e-GRO Alert


Lauren Seltsam


W. Garrett Owen
wgowen@uky.edu

Volume 11 Number 25 April 2022

Heat Stress and Injury of High Tunnel-grown Bedding Plants

High tunnel bedding plant production can be successful, yet risky because plants may be exposed to undesirable temperatures. Lengthy exposure to supra-optimal temperatures can cause discoloration of foliage, delay flowering, and plant injury. This Alert highlights heat stress symptomatology of celosia grown under high tunnel conditions.

Bedding plants are commonly grown in greenhouses equipped with environmental controls used to manage and manipulate temperature, humidity, and light. While not all greenhouses may be outfitted with horticultural lights, most if not all contain heaters and exhaust fans utilized to heat and cool the growing environment. Advantages of heating and cooling the growing environment allow growers to control the rate of crop development such as leaf unfolding or the progression toward flowering. Behind labor, fuels for heating and utilities (lighting, ventilation, and water) to control greenhouses can lead to substantial operating costs. To reduce heating and utility costs and offset carbon emissions and water usage, many growers have begun utilizing high tunnels (Fig. 1) or modified haygroves (Fig. 2) as alternative production environments for growing bedding plants.

Figure 1. Example of an unheated high tunnel used for bedding plant production. Photo by W. Garrett Owen.

A high tunnel can best be described as a semi-controlled environment because the structure is typically glazed with a single layer of polyethylene providing protection from outdoor climatic conditions and lacks a heater and exhaust and horizontal air flow fans (Fig. 3). High tunnels are heated by solar radiation and cooled by passive ventilation through side and/or endwalls that are manually opened by growers (Fig. 4) or with handheld power tools. In some instances, growers can install solar-powered ventilators and/or motorized crank systems that can raise and lower the sidewalls. Previous research has shown that growers can utilize high tunnels and low-cost technologies to reduce or eliminate heating costs associated with bedding plant production. From an operating perspective, researchers at the University of Kentucky (UK) recently demonstrated that unheated high tunnel bedding plant production led to 23% (0.26 kg CO_2e per 18-count bedding plant tray) and 33% (58 gallons) less carbon and water usage, respectively, than an un-lit heated greenhouse. For these reasons, high tunnels are an attractive structure to grow bedding plants, however if ventilators, side and/or endwalls are left closed or fail to open (Fig. 5), heat can quickly accumulate inside the high tunnel exceeding 100°F (Fig. 6) and become detrimental to plant health and quality.

When crops are exposed to excessively high temperatures, heat stress and injury can occur, thus diminishing crop quality. In general, heat stress can be observed as leaf rolling (Fig. 7). Heat injury symptoms include:

1. Foliage discoloration
2. Delayed flower initiation
3. Flower bud abortion
4. Faded flower color

Figure 2. Example of a modified haygrove used for bedding plant production. Photo by W. Garrett Owen.

Figure 3. Example of a high tunnel which is glazed with a single layer of polyethylene and lacks a heater and exhaust and horizontal air flow fans. Photo by W. Garrett Owen.

Figure 4. High tunnel with roll down sidewalls. Photo by W. Garrett Owen.

5. Flower color reversion
6. Poor plant growth
7. Plant death

Heat injury symptoms will vary depending on 1) the actual exposure temperature and 2) the duration of exposure to high temperatures. For example, short-term exposure to high temperature in a high light environment such as a closed high tunnel can burn foliage. During preliminary trials at UK, we observed heat injury as discoloration and necrotic (dead) patches on leaves of 'Dragon's Breath' celosia (*Celosia plumosa*) grown in a high tunnel where air temperature exceeded 103°F before 8:30 AM EST (Fig. 8). Therefore, growers should be aware of the risk of heat injury to bedding plants grown under high tunnel conditions. To prevent injury, growers should open side and/or endwalls early, especially in late-spring and early-fall when daytime air temperatures inside a high tunnel can be 5 to 20°F warmer than ambient outdoor air temperatures. Do not drought stress plants. A water-stressed plant has a greater probability of developing heat stress symptoms and being damaged because of the lack of transpiration which cools plant tissues. High humidity in a high tunnel can also reduce transpiration and thus, induce heat stress and injury. If heat stress is observed, growers can spray plants with water to promote evaporative cooling of the plants, but note, leaf wetness can increase the likelihood of foliar pathogen infection. In addition, if bedding plants inside a high tunnel are covered with reemay cloth to provide added protection to cool nighttime temperatures and not removed the next morning or day, heat can possibly accumulate and cause heat stress and injury. Therefore, growers should carefully monitor temperature under these additional protective conditions.

Figure 5. High tunnel where the motorized sidewall crank system failed to open. Photo by W. Garrett Owen.

Figure 6. A thermometer displaying high temperatures within a closed high tunnel. Photo by W. Garrett Owen.

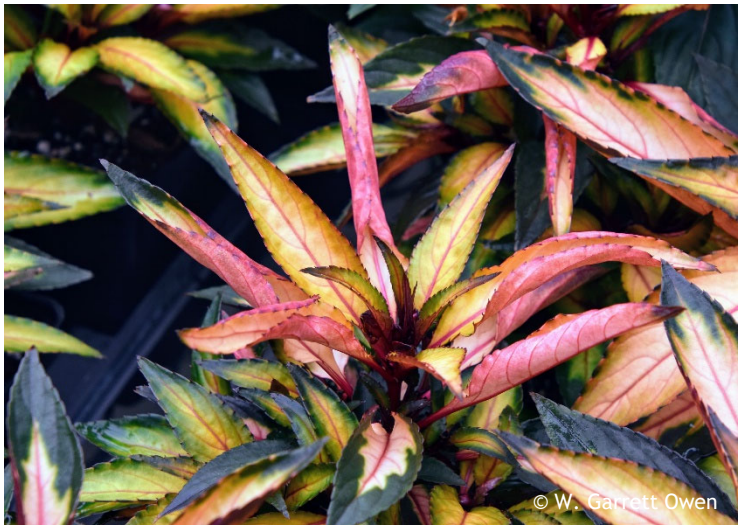

Figure 7. A New Guinea impatiens crop exhibiting leaf rolling because of heat stress. Photo by W. Garrett Owen.

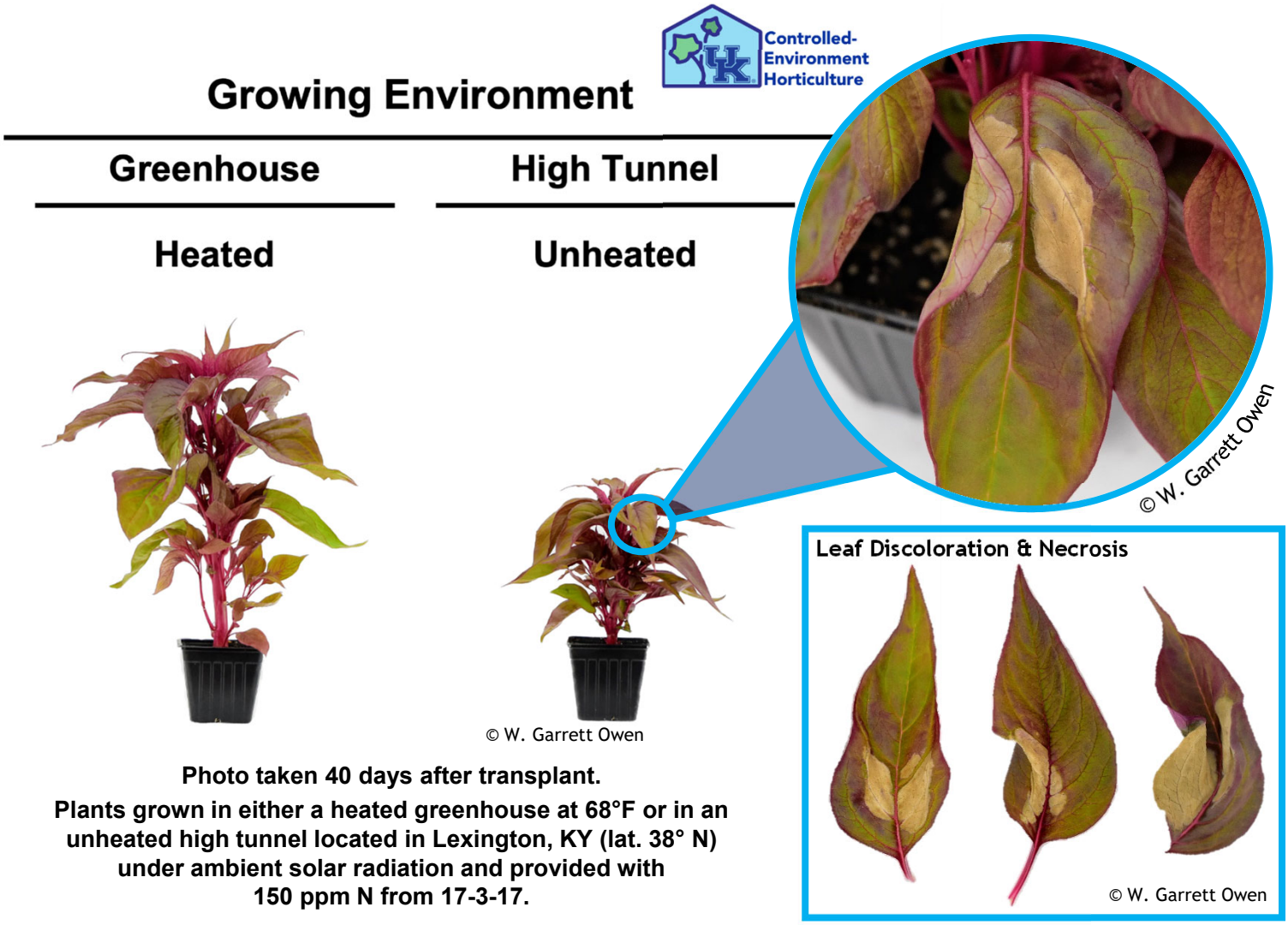

Figure 8. Heat injury developed as leaf discoloration and necrotic (dead) patches on 'Dragon's Breath' celosia (*Celosia plumosa*) grown in a high tunnel where air temperature exceeded 103°F before 8:30 AM EST. Photo by W. Garrett Owen.

To learn more about heat stress and symptoms, specifically of greenhouse-grown zonal geranium, refer to:

- e-GRO Alert 9-27: Chilling and Freeze Injury and Heat Stress of Geraniums
- e-GRO Alert 6-30: Heat Stress Causes Foliar Bleaching and Chlorosis of Zonal Geranium

Overall, there are no corrective actions for heat stress and injury. To mitigate supra-optimal temperature-induced stress and injury of high tunnel-grown bedding plants, growers should be knowledgeable of crop-specific temperature requirements; be aware of ambient outdoor conditions and be prepared to manually open high tunnel side and/or endwalls; consider installing solar-powered technologies; and deploy exterior shade. Furthermore, growers should consider grouping plants by temperature requirements to prevent damage and maintain crop quality. For more information about crop specifics, refer to Michigan State University Extension Floriculture and Greenhouse Crop Production webpage, "Greenhouse Temperature Management."

L. Seltsam and W. G. Owen thanks Raker-Roberta's for plant material and the United States Department of Agriculture – Agriculture Research Service for research funding.

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. Chieri Kubota
Controlled Environments Agriculture
The Ohio State University
kubota.10@osu.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. Alicia Rihn
Agricultural & Resource Economics
University of Tennessee-Knoxville
arihn@utk.edu

Dr. Debalina Saha
Horticulture Weed Science
Michigan State University
sahadeb2@msu.edu

Dr. Beth Scheckelhoff
Extension Educator - GreenhouseSystems
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

Cooperating Universities

Cornell CALS College of Agriculture and Life Sciences

Cornell Cooperative Extension Suffolk County

Iowa State University

University of Kentucky

Penn State Extension

UTIA Institute of Agriculture, The University of Tennessee

Michigan State University

UConn

Purdue University

College of Agricultural & Environmental Sciences, University of Georgia

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.

Kentucky Horticulture Council