Center for Crop Diversification
Martin-Gatton College of Agriculture, Food and Environment

Center for Crop Diversification Educator Resource
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Monitoring pH and EC in Greenhouse Production

Greenhouse and other controlled environment growers that want to improve their harvest yields through providing their plants with optimal balances of nutrients, such as nitrogen, phosphorus, and potassium should consider regularly monitoring of their crop's pH and electrical conductivity (EC). EC is used as an indicator for the salinity and availability of nutrients in the growing system. Regularly monitoring and proper mitigation of undesirable readings can improve cost efficiency of your production, ensure crop consistency, prevent diseases, and foster a more sustainable growing season.

Image 1: Exterior shot of a greenhouse

Testing Your Water Source

Greenhouse growers tightly control nutrient levels in their fertigation by adding appropriate amounts of fertilizer to a water source; this treated water is then supplied to the plants. Before you can select an appropriate fertilizer regime, you need to know what you're starting with – that means testing the untreated source of water.

Testing your greenhouse's water source is important to understanding the baseline pH and EC. In ornamental plants, understanding the fluoride levels in your water is important as high levels can cause issues with certain plant species. Although there is not much that can be done to ameliorate municipal water with added fluoride, adding pH can help reduce some of the aesthetic impacts that growers may experience. Calcium and magnesium are also common in municipal water, but they are not always present. Salt content is also of specific interest for crop health as high levels of salt can burn the root systems causing stunted growth and lower nutrient uptake.

There are several ways to learn about your water source, using a pH or EC meter can provide a simple and accessible method for weekly monitoring. Growers can request the most recent water quality test from their water company- municipal water companies are required by law to publicize their annual water quality tests. These tests include the detected levels of arsenic, fluoride, nitrate, turbidity, lead, copper, and a plethora of other pertinent information. You may also send water samples from on-farm sources (e.g., well water) to your Extension Service for testing.

pH

In commercial horticultural production, regular monitoring of pH is an important step in proper plant care and management planning as pH levels affect the nutrient availability to plants. pH is a measuring scale for determining how acidic or basic something is when it is dissolved in water. The pH scale goes from 0 to 14. A 0 means the substance is very acidic; whereas a 7 means it is neither acidic nor basic (neutral); and 14 means it is very basic.

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Equally important, pH influences how well plants can absorb nutrients. Proper pH levels enable plants to absorb essential nutrients efficiently for healthy growth. On the other hand, imbalanced pH levels can cause stress to plants that can lead to stunted growth, leaf discoloration, and overall reduced plant health and higher yield penalties.

EC

Maintaining optimal EC levels ensures that plants receive the right amount of nutrients for growth without overloading or starving them. Electrical conductivity (EC) measures the free ions in a solution and represents an index of salt concentration and is also an indicator of electrolyte concentration of the solution. Note that different salts contribute differently to EC, which is influenced by ion mobility, solubility, and interactions. The EC of the nutrient solution is related to the number of ions available to plants in the root zone.

The optimal EC is often crop specific and dependent on environmental conditions but an ideal range for EC is largely dependent upon the stage of growth. Due to the changing nutrient needs of growing plants, growers should consider adjusting EC levels based on plant growth stages to prevent nutrient imbalances that can harm plant development. EC measurements are expressed in mS/cm and recommended EC reading ranges for most plants are as follows:

Vegetative stage: Optimal growth obtained at 1.2-2.0 mS/cm for root development.
Fruiting stage: Increases up to 2.5-3.5 mS/cm for flowering/ fruiting
Remember, EC in partnership with pH (5.5-6.5) and temperature (18-22°C), plays a critical role in plant health.

Types of Meters

1. Portable handheld meters: Small and great for travel, these probe style units are accurate and affordable.
2. In-line sensors: More permanent fixture to a growing system, most used in soilless hydroponic systems. These often are sold with other monitoring systems and custom made for the production size.
3. Benchtop meters: Stationary units commonly used in research and industrial use.
4. Wireless meters: Monitor EC remotely, ideal for large-scale operations.
5. Smart probes: Submersible probe for use in soil or nutrient solution.
6. Multiparameter meters: Measure multiple factors like EC, pH, and temperature. Typically offered in a portable electrode style handheld unit.

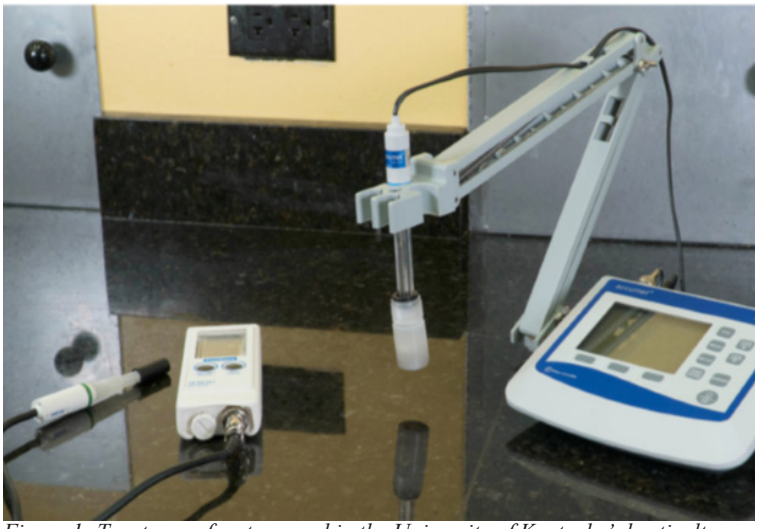

Figure 1: Two types of meters used in the University of Kentucky's horticulture lab. On the left is a portable handheld meter, on the right is a bench top meter.

Preparation and calibration

Proper care, maintenance, and storage of the meter and electrode is vital to the accuracy of the meter's readings and the longevity of the unit. Be sure to thoroughly read and review the owner's manual of your meter and follow the care instructions and suggested maintenance schedule. Most electrodes require submersion in pH4 buffer solution when not in use and calibration solutions, therefore be sure to have plenty of any required solutions for your meter before use. It's recommended to have distilled water on hand for rinsing off the storage and calibration solutions from the electrode because distilled water does not conduct electricity.

Monitor pH and EC of container crops

There are generally three methods to monitor substrate pH and EC in container crops: the pour-through method, the saturated media extract method, and the 2:1 technique (1:2 substrate-to-water dilution test). The pour-through method is the most widely accepted and works for both small and large container crops.

Acquiring measurements from samples

For container-based production, select a few plants from a few different locations to collect leachate samples using the pour-through method. This can be measured if you have a handheld pH/EC probe. Place the potted plant in a tray and pour water into the

medium until liquid runs out the bottom and collects in the tray. The liquid can then be transferred to a sterile cup, where you may dip the probe to measure.

The probe may also be directly dipped into a diluted nutrient solution for recirculating irrigation systems in hydroponic operations.

Selected Resources

Measuring pH in food products:
https://publications.ca.uky.edu/sites/publications.ca.uky.edu/files/ID246.pdf

What is EC & pH and why does it matter?

https://hortphys.uga.edu/hortphys/files/2020/03/EC-and-pH.pdf

Understanding soilless media test results (HO-111, HO-112)

https://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1161&context=anr_reports

Pour Through Method

https://greenhousehort.ca.uky.edu/sites/greenhousehort.ca.uky.edu/files/2022-05/PourThru%20Method_Nursery%20Crops.pdf

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Image 1 courtesy of UKphoto Carter Skaggs **April 2025**

Instructor Module

This educational module is presented in partnership with the Appalachian Regional Commission (ARC). These activities are intended to provide inspiration for activities that supplement greenhouse technician/ management curriculums.

Learning objective:

- Educate students on EC/pH and their roles in plant nutrition
- Emphasize the importance of monitoring
- Familiarize students with varying levels of monitoring equipment, and data interpretation

Optional: Comparative Study on using different equipment

Activity 1: Calibrating and maintaining equipment

Materials needed:

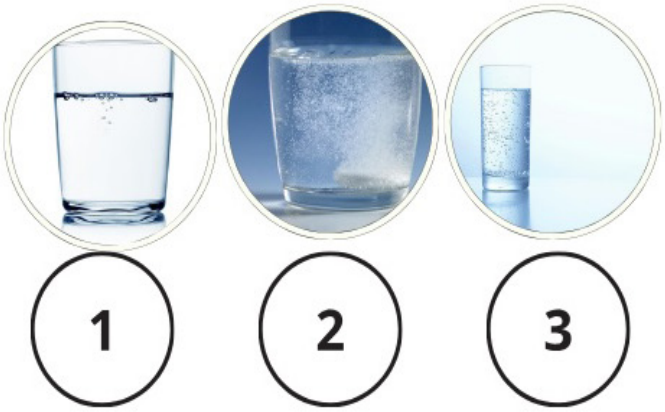
- EC/pH meter
- Data collection notebook

Step 1: Demonstrate the calibration and storage processes for students emphasizing the importance of proper care and maintenance of the meter and electrode. Consider assigning students to rotating responsibility of calibrating equipment each month.

Step 2: Provide students with a printed step-by-step procedure to calibrate your classroom's meter to study. Cut them out and instruct the students to put them in the correct order.

Activity 2: Testing water source's pH and EC

Materials needed:



- EC/pH meter
- 3 beakers or cups
- Water
- Salt
- Fertilizer/Plant Food

Option 1: Create a quiz or class discussion prompt to challenge students to think about what actions that could take to get pH and/or EC within an optimal range.

Option 2: Provide three water samples (fertilized water, salt, tap) in 3 different cups. Instruct students to monitor the EC and pH of each sample & record it on the worksheet.

Activity 3: Test your plants

Step 1: Provide students with 3-4 potted plants (preferably plants that are struggling)

Step 2: Use the cheaper probe and record the pH displayed for each pot (be sure to sanitize the probe after testing each sample)

Step 3: Use the classroom meter and perform the pour through procedure on each sample and record the pH.

Step 4: Have students come up with a plant care plan for the following weeks to help bring the plant back to a suitable state (or maintain its great health)