

Water Chemistry As It Applies to pH and Alkalinity

Although we hear and read many references to the importance of pH for growing media, the pH we actually measure is the pH of the water in the media or media solution. Growers measure media solution pH because it affects the availability of fertilizer nutrients.

The four primary factors affecting media pH are:

- 1) the media components,
- 2) the amount of lime in the media,
- 3) the type of fertilizer used, and
- 4) the irrigation water quality.

The pH of irrigation water does not affect the pH of the growing media. No, you did not misread that sentence! When considering irrigation water quality and its effects on media pH, do not look at the water pH. On the other hand, irrigation water pH is an important factor as it relates to the solubility of fertilizers and the stability of some pesticides.

Water pH does not indicate the levels of alkalinity in the water. The alkalinity refers to the neutralizing of acids which over time drives up media pH. In fact, it is not unusual to find water with a pH of 8 or higher with low alkalinity, or water with a pH of 7 and high alkalinity. Note also that water hardness is not a direct indicator of water alkalinity.

Water alkalinity is determined by the levels in the water of bicarbonates (HCO_3^-), and carbonates (CO_3^{2-}); bicarbonates are normally the most important factor in irrigation water. For instance, watering crops with high-alkalinity water is the same as applying lime at each irrigation.

The desired pH for soilless media in most situations is slightly acidic (5.5 to 6.2). By definition, pH is a measure of the number of hydrogen ions (H^+) in the media solution—the more hydrogen ions, the lower the pH, and consequently, the more acidic the solution. Because peat moss and most fertilizers are acidic, they contribute hydrogen ions to the media solution. Bicarbonates applied to irrigation water removes hydrogen ions, and consequently raises the pH of the media solution.

The alkalinity of irrigation water can be determined with an alkalinity test kit or by sending a water sample to an analytical laboratory. The units used to express alkalinity level can be somewhat confusing. Often scientists will convert the total alkalinity effect of water to equivalent amounts of calcium carbonate (CaCO_3) in milligrams per liter (mg/L CaCO_3) or parts per million (ppm CaCO_3). When doing calculations with alkalinity for injecting acids, scientists use the term milliequivalents of CaCO_3 per liter (me/L CaCO_3). Thus, many labs report ppm of bicarbonates (ppm HCO_3^-), since bicarbonates are the major contributor to irrigation water alkalinity. (See the accompanying insert for conversion factors for these terms).

Values for excessive alkalinity in irrigation water have never been set; Whether alkalinity presents a problem totally depends on the situation. Alkalinity is a greater problem in plug production because plug cells are so small in media-holding capacity that pH can change drastically and rapidly. Alkalinity also is more likely to be a concern with long-term crops, with heavy irrigation, with smaller container sizes, with programs using less acidic high-nitrate fertilizer, and when media starting pH is high. A good range for alkalinity is between 60 and 100 ppm bicarbonates. Alkalinity levels between 100 and

200 ppm will probably cause some elevation in media pH. At this level, you can moderate alkalinity by reducing the amount of lime you add to the media, or by using more acidic fertilizers.

Water alkalinity also can be too low. A certain level of bicarbonate in irrigation water is beneficial as a safeguard against rapid drops in pH due to the effects of fertilizers. At levels below 60 ppm, it may be necessary to add potassium bicarbonate to raise water alkalinity.

The most effective way to deal with high alkalinity is by injecting acid into the irrigation water. The bicarbonates in the water react with the hydrogen ions from the acid without removing hydrogen from the media solution. Nitric acid, sulfuric acid, and phosphoric acid are the most commonly used inorganic acids. However, these acids are very caustic and call for the appropriate safety precautions. Likewise, the injectors used should be designed for handling acids. To prevent reactions with fertilizers and solubility problems in concentrate tanks, use separate injectors for acids. Fertilizers and acids are compatible at the levels incurred after they are mixed in irrigation lines. The acids also contribute to the total nutrient supply.

When alkalinity is very high it is often desirable to use a combination of two acids to prevent excessive levels of individual elements. Two methods can determine how much acid to use. The first and the most accurate is to calculate the amount needed based on an analysis of the level of alkalinity in the water. Usually only enough acid is used to reduce alkalinity to about 80 to 100 ppm. See the accompanying example in which the water alkalinity is 300 ppm and in which 210 ppm will be neutralized. Once neutralized, the 210 ppm of bicarbonates must be converted to milliequivalents of CaCO₃. For each acid, the amount that neutralizes one milliequivalent of CaCO₃ for 1,000 gallons of irrigation water is given in the accompanying insert. The second method does not require the above calculations, but it is less accurate.

Using a volume of irrigation water of about 10 or 100 gallons, slowly add acid to the water while stirring and monitoring the change in pH. This is called a titration procedure. At first, the pH will change very slowly as the acid and bicarbonates reacts, but once most of the bicarbonates are neutralized, the pH will change faster. Determine the amount of acid required to bring the water to a pH of 5.8 to 6.0.

Conversions for measurements of alkalinity:
1 mg/L CaCO ₃ = 1ppm CaCO ₃
1 me/L CaCO ₃ = 50 mg mg/L CaCO ₃
1 me/L CaCO ₃ = 60 ppm HCO ₃

Amounts of acids for neutralizing 1 me/L CaCO ₃ :Acid % fl. Oz. Of acid per 1,000 gal. of irrigation water		
Nitric (61%)	Phosphoric (85%)	Sulfuric

15.6	7.5	(93%) 3.5
------	-----	-----------

Example Problem:

Water alkalinity = 300 ppm

Desired alkalinity = 90 ppm

Alkalinity to remove = 210 ppm

First convert 210 ppm bicarbonates to me/L CaCO₃

$$210 \text{ ppm}/60 = 3.5 \text{ me/L CaCO}_3$$

Second, determine amount of acid needed (in this example sulfuric acid is used).

$3.5 \text{ me/L CaCO}_3 \times 3.7 \text{ fl. oz./1,000 gal.} = 13 \text{ fl. oz. of sulfuric acid per 1,000 gal. of irrigation water.}$

Reprinted with permission from Greenhouse Product News Feb. '99