Root Zone Management of Hydroponic Leafy Greens

Dan Gillespie, M.S. Graduate Associate, Department of Horticulture and Crop Science, The Ohio State University
E-mail: gillespie.286@buckeyemail.osu.edu
Phone: (610)-675-8372

HYDROPONIC SYSTEMS

Water Culture Systems for Leafy Greens

Deep Water Culture (DWC)

Passive system, consisting of a large volume of nutrient solution and some type of raft that anchors plants and floats on nutrient solution. Plant roots grow into nutrient solution to uptake nutrients and water.

Nutrient Film Technique (NFT)

Active system, consisting of a reservoir of nutrient solution and a gutter like trough where plants are located. Nutrient solution is pumped to troughs and supplied to plant roots for uptake. Excess solution is recirculated to reservoir.

Ebb and Flow

Active system where planting area is flooded with nutrient solution and drained. Excess solution is either reused or discarded.

Aeroponics

Active system where plant roots are suspended in air and supplied nutrient solution in form of mist rather than liquid.

System Choice Considerations

Planting density

Some systems may be better suited for high/low density. (i.e. DWC typically is better suited for high density crops than NFT).

Location

System weight and chance of failure should be considered when choosing a system. If you are growing on a rooftop, NFT is likely more feasible than DWC due smaller volume and weight. However, in hot and dry environments DWC is typically preferred due to decreased chance of failure (passive vs. active system).

Budget

What can you afford? A greenhouse sized DWC pond will typically be more expensive than NFT gutters.

Lettuce growing in NFT system

Healthy spinach roots in DWC system

WATER SOURCE AND QUALITY

Water Source

Municipal Water

Municipal water is unique to each municipality and will likely change throughout the year.

- Concern of chlorine toxicity

Well Water

Unique to each location, but typical for water to be very alkaline and hard (high mineral content).

- Potential for increased disease pressure, but not always!

Alkalinity and Hardness

Alkalinity is a measure of water's capacity to resist acidic changes in pH (buffering capacity), whereas **hardness** is a measure of carbonate and bicarbonate present in water.

- **Optimum Alkalinity**: 60-120 ppm

Chlorine

Chlor**ine** (Cl) and chlor**amines** (NH_2Cl) may be present in source water and can cause phytotoxicities. Do not confuse chlor**ine** with chlor**ide** (Cl-), which is a plant nutrient.

- Toxic levels are species, system, and substrate specific
- Disease like symptomology (wilting, chlorosis, root browning)

Water Treatment Options

Reverse osmosis (RO): Effective in removing some microorganisms and minerals. Will need to add alkalinity/buffer back to water to avoid pH swings.

Carbon/Charcoal filter: Removes chlorine and organic compounds. Not effective in removing microorganisms and minerals.

Sodium thiosulfate: Dechlorination only. Should be added to water before fertilizer is added, as chlorine can degrade EDTA and DTPA chelates (**2.5 ppm** is appropriate for dechlorinate).

Water Disinfectant: Ultraviolet (UV) radiation lamps, chlorine dioxide systems, and ozone treatment.

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NUTRIENT SOLUTION

Nutrient Solution Components

pH: Unitless measurement of hydrogen ion concentration of a solution that affects plant nutrient availability and fertilizer solubility.

- Cation uptake decreases pH; anion uptake increase pH
- **Optimum nutrient solution pH:** 5.5-6.5

Electrical Conductivity (EC): Provides information on the general fertility level of nutrient solution and whether salinity problems are likely to exist.

- **Units:** dS m^{-1} (=mS cm^{-1}=1 mmho cm^{-1}=1,000 uS cm^{-1})
- **Typical leafy green solution EC:** 1.0-2.5 dS m^{-1}

Dissolved Oxygen (DO): Measure of presence of free 0_2 molecules in water. Water temperature will impact DO (warmer water holds less DO).

- **Units:** mg L^{-1} (ppm)
- **Optimum nutrient solution DO:** +6 ppm

Nutrient Solution Temperature

- 20-22 °C (68-72 °F)

Nutrient Solution Management

Typically, growers will keep the same nutrient solution for many crop cycles, adjusting pH and EC as needed and discarding solution when problems arise (disease, toxic accumulation of specific nutrients, etc.).

- pH, EC, and DO measurements should be taken daily by gently stirring meters. Meters should be calibrated weekly.
- Sanitize meters with 1:50 peracetic acid solution to avoid inoculating solution/system
- Rinse meters with clean water after use and store correctly (i.e. store pH electrode in storage solution)

Fertilizer cost are minimal, but mismanagement of nutrient solution can be costly!

Tip burn in lettuce

COMMON ISSUES

Tip Burn (Calcium deficiency)

Physiological response of calcium (Ca) deficiency. However, this is not a result of insufficient Ca in nutrient solution, but is a result of leaves growing at a faster rate of Ca translocation to these leaves or growing point.

- Browning of edges or tips of leaves
- Occurs on new young leaves
- Often seen when growth rate is very fast

Tip Burn Prevention

Vertical Airflow Fans (0.3-0.5 meters/second)

Enhances transpiration at growing point, therefore increasing water and Ca translocated to growing point

High Night Humidity (>95%)

Increases root pressure which increases water and Ca translocation to growing point

- Run risk of increasing disease pressure

Reduce growth rate

Reduce daily light integral (DLI) or EC

- Decreases potential profit

Iron Deficiency

Result of decreased availability/solubility at high pH. Iron solubility will depend on chelating agent used, but precipitation can occur at pH as low as 7 or as high as 10.

- Maintain pH 5.5-6.5 to ensure iron is available and soluble in nutrient solution
- Chlorosis of young new leaves

Root Pathogens

Primarily fungal and introduced through water supply or unsanitary practices. Control options are limited for edible crops.

Prevention is key:

- Clean growing area
- Healthy, strong seedlings/transplants
- Maintain DO +6 ppm
- Maintain water at 20-22 °C (68-72 °F)

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