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Diagnosing Low Substrate pH Disorders:
Steps for pH and Tissue Testing

When a low substrate pH induced micro-nutrient (iron/manganese) toxicity is suspected, the first step is to test the pH. For plants that accumulate iron and manganese in the tissue, a slight modification to the location of taking the leaf tissue sample is recommended to help confirm your diagnosis.

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The management of substrate pH is important in order to optimize the availability of nutrients (Fisher, 2011; Dole and Wilkins, 2005). Optimal pH ranges are published for many floriculture species. These ranges were established after observation of iron (Fe) and manganese (Mn) toxicity (Fig. 1) when the substrate pH was too low or Fe deficiency when the substrate was too high (Whipker et al., 2011).

Step 1. When low substrate pH induced problems are suspected, the first step is to test the substrate pH and electrical conductivity (EC). This can be done in-house using the 1:2, saturated media extraction method, or PourThru method. The pH values obtained are similar for any of these three methods. (Only EC values vary by the method used.) Your values can be compared with those published by the plant supplier or utilize the values provided in e-GRO Alert 4.02 (http://www.e-gro.org/pdf/2015_402.pdf).

Figure 1. Reddish-tan spots appear on the lower foliage of geraniums when the substrate pH is lower than 5.4. Photo by Brian Whipker

For plants in which we classify as being susceptible to low pH problems, what is occurring is an accumulation of toxic levels of micro-nutrients which lead to cell death and necrosis. The primary elements that accumulate at excessive levels are Fe and Mn. Because uptake is greater at lower pH levels for all micro-nutrients, except molybdenum (Mo), higher accumulation of boron (B), zinc (Zn) and sometimes copper (Cu) can also occur.

In diagnosing low pH induced toxicities, there are two additional follow-up confirmation steps. These steps are especially important the first time encounter a new problem. The additional data will help improve your diagnostic skills.

Step 2. A sample should be sent to a commercial lab for complete nutrient analysis. Substrate testing is invaluable in helping to determine the exact nutrient levels in the substrate and allow you to see if there are any imbalances with your fertilization program. (The EC values from your in-house test only indicate the total level of fertilizer salts, not the actual levels of each element.)

Step 3. Tissue nutrient analysis is used to determine if excessive levels of micro-nutrients have accumulated in the leaves. The normal procedure to follow is to sample the most recently mature leaves (MRML) and compare the sample levels against published values. The sample location for the MRML will therefore vary with age, moving up the plant over time.

A challenge with this approach is that the symptomatic tissue is not tested, especially with bigger plants. With low pH problems, it is the older, lower leaves that have symptoms. Therefore to obtain an accurate idea of nutrient levels, it would be a good idea of also sampling those lower leaves.

To illustrate this point, look at the gerbera graphic (Fig. 2). Two tissue samples were taken from the same group of gerbera plants. At this stage of development, the

MRML was near the top of the plant. With this advanced stage of symptom development, some of the MRML were exhibiting purplish-black spotting. The results of that test are represented in the blue table at the top and found Fe was at 752 ppm and Mn at 262 ppm. Both of these numbers are higher than the recommended range of 60 to 130 ppm Fe and 30 to 260 ppm Mn (Dole and Willins, 2005).

In contrast, sampling the lower, symptomatic, leaves as shown in the orange table, found significantly higher values for Fe (3080 ppm) and Mn (1240 ppm). Across the board, B, Cu, and Zn concentrations were also higher in the lower tissue too, as compared with the upper MRML. In plants just beginning to develop symptomology, an accumulation of micro-nutrients may not yet occur if the MRML were tested. This may lead to an incorrect diagnosis of the situation. By also sampling the symptomatic tissue, the data is much more conclusive to confirm a low substrate pH induced micro-nutrient toxicity.

Conclusions

Low substrate pH induced micro-nutrient toxicity occurs readily on a number of plant species. Problems occur more frequently in areas without high levels of alkalinity. That is because elevated alkalinity levels tend to increase the substrate pH over time, thus low substrate problems are rarely seen.

When low substrate pH problems occur, the first step is to conduct a quick substrate pH and EC test. That should be followed-up with a complete substrate nutrient analysis and a tissue sample to determine actual levels. Taking a tissue sample from both the MRML and lower symptomatic

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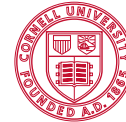
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leaves will help confirm your diagnosis.

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Gerbera Tissue Analysis

Upper Leaves

N %	P %	K %	Ca %	Mg %	S %	Na %	B ppm	Cu ppm	Fe ppm	Mn ppm	Zn ppm
4.34	0.36	3.00	0.74	0.39	0.27	0.03	22.4	5.20	752	262	50.4

Lower Leaves

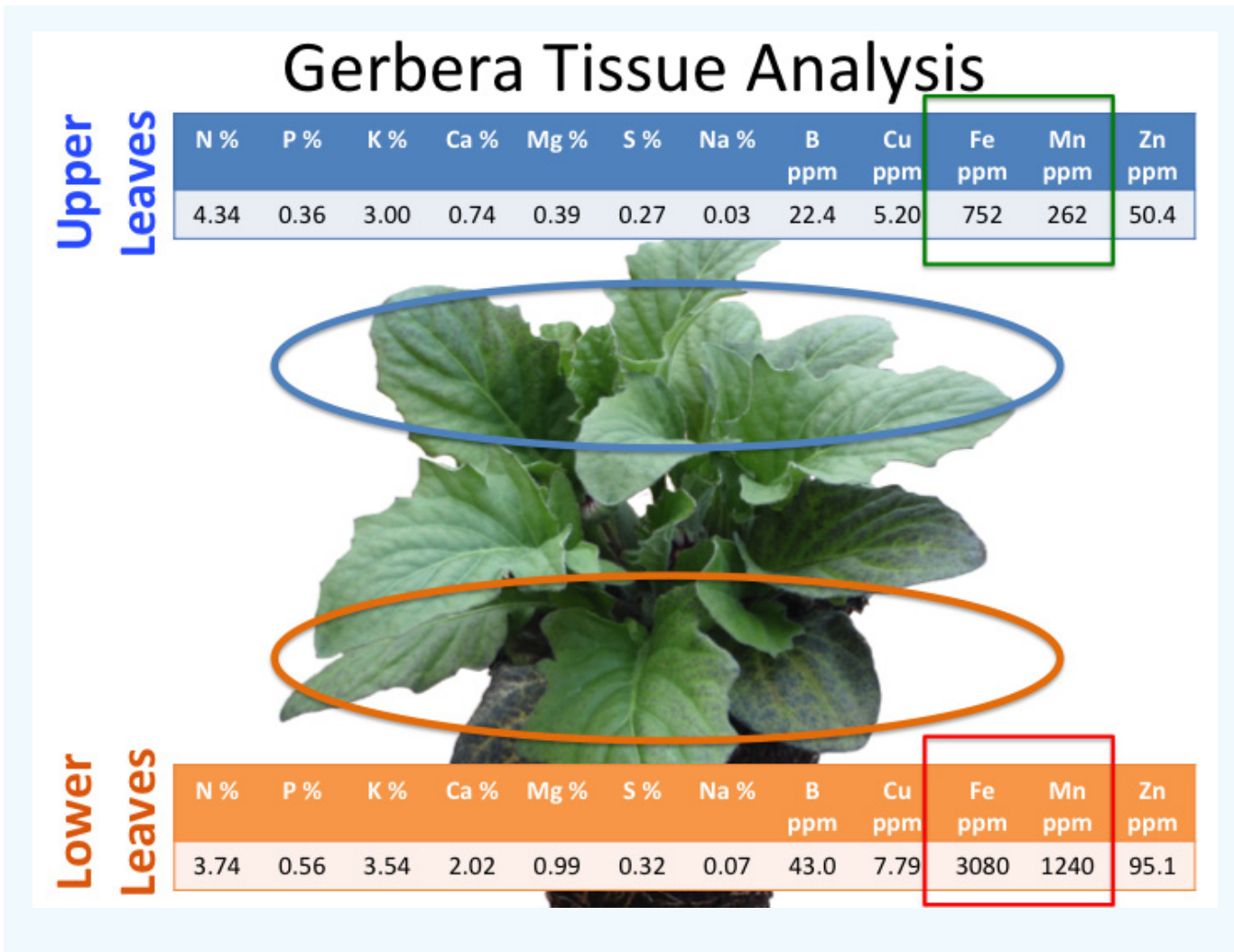| N %	P %	K %	Ca %	Mg %	S %	Na %	B ppm	Cu ppm	Fe ppm	Mn ppm	Zn ppm
3.74	0.56	3.54	2.02	0.99	0.32	0.07	43.0	7.79	3080	1240	95.1

Figure 2. Comparing the location of collecting the leaf tissue sample on a plant. The blue table values represent the most recently matured leaves (MRML) and the sample was taken from the upper foliage. In contrast, the lower symptomatic leaves were sampled to provide the orange table values. By taking the symptomatic leaves, iron (Fe) and manganese (Mn) are higher and it makes diagnosing low substrate pH induced Fe and Mn toxicities easier to confirm.
Photo by Brian Whipker