



Figuring Out Right Here Fertilization

Understanding how to perform a few simple tests can help keep your fertilization program from interfering with your crop schedule and save your margins.

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Problems with greenhouse fertilizer programs are common and can result in decreased quality or a prolonged growing period, both of which will decrease profit margin. It is crucial to ensure that the fertilizer needs of your plants are met without applying too much fertilizer. Modern growing media consists mainly of peat or coconut coir, pine bark, perlite and vermiculite, which do not supply many nutrients to the plants. Lime is normally mixed into the growing medium, mainly to ensure that the media's pH is suitable for plant growth; lime also supplies calcium and some magnesium.

A starter fertilizer is often mixed into the growing medium as well. After transplant, this starter charge supplies plants with the needed mineral nutrients. Unfortunately, it is not possible to incorporate all of the nutrients needed for the production of strong, healthy plants. This would result in very high fertilizer levels (or soluble salts) in the growing medium, which can damage tender, young roots as well as make the plant more susceptible to insects and diseases.

You can provide plants with the nutrients they need throughout the production cycle by incorporating a slow-release fertilizer into the growing medium or by using water-soluble fertilizers. The disadvantages of slow-release fertilizers are that you don't have any control over them after they have been incorporated and they are quite a bit more expensive than water-soluble fertilizers. The best methods to make sure that your plants have all the nutrients they need are to make sure that you are applying the correct fertilizer concentration, to test the growing medium and to have leaf tissue analyzed.

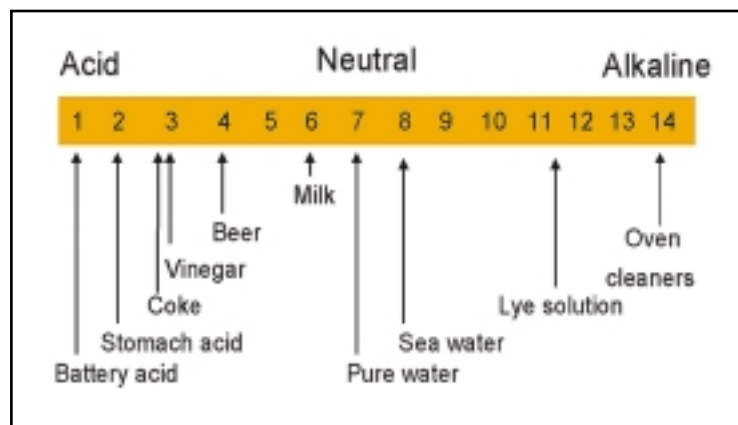
WHAT DO YOU NEED?

To perform basic tests in your greenhouse, you need only two pieces of equipment: a pH

meter and an EC meter. EC is a measure of the total amount of fertilizer salts in the growing medium, and pH is important because it affects the availability of micronutrients.

pH. The pH is a measure of how acid or alkaline (or basic) the fertilizer solution or growing medium is. It is expressed on a scale from 0-14, where 0-7 is the acid range and 7-14 the alkaline range. The pH of the growing medium is much more important than the pH of the fertilizer solu-

Figure 1. The pH of some common chemicals and fluids.



tion, since the pH of the growing medium determines how available the various nutrients are. In general, the availability of macronutrients (nitrogen, phosphorus, potassium, sulfur, magnesium and calcium) is not greatly affected by the pH of the growing medium, while the availability of micronutrients does depend on pH. For example, iron and manganese are much more available at low pH than at high pH. Because of this, plants can take up large amounts of iron and manganese when the pH of the growing medium is low, which can produce toxicity in sensitive species, such as marigold.

On the other hand, at high pH, manganese, iron and boron become less available and the plants may not be able to take up these nutrients from the growing medium, resulting in deficiencies. It is important to realize that at high pH, deficiencies occur because plants are unable to

take up these nutrients from the growing medium, not because the nutrients are not present; adding more micronutrients such as iron, manganese and boron will not solve the problems associated with high pH. The only solution is to reduce the pH of the growing medium, making those nutrients more available.

To measure pH, you will need a pH meter and two calibration solutions. The price of pH meters starts at about \$45 and can be as high as \$1,000. Cheap pH meters are good enough for use in greenhouses, but you do need to keep in mind that they may not last very long (don't count on more than one year). For approximately \$200, you can get a pH meter that will last a long time. Calibration solutions cost only a few dollars, and for use in greenhouses, you should get calibration solutions of pH 4 and 7.

EC (electrical conductivity). When salts (including fertilizer salts) dissolve in water, they conduct electricity. By measuring how well a solution conducts electricity, we can determine the total amount of dissolved salts in the solution. Since almost all salts in

fertilizer are macronutrients, EC can be used to indicate the presence of macronutrients, but it gives little or no information about the presence of micronutrients. Like pH meters, the price of EC meters starts at approximately \$45, but only one calibration solution is needed for EC meters.

Unfortunately, the units in which EC is expressed can be a bit confusing, although most of them are really the same: 1 milliSiemens = 1 mS = 1 mS/cm = 1 mMho = 1 mMho/cm = 1 dS/m = 1,000 μ S (microSiemens) = 1,000 μ S/cm. Some meters will measure conductivity in units of ppm. The conversion of ppm to mMhos can be tricky, since it depends on the exact meter you are using. Conversion factors to change ppm measurements to mMhos vary from 640-700 ppm per mMho. Since most recommendations for the fertilizer status of growing

media are based on mMhos and not on ppm, we recommend that you get a meter that measures conductivity in mMho. The instrument should have a range of at least 0-8 mMho.

Calibration. When using pH and EC meters, it is absolutely crucial to calibrate them every time you use them. If you don't calibrate your meter, it will not give you accurate values, and you will get the wrong information about what is happening with your fertilizer solution or growing medium.

Calibration solutions for pH and EC meters are available in bottles and single-use pouches. You can also buy capsules to mix your own calibration solutions. If you buy the solutions in bottles, don't calibrate your meter by inserting it into that bottle. Instead, pour just enough of the solution into a clean plastic or glass container and use that solution to calibrate your meters; this minimizes the possibility of contaminating or spilling all of the solution. Replace the calibration solutions with fresh solution at least once per month, so they don't get diluted or contaminated.

pH meters should first be calibrated with a solution of pH 7 and then with a solution of pH 4. Make sure to rinse the pH meter with distilled water before placing it in the pH 4 solution to prevent contamination. Most of the basic pH meters will have two calibration screws that you adjust to calibrate the meter, while some of the more expensive meters can calibrate themselves when they are placed in the appropriate solutions. Proper storage of pH meters is also very important. Most meters have a glass bulb that contains the actual sensors; if it dries out, the meter will no longer work. To prevent this, pH meters should be stored with a little pH 7 solution in the cap.

Only one calibration solution is needed for EC meters, normally either 1.413 or 2.764 mMho. Just as with pH meters, calibration is nor-

mally done by adjusting a screw. Storage of EC meters is easier than that of pH meters — they should be stored dry and clean.

TEST YOUR FERTILIZER SOLUTION

The easiest things to measure in your greenhouse are the EC and pH of your fertilizer solution. Of these two measurements, the EC is more important because you can use it to calculate the concentration of your fertilizer solution. The calculations are fairly simple, and should take less than a minute. First, you need to do three things:

1. Measure the EC of your irrigation water (without any fertilizer in it). Keep in mind that this can change throughout the year, especially if you live somewhere with pronounced wet and dry seasons.
2. Measure the EC of the fertilizer solution. Make sure that the stock solution is mixed well. To get a representative sample, we recommend that you collect some solution at different places in your greenhouse (as long as they are all supplied by the same injector) or at different times (a minute or so apart).
3. Find out what the EC of a 100 ppm nitrogen solution of your fertilizer is. If you are using a premixed, water-soluble fertilizer, this information should be available on the back of

the fertilizer bag. If not, contact your supplier or company representative to get this information. Keep in mind that this value assumes that there are no soluble salts at all in your water source.

Now you're ready to calculate the concentration of your fertilizer solution:

1. Subtract the EC of the irrigation water from the EC of the fertilizer solution. This will tell you how much the fertilizer contributes to the total EC.
2. Divide this value by the EC of a 100 ppm nitrogen solution.
3. Multiply this number by 100, and you have the nitrogen concentration of your fertilizer solution (in ppm of nitrogen).

Here is an example: The EC of your irrigation water is 0.45 mMho. ▶

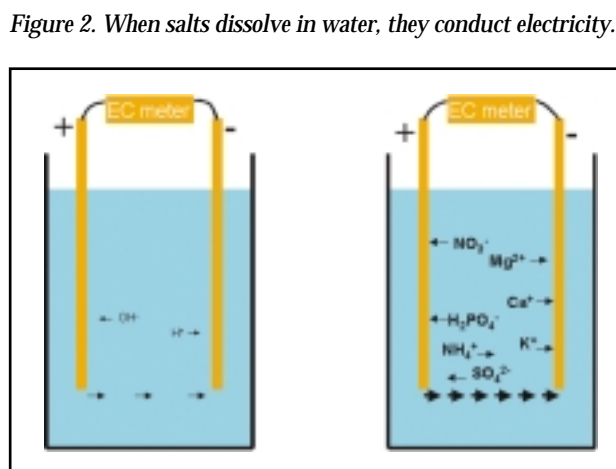


Figure 2. When salts dissolve in water, they conduct electricity.

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The EC of the fertilizer solution is 2.1 mMho and the fertilizer bag shows that a 100 ppm solution has an EC of 0.60 mMho.

Step 1 of the calculations tells us that the fertilizer contributes $2.1 - 0.45 = 1.65$ mMho to the EC of the

fertilizer solution. We now divide this value by the EC of the 100 ppm solution and get 2.75 ($1.65/0.6 = 2.75$). Therefore, the concentration of the fertilizer solution is $100 \times 2.75 = 275$ ppm nitrogen.

You can do a very similar calcu-

lation to determine what the EC of your fertilizer solution should be at a particular fertilizer concentration. For help with these and other fertilizer calculations, you can download a spreadsheet (in Excel format) from my Web site at

www.uga.edu/~hort/FacMWV.html.

TEST THE GROWING MEDIUM

The most important characteristics of media are the pH and EC, both of which can be measured quickly in the greenhouse. The pour-through method was developed for this specific purpose and is based on the idea of extracting some of the solution from the growing medium, which can then be analyzed. It is important that the pots are watered thoroughly before collecting the leachate. The leachate should be collected about two hours after the last irrigation.

The pour-through method is very simple. First, place a pot or cell pack in a saucer. It is best to elevate the pot or cell pack slightly by placing it on top of a ring cut from a PVC pipe. Then pour just enough water on top of the growing medium in the pot to leach some of the solution out of the bottom. If your irrigation water is high in alkalinity (more than 100 ppm), you should use distilled water instead. Don't use more water than is needed to get enough leachate for the EC and pH measurements.

After you collect the leachate, you can measure the pH and EC according to the requirements of your meters. Collect leachate from at least five different pots to get representative samples.

The pH of the leachate should be between 5.4 and 6.0 for most crops. Some exceptions include Easter lily, which prefers a pH of 6.4-6.8, and azalea and blue hydrangea, which need a pH below 5.6. As long as the pH is within the recommended range and you are using a fertilizer that includes the necessary micronutrients, it is unlikely that you will have problems with micronutrient deficiencies or toxicities.

The leachate EC is a measure of the total amount of soluble salts in the growing medium and should be between 2.0 and 3.5 mMho for most crops. Heavy feeders, such as poinsettia and chrysanthemum, prefer a higher EC (2.5-4.6 mMho), while salt-sensitive plants prefer an EC between 1.0 and 2.6 mMho. The optimal leachate EC also depends on the quality of your irrigation water. If the EC of the irrigation water (without

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any fertilizer in it) is high (more than 1 mMho), you should keep the leachate EC in the upper part of the recommended range.

Keep in mind that measuring EC with the pour-through method only determines the TOTAL amount of soluble salts and gives no information about the presence or absence of individual nutrients. Thus, it is possible that a particular nutrient may not be present in sufficient amounts, even if the EC is within the recommended range. If you are using a well-balanced fertilizer, this will probably not be a problem, but if you want to be certain, you can send a sample of the growing medium to a soil testing laboratory. Most land-grant universities and several private labs have this service.


TEST THE PLANT TISSUE

Leaf tissue analysis is a reliable method to ensure that your plants contain all nutrients in sufficient amounts. Unfortunately, these tests cannot be done in a greenhouse, so samples need to be sent to an analytical lab. Normally, full-grown leaves from the top of the plants should be collected. If an overhead irrigation system is used to apply water-soluble fertilizer, the leaves should be rinsed and blotted dry before mailing to the lab. This ensures that any fertilizer residue is washed from the leaf surface. Do not sample leaves from diseased or wilted plants; they are likely to suffer from other problems that will confound the tissue analysis data. Different labs may require different amounts of leaf tissue, so check with your lab on how much leaf tissue to send.

Labs can analyze leaf tissue for concentrations of all essential nutrients. Keep in mind that micronutrient deficiencies are most likely caused by the pH of the growing medium. When this is the case, extra applications of micronutrients are unlikely to solve the problem. Instead, the pH of the growing medium should be altered. Therefore, when trying to identify a nutritional problem, get analyses of both the leaf tissue and the growing medium. For help with interpretation of leaf tissue and growing medium analyses, contact your extension service.

The bottom line is that routine monitoring of growing medium EC

and pH can be a great tool in preventing serious nutritional problems in your crops. Occasional analysis of the growing medium and leaf tissue by a soil testing lab can help you fine-tune your fertilizer program and will provide valuable information

when you have a fertilizer-related problem in your greenhouse. 

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