Water Quality and Vegetable Irrigation

- Chemical, physical, and biological factors impact the quality of water used to irrigate vegetable crops.
- Salinity and alkalinity are important chemical characteristics of irrigation water.
- Irrigation water sources should be protected from contamination with plant and human pathogens.

The quality of irrigation water can affect crop growth and the soil environment in vegetable production systems. Water quality criteria include salinity, sodium hazard, pH, alkalinity, particulate matter, and the presence of microorganisms. Water test results should be evaluated along with soil test results to help maximize crop production. Crops vary in their tolerance to water quality parameters, so growers should become familiar with the specific requirements of their crops.[1,2]

Chemical Characteristics

Chemical aspects of water quality include salinity, sodium hazard, pH, alkalinity, and specific ion concentrations. Of these, salinity is often the most important, especially in arid regions that receive little rainfall during the growing season.

Salinity: Salinity is a measure of the total salt concentration in the water as measured by electrical conductivity (EC_w). The salinity of the water can have short-term effects on the growth of the current season's crop and long-term effects on the salinity of the soil (EC_e). All irrigation water contains some level of dissolved salts. When the water evaporates from the soil or is transpired through the plant, the salt is left behind. The salinity of the soil increases with each irrigation if the accumulated salt is not leached from the root zone by natural precipitation or an abundance of irrigation. A soil is classified as saline if the salt level in the root zone is high enough to reduce crop growth and yield.[2,3] In general, vegetable crops are more sensitive to saline conditions than cereal crops.[1,2,3] Most vegetables are considered sensitive to moderately sensitive, with yield reductions starting when salinity levels reach 1.0 to 3.0 dS/m and have zero yield when levels reach 7.5 to 15.0 dS/m, depending on the crop.[2]

Soil salinity issues may be mitigated by applying excess water to help leach some of the salt out of the root zone. If lower salinity water is used during the early stages of crop establishment, water with a higher saline content can be used later in the season; however, the salt will need to be washed from the root zone by rainfall or high-quality irrigation water before the next crop is planted.[3]

Sodium hazard: the sodium hazard relates to the proportion of sodium (Na), calcium (Ca), and magnesium (Mg) ions in the water. A high proportion of Na in the water can cause soils with a high clay content to swell, resulting in reduced water movement through the soil, soil crusting, and plugging of soil pores. Irrigation water with high Na levels may need to be treated to adjust the ion ratios of the water.[4]

Figure 1. The quality of water used for irrigating vegetable crops can impact crop growth, soil properties, irrigation equipment, and food safety.

pH and Alkalinity: pH is a measure of the hydrogen ion (H^+) concentration of water or other liquid with a range from 0 to 14. A pH value of 7.0 is neutral, with values below 7.0 considered acidic and above 7.0 considered basic or alkaline. The pH of irrigation water should be between 5.0 and 7.0.[5,6] Highly acidic or highly basic irrigation water can affect the availability of nutrients in the soil solution, leading to nutrient deficiency and toxicity problems. Highly acidic water can also increase the rate of corrosion of irrigation equipment.[1,4]

Alkalinity is a measure of the water's capacity to neutralize acidity or the ability to resist a change in pH.[5,6] The terms alkaline and alkalinity are not synonymous, nor do they refer to the same property of water. Tests for alkalinity measure the levels of carbonates, bicarbonates, and hydroxides in water. Carbonates, bicarbonates, and hydroxides are introduced into the water from materials like limestone and dolomite in aquifers. High alkalinity can result in the precipitation of calcium and magnesium out of solution, forming calcite scale that can clog drip emitters and micro-spray nozzles. Low alkalinity levels can also be problematic when using acid fertilizers due to the low buffering capacity.[1,4] The alkalinity level of irrigation water should be between 0 and 100 ppm, with an optimum range of 30 to 60 ppm.[7]

Measurements of both the pH and alkalinity level of irrigation water should be tested. However, the alkalinity level is usually more informative as a measure of water quality because the alkalinity level can directly affect the availability and balance of nutrients in the soil solution that impact crop development.[1,5]

Specific ion concentrations: Irrigation water with high chloride levels can cause leaf burn when applied using overhead sprinklers. Using drip irrigation, drop nozzles, and drag hoses can help reduce leaf burn by minimizing application directly to the foliage. High boron levels can reduce yields in boron-sensitive crops such as beans, onion, garlic, and lettuce.[3,4] High iron levels can result in the formation of sediments that clog irrigation equipment. Iron can also cause foliar spotting and toxicity problems on iron-sensitive crops.[1]

Particulate Matter

Particulate matter such as sand, soil, algae, and other forms of organic matter, needs to be removed to prevent clogging of pipes, valves, nozzles, and emitters. Surface water taken from ponds, lakes, and streams is most likely to contain particulate matter, but groundwater can also contain sand and other particles. Levels of particulates can vary over the season from factors such as algae growth and spring runoff. Particulate matter should be removed by filtration, with filters selected based on the results of water analysis. Filter system flow rates should be designed to supply needed amounts of water during periods of peak demand. Filter systems need to be monitored and maintained on a regular basis throughout the season.[7]

Microorganisms

Another aspect of irrigation water quality is the presence of microorganisms. Surface sources such as ponds, streams, creeks, lakes, and tailwater retention basins are subject to contamination by microorganisms from surrounding soil, water runoff, windblown particles, nearby livestock, and wild animals. These sources of contamination can introduce microorganisms that are pathogenic to humans and crops.[8,9]

Contaminated irrigation water can disseminate plant pathogens resulting in the infection of susceptible plants and infestation of fields. The pathogens *Phytophthora, Pythium, Fusarium*, and *Rhizoctonia* have all been detected in surface water sources in the U.S. Because of increased levels of crown and fruit rots caused by *Phytophthora capsici*, fewer cucumber growers are now using surface water for irrigating theircrops.[8]

Well water is less likely to be contaminated than surface water, but shallow wells can be infested if not properly capped or if the well casing is cracked. Well water stored in open containers or impoundment areas also can become contaminated before use. Municipal water is less likely to be contaminated, as this water is usually monitored and often treated by the supplier.[8]

Irrigation water can also become contaminated with microorganisms that cause human illness, typically from contact with human and animal feces.[9] As with plant pathogens, human pathogens are most likely to be found in surface water sources, less likely in well water, and even less likely in municipal water sources. The proximity of water sources to wastewater discharge areas and livestock operations should be noted when selecting sources of irrigation. The method of application can affect the level of risk for contamination. Water applied to foliage and fruit using overhead irrigation systems is more likely to result in contamination of the harvested product than water applied using drip or furrow irrigation systems. Applications close to harvest are also more likely to result in the presence of unwanted microorganisms on the product than are applications earlier in the season.[9] Water can also be treated to remove pathogens by methods such as filtration, chlorination, electrolysis, and UV irradiation.[10]

Growers should follow procedures to protect irrigation water quality. Properly construct, protect, and maintain wells. Limit the access of livestock and wildlife to production fields and areas that drain into irrigation sources. Test well water biannually and treat if coliform bacteria are detected. Test surface water sources quarterly in areas with warm climates and three times per season in northern areas. Request test results of municipal water from the water authorities. Use methods that minimize the direct application of irrigation water to produce. Treat water if necessary. Keep accurate records of sources, methods, and timing of irrigation.[9,10]

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Websites verified 6/29/2023

For additional agronomic information, please contact your local seed representative.

5021_259450 Published 07/21/2023