Understanding and Managing Irrigation Water Alkalinity

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Alkalinity is the measure of the water's ability to neutralize acids including those found in fertilizers and growing substrates. Water that is high in alkalinity will neutralize this acid causing the pH of substrates to rise over time or in some cases very quickly. Alkalinity is composed of dissolved calcium, magnesium, or sodium bicarbonates and calcium or magnesium carbonates. These dissolved carbonate and bicarbonate ions neutralize hydrogen ions which increases the pH of the substrate solution. Most laboratories report alkalinity in ppm (parts per million) or meq/L (milliequivalents of calcium carbonate per liter of water). The UK Soil Testing Lab expresses alkalinity in ppm. The recommended upper limit for alkalinity in irrigation water varies depending on the buffering capacity and volume of the substrate, the cropping cycle and the pH sensitivity of the crop. The larger the substrate volume the more buffering capacity is present so the pH will change much more gradually in large containers than small containers or individual cells in a plug tray.

Plug production is very sensitive to high alkalinity as the very small volume of substrate in the plug has very little buffering capacity, allowing the pH to change rapidly. The same is true in hydroponic systems as the substrate is usually inert, offering almost no buffering capacity. In these systems, problems can occur with an alkalinity as low as 50 to 75 ppm. For production of plants in 4-inch or larger containers that are not particularly pH sensitive, an alkalinity value of up to 150 ppm is manageable. However, an alkalinity of 150 to 300 causes increasing concern, especially if the water pH is greater than 7.5. You can expect the pH of the growing substrate to increase throughout the production cycle if no management strategy is employed. An alkalinity of greater than 300 ppm will cause significant problems if the water pH is greater than 7.5. The substrate pH will rise rapidly throughout the production of the crop and cause many nutrient problems. Ideally, water with such a high alkalinity should not be used for irrigation of container-grown plants. Acid injection may be the only remedy if this water source must be used for irrigation.

Management of Alkalinity

Fertilizer selection is one method to manage pH in soilless production systems when using irrigation water with moderate alkalinity. Every fertilizer is labeled with a potential acidity or basicity value in CCE (calcium carbonate equivalents; lbs/ton). A fertilizer formulation with a high potential acidity can balance the effects of moderately high alkalinity, keeping the substrate pH within an acceptable range. This is especially true in systems where soluble fertilizers are added frequently during irrigation. If this method is used, regular sampling of substrate pH is imperative. Common nursery and greenhouse fertilizers have been carefully formulated and their expected impact on pH is known and documented.

In simple terms, “Potential Acidity” or “Potential Basicity” as listed on the fertilizer package refers to the effect that this fertilizer product has on substrate pH. The higher the number for

"Potential Acidity," the more acidity the fertilizer provides. "Potential Basicity" works the same way. For example, Peters Peat-Lite Special has a moderate acidity potential but their 21-7-7 Acid Special has more than three times the acidification potential.

Acid Injection would likely be necessary if alkalinity is excessively high (300 ppm or more) to make the water suitable for irrigation in soilless production systems. There are several types of acid that are used to neutralize excess alkalinity in irrigation water. No matter which type is used, safe handling of concentrated acids is a serious concern. When mixing any acid, proper safety gear must be worn including safety glasses, face shield, and acid resistant apron, gloves and boots. Also all employees that will be working around the system should be aware of the nature of these materials and what precautions are warranted. When acid injection is necessary it is advisable to invest in an alkalinity test kit to allow monitoring alkalinity on a regular basis to ensure the system is running properly.

The acid must always be added to the water. Never add water to concentrated acid as an energetic reaction will occur that may cause the acid to splash. When mixing an acid solution, measure carefully to ensure accuracy and use acid resistant containers and tools. Always stir the solution after the acid is added as acids are heavier than water and will sink to the bottom of the tank leading to inconsistent injection.

The most commonly used acids are phosphoric, nitric, sulfuric, and citric. The choice of which acid to use depends upon the amount of acidification needed, as well as the relative cost and safety of the material. For moderate alkalinity levels, many growers opt for phosphoric acid as it adds phosphorus to the final fertilizer solution, and is safer and inexpensive than most other acids. For extremely high alkalinity, sulfuric (or battery) acid may be used as it has a higher neutralizing ability but is more hazardous to handle. Citric acid is relatively weaker and more expensive but the safest to handle and may be approved for use in some organic production systems.

Once the choice of acid has been made, the next steps are selecting the right injector and calculating the amount of acid needed in the stock solution. Read the specifications before purchasing an injector for use with acid. The manufacturer will state the maximum concentration of acid that the device can withstand.

There are many factors contributing to the actual alkalinity change that will occur so conducting a test or calibration run of the acid injection system is a must. For more information on calibrating acid injection, please refer to a University of Florida publication on the subject at http://edis.ifas.ufl.edu/ss165.

In summary, it is important to know the characteristics of your irrigation water, especially the alkalinity. Water with above optimum alkalinity water can be used for crop production. Fertilizer choice and acid injection are two tools / protocols available to managers. However, management must be based on test results and the substrate pH must be routinely monitored.