Use of Soluble Salts as an Indicator of Soil Fertility for Dieffenbachia and Dwarf Schefflera[1]

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Abstract

Fifteen-cm (6 in) pots containing a peat-lite medium and no plants were leached with varying amounts of water for soluble salts (SS) analysis. Volume of water applied to pots within ranges tested was not an important factor when determining leachate soluble salts. *Dieffenbachia maculata* (Lodd) G. Don 'Compacta' and *Schefflera arboricola* H. Ayata (Dwarf schefflera) were fertilized with different sources and rates. Good quality Dieffenbachia were grown with a range of 2750 to 7700 kg N/ha/year (2500 to 7000 lbs/A/yr) with SS of leachate from 341 to 9750 micromhos/cm and 128 to 1243 from a 2:1 by volume method. Dwarf schefflera grew best with a range of 1100 to 6050 kg N/ha/year (1000 to 5500 lbs/A/yr) and SS of leachate from 1384 to 11796, and 2:1 extract from 159 to 1512. Level of conductivity varied considerably within treatments and was not a good indicator of desired soil fertility. Further tests showed that the pour-through method was best when percent of soil moisture varied between 33 and 100%.

Index words: foliage plants, nutrition

Introduction

Soluble salts (SS) levels of the soil solution have commonly been used as a method of determining soil fertility (5, 7, 12). Many tables have been published in popular articles and textbooks suggesting SS ranges for best growth of a wide variety of plants. Some of these tables list 3 methods of determining SS; volume:volume of water:soil, usually 2:1; the saturated paste method; and, the weight:weight method which is generally not used for artificial media. The pour-through method (PT), pouring water through the container medium and collecting the leachate for SS determination, has been used to report SS, pH and nutrient content (4, 6, 8, 9, 11, 13, 14, 15). Previous research with foliage plants had indicated many species can be grown profitably when supplied a wide range of fertilizer levels with resultant divergent SS levels (1, 2, 3, 10). The purposes of these experiments were to investigate the most desirable fertilization ranges for Dieffenbachia and Dwarf schefflera and use of SS as a method to determine these ranges.

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Materials and Methods

Experiment 1: A variable that could be important while determining SS by the PT method is the amount of water poured on the potting medium. To determine variability of water volume on SS readings, various amounts of water (Table 1) were poured through Vergro Container Mix (Canadian sphagnum peat moss: coarse grade vermiculite: perlite, 2:1:1 by volume plus starter nutrient charge) in a 15 cm (6 in) pot. All leachate was collected in a beaker and SS determined. SS of the soil were then determined by the 2:1 water:medium by volume method, and results by the two

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Table 1. Volume effect on SS (Micromhos/cm) as determined by PT and 2:1, water:soil, by volume methods.

Volume (ml) applied/15-cm (6 in) pot	micromhos/cm[y]		s⁻/x)100	
	PT	2:1	Leachate	2:1
	$\bar{x} \pm s$	$\bar{x} \pm s$		
160	1482 ± 620	332 ± 88	41	26
260	1525 ± 854	380 ± 129	56	34
360	1135 ± 79	231 ± 41	7	18
460	1041 ± 159	238 ± 5	15	2
F-value				
Linear	2.04NS[z]	5.79*		
Quadratic	0.04NS	0.26NS		
Cubic	0.40NS	3.80NS		

[z]NS, *, Nonsignificant (S) or significant at 5% (*), 1% (**) level.
[y]Decisimens/meter, same as μmhos/cm.

methods were compared. Five hundred ml of deionized water containing 1.2 g of 20N-3.9P-14.1K (20-9-17) were poured on each container 3 days prior to leaching. This experiment was conducted twice with 4 treatment replications.

Experiment 2: An additional experiment with the same conditions as Expt. 1 was conducted with 160, 260, 360, 460 or 560 ml/15-cm (6 in) pot and 10 replications.

Experiment 3: One of two sources, soluble 20-9-17 or an equivalent amount of N-P-K from a 14N-2.6-10K (14-6-12) Osmocote slow-release fertilizer was applied to 15 cm (6 in) containers with Dieffenbachia and Arboricola in Vergro Container Mix. Osmocote 14-6-12 fertilizer was applied to the surface Oct. 3, 1985 at rates of 3.7, 9.3, 14.9, 20.5 and 26.1 g/15 cm (6 in) container, soluble 20-9-17 was mixed in 1500 ml of water at rates of 2, 5, 8, 11 or 14 g and 150 ml added to each container weekly. Rates were equivalent to 1100, 2750, 4400, 6050 and 7700 Kg N/Ha·year. Plants were grown in a glasshouse with a maximum of 200 micromols $s^{-1}m^{-2}$ (1500 ft-c), and temperatures from 20 to 35°C (68–95°F). Plant height was determined Sept. 30, Oct. 23, Nov. 11, and Dec. 6, 1985. Plant and root grades were determined Nov. 25, 1985 and fresh top and root weights determined Dec. 9, 1985. SS by the PT method was determined Oct. 22, Nov. 12, and Dec. 2, 1985, and by the 2:1 by volume method Dec. 10, 1985. Sufficient water was applied to collect about 50 ml for the PT method (Table 3). There were 10 single pot replications. Standard deviation(s) of the SS were determined.

Experiment 4: Sixteen 15 cm (6 in) pots were filled with Vergro within 1 cm (0.4 in) of the top. The medium was irrigated to saturation the morning of June 3, 1985, then 500 ml of solution was applied for each pot from a solution containing 2.4 g/liter of 20-9-17 (N-P-K). SS were determined June 4, 7, 10, and 13 by PT. Standard deviation of SS was determined for the replicate pots.

Experiment 5: Fifty 13 cm (5 in) pots were filled with Vergro within 1 cm (0.4 in) of the top and weighed. Pots were then watered slowly several times to completely saturate the medium. Pots were under mist when not being watered. They were then weighed daily and 10 pots each were selected for 0, 25, 33, 75, 100 percent moisture. SS were determined by the PT, saturated soil extract (SSE) and 2:1 method.

Results and Discussion

Results of Expt's 1 and 2 where different amounts of water were poured through the medium were variable. Only the first test of Expt. 1 is shown. Soluble salts determined by the 2:1 method were less variable than SS determined by the leachate method, however SS of leachate were 3 to 4 times higher than SS of 2:1 method and there was no significant difference between samplings using the PT method. If SS are used as a guide for fertilization of foliage plants, the extreme variability of samples should be considered. The leachate method appears to be comparable to the 2:1 method, and has the advantage of not destroying roots or removing soil from the containers, which allows repeated periodic sampling of smaller pots.

In Expt. 3, differences in plant height caused by fertilizer source were evident by Oct. 23, only 20 days after beginning fertilization. Dieffenbachia receiving soluble fertilizer were 2 cm taller than plants receiving slow-release fertilizer. An abrupt increase in growth of Dieffenbachia at the second and subsequent levels of fertilizer applied to pots containing Dieffenbachia and a slight decrease in growth with increasing fertilization for Dwarf schefflera was observed by Nov. 14, with the same trends more pronounced Dec. 6 (Table 2). Plant grade and foliage fresh weight followed the same trend for each plant. Root grade decreased with increased fertilizer for Diffenbachia, while root fresh weight was unaffected.

Soluble salt increased with fertilizer rate (Table 3) and were higher at each sampling date. There was usually an interaction between source and level but response was inconsistent and is not shown. SS from containers with Dieffenbachia were lower than those from containers with Dwarf schefflera indicating that Dieffenbachia, which improved with increasing fertilizer, was utilizing fertilizer while Dwarf schefflera, which decreased in size and grade, was not utilizing available fertilizers. Comparing data in Tables 2 and 3 for Dieffenbachia would indicate a minimum of 341 micromhos/cm for good groups, but the maximum could be as high as 9,750 when using the PT method. When using the 2:1 method, the range might be from 128 to 1243. Plant grades of Dwarf schefflera were not as good as those of Dieffenbachia and differences were not as great, but using plant grade as an indicator, satisfactory SS appear to range from 1117 to 11796 using the PT method, a 10-fold increase as observed with Dieffenbachia.

Very little evaporation occurred from the pots during a 9 day sampling period. There was considerable variation between samples within each sampling time, the percent variation ranged from 17 to 41 and the maximum reading taken within a sampling time was about twice the minimum reading taken (Table 4), but average SS were about the same.

When examining the variableness within extraction methods (Tables 5 & 6), all three methods are seen to vary considerably from 0 to 100% soil moisture, but the 2:1 and SSE are less variable in the range 0–33% soil mositure, 4 and 15% respectively compared with PT of 39% (Table 6). However, the PT method is better in the range of 33–100% soil moisture, 12% (PT) compared to 42 and 36% for SSE and 2:1. This suggests that the PT method would be less influenced by soil moisture in ranges that are usually used to grow foliage plants.

Table 2. Growth of *Dieffenbachia* and *S. arboricola* fertilized with weekly or slow release fertilizer at varying rates.

Source	Plant height (cm) 12/6/85 Dief	Plant height (cm) 12/6/85 Arbo	Plant grade[z] 11/25/85 Dief	Plant grade[z] 11/25/85 Arbo	Root grade[y] 11/15/85 Dief	Root grade[y] 11/15/85 Arbo	Top fresh wt (g) 12/9/85 Dief	Top fresh wt (g) 12/9/85 Arbo	Root fresh wt (g) 12/9/85 Dief	Root fresh wt (g) 12/9/85 Arbo
Slow release[x]										
14-6-12	50	39	4.4	3.7	4.3	3.0	409	80	104	21
Liquid[w]										
20-9-17	52	40	4.4	3.7	4.7	3.0	454	87	114	20
Kg N/ha/year										
1100	46	42	3.6	3.7	4.9	3.2	325	91	131	21
2750	51	39	4.7	3.8	4.7	3.1	440	92	118	21
4400	53	41	4.4	3.8	4.4	3.0	453	78	100	20
6050	52	39	4.7	3.7	4.4	3.0	474	77	95	20
7700	53	37	4.8	3.4	4.1	2.6	468	79	103	20
F Value										
Source (S)	4.12*	NS	NS	NS	17.74**	NS	14.96**	NS	NS	NS
Rate (R)										
Linear	14.56**	NS	39.47**	NS	25.97**	8.20**	58.48**	4.47*	6.73**	NS
Quadratic	5.87*	NS	14.02**	NS	NS	NS	10.38**	NS	NS	NS
Cubic	NS	NS	8.60**	NS	NS	0.88	8.64**	NS	NS	NS
SXR	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z]1 = poor, not salable, 5 = excellent quality.

[y]1 = no rooting or dead roots, 5 = 100% coverage of soil ball with white healthy roots.

[x]3.7–26.1 g 14-6-12 surface applied, Oct. 3, 1985.

[w]2–14 g 20-9-17/1500 ml, 150 ml/pot/wk, Oct. 3, 1985.

NS, *, ** Nonsignificant (NS) or significant at 5% (8), 1% (**) level.

Table 3. Soluble salts (micromhos/cm) of containers receiving various fertilizer sources and levels. 1985.

Source	*Dieffenbachia* 'Compacta' Leachate 22 Oct.	Leachate 12 Nov.	Leachate 2 Dec.	2:1 vol. 10 Dec.	*Schefflera arboricola* Leachate 22 Oct.	Leachate 12 Nov.	Leachate 2 Dec.	2:1 vol. 10 Dec.
Slow release[z] 14-6-10	3482	3562	4345	650	4772	7856	10387	1495
Soluble[y] 20-9-17	662	1548	2810	390	2736	4810	7136	852
F value	248.34**	116.55**	11.11**	18.05**	56.75**	102.48**	127.85**	107.77**
Kg N/ha/year								
1100	184	165	127	51	1117	1888	1384	159
2750	684	498	341	128	2196	4260	6228	774
4400	2028	2312	2127	355	3774	6715	9769	1234
6050	2897	3668	5542	823	4885	8170	11796	1512
7700	4567	6135	9750	1243	6800	10630	14630	2188
F-value	77.46**	138.15**	62.58**	54.12**	54.56**	101.70**	255.24**	121.87**
F-value Source × Rate	28.94**	13.01**	13.26**	1.66NS	6.09**	3.94**	3.51**	30.73**

[z]2, 5, 8, 11, 14 g 20-9-17/1500 ml; 150 ml/pot/week, initial application Oct. 3, 1985.

[y]3.7, 9.3, 14.9, 20.5, 26.1 g 14-6-12, 3 month slow release, surface applied Oct. 3, 1985.

NS, *, ** Nonsignificant (NS) or significant at 5% (*), 1% (**) level.

Table 4. Micromhos/cm variability of pots sampled various times after irrigation. June 3, 1985.

Sampling time, days	Micromhos/cm Min	Max	$\bar{x}$	s	$s/\bar{x} \times 100$
4, June 4	1280	2300	1616	467	29
3, June 7	1500	2200	1775	310	17
6, June 10	1100	2600	1825	695	38
9, June 13	1190	2800	1792	742	41

Significance to the Nursery Industry

Soluble salts have been used for years as an indication of soil fertility. Results from these and other tests show that SS should be used cautiously to determine fertilization practices. Foliage plants have been grown within a large range of soluble salts. After the fact SS can be misleading. High salts can hurt roots, but top growth may not show symptoms until later when the harmful salts have already been leached. If SS are to be used, the grower should examine his own SS periodically to determine his own base line.

Table 5. Percent variability of micromhos/cm determined by different procedures at different percent moisture of the soil.

Percent soil moisture	µmhos/cm Determination method			Percent variability of µmhos/cm ($\bar{x}$/s) Determination method		
	pour-through	sat. soil ext.	2:1 vol.	pour-through	sat. soil ext.	2:1 vol.
0	649	453	784	30	21	19
25	1312	336	772	35	32	25
33	1533	380	721	26	34	26
75	1928	225	607	31	21	18
100	1701	171	329	34	30	36

Table 6. Variability ($\bar{x}$/s) of averages of micromhos/cm at various soil moisture levels within a determination method.

	Determination Method		
	Pour-through	sat. soil ext.	2:1 vol
	Variability within 0–100% soil moisture		
$\bar{x}$	1425	313	643
s	489	114	189
s/$\bar{x}$	34	37	27
	Variability within 0–33% soil moisture		
$\bar{x}$	1165	390	759
s	460	59	33
s/$\bar{x}$	39	15	4
	Variability within 33–100% soil moisture		
$\bar{x}$	1721	259	552
s	198	108	202
s/$\bar{x}$	12	42	36

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