Micronutrient Disorders

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Micronutrient disorders are the fertility problems that I see most often while visiting growers as an Extension Specialist (Figure 1 and 2). Micronutrients (from the Greek *Micro*=small and *nutrient*=nutritive) are mineral elements needed by plants in small quantities. Small variations from the optimum level required for plant growth can be damaging. By the same token, levels slightly above those required for good growth can be toxic. It is very important for growers to have a clear understanding about micronutrient management. This article is a brief overview of the principles that control the availability of micronutrients in soilless mixes and how to correct imbalances.

Figure 1. *Typical iron deficiency symptoms on Streptocarpella. Please, note that the sysmptoms manifest on young leaves.*

Figure 2. *Typical iron-manganese toxicity symptoms on Geranium.*

Deficiency or Toxicity?

A micronutrient disorder may be a **deficiency** (when the micronutrient is in deficit) or a **toxicity** (when the micronutrient is in excess). Deficiencies can occur either because the nutrients are not present in the growing mix or because the nutrient is present but unavailable to the plant. (Occasionally, plants with roots damaged by *Pythium* or other pathogens may show micronutrient deficiency symptoms.) Some commercially prepared mixes have a fertilizer charge that may include micronutrients. Growers preparing their own mixes should use one of the many commercially available micronutrient complexes to ensure that the micronutrients are present in the growing mix.

Nutrient Availability

Sometimes, the micronutrient present in a growing mix is not available to the plant (the plant cannot take it up). Micronutrient availability is influenced by media pH: except for molybdenum, the availability of micronutrients decreases with increasing media pH and vice versa. Water alkalinity is an important factor modifying media pH and hence micronutrient availability. It is important to maintain the pH for soilless media between 5.5 and 6.3. Some crops are more sensitive to media pH than others: petunias and gerberas must be maintained at pH levels of 5.5 in order to avoid micronutrient deficiency symptoms. Other crops are more tolerant of pH changes. Table 1 shows the minimum and maximum critical foliar levels for floral crops.

Table 1. *General critical foliar ranges for floral crops. (After J. Biernbaum, Water, growing media, fertilizer, and root zone management. OFA Short Course, July 1994.)*

Nutrient	***Minimum ppm***	***Maximum ppm***
Iron (Fe)	50	?
Manganese (Mn)	30	500
Zinc (Zn)	20	100-200
Copper (Cu)	5	20-100
Boron (Bo)	25	100-300
Molybdenum (Mo)	0.5	15

Substrate pH

If the deficiency is due to pH imbalance, the approach is to modify the pH of the mix. In this case, adding micronutrients can make matters worse because the level of individual micronutrients may affect the level of other micronutrients in the plant through a process called *antagonism*. For example, too much iron may produce manganese and zinc deficiencies, while high levels of manganese may result in iron and zinc deficiencies. Copper and zinc are also antagonistic: too much of one may produce a deficiency of the other (Table 2).

Nutrient Toxicity

Toxicity on the other hand, can occur when micronutrients are applied in excess (usually more than one application). Common sources of micronutrients are: the charger in the mix and fertilizers applied during the crop cycle. Growers MUST have an idea of how much micronutrient they are adding through each of these sources in order to avoid toxicities. Toxicity symptoms are difficult to recognize visually (only someone with a lot of experience can do it) and are usually mistaken by deficiency symptoms by growers.

Correct Diagnosis

How do we resolve these problems? First of all, only a correct diagnosis of the problem will lead to the proper solution. Do you have a micronutrient deficiency or is it an excess? Identify the micronutrient causing the problem. Identify the cause of the deficiency/toxicity: is the nutrient not present or is it present but unavailable? Answering these questions will help you (and your extension agent or consultant) tackle the problem.

Table 2. *Availability of micronutrients as affected by other micronutrients (antagonism) and macronutrients in soilless mixes.*

Element	Availability reduced by:
Boron	Organic nitrogenous fertilizers and high levels of phosphorus.
Manganese	High levels of potassium, phosphorus, iron, copper, and zinc.
Copper	High levels of zinc, nitrogen, and phosphorus
Iron	High levels of copper, manganese, zinc, and phosphorus.
Molybdenum	High levels of manganese and nitrate-nitrogen fertilizer.
Zinc	High levels of copper and phosphorus.

How to Correct the Problem

If deficiency or toxicity are suspected, soil and foliar analysis are recommended for several reasons. First, visual identification of the problem is difficult in the absence of information (made available through analysis). Second, damage may be occurring that is not yet visible and by the time it becomes visible, the damage may be irreversible.

Deficiencies can be corrected by adding the micronutrient that is in deficit or by correcting the factor that makes it unavailable (e.g. high pH). This second course of action is very common among growers who have high alkalinity irrigation water. If only one micronutrient is deficient, DO NOT apply a micronutrient complex fertilizer because, as we mentioned above, imbalances can cause antagonism. Apply a salt that contains only the deficient micronutrient.

Micronutrients can be I) added over time in small amounts with the irrigation water (Table 3); II) applied once with a concentrated solution during a normal watering (Table 4); III) applied as a single foliar spray (Table 5).

Table 3. *Sources, rates, and micronutrient concentration for* ***continuous soil application*** *of one or more micronutrients with every liquid fertilization.* *(After D.A. Bailey and P.V. Nelson, Managing micronutrients in the greenhouse. NCSU Extension, Leaflet No 553, 1991.)*

Micronutrient source	***Weight of source per 100 gal (oz)***	***Concentration (ppm)***
Iron sulfate--20% iron	0.13	2.00 Iron
Iron chelate (EDTA) — 12% iron	0.22	2.00 Iron
Manganese sulfate — 28% manganese	0.012	0.25 Manganese
Zinc sulfate — 36% zinc	0.0018	0.05 Zinc
Copper sulfate — 25% copper	0.0027	0.05 Copper
Borax — 11% boron	0.030	0.25 Boron
Sodium molybdate -- 38% molybdemum	0.00035	0.01 Molybdemum
Ammonium molybdate — 54% molybdenum	0.00025	0.01 Molybdemum

Toxicities are not easily corrected. The first step is stop adding the micronutrient that is in excess (switching to a fertilizer without the nutrient causing the problem). Slightly changing (raising, for most Micronutrients) the media pH will decrease the availability of all micronutrients (including the one in excess). Growers trying to correct a micronutrient excess should raise the pH at the maximum level that the species/cultivar can tolerate for normal growth. Lastly, use antagonism as a tool: increase slightly the level of a micronutrient that will reduce the availability of another (e.g. if zinc is at high levels, slightly increase the level of copper).

Table 4. *Sources, rates and micronutrient concentrations for a* ***single corrective application*** *of one or more micronutrients applied to the soil*.* *(After D.A. Bailey and P.V. Nelson, Managing micronutrients in the greenhouse. NCSU Extension, Leaflet No 553, 1991.)*

Micronutrient source	***Weight of source per 100 gal (oz)***	***Concentration (ppm)***
Iron sulfate--20% iron	4.0	62.0 Iron
Iron chelate (EDTA) — 12% iron	4.0	36.4 Iron
Manganese sulfate — 28% manganese	0.5	10.0 Manganese
Zinc sulfate — 36% zinc	0.5	13.9 Zinc
Copper sulfate — 25% copper	0.5	9.3 Copper
Borax — 11% boron	0.75	6.25 Boron
For soil-based media (>20% soil in media)		
Sodium molybdate --38% molybdemum	0.027	0.77 Molybdemum
Ammonium molybdate — 54% molybdenum	0.019	0.77 Molybdemum
For soilless media		
Sodium molybdate --38% molybdemum	2.7	77 Molybdemum
Ammonium molybdate — 54% molybdenum	1.9	77 Molybdemum

* *Do not apply combinations without first testing on a small number of plants. Wash solution off foliage after application.*

Conclusion

Micronutrient management is complex and difficult. A more complete treatment of this subject would require more space than we have available here. I hope, nevertheless, that my description of the problem piqued your curiosity. At the very least, I hope that you follow this advice: **Don't guess. Test!**

Following, is the contact information of some laboratories where you can send your samples for tissue analysis. Consult with your local Extension Agent for a local plant testing laboratory.

BROOKSIDE LABS
308 S. Main Street
New Knoxville, OH 45871
419-753-2448

CALMAR LAB
130 S. State Street
Westerville, OH 43081
614-523-1005

CLC LABS
325 Venture Dr.
Westerville, OH 43081
614-888-1663

NA-CHURS
421 Leather St.
Marion, OH 44654
800-344-1101
330-893-2933

SOIL AND PLANT NUTRIENT LAB
Department of Crop and Soil Sciences
81 Plant & Soil Sciences Building
East Lansing, MI 48824-1325
515-355-0218

SOIL TESTING LABORATORY
University of Kentucky
103 Regulatory Service Building
Alumni & Shawneetown Roads
Lexington, KY 40546-0275
606-257-7355

SPECTRUM ANALYTICAL INC.
PO Box 639
Washington Court House, OH 43160
800-321-1562

AGRICULTURAL ANALYTICAL SERVICES LABORATORY
Penn State University
University park, PA 16802
814-863-4540

A & L GREAT LAKES LAB
3505 Conestoga drive
Ft. Wayne, IN 46808
219-483-4759

BROOKSIDE LABS
308 S. Main Street
New Knoxville, OH 45871
419-753-2448

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130 S. State Street
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