CHECKLIST
CONTAINER NURSERIES— NUTRIENT MANAGEMENT

Mixing and Handling Growing Media

- ✓ Test the media pH, electrical conductivity, and wettability before use.
- ✓ Do not make changes to current growing media without experimenting first to see if changes may affect cultural practices.
- ✓ When mixing, thoroughly mix components, but do not over-mix, especially if a medium contains vermiculite or controlled release fertilizer.
- ✓ Do not store media that contains fertilizer especially if the media is moist.
- ✓ Avoid contamination of components for finished media by keeping amendments in closed bags or by covering outdoor piles.
- ✓ Do not allow mixes containing peat most to dry out.

Using Fertilizers

- ✓ Use a backflow preventer to ensure that water containing fertilizer or pesticide is not mixed with water used for human consumption.
- ✓ Apply fertilizer only when needed. Use a fertilizer nutrient ratio of approximately 3:1:2 N: P_20_5: K_20.
- ✓ Use soil test results and product manufacturer guidelines to determine fertilizer rates.
- ✓ Amend the growth substrate prior to potting with controlled-release fertilizer (CRF) rather than applying fertilizer to the substrate surface if containers are subject to blow over.
- ✓ Mix CRFs uniformly throughout the growth substrate.
- ✓ Do not add superphosphate to the container substrate.
- ✓ Adjust application rates for fall and winter (after first frost) or when using subirrigation. Application rates are usually one-half the rates used in summer.
- ✓ Apply supplemental fertilization or reapplication by injecting fertilizer into irrigation water or placing fertilizer on the surface of container substrate.
- ✓ If injection is used with overhead irrigation systems, collect runoff or take steps to address nutrient runoff.
- ✓ Inject an individual element or a combination of elements in concentrations slightly less than desirable levels to be maintained in the growth substrate.
- ✓ Surface-applied fertilizer should be applied to small blocks or groups of plants to minimize nutrient runoff.
- ✓ Avoid broadcast fertilizer applications unless containers are pot to pot.
- ✓ Record fertilizer product name and analysis, date and location applied, and general notes about plant and environmental conditions. Use past records for troubleshooting current problems.
- ✓ Group plants according to their fertilizer needs so supplemental fertilizer applications can be made only to plants requiring additional fertilizer. This is particularly important if fertilizer is injected in irrigation water.

Monitoring Nutrient Status

- ✓ 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 to ensure that samples represent the growth substrate being considered.
- ✓ Have irrigation water tested at least once each year.

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Growing Media

The most common components in an outdoor container nursery mix are bark, sphagnum peat moss, and sand. Some alternative materials being used are shredded coconut husks (coir), composted yard wastes and animal wastes, composted hardwood bark, and other composted materials. Softwood bark typically comprises from 80 to 100% of a mix. Peat is often included to increase the water-holding capacity of a mix, while sand and soil are often added to increase the weight, which reduces container tip-over. Many growers use a recipe of 80% pine bark, 10% peat and 10% sand.

Use of Composts in Nursery Potting Media

Organic materials that have been properly composted can also be used in nursery potting mixes. For container use, be cautious and use approximately 10% compost by volume in pine bark mixes. The compost should be considered a substitute for peat moss and sand. Conduct a soil test before adding fertilizer. Addition of minor elements will probably be recommended. For container production, the use of slow-release fertilizers is also recommended. Dolomitic limestone should be omitted or reduced to no more than 3 pounds per cubic yard of potting mix. The soluble salts level and pH should be monitored during the growing season. Before using compost on any nursery crop, establish a small test area to determine the material's suitability for the particular ornamental species.

Mixing and Handling Growing Media

- Test the media pH, electrical conductivity and wettability before use.
- Do not make changes to your current growing media without experimenting first to see if changes may affect your cultural practices.
- If mixing your own media, thoroughly mix components, but do not over-mix, especially if a media contains vermiculite or controlled release fertilizer.
- Do not store media that contains fertilizer especially if the media is moist.
- Avoid contamination of components for finished media by keeping amendments in closed bags or by covering outdoor piles.
- Do not allow mixes containing peat most to dry out.

Fertilizing Container Nurseries

Container-grown plants are fertilized using water soluble fertilizers through an irrigation system or controlled-release fertilizers (CRFs). The amount of N applied generally determines the rate used.

When fertilizer is injected in the overhead irrigation system, steps need to be taken to address the irrigation water leaving the property, because much of the water from overhead irrigation systems falls between containers. Fertilizing through irrigation water is appropriate for low-volume irrigation systems in which irrigation water is delivered to the container such as drip irrigation. Even then, care needs to be taken to minimize leaching from the container to prevent nutrient runoff from entering surface or ground water.

When preparing a nutrient management plan for a container operation, a nutrient management consultant should conduct an environmental risk assessment. The purpose is to evaluate the potential risk to the environment of nutrient movement from container growing areas.

- Apply fertilizer only when needed. Use a fertilizer nutrient ratio of approximately 3:1:2 N: P_20_5: K_20.
- Use soil test results and product manufacturer guidelines to determine fertilizer rates.

CRFs supply essential plant nutrients for an extended period of time (months). Fertilizers are available that contain different mechanisms of nutrient release and different components.

- Amend the growing media prior to potting with CRF, rather than applying fertilizer to the surface, to prevent fertilizer being spilled if containers blow over. Also, surface-applied fertilizer encourages weed growth.
- Mix CRFs uniformly throughout the growth substrate.
- Do not broadcast fertilizer on spaced containers.

Nutrients in the growing media can be leached regardless of the type of fertilizer applied. Irrigation practices play an important role for preventing fertilizer runoff.

P leaches rapidly from a soilless growing media. Complete CRFs applied during the growing season should supply adequate P. Therefore, do not add superphosphate to the growing media.

CRF application rates vary from product to product, but also depend on plant species and container size. The goal of a fertilizer program is to apply the least amount of fertilizer for the desired growth so that nutrient leaching is minimized. Apply CRF at the manufacturer's recommended rate and reapply fertilizer when substrate solution status is below desirable levels. Application rates should be adjusted for fall and winter (after first frost) or when subirrigation is used since the rates used then are usually one half the rates used in summer.

When supplemental fertilization is needed, fertilizer is either injected into irrigation water or CFR is placed on the surface. If injection is used with overhead irrigation systems, runoff must be collected or steps taken to address nutrient runoff.

When CFR fertilizer is applied to the surface as a supplemental fertilizer it should be applied to small blocks or groups of plants to minimize nutrient loss and runoff. Surface applied fertilizer should not be broadcast unless containers are pot to pot.

Group plants according to their fertilizer needs so supplemental fertilizer applications can be made only to plants requiring additional fertilizer. This is particularly important if fertilizer is injected in irrigation water.

Record fertilizer product name and analysis, date and location applied, and general notes about plant and environmental conditions. Use past records for troubleshooting current problems.

Preventing Backflow
All potable water must be protected against backflow to ensure that water containing fertilizer or pesticides is not mixed with that used for human consumption. Backflow or backsiphoning occurs when a negative pressure develops in the water supply line, causing water that contains fertilizer or pesticides to be drawn back into the supply lines. The National Plumbing Code, which has been adopted in most states, requires that backflow preventers be installed on any supply fixture when the outlet may be submerged. Examples of this are hoses that fill spray tanks or barrels, fertilizer injectors, or equipment wash tubs.

Monitoring Nutrient Status for Container Production
The longevity of the release of CRFs is influenced by environmental factors. To ensure that adequate nutrient levels are maintained in the growing media, monitor the nutrient status and use the results to determine fertilizer reapplication frequency. Regular monitoring is important because plants may not show visible symptoms of excessive or inadequate nutritional levels, however growth may be reduced. High concentrations of nutrients can result from media components, inadequate irrigation frequency and duration, water source, and/or fertilizer materials and application methods. Nutrients may also accumulate during the overwintering of plants in polyhouses. Excessive nutrient concentrations injure roots, restricting water and nutrient uptake. Rainfall and excessive irrigation can leach nutrients from containers resulting in inadequate nutrient levels and runoff.

Growing media used for long-term crops should be tested at least monthly, but biweekly monitoring during the summer may be necessary to track fluctuations in electrical conductivity (EC), which is used as a relative indicator of the nutritional status of the container media. Even when CRFs are used, media nutritional levels will gradually fall during the growing season to levels that may not support optimal growth.

High temperatures in overwintering structures can result in nutrient release from CRFs. Monitor EC two or three times during the winter.

- During the growing season, monitor container media every two to four weeks.
- During the winter, monitor EC two or three times.
- Collect several representative media samples to ensure that samples represent the growing media being considered.

Irrigation Water Testing
In addition to monitoring the nutrient status of the growing media, irrigation water should be tested for pH, alkalinity, sodium (Na), chloride (Cl), and EC each year.

pH is a measure of the concentration of hydrogen ions (H+). In general, water for irrigation should have a pH between 5.0 and 7.0. Water with pH below 7.0 is termed “acidic” and water with pH above 7.0 is termed “basic;” pH 7.0 is “neutral”. Alkalinity is a measure of the water’s ability to neutralize acidity. An alkalinity test measures the level of bicarbonates, carbonates and hydroxides in water and test results are generally expressed as “parts per million (ppm) of calcium carbonate ($CaCO_3$)”. The desirable range for irrigation water is 0 to 100 ppm $CaCO_3$. Levels between 30 and 60 ppm are considered optimum for most plants.

In most cases, irrigating with water having a “high pH” (7) causes no problems as long as the alkalinity is low. This water will have little effect on growing medium pH because it has little ability to neutralize acidity. This situation is typical for many growers using municipal water in Massachusetts, including water originating from the Quabbin Reservoir.

Na and Cl are naturally occurring elements in soils and water but their levels can become elevated due to road salt, water softeners, and some fertilizers. High levels of Na and Cl uptake can accumulate to toxic levels in plants and abundant amounts in water can raise the EC to levels undesirable for plant by inhibiting water uptake. Most often, these high levels are from private well or pond water but sometimes public water is the source. The solutions to the problem of high Na and Cl include regular water testing during the growing season (in borderline cases of excess Na and Cl) and avoidance of over-fertilization to prevent high growth medium EC; installation of water treatment systems to remove Na and Cl; efforts to protect wells and ponds from salt contamination by runoff; or finding new sources of water.

Table 5. Ranges for electrical conductivity (EC), sodium (Na), and chloride (Cl) in irrigation water

Factor	**Target Range**	**Acceptable Range**
EC (mmho/cm)	0.2-0.8	0-1.5
Na (ppm)	0-20	Less than 50
Cl (ppm)	0-20	Less than 140

Interpretation of a Soil Test Report

Interpreting a soil test involves comparing the results of a test with the normal ranges of pH, soluble salts, and nutrient levels set by the testing laboratory. Normal ranges are specific to the lab and its method of testing. Some interpretation may be done for you, often by a computer program. Best interpretations take into account the crop, its age or stage of development, the growth media (soil or soilless media), the fertilizer program (specific fertilizer, rate, frequency of application) and if there is a problem, what the symptoms are.

pH or Soil Acidity—What action to take on pH depends on the specific requirements of the plants being grown and knowledge of the factors which interact to affect the pH of the media. Limestone (rate, type, neutralizing power, particle size), irrigation water pH and alkalinity, acid/basic nature of fertilizer, and effects of mix components (container plants) are major influences on pH.

Electrical conductivity (EC)—Measuring EC provides a general indication of nutrient deficiency or excess. A high EC reading generally results from too much fertilizer in relation to the plant’s needs, but inadequate watering and leaching or poor drainage are other causes. Sometimes high EC levels occur when root function is impaired by disease or physical damage. Always check the condition of the root system when sampling soil for testing.