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by Roberto G. Lopez
rglopez@purdue.edu

Calcium Deficiency = Upper Leaf Necrosis in Oriental Lilies

Research determines that calcium deficiencies in Oriental lilies can lead to water-soaked, curling, distorted and nectrotic upper leaves

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During my recent greenhouse visits, I have seen the all too common upper leaf necrosis on oriental lilies. The symptoms can appear as curled, distorted, water-soaked, or necrotic upper leaves that appear "burned", resulting in reduced aesthetic appeal and shrink for the grower (Figure 1). Research by Yao-Chien Alex Chang and William B. Miller at Cornell University has clearly demonstrated that these symptoms are related to a calcium deficiency disorder and they have termed the disorder upper leaf necrosis (ULN). In general, calcium deficiencies are not due to insufficient calcium content in the substrate or soil, instead there is an imbalanced calcium distribution within the plant (similar to blossom end rot in tomato).

Cornell Research Findings

Upper leaf necrosis of greenhouse grown Oriental lilies is only found on the leaves adjacent to flower buds and leaves immediately below the flower buds (Figure 2).

Figure 1. Water-soaked, distorted, curling, and necrotic leaves are symptoms of calcium deficiency in Oriental lilies. Photo courtesy of Bill Miller, Cornell University; Roberto Lopez and Garrett Owen, Purdue Univeristy.

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CONTRIBUTORS

Dr. Nora Catlin
Floriculture Specialist
Cornell Cooperative Extension - Suffolk County
nora.catlin@cornell.edu

Dr. Kristin Getter
Floriculture Outreach Specialist
Michigan State University
getterk@msu.edu

Dan Gilrein
Entomology Specialist
Cornell Cooperative Extension - Suffolk County
dog1@cornell.edu

Dr. Brian Krug
Floriculture Ext. Specialist
Univ. New Hampshire
brian.krug@unh.edu

Dr. Joyce Latimer
Floriculture Extension & Research
Virginia Tech
jlatime@vt.edu

Dr. Roberto Lopez
Floriculture Extension Specialist & Research
Purdue University
rglopez@purdue.edu

Dr. Paul Thomas
Floriculture Extension & Research
University of Georgia
pathomas@uga.edu

Dr. Brian Whipker
Floriculture Extension & Research
NC State University
bwhipker@ncsu.edu

Necrosis is not found on lower leaves or on the flower buds. Symptoms can be observed on young expanding leaves approximately 30 to 40 days after planting, when plants are 10 to 12 inches tall (25 to 30 cm). A leaf exhibiting the disorder will have small depressed spots on the lower surface. In more severe instances, the affected leaf will appear water-soaked.

Bulb crops obtain calcium from two sources: 1) bulb scales and in the young shoots inside the bulb and 2) calcium that is absorbed from the substrate or soil by the roots during active growth. Some Oriental lilies such as 'Stargazer' have very low calcium concentration in the bulb. This calcium is only sufficient in providing calcium to lower leaves, but is not enough for upper leaves where we see ULN (Figure 3).

Another cause of ULN is the nature of lily leaf unfolding where young leaves overlap and cause leaf enclosure. As lilies emerge and grow, roots absorb calcium from the substrate and it is moved upward to actively transpiring leaves. Since these young, expanding leaves are physically enclosed by outer leaves, transpiration of the young leaves is restricted. Since transpiration is required for plants to move calcium (an immobile nutrient) from the substrate to the leaves, leaf enclosure reduces calcium translocation to young leaves, with calcium deficiency and ULN as the result. Once all leaves are unfolded (not touching

Figure 2. Upper leaf necrosis of greenhouse grown Oriental lilies is typically only found on the leaves adjacent to flower buds and leaves immediately below or adjacent to the flower buds.

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other leaves) they are no longer susceptible to ULN.

How to Avoid the "Burn"
Research has shown that ULN is affected by many factors. The easiest way to avoid ULN is to grow cultivars that are not susceptible to ULN or grow smaller bulbs of susceptible cultivars. Lilies grown from smaller bulb sizes such as 12/14 cm rarely show ULN, but the incidence of ULN is higher for lilies grown from larger bulbs (16/18 cm). For example, the critical period for 'Stargazer' lilies grown from 16/18 cm bulbs is from 25 to 50 days after planting or from the time plants are 10 inches (25 cm) tall until flower buds are visible. Cultivars such as 'Sissi', 'Alliance', 'Berlin', 'Helvetia' and 'Tom Pouce' are not susceptible, other cultivars may also exist.

Since ULN occurs long before symptoms are visible, it is unlikely that the symptoms appear when plants are exposed to bright and sunny days followed by periods of dark and cloudy weather. Upper leaf necrosis is most prominent in crops grown in late winter or early spring than when grown under higher light intensities. Supplemental lighting from HID lamps, especially in Northern latitudes can help increase transpiration, thus reducing ULN.

High humidity in the greenhouse reduces transpiration rates and consequently calcium movement in the plant and commonly increases calcium deficiency.

Figure 3. Close up of a Oriental lily leaf exhibiting leaf necrosis

Air movement over the crop can drastically reduce ULN. However, the airflow from horizontal airflow fans (HAF) does not provide enough airflow to reduce ULN. To be effective, air movement must be provided directly onto the crop.

Calcium sprays can be effective if properly applied, but may be non-effective if done incorrectly. Both calcium nitrate and calcium chloride are effective sources of calcium. Daily sprays are reccomended from day 25 to 45 because individual leaves are unfolding and growing rapidly and the calcium solution must touch each new leaf in sequence before it develops its own calcium deficiency.

Take Home Message

Upper leaf necrosis is a calcium deficiency disorder caused by:

- Insufficient calcium supply from the bulb
- Insufficient transpiration resulting from leaf enclosure
- Water soaked/ necrotic symptoms begin to appear 30 to 40 days after planting
- Plants are approximately 10 to 12” tall
- The five leaves immediately below the flower buds and the leaves associated with the buds are most susceptible to ULN

Factors that increase ULN:

- Larger bulbs
- Low transpiration
- High humidity
- Low light levels
- Little to no air circulation

Methods to reduce ULN:

- Plant smaller bulbs of susceptible cultivars if possible
- Prevent water accumulation on leaves
- Provide supplemental lighting in winter
- Daily foliar calcium sprays (between day 25 to 45 after planting)
- Air movement directly over the plants with fans