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SALINITY V: COLUMN EXPERIMENTS

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The leaching of salt was studied in ten mixes. As mixes got "tighter", the efficiency of replacement of the soil solution by the leaching solution increased. The soil water replacement efficiency was not affected by solution concentration. A general leaching recommendation of 1 to 1.5 container capacities of drainage was proposed because salt removal decreased rapidly beyond this amount.

Leaching of Salt from Container Media

The leaching of salt from potting mixes remains a problem for the industry. It is known that potting mixes vary widely in their components and physical properties, and it is also known that these properties change the leaching process, mainly by changing the flow of water through the medium. In order to study leaching from container media, we had to test mixes with a range of physical properties. This was accomplished by starting with a basic, highly porous mix, peat-perlite, and adding progressive amounts of very fine glass beads (.0039 - .0043 inches diameter). These glass beads filled large pores in the peat-perlite and allowed the study of a range of physical properties with minimal changes in chemical properties. Four other mixes were also tested (Table 1).

Table 1: Potting mixes used in experiments.

Components[z]	Ratio (V-V-V)
Glass Bead Mixes	
PM-P-GB	10-10-0
	10-10-1
	10-10-2
	10-10-4
	10-10-6
	10-10-8
Standard Mixes	
PM-P	1-1
RW-P	1-1
PM-V	1-1
PM-P-S	2-2-1

[z]PM = peat moss, P = perlite, GB = glass beads, RW = rock wool, V = vermiculite, S = field soil

Leaching was examined in these mixes by salinizing soil columns with a solution of 15 meq/l each of calcium chloride and sodium chloride. The columns were allowed to stand and then leached by flooding with three different concentrations of leaching solutions: 1, 4, 7 meq/l of calcium chloride and sodium chloride (equal parts of both salts). The electrical conductivity of the drainage was continuously measured.

Physical Properties

The physical properties (Table 2) of the glass bead mixes varied with glass bead content as expected. Bulk density and container capacity increased, while total pore space, air porosity, and percolation rate decreased with increasing proportion of glass beads.

Except for percolation rate, the properties of the mixes were similar to those reported elsewhere. Percolation rates measured in this study ranged from 16 to 2015 in/hr. A mix with a percolation rate of 16 in/hr required 36 minutes for 1 pint (500 ml) of drainage to accumulate, but a mix with a percolation rate of 2015 in/hr required less than 20 seconds.

Leaching Curves

Leaching curves (Fig. 1 and 2) reflect how the electrical conductivity of the drainage changed as leaching occurred. Fig. 1 shows that as the glass bead content of the mix increased, the electrical conductivity of the first portion of the leachate increased. This meant that more of the salty soil solution was removed as the mix got "tighter" (i.e. greater

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Table 2: Physical properties and piston flow index of potting mixes. See "Time for Technical Improvement" for definitions.

	PM-P-GB						PM-P	RW-P	PM-V	PM-P-S	HSD (.05)
	10-10-0	10-10-1	10-10-2	10-10-4	10-10-6	10-10-8	1-1	1-1	1-1	2-2-1	
Bulk Density ($g\ cm^{-3}$)	.08	.17	.26	.44	.61	.74	.08	.11	.09	.33	.04
Container Capacity (ml)	98	107	121	128	128	127	94	107	155	115	7
Water Porosity[w] ($cm^3\ cm^{-3}$)	.32	.35	.40	.42	.42	.42	.31	.35	.51	.38	.02
Total Porosity[x] ($cm^3\ cm^{-3}$)	.95	.92	.88	.82	.76	.71	.95	.94	.95	.86	.01
Air Porosity[y] ($cm^3\ cm^{-3}$)	.63	.57	.48	.40	.34	.30	.64	.59	.44	.48	.03
Percolation Rate ($cm\ hr^{-1}$)	4256	2922	986	243	57	41	4519	5436	1761	171	
Piston Flow Index[z]	42	55	61	64	70	74	43	40	54	59	10

[w] Water porosity = (container capacity)/(bulk volume of media).
[x] Total porosity = .98 - .362 (Bulk density).
[y] Air porosity = Total porosity - water porosity.
[z] Piston Flow Index is a measure of the efficiency of the replacement of the soil solution by the leaching solution, where PFI = 100 for piston flow.
PM-P-GB = peat moss - perlite - glass beads (V/V)
PM-P = peat moss - perlite
RW-P = rockwool - perlite
PM-V = peat moss - vermiculite
PM-P-S = peat moss - perlite - soil
HSD = the difference between values required for statistical significance.

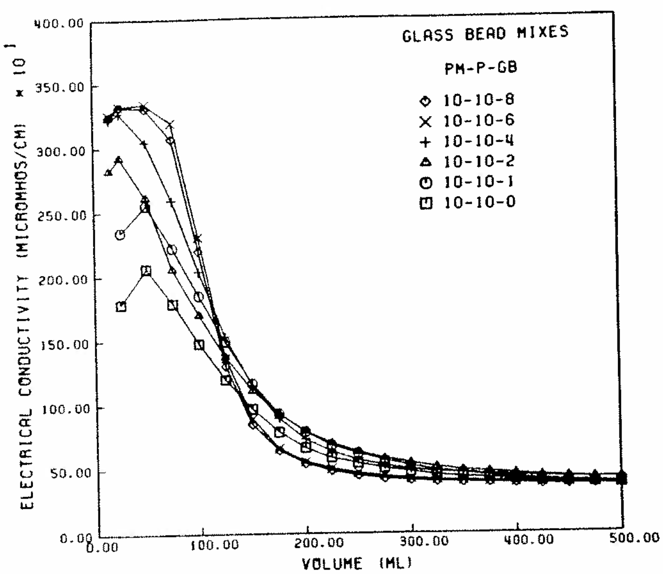

Fig. 1: Average leaching curves of glass bead mixes leached with 2 meq/l solution. Leaching efficiency increased as glass bead content increased. More efficient leaching is shown as a higher curve. EC can be converted to meq/l by multiplying micromhos/cm by 0.1.

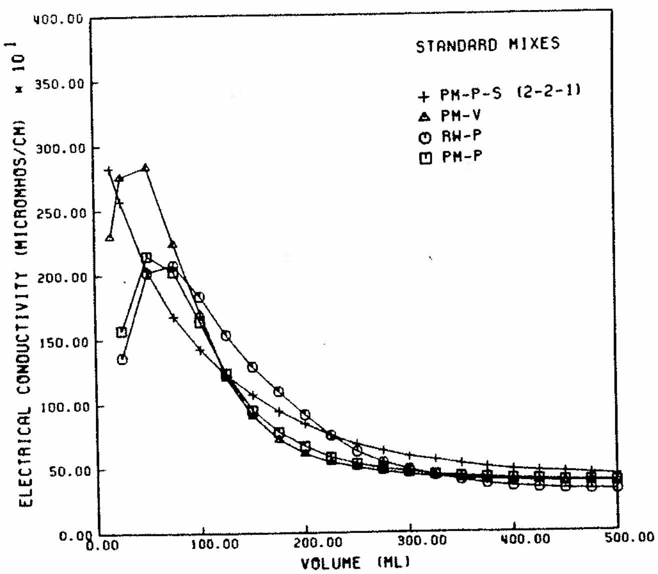

Fig. 2: Average leaching curves of standard mixes leached with 2 meq/l solution. Leaching efficiency was higher for PM-V and PM-P-S (2-2-1) than for PM-P or RW-P.

water holding capacity, less air space, and lower percolation rate). A grower with salinity problems may, therefore, want to stay away from very "light" mixes.

These curves also showed that the electrical conductivity of the leachate could not be used as a direct measure of the soil solution concentration because only the leachate of the mixes with very low percolation rates ever reached the concentration of the soil solution, and then only briefly.

Replacement Efficiency

In order to rate the efficiency of the replacement of the soil solution by the leaching solution (Replacement Efficiency), the data for each medium were compared to the most efficient case: piston flow. Piston flow occurs when the application of one container capacity of leaching solution pushes out all of the soil solution. In other words, by adding the amount of water that the mix holds (for that container), one would completely replace the soil solution. Unfortunately, piston flow never occurs, but the piston flow index (PFI) allowed us to see how close the mixture came to the ideal. The higher the PFI, the more efficient the replacement. Table 2 includes the PFI for the various mixes and this value increased with glass bead content. Of the standard mixes, PFI was significantly higher in the PM-P-S (2-12-1) and PM-V, than in the PM-P or RW-P.

PFI allowed us to compare replacement efficiency (i.e. liquid replacement, not salt removal) not only among mixes, but also among the different concentrations of leaching solution. The replacement efficiency was not greatly affected by the leaching solution concentration. The same amount of the original soil solution was removed, no matter what the leaching solution concentration. However, the total amount of salt in the mix was decreased by leaching with a solution of low concentration.

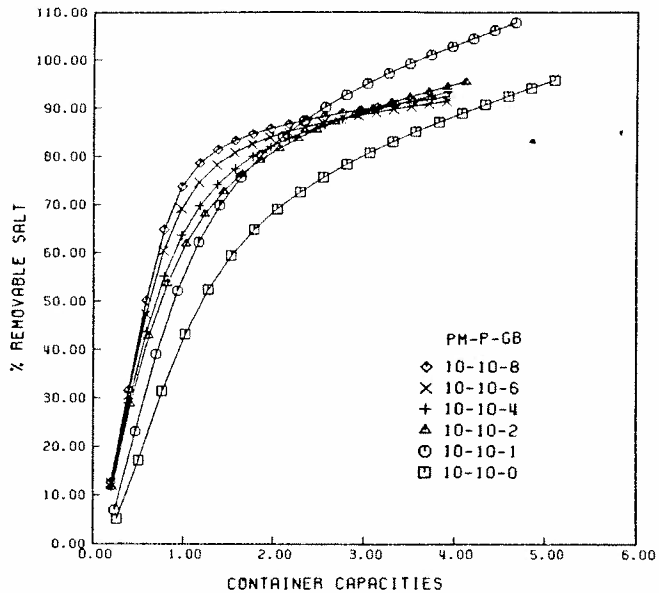

Fig. 3: Average curves of salt leached from column expressed as % Removable Salt for glass bead mixes. Data for all three leaching solutions were combined. These curves level off between 1 and 1.5 container capacities of leachate, showing that salt removal decreased considerably at this point.

Leaching Recommendations

Since the soil solution concentration could not be less than the leaching solution concentration, the maximum amount of salt which could be removed from a medium depended on the leaching solution concentration and was called Removable Salt. When the amount of salt actually leached from these mixes was expressed as a percent of Removable Salt, and then plotted versus volume of leachate, we obtained Figures 3 and 4. Note that the volume of leachate was measured in container capacities. One container capacity of leachate meant that enough leaching water was applied to collect the same amount of water that was originally in the mix. Two container capacities was twice the volume of water originally in the mix, etc. These results showed that the rate of salt removal decreased dramatically between 1 and 1.5 container capacities of drainage. These values (1 to 1.5 container capacities) can be used as a general rule of thumb for leaching container media.

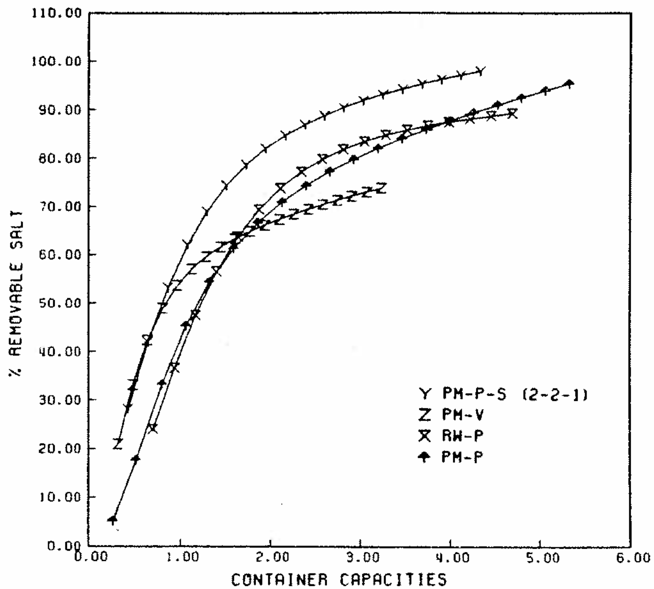

Fig. 4: Average curves of salt leached from column expressed as % Removable Salt for standard mixes. Data for all three leaching solutions were combined.