e-GRO Nutritional Monitoring




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Volume 4 Number 1 May 2021

Nutritional Monitoring Series

Stevia

(Stevia rebaudiana)

Stevia requires low fertility levels between 100 and 150 ppm N. Insufficient fertility can cause chlorosis (yellowing) and stunted plant growth. Optimal substrate pH values for stevia range from 5.8 to 6.2.

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Figure 1. High pH-induced iron deficiency resulting in yellowing (chlorosis) in the upper foliage of the plant. Note that the interveinal chlorosis begins at the tip and encroaches into the leaf. Iron is an immobile element resulting in deficiency symptoms occurring in the newly developed foliage.

Stevia

Target Nutrition Parameters

pH Category III:
5.8 to 6.2

Fertility Category:
Low
100 - 150 ppm N

EC Category A:
1:2 Extraction:
0.4 to 0.6 mS/cm

SME:
0.9 to 1.3 mS/cm

PourThru:
1.3 to 2.0 mS/cm

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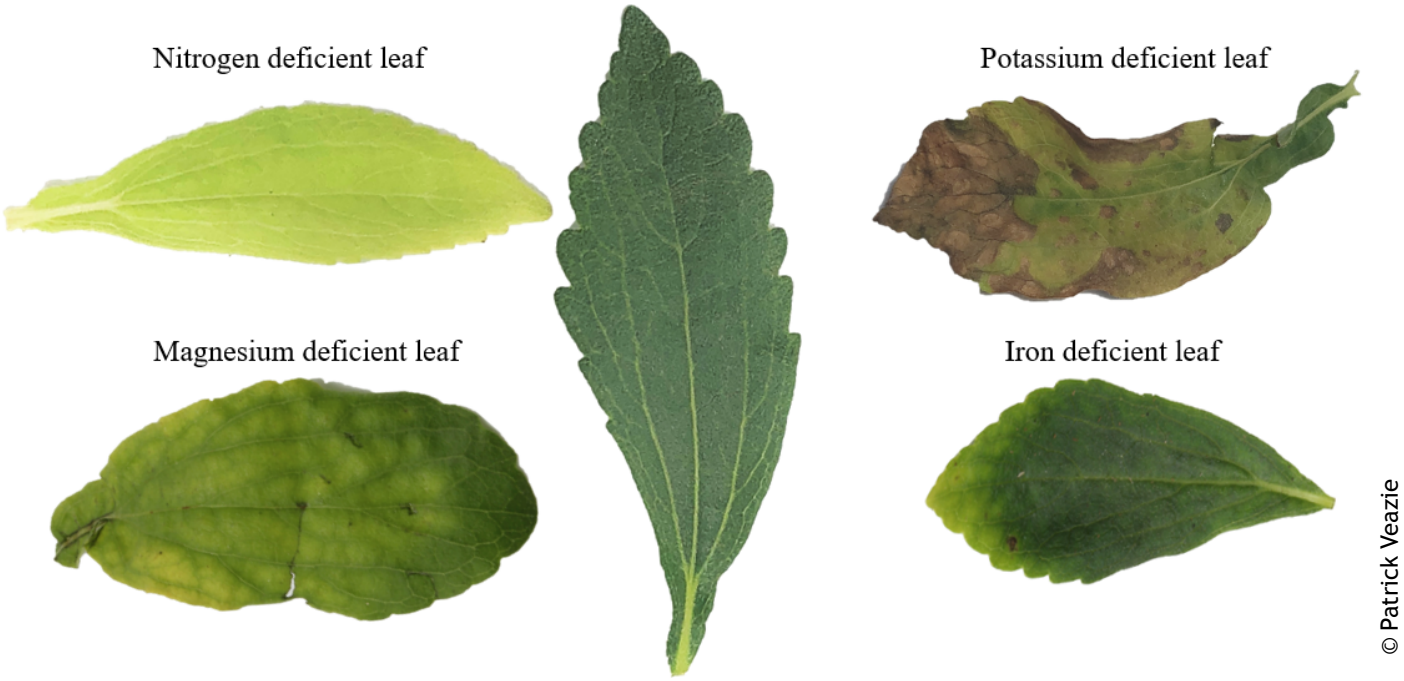

Figure 2. Nitrogen (N; top left), magnesium (Mg; bottom left), potassium (K; top right), and iron (Fe; bottom right) symptomology compared to a normal healthy stevia (*Stevia rebaudiana*) leaf (center). Note that N, K, and Mg deficiencies first appear on the lower foliage and if not corrected, will develop higher in the plant in advanced stages. However, Fe deficiency will initially occur in the upper foliage and intensify if not corrected. Photo by: Patrick Veazie.

Fertility Management of Stevia

The stevia plant requires low fertility. A target range of 100-150 ppm N with a complete fertilizer should be maintained (Veazie et al., 2021). Using a calcium plus magnesium fertilizer will be beneficial as the stevia has a high requirement for those nutrients. In a trial conducted at North Carolina State University, nutrient disorders were induced on stevia plants. Nitrogen, potassium, and magnesium deficiencies were the first to appear (Fig. 2). Iron deficiency was next to manifest (Fig. 1). Iron deficiency can be an issue if the pH is too high. These nutrients should be monitored as they will be most likely to be nutritional issues that growers encounter.

High levels of salts supplied in the irrigation water can build up in the growing substrate and cause high substrate electrical conductivity (EC; referred to as soluble salts) and salt stress on plants. These symptoms will appear as stunted growth, wilting (Fig. 3) and leaf necrosis (Fig. 4). Dark interveinal spotting was the initial symptom that occurred prior to the wilting of the leaves which eventually turned necrotic (Fig. 4). The target EC levels are 0.4 – 0.6 mS/cm using a 2:1 extraction method, 0.9 – 1.3 mS/cm for SME, and 1.3 – 2.0 mS/cm for PourThru extraction of top irrigated plants during the main growing season.

Substrate pH should be monitored during stevia production. The optimal substrate pH range for stevia is 5.8 to 6.2 (Veazie, unpublished data). A pH that is too high will result in chlorosis and stunting (Fig. 1) (Veazie et al., 2021). To adjust substrate pH, limestone applications can be applied to raise the pH or acid water drenches to lower the substrate pH. A PourThru will help monitor both the pH and EC and should be done at the beginning, middle, and end of the production cycle. Fertilizers can also affect pH, as most mixed fertilizers are acidic. To avoid altering the pH through your fertilizer, choose a neutral reacting fertilizer mix.

Summary
Providing low fertility of 100 to 150 ppm N and maintaining a pH of 5.8 to 6.2 will help prevent most nutritional disorders.

Literature Cited
Veazie, P., Cockson, P. and Whipker, B.E. 2021. Stevia: High Substrate pH. e-Gro Alert 10.07.

Veazie, P., Cockson, P. and Whipker, B.E. 2021. Stevia: Elevated EC Symptomology. e-Gro Alert 10.08.

Table 1. Recommended foliar nutrient concentrations for stevia (*Stevia rebaudiana*) grown under greenhouse conditions as a vegetative bedding plant.

Element		Recommended Range [1]
Nitrogen (N)	(%)	2.50 – 3.60
Phosphorus (P)		0.15 – 0.24
Potassium (K)		2.00 – 3.20
Calcium (Ca)		0.55 – 0.85
Magnesium (Mg)		0.35 – 0.55
Sulfur (S)		0.15 – 0.25
Iron (Fe)	(ppm)	50 - 75
Manganese (Mn)		40 – 60
Zinc (Zn)		20 – 50
Copper (Cu)		5 – 12
Boron (B)		20 – 30

Source: Unpublished data by Patrick Veazie et al., 2021 NC State University.

Figure 3. A comparison between a plant grown under high electrical conductivity (EC; referred to as soluble salts) conditions (left) and a plant grown under optimal EC conditions (right). The plant on the left is exhibiting wilting and leaf burn caused by high EC conditions. Photo by: Patrick Veazie

Figure 4. The progression of leaf burn on stevia caused by high electrical conductivity (EC; referred to as soluble salts) from least severe (left) to most severe (right). Photo by: Patrick Veazie

Corrective Procedures for Modifying Substrate pH and Electrical Conductivity (EC)

When the pH or substrate electrical conductivity (EC) drifts into unwanted territory, adjustments must be made. Below are the standard corrective procedures used to modify the substrate pH and EC for greenhouse grown crops in soilless substrates.

1. Low Substrate pH Correction

When Fe and Mn toxicity becomes a problem, adjust (raising) substrate pH to the recommended pH range. Corrective procedures to raise low pH levels are listed below. Switching to a basic fertilizer when the substrate pH is nearing the lower limit will help stabilize the pH. If the pH is below the recommended range, then corrective procedures will need to be implemented. Flowable lime is one option. Using a rate of 2 quarts per 100 gallons of water will typically increase the substrate pH by roughly 0.5 pH units. Two quarts can be used through an injector. Additional applications can be made if needed. Potassium bicarbonate ($KHCO_3$) can also be applied. A rate of 2 pounds per 100 gallons of water will increase the substrate pH by roughly 0.8 pH units. This treatment will also provide excessive potassium (K) and cause a spike in the substrate EC. A leaching irrigation with clear water is required the following day to restore the nutrient balance (the ratio of K:Ca:Mg) and lower the EC. As always, remember to recheck your substrate pH to determine if reapplications are needed.

pH Adjustment Recommendations

Flowable Lime

- Use 1 to 2 quarts per 100 gallons of water.
  Rinse foliage.
- Avoid damage to your injector by using rates of 2 quarts per 100 gallons of water, or less.
- Can split applications.

Hydrated Lime

- Mix 1 pound in 3 to 5 gallons of WARM water. Mix twice. Let settle. Decant liquid and apply through injector at 1:15.
- Caustic (rinse foliage ASAP and avoid skin contact)

Potassium Bicarbonate ($KHCO_3$)

- Use 2 pounds per 100 gallons of water
- Rinse foliage immediately.
- *Provides 933 ppm K.*
- Leach heavily the following day with a complete fertilizer to reduce substrate EC and restore nutrient balance.
- Rates greater than 2 pounds per 100 gallons of water can cause phytotoxicity!

2. High Substrate pH Correction

The target pH for many species is between 5.8 and 6.2. Higher pH values will result in Fe deficiency and lead to the development of interveinal chlorosis on the upper leaves. Check the substrate pH to determine if it is too high. Be careful when lowering the substrate pH, because going too low can be much more problematic and difficult to deal with.

Acid-based Fertilizer
If the substrate pH is just beginning to increase, then first consider switching to an acidic-based fertilizer. These ammoniacal-nitrogen (N) based fertilizers are naturally acidic and plant nitrogen uptake will help moderate the substrate pH over a week or two.

Acid Water Drench
Some growers use this intermediate correction if pH levels are not excessively high, and a quick lower of the substrate pH is desired. Use sulfuric acid to acidify your irrigation water to a pH 4.0 to 4.5. Apply this acid water as a substrate drench providing 5 to 10% excessive leaching of the substrate. Rinse the foliage to avoid phytotoxicity. Results should be visible within 5 days. Retest the substrate pH and repeat if needed.

Iron Drench
If the levels are excessively high, then an Fe chelate application can be made to the substrate.
Below are the options.

Iron Chelate Drench (options)
- Iron-EDDHA: mix 5 ounces in 100 gallons of water
- Iron-DTPA: mix 5 ounces in 100 gallons of water
- Iron sulfate: mix 4-8 ounces in 100 gallons of water

- Apply as a substrate drench with sufficient volume to leach the pot.
- Rinse foliage immediately.
- Avoid use on iron efficient plants (geraniums).

3. Low EC Correction

If low EC problems occur, increase the fertilization rate to 300 ppm N for a few applications before returning to the recommend fertilization rate for the crop.

4. High EC Correction

Excessively high fertilization rates will result in a marginal leaf burn. Check the substrate EC to confirm your diagnosis. Values greater than 6.0 mS/cm based on the PourThru sampling method can be problematic for many plants.

Switch to Clear Water Irrigations
If the substrate EC is just beginning to increase over time, then leach with a few clear water irrigations to lower EC levels by flushing out the salts.

Clear Water Leaching
If the EC values are excessively high, leach the substrate twice with back-to-back clear water irrigations. Then allow the substrate to dry down normally before retesting the EC. If EC levels are still too high, repeat the double leach. Once the substrate EC is back within the normal range, use a balanced fertilizer at a rate of 150 to 200 ppm N.

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