e-GRO Edible Alert

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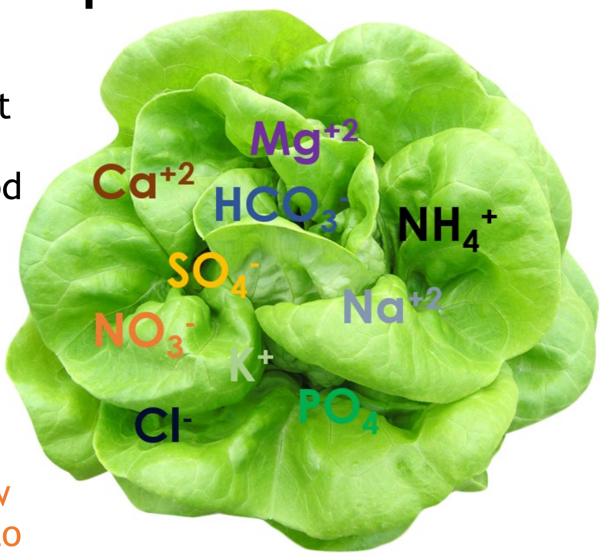
Test & Adjust Nutrients in Hydroponics



In hydroponic systems, we supply nutrients in forms that are available to the crop. Plants respond rapidly to good and bad fertilizer choices. Therefore, we need to use precision in applying the fertilizers to sustain crop yields and quality.

In this e-Gro Edible Alert, I will discuss sampling and how to use the results of testing to adjust nutrient programs.

NUTRIENT SOLUTION

In-house monitoring of pH and electrical conductivity (EC) of the nutrient solution with a meter allows growers to detect trends and irregularities before problems arise.

Lettuce tends to be sensitive to changes in pH. Dr. Hansen *et al.* (2009) reported that not lowering the pH (while keeping the same EC) resulted in 24% yield loss. Most leafy greens grow well at a pH of 5.8, except rosemary which requires a pH >6.2. Measure and adjust the pH of the nutrient solution daily or every other day.

Growers producing lettuce commonly report that it is very difficult to maintain the pH of the nutrient solution in hydroponics. The pH tends to raise. A major cause is that most hydroponic operations use nitrate-N as the sole nitrogen (N) source.

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Nutrient Solution (continued):

There are two ways to react to high pH:

1. Acidify with acid of choice.
2. Use 5-8% of the total N in the form of ammonium. Crops differ in how they react to N form. Dickson and Fisher (2017) reported that lettuce, basil, spinach, and arugula raise the pH when nitrogen is provided exclusively as nitrate. Lettuce (unlike arugula) results in an acidic effect when you add ammonium-N. Too much ammonium can be phytotoxic and too acid, but a little will result in an acidic reaction that will prevent pH from increasing too fast or too frequently.

Vine crops —like tomatoes and cucumbers — are not as sensitive to small changes in pH, as long as they are close to the neutral range. For these crops, measure the pH of the water source, adjust the pH if the levels are extreme (<5 or >7), and then add the fertilizers.

The EC of the nutrient solution will serve as reference of the overall nutrient levels and it should closely match the target EC for each crop (Table 1). While the EC is an excellent indicator of nutrient levels, it does not tell us anything about which elements are missing or at high concentration.

Crop	Typical EC (mS/cm)*	
	Open	Closed
Lettuce	1.3	0.9
Tomato	2.0	1.2
Cucumber	1.6	1.2
Peppers	1.8	1.3

Table 1. Typical EC for crops commonly grown in hydroponics.
* EC provided for reference only, actual EC may vary by cultivar or crop stage.

If the EC is extremely high or low, we should identify the cause of EC discrepancy (i.e. miscalculation of fertilizers, injector or scale malfunction). When the EC is outside the optimum range, then the following actions are recommended:

- If the volume is small, replace the fertilizer solution with a freshly prepared batch.
- If the volume is large, like in deep water culture (Figure 1), respond similarly to what we do with recycled solutions (more below).

Figure 1. Deep Water Culture production system with large volume of water.

In operations where the nutrient solution is recycled, it is essential to send samples for complete nutrient analysis every 7-14 days (or immediately when facing abnormalities). Most labs are capable of sending the results back in 24 hours.

Once the results are in, compare the analysis to target levels. Then balance the nutrient solution to reach optimum levels by diluting first — if needed — and then add only the nutrients that are not in range. Use the most limiting nutrient as reference of how much needs to dilute. Then add the other elements to reach a balanced solution. Finally, you can top it off with fresh solution.

For example, if potassium is high (>500 ppm), dilute first to take the potassium to about 200 ppm and then adjust other individual elements.

Growers capturing and reusing large volumes of nutrient solutions should have a supply of salts to adjust individual elements. The one, two, or three bag fertilizer programs are not compatible with this production system.

Vine crops produced in closed-systems are less problematic in this sense, because only about 10% of the initial solution returns to catchment tanks. Therefore, every time the growers refill the tanks, the resused solution is diluted with fresh solution at 1:9 rate.

SUBSTRATE TESTING

Test the substrate pre-planting. Identify potential faulty batches before transplant, it can save a lot of money and headaches. Make this a habit, ALWAYS test new substrate batches.

During the growing season, test the growing media in vegetable crops when the volume of the substrate is large enough to covers most of the roots (Figure 1). In contrast, the majority of roots in NFT or DWC systems are in solution, so testing the solution is the best approach.

Figure 2. Tomato production in coconut coir substrate.

TISSUE TESTING

The plant tissue is the ultimate proof of whether the nutrient programs work. Tissue testing is primarily conducted to identify the cause of nutrient disorders.

Interpreting tissue testing can be complicated because the results and optimum levels depend on the part of the plant, sampling timing, and production system.

Bryson et al. (2014) reported that nutrient levels in lettuce plants tends to be higher in greenhouses than in field production. For example, the range of potassium was 7.8 -13.7% in greenhouses and 6.0-7.0% in field production. Iron range was 198-223 ppm compared with 50-100 ppm. Compare your results to the right reference.

The ideal sample is the most recently fully mature leaf. Typically, in tomatoes is the 5th leaf from the growing tip down, cucumbers is the 3rd leaf from the growing tip down or the newest leaf with a diameter of approx. 10cm, peppers a young and fully expanded leaf, and lettuce a mature leaf (MAFRA, 2010).

Compare the results to ideal levels for the specific cultivar or published levels. Be aware that some levels may reflect previous practices.

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