WATER QUALITY: pH AND ALKALINITY

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Introduction

Recently, some growers have expressed concern about the "high pH" of their irrigation water and its potential adverse effects on plants. The purpose of this article is to allay some of these concerns by pointing out the difference between "high pH" and "high alkalinity."

Alkalinity and pH are two important factors in determining the suitability of water for irrigating plants. *pH is a measure of the concentration of hydrogen ions (H^+) in water and other liquids.* In general, water for irrigation should have a pH between 5.0 and 7.0. Water with pH below 7.0 is termed "acidic" and water with pH above 7.0 is termed "basic;" pH 7.0 is "neutral." Sometimes the term "alkaline" is used instead of "basic" and often "alkaline" is confused with "alkalinity." *Alkalinity is a measure of the water's ability to neutralize acidity.* An alkalinity test measures the level of bicarbonates, carbonates, and hydroxides in water and test results are generally expressed as "ppm of calcium carbonate ($CaCO_3$)." The desirable range for irrigation water is 0 to 100 ppm calcium carbonate. Levels between 30 and 60 ppm are considered optimum for most plants.

Irrigation water tests should always include both pH and alkalinity tests. *A pH test by itself is not an indication of alkalinity.* Water with high alkalinity (i.e., high levels of bicarbonates or carbonates) always has a pH value 7 or above, but water with high pH doesn't always have high alkalinity. This is important because high alkalinity exerts the most significant effects on growing medium fertility and plant nutrition.

High pH and High Alkalinity Effects on Plant Nutrition

Potential adverse effects. *In most cases irrigating with water having a "high pH (7) causes no problems as long as the alkalinity is low."* This water will probably have little effect on growing medium pH because it has little ability to neutralize acidity. This situation is typical for many growers using municipal water in Massachusetts, including water originating from the Quabbin Reservoir.

Of greater concern is the case where water having both high pH and high alkalinity is used for irrigation. In Massachusetts this situation is most common in Berkshire County. One result is that the pH of the growing medium may increase significantly with time. This increase may be so large that normal lime rates must be reduced by as much as 50%. In effect the water acts as a dilute solution of limestone! The problem is most serious when plants are grown in small containers because small volumes of soil are poorly buffered to pH change. Therefore, the combination of high pH and high alkalinity is of particular concern in plug seedling trays. Trace element deficiencies and imbalances of calcium (Ca) and magnesium (Mg) can result from irrigating with high alkalinity water.

It is much more difficult to predict the effects of irrigating outdoor flower crops, gardens, and landscape plants with water having high pH and high alkalinity. On the other hand, in some parts of the United States, long-term irrigation of crops with water high in bicarbonates and carbonates has led to yield-limiting trace element deficiencies which must be corrected with special fertilizers. On the other hand, in New England, several factors probably act together to partially offset the effects of high alkalinity water. First, rainfall levels are relatively high and historically this has caused Ca and Mg ions to leach from the soil. These are replaced with H^+ and the result is acidic soil. Second, this acidification may be helped along by the rather acidic rainfall common in more recent times. Third, acid-forming fertilizers also help counteract high pH and alkalinity.

Potential beneficial effects. For some greenhouse operators, water with moderate levels of alkalinity (30-60 ppm) can be an important source of Ca and Mg. With the exception of Peter's EXCEL and a few other fertilizers, most water soluble fertilizers do not supply Ca and Mg. Also, the Ca and Mg from limestone may be inadequate for some plants. Moderately alkaline water could be beneficial as a source of extra Ca and Mg for crops prone to Ca and Mg deficiencies (e.g., poinsettia).

Other Effects of High pH and High Alkalinity

In addition to nutritional disorders of plants, water with high alkalinity can cause other problems. Bicarbonates and carbonates can clog the nozzles of pesticide sprayers and drip tube irrigation systems with obvious effects. The activity of some pesticides, floral preservatives and growth regulators is markedly reduced by high alkalinity. When some pesticides are mixed with water, they must acidify the solution to be completely effective. Additional acidifier may be needed to neutralize all of the alkalinity. To determine if a chemical is affected by high alkalinity, carefully review the product's label. Unfortunately this potentially important information is not always printed on the label, so considerable extra effort may be necessary to find the information. A call to the manufacturer will probably be needed for most chemicals.

Acidification of High Alkalinity Water

Many greenhouse operators inject acid (e.g., phosphoric, nitric, or sulfuric acid) into water with problematic high levels of alkalinity. *Acidification of water having high pH but low alkalinity is rarely necessary.*

The use of acid injection should be considered very carefully for several reasons. First, it is an extra step in production which will require additional materials and equipment. Second, acids are dangerous to handle and may damage some injectors and piping systems. Third, phosphoric or nitric acid are sources of P and NO_3, so the regular fertilizer program may need to be modified to take into account the addition of these nutrients. This would depend on how much acid must be used to neutralize the alkalinity and reduce pH. Fourth, sometimes acid injection cause the solubilization of normally precipitated (unavailable) forms of trace elements resulting in levels toxic to plants.

The amount of acid required to reach the desired pH (i.e., neutralize alkalinity) is determined by laboratory titration of a water sample with the appropriate acid or by a calculation procedure. Some "fine-tuning" may be needed later when actual injection is started. Acid is always injected prior to the addition of fertilizer or other chemicals.

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