GROWERTALKS

Cover Story

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A Toast to pH

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Years ago, I was giving a seminar to a group of vegetable farmers. I said to them, “You guys know all about pH, right? We don’t need to go over that, do we?” They all said, “Yeah, yeah, we know all about pH.” I replied, “Who can tell me what pH stands for?” The room went silent. I said, “Well, maybe we should delve into this a little further.”

What is pH really?

What does it mean? What does it do? Does it matter? How does it affect my soil and plants? How do I change it if I need to? Why don’t we express it in parts per million?

Which leads us to: why do we express things in parts per million or percent in the first place? Why not other units? Well, we can deal with numbers like 3 or 27 or 506. We have trouble dealing with numbers like 3.5 X 10 to the -6 power or 19 trillion. We express nutrient levels in parts per million and percent because they come in numbers we can wrap our heads around.

pH really isn’t all that complicated. Let’s start by going back to 1909. There was no widely accepted way of expressing acidity back then. It was usually expressed as slightly acid or strongly basic or moderately acid or neutral or whatever. Just general, not specific.

So along comes Dr. Soren Sorenson. He was a Danish chemist who worked for a beer company. It seems that the flavor of beer was very dependent upon the amount of acidity or alkalinity that the beer had. The only way people measured acidity at the time was with litmus paper or colorimetric reactions with indicator chemicals. However, small differences in acidity could have a major impact on how beer tasted.

What was needed was a more precise way to quantify the acidity or alkalinity of beer in order for it to taste better. (An urgent need, don’t you think?) But the way acidity was expressed at the time was as a molality of the hydrogen ion concentration. (Now, I won’t bother you with molality or what a mole is or Avogadro’s number or any of that stuff—what does all this have to do with growing plants anyway?)

Well, it turns out that acidity could be expressed as the concentration of hydrogen ions in the solution, but these numbers were very hard to work with. They were numbers like .000001 Molar H+ or .00000001 Molar H+. Not exactly numbers you’d want to kick around at your next beer bash.

So Dr. Sorenson decided to come up with a simple scale to express acidity as hydrogen ions. He simply took the exponent or power of the hydrogen ion concentration and flipped it over from being a negative exponent to a positive exponent. Thus, a hydrogen ion concentration of .000001, which is 10 to the -6 power, he simply called it 6! A hydrogen ion concentration of .00001 or 10 to the negative fifth power became 5.0, etc. Now, those are numbers we can get our heads around—4 and 5 and 6 versus all that other gobbledygook.

Now finally, they had a simple, understandable, quantifiable way of expressing the degree of acidity in beer. Because Dr. Sorenson spoke French, the new acidity scale was called “pouvoir hydrogene” or “puissance hydrogene.” Both of these roughly translate to “power of hydrogen” or “potential of hydrogen,” which the world now knows as pH. So pH came from beer? Yeah, pretty much. Dr. Sorenson was nominated for a Nobel Prize, but he never won.

pH and soil

Let’s now fast-forward to 1934. A guy named Glen Joseph was a chemist for the California Fruit Growers Exchange. They needed a reliable way of measuring the acidity of citrus fruit juice, especially lemons. The ways they had to measure acidity at the time were crude and the glass instruments often broke. Joseph called on a Caltech professor named Arnold Beckman. Dr. Beckman immediately saw that they were doing it the wrong way. He then proceeded to build them a sturdy meter to measure pH.

Beckman was later quoted as saying, “I only built the pH meter as a favor to Glen Joseph.” (As an aside, when I started in the laboratory business almost 40 years ago, we were still measuring conductivity with a Beckman Solubridge. In case you’re wondering, the pH of beer is about 4.5. The pH of lemon juice is 2.4. The pH of bleach is 12.5.)

So what about pH in soil and container media? We tend to think about soil pH only in terms of nutrient availability. If that’s all that matters, then why don’t all plants grow best at the pH of maximum nutrient availability, say 5.5? Do they? They don’t.

Well, why not? The reason is that soil pH affects a lot more than just nutrient availability. It also affects soil microbe populations—both beneficial microbes and pathogens. Fungi generally grow better at lower soil pH, whereas bacteria grow better at higher soil pH. It’s low pH that enables us to leave a bottle of hot sauce on a restaurant table for months without it going bad. Hot sauce is too acidic for most bacteria to grow in it.

Beneficial microbes, such as mycorrhizae, grow better at low pH. For example, plants in the family Ericaceae (azaleas, etc.) don’t make root hairs. They need lower soil pH in part in order to encourage the mycorrhizae, which they need for best root function. Media pH also affects the availability of potential plant toxins, such as sodium, aluminum, heavy metals and fluoride.

Some experts claim that pH in container media doesn’t matter. Well, does it or doesn’t it? Here’s my two cents: For Exhibit 1, I will offer the previous two paragraphs.

Second, I owned a soil testing laboratory for 28 years. In my career, I’ve seen about 1.5 million soil and media analyses. How and whether media pH affects plant growth in my experience depends on the plant. Some plants are able to adjust the pH in the root zone by secreting hydrogen ions (acidity by definition), organic acids or even chelating agents. Other plants can't do this so well.

I cite two examples: I work with the tropical foliage plant aglaonema, or Chinese evergreen, all over the world, in many types of soils and media. The plant grows fine at pH 4 and it grows fine at pH 8. It doesn't seem to matter. However, if you're growing geraniums and your media pH is outside of 5.8 to 6.2, you've got problems.

Also realize that the pH scale is a logarithmic scale, like the Richter scale for earthquakes. An earthquake of 8.0 is 100 times stronger than an earthquake of 6.0. The same relationship exists on the pH scale. When you measure the pH of something, you're actually measuring the quantity of hydrogen ions (protons) in the material, like you might measure zinc or potassium.

So now that we know this, I propose a toast to Dr. Sorenson and Dr. Beckman. Their work has made both our lives and plants happier in numerous ways. **GT**

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