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The How-to and Why of Four Medium Extraction Methods Used for Soluble Salts and pH Measurements[1]

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Media soluble salts (SS) or electrical conductivity (EC) and pH are two easily measured parameters critically important to the growth of containerized plants. When pH values are not within optimum ranges, valuable micronutrients become unavailable to the plants and inadequate SS levels can lead to detrimental production outcomes such as small plant size and foliar chlorosis at one extreme, and foliar necrosis and stunted growth at the other extreme. Therefore frequent monitoring of media SS and pH will always be a requirement for best management practices. With the availability of less expensive and portable meters, pH and SS can now be measured on site by production personnel. However, because different leachate extraction methods may be used, readings for the same medium may differ significantly, which can cause confusion and misinterpretations of the results and subsequent inaccurate recommendations for treatment. Always be certain of extraction method(s), especially when using the readings for comparisons and/or to research recommendations. Irrigation practices play an important part in the reliability of soluble salts readings as well. We recommend that the medium be well and evenly moistened before any extraction procedure is initiated.

Currently, growers, extension agents and analytical laboratories use four methods of extracting leachate from potting medium: (1) 1:2 dilution by volume and (2) 1:5 dilution by volume require that one part air-dried medium be mixed with two or five parts of distilled or de-ionized water, respectively. The mix is stirred and allowed to sit (equilibrate) for 30 min, then filtered using filter paper or several folds of cheese cloth; (3) pour-through (PT) method calls for adequate amounts of distilled or de-ionized water to be slowly poured over the surface of near-saturated container-medium so that only about 50 mL (~2 oz) of solution can be collected as leachate from the drainage holes; (4) saturated medium extract (SME) needs about 500cc (~2 cups) of medium removed from container and mixed with distilled or de-ionized water until just saturated (medium surface glistens). After equilibrating for 1.5 h, SME solutions are extracted using a vacuum filter. All final solutions should be measured using available meters. Attention should be paid to the particular designated units (mmhos/cm, dS/m etc.) when checking for related (crop and extraction-method-specific) recommendations.

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Other factors that can influence SS and pH readings include type of fertilizer, controlled release (CRF) vs. water soluble (WSF), potting media, sampling depth, equilibration (sit) time as well as amount of water used for leaching when using the PT method.

In a continuing effort to remove the confusion surrounding SS- and pH-related questions, we designed simultaneous experiments to determine the effects of varying the units of these factors affecting extraction methods. When we used plants, we used Golden Pothos. We used 6-inch shallow (15.1-cm) containers and three representative media containing widely-used basic components, designated as (1) FM1 (40% sphagnum peat, 25% pine bark, 25% coconut coir and 10% styrofoam), (2) FM2 (55% sphagnum peat, 25% perlite and 20% vermiculite), and (3) VM (60% sphagnum peat, 20% perlite and 20% vermiculite with 4 kg/m^3 dolomite). Our general findings are discussed here and used as guidelines to answer the following frequently asked questions.

From Where Should I Take the Sample? How Far down Do I Need to Dig?

Extraction methods (1:2, 1:5, SME) require the removal of portions of medium from the container. When we measured SS and pH in leachate collected at three depths, top (2 cm down from surface of media), middle (3 to 5 cm from surface), and bottom (6 to 8 cm from surface), the SS readings were similar, within the same media, at the middle and bottom layers. Generally, root distribution is heavier in the middle and lower two thirds of the container, so samples taken from the middle of pot should be reliable. pH readings were not affected by sample depth.

How Long Should the Sample Sit (Equilibrate) Before Measuring?

Samples taken using either the 1:2,1:5 or SME methods should be equilibrated with distilled or de-ionized water before final solution filtration. Using the aforementioned media, we took samples from the middle layer of containers using the 1:2 method and left to equilibrate for 0.5, 1, 2, 3, 4, 5 or 6 h before filtering. SS readings within the same medium were similar, regardless of equilibration time; pH results were unaffected from 0.5 to 4 h, as well. However, at 5 and 6 h, pH readings significantly decreased. Therefore, the timesaving 30-min wait is recommended for both SS and pH readings.

When Using the PT Method, How Much Water Should I Use? Does it Really Matter How Much Water I Pour onto the Medium?

Using the representative media (VM, FM1, FM2) to fill the containers, we measured SS and pH in solutions collected after slowly leaching the pots with 200, 250, 300, 350 or 400 mL of deionized water. Using 200 mL of water resulted in higher SS readings in all media. Varying the water volume did not change the pH. Pouring minimal amounts of water into the pots only displaced available dissolved salts, rendering a higher reading, whereas large volumes of water diluted the available salt concentrations. We recommend using 250 mL (~8 oz) of water to collect 50 ml (~2 oz) of leachate from a 6-inch pot of evenly moist medium. Note that regardless of pot size, you should pour only enough water onto the medium to collect 50 mL of leachate.

Does Either Fertilizer Type or Extraction Method Affect pH or SS Readings?

We filled containers with VM, FM1, and FM2, planted them with a single plant, and fertilized them using either a WSF or a CRF. We used the four extraction methods (1:2, 1:5, PT, SME) to collect leachates on three different dates (108 samples per date). The pH readings ranged from 5.2 to 7.6 depending on individual media and applications, but were not significantly affected by extraction method. However, SS readings from the same medium varied substantially according to extraction method regardless of sample date (Table 1; readings from sample dates 2 and 3 not included). In addition, fertilizer type also affected SS readings. For example, when 1:2, 1:5, PT and SME were used to collect leachate from FM1 fertilized with the WSF,

SS readings were 0.73, 0.35, 6.04 and 1.28 dS/m, respectively, whereas the same medium, when fertilized with CRF, gave corresponding SS readings of 0.24, 0.13, 1.73, 0.24 respectively.

Table 1. Soluble salts readings of leachates collected using 1:2, 1:5, pour through (PT) and saturated media extract (SME) methods from three potting media (FM1, FM2, and VM) fertilized with either a controlled-release (CRF) or a water-soluble fertilizer (WSF).

	Extraction Method			
Media	1:2	1:5	PT	SME
FM1	0.13	0.08	1.30	0.18
FM1/WSF	0.73	0.35	6.04	1.28
FM1/CRF	0.24	0.13	1.73	0.24
FM2	0.16	0.08	2.34	0.34
FM2/WSF	0.60	0.43	8.54	1.58
FM2/ CRF	0.18	0.09	2.65	0.49
VM	0.20	0.12	1.65	0.32
VM/WSF	0.95	0.39	4.97	1.48
VM/CRF	0.22	0.11	1.63	0.29

Since There is a Method to Reading Difference, are the SS Readings from the Four Methods Related?

Soluble salts readings from our experiments were grouped by extraction methods and statistically analyzed. Calculations proved that readings from the four methods are related. We then developed conversion formulas to allow comparisons of results from one extraction type to the equivalent results of the other three types (Table 2).

How and When Are the Formulas Used?

When referencing and/or comparing SS levels, final readings may not be reported using results from identical extraction procedures. If different extraction methods are used, the final readings will differ significantly. For example, a SS reading of 0.8 dS/m from solution extracted by 1:5 is approximately equivalent to 1.65, 10.69 or 3.24 dS/m SS reading if extracted by the 1:2, PT or SME method, respectively (Table 2). Note that the meter base units (dS/m or mmhos/cm, etc.) need to be the same or further conversion of meter units will be necessary.

All of the reviewed extraction methods yield comparable results. Any of the four can be adapted to any type of operation. However, three (1:2, 1:5, SME) of the four methods require medium removal from containers. Care must be taken especially when a CRF is being used because fertilizer granules may be lost or collected as a part of sample, which can lead to erroneous SS readings. Sampling can also damage roots and cause media loss. In addition, when using SME, a vacuum filtering system is a necessity. With the PT method, no medium is removed and no specialized extraction equipment is needed.

Table 2. Formula for converting soluble salts readings from one extraction method to another.

To Convert Readings (X)	Multiply X by	Add or Subtract	To Obtain
1:2	0.34	+ 0.06	1:5
1:2	4.61	+ 0.75	PT
1:2	1.67	+ 0.14	SME
1:5	2.07	- 0.002	1:2
1:5	13.56	- 0.11	PT
1:5	4.02	+ 0.02	SME
PT	0.08	+ 0.21	1:2
PT	0.04	+ 0.10	1:5
PT	0.20	+ 0.32	SME
SME	0.41	+ 0.08	1:2
SME	0.16	+ 0.07	1:5
SME	2.76	+ 0.40	PT

For example: suppose a SS reading of 0.8 dS/m (800 µmhos or 0.8 mmhos/cm) is obtained using the 1:5 method, what are the equivalent SS readings if 1:2, PT and SME methods were used for solution extractions?
(1) To convert 1:5 readings to 1:2:
0.8 x 2.07 - 0.002 = 1.65 dS/m.
(2) To convert 1:5 readings to PT:
0.8 x 13.5 - 0.11 = 10.69 dS/m.
(3) To convert 1:5 readings to SME:
0.8 x 4.02 + 0.02 = 3.24 dS/m.