Monitoring and Managing Soluble Salts in Ornamental Plant Production

Fact Sheet FS848

Cooperative Extension

Raul I. Cabrera, Ph.D., Extension Specialist in Nursery Crops Management
James R. Johnson, Agricultural Agent, RCE of Cumberland County

It is necessary to maintain optimum nutrient levels in the soil or growing media to maximize growth in ornamental plant production. Since plant size along with plant quality dictates sale price, nursery growers certainly recognize this relationship. There is also the need to recognize that adequate moisture levels must be maintained as medium nutrient levels increase to avoid soluble salt injury to the roots. Excessively high soluble salt levels can damage roots, severely restrict plant growth, causing undesirable foliage damage (salt-burn) and possible death of the plants. A systematic salinity-monitoring program is thus required to successfully produce high-quality plants.

Several methods can be used to determine the salt concentration or electrical conductivity (EC) of the soil solution from soil and soilless growing media. Two of these methods are best suited and recommended for EC monitoring in ornamental plant production: the saturated media or paste extract (SME) and the pour-through (PT) method.

Saturated Media Extract

The SME is widely used in university and commercial soil/media testing laboratories. Numerous research studies and fertility trials have aided in developing general interpretation guidelines for growing media and mixes used in ornamental plant production. The general guidelines given in Table 1 can be used in making preliminary judgments of the results obtained with the SME method. Keep in mind, however, that the desirable pH, soluble salt and nutrient levels will vary with plant species and their specific management and cultural practices. For example, it is well known that woody ornamentals are generally more sensitive to salinity than herbaceous plants like perennials. As a rule of thumb, the soil solution EC should not exceed 2 to 3 mmhos/cm (same as mS/cm or dS/m) for most woody ornamentals. However, this level may be too high for some salt-sensitive plants like azaleas.

Table 1. General interpretation guidelines for growing media analyzed by the Saturated Media Extract method.

Analysis	Low	Adequate	High
Soluble salts (dS/m)*	0–1.0	1.0–2.0	3.0+
pH	3–4	5–6	7+
Nitrate-N (ppm)	0–50	50–200	200+
Phosphorus (ppm)	0–3	5–10	10+
Potassium (ppm)	0–100	100–200	250+

SME Procedure

- Growth medium removed from the root ball (zone where most of the roots are growing) is put in a glass or plastic container. A volume of 400-600 ml (approximately 1 pint) is recommended.
- If controlled-release fertilizer is present, avoid damage to fertilizer particles during handling.
- Gradually add distilled water while mixing until the sample is just saturated. The saturation point occurs when the mix begins to flow slightly when the container is tipped. The saturated sample should have minimum free water on the surface. Adjust as necessary by adding growing medium or distilled water. Once the saturation point is reached, the sample is allowed to equilibrate or "rest" for 30-60 min.

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Phone: 848.932.5000

- The soil solution is then extracted from the medium, typically done by applying vacuum or suction. The saturated medium is placed in a filter-paper lined funnel, which is inserted in a sidearm flask. The sidearm is then connected to a vacuum source, which may be a pump or a running water-suction setup. The extraction could also be done by mechanically squeezing or compressing the medium. This is, however, undesirable as it modifies the physical and chemical properties of the medium. It is of particular concern if controlled-release fertilizers are present, this handling breaks them, and additional salts are released into solution.
- The extracted solution EC is measured with a conductivity meter. An EC meter typically provides a reading measure as mmhos/cm, dS/m or mS/cm, which are synonymous. If you have a meter that reads soluble salt concentration in parts per million (ppm), the readings can be converted to EC units using the following calculation:

EC (in dS/m) =	Total soluble salts reading (in ppm)
	640

- If an insertion-type portable EC meter (they have a probe or tip similar to portable pH meters) is available, you could measure EC directly in the medium sample without having to extract the solution. Carefully insert the meter into the saturated medium with a wiggling motion to ensure a good solution contact.

Although SME is the method most widely used by commercial soil testing laboratories, it poses some difficulties to growers. Achieving the saturation point may be ambiguous and extracting of the soil solution may be cumbersome. Furthermore, the EC reading obtained by the SME method is lower than the environment EC roots experience after irrigation and drainage (called field capacity in regular field soils and container capacity in container media), and even lower than that occurring before irrigation.

Pour-Through (PT) Method

This method was developed in the Virginia Polytechnic Institute and State University nursery crops research program by Dr. Robert Wright in the 1980's. While the SME is applicable to a wide range of plant growing conditions, PT is most applicable to container crops.

PT Procedure

- Irrigate your plants as you normally do, avoiding excessive leaching (i.e., runoff). Wait until the pots have completely quit draining. Pick a time from 30 minutes to 2 hours after irrigation and attempt to keep that time as a standard for testing. This procedure allows the moisture content of the container to be similar at the time of each extraction, allowing for meaningful comparisons between samples taken on different dates.
- Select a representative number of containers, and place them on a suitable object to elevate the container bottoms from the surface of the collection vessels or trays. The collection vessel or tray (like a plastic saucer) should be wide enough to collect leachate from both the center and side holes.
- Sample the water to be used for the PT procedure to determine if it can have an impact on the analysis. Elevated salt levels in the test water can influence results, especially if water can channel through the medium instead of evenly flowing through the medium. If the pH is to be tested, a baseline must also be determined for the test water.
- Add sufficient water to the surface of the container media so that about 50 ml (2 fl oz) of water is accumulated in the collection vessel. Applying rates of 150 and 350 ml (6 and 12 fl oz) of water per 1-gallon and 3-gallon containers, respectively, is normally sufficient.
- Leachate collected is then poured into a suitable container and is ready for soluble salts, pH and nutrient analysis. It is recommended to refrigerate and/or freeze if an extended period is to occur before analysis.

The practical advantages of the PT procedure over SME are: (a) no medium is actually handled; (b) there is no danger of rupturing controlled-release fertilizer particles, which may cause high salt readings; (c) no specialized equipment is required for extracting the soil solution; (d) the time required for each extraction is reduced; and (e) plant roots are not disturbed. The results obtained by this method are believed to more accurately reflect the root-zone salt and nutrient conditions at container capacity. However, and contrary to the SME procedure, the current interpretation guidelines for PT (Table 2) have been developed from a limited number of species (like Ilex crenata) and growing media (mainly media based in pine-bark). Caution is recommended when interpreting your results. Refine the guidelines according to your crops and cultural conditions and practices.

Table 2. Pour-through soil solution elemental and soluble salt levels associated with vigorous growth of Ilex crenata and other nursery species growing in pine-bark based media.

Analysis	Soluble salts (dS/m)	N	P	K (ppm)	Ca	Mg
Level in leachate	0.6 - 2.0	75-100	10-15	30-50	10-15	10-15

Water Quality In Relation To Soluble Salts

The quality of irrigation water plays a significant role in the production of ornamental crops, determining which crops, if any, can be grown. It also determines how irrigation and other cultural practices must be managed. Thus, in most instances, testing and evaluating of irrigation water should precede any other considerations when planning ornamental crop production or purchasing agricultural land for this purpose. Of all the parameters listed in an analysis of water for irrigation purposes, salinity is the main criterion to be considered. An ideal irrigation water for ornamental crops should be less than 0.5 mmhos/cm. Waters with EC readings higher than 0.75 mmhos/cm have been shown to present increasing salinity problems. Only close monitoring and careful management will prevent salt accumulation when high-EC waters are used for irrigation.

Managing Soluble Salts

The highest concentration of salts, expressed in electrical conductivity (EC) units, is normally present before a plant is irrigated. The resident soil solution is displaced down the container or soil profile by incoming irrigation water or liquid feed. Reduction of the soil solution salinity is, however, dependent on the irrigation water EC and the volume applied. To prevent and control salinity buildups when using typical irrigation waters or nutrient solutions, it is recommended to apply enough water to produce a leaching fraction of 10-30%. The leaching fraction (LF) is the percentage of applied water that must leave the root zone or container to accomplish the degree of leaching desired.

$$\text{Leaching Fraction} = \frac{\text{Volume Leached}}{\text{Volume Applied}} \times 100$$

When the level of soluble salts becomes excessive, higher leaching fractions must be produced. For container growing media, leaching with one container volume of good quality water (low EC) will remove most of the soluble salts in the resident soil solution. At higher soluble salt levels, an additional leaching cycle should take place 24 hours later to remove additional soluble salts that have entered the solution.

Other measures to help control and/or maintain soluble salt levels are: (a) keep adequate moisture in the growing medium, (b) avoid applications of dry fertilizer or highly concentrated nutrient solutions to a dry growing medium, (c) avoid fertilizers that give a high salt stress for a given amount of nutrient (high salt index), and (d) be alert to changes in environmental conditions (like temperature and humidity) that affect plant transpiration, soil water evaporation, and nutrient release from slow or controlled-release fertilizers.

References:

The following articles go into additional detail on attributes and procedures for use of the PT testing system.

1. Altland, J. 2006. Perfecting the pour-through. rngr.net/publications/fnn/2007-winter/literature/perfecting-the-pour-through.
2. Torres, A. P., M. V. Mickelbart, and R. G. Lopez. 2010. Leachate Volume Effects on pH and Electrical Conductivity Measurements in Containers Obtained Using the Pour-through Method. HortTechnology 20(3): 608-611.
3. Wright, R. D. 1986. The pour-through nutrient extraction procedure. HortScience 21:227-229.

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