e-GRO Alert
Volume 4, Number 33 May 2015

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Is your greenhouse irrigation water alkalinity ailing your crop?

If the pH of your media is out-of-whack, consider checking your irrigation water alkalinity

Many growers monitor their crop's substrate pH and electrical conductivity (EC) periodically in order to avoid nutritional and crop quality issues. For more information on how and why to monitor pH and EC, see the Michigan State University Extension article titled '[pH and EC issues still a problem in some greenhouses]'. If substrate pH is routinely a problem, it is possible that the irrigation water alkalinity may be the cause. In this article, we review why it is important to monitor your greenhouse irrigation water alkalinity.

Water alkalinity is a measure of water's capacity to neutralize acids. Dissolved bicarbonates, such as calcium bicarbonate, sodium bicarbonate, and magnesium bicarbonate, as well as carbonates like calcium carbonate are the major chemicals contributing to alkalinity in irrigation water. Alkalinity is related to pH because alkalinity establishes the buffering capacity of water or how resistant it is to a change in pH. The greater the alkalinity, the more buffered the water is, thus the more acid is required to change the pH. In this way, irrigation water alkalinity effects media pH more than the irrigation water pH itself.

Units of alkalinity are expressed as either meq/L (milliequivalents per liter) or ppm (parts per million). Irrigation water sources acceptable for use in a greenhouse will usually have an alkalinity of 40 to 65 parts per million. Anything above 150 ppm will likely need treated.

Why is alkalinity of greenhouse irrigation water so important to a grower? Because the alkalinity of the irrigation water impacts the growing medium pH over time, which in turn impacts the availability of nutrients. In Figure 1, three identical growing media started at the same pH of 6.0. When irrigated with water sources that differed

Did you know?
Some growers get the terms alkalinity and alkaline confused. The two terms are not identical or synonymous. Alkaline means that the pH is above 7 (basic), where alkalinity describes a water's capacity to neutralize acids.

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in alkalinity, the medium pH becomes very different over time. In this example, the medium that was irrigated with high alkalinity well water ended with a pH near 8.5 after 17 weeks, while the medium that was irrigated with low alkalinity reverse osmosis water remained near a pH of 6.0 over the entire study.

Testing of water alkalinity should be performed at least once a year (preferably once per season). There are a variety of ways to test water alkalinity. Do-it-yourself tests can be purchased from grower supply stores. The most inexpensive kits are alkalinity test strips that approximate alkalinity, such as the one shown in Figure 2. These disposable strips are dipped into collected irrigation water and then strip results are compared to a chart which broadly estimates the water's alkalinity level. There are more sophisticated tests available for purchase as well, such as titration alkalinity test kits and handheld colorimeters which provide more accurate alkalinity readings (Figure 2). For any alkalinity kit purchased, follow the manufacturer's instructions on how to perform the test using their product. Testing can also be performed at a professional lab. For instructions on how to collect a water sample for

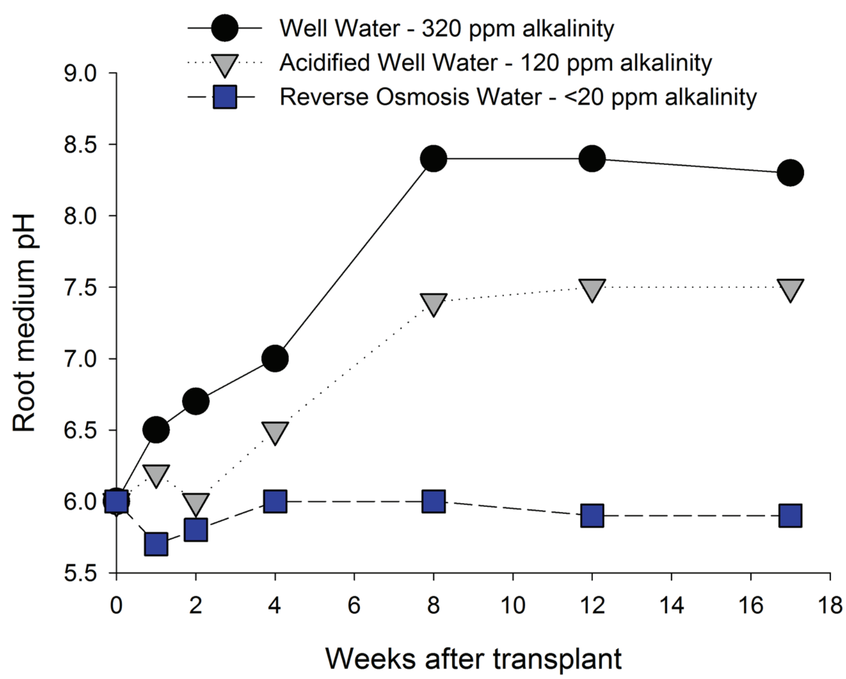

Figure 1. Effect of irrigation water alkalinity on substrate pH over time. Each irrigation included water soluble fertilizer (97% nitrate N at 200ppm). Source: Adapted from research by Bill Argo and John Biernbaum at Michigan State University (unpublished work).

such a test and labs that perform alkalinity testing, read the e-Gro article written by Roberto Lopez from Purdue University titled '[Sampling and Submitting Greenhouse Substrate, Irrigation Water and Tissue for Analysis]'.

How can high water alkalinity be corrected? Acidifying water is the most common option. Acids vary in their strength and degree of purity. It is advisable to buy technical grade purity acids in order to avoid contaminants that may damage plants. As some of the concentrated acids are highly corrosive, wear protective clothing, including eye protection, when handling acids. And ALWAYS add acid to water; never water to acid. This is because a large amount of heat is released when strong acids are mixed with water. So much heat is released that the solution may boil very violently, splashing acid out of the container (and onto you)! If you add acid to water, the solution that forms is very dilute and the small amount of heat released is not enough to vaporize and spatter it. So, always add acid to water and never the reverse.

Nitric, phosphoric, or sulfuric acids can be used in green-

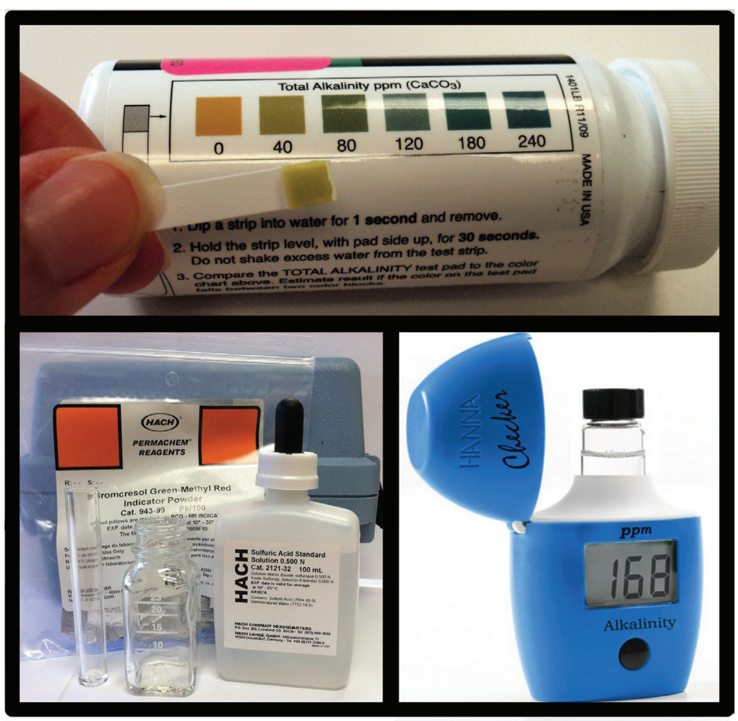

Figure 2. Examples of do-it-yourself testing kits for water alkalinity. Top: A test strip kit that approximates water alkalinity. Bottom Left: A titration style water alkalinity testing kit. Bottom Right: A handheld colorimeter.

houses (Table 1). Nitric acid, available in some areas at 61% grade, is quite corrosive and must be handled with great care and therefore is not often used. Phosphoric acid, usually available at 75% or 85% grade, is the least corrosive of the three acids, but typically provides too much phosphorous nutrition to the crop at the amount needed to neutralize alkalinity. Therefore, sulfuric acid is most often the acid of choice. Sulfuric acid is commonly available in a fairly pure (93% by weight) form.

Table 1. Properties of acids used to treat water that is high in alkalinity.

Acid	ppm bicarbonate neutralized by 1 oz of acid per 100 gallons of water	ppm P, S, or N for 1 oz of acid per 100 gallons of water
75% phosphoric	87	32 P
85% phosphoric	98	36 P
93% sulfuric	191	30 S
61% nitric	57	17 N

Reverse Osmosis is another water treatment option to lower water alkalinity (Figure 3). However, the cost of reverse osmosis needs to be justified based on the value of the crop(s). Reverse osmosis works by using a semi-permeable membrane that does not let impurities (including bicarbonates and carbonates) through. Pressure is then applied to the water that needs purified, forcing the clean water through the membrane, leaving salts and other impurities behind and resulting in purer water. Twenty to 50% of the initial water, enriched in dissolved impurities, remains to be carried away. Where to put this waste water is an important issue to consider.

Figure 3. A reverse osmosis system in a commercial greenhouse. Photo credit: Dr. Erik Runkle, Michigan State University.