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PARTICLE-SIZE OF DOLOMITE EFFECT IN CINDER-BASED MEDIA

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INTRODUCTION

In Hawaii, artificial media used in foliage production contains a small amount of peat moss in relation to black cinder. The starting media is often mildly acidic and not requiring much lime. However, the use of acid-forming fertilizers and heavy rainfall or irrigation may decrease the pH of the potting medium over time. It is not uncommon to find media pH levels of 4 or lower on the windward side of the island of Hawaii where average annual rainfall exceeds 120 in (300 cm) and is slightly acidic. The majority of Hawaii's foliage production is located within this area and disorders attributed to low pH and related plant nutrient imbalances occur.

Selection of liming materials in terms of particle size for plant production under these conditions is a question that has often been raised by area nurserymen. Frequently used liming products in Hawaii include dolomitic limestone and Kawaihae crushed coral, a calcitic limestone. The particle sizes for three dolomitic products and crushed coral are shown in Table 1.

The neutralizing value of a liming material depends on two factors: the purity of the limestone and the fineness to which it has been ground. The purity of limestone is expressed as the calcium carbonate equivalent where pure calcium carbonate is considered to have a neutralizing value of 100% and pure dolomitic limestone about 109%. Most agricultural limestones have neutralizing values of 90-98%.

The fineness of limestone determines its rate of reaction in the soil. The smaller the particle size, the greater the surface area exposed to soil particles and the greater its reactivity. Fineness is measured in mesh sizes which indicate the number of openings per linear inch in the screens (Table 2). Thus, the higher the mesh number the finer the particle size. Finer particles react more quickly than coarser particles, but the coarser particles may react over a longer period of time (Kelling and Schulte, 1980).

Most agricultural liming materials contain combinations of particle sizes. Selecting a liming material according to particle size depends on the grower's needs. When an immediate change in pH

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is desired, fine limestone with high proportions of 100 mesh size and smaller particles is desired. For greenhouse purposes, a fine limestone which reacts within 2 weeks is generally recommended. If the intent is not to greatly raise the current pH, a coarser material is sufficient. As a general purpose limestone for soils, a limestone having 50% passing through 100 mesh, 60% through 60 mesh, and 95% through 20 mesh allows half of the material to react immediately and the other half over a 2-3 week period (Hinnish, 1979). About 100% of limestone passing a 60 mesh screen is gone in 1 year while 50% of the 30-50 mesh and 80% of the 8-20 mesh fractions remain in the soil after 1 year and continue to react in subsequent years (National Crushed Stone Association, 1981).

The objective of this experiment was to determine the reactivity of commercially available liming materials with different degrees of fineness in a potting medium of 2:1 black cinder:peat moss (by volume).

MATERIALS AND METHODS

This experiment utilized a randomized complete block design with 4 blocks and 15 treatments. Three dolomitic limestones differing in particle size distribution (Table 1) were evaluated at 5 rates. Dolomite Ag10 and Ag65 are commercially available agricultural limestones while dolomite Ag7 is used as a filler in dry fertilizer mixes.

The dolomitic limestones were added to 0.5 gal (1.9 liter) black cinder:peat moss (2:1 by volume) medium in 1 gal (3.8 liter) resealable plastic bags, and mixed thoroughly. Distilled water (250 mL) was added to the mix and the bags were sealed. The amount of water added was approximately 40% of the container capacity. The bags were placed on greenhouse benches where the average minimum temperature was 60°F (15.4°C) and the average maximum temperature was 80°F (26.8°C).

The peat moss was grower grade Canadian sphagnum peat moss. The black cinder was screened to achieve particle sizes between 0.25 in (0.64 cm) and 0.5 in (1.27 cm). The medium had an initial pH of 5.4 and contained 40 ounce yd^{-3} (1.49 kg m^{-3}) of extractable Ca and 9 oz yd^{-3} (0.33 kg m^{-3}) of extractable Mg as determined by soil analysis (0.3 N HCl extractant) at the University of Hawaii Agricultural Diagnostic Service Center.

Treatment rates of Ca applied as dolomitic limestone were based upon multiples of half the extractable Ca reported in the medium. These rates were 0, 20, 40, 60, and 80 oz Ca yd^{-3} (0, 0.74, 1.49, 2.23, and 2.98 kg Ca m^{-3}). These rates correspond to 0, 5.8, 11.6, 17.4 and 23.3 lb yd^{-3} (0, 3.5, 6.9, 10.4, and 13.9 kg m^{-3}) of dolomitic limestone. At weekly intervals, pH of subsamples was measured using the Saturated Media Extract (SME) method (Warncke, 1986).

Regression analysis was used to determine best-fit curves for the response of pH to dolomitic limestone sources and rates. Best-fit curves were determined for the relationship between pH and time (weeks) for each dolomitic limestone source applied at the rate of 5.8 oz yd^{-3} (3.5 kg m^{-3}). Best-fit curves for relationships between pH and liming rates were determined for each dolomitic limestone source at week 4 (Fig. 2). All curves were calculated using polynomial models and only coefficients significant at $p<0.05$ were retained in the models.

RESULTS AND DISCUSSION

Under the conditions of this experiment, Ag7, Ag10 and Ag65 applied at 5.8 oz yd^{-3} (3.5 kg m^{-3}) reached equilibrium by week 6 (Fig. 1). At this time Ag7 resulted in a pH of 5.6, Ag10 a pH of 6.8, and Ag65 a pH of 8.5. Results are consistent with expectations that the finest particle size dolomitic limestone (Ag65) resulted in the greatest change in pH (Fig. 2).

The liming response to rates and grades of dolomitic limestone (Fig. 2), indicate that to achieve any given pH, a substantially greater amount of Ag10 is required than is Ag65. The upper limit of the optimum pH for soilless media is 6.5 (Arent, 1984). It required approximately double the amount of Ag10 compared to Ag65 to achieve this pH. Dolomite Ag10 applied at 11.6 lb yd^{-3} (6.9 kg m^{-3}) resulted in a pH of approximately 6.5 by fourth week. The application of the lowest rate of Ag65 (3.5 kg m^{-3}) resulted in a pH of 7.2 which exceeds the optimal limit of 6.5. Dolomite Ag7, which is not classified as a liming material, did not result in a pH of 6.5 even at the highest application rate.

These results can only approximate what one might expect in a nursery situation. Higher water contents which often exist in growing conditions may increase the liming response. It is likely that the effects of leaching, acidifying fertilizers, and plant interactions with the media will lower media pH. Further studies are needed to investigate how well pH is maintained in a growing medium over long production periods by different grades of limestone.

ACKNOWLEDGEMENT

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Table 1. Particle size profiles[1] for three dolomitic limestones and a locally available calcitic limestone used in the study.

Mesh no.	Dolomitic limestone Ag 65[1]	Ag10[1]	Ag7[2]	Crushed coral[3]
	%			
6	100	100	100	100[4]
8	100	100	92	99
10	99	98	52	92
20	97	60	5	84
40	95	28	trace	66
60	90	18	0	48
100	80	8	0	14

[1] National Refractories and Mineral Corp., Oakland, Ca.
[2] Kaiser Minerals Dept., 1982
[3] Brewer Environmental Industries, Inc., Hilo, HI
[4] Percentage values represent the percentage of the material passing through a given mesh size.

Table 2. Mesh size used in profiling fineness of limestone particles and their associated characteristics.[1]

Mesh no.	Opening size	Fineness efficiency[1]	Comments
	mm	%	
100	0.15	100	Reaction within 2-4 wk Almost as reactive as $Ca(OH)_2$
80	0.30	100	Reaction within 2-4 wk
60	0.40	100	
20	0.84	60	Relatively ineffective 30-60 mesh requires 6-18 mos.
10	2.00	20	Relatively ineffective
8	2.80	20	Considered ineffective
<8	<2.80	0	Considered ineffective

[1] Fineness efficiency represents an arbitrary relative efficiency rating used in some states to rate liming material by mesh size.

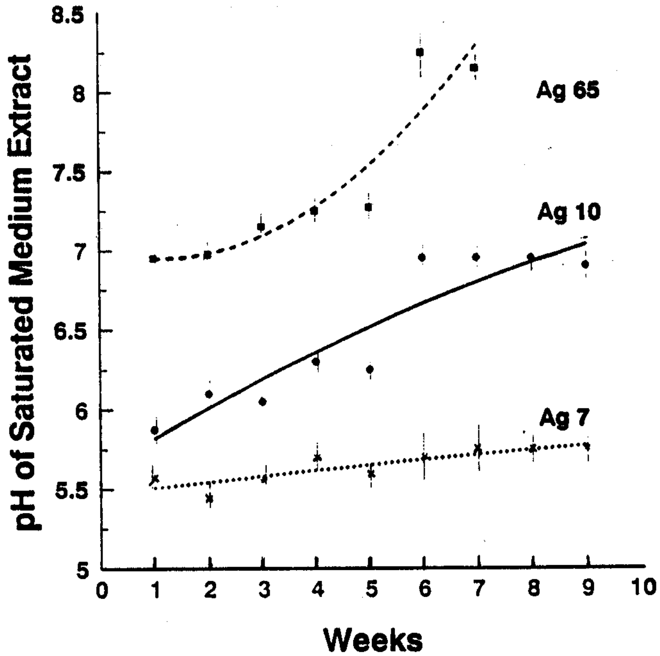

Figure 1. Saturated medium extract pH response curves to 5 rates and 3 grades of dolomitic lime in a 1:2 ratio (by volume) of black cinder to Canadian sphagnum peat moss (grower grade) medium, maintained at 40% moisture saturation, over ten weeks.

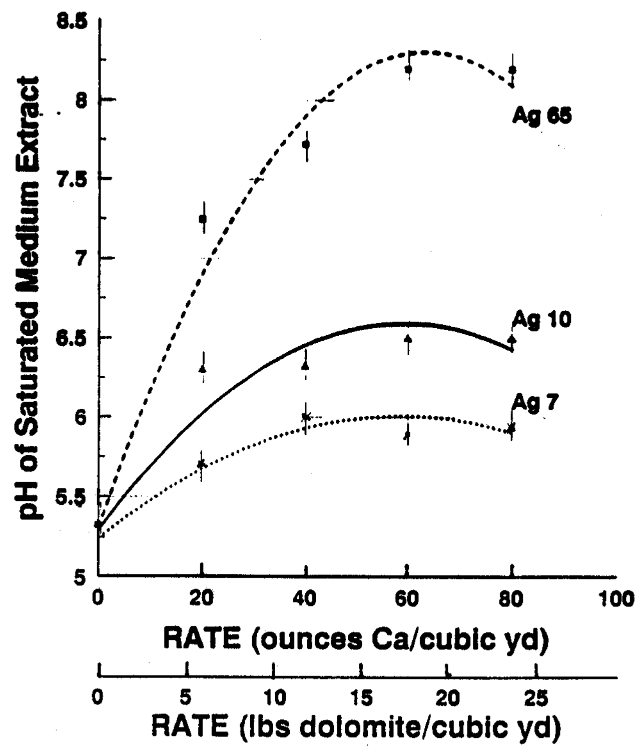

Figure 2. Saturated medium extract pH response curves to 5 rates and 3 grades of dolomitic lime in a 1:2 ratio (by volume) of black cinder to Canadian sphagnum peat moss (grower grade) medium, maintained at 40% moisture saturation, at week 4.