Leaf analysis made simple

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Key words:
chlorosis: a condition marked by yellowing.
tiller(ing): to sprout, especially from the base of a plant.
translocation: the act or process of changing location or position.

Your daylily is trying to tell you something. Are you listening? A quick look at the leaves of a daylily can often be enough to determine many things about its health. Some of the obvious things first noticed might be the presence or absence of diseases like rust or leaf streak. Further examination might reveal the presence of insects or the damage they have caused.

Upon more thorough examination, new details about the leaf may become apparent, although their exact cause may be a mystery. For example, leaf shape and size might be noted and questions asked: Are the leaves of normal size, or are they smaller? Is the leaf shaped normally, or, is it twisted, cupped, crinkled or folded?

Additionally, the color and uniformity of color on the leaves might be noted and questions asked: Are there discolorations on the leaves? If so, do the discolorations cover the entire plant, just the younger leaves, or just the older leaves? Where on the individual leaf are they? Do the discolorations cover the entire leaf, or just part of it? If only part, is it discolored along the leaf margins, only in the center or in between the veins?

But what does it all mean? Hopefully, this article will be able to translate some of the things that your daylily is trying to tell you about its health, nutritional status and overall well-being.

To this end, one of the greatest investigative tools available is the effect of nutrient mobility on deficiency symptoms. The location on the plant where deficiency symptoms are expressed, or first appear, can help in diagnosing the nutrient disorder. The plant nutrients can be divided into three categories depending upon their mobility within plant tissues. The mobile nutrients, nitrogen, phosphorus and potassium, easily translocate between older and younger leaves. Thus, deficiency symptoms of these nutrients will first show up in older leaves because the nutrients are quickly moved to the newer, faster growing parts of the plant.

In contrast, the immobile nutrients, calcium and boron, are nutrients that cannot be translocated easily within a plant.

Figure 1. Nitrogen Deficiency. *The characteristic "V" shaped chlorotic region on older leaves indicates nitrogen deficiency. The top leaf indicates severe nitrogen deficiency.*

— All photos by Scott Elliott unless noted otherwise.

Figure 2a. Phosphorus Deficiency. *Characteristic dark purple margins and tips on older leaves indicate a phosphorus deficiency, illustrated here in corn because of my inability to induce phosphorus deficiency in the test daylilies.*
— Image number 5361286
R.L. Croissant, Bugwood.org

Figure 2b. Phosphorus Deficiency. *Echinacea, growing in the daylily phosphorus deficiency test area, shows the classic purple along the margins.*

Symptoms of deficiency in this category will show up first on the newer leaves because the plant is not able to move the nutrients away from the older leaves.

The moderately mobile nutrients, sulfur, zinc, copper, molybdenum, magnesium, iron and manganese, lie somewhere in between; able to be translocated, but at a slower rate than the mobile nutrients. Deficiencies within the moderately mobile category tend to be more severe in faster growing plants.

This information, along with observations on color, shape, size and pattern of the discoloration, can be used to distinguish between the various nutrient deficiencies and find out what it is a daylily is "trying to say."

Primary Macronutrients

Nitrogen deficiency results in a general yellowing of older leaves while the newer leaves are often light green. In more severe cases, a pale yellow chlorosis begins at the leaf tip and advances down the leaf along the mid-rib in a characteristic V-shaped pattern. Gross plant symptoms may include: stunted growth and shorter internodes. See figure 1.

Phosphorus deficient leaves are dark green with a characteristic dark purple margins and tips, especially on older leaves. Symptoms usually occur when the soil temperature is less than 60 degrees F. Gross plant symptoms may include: inhibition of flowering and root system development; loss of lower leaves; stunted growth and delayed maturity. See figures 2a and 2b.

Potassium deficient leaves exhibit chlorosis and necrosis along the margins and tips of the older leaves. In severe cases, older leaves may wilt and the leaves appear dry and scorched along the edges and tips. The newer leaves may look completely normal. Gross plant symptoms may include: slow or stunted growth; a tendency to wilt readily; poor resistance to pests; weak, unhealthy roots and uneven ripening of fruits. See figure 3.

Secondary Macronutrients

Calcium deficiency causes the newest leaves to be distorted, hooked or irregularly shaped, often remaining rolled and joined together at their tips. Gross plant symptoms may include: a rusty appearance and premature death of older leaves; cupping of older leaves and death of terminal buds. See figure 4.

Magnesium deficiency appears in older leaves as yellow or white

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Figure 3. Potassium Deficiency. *Chlorosis and necrosis along the margins and tips of older leaves indicates a potassium deficiency.*

Figure 4. Calcium Deficiency. *Distorted, hooked or irregularly shaped, newer leaves that often remain rolled-up and joined together at their tips indicates calcium deficiency. (Some iron deficiency is also present.)*

Figure 5a. Magnesium Deficiency. *Yellow or white streaking or mottling between the veins of older leaves. Can appear very similar to iron and manganese deficiencies. The upper leaf is normal, the bottom leaf is magnesium deficient.*

Figure 5b. Magnesium Deficiency. *In severe cases of magnesium deficiency red necrotic lesions appear ultimately resulting in browning of leaf tips and margins*

Figure 6. Sulfur Deficiency. *General yellowing of youngest leaves. Upper leaf is normal, lower leaf is sulfur deficient.*

Figure 7. Iron Deficiency. *The typical interveinal chlorosis associated with iron deficiency is first seen on newer leaves. Can appear very similar to magnesium and manganese deficiencies.*

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streaking or mottling between the veins. Sometimes, the leaves will turn yellow at the edge leaving a green arrowhead in the center of the leaf (contrast this with nitrogen deficiency, above). In severe deficiency, red necrotic lesions may appear ultimately resulting in browning of leaf tips and margins. Looks very similar to manganese and iron deficiencies, except manganese and iron deficiencies occur in newer leaves first. Gross plant symptoms may include: decreased seed production and increased susceptibility to cold weather injuries. See figures 5a (previous page) and 5b (above).

Sulfur deficiency presents as a general yellowing of the entire plant, starting with the youngest leaves; sometimes the older leaves remain dark green for a period of time. Sulfur deficiency is confirmed by the yellowing process of newer leaves that begins at the leaf margins, in contrast to nitrogen deficiencies in which yellowing usually begins at the leaf tips or the entire leaf as in the case of general yellowing). Leaves can also appear narrower and shorter, although this is often difficult to determine without extensive knowledge of the individual cultivar. Gross plant symptoms may include: stunted plants and delayed maturity. See figure 6.

Micronutrients

Boron deficiency results in the newer leaves being light green, distorted and often folded or wrinkled. Gross plant symptoms may include: translucent lesions or water sacks along the leaf and stem margins accompanied by necrosis; brittle, bunched plants with many tillers due to a loss of apical dominance; reduced flowering and failure to set seeds. (Sorry! No pictures available for boron deficiency.)

Warning: Because toxic levels of boron are only slightly higher than deficiency levels, it is advisable to perform quantitative soil and plant analysis tests prior to initiating a boron fertilizer regimen. Additionally, follow all boron fertilizer label directions very carefully.

Copper deficiency in plants is expressed through generally pale green newer leaves, sometimes with interveinal bleaching and dark green older leaves. However, as the plant becomes more severely affected, plants will show increased splotching with leaves eventually becoming twisted, wilted and whitened. Leaves will also tend to be smaller with spots of necrosis. Gross plant symptoms may include: twisted stems and leaves. (Sorry. No picture available for copper deficiency.)

Iron deficiency symptoms first appear on younger leaves as interveinal chlorosis, while older leaves remain normal. If iron deficiency persists, the prominent green veins will fade, and the entire leaf will become light green to pale yellow. This deficiency appears very similar to manganese deficiency. Gross plant symptoms may include: leaf dieback; decreased flowering and seed set. See figure 7.

Manganese deficiency appears in newer leaves as interveinal

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Figure 8. Manganese Deficiency. *The typical interveinal chlorosis associated with manganese deficiency is first seen on newer leaves starting at the leaf tips and moving towards the middle of the leaf. Can appear very similar to magnesium and iron deficiencies.*

Figure 9. Molybdenum Deficiency. *Short longitudinal chlorotic streaks on the top one-third of the leaf of older leaves indicate a more severe molybdenum deficiency.*

Figure 10. Zinc Deficiency. *White to yellow bands beginning at the base of new leaves, while the midrib and leaf margins remain green is characteristic of zinc deficiency.*

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chlorosis (yellowing between the veins) starting at the leaf tips and moving towards the middle of the leaf. Bleaching of the leaves can occur under severe deficiency. It looks very similar to magnesium and iron deficiency except magnesium deficiency occurs in older leaves first, and the pattern is not as distinct as with iron. Gross plant symptoms may include: smaller flowers and decreased fertility. See figure 8.

Molybdenum. The initial signs of molybdenum deficiency are the same as those for nitrogen deficiency with a more pronounced yellowing of the older leaves. Because molybdenum is used by plants to reduce nitrates into usable forms, a deficiency of molybdenum generally results in the same problems as a deficiency of nitrogen. In more severe cases, short longitudinal chlorotic streaks on the top one-third of the leaf may develop. See figures 1 and 1a for nitrogen deficiency; see figure 9 for severe molybdenum deficiency.

Zinc deficiency is confirmed by the presence of white to yellow bands beginning at the base of new leaves, while the midrib and leaf margins remain green. Gross plant symptoms may include: stunted plants with short internodes and smaller leaves; early loss of leaves. See figure 10.

Caveats to the exclusive use of leaf appearance for determining nutrient deficiencies:

1. Many of the nutrient deficiencies look alike.

2. pH is a major factor in nutrient availability. In fact, micronutrient deficiencies are rare in the majority of soils in the U.S. (pH range of about 5.5-6.7). To complicate matters, when the pH is outside this range it is likely that more than one nutrient will be deficient. This may cause the symptoms to appear differently, or, in some instances, the deficiency of one nutrient may mask the deficiency of another. A soil test, in addition to a plant tissue analysis, is critical to determine the cause of the deficiency and to avoid application of excess fertilizers and possible toxicity development. (Typically, the soils in the rainy South tend to be more acidic, and those in the dry West tend to be more basic, leading to more problems with micronutrient deficiency in these areas as opposed to the remainder of the country.)

3. The normal appearance of a healthy cultivar must be known in order to recognize the symptoms of distress. There are large differences between the naturally occurring healthy states of different cultivars.

4. The visual appearance of a leaf may be changed by factors other than nutrient deficiencies, such as: water stress, insect damage and disease damage, especially rust and leaf streak.

5. Some micronutrients are involved in the processing or uptake of other nutrients. In this case, the deficiency of one nutrient might look like the deficiency of another nutrient.

Testing your plant

Once possible nutrient deficiencies have been identified, the next step is to submit a sample of leaves for plant analysis testing to confirm the visual evidence. This can serve as the basis, along with a soil test, for making fertilizer recommendations. It also helps to avoid mistakes made by inaccurate identification of nutrient deficiencies and to determine if multiple nutrients are deficient.

After the deficiencies have been correctly identified, further testing is helpful to monitor the plant nutrient element status to maintain optimum concentrations of the nutrients. Although plant analysis has proved to be a very effective means of predicting fertilizer needs for ornamental plants, it does not completely replace a soil test. Soil and plant analyses serve different purposes, and when properly used, they supplement and support each other[1].

Test Kits

To obtain plant analysis sampling instructions and kits along with specific instructions, contact the Cooperative Extension listed under Federal Government in your local phone book or online at **http://www.csrees.usda.gov/Extension/**.

For information on testing in Georgia, with links for other southern states, visit:
http://aesl.ces.uga.edu/soiltest123/Georgia.htm

Reference:

1. Plant Analysis Handbook for Georgia. Cooperative Extension Service, University of Georgia College of Agriculture, 1989.

Leaf symptoms and possible nutrient deficiencies

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Key to the symbols			
N	Nitrogen	Fe	Iron
P	Phosphorus	Mn	Manganese
K	Potassium	B	Boron
Ca	Calcium	Cu	Copper
Mg	Magnesium	Zn	Zinc
S	Sulfur	Mo	Molybdenum

Symptom	N	P	K	Ca	Mg	S	Fe	Mn	B	Cu	Zn	Mo
Appears first on older leaves	Yes	Yes	Yes		Yes							Yes
Appears first on younger leaves				Yes		Yes	Yes	Yes	Yes	Yes	Yes	
General chlorosis	Yes					Yes				Yes		Yes
Marginal chlorosis			Yes		Yes	Yes						
Interveinal chlorosis					Yes		Yes	Yes				Yes
V-shaped chlorosis	Yes											Yes
Arrowhead-shaped chlorosis					Yes							
White streaking or bleaching					Yes			Yes		Yes	Yes	
Purple leaf margins		Yes										
Marginal necrosis					Yes				Yes			
Deformed leaves				Yes					Yes	Yes		
Short internodes	Yes										Yes	Yes
Stunted growth	Yes	Yes	Yes			Yes					Yes	Yes
Poor flowering		Yes						Yes	Yes		Yes	
Poor root development		Yes	Yes									
Delayed maturity		Yes				Yes						
Loss of older leaves		Yes		Yes					Yes		Yes	
Poor seed development			Yes		Yes		Yes					
Poor seed set							Yes	Yes				
Bunched plants (tiller production)									Yes			
Death of terminal buds				Yes					Yes			