ESTABLISHING A SOLUBLE-SALT MONITORING PROGRAM

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Providing the proper nutrition program for your plants is important for optimal growth. Monitoring the pH and soluble salts of your root media is a simple check of the nutritional status of your plants. Soluble salts refers to the total dissolved salts in the root medium at any given time. All fertilizer materials contribute to the salts content of the medium, most commonly these are nitrates, ammonium, phosphates, potassium, calcium, magnesium, boron, iron, zinc, copper, sulfates sodium, bicarbonate and chlorides. Organic materials also contribute to the salts content after they have been changed from an insoluble to soluble form. Nitrogen and potassium are the fertilizer materials that most often contribute to the high soluble salts content of the medium. Sulfates and chlorides from fertilizer material can also add to the soluble salts in greenhouse root media.

Excess soluble salts accumulate when leaching during irrigation is insufficient or too much fertilizer is applied. Excessively high soluble salt readings are associated with poor plant growth. Plant symptoms often begin on the lower leaves as leaf chlorosis and progress to necrotic leaf tip margins. Plants may also exhibit wilting symptoms caused by the movement of water out of the root and into the root media having a higher osmotic potential because of the high salt level. At the opposite end of the spectrum, when the soluble salts content of the root medium is too low, plant growth is stunted from lack of fertilizer.

Establishing a soluble salt and pH monitoring program will help you detect changes before conditions cause crop damage. Many greenhouse supply firms sell conductivity meters for measuring soluble salts. (Sources listed at the end of the article.) Good units cost between $150 to $350. A conductivity meter measures the passage of electrical current through a solution. The higher the salt content, the easier it is for electric current to move through the solution. To improve the sensitivity of the measurement, purchase a meter that can be calibrated for temperature. In addition, purchase a known soluble salt standard for calibrating the meter each time you read your samples. Think of soluble salts and pH meters as an insurance policy for your crop with the payback of improved crop quality.

The following is a step by step procedure to follow in developing a soluble salt and pH monitoring program.

<u>Step 1. Collecting Root Media Samples</u>

The methods used in collecting a root media sample can significantly influence the media test results. It is important to have a representative sample for an unbiased analysis of nutrient levels. Remember the readings obtained are only as good as the methods you used to collect a representative sample.

The root media samples should be representative of the crop or problem you wish to analyze. If you have a problem, it is wise to take a "normal" and "problem" sample so you can compare the results. Keep in mind that variations may exist between benches, pots or crops in a greenhouse, your sampling program should monitor differences between all of those variables. For example, separate weekly analysis on your 4", 6" and 8" poinsettias would be useful. For routine analysis of a crop, samples should be collected from several pots or locations on the bench and combined into a single sample. Problem pots or bench areas should be sampled individually. Avoid samples from locations where fertilizers or lime were not thoroughly mixed throughout the media because of potential incorrect readings.

The sample should be a core sample from the top to the bottom of the pot or bench, so it includes the entire root zone of the plant. Frequently, the top 1/4-inch of medium is removed to avoid surface contaminations of fertilizers or salt accumulations. For large crop areas, it is suggested that at least 10 core samples be combined for a sample. The core samples should be thoroughly mixed together and discard any large stones or plant debris. Remember to follow the same procedure every time you sample so you can compare results and detect trends over time.

2. Mix Root Media and Water

With in-house testing, the volumetric method with 1 part root media : 2 parts distilled water is well suited. Some individuals may choose to use an 1 : 5 dilution for growing medias that have a high water holding capacity, those with a high percentage of sphagnum peat moss. Either dilution is acceptable, although the 1 : 2 method tends to give more accurate results because the water extract is not as diluted. Soluble salts results obtained via the 1 : 2 or 1 : 5 dilution method may vary from results obtained when you send your samples into a commercial lab or Purdue University Greenhouse Media Testing Lab which uses a saturated paste extract method.

When analysizing samples, use a measuring cup to measure out 1/2 to 1 cup of root media and place it into a clean plastic container such as old cottage cheese container. Add a volume of distilled water equal to two times the volume of root media, or if using the 1 : 5 proportions add five times the volume of distilled water. Thoroughly mix the suspension and allow it to stand for a minimum of a half an hour, but stir it two or three times during that period. *(When handling samples containing slow release fertilizer Osmocote, stir the media carefully to avoid breaking the fertilizer capsules.)*

A new root media should be wetted to field or container capacity and allowed to stand for 2 days before measuring the pH, which allows time for the lime in the media to react. The sample can be put into a growing container and watered until drainage occurs. When drainage stops, the sample can be placed in a plastic bag and held for 2 days before the analysis is run.

3. Determine pH

(For complete details, refer to Floriculture Indiana, Vol. 6, No, 3, Summer 1992, pages 10-11.) First, calibrate your pH meter based on the manufacturers instructions by using standard buffer solutions each time. Immerse the pH electrode into the growing media and distilled water suspension. Allow the measurement to stabilize before reading. This can sometimes take up to one minute depending on the meter.

4. Determine Soluble Salts

First decant off the liquid from the media-water solution. Use a funnel with filter paper or a hand-held kitchen strainer, which is available for around $3, to separate the liquid from the root media. Calibrate your conductivity meter with a solution of potassium chloride, which should be available from the source where you purchased the meter. Use the conductivity meter to determine the salt level in your sample. *(If tap water was used in making the dilution instead of distilled water, you will also need to take a salt reading of your tap water and subtract that value from the soil sample reading.)*

5. Interpreting Results

The sensitivity of plants to different soluble salt readings varies with plant type and stage of development. Table 1 contains a listing of the degree some plants are sensitive to salts. Guidelines have been developed which help interpret soluble salt readings. Remember that results will vary with the dilution rate used (1 : 2, 1 : 5, or the Saturated Paste Extract) and if you growing in soil-less or soil-based media. Table 2 contains guidelines for dilutions of 1 : 2, 1 : 5, and a saturated paste extract. If you want to compare results obtained with 1 : 5 and 1 : 2 dilution rates, Bunt (1988, page 93) states that salinity values for the 1 : 5 volume procedure will be approximately 40% of those obtained by the 1 : 2 method, unless the medium contains much sulfate. Purdue University uses the saturated paste extract method, which involves the addition of just enough water to thoroughly moisten the media. Table 3 contains a more in-depth interpretation for the saturated paste extract procedure. The units of measurement used with conductivity meters are called mhos. Since the amount of dissolved salts in the sample solution is quite small, the readings are usually expressed in whole numbers (ie.: 150). This is the procedure followed by the Purdue University Soil Testing Lab. (Other labs may only multiply mhos by 100 and express values in smaller units, for example Purdue's 150 would be 1.50 on their scale.)

6. Modifying Soluble Salts

If the soluble salts concentration be too high, leaching will reduce the salts level. The root medium should be irrigated normally, then followed immediately with another irrigation. After this, the medium should be allowed to dry to the usual stage, and a double-irrigation treatment then repeated. Check the soluble salt concentration again to make sure it is within the acceptable range.

Additional Tips

Once the equipment has been purchased, it is easy to set up a weekly monitoring program. It is better that the same person conduct the test to reduce the variability in how people take samples, even though everyone should be instructed to follow the same procedures. When a monitoring program is in place, it may be helpful to plot the weekly results on graph paper for each crop, pot size or greenhouse range, Figure 1. Graphing the results will allow you to see gradual shifts in pH readings and soluble salts which can alert you to a developing problem before your crop's quality is affected.

In addition, it is still useful to send media samples to a commercial lab every three to five weeks to monitor your nitrate nitrogen, ammonia nitrogen, phosphorus and potassium levels and to check your accuracy. Readings for pH should be similar between your in house results and the lab. Use Tables 2 and 3 for comparing soluble salt readings.

Sources of Conductivity and pH Meters

You can check locally with your main supplier for a soluble salt and pH meter, or use this abbreviated listed of firms.

Agro Dynamics, Bldg 3, Navy Yard, Brooklyn, NY 11205 800/872-2476.

B.F.G. Supply Co., 14500 Kinsman Rd, Burton, OH 44021 800/321-0608.

George J. Ball, Box 335, West Chicago, IL 60185 312/231-3500.

Beckman Instruments, 2500 Harbor Blvd., Fullerton, CA 92634 800/742-2345.

Engineering Systems & Designs, 3 S. Tatnall St., Wilmington, DE 19801 800/742-4325.

Florist Products Inc., 2242 N. Palmer Dr., Schaumburg, IL 60173 800/828-2242.

E. C. Geiger Inc., Rt 63, Box 285, Harleysville, PA 19438 800/443-4437.

Fred C. Gloeckner, 15 E. 26th St. New York, NY 10010 212/481-0920.

Hummert Seed Co., 2746 Chouteau Ave., St. Louis, MO 63103 800/325-3055.

J-M Trading Corp., 241 Frontage Rd, Suite 47, Burr Ridge, IL 60521 800/323-7638.

Vaughan's Seed Co. 5300 Katrine Ave., Downers Grove, IL 60515 312/969-6300.

Waldo and Associates, Inc. 28214 Glenwood Road, Perrysburg, OH 43551.

References

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Devitt, D.A. and R.L. Morris. 1987. Morphological Response of Flowering Annuals to Salinity. J. Amer. Soc. Hort. Sci. 112(6):951-955.

Holcomb, E.J. 1982. Fertilization Programs From Soil Test to Finished Crop. Pennsylvania Flower Growers Bulletin, No. 336: 3-6, 9.

Knauss, J. 1989. Put Your Plants Through Analysis. Greenhouse Grower. 7(6):42-51.

Peterson, J.C. 1982. Monitoring and Managing Fertility - Part II: Monitoring pH and Soluble Salt Levels in Growing Media. Ohio Florists' Association Bulletin, No. 630: 3-4.

Peterson, J.C. 1984. Current Evaluation Ranges For the Ohio State Floral Crop Growing Medium Analysis Program. Ohio Florists' Association Bulletin, No. 654: 7-8.

Warncke, D.D. and D. M Krauskopf. 1983. Greenhouse Growth Media: Testing & Nutrition Guidelines. Michigan State University Extension Bulletin, E-1736. pp. 6.

Wilkerson, D.C. Soilless Growing Media and pH. Texas Greenhouse Management Handbook. p. 30-34, 45-47.

Table 1. Soluble Salt Tolerance Level of Plants.

Very Sensitive	Sensitive
Ageratum	African violet
Alysuum	Aphelandra
Azalea	Calcelaria
Calellia	Chlorophytum
Celosia	Chrysanthemum
Cosmos	Clivia miniata
Cytisus x praecox 'Moonlight'	Dianthus
Marigold	Erica
Pittosporum tobira 'Variegata'	Ficus benjamina
Primula	Geraniums
Mahonia aquifolium ' Compacta'	Lettuce
Zinnia	Many bedding plants
	Petunias
	Portulacas

Tolerant	Very Tolerant
Carnation	Acacia cyanophylla
Cupressus arizonica	Atriplex
Diffenbachia	Bougainvillea 'Barbara Karst'
Hydrangea	Callistemon citrinus
Magnolia grandifolia	Cordyline indivisa
Philodendron	Dietes vegeta
Tomato	Hibiscus rosasinensis
	Spartium junceum
	Yucca aloifloia

Adapted from Bunt, p. 89, Devitt and Morris, and Wilkerson, p.47.

Table 2. Interpretation of substrate soluble-salt levels with three dilution methods.

Dilution 1:2 Soil-based	Dilution 1:2 Soil-less	1:5 (soil-based)	Saturated paste extract, soil-based and soil-less substrates	Interpretation
0-25	0-7	0-10	0-75	Insufficient nutrition
26-50	?-100	11-25	75-200	Low fertility unless applied every watering
100	-----	50	-----	Maximum for planting seedlings or rooted cuttings
51-125	100-175	26-60	200-400	Good for most crops
126-175	176-225	61-80	-----	Good for established crops
176-200	225-350	81-100	400-800	Danger area
Over 200	Over 350	Over 100	Over 800	Usually injurious

* Units are mho x 10-5/cm.

Adapted from Bailey, 1992, p.18.

Table 3. Interpretation of Saturated Paste Extracted Soluble-Salt Levels.

	Soluble Salts* Not Planted	Soluble Salts* Planted Less Than 2 Weeks or Seedlings	Soluble Salts* Planted More Than 2 Weeks
Extremely Low	0-74	0-74	0-74
Very Low	75-99	75-99	75-99
Low	100-124	100-124	100-149
Slightly Low	125-199	125-199	150-199
Optimum	200-299	200-299	200-349
Slightly High	300-349	300-349	350-374
High	350-399	350-399	374-399
Very High	400-424	400-424	400-499
Extremely High	425-429	425-499	500-799
Toxic	450 +	500 +	800 +

*units are mhox10-5/cm

Adapted from Peterson, 1984, p.3.

Figure 1. Method of Graphically Tracking pH and Soluble Salts Readings with Poinsettias.