Fruit production in a changing climate: Reducing risks

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15 of 16 hottest years all since 2000

Last three years the hottest since 1884

15 of 16 hottest years all since 2000
Why is it getting so hot??

1. Current CO$_2$ levels way out of natural range

Carbon dioxide over 400,000 yrs

- Ice Age Cycles
- CO$_2$ now observed directly
- CO$_2$ now from ice cores
- Both

Year (AD)
2. Temperature tracks CO$_2$

How does CO$_2$ cause warming?
Some energy is radiated back into space as infrared (heat) waves. Greenhouse gas molecules absorb infrared waves and reflect some heat back to Earth, slowing heat loss more gas molecules, slower heat loss, more warming.

Most solar radiation is absorbed by the Earth and warms it.

The Greenhouse Effect: More CO$_2$ in the atmosphere slows heat loss.
Warmer ocean = more evaporation
more water vapor in air
Severe Weather

“Global warming is contributing to an increased incidence of extreme weather because the environment in which all storms form has changed ...”

Dr. Kevin Trenberth
National Center for Atmospheric Research
June 2011

- warmer air
- warmer ocean
- more water vapor in air
- higher sea level
The “New Normal”

- More severe weather; more extreme extremes
- More tidal flooding and storm surge

- Warmer winters, earlier springs, hotter summers
- Heat waves last longer

- More rainfall comes as downpours; flash flooding
- Rainy springs & falls (MD)
- Dryer summers
Effects of Climate Change: Temperature

Spring comes earlier
Fewer cold nights for required plant chilling
Warmer winters = earlier blooming

NY apples bloom 8 days earlier than in the 1960s

Grapes bloom 6 days earlier

Late spring cold snap ➔ freezing, fruit loss
Plant new orchards on hilltops, plant longer season varieties?

**False Spring**

- Feb and/or early March very warm followed by hard frost
- Outcome depends on fruit stage when frost occurs

<table>
<thead>
<tr>
<th>Stone Fruit (Apricots, Peaches and Plums)</th>
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<table>
<thead>
<tr>
<th>Apricots</th>
<th>Swollen Bud</th>
<th>Tips separate</th>
<th>Calyx red</th>
<th>First White</th>
<th>First Bloom</th>
<th>Full Bloom</th>
<th>In the shuck</th>
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</thead>
<tbody>
<tr>
<td>Old temp</td>
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<td>23</td>
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<td>25</td>
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<td>10% kill</td>
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<td>90% kill</td>
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<td>19</td>
<td>22</td>
<td>24</td>
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<table>
<thead>
<tr>
<th>Peaches</th>
<th>Swollen Bud</th>
<th>Calyx Green</th>
<th>Calyx Red</th>
<th>First Pink</th>
<th>First Bloom</th>
<th>Full Bloom</th>
<th>Post Bloom</th>
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credit: MSU Extension
False Spring 2017

- Feb 2017 warmest ever, then hard freeze in March
- Apricots all lost in MD
- MD Peaches borderline

- Problem: can’t predict when in March or April frost will occur
- Good site, frost protection: fruit.cornell.edu/frost-protection
Increasing Night Temperatures

- Night temperatures rising faster than daytime temps

- Harder to accumulate chill hours
Warm winter? Not enough chill hours

- In 2017, most Georgia peaches needed 650 hrs, they got <500 hrs
- Dormex, growth regulator that simulates chill hours not very helpful in GA in 2017
- Then, false spring wiped out the rest of the crop
- NOAA: SC and GA $1billion in peach losses 2017
- NC lost entire blueberry crop
Effects of warmer winters, earlier springs

Pest insects

- better overwinter survival
- earlier appearance
- more generations/yr
- range expansion
- be vigilant & scout!!
- expect the unexpected

Stressed plants are more susceptible to insects & disease
Temperature changes in Maryland

Source: NOAA
Summer heat stress: sun scald

This apple tree was affected by sunscald many years ago that later served as an entry for a canker disease.

ozone damage!
High Temperature Impacts

- Increased plant respiration and carbon loss
- Decreased yield
- Reduction in pollen production
- Reduction in pollination (pollen tube growth)
- Moisture stress

Apples sensitive to fruit drop, bitterpit

- Increased insect activity
  Codling moth may add another generation
High Temperature Impacts

- Apples remain pale because pigment production reduced by warm nights

Adapting to increased temperature

- Try heat tolerant varieties, perhaps from South
- Breed heat tolerant varieties
- Build shade, use evaporative cooling?
- Mulch (plant material, white or reflective)
- Stagger planting dates to hedge bets
- Plant earlier in spring

2104: Oakmoor Orchard, BC lost 40% Granny Smith yield to sun scald. Saved $47,000/yr with overhead evaporative cooling

Summer drought: adaptation strategies

- Add irrigation, increase water storage?
- Add drainage that goes to pond
- Build up the soil- more organic matter holds water
- Mulch
- Grow cover crops between rows as living mulch?
Drip Irrigation for Fruits & Vegetables
More rain in spring and fall
⇒ flash floods

- Can contaminate fields,
- Stunt or kill plants,
- Increase disease,
- Delay planting or harvest
Rainfall changes in Maryland

Observed number of rains > 4”

5-year intervals

1950 2014

Observed rainfall in
Spring
Summer
Fall


Source: NOAA
Spring/Fall flooding: adaptation strategies

- Improve drainage

- Improve soil health for better infiltration

- Prevent erosion/ cover crops

- Use flood-resistant rootstocks

- Stagger planting dates

- Diversify crops
Contact me anytime with questions or comments!

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Breeding heat-tolerant varieties with viable pollen at high temperatures

Tomatoes

<table>
<thead>
<tr>
<th>Heat tolerant</th>
<th>Non-tolerant</th>
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<tbody>
<tr>
<td>HOT</td>
<td>NORMAL</td>
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good | good | OK  | bad

What has already happened?

This is EVIDENCE, not opinion

Source: NASA Goddard Space Flight Center Scientific Visualization Studio
Important Resources for Climate-Smart Farming

Northeast and Northern Forests Regional Climate Hub Assessment of Climate Change Vulnerability and Adaptation and Mitigation Strategies

Photo Credit: Scott Bauer (2007)

Authors: Daniel Tobin, The Pennsylvania State University; Maria Janowiak, Northern Forests Sub Hub; David Y. Hollinger, Northeast Hub Lead; R. Howard Skinner, Northeast Hub Co-Director; Christopher Swanston, Northern Forests Sub Hub Lead; Rachel Stede, National Climate Hubs Coordinator; Ramas Radaskrishna, The Pennsylvania State University; and Allison Chatt, Cornell University.

Northeast Hub
Northeastern Research Station USDA Forest Service
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Edited by: Terry Anderson, ARS.
Climate-related incidents are affecting yield now

from USGCRP 2009
High Night Temperatures During Summer

- Night temperatures rising faster than daytime temps

- Bad for chill hours
High Night Temperatures During Summer

- night temperatures rising faster than daytime temps
- plants respire to keep cool, lose carbon, reduces yield
- high night temps reduce pollen production, cause flower and fruit drop (peppers, tomatoes)
Warmer winters = earlier blooming

Cherry blossom peak bloom dates in Washington, D.C. and Kyoto (1921-2017)

Source: Yasuyuki Aono, Osaka Prefecture University
Economist.com
Effects of warmer winters, earlier springs

Weeds
- weeds & invasives doing well under climate change
- better overwinter survival
- earlier appearance & flowering
- expect the unexpected
- mulch!
  cover crops between rows
  plant into dead cover crops

Credit: Texas A&M