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Analysis Report For:	Copy To:
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LAB ID:	SAMPLE ID:	REPORT DATE:	DATE SAMPLED	SAMPLE TYPE	INTENDED USE	COUNTY
W33439	Worm Castings Extract 2	8/9/2024	7/30/2024	Irrigation Water	Greenhouse	

WATER ANALYSIS
Irrigation Water Report (WH02)

Analysis	Result	Units	Level of concern
pH	7.2	-	Below 5.0 or above 7.0
Total Alkalinity as $CaCO_3$	254.0	mg/L	Below 30 or above 100
Bicarbonate (HCO_3) Alkalinity	309.9	mg/L	-
Carbonate (CO_3) Alkalinity	0.0	mg/L	-
Hardness as $CaCO_3$	126.2	mg/L	Below 50 or above 150
Electrical Conductivity (EC)	0.78	mmhos/cm	Above 1.0 for plugs or above 1.5 for others
Total Dissolved Solids (TDS)	499.2	mg/L	Above 640 for plugs/seedlings or above 960 for others
Nitrate-Nitrogen (NO_3-N)	< 0.2	mg/L	Consider in overall fertility program
Ammonium-Nitrogen (NH_4-N)	6.54	mg/L	Consider in overall fertility program
Phosphorus (P)	4.43	mg/L	Above 5.0 may cause micronutrient deficiencies
Potassium (K)	149.37	mg/L	Consider in overall fertility program
Calcium (Ca)	35.35	mg/L	Below 40 or above 100
Magnesium (Mg)	9.22	mg/L	Below 25
Iron (Fe)	< 0.10	mg/L	Above 0.30 for micro-irrigation or above 5 for plant toxicity
Manganese (Mn)	0.02	mg/L	Above 0.05 for micro-irrigation or above 2 for plant toxicity
Zinc (Zn)	0.07	mg/L	Above 0.30 toxic to most plants
Copper (Cu)	0.02	mg/L	Above 0.20 toxic to some plants
Boron (B)	0.12	mg/L	Above 0.50 for sensitive plants, above 2 for most plants
Molybdenum (Mo)	< 0.010	mg/L	Above 0.05 toxic to some plants
Sulfur (S)	15.4	mg/L	Below 10 may require addition of S fertilizer
Chloride (Cl)	48.53	mg/L	Above 30 for sensitive plants, above 100 for most plants
Sodium (Na)	31.27	mg/L	Above 50
Sodium Adsorbtion Ratio (SAR)	1.21	-	Above 2.0

The above results and interpretations are applicable to raw irrigation water used for greenhouse or high tunnel production only. Level of concern for each parameter are general; some plants have water quality tolerances that differ from those listed here. A brief description of each parameter is provided on the back of this report. Additional information about irrigaiton water quality may be found on the Penn State Water Quality Extension website, https://extension.psu.edu/water/water-for-agriculture/irrigation-water

Comments

pH: Optimum pH for most plants is between 5 and 7. High pH (>7.0) may reduce micronutrient availability. Higher pH levels can be tolerated if water alkalinity is not excessive. High pH can be corrected by acid injection and/or use of acid forming fertilizers. Low pH (<5.0) may result in toxicity of some micronutrients (e.g., iron and manganese) and is usually found in combination with low alkalinity. Low pH problems may be corrected by using a basic fertilizer or liming soil/media.

ALKALINITY: Alkalinity generally originates from carbonates and/or bicarbonates dissolved in groundwater. While measurement of carbonate and bicarbonate alkalinity can be useful to determine the source of alkalinity, total alkalinity is the most important value for evaluation and management of water quality. Use of irrigation water with high alkalinity (>150 mg/L $CaCO_3$) may lead to elevated media pH resulting in induced micronutrient deficiency. Low alkalinity (less than 30 mg/L $CaCO_3$) provides little buffering capacity against changes in pH, which may be problematic where acid fertilizers are used.

ELECTRICAL CONDUCTIVITY and TOTAL DISSOLVED SOLIDS: EC is a measure of the electrical current carried by dissolved substances in water. It is commonly referred to as salinity or soluble salts. The EC of clean water is generally 0 to 0.6 mmhos/cm. The EC of fertigation water varies with the fertilizer salt concentration, but is generally in the range of 1.5 to 2.5 mmhos/cm. In order to avoid problems from excessive salts, EC of raw water (without fertilizer) should be <1.0 mmhos/cm for plugs or seedlings and <1.5 for larger plants. Raw water with an EC >3 mmhos/cm can be expected to cause problems for most plants. TDS is another measure of dissolved substances in water. TDS and conductivity are closely correlated. TDS can be estimated using the EC value and a standard conversion factor, TDS (mg/L) = 640 x EC (mmhos/cm). Using the equivalent EC limits outlined above, TDS should be <640 mg/L for plugs and seedlings or <960 mg/L for other plants.

NITRATE-NITROGEN: Typical values for clean water are 0.3 to 5 mg/L. The drinking water standard for nitrate-nitrogen is 10 mg/L. Discharged waste water from greenhouses or nurseries entering surface waters or streams should meet or exceed the drinking water standard. The acceptable range for fertigation of most crops is 50 to 150 mg/L.

AMMONIUM-NITROGEN: Typical ranges for clean water are 0 to 2 mg/L. The typical range for fertigation is 0 to 75 mg/L. Toxicity symptoms may occur in sensitive plants when ammonium is used in fall, winter, or early spring. Toxicity symptoms include stunting, root death, leaf yellowing and distortion of growing points and can be corrected by switching to nitrate fertilizer.

PHOSPHORUS: Levels in groundwater or clean surface water are generally very low (<1 mg/L). Higher levels indicate contamination from manure or fertilizer. Concentration should be considered in overall fertility program. Levels greater than 5 mg/L in fertigation water may reduce availability of other nutrients. Waste water discharged to surface waters should be as low as possible (less than 1 mg/L is desirable) to reduce environmental impact.

POTASSIUM: High concentrations of potassium are generally not an issue for plant growth. Levels should be considered in overall fertility program.

CALCIUM, MAGNESIUM and HARDNESS: Concentrations of Ca and Mg typically reflect the rock where the water originates. Ca levels <40 mg/L or Mg levels <25 mg/L in irrigation water will require addition of Ca and/or Mg in fertilizer. Both Ca and Mg contribute to water hardness. Hardness levels >150 mg/L may result in scale formation, leading to clogged irrigation equipment.

IRON: Concentrations >0.3 mg/L can result in clogging of irrigation equipment. Levels >1.0 mg/L may cause foliar spotting with overhead irrigation. Levels >5.0 mg/L can cause severe staining and toxicity in sensitive plants.

MANGANESE: Concentrations >0.05 mg/L can cause staining and result in clogging of irrigation equipment. Levels >2.0 mg/L may be toxic to sensitive plants especially if the pH of growth media is low.

ZINC: Levels >0.3 mg/L can be toxic to some plants especially if the pH of growth media is low. Typically originates from corrosion of galvanized plumbing. Mine drainage may also be a source in some areas.

COPPER: Levels as low as 0.2 mg/L can be toxic to some plants. Typically originates from corrosion of copper plumbing.

BORON: Boron toxicity may occur if irrigation water of fertigation solution exceeds 0.5 to 1.0 mg/L, particularly with long-term exposure in slow-growing crops. Toxic levels are rarely observed in Pennsylvania irrigation waters.

MOLYBDENUM: Levels >0.05 mg/L can be toxic to plants, but these levels are very rare in Pennsylvania irrigation waters.

SULFUR: High levels of sulfur are rare, but may be elevated in coal mining regions. Where sulfur levels are <10 mg/L, sulfur may need to be included in the fertilizer program for greenhouse production.

CHLORIDE: Chloride may occur naturally in water supply or from contamination (e.g. road salts, gas well drilling, etc.). Chloride can impact plants from excessive foliar absorption or root uptake. Most plants can tolerate levels as high as 100 mg/L, but levels above 30 mg/L may cause problems for sensitive plants.

SODIUM and SODIUM ADSORPTION RATIO: Sodium may originate from road salt, wastewaters, or water softentng wastes. Levels in excess of 50 mg/L may cause toxicity in sensitive plants, particularly in recirculating irrigation systems. Problematic sodium levels may be further diagnosed by evaluating the relative concentrations of sodium, calcium, and magnesium, referred to as the Sodium Adsorption Ratio (SAR). A SAR of <2.0 is considered safe for most plants, especially if sodium is <50 mg/L.