



by Neil Mattson
nsm47@cornell.edu

Bolting of Hydroponic Lettuce and Spinach

Avoid hot temperatures in the greenhouse to keep your lettuce and spinach plants from prematurely going to seed. Bolting causes leaves to become bitter and limits crop marketability. Learn what triggers bolting and how to keep your leafy greens vegetative.

Lettuce (*Lactuca sativa*) and spinach (*Spinacea oleracea*) grow in a compact, rosette form during vegetative growth. During this stage there is very little elongation of the main stem, i.e. the point from which new leaves unfold from. However, once flower initiation is triggered the main stem begins to elongate into a flower stalk (Figure 1). On lettuce, bolting leads to incomplete or poor head development (Figures 2 and 3) and greater latex (white sap) content. During bolting of spinach, leaves change from their standard oval shape (during vegetative growth) to an arrowhead shape (during reproductive growth). Bolted spinach quickly flowers, with the fan-shaped white flowers present at leaf



Figure 1. Bolting spinach with flowers at leaf nodes.
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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
Floriculture Extension & Research
University of New Hampshire
ryan.dickson@unh.edu

Thomas Ford
Commercial Horticulture Educator
Penn State Extension
tgf12@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

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. Garrett Owen
Floriculture Outreach Specialist - Michigan State Univ.
wgowen@msu.edu

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

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

Lee Stivers
Extension Educator – Horticulture
Penn State Extension, Washington County
ljs32@psu.edu

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

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

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

Heidi Wollaeger
Floriculture Outreach Specialist - Michigan State Univ.
wollaeger@anr.msu.edu

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Figures 2 and 3. Bolting of hydroponic romaine lettuce. (Photos copyright by Beth Scheckelhoff, OSU)



nodes (Figures 4 and 5). Once lettuce and spinach have begun to bolt they are no longer marketable and leaves will begin to taste bitter.

What triggers bolting?

Lettuce is a facultative long day plant, which means that flower initiation occurs in response to long days (typically day length greater than 12 hours, although photoperiod response varies by cultivar). Lettuce plants are often exposed to long days in hydroponic greenhouse production because during darker times of the year supplemental

lights are used during the evening hours. However, even under long day lengths, bolting seldom encountered before heads reach marketable maturity unless high temperature are also encountered (Figure 6). (Therefore growers due to need to be concerned about supplemental lighting during the evening). The most common cause of premature bolting in lettuce is high temperatures, typically multiple days greater than 80 °F. The number of days of hot temperatures (rather than the severity of the temperature) seems to have a greater influence on premature bolting. Other stresses, such as drought stress can trigger bolting.

Spinach is an obligate long day plant, meaning that flower initiation requires long days (with a critical day length of 13-14 hours, depending on cultivar). As in lettuce, the most common cause of premature bolting in spinach is high temperatures. In hydroponic baby leaf spinach production, if temperatures are moderate, bolting is not a problem even when supplemental lights are used. However, under high temperatures (>80 °F) bolting can quickly occur.

Strategies to delay bolting

Control of greenhouse air temperature through shading, venting, and evaporative cooling to maintain moderate air temperature is the most effective method to prevent premature bolting. If you are not able to maintain moderate air temperature you may need to harvest lettuce and spinach earlier than you normally would doing these hot periods so that you can market these crops before the bolt. It has been reported that a commercial producers of lettuce in deep water culture (i.e. raft/pond hydroponics) were able to delay bolting by several days during periods of high day air temperature (>90 °F), when the pond water that plants were growing in was chilled to 65 °F (Resh, 2012). For spinach cooler temperatures and short photoperiods (<13 hour daylength) during the seedling development stage, delayed

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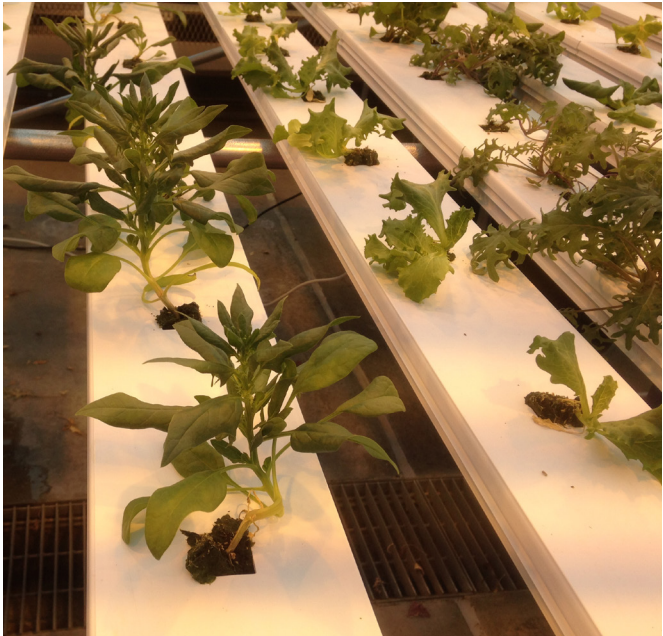


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Figures 4 and 5. Bolting of spinach due to high greenhouse temperatures and night lighting. (Photos copyright by Neil Mattson)

subsequent bolting of spinach after they were transplanted (Chun et al., 2001). Both lettuce and spinach cultivars vary greatly in how long they take to bolt and how sensitive they are to high temperatures. For example, in a study on several genetically diverse lettuce varieties, under a 16 hour day length, bolting occurred from 32 to 128 days after seeding depending on lettuce variety (Waycott, 1995). Therefore it is possible to select cultivars that are slow to bolt and more heat tolerant. Such a strategy is routinely done in outdoor production, but may require trialing under your own greenhouse conditions or contacting the seed supplier for more information. Lettuce cultivar 'Rex' is reported to be resistant to bolting under high temperatures in tropical greenhouses (Resh).

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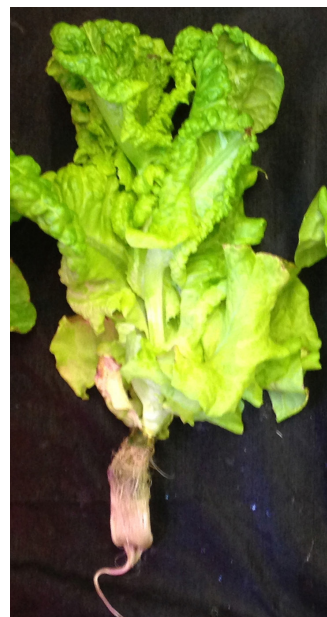


Figure 6. Bibb lettuce bolting from high greenhouse temperatures (Photo copyright by Neil Mattson)