Cold injury to fruit trees (well, with an emphasis on tender fruit)

Jon Clements
University of Massachusetts Amherst

Ontario Fruit & Vegetable Conference
February 2014
Extension fruit specialist

• But I am not Dr. Clements! 😊
• Statewide responsibility for tree fruit
• Apple, peach, pear, plum, plum, cherry
• Applied research at UMass Cold Spring Orchard
• Primarily a horticulturist
Massachusetts

- 500 acres of peaches
- Much less plum, cherry, apricot
- Direct market, some (minor) wholesale
- Specialize in tree “very ripe”
- Retail ranges from $2-4 per pound
We need to understand...

- Acclimation, dormancy, and freezing
- “Cold hardiness” (whatever that is?)
- Types of winter injury
- What can we do?
The problem with “tender” fruit in Ontario

• They don’t call it “tender” for nothing...
• Cultivated plant not found in it’s natural habitat
• Bred for other qualities, but not necessarily environmental adaptability
• *Cultural practices become important to augment natural ability of species to survive cold winters*
Types of dormancy

• Ecodormancy
  – Quiescence
  – Buds are dormant as a result of external conditions unfavorable to growth
  – Example: late fall, early spring
Types of dormancy

• Paradormancy
  – Correlative inhibition
  – Buds are dormant from inhibitory influence of another plant
  – Example: dormancy of lateral buds because of (apical) dominance of terminal shoot
Types of dormancy

• Endodormancy
  – Rest
  – Buds are dormant because of internal physiological blocks that prevent growth even under ideal external conditions for growth
  – Example: chilling hours
  – Thus, mid-latitude temperate species subject to temperature fluctuation have evolved with long chilling requirements!
Chilling Hours (Between 32°F and 45°F)
October 1 through Midnight February 11, 2014
4b -29 to -32 °C.
5a -26 to -29 °C.
5b -23 to -26 °C.
6a -21 to -23 °C.
6b -18 to -21 °C.
Initiation of dormancy

• Cold acclimation
• Process leading to development of freezing tolerance in plants
• Short photoperiod
• Warm days; cool, non-freezing nights
• Exposure to sub-freezing temps (10 degrees F. more cold hardy than before freeze)
• Maximum cold tolerance follow exposure to temperatures approaching ZERO degrees F.
Endodormancy Begins?

May
August
November
January

Summmer growth and correlative inhibition

Winter dormancy (rest and quiescence)
Cold hardiness

• Enables plants to withstand winter cold
• Related to dormancy/winter rest (endodormancy)
• Gain hardiness in sub-freezing conditions
• Lose hardiness in warm weather
• Lose hardiness faster than they can regain it!
Cold hardiness of shoots and buds

- Shoots generally more cold hardy
- Water freezes in shoots/bud scales
  - Ice pulls water from cells
  - Concentrates solution in cells
  - Lowers freezing point of cells
- Eventually, however, cells “freeze” and structure/function damaged
Cold hardiness of flower buds

• Genus and variety dependent
  – Peach -10 F.
  – Cherry -15 F.
  – Apple and pear -25 to -30 F.
• Not as much information on shoot/leaf hardiness
• Flower buds freeze individually, range of sensitivity
• Terminal flower buds more vulnerable than lower flower buds
“Cold hardiness” depends...

• When low temperature occurs (early vs. mid- or late-winter)
• How fast the temperature drops
• Temperatures preceding cold temperature
• Length of sustained cold temperature
• ‘Siberian C’ peach rootstock hardy in Ontario (sustained cold temperature) but not hardy in South Carolina (fluctuating temperature)
  – Rich Marini, Penn State
Kingsville, ON

Max Temp (°C)

Min Temp (°C)

-25 C = -13 F
Cedar Springs, ON

Max Temp (°C)
Min Temp (°C)
01/01/2014 14:15:00 - 01/31/2014 14:15:00 (EST)

air @ 2 meters

Temp (°F)

DewPnt (°F)
Winter injury most often occurs...

- Extreme low temperature
- Low temperatures following warm temperatures
- Fall, early hard cold before plants are acclimated
- Warm up during winter (loss of cold hardiness)
- Cold snap after spring warm-up, loss of dormancy and cold hardiness
Cold hardiness and stress

• Stressed plants can gain cold hardiness faster than normal; for example, drought stress
• BUT, stressed plants have less sugars and cannot withstand as much cold
• Heavy crops in particular can reduce reserves (sugars) available and reduce cold hardiness (particularly if incomplete harvest)
Types of winter injury

• Blackheart
• Cambium injury
• Crotch injury
• Crown or collar injury
• Sunscald
• Trunk splitting
• Killing back of shoots
• Injury to leaf and flower buds
• Killing of roots
Blackheart

• Fairly common
• Pith killed and heartwood darkened
• Gumming occurs with cell death
• Found in apple, peach, cherry, plum, pear
• Young and nursery trees more affected
• Weakens trunk and branches, but recovery can be rapid in healthy trees
Cambium injury

• Most common on stone fruit (peach)
• Exacerbated by warm temperatures preceding and fact that cambium is last to harden off
• Results in weakening of tree, secondary infection by fungi, canker
• Gumming often a symptom
BUT
Gumming is not always a sign of cold injury
Freeze damage to peach cambium

Brown cambium following -19 F low temperatures in 1994 (Bill Shane)
Cambium damage to peach – 1994, Randy Willmeng farm ~ -17F (Bill Shane)
Crotch injury

- May be last area to harden off
- Upright limbs with narrow crotch angles most likely to be cold injured
- Injury may extend up and down the limb
- Cultivar susceptibility?
Crown/collar injury

- Winter killing of bark near ground
- May be late hardening off
- Apple (Gravenstein, Northern Spy) may be more susceptible
Winter sunscald

• Commonly known as southwest injury
• Trunk heats during sunny day, followed by rapid drop in temperature with sunset
• Peach with lower branches may be less at risk (vs. apple)
• White latex trunk paint is advised
Trunk splitting

• More common on sweet cherry and apple
• Occurs most often in late fall, early winter with rapid temperature drop
• Splitting/cracking can extend all the way to pith
• May or may not close up/heal over
• “Beginning of the end” with stone fruit
Photos: Bill Shane, MSU
Shoot death/die-back

- Most likely with very cold weather when tree has not fully acclimated/hardened-off
- Seen more often in young trees
- Watch nitrogen fertilization, late pruning
- Effect similar to heading cut
Injury to leaf and flower buds

• PEACH: Expect to see some damage (10%) at -23 C., 100% damage at -29 C. (Peter Hirst/Dick Hayden, Purdue)
• During the winter, the temperature required to damage peach buds may vary by as much as 5-6 C. because of acclimation/de-acclimation difference (Rich Marini, Penn State)
• TREE DAMAGE
• -35 C. for apple; -32 for apricot; -29 for tart cherry; -26 for sweet cherry; -25 for peach (Bill Shane, Michigan State)
Root death

• Less common than injury to above-ground portion of tree
• Apple roots can be killed beginning at -4 C. to -12 C.
• Bare ground exacerbates
Horticultural practices

• Site selection
• Manipulation of water and fertilizer to prevent late season growth and reduce stress
• Choice of variety and rootstock
• Frost/freeze protection
• Pruning practices
Site selection

- Elevation
- Wet feet/drainage
- Latitude
Irrigation/fertilization

- Drought stress followed by cold winter can be bad news
- Too much water can keep trees growing later in fall = reduced hardiness
- High nitrogen = reduced hardiness
- Don’t fertilize too late into the fall
Variety/rootstock

“In an NC-140 peach rootstock trial, it looks like flower bud injury ranges form app. 3% to 75% following temperatures of -11 F. in early January, 2014. Redhaven is the variety, 12 different rootstocks.”

M. Warmund
Pruning

• Pruning late decreases cold hardiness
• Pruning effect can last well into mid-winter
• Late pruned trees showed enhanced cambium activity into winter
• Summer pruning of peach might impact cold hardiness in early winter
• (Peach pruned at pink might show reduced tolerance to frost during bloom)
  – Rich Marini, Penn State Fruit Times
Cherry leaf spot

- Early defoliation
- Michigan State research
- Slower to acclimate
- Begin growth earlier in spring
Thank you!

• Michelle Warmund, U. of Missouri
• Bill Shane, Michigan State University
• Mark Longstroth, Michigan State University
• Diane Miller, Ohio State University
• Gregory Reighard, Clemson University