CHECKLIST
NUTRIENT MANAGEMENT

Field Production

- ✓ Take soil samples at or near the same time each year, so results from year to year can be compared.
- ✓ Take soil samples during mid summer or fall each year.

Container Production

- ✓ During the growing season, monitor container media every 2 to 4 weeks.
- ✓ During the winter, monitor substrate electrical conductivity two or three times.
- ✓ Collect several representative substrate samples of the growth substrate being considered.
- ✓ If on-site testing is used, send the leachate solution for laboratory analysis at least once during the growing season to check accuracy of meters.
- ✓ Analyze container leachate and leaf tissue to diagnose nutritional disorders.

Soil pH

- ✓ Test soil pH levels prior to planting.
- ✓ In field production, adjust pH prior to planting.
- ✓ In container production, incorporate pH adjustments during the potting mix preparation.

NUTRIENT MANAGEMENT

Soil Testing

A soil test is important for several reasons: to optimize crop production, to protect the environment from contamination by runoff and leaching of excess fertilizers, to aid in the diagnosis of plant culture problems, to improve the soil's nutritional balance, to save money and conserve energy by applying only the amount of fertilizer needed, and to identify soils contaminated with lead or other heavy metals.

Determining the pH and fertility level of a soil through a soil test is the first step in planning a sound lime and fertilization program. A soil test provides the means of monitoring the soil so deficiencies, excesses and imbalances can be avoided. Avoid sampling when the soil is very wet or has been recently limed or fertilized. Soils that look different or have been used differently should be sampled and tested separately. Areas where there is poor growth should also be tested separately.

The numerical results of a soil test reflect analytical procedures used by specific laboratories. For this reason, soil test results from different laboratories should not be compared.

Field Production

Soil samples from field nurseries can be taken any time during the year; however, midsummer to fall is the most desirable time to determine fertilizer needs for the following year. Soils should be dry enough to till when sampling, and fields are usually dry and easily accessible in the fall. The soil pH and nutrient levels will be at or near their lowest points during late summer and early fall. Therefore, samples collected in the fall are more representative of the actual fertility conditions during the growing season than samples collected in late winter or early spring. Fall sampling also allows sufficient time for results and recommendations to be received from the laboratory so any necessary limestone and fertilizer can be applied before planting.

Soil nutrient levels change during the year depending on the temperature and moisture content of the soils. It is important, therefore, that samples be taken at or near the same time each year, so results from year to year can be compared.

Container Production

Soil samples from soilless mixes are tested differently than samples from field soil. There are three commonly used methods of testing soilless media based on the use of water as an extracting solution: 1:2 dilution method, saturated media extract (SME), and leachate Pour Thru. The value representing the level of soluble salts from a soil test using a 1:2 dilution method will mean something different than results from SME or leachate Pour Thru. For example, 2.6 would be "extreme" (too high) for the 1:2 method, "normal" for SME, and "low" for leachate Pour Thru. Likewise, values for specific nutrients are likely to differ with testing methods. Always use the interpretative data for the specific soil testing method used to avoid incorrect interpretation of the results. For more details, see Appendix C, Interpretation of Soluble Salt and pH Measurements.

Most fertilizers (except urea) are salts and when placed in solution they conduct electricity. Thus, the electrical conductivity (EC or soluble salts) of a substrate solution is indicative of the amount of fertilizer available to plant roots. In addition to carrying out a complete soil test, container growers should routinely check the EC and pH of their container crops and irrigation water. These checks can be done onsite using portable testing meters, or samples can be sent to the University of Massachusetts soil test laboratory. Growing media for long-term crops should be tested at least monthly, but biweekly monitoring during the summer may be necessary to track fluctuations in EC. Even when controlled-release fertilizers are used, substrate nutritional levels will gradually fall during the growing season to levels that may not support optimal growth.

pH and EC Monitoring Equipment

Many horticulture or nursery supply companies carry pH and EC testing equipment, usually in the form of pens or meters. Most pens and meters are temperature-compensating; however, the instructions that come with the equipment will help growers determine if any adjustments are necessary related to environmental conditions. A buffer (standardizing) solution (pH 4 or 7) should be purchased with pH meters or pens. A standard solution should also be purchased with EC pens and meters to assure that equipment is calibrated and working properly.

Sending the leachate solution collected from the Pour Thru method for laboratory analysis at least once during the growing season is a good idea, so that actual nutrient levels in the container can be determined and corrected if needed. The accuracy of EC and pH meters can also be checked by sending a leachate sample to the laboratory at least once during the growing season.

Growers can plot or record average leachate EC and pH values from 3 to 5 containers scattered within a block of plants in an irrigation zone. Routinely sample leachates for EC and pH to obtain data on when fertilizer runs out, whether or not irrigation volume is appropriate, and whether or not irrigation distribution over the block is uniform. Sample containers diagonally across a growing block to help diagnose poor uniformity in irrigation patterns.

High temperatures in overwintering structures can result in nutrient release from controlled-release fertilizers. Monitor substrate EC two or three times during the winter to ensure levels are not toxic.

When plant foliage becomes chlorotic or off-color, analyzing container leachate and leaf tissue are the best diagnostic steps to determine nutritional disorders. A leaf tissue laboratory sample should include 20 to 100 (depending on the size of the leaves) of the most recently fully expanded leaves. Send a leachate sample with the leaf tissue sample to supply information about recent and current nutrient conditions in the container. Test results generally provide insight into problems related to nutritional imbalances in the plant or substrate.

Soil Sampling Instructions
Sampling can be done at any time; but if pH adjustments are necessary, test as early as possible prior to planting. Avoid sampling soils that have been fertilized very recently. The following procedure covers taking a soil sample to be sent to the soil test laboratory or tested onsite using the 1:2 method:

1. Soils that are distinctly different as judged by appearance, crop growth or past treatment should be sampled separately.

2. Each field nursery sample submitted for testing should be a mixture of approximately 12 separate samplings taken over a well-defined area.

For container production take a sample at root depth from several pots and mix together. Skip to step 6.

3. Look over the field or property. Define a sample area based on uniformity of texture, slope, drainage, color, and past pest and fertility management.

4. Avoid sampling very wet soils. In soils where fertilizer has been placed in bands (rows), do not sample directly in a band. It is best not to obtain samples very near the edge of a field or plot.

5. Using a clean spade, auger, or sampling tube, obtain soil from the surface through the primary rooting zone of the crop. Rooting depth will vary with crop type. For most plants the top 6 to 8 inches is appropriate.

6. Place each of the 12 randomly spaced samplings in a clean container (pail or bag) and mix thoroughly. Spread the mixture out on a clean paper to air dry (do not place soil in an oven).

7. Mix the soil again. Obtain a one cup measure of the soil mixture and place it in a zip-lock type bag.

8. Label the outside of the bag clearly with your name, address, and your name for the sample (ID).

Send the sample to the University of Massachusetts Soil and Tissue Testing Laboratory, West Experiment Station, 682 North Pleasant Street, UMass, Amherst, MA 01003. For more information, see Appendix B, Soil and Tissue Testing Service.
Soil samples from container crops can be tested on site for pH and EC using the 1:2 soil testing method. For information, access the online fact sheet “How to Use pH and EC ‘Pens’ to Monitor Greenhouse Crop Nutrition” (http://www.umass.edu/umext/floriculture/fact_sheets/greenhouse_management/phecpens.html).

Pour Thru Procedure for Collecting and Testing Leachate from Container Nursery Crops

In addition to collecting a soil sample to test, growers can collect leachate from container grown stock using the Pour Thru method. The leachate that is collected can be tested onsite to determine EC and pH for container crops or it can be sent to a laboratory for a complete test. Simply testing container leachate without adhering to the following procedure will lead to misinterpretation of results:

1. Irrigate nursery containers to container capacity (10% to 20 % leaching expected).

2. Wait 30 minutes to 2 hours for equilibration of nutrients in container solution.

3. Place containers to be tested in a shallow saucer to collect leachate. Pour 2.4 fl.oz. (80 milliliters (ml)) of water over the surface of a 1 gallon container, 2.9 fl. Oz. (86 ml) for 3 gallon container, 4.1 fl.oz. (122 ml) for 5 gallon container and 5.1 fl.oz. (151 ml) for 10 gallon container.

4. An alternative for nursery containers is to lift and tip containers to drain leachate into a collection vessel.

5. Calibrate the pH and EC test equipment using manufacturers' descriptions and appropriate standard solutions.

6. Read and record results.

7. Develop a log book for crops and irrigation zones for the season.

Make conductivity and pH equipment readily available to employees; keeping it in their vehicle or work area provides them with an opportunity to check EC and pH as part of the routine nursery scouting program. If equipment is kept in a truck cab, place it in an insulated cold drink cooler. This will reduce exposure of the equipment to extreme heat, cold, and evaporative conditions, thus extending its useful life. Train employees to use and calibrate the equipment using clean, fresh standards. Calibrate pH and EC equipment daily before use or each time before testing a group of solutions, and between samples, if critical decisions are going to be made based on results or if the readings seem questionable.

Soil pH

A fertility program for woody plants begins with obtaining an analysis of soil pH, or level of acidity. Soil pH is measured on a scale of 0 to 14. Soils with a pH below 7 are acidic while those above 7 are alkaline. Adjusting pH is important not only because specific plants grow best within a certain pH range, but also because soil pH affects the availability of both major and minor nutrient elements. Furthermore, soil pH influences the level of microbial activity in soils. Microbes involved in mineralization of organic matter are most active between a pH of 6 and 7. At extremes in pH, many nutrients occur in forms unavailable for uptake by plant roots.

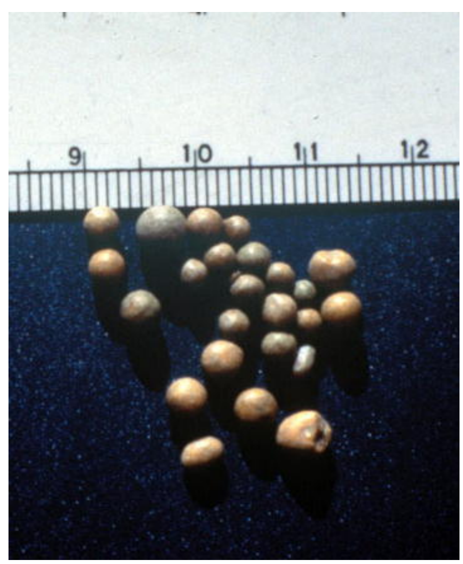
Analysis of soil pH should be routinely made prior to planting. Typically, limestone is required to adjust pH upward while sulfur is used to lower pH. These materials are best incorporated (in the field or in containers) prior to planting, since surface applications are slow to affect pH. In the field, most liming and sulfur recommendations are based on the assumption that the material will be worked in to a depth of 8 inches. Deeper incorporation of either limestone or sulfur will require adjustments in application rates to accommodate larger volumes of soil. In container production, pH adjustments are made during the potting mix preparation.

Fertilizer Choices

A distinction is necessary between field production and container production regarding plant nutrition. Field nurseries grow in soil and container nurseries grow in soilless potting mixes.

Basic plant nutrition involves the uptake of sixteen mineral elements essential to plant growth. In addition to carbon, hydrogen, and oxygen, which they obtain from air and water, plants require the elements nitrogen (N), phosphorus (P), and potassium (K) in greatest abundance.

Nutrition research on field grown woody plants has shown that N is the element that yields the greatest growth response in trees and shrubs. For this reason, high N fertilizers with N-P-K ratios of 4-1-1, 3-1-1, or 3-1-2 are generally used for feeding established woody plants. These include fertilizers with analyses such as 8-2-2, 15-5-5, 24-8-16 and similar formulations. The N-P-K analysis refers to % N, % P (as P_2O_5) and % K (as K_2O) in the fertilizer. Although a combination or complete (N,P, K) fertilizer is less expensive than applying straight (nutrient specific) fertilizers, if one of nutrient element is not needed or is needed in less amounts, potential negative environmental impacts may be greater. It is better to apply specific nutrient as recommended by a soil test. In field soils, P, K, and essential elements other than N are slow to be depleted. Provided these nutrients are at recommended levels, a fertilizer program for established woody plants can consist of applications of N sources alone. Under normal conditions, complete fertilizers as mentioned above may be used every 4 or 5 years to ensure a supply of the other essential nutrients.



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Fertilizers are available as a granular, controlled-release, or water soluble formulations. Field nurseries use granular or controlled-release fertilizers (CRFs). Container nurseries use CRFs and water soluble fertilizers (fertigation). CRFs package nutrient salts in "capsules" with resin or polymer coating. The coating "controls" the release of nutrient salts according to moisture content or temperature of the substrate. The method of application also affects nutrient release..Research has shown that topdressing results in reduced nutrient losses compared to incorporation. CRFs are available in several formulations to suit the nutrient requirements of different plants, and also are available with different coatings to provide nutrient release over different time frames (e.g. 4-month versus 12-month formulations). These products generally provide more consistent nutrient availability to plants over time. Application of controlled-release forms of N provide the most efficient use of this nutrient because root growth and nutrient absorption can occur anytime soil temperatures are above 40°F. Research on some CRFs in New Jersey indicated that some CRFs are more responsive to temperature changes than others. Test CRFs new to you to find their performance under your particular growing conditions to adjust your fertilization management accordingly. The amount of N applied generally determines the rate used. Monitor the EC of the substrate regularly when using CRFs to check for soluble salts.