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Crushed Eggshells in the Soil

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As a dedicated gardener, I've read many articles over the years about home omposting and the benefits of adding crushed eggshells to the compost pile. Since shells are mostly calcium carbonate, it is reasonable to assume that they add calcium to the soil and help to reduce soil acidity. This is indeed what most of these gardening articles propose. Therefore, I've always saved the shells along with other compostable kitchen wastes for my compost pile without really giving it much thought.

Recently, however, I had a call from an enterprising farmer who wanted to know just how effective eggshells were when applied as an alternative to ground, agricultural limestone. A nearby company processed raw eggs into egg products and produced several tons of eggshells each day which went into the local landfill. "What a waste of valuable landfill space and a potentially good soil amendment!" he thought. The company was more than grateful to have him truck them off. They may even pay him to land apply this by-product. This was a good opportunity to really see how effective eggshells may be when applied as a alternative to ground agricultural limestone.

Testing

Samples of the eggshells were dried, finely ground, and analyzed by the Auburn University Soil Testing Laboratory. In a 3-week incubation study, very acid topsoil from a Marvyn sandy loam (pH=4.9) was treated with 4 different liming materials (Table 1). An untreated control that had nothing applied was also used. The hand-crushed eggshells were to simulate what would happen when a farmer actually moved the shells and spread them on farmland. This is also what would happen when a home gardener adds them to the compost or garden soil.

Each material was applied at 4 different rates based upon the actual calcium carbonate equivalent of each material: 0.5x, 1x, 2x, and 4x. The x rate is the estimated rate of pure $Ca(OH)_2$ (effective $CaCO_3$ equivalent of 135%) needed to raise the pH of the soil to 6.5. Because each material has a different calcium carbonate equivalent, each material was applied at different "x" rates. Treated soil was moistened to approximately field capacity and allowed to incubate at room temperature for 3 weeks. Soil pH was determined after 24 hours, 7 days, 14 days, and 21 days. Soil was mixed each time it was sampled.

Lime Effectiveness

The effectiveness of $CaCO_3$ and ground agricultural limetone is a product of its neutralizing value (total alkalinity) expressed as calcium carbonate equivalency and its fineness. Calcium carboate is not water soluble. Eggshells are not water soluble. They must be ground finely enough and mixed

with the soil so that lime particles come into contact with acidity on the surface of soil clay and organic matter. This is why Alabama's lime law states that all ground agricultural limestone sold in Alabama must pass certain particle size specifications. This must be stated on the bag or label. Applying coarse, sand-sized limestone is not much better than applying sand. The finer the lime, the more effective it is. We expected the same would be true for eggshells.

Results

Coarse, hand-crushed, shells were not much better than nothing at all in raising soil pH (Fig-ure 1). On the other hand, finely ground shells were as effective as pure $Ca(OH)_2$ when applied at equivalent rates based upon their respective neutralizing values.

Why was ground agricultural limestone not as effective as pure Ca(OH)? Because it contains a lot of ineffective, coarse, sand-size particles. It wasn't as fine as finely ground eggshells. However, in the "real world", lime recommendations usually take this into consideration. The Auburn University Soil Testing Laboratory's limestone recommendations assume that ag. lime is only about 63% as effective as powder-fine, pure $CaCO_3$ with a neutralizing value of 100%.

Finely ground shells were also very effective at increasing soil test (Mehlich 1) extractable calcium in the soil but soil treated with the hand-crushed shells had no more extractable Ca than untreated soil (Table 3). This suggests that coarse shells would not be a good source of Ca for a crop such as peanuts which require high Ca in the pegging zone. However, dried and finely-ground shells would be an acceptable alternative to conventional agricultural lime as a source of Ca for peanuts.

Conclusions

Coarsely crushed eggshells are relatively ineffective as a soil liming material or as a source of calcium. Although the sample used in this study had a total neutralizing value of 59% of pure calcium carbonate, it had to be very finely ground in order to be effective at increasing soil pH. Broken eggshells can be safely land applied. Nitrogen from protein residues in eggshells and possibly other nutrients will eventually add to the fertility of the soil. Except for nitrogen, this will probably be a very slow process. Therefore, unless shells are mechanically ground at least as finely as ground agricultural limestone, they should not be used as a substitute for conventional soil liming materials. However, we do not suspect any negative effect from their application to the soil.

Acknowledgement

This Timely Information Sheet is a revision of one first released in February, 1994, as S-01-94 but was never available electronically. This investigation was done solely to provide information to county agents, farmers, and gardeners. Mr. Fuhan Lui and Mr. John Muse, former Graduate Research Assistants in the Department of Agronomy & Soils, did most of the work involved in the incubation study. Their help is sincerely appreciated.

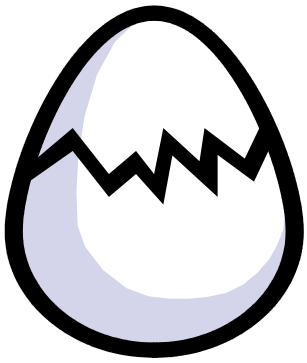

Table 1. Liming materials used in a soil incubation study.

Material used	$CaCO_3$ equivalency	X rate applied	
	----------%----------	-g/kg--	-lb/ac-
1. Reagent grade $Ca(OH)_2$	135	0.4	800
2. A commercial, bagged, ground dolomitic limestone	100	0.54	1080
3. Dried, very finely ground, eggshells (powder fine)	59	0.91	1820
4. Dried, coarsely crushed (by hand) eggshells	59	0.91	1820

Table 2. Composition of oven-dried, ground eggshells.

Analysis	Results
Neutralizing value	59% CCE*
Carbon (C)	13.44%
C:N ratio	10:1
Primary Plant Nutrients	
Nitrogen (N)	1.33%
Phosphorus (P_2O_5)	0.25%
Potassium (K_2O)	0.08%
Secondary Plant Nutrients	
Calcium (Ca)	36.8%
Magnesium (Mg)	0.35%
Sulfur (S)	0.15%
Micronutrients	
Copper (Cu)	23 mg/kg
Iron (Fe)	1380 mg/kg
Manganese (Mn)	23 mg/kg
Zinc (Zn)	26 mg/kg
Boron (B)	10 mg/kg
Molybdenum (Mo)	3 mg/kg
Other non-nutrient metals	
Barium (Ba)	10 mg/kg
Cobalt (Co)	2 mg/kg
Chromium (Cr)	76 mg/kg
Lead (Pb)	21 mg/kg
Sodium (Na)	1500 mg/kg
*calcium carbonate equivalent	

Table 3. Mehlich-1 (weak, double acid) extractable nutrients on soil from the "x rate" treatment at the end of the incubation study.

Material used	Extractable nutrients			
	----------mg/kg----------			
	P	K	Mg	Ca
1. Reagent-grade $Ca(OH)_2$	60	25	4	65
2. A commercial, bagged, ground dolomitic limestone	59	22	3	195
3. Dried, very finely ground, eggshells (powder fine)	55	20	11	110
4. Dried, coarsely crushed (by hand) eggshells	60	27	2	60

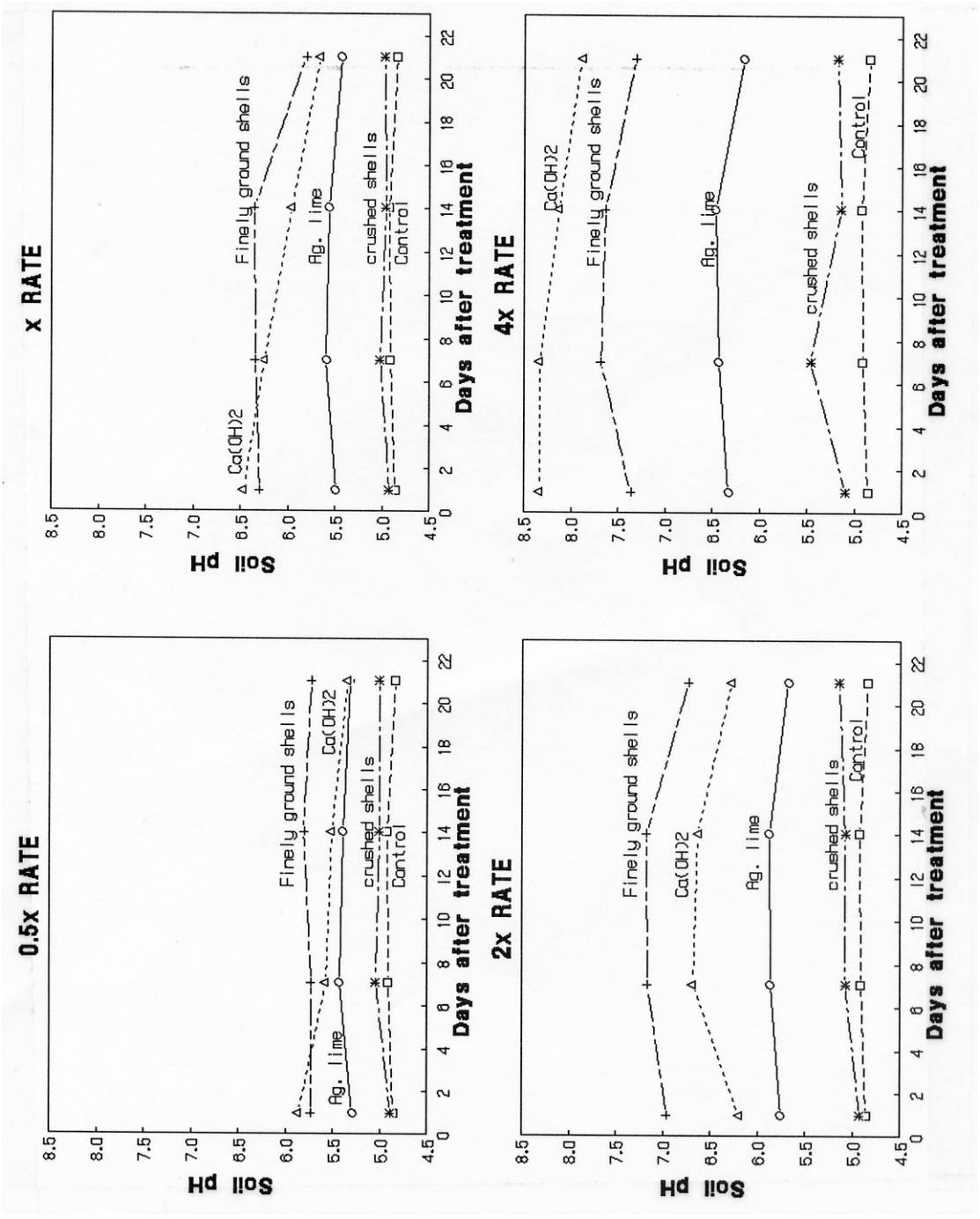

Figure 1. The effect of eggshells compared with ground, agricultural limestone (ag. lime) and reagent grade calcium hydroxide [$Ca(OH_2)$] when applied at equivalent rates based upon the neutralizing value of each material. The "x rate" is the estimated amount of Ca(OH)2 needed to raise the soil pH near 6.5.