e-GRO Edible Alert

Christopher Levine
cpl43@cornell.edu

Neil Mattson
nsm47@cornell.edu

Volume 6 Number # 1 January 2021

Managing Leaf/Calyx Tipburn in Greenhouse Strawberries

Browning of leaf and calyx edges of strawberries is a common disorder in greenhouse production (Figure 1). This disorder is called leaf/calyx tipburn and is often due to a lack of calcium supply to the leaves during development. However, the lack of calcium uptake frequently stems from poor environmental conditions rather than a lack of calcium availability in the nutrient solution. Symptoms of strawberry tipburn include marginal necrosis (browning on the edges) of leaves as well as the calyx (flower sepals). Outer leaves affected by tipburn may be curled and the necrosis/curling reduces the leaf area available for photosynthesis (Figure 2). When the calyx exhibits tipburn, the marginal browning can reduce the marketability of strawberry fruits (Figure 3).

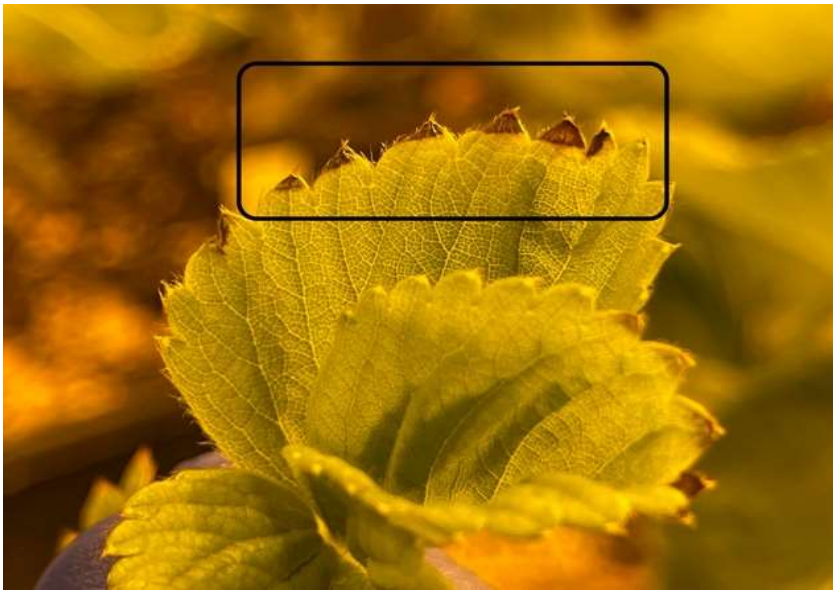

Figure 1. Browning (necrosis) of leaf tips is a symptom of strawberry tipburn. Image: Chris Levine, Cornell University

2021 Sponsors

American Floral Endowment
Funding Generations of Progress Through Research and Scholarships

Ball

fine

GRIFFIN
GREENHOUSE & NURSERY SUPPLIES

P.L. LIGHT SYSTEMS
THE LIGHTING KNOWLEDGE COMPANY

Reprint with permission from the author(s) of this e-GRO Alert.

Causes of strawberry tipburn

In controlled environment strawberry operations, low nighttime relative humidity (high vapor pressure deficit) exacerbates leaf/calyx tipburn. Calcium uptake by plants is primarily driven by transpiration (water loss from the stomates). However, in strawberries, young tissues that are developing and haven't emerged rely on a different mechanism for calcium supply: positive root/xylem pressure. During the daytime, transpiration causes negative root/xylem pressure and this is important for delivering calcium to expanded leaves. However, non-transpiring extremities (young leaves and calyxes that have not emerged) rely on nighttime positive root/xylem pressure to deliver calcium. These positive pressure conditions occur mainly during the night with high humidity and closed stomates. When a strawberry greenhouse is not humid enough at night, transpiration can occur through leaf cuticles (i.e. the waxy surface of leaves). This cuticular transpiration stops positive pressure from building up which leads to inability to supply calcium to developing leaves/calyxes. After some days of calcium deficiency, the tipburn symptoms may first be observed as a darker-colored shoot tip, as the leaf/calyx expands the marginal necrosis becomes more evident.

Interestingly, tipburn of lettuce is a related issue with a different solution. Inner leaf tipburn of lettuce also occurs due to insufficient calcium supply to the young developing leaves. However, supply of calcium to young shoot tips in lettuce is improved by increasing transpiration during the daytime (such as lower daytime humidity or promoting airflow on shoot tips through vertical fans).

Figure 2. Necrotic/brown leaf edges and curling of outer leaves is a symptom of tipburn. Damage can reduce the surface area available for photosynthesis. Image: Chris Levine, Cornell University

Figure 3. Necrotic edges of the flower calyx can reduce the marketability of strawberry fruit since visual appearance is used by consumers to assess fruit quality. Image: Chris Levine, Cornell University

Guttation (water droplets where veins terminate) on strawberry leaves are signs that there is sufficient nighttime humidity for adequate calcium supply to developing strawberry leaves/calyxes. Image: Schnobby, via Wikimedia Commons

Versus strawberry tipburn correction relies on high nighttime humidity to cause calcium supply by positive root/xylem pressure. For more information on lettuce tipburn see e-Gro Alert 4.31 Tipburn of Hydroponic Lettuce.

In summary, calcium moves passively and is transported with the flow of water. During the day, transpiration is able to passively move calcium to the leaves when there is a low relative humidity. However, at night when transpiration is halted, positive root pressure is needed to facilitate calcium transport to emerging leaf/calyx tissues of strawberries. If the relative humidity is low at night, then it is difficult for the plant to keep the positive water pressure in the xylem to supply the needed calcium to the strawberry leaf tips.

Verifying low night humidity as the cause of calcium tipburn

One indication that humidity is sufficient at night is that guttation can be observed in the early morning on the outer edges of the leaves. Guttation is the secretion of droplets of xylem sap where the veins terminate on the leaves (Figure 4). Guttation should not be confused with water condensation (water droplets that form on form on cool surfaces when humidity is high). Guttation always forms in specific areas on the edges of leaves where veins end. When nighttime relative humidity is low, root pressure remains low (i.e. positive pressure doesn't occur), then guttation will not be present on strawberry leaves. Under the ideal high humidity conditions at night, guttation is able to occur because positive root pressure pushes the nutrient solution to the extremities of the plant which result in guttation. If your computer has an environmental control sensor, you can check the logged data to observe nighttime relative humidity conditions. Sustained relative humidity of 95% for three hours nightly reduces incidence of strawberry leaf tipburn. In our greenhouses at Cornell University, we have observed nighttime humidity between 40-50% which leads to ample tipburn symptoms. The low humidity is due to heating the greenhouse during the wintertime, as well our research greenhouses have cement floors (i.e. no damp gravel underneath), and a relatively small canopy of plants for the greenhouse area.

Solutions to strawberry tipburn

First, verify adequate calcium is being supplied in the fertilizer and the pH is within the ideal threshold.

- Make sure the fertilizer injectors are working properly, this can be verified with an EC meter or alternatively by volumetric calibration of the injector.
- Make sure the pH sensor is calibrated and that root-zone pH is 5.5-6.0. (Low pH can reduce calcium availability).
- Make sure nutrients in fertilizer stock tank have not precipitated (i.e. not turned into a solid/sludge at the bottom of the tank)

Second, make sure excess salt is not present in the substrate media as high electrical conductivity (EC) can also contribute to calcium tipburn.

- Check EC. Strawberry is a low fertilizer requiring plant, target nutrient solution EC is 1.0-1.2 mS/cm. If leachate/PourThru EC is above 1.5 mS/cm then flush the substrate with clear water and allow excess salt to leach out.

Third, check the relative humidity data history if available to verify low humidity conditions were present. Also check if

guttation is present early in the morning.

- Spraying down the greenhouse floor with water can be a temporary solution to keep high night humidity conditions.
- Placing shallow beds of water can also temporarily increase nighttime humidity.
- Make sure humidity sensor is located near the plants to ensure accurate readings.

Protocols for effective nighttime humidification:

An under-bench mist or fogging system (Figure 5) can be built to maintain 95% relative humidity for three hours at each night. This method was found by the University of Arizona CEA center to significantly reduce strawberry tipburn symptoms. Tips for using the mist system:

1. Initiate misting after sunset, 5 minutes of misting every 20 minutes for 3 hours
2. Below plant misting is ideal to prevent direct water contact on leaf foliage/fruit (be careful to ensure mist does not hit low hanging fruit which can lead to botrytis gray mold)
3. Achieve 95% RH for a minimum of 3 hours
4. Stop greenhouse ventilation during this 3-hour period
5. Resume normal environmental control after the 3-hour, 95% RH treatment
6. Carefully monitor the greenhouse make sure foliar diseases are not increasing in incidence. Consider applying high night humidity every other night to minimize risk of fungal/foliar disease

Figure 5. An under-bench mist system to increase nighttime humidity. Image: Chieri Kubota, Ohio State University, https://u.osu.edu/indoorberry/tip-burn/

References

Kubota, C., Strawberry Tipburn. Available online: https://u.osu.edu/indoorberry/tip-burn/

Mason, G.F.; Guttridge, C.G. The Influence of Relative Humidity and Nutrition on Leaf Tipburn of Strawberry. *Scientia Horticulturae* **1975**, *3*, 339–349, doi:10.1016/0304-4238(75)90048-5.

Kroggel, M.; Kubota, C. Controlled Environment Strategies for Tipburn Management in Greenhouse Strawberry Production. *Acta Hortic.* **2017**, 529–536, doi:10.17660/ActaHortic.2017.1156.78.

Guttridge, C.G.; Bradfield, E.G.; Holder, R. Dependence of Calcium Transport into Strawberry Leaves on Positive Pressure in the Xylem. *Annals of Botany* **1981**, *48*, 473–480, doi:10.1093/oxfordjournals.aob.a086151.

American Floral Endowment
Funding Generations of Progress Through Research and Scholarships
eGRO Electronic Grower Resources Online
Project Sponsor

e-GRO Alert

www.e-gro.org

CONTRIBUTORS

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

Dr. Chris Currey
Assistant Professor of Floriculture
Iowa State University
ccurrey@iastate.edu

Dr. Ryan Dickson
Greenhouse Horticulture and
Controlled-Environment Agriculture
University of Arkansas
ryand@uark.edu

Thomas Ford
Commercial Horticulture Educator
Penn State Extension
tgf2@psu.edu

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

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

Heidi Lindberg
Floriculture Extension Educator
Michigan State University
wolleage@anr.msu.edu

Dr. Roberto Lopez
Floriculture Extension & Research
Michigan State University
rglopez@msu.edu

Dr. Neil Mattson
Greenhouse Research & Extension
Cornell University
neil.mattson@cornell.edu

Dr. W. Garrett Owen
Greenhouse Extension & Research
University of Kentucky
wgowen@uky.edu

Dr. Rosa E. Raudales
Greenhouse Extension Specialist
University of Connecticut
rosa.raudales@uconn.edu

Dr. Beth Scheckelhoff
Extension Educator - Greenhouse Systems
The Ohio State University
scheckelhoff.11@osu.edu

Dr. Ariana Torres-Bravo
Horticulture/ Ag. Economics
Purdue University
torres2@purdue.edu

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

Dr. Jean Williams-Woodward
Ornamental Extension Plant Pathologist
University of Georgia
jwoodwar@uga.edu

Copyright ©2021

Where trade names, proprietary products, or specific equipment are listed, no discrimination is intended and no endorsement, guarantee or warranty is implied by the authors, universities or associations.

Cooperating Universities

Cornell CALS College of Agriculture and Life Sciences

Cornell Cooperative Extension Suffolk County

Iowa State University

University of Kentucky

Penn State Extension

Virginia Tech

Michigan State University

UConn

College of Agricultural & Environmental Sciences University of Georgia

Purdue University

NC State University

The Ohio State University

Division of Agriculture Research & Extension University of Arkansas System

In cooperation with our local and state greenhouse organizations

Maumee Valley Growers — Choose the Very Best.

Metro Detroit Flower Growers Association

NC Flower Power

Western Michigan Greenhouse Association

Connecticut Greenhouse Growers Association

Indiana Flower Growers Association

LIFGA

Michigan Greenhouse Growers Council

NYSFI New York State Flower Industries, Inc.

Virginia Flower Growers Association Since 1954