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Influence of Liming Rate on Phosphorus Leaching from a Peat-Sand Medium[1]

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Abstract

Leaching of phosphorus (P) from a peat-sand medium was measured at 3 liming rates. Leaching of P from superphosphate was reduced only at the highest rate of hydrated lime, 2.65 kg/m^3 (4.5 lb/yd^3), which resulted in pH 6.6. Each rate of lime reduced P leaching from the slightly soluble dicalcium phosphate. Further investigation of sparingly soluble P sources for amending soilless media is suggested.

Index words: soilless media, superphosphate, dicalcium phosphate, plant nutrition

Introduction

A long lasting source of phosphorus (P) is desirable for container nurseries. A common nursery practice is to amend container media with superphosphate or treble superphosphate. These have been assumed to be slowly available forms of P in soilless media because of the known capacity of soil to fix P. Flint in 1962 (2) reported that P was only 0.7 ppm in Spurway extract 3 months after a peat-perlite medium, pH 5.5, had been amended with superphosphate at 3 kg/m^3 (5 lb/yd^3). A similar finding was reported 20 years later (9) with pine bark, pH not given, and additionally that the medium solution P concentration fell 10-fold in the first 3 weeks. By collecting and analyzing the leachate (drainage water) one can measure the amount of P leached from the superphosphate amended media. When this was done, the amounts found were 34% in 9 weeks, pH not reported (4), and as much as 76% in 3 weeks at pH 5.5 (8). The large differences may have been due in part to different volumes of water and frequency of leaching, but could have been caused by differences in pH. Varying soilless media components had relatively little effect on P leaching (8).

Peterson (5) made a significant contribution when he reported the effects of soilless media pH on the availability of several nutrients based on their concentration in the saturated media extract (6). The availability of P was especially affected by pH, being much more available (soluble) at low than at high pH, the opposite to soil. The most striking effect was above pH 6.0, as P was 5 times less available at 6.5 than at 6.0. When P is highly available i.e., highly soluble, it should be readily leached. At high pH, P reacts with calcium to form calcium phosphates of low solubility. If this accounts for the decreased availability of P at high pH, perhaps a calcium phosphate would act as a long lasting source of P.

The purpose of this study was to compare the leaching of P from superphosphate and the less soluble dicalcium phosphate in a soilless medium at wide differences in pH.

Materials and Methods

A container medium of sphagnum peat and concrete grade sand, 1:1 by vol, was amended with hydrated lime at rates of 0, 1.12 kg/m^3 (2 lb/yd^3) or 2.65 kg/m^3 (4.5 lb/yd^3). Media at each rate of lime was further amended with 20% superphosphate at 3 kg/m^3 (5 lb/yd^3) or dicalcium phosphate at 1.35 kg/m^3 (2.3 lb/yd^3). When medium from each treatment was placed in 2.5 L plastic containers (#1 nursery containers), each container had approximately 765 mg P. The containerized medium was saturated with deionized water, covered with plastic film to minimize evaporation and incubated at room temperature. After 4 weeks, 3 containers from each treatment were sampled and the saturated extracts (6) were tested for pH and analyzed for P (7). A duplicate set of containers was leached with 460 ml deionized water (equivalent to 1 acre-in) 7 times at weekly intervals. The leachate (drainage water) from each container

[1]Received for publication January 22, 1985; in revised form March 4, 1985.

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was collected, the volume was recorded, tested for pH and analyzed for P.

Results and Discussion

At each lime rate, the superphosphate amended medium was approximately 0.5 pH unit lower than the dicalcium phosphate amended medium due to reactions of the P sources (Table 1). Although these differences prevent direct comparisons of the P sources at a given pH, the wide range of pH reveal interesting and useful information. With superphosphate, P in water extracts before leaching was 131 ppm at pH 3.6 (unlimed) and 135 ppm at pH 5.1, but was only 55 ppm at pH 6.4. Seven leachings removed about one-half as much P at pH 6.4 as from more acid media (Table 1, Fig. 1). These results agree with the previous report on the effect of pH on P availability from treble superphosphate (5). The availability of P from dicalcium phosphate before leaching was reduced by increasing the pH. Both the percentage of P removed by 7 leachings and the available P remaining were more strongly affected by pH with dicalcium phosphate than with superphosphate (Table 1).

The P removed by each leaching was calculated as a percentage of that initially added minus the amount removed by previous leachings (Fig. 1). The decline in percentage removal of P remaining in the container as leaching proceeded indicates some fixation of P in a less soluble form even at low pH in this soilless media. The leaching profiles illustrate that only the highest rate of lime reduced the leaching of P from superphosphate. The P loss from dicalcium phosphate was reduced by each increment of lime addition.

A desirable source of P for soilless media should release at a rate that minimizes loss by leaching but that provides a concentration of about 10 ppm in the saturated extract (6) or container leachate (9) for good growth of nursery plants (3). The highly soluble super-

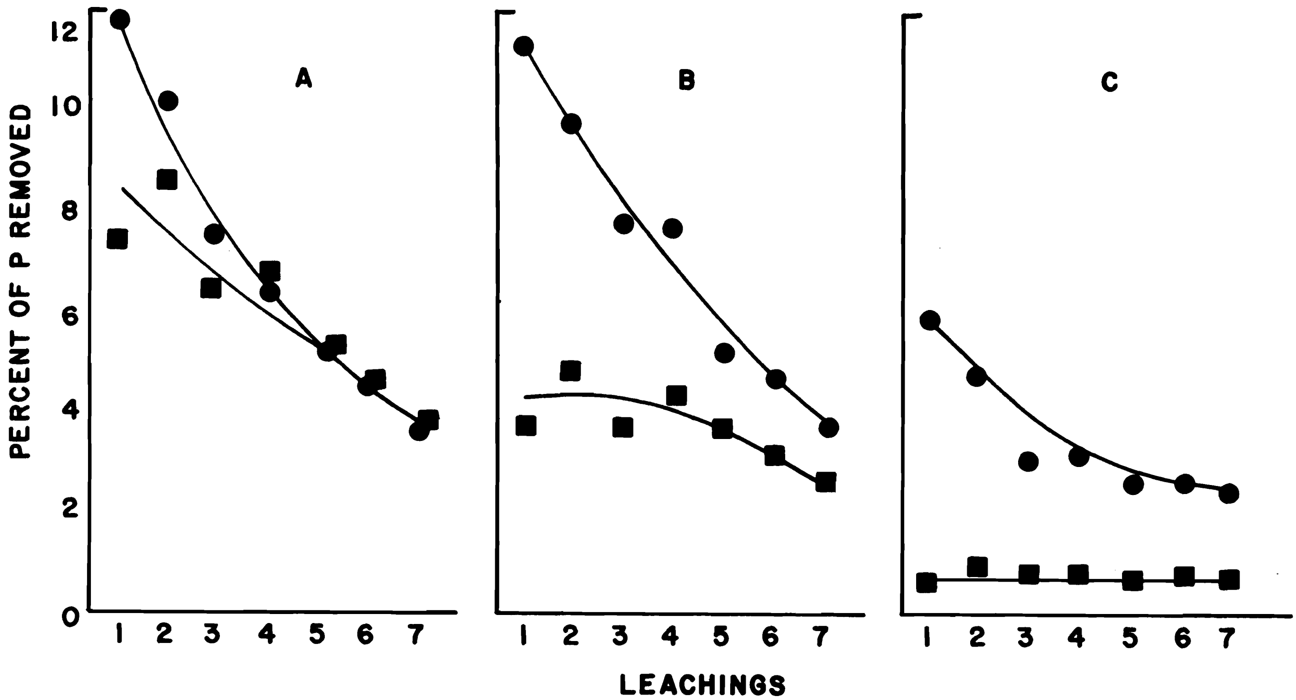

Fig. 1. Percent of P removed by each of 7 leachings from a peat-sand medium amended with superphosphate (•) and dicalcium phosphate (■). The pH was adjusted with hydrated lime at 0 (A), 1.12 kg/m³ or 2 lb/yd³ (B) and 2.65 kg/m³ or 4.5 lb/yd³ (C).

Table 1. Phosphorus content of saturated media extracts before and after leaching a peat-sand medium amended with 3 rates of hydrated lime and 2 sources of phosphorus.[z]

	Hydrated lime		Before leaching		After 7 leachings		
P source	Kg/m³	(lb/yd³)	pH	P (ppm)	pH	P (ppm)	% P removed
Superphosphate	0.0	(0.0)	3.6	131 a[y]	4.2	22 a	40 a
	1.12	(2.0)	5.1	135 a	5.1	23 a	41 a
	2.65	(4.5)	6.4	55 b	6.6	23 a	22 b
Dicalcium phosphate	0.0	(0.0)	4.0	116 a	4.5	52 a	36 a
	1.12	(2.0)	5.6	46 b	5.6	24 b	23 b
	2.65	(4.5)	6.8	15 b	7.1	4.5 c	4.6 c

[z]Data are averages of 3 containers, each initially receiving 765 mg P.

[y]Means within columns for each P source followed by the same letter are not significant at the 5% level using Duncan's Multiple Range Test.

phosphate leached rapidly in acid media and became somewhat more stable at about pH 6.5 (Table 1, Fig. 1). Such a high pH may not favor growth of some plants. Holly, azalea and juniper made the best growth in pine bark at pH 5.4 and lower, when nutrients were adequately supplied (1). Dicalcium phosphate showed promise of a favorable solubility at pH 5.6 (Table 1, Fig. 1). Excessive leaching occurred in more acid media, and at pH 7 it was so nearly insoluble as to restrict the availability of P needed for plant growth (Table 1). Dicalcium phosphate may not be commercially available for fertilizer use at reasonable prices. Various forms of P with low solubility should be investigated, especially under nursery conditions.

Significance to the Nursery Industry

Phosphorus is rapidly leached from acid soilless media amended with soluble forms of phosphorus such as superphosphate and treble superphosphate. The leaching can be reduced by liming to raise the pH to 6.5, but nursery crops may not make the best growth at high pH levels. Phosphorus sources with low solubility, such as dicalcium phosphate used in this study, may provide release rates that do not leach rapidly near pH 5.5, but supply a phosphorus concentration adequate for plant growth. Slowly soluble forms of phosphorus should be investigated as amendments for soilless media.

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Amended Backfills: Their Cost and Effect on Transplant Growth and Survival[1]

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Abstract

Amendment of backfill soil at planting with peat moss, fired montmorrilonite clay or a "superabsorbent" gel had no significant positive influence on growth and establishment of container grown *Liquidambar styraciflua* L., sweet gum, plants placed in well-drained Arredondo fine sand soil. A cost estimate indicated the addition of amendments to backfill soil would increase installation costs 27 to 30% over those for control plants.

Index words: landscape contracting, landscape installation, plant growth, plant establishment, *Liquidambar styraciflua,* sweet gum, soil amendment, "superabsorbent" gel

Introduction

Recent research studies have shown no consistent improvement in growth and establishment of woody plants from incorporation of soil amendments into the backfill at planting (2, 5, 7, 10, 12). According to Harris (4), soil dug from the planting hole is satisfactory for backfilling around roots of trees and shrubs in most landscape installations. Whitcomb (13) recommends using no soil amendments when planting. Despite this evidence, most landscape installation specifications still routinely require backfill amendment. The most common specification in Florida is 1 part by volume peat moss and 2 parts by volume topsoil (3, 8, 11). In addition, manufacturers of "superabsorbent" gels are encouraging use of their products as backfill amendments claiming that improved soil water holding capacity will reduce drought stress thus increasing survival of newly transplanted trees and shrubs (1).

The objectives of this research were: 1) to determine the influence of peat moss, fired montmorillonite clay and a "superabsorbent" gel, Terrasorb (Industrial Ser-

[1]Received for publication January 2, 1985; in revised form March 15, 1985. University of Florida Journal Series No. 6124.