



Best Management Practices for Watershed Protection

Greenhouse Fertilizers

Thomas Weiler, Department of Horticulture, Cornell University

Why care about a fertilizer program?

Water carries fertilizers and other agricultural chemicals via runoff to surface water or by leaching through the earth to ground water. Although environmental processes and landscape buffer zones may mitigate the effects of small amounts of these chemicals, large releases can result in serious deterioration of water quality. For especially sensitive sites, the Department of Environmental Conservation may monitor nearby water resources as proof of good stewardship. Thus, monitoring fertilizer practices is important to crop health and conserves the natural environment of the greenhouse site and beyond.

Efficient use of resources is common sense and good greenhouse management. Cost of an input (e.g., heat or labor) for a unit of output (such as a flat of bedding plants) is the usual way of evaluating efficiency. For an intensive, high-input, high-cost-of-production facility such as a greenhouse operation, the cost of fertilizer is low, but the risk of environmental contamination is high. Installing zero-effluent growing systems like flood floors or Dutch trays, however, can reduce fertilizer use to about one-half of the former amount. The point? A significant portion of the fertilizer applied to crops in a typical leached greenhouse system may be lost to the watershed.

Avoid excessive irrigation

The leached growing systems so common in greenhouses rely on 10% of the irrigation water washing through the root zone and out the bottom of the container, flushing out excess soluble salts. Using more irrigation volume than 110% ("heavy watering") is especially common with small units, such as plug trays and bedding plant flats. Excessive irrigation is no more effective than routine leaching and washes out desirable amendments to the root zone, such as limestone. It also adds to leachate volume and degrades the environment.

Leached systems are inexpensive to install and easy to use compared to zero-effluent systems, which recirculate leachate. "Closed" zero-effluent systems are generally more space efficient and more mechanized than leached systems, but it can be difficult to provide the right amount of fertilizer. Operation requires expensive monitoring, the risk to the crop is greater than in a leached system, and many growers find plant quality and post-production shelf life may be compromised.

Pay attention to water pH

To grow greenhouse crops, you must pay attention to water quality applied to the crop. Although high levels of bicarbonate

How much fertilizer do you use?

Comparisons of fertilizer use typically focus on nitrogen. The amount of nitrogen used in your greenhouse operation each year is easy to tally:

- ✧ Determine the amount of each fertilizer in inventory at the start of the year.
- ✧ From purchasing records, tally the amount of each fertilizer purchased during the year.
- ✧ At the end of the year, tally the amount of each fertilizer remaining. The amount used in a year is equal to the initial inventory plus purchases, less ending inventory.
- ✧ To determine the amount of nitrogen applied per year, multiply the amount of each fertilizer used by the percent nitrogen (as a decimal number), e.g., 100 lb 15-5-15 \times 0.15 = 15 lb nitrogen. Add the amounts of nitrogen of the various fertilizers used.
- ✧ Determine the acreage of the operation. An acre is 43,560 sq. ft. Thus a 20,000 sq. ft. facility is 0.459 acres.
- ✧ Finally, calculate lb N/acre/year by dividing total lb N by the acreage figure.

Field crop growers typically apply 0–150 lb N/acre/year. Because greenhouses operate year-round and provide an optimal environment for growth, growers may use as much as 1–2,000/lb N/acre/year.

ion (resulting in alkalinity) are undesirable, they can be managed by injection of an acid into the irrigation water. Sometimes high levels of sodium, chloride, or sulfate in the water source pose too great a problem to solve. Specific nutrient elements are important in a fertilizer program (N, P, K, Ca, Mg, S, B, Cu, Fe, Mn, Mo, Zn, Cl, Na, Ni). The hydrogen concentration or pH determines the availability of these nutrient elements to the plant. The entire soluble chemical (ionic) environment in the crop's root zone can be assessed by measuring electrical conductivity (EC) or strength of the soluble salts around the root system. Accurately providing fertilizer to the crop maximizes the likelihood of a high quality finished product and minimizes release to the environment.

Planting mixes and fertilizer formulations are designed to provide an optimal chemical environment in the root zone. Following product directions and periodically testing root zone pH and EC are often sufficient for growing a crop successfully.

Many easy-to-use pH and EC meters are available. Two accurate ones in the \$30-\$60 range are

- *Agritest pH and EC pocket-sized meters* (Hanna Instruments, Inc., 584 Park East Drive, Woonsocket, RI 02895, www.hannainst.com.)
- *Waterproof hand-held meters* (Oakton Instruments P.O. Box 5136, Vernon Hills, IL USA 60061, <http://4oakton.com>.)

How to get started

Ingredients

- ✓ Trained applicators
- ✓ Well-engineered watering systems
- ✓ An accurate proportioner/injector (choose a proportioner in the \$100+ range; proportioners in the \$20 range are notoriously imprecise)
- ✓ A pH meter for in-house testing
- ✓ An EC meter for in-house testing
- ✓ A high-quality planting mix from a reputable formulator
- ✓ High-quality fertilizers from a reputable formulator
- ✓ Access to a reliable commercial analytical laboratory specializing in greenhouse nutrient testing

Recipe

The recipe for best management involves initial tests of water; careful selection of planting mix and fertilizer; routine testing of pH and EC during crop growth; and adjusting the fertilizer program as needed.

1. Review the chemistry of the water as reported in a complete analysis from a nutrient analysis laboratory that works with greenhouse operators.
2. Select the planting mix for physical characteristics (drainage, aeration, weight), and determine the extent of nutrient charge (often a nutrient analysis is needed).
3. Select fertilizer product(s) based on water and planting mix chemical characteristics, as well as crop production time.
 - Short-term crops: for most bedding plants and crops requiring 2-3 months, sufficient calcium, magnesium, and sulfur will be available if fertilizers for soil-less mixes are applied at each irrigation.
 - Long-term crops: for crops growing several months, such as stock plants and start-to-finish production of

How to change pH

Methods for changing root zone pH are well-described in trade magazine articles and at the University of New Hampshire's website (see resources).

Briefly, to control pH of irrigation water:

1. Choose a planting mix that is buffered to remain at an optimum pH, 5.8-6.2.
2. Mitigate the effects of irrigation water on pH. For high pH, high alkalinity water, inject an acid such as nitric acid or sulfuric acid; for low pH, low alkalinity water, inject a base such as potassium carbonate or potassium bicarbonate.
3. You may need to inject an acid or base with a double-headed proportioner; the amount of acid or base to use is determined by a titration curve supplied by an analytical laboratory.
4. To test the pH of the root zone, use the PourThru method, then graphically track trends.
5. For minor adjustments of pH during crop growth, if the trend is toward rising pH, apply fertilizer with a 33% ammonium-nitrogen content, such as 20-10-20; if the trend is toward falling pH, apply fertilizer with a high nitrate-nitrogen content, such as 15-5-15. Information on the fertilizer bag will indicate whether the net effect of the fertilizer will be to lower pH (acidity index) or raise pH (basicity index).

African violets, azaleas, cyclamen, and hydrangea, use fertilizer products or combinations containing all nutrients (including calcium, magnesium, and sulfur) at each irrigation

4. Monitor the crop root zone for trends in pH and EC, and adjust the fertilizer program as needed.

Establish a routine

Having a fertilizer management system in place adds a degree of certainty and predictability to crop growing. Daily observation of crop growth, frequent scouting for abnormal crop symptoms, routine testing of pH and EC, and maintenance of equipment greatly reduce the risk of crop-threatening events or crop failure.

Routine monitoring varies with each operation. At a minimum, it should include monthly, semimonthly, and as-needed tasks.

Monthly

- ✓ Check the accuracy of the fertilizer stock solution. Example: for a 1:100 ratio, mix 1 part fertilizer stock and 99 parts water to obtain the EC desired (see fertilizer bag for more information).
- ✓ Check the accuracy of the fertilizer proportioner (e.g., for a 1:100 ratio, the EC delivered to the crop should be one hundredth of the stock solution EC)

Every 1-2 weeks

- ✓ Check crop pH and EC using in-house approaches, e.g., the PourThru method:
 - ✧ pH and EC of the leachate should be in the desired range and similar from test to test unless changes you have made in the fertilizer program or water source.
 - ✧ pH and EC should be similar from plant to plant when several plants are tested; large differences suggest that fertigation is not uniform, the planting mix was not uniformly prepared, or testing has not been carefully carried out.

As needed (problem-solving)

- ✓ Crop problems, such as slowed growth, wilting, and unusual color in leaves often suggest the need for immediate pH and EC testing and perhaps changes in growing procedures.

Getting help

If an unexpected and confusing problem occurs, or if negative trends persist despite your best efforts to correct them, it's time to involve the experts. Other people bring a fresh look and different experiences. Analytical data (from a laboratory) on water, plant, and planting mix samples will highlight difficulties with a particular nutrient or toxic chemical. In situations where analytical differences are slight, assistance from of a consultant, such as an Extension Educator, private sector advisor, or a company's customer service representative, may help determine if your fertilizer program needs improvement.

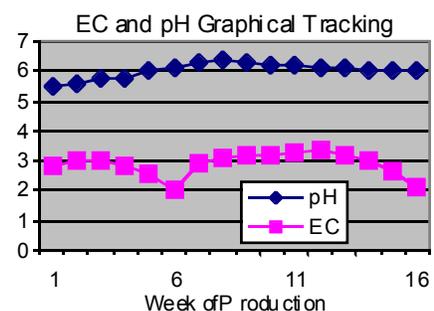
Monitoring fertilizer practices is important to crop health and conserves the natural environment

Steps to in-house testing

For complete instructions on using PourThru for testing pH and EC, access the North Carolina State University website (see resources).

Briefly, the procedure involves 4 steps:

1. Preparation: Irrigate the plants one hour before testing, making sure the planting mix is thoroughly wet. Allow the pots to drain for 30-60 minutes. Once drainage has stopped, place each pot to be sampled into individual plastic saucers.
2. Extraction: Pour onto each pot enough deionized or distilled water to get about 2 oz. (50 ml) leachate out the bottom of the pot.
3. Testing: EC and pH will be measured directly from the leachate.
4. Graphing: Use graphing paper or spreadsheet software to plot pH and EC readings throughout the cropping period.



Resources

"How to Change pH." For a reprint, contact Greenhouse Grower, 800-5772-7740; <www.meisterpro.com>.

For information on the PourThru Method: North Carolina State University, www.floricultureinfo.com (under TOPICS, select "PourThru Sampling," then choose one of the PDF documents). You can find "Monitoring and Managing pH Using the PourThru Extraction Method" at this site. For a hard copy: North Carolina Commercial Flower Growers' Association, 3906 Wake Forest Rd., Suite 102, Raleigh, NC 27609.

"Managing the pH of Container Growing Media" from the University of New Hampshire website, <http://ceinfo.unh.edu/agriculture/documents/flora.htm> (under Nutrition); hard copy: Meister Publishing Company, 37733 Euclid Avenue, Willoughby, OH 44094-5992; 800-572-7740; <www.meisterpro.com>.

"Water and Nutrient Management for Greenhouses," (NRAES 56), 110 pages, \$15 list price from Natural Resource, Agriculture, and Engineering Service, <www.nraes.org>, NRAES@cornell.edu, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, New York 14853-5701; 607-255-7654; (fax) 254-8770.

Written by Thomas Weiler.
Edited by Jana Lamboy and
Carrie Koplinka-Loehr.
Cover photo by Aimee
Roberts. Produced by the
New York State Integrated
Pest Management Program,
which develops sustainable
ways to manage pests and
helps people use methods
that minimize environ-
mental, health, and
economic risks. For more
information:

www.nysipm.cornell.edu. This project funded by the
Water Resources Research Grants Program. NYSAES 2M 2/03.



Cooperative Extension

Where to send soil samples

Some New York greenhouse operators rely on the services of the following laboratories.

CHEMICAL CONSULTING OF
BABYLON, 40 East Main Street, Babylon
Village, NY 11702,
www.babylonvillage.com/soil&plant_tissue_testing, 516.587.0632.

FAFARD ANALYTICAL SERVICES, 183
Paradise Blvd., Suite 106, Athens, GA
30607, 800.457.3301, www.fafard.com.

J. R. PETERS LABORATORY,
6656 Grant Way, Allentown, PA 18106,
800.743.4769, www.jrpeterslab.com.

SUN GRO HORTICULTURE
ANALYTICAL SERVICES,
800.682.6667.

Procedures for taking and sending samples are precise and provided by each laboratory. Typically they include where and when to take samples, how large the sample must be, and how to package (and if necessary, store) samples.