Determining Optimal Nutrient Value through Leaf Tissue Analysis on Tomato

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Introduction

Heirloom tomatoes, which are open-pollinated varieties, are increasing in their popularity in the United States. Because of their popularity, there is a significant positive price differential for them versus the standard red tomatoes. Theoretically, these tomatoes could benefit from being produced in a greenhouse setting. A greenhouse has the potential to reduce cracking and cat-facing of the fruit and will also bring the fruit in earlier in the season. However, the heirloom strains that are popular to consumers have not been fully tested for premixed nutrient solutions as the standard red hybrids have.

Dr. Michael Best, a professor in the School of Agriculture, recently received a grant to create a hydroponic growing system for the 30,000 square feet of greenhouse at Oakley Farm. The goal of the summer research project is to determine whether heirloom tomato varieties will produce well on premixed fertilizer.

Research Questions

- What is the appropriate methodologies for sampling tissue in hydroponic greenhouse tomatoes?
- Does using a standard hydroponic fertilizer solution allow for the different varieties to absorb the proper amounts of micro and macronutrients for proper plant growth?
- If testing shows deficiencies in absorbed nutrients, what supplements could benefit the production of heirloom tomatoes?

Figure 1. At first cluster stage, no deficiencies observed.

Figure 2. Chlorosis of leaf shows signs of nutrient deficiency.

Design & Methods

- Four heirloom tomatoes and one standard hybrid were selected for leaf analysis. The four heirlooms were Vinson Watts, Tough Boy, Willard Wynn, and Cherokee Purple. The standard hybrid was Tanager.
- We decided that we would test the nutrient levels in the plants when they first started showing signs of any deficiencies.
- The method for sampling is as follows:
  - The most recent mature or fully expanded leaf is the best indicator sample for all growth stages. This is the third or fourth leaf from the growing point.
  - 8-10 leaves are required for a good sample. These leaves can come from multiple plants.
  - One could take the leaves fresh for testing or dry them before delivery. If fresh samples are taken for testing, leaves must be stored in a paper bag to prevent mildewing during transportation.
- If the plants show a sign of nutrient deficiency, the nutrient will be added to either the irrigation system or will be applied to the foliage.

Results

- On June 8th, while examining leaf tissue, we noticed chlorosis on three varieties including Vinson Watts German Pink and Willard Wynn's German Yellow.

Table 1. First Leaf Analysis Results on June 12, 2019

	N	P	K	Ca	Mg	S	Zn	Mn	B	Fe	Cu
Sufficiency Range	4 - 6 %	0.25 - 0.8 %	2.5 - 5 %	1 - 3 %	0.4 - 0.9 %	0.3 - 1.2 %	20 - 50 ppm	40 - 100 ppm	25 - 50 ppm	40 - 80 ppm	5 - 20 ppm
Vinson Watt	4.29	0.58	2.81	2.54	0.63	1.35*	22	221*	109*	65	2*
Tough Boy	4.69	0.92*	2.32*	1.84	0.69	0.9	21	193*	96*	83	4*
German Yellow	4.09	0.89*	3.46	2.6	0.78	1.39*	23	289*	103*	63	2*
Cherokee Purple	4.17	0.43	3.8	1.95	0.54	1.25*	21	264*	98*	58	3*
Tanager	4.7	0.85*	2.19*	2.24	0.61	0.99	20	194*	127*	68	5
* Not within sufficient levels											

Table 2. Second Leaf Analysis Results on July 10, 2019

	N	P	K	Ca	Mg	S	Zn	Mn	B	Fe	Cu
Sufficiency Range	4 - 6 %	0.25 - 0.8 %	2.5 - 0.8 %	1 - 3 %	0.4 - 0.9 %	0.3 - 1.2 %	20 - 50 ppm	40 - 100 ppm	25 - 50 ppm	40 - 80 ppm	5 - 20 ppm
Vinson Watt	3.96*	0.65	3.18	2.6	0.88	0.99	23	284*	102*	62	5
Tough Boy	4.58	0.72	3.45	1.88	0.72	0.68	18*	138*	75*	64	7
German Yellow	4	0.5	3.16	2.15	0.71	1.1	21	158*	83*	64	6
Cherokee Purple	4.68	0.51	3.7	2.63	0.85	0.95	23	245*	107*	64	6
Tanager	3.74*	0.61	3.49	2.23	0.69	0.93	24	181*	89*	68	8
* Not within sufficient levels											

- Table 1 shows the results for all five varieties from the first leaf sample analysis. Of the heirloom varieties, two had high Phosphorus levels, three had high Sulfur levels, all had low Copper levels, and one had a high Iron level. Our control, Tanager, had low Potassium and Copper levels while also having high Phosphorus levels. All varieties showed higher than sufficient levels of Manganese and Boron.
- After discussing our first sample results, we decided to begin supplementing our fertilizer regime even though the test results were showing elements well within the normal ranges. The plants were continuing to have chlorosis which could be either a Nitrogen or Magnesium deficiency and blossom end rot which is a Calcium deficiency. Cal-Mag was chosen as a supplement because it provides the following nutrients: N 2.0%, Ca 3.2%, Mg 1.2%, and Fe 0.1%.
- Table 2 shows the results from our second round of testing. A Nitrogen deficiency was found in one heirloom and our standard hybrid variety. A Zinc deficiency was found in one heirloom variety. All samples were still higher than sufficient in Manganese and Boron.
- Even though Cherokee Purple was showing sufficient levels of Calcium there was still an issue with Blossom End Rot as seen in Figure 3. We started supplementing with 16 oz. per 1,000 gallons of water of Calcium Nitrate daily.
- Since our last supplementation, the blossom end rot issue has been resolved and we are sending one last sample to determine the current nutrient levels.

Figure 3. Calcium deficiency creating blossom end rot in mid-July on Cherokee Purple.

Figure 4. After calcium nitrate supplement, sixteenth cluster has no visible deficiencies.

Conclusions & Implications

- Although the leaf sample analysis results showed consistently that the nutrients were in the normal range for "greenhouse tomatoes" it was obvious from observation of the plants that they still lacked nutrients like Calcium, Nitrogen, and Magnesium.
- The results of this research show that a standard hybrid is not necessarily a good model for heirloom varieties.
- We feel that further research is necessary to determine the appropriate levels of macro and micronutrients needed for the most popular heirloom varieties that are in commercial production. This will allow producers of those crops to not have to use trial and error methods to determine plant nutrient needs.

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