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152. The three keys of pH management. Baumbauer, D. American Nurseryman 205(5):36-38, 40. 2007. Irrigation water quality, growing media components and fertilizer selection all are important parts of pH management.

The Three Keys of pH Management

Irrigation water quality, growing media components and fertilizer selection all are important parts of pH management. When all the pieces are put into place, the desired outcome of optimal crop growth and nutrient uptake by the plant can be achieved.

by DAVID BAUM BAUER

Managing the pH of growing media is critical in maintaining the availability of nutrients for your crop. Irrigation water quality, growing media components and fertilizer selection all play a role in pH management. Growers need to be proactive in monitoring the pH change of the media in their containerized crops. Proper pH management, along with adequate fertilizer applications, will minimize nutrient deficiency problems, reduce fertilizer expenses and assure your crop is ready for sale on time.

At the Plant Growth Center (PGC), the teaching and research greenhouse complex at Montana State University (MSU), Bozeman, we grow everything from weeds to willows. In-house monitoring of growing media pH and soluble salt levels using the PourThru test is the most practical way to keep up with the fertility needs of a wide range of crops grown in a variety of media.

Let's take a look at how irrigation water quality, growing media components and fertilizer selection interact to influence growing media pH.

Irrigation water quality. Irrigation water quality must be tested by a laboratory. Water sources, especially surface water, can exhibit seasonal fluctuation in the minerals that influence the water's chemistry. Therefore, biannual testing may be required.

The three main indicators of water quality are soluble salts (reported as electrical conductivity [EC]), pH and alkalinity (reported as milliequivalents [meq] or parts per million [ppm] of equivalent calcium carbonate; table, opposite).

Soluble salts dictate the flow of water from the growing media to the plant roots. Irrigation water with high levels of soluble salts can inhibit water uptake by the crop's roots.

Water pH can affect the solubility and effectiveness of compounds, such as water-soluble fertilizers, pesticides and growth regulators. Always read the label of the compound that is added to the irrigation water to see if you must acidify overly basic water sources. However, irrigation water pH has a minimal impact on growing media pH.

The alkalinity of your irrigation water source is going to have the largest impact on the growing media pH. If your irrigation water source has high alkalinity, it is the same as applying limestone to your growing media with each irrigation.

Our water source at the PGC is a municipal water system that draws from both reservoirs and deep wells. It has low soluble salts, moderate alkalinity and high pH. The impact of your water's alkalinity level on the growing media pH is influenced by three factors: the length of the crop's production period, plant-to-substrate ratio and the highest pH level tolerated by the crop. Crops with short production times and those grown in larger containers tolerate water with high alkalinity better than those with long production periods or crops produced in small containers, as is typical in the greenhouse.

Growing media. At the PGC, we produce MSU mix, a soil-based growing media consisting of one part mineral soil, one part washed concrete sand and one part sphagnum peat moss by volume. A wetting agent, such as AquaGro 2000 G, is added to aid in the initial watering of the media. We also use a commercially prepared soilless mix consisting of sphagnum peat moss, perlite, dolomitic limestone, a wetting agent and a starter fertilizer charge. Laboratory analysis for the MSU mix and the soilless mix are shown in the graphs below.

Both media have optimum pH values and very high calcium levels. In the MSU mix, the high level of calcium can be traced to the mineral soil and sand, which are formed from calcareous parent materials. In the soilless mix, dolomitic limestone is added to buffer the acidic nature of sphagnum peat moss and is responsible for the high level of calcium.

Testing the interaction of your irrigation water and growing media is easy. For those unfamiliar with the PourThru test, it is simple and quick, but reveals valuable information. The only specialized piece of equipment required is a pH/EC meter. Fill three containers with new growing media, and saturate the media with your irrigation water source. After allowing the irrigated containers to drip for an hour, pour just enough distilled water on top of the media to collect 50 milliliters of leachate. Measure the pH of the leachate, and record the average pH of the three pots. Repeat the test daily for a week. For more information on the PourThru test, visit the North Carolina State University Extension commercial floriculture

Water quality guidelines and PGC water test results

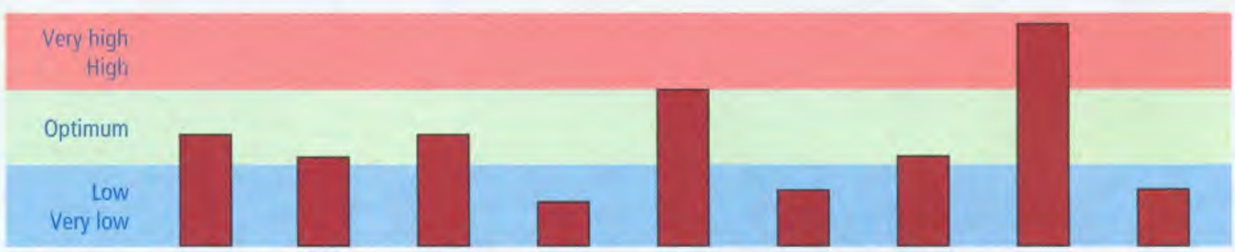
The following lists the desirable qualities of irrigation water, as well as the results of a recent Plant Growth Center (PGC) irrigation water test. (mMhos/cm = milliMho per centimeter; meq/L = milliequivalents per liter)

Characteristic	Acceptable limit without treatment required	PGC test results
Electrical conductivity (mMhos/cm)	0.75 for propagation 2.0 for general production	0.20
pH	5.4 to 6.8	8.3
Alkalinity (meq/L)	1.5*	1.9

*Alkalinity levels from 3 to 8 meq/L may require acid injection to counteract the impact on growing media pH.

Test results for Montana State University soil mix

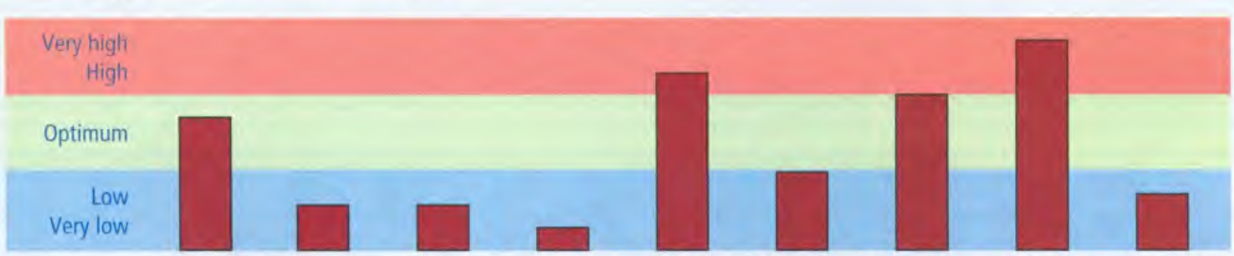
Container Media Analysis: Modified Saturated Media Extract



Analyte	pH	EC dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	Potassium ppm	Magnesium ppm	Calcium ppm	Sodium ppm
Results	5.9	1.1	120	11	24	70	74	342	35
Optimum range	5.5 6.8	1.0 2.0	70 200	50 100	15 25	100 150	70 150	100 200	50 80

Test results for commercially prepared soilless mix

Container Media Analysis: Modified Saturated Media Extract



Analyte	pH	EC dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	Potassium ppm	Magnesium ppm	Calcium ppm	Sodium ppm
Results	6.4	0.6	40	4	37	99	146	318	32
Optimum range	5.5 6.8	1.0 2.0	70 200	50 100	15 25	100 150	70 150	100 200	50 80

Fertilizer acidity/basicity

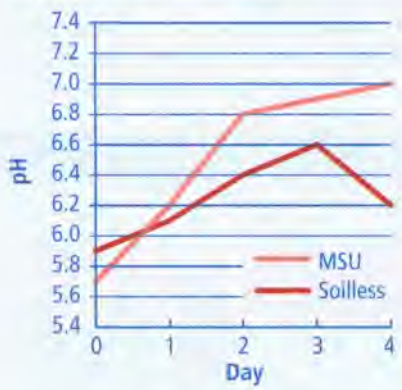
The following shows the potential acidity/basicity for various fertilizers.

Fertilizer	% NH_4^+	Potential acidity
20-20-20	69	474 pounds
20-10-20	38	393 pounds
15-16-17	30	165 pounds

Fertilizer	% NH_4^+	Potential basicity
15.5-0-0	6	400 pounds
13-0-44	0	460 pounds

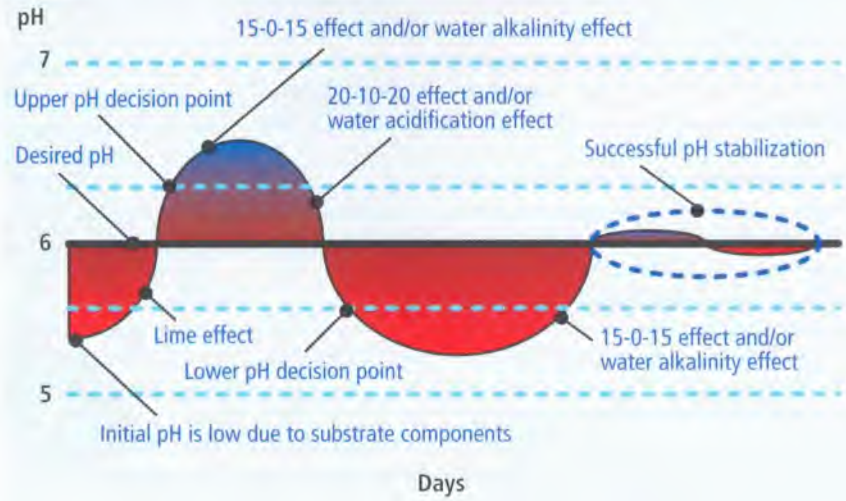
Media pH in two mixes

Media pH of commercially prepared soilless mix and Montana State University (MSU) prepared mix with daily application of irrigation water



Substrate pH regulation

Growing media pH regulation using fertilization selection and/or acidification of irrigation water



Web site at www.floricultureinfo.com, and look up "PourThru Sampling" in the topics pulldown menu. The results from a recent comparison of MSU soil mix and the purchased soilless mix over a five-day period are illustrated above.

The pH increase of the soilless mix is due to the activation of the dolomitic limestone by contact with irrigation water. By the fourth day, the change in pH begins to moderate. The pH of the MSU mix does not decrease, but will continue to rise gradually due to the calcareous nature of the sand and topsoil sources. This is a fairly dramatic impact on the growing media pH given the moderate level of alkalinity of the PGC irrigation water. Many growers in the western US are faced with irrigation water alkalinity levels two to four times greater than those of the PGC.

Select the most pH-sensitive crops that you grow, and get in the habit of monitoring media pH on a weekly basis. Perform the PourThru test on three pots of each species, and average the results. Draw a graph so that you can monitor the rate of pH change.

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Fertilizer selection. The form of nitrogen in the fertilizer formulation determines whether the fertilizer will be acid-forming or base-forming. Obtain a copy of the label for each of the fertilizers used at your nursery, and read the fine print. Under the brand and grade (such as 20-10-20 GP) will be the guaranteed analysis section listing the breakdown of the ingredients by percentage. Look closely at the forms and percentages of nitrogen. Urea forms of nitrogen are converted to ammoniacal forms (NH_4^+), and the two should be added together when considering the potential acidity/basicity of the fertilizer formulation. Nitrate forms (NO_3-) of nitrogen will increase growing media pH. Fertilizer manufacturers blend the different forms of nitrogen to create balanced vegetative growth. Many fertilizer labels will include a section below the guaranteed analysis describing the potential acidity/basicity.

Potential acidity is defined as the pounds of limestone required to neutralize the acidity caused by using 1 ton of fertilizer. Potential basicity is defined as the effect that 1 ton of fertilizer has on pH in terms of pounds of limestone. While the definitions are clunky, the important thing to remember is the larger the number, the greater the reaction (table, top left).

Another important piece of information on most fertilizer labels is a table listing the EC reading for different levels of nitrogen. These EC readings allow the grower to check the operation of the fertilizer injector to make sure the proper rate of fertilizer is being applied. Fertilizers can be caustic and cause wear on components within the injector. Collect fertigation water, and measure the EC of the solution. Subtract the EC of the clear irrigation water, and you now have the EC being contributed by the fertilizer formulation.

Putting it all together. Graph the results of your weekly PourThru test. The rate of growing media pH change will be a guide to fertilizer selection. Use fertilizers with a high potential acidity/basicity when the media pH is out of optimum range. Switch to fertilizers with low to moderate potential acidity/basicity to maintain the desired media pH. Growing media pH regulation over time is illustrated above.

At the PGC, we use 20-20-20 fertilizer, with its high potential acidity, to lower growing media pH of high pH-sensitive crops grown in the soil-based MSU mix. Once the desired pH level is reached, Select the most pH-sensitive crops that you grow, and get in the habit of monitoring media pH on a weekly basis.

20-10-20 fertilizer then is used to regulate media pH. If the pH drops below 5.5, one or two irrigations with clear water raises the media pH back into the optimum range. For the same pH-sensitive crops grown in the commercially prepared peat/perlite mix, we use 20-10-20 fertilizer to lower media pH and 15-16-17 fertilizer to maintain desirable levels. The acidic nature of the peat-based media requires fertilizer with a lower potential acidity than 20-20-20 to achieve the desired media pH level.

Certain crops have a higher calcium requirement than is supplied by the dolomitic limestone present in the peat/perlite media. Nurseries with a multiple-head fertilizer injector can apply calcium nitrate alongside the all-purpose fertilizer without fear of forming a precipitate. Nurseries with single-head injectors must alternate the two fertilizers. A typical fertilizer schedule for a high calcium-requiring crop (such as garden mums) would be two applications of 20-10-20, one application of 15.5-0-0 and one clear-water irrigation.

Greenhouse production vs. **outdoor production.** While the majority of this article deals with greenhouse production of containerized plants, outdoor growers also will benefit from using the PourThru test to monitor growing media pH. One major difference in cultural practices between greenhouse and outdoor production is the use of controlled-release fertilizers, which is far more prevalent in containerized outdoor production. Ammoniacal nitrogen is the most common form of nitrogen in controlled-release fertilizers, so these products tend to have high potential acidities.

Growers who use peat-based media and have irrigation water with low alkalinity need to take care to avoid low media pH levels and the resulting micronutrient toxicity that may occur.

David Baumbauer manages the Plant Growth Center at Montana State University, Bozeman, and teaches greenhouse management and organic market gardening in the university's department of plant sciences and plant pathology. More information on the Plant Growth Center can be found at http://ag.montana.edu/plantgrowth.

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