AEtrium System Maintenance

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Automating Passive Cleaning Using Stabilized Hydrogen Peroxide

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Recirculating aeroponic systems provide an ideal environment for microbial growth to flourish. The frequent mists of fertigation solution provided to the plant roots create a microclimate that is rich in oxygen, moisture, and nutrients – conditions that are highly conducive for microbial growth to take form. Furthermore, the recirculating nature of the system ensures a continuous supply of nutrients and water, fostering the growth and spread of established microbial populations.

While maintaining a clean and pathogen-free environment is critical, seeking to achieving a sterile environment is unrealistic. Microbes, including beneficial ones, are ubiquitous and play vital roles in nutrient cycling, root health, and disease suppression. Furthermore, the introduction of microbes through airborne channels, worker contact, and even the plant roots themselves make doing so impossible. Instead of striving for sterility, a more practical approach is to manage microbial growth in a way that prevents pathogen establishment and promotes plant health. One such method , is through the use of hydrogen peroxide.

Hydrogen peroxide, is a powerful and dynamic oxidizing agent. When supplied in the fertigation solution at the correct concentrations, hydrogen peroxide suppresses microbial growth and pathogen establishment, while also promoting plant growth. By perpetually maintaining non-phytotoxic concentrations of hydrogen peroxide in the fertigation solution, growers can provide an oxidative first line of both offense and defense to existing and opportunistic microbial species alike.

Peracetic acid is a chemical compound formed by the reaction of acetic acid and hydrogen peroxide. When peracetic acid is present in solution with Hydrogen Peroxide, the peracetic acid stabilizes the hydrogen peroxide, preventing the hydrogen peroxide from degrading naturally before it has the opportunity to oxidize organic molecules.

When added to clean water in the absence of peracetic acid, hydrogen peroxide typically lasts in solution for minutes to hours; conversely, when peracetic acid is present in the same solution, hydrogen peroxide can endure in solution for days to weeks, provided no compounds capable of being oxidized are added.

Furthermore, unlike most chlorine-based oxidizers, hydrogen peroxide does not produce any harmful disinfection by-products and/or combined-chlorines that can cause phytotoxicity when accumulated in sufficient concentrations. When hydrogen peroxide degrades or oxidizes, it always breaks down into water (H_2O) and oxygen (O_2), increasing the dissolved oxygen content in the solution.

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Materials:

- ❑ Hydrogen Peroxide (H_2O_2)
  - Any stabilized H_2O_2 product with a percent strength between 20% - 34%
    - (i.e. Zerotol 2.0, food grade 34%, etc.)
- ❑ H2O2 Test strips (1-100 PPM)



- ❑ 25 mL volumetric cylinder

Note: Ensure local regulations allow the use of hydrogen peroxide on the target crop

Step 1. Pick a device to automate

- **Note:** the data generated from this test will only be applicable for devices with a similar number of growth tubs running the same grow plan. A separate test should be performed for all other devices.

Step 2. Determine the average water volume for the chosen device

- I.E. How many gallons or liters are usually in the reservoir

Step 3. Determine roughly how many milliliters (mL) of H_2O_2 should be added to the reservoir to bring the reservoir water H_2O_2 concentration to 50 parts per million (ppm)

Use the following simplified equation:

$$([\text{Average Reservoir Water Volume}] \times [U]1_{\text{ or } 2}) \div [\text{Percent Strength of } H_2O_2 \text{ Stock Solution}]$$

$$[U]_1 = 17.2 \; [If \; Average \; Reseroir \; Volume \; is \; in \; Gallons]$$
$$[U]_2 = 4.54 \; [If \; Average \; Reservoir \; Volume \; is \; in \; Liters]$$

Example:

30 gallon reservoir with 34% H_2O_2 Stock Solution

$$([30\,] \times [17.2]) \div [34] = 15.2 \text{ mL}$$

When 15.2 mLs of 34% H_2O_2 are added the reservoir – we can expect roughly 50 PPM of H_2O_2 to be present in the reservoir shortly after

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Step 4. Pause the grow plan on the selected device and manually run the drain/mix pump

- Running the drain/mix pump without opening the drain valve will mix the reservoir water

Step 5. (While the water is mixing) add the calculated volume of the stock H_2O_2 solution into the reservoir of the selected device and allow at least 2 minutes for uniform mixing

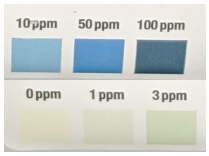
- Make sure the reservoir water volume is within ±5 gallons / ±15 liters of the [Average Reservoir Water Volume] used when calculating the dilution

Step 6. Measure and record the H_2O_2 concentration in the reservoir, then resume the grow plan.

Step 7. Measure and record the H_2O_2 concentration in the reservoir using test strips every half hour until there is between 0-3 PPM of H_2O_2 remaining.

- **Note**: Initial H_2O_2 concentrations and H_2O_2 consumptions rates will vary between devices/facilities depending upon the

Example:

Measured H_2O_2 Concentration Over Time (Test Strips)						
Time After Hand Dose (Minutes)	2	30	60	90	120	180
[H_2O_2] (PPM)	50	50	10-50	10	3-10	0-1
Test Strip (Reference) 						

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Step 8. Using the test strip data – determine the correct dosing rate and interval. The goal is to maintain between 3 and 50 PPM of H_2O_2 in the reservoir at all times.

- In the above example, when 15.2 mLs of a 34% H_2O_2 stock solution were added into the reservoir, the H_2O_2 concentration reached 50 PPM and remained above 3 PPM for roughly 180 minutes (3 hours).
  - Dose rate = Amount Dosed / Reservoir Volume = 1.7 mL /30 gallons = .55 mL/gal
  - Dose interval = 3 hours

Step 9. Ensure the GGM software is up to date (GGM Version 4.2.12)

- Required for:
  - Small volume dynamic dosing (<1.0 ml/gal dosing)
  - Peristaltic pump calibration

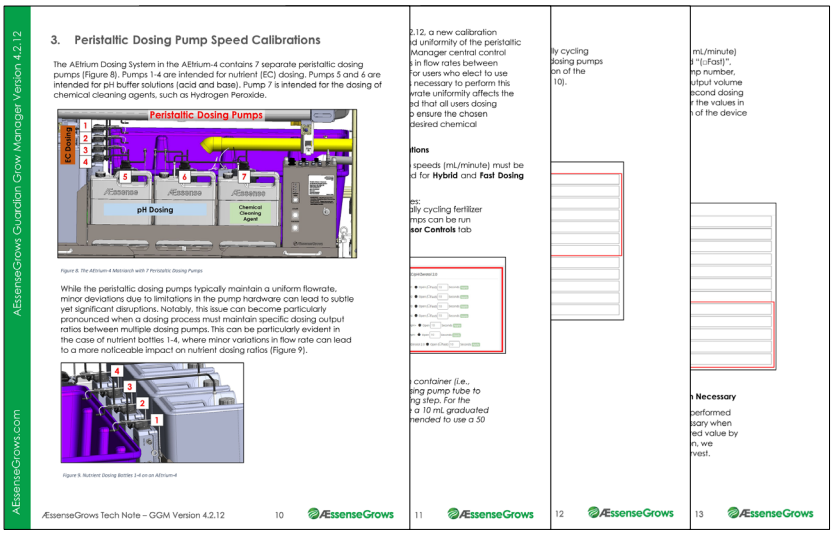
Step 10. Fill Doser Bottle 7 with the chosen H_2O_2 product

Step 11. Calibrate the Peristaltic Doser Pump for bottle #7

- See pages 10 -13 of the "Guardian Grow Manager (GGM) v.4.2.12 Tech Note"(on the Private Grow Partner Portal).



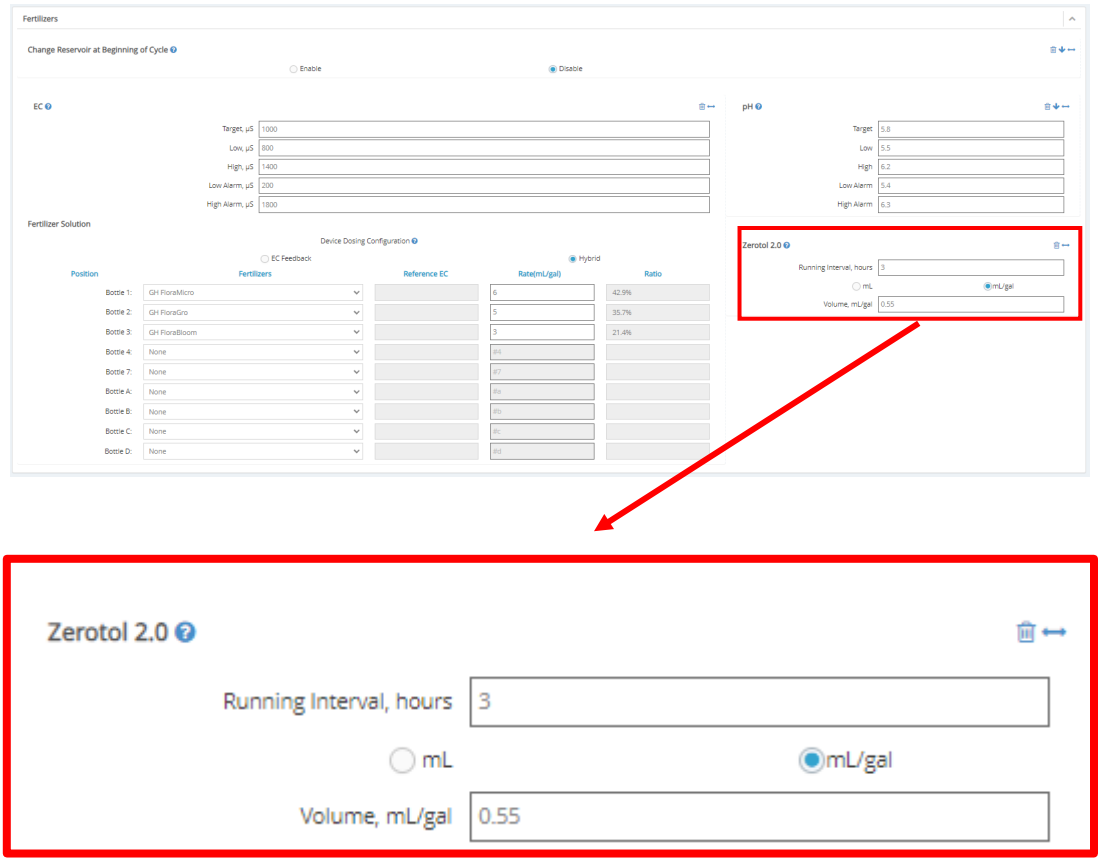




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Step 12. In the Fertilizers section of a grow plan running on the chosen device, enter the dose interval in the "Running Interval, hours" box and the dose rate in the "Volume, mL/gal" box. Save and run the grow plan.

Example:



Step 13. Measure and record the H_2O_2 concentration in the reservoir of the chosen device several times over the following days to ensure the chosen automated dose rate and dose interval continue to maintain between 3 and 50 PPM of H_2O_2 in the reservoir.

- Overtime, the required dose rate and dose interval may change as the amount of organic matter in the system capable of reacting with the H_2O_2 can change
  - If the H_2O_2 concentration builds to 100 PPM at any point, decrease the dose rate slightly (reduce by 0.1-0.2 mL/gal)
  - If the concentration of H_2O_2 does not reach roughly 25 PPM, increase the dose rate slightly (increase by 0.1-0.2 mL/gal)