data in Figure 1 are from samples collected in late summer of 1999.

Results in Figure 1 are similar to data from several previous studies of shorter duration. Results show that ECCE 100% limestone increases soil pH faster and to a higher level than limestone that has an ECCE of 62%. These data reveal that three tons of ECCE 100% limestone per acre increases soil pH to a level that nearly equals the pH from 6 tons of ECCE 62% limestone. When equal rates of ECCE 62 and 100 material were compared, the pH change effected by finer limestone remained 0.32 pH unit higher than pH effected by coarse lime seven years after the last application. This disputes the idea that the pH change brought about by the coarser limestone lasts longer than pH change due to the fine lime.

On incorporation into a moist acid soil, limestone particles begin to dissolve by reacting with hydrogen (H^+) and aluminum (Al^{3+}). As the reaction progresses, the H^+ and Al^{3+} on the soil particle surfaces are replaced by calcium (Ca) or magnesium (Mg). The neutralization reaction will continue as plant roots take up the Ca and Mg and as Ca and Mg diffuse away from the soil clay surfaces. Calcium uptake and diffusion will be accompanied by negative ions, or the counter diffusion of H^+ and Al^{3+} toward the clay particles to maintain the balance of charges. Since the rate of Ca and Mg diffusion in the soil is slow, finely ground limestone mixed with the soil provides more surface area and particles per unit volume of soil, less distance between particles, and, more rapid neutralization of soil acidity.

As the percentage fineness increases, the amount of reactive surface area in a given quantity of ag-lime increases. A piece of limestone with a volume of one cubic inch has a surface area of approximately six square inches. That same piece of limestone ground so that each particle is the exact size to just pass a 100-mesh screen, and assuming that these particles would remain perfect cubes (which they won't), would have an increased surface area of approximately 1,016 square inches. As surface area is increased, ag-lime dissolves more rapidly in acid soils, and effects needed changes in soil pH over a shorter time. In addition, the finer particle-size limestone will neutralize a greater concentration of soil acidity, raise pH to a higher level than will the same weight of a coarser grind material from the same limestone source, and maintain that higher pH change against re-acidification for a longer time than the coarser material.

These results discredit the myth that agricultural limestone must contain some coarse material to induce a longer lasting change in pH and resist the acidifying effect of nitrogen fertilizers. The finer limestone neutralizes much more acidity than does the coarser material. Because pH is a logarithmic function (pH = - log $[H^+]$), an increase of 0.32 pH unit is actually a 2.09-fold, or a 209% decrease in soil acidity. (A pH change from 5 to 6 is a 10-fold, or 1000% decrease in acidity.)

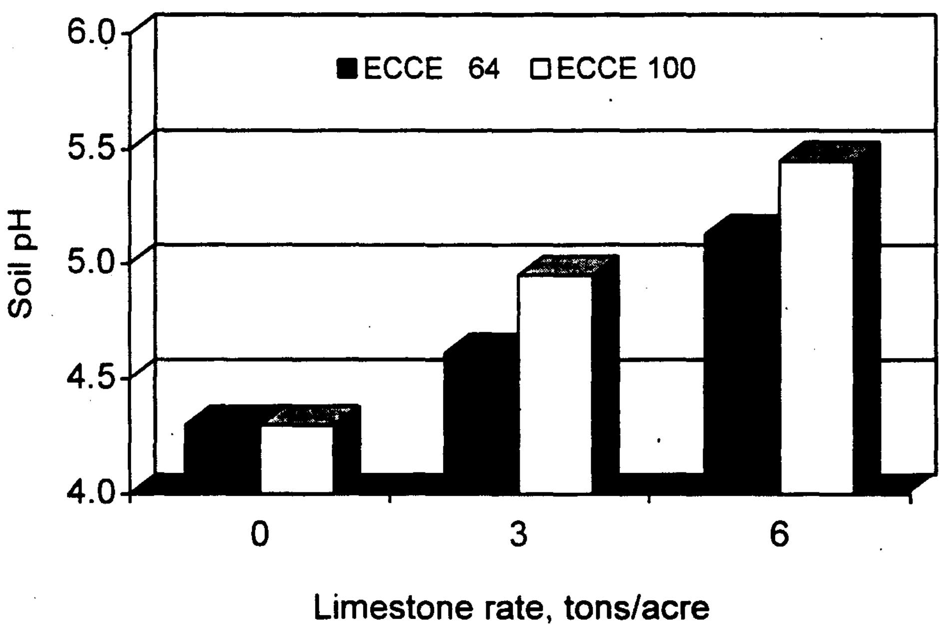

Fig. 1. Effect of limestone rate and ECCE on soil pH in a Darco loamy fine sand seven years after the last treatment. Lime was applied in 1988, 1991, and 1992 at rates of 0, 1, and 2 tons/ac.