Understanding and Managing the Impact of Climate Change on Tree Fruit Production; Case Study Peach

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What is climate change?

“Climate change is a change in the pattern of weather, and related changes in oceans, land surfaces and ice sheets, occurring over time scales of decades or longer”

• Natural processes, such as changes in the Sun’s radiation, volcanoes or..........

• Internal variability in the climate system

• Human influences such as changes in the composition of the atmosphere or land use

“Global temperatures have already increased by an average of 1°C since industrialization. Climate change scientists predict that by 2050, air temperatures will increase further by between 2-4°C depending on mitigation activities (Measham and Quentin, 2014).”

• **Ecosystems**: Climate warming causes land and ocean life to migrate away from areas that have become too warm, and towards areas that previously were too cool.

• **Bushfires**: The number of extreme fire risk days has grown over the past four decades.

• **Food security**: Human influences such as changes in the composition of the atmosphere or land use.

• **Health**: Heatwaves are among the highest-impact climate events in terms of human health in Australia. In very hot conditions, people can suffer from heat stress.

Climate change

- Chilling hour
- Heat accumulation
- Effective pollination
- Affecting crop growth
- Frost damage
- Drought
- Rainy days near harvesting
- Diseases and insects
- Waterlogging/flooding

Darbyshire et. al., 2016
Chilling Hour

• Chilling unit/hour
  1 chilling unit=1 hour 0°C - 7.2°C (32°F-45°F)
  It is cultivar specific/“chilling requirement”

• Insufficient chill unit
  Delayed and prolonged bud burst
  Abnormal growth in trees such as apical dominance
  Uneven shoot development, flowering and fruit maturity

Erez and Fishman, 1998, James 2011
UF Stonefruit Breeding Program

• Bred peaches with chilling requirements of 350 to 450 chilling units

• Developed varieties into subtropical climates around the world

• Developing varieties requiring less than 200 chilling units for Central FL

• Developing root-stock ‘Flordaguard’
Production History

- Peaked in the 1980s
- Medium-chill varieties
- Lack of overhead irrigation
- Marketing challenges
- Domestic competition

~4,500 acres
Reduced to ~400 acres in 2008
Production Window for FL

Targeted Market Window for Florida Peaches

US Marketing Season Peaks
May 20 - September 30

Source: U.S. Census Bureau
UF Peach Cultivars

North/North Central
- Gulfking
- UFSharp
- Gulfcrest

Central
- UFGem

South Central
- UFBest
- UFSun

*Will require frost protection.


500-600 chill units = Gulfcrest
400-500 chill units = Gulfprince, Gulfcrimson, Gulfsnow, Flordaking, UFGlo
300-400 chill units = Flordadawn, UFBblaze, UF2000, Flordacrest, Gulfking, UFSharp, Sundollar (N), Suncoast (N)
200-300 chill units = UFBbeauty, UFGold, TropicSnow, Ufone, UFO, Flordabest, UFRoyal (N), Sunraycer (N), Sunmist (N), UFGFqueen (N)
100-200 chill units = UFSun, UFBest, UFGem, Flordaprince, Flordaglo, TropicBeauty

*Map shows the number of hours between 32-45°F received to February 10th in 75% of winters.
Production

~2,000 acres

‘UFSun’

‘UFOne’

‘UFBest’

‘Tropicbeauty’
The Fresh Market

Whole Foods Market

Walmart
# Chilling Hour


<table>
<thead>
<tr>
<th>Season/County</th>
<th>Indian River</th>
<th>Polk</th>
<th>Hillsborough</th>
<th>Pasco</th>
<th>Orange</th>
<th>Lake</th>
<th>Marion</th>
<th>Alachua</th>
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<tbody>
<tr>
<td>2018-2019</td>
<td>76</td>
<td>106</td>
<td>209</td>
<td>188</td>
<td>127</td>
<td>229</td>
<td>345</td>
<td>406</td>
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<tr>
<td>2017-2018</td>
<td>141</td>
<td>163</td>
<td>281</td>
<td>304</td>
<td>203</td>
<td>302</td>
<td>418</td>
<td>524</td>
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<tr>
<td>2016-2017</td>
<td>61</td>
<td>59</td>
<td>104</td>
<td>113</td>
<td>86</td>
<td>167</td>
<td>241</td>
<td>327</td>
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<tr>
<td>Historic average</td>
<td>211</td>
<td>233</td>
<td>288</td>
<td>267</td>
<td>282</td>
<td>420</td>
<td>417</td>
<td>625</td>
</tr>
</tbody>
</table>
Chilling Hour
Chilling Hour

• Fully dormant peach tree
Chilling Hour

• Apical dominance
Chilling Hour

• Uneven shoot development, flowering and fruit maturity
Chilling Hour

• Overcome insufficient chill
  1. Short-term adaptation strategies
     1.1. Climatic factors that contribute to a lack of chilling
     1.2. Use dormancy breaking agents
  2. Long-term adaptation strategies
     2.1. Variety selection
     2.2. Rootstock selection
Chilling Hour

Shading

East windbreak looking South
Chilling Hour

Shading

Middle row looking North
Chilling Hour

Shading

West windbreak looking South
Chilling Hour

Shading
Chilling Hour

Data logger
Chilling Hour

Data logger map

Growing stage:
1) Chill hour/dormancy
   Oct 15\textsuperscript{th} to Jan 15\textsuperscript{th}

2) Flowering/ harvest
   Jan 16\textsuperscript{th} to May 15\textsuperscript{th}

3) Postharvest
   May 16\textsuperscript{th} to Oct 15\textsuperscript{th}

2/26/2020
Chilling Hour

Chill hours between 0-7.2°C

Treatment

- Second West (a)
- West (ab)
- Middle (ab)
- Second East (bc)
- East (c)
Chilling Hour

Average minimum daily temperature

![Bar chart showing temperature by treatment](chart.png)
Chilling Hour

Average maximum daily temperature

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second West</td>
<td>a</td>
</tr>
<tr>
<td>Second East</td>
<td>ab</td>
</tr>
<tr>
<td>Middle</td>
<td>ab</td>
</tr>
<tr>
<td>West</td>
<td>ab</td>
</tr>
<tr>
<td>East</td>
<td>b</td>
</tr>
</tbody>
</table>

Average maximum daily temperature
Chilling Hour
Use dormancy breaking agents

• Plant bio-regulators, e.g. Gibberellic Acid (GA 3, GA 4 & 7), Ethephon, Dormex,…
• Fertilizers, e.g. Potassium nitrate (KNO3), ERGER (mono-, di- and poly-saccharides, proteins and nitrogen),…
• Registration
• Application time and rate
• Safety for both human and plant
Chilling Hour
Foliar application of ERGER

• ERGER is a mineral fertilizer specially designed to be sprayed on dormant wood in a specific period of time.
• ERGER is intended to supplement a standard fertility program with a source of Nitrogen and Calcium prior to the new growing season.
• It ensures the supply of nitrogen to plant tissues in the first stages of development, such as buds.
• It is beneficial to plant development even prior to bud break.
Application rates: control, 6gl/100gl of water, 8gal/100 gal of water
ERGER on ‘Tropicbeauty’ in Citra

01. 22. 2019

First application, 12.12.18

Control

6 gallon ERGER/ 100 gallon

8 gallon ERGER/ 100 gallon

Accumulated 109 CU
ERGER on ‘Tropicbeauty’ in Citra

01. 22. 2019

Second application, 12.23.18

Control

6 gallon ERGER/ 100 gallon

8 gallon ERGER/ 100 gallon

Accumulated 137 CU
ERGER on ‘Tropicbeauty’ in Citra

01.22.2019

Third application, 01.02.19

Control

6 gallon ERGER/ 100 gallon

8 gallon ERGER/ 100 gallon

Accumulated 146 CU
ERGER on ‘UFGem’ in Bartow

Control

6 gallon ERGER/ 100 gallon

8 gallon ERGER/ 100 gallon

Accumulated 43 CU
ERGER on ‘UFGem’ in Bartow

Control
6 gallon ERGER/ 100 gallon
8 gallon ERGER/ 100 gallon

Accumulated 51 CU
ERGER on ‘UFGem’ in Bartow

Control

6 gallon ERGER/ 100 gallon

8 gallon ERGER/ 100 gallon

Accumulated 51 CU

01. 14. 2019
Third application, 01.03.19

2/26/2020
Citra ‘Tropicbeauty’ 150 CU

12.23.18 137 CU
12.12.18 109 CU
01.02.19 146 CU

Bartow ‘UFGem’ 175 CU

12.26.18 51 CU
12.18.18 43 CU
01.03.19 51 CU

Application rates: control, 6gl/100gl of water, 8gal/100 gal of water
Waterlogging
Rootstock Evaluation
Waterlogging
Rootstock Evaluation

Photo: Leah Millis
Financial losses in crop production due to environmental stresses in the US from 2000 to 2011, Bailey-Serres et al., 2012)
Waterlogging

‘Flordaguard’ peach tree

Differences between peach tree root infected by root-knot nematode, *Meloidogyne floridensis* (a), and non-infected root (b).
## Rootstock selection against waterlogging

<table>
<thead>
<tr>
<th>Root stock</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Nemaguard’</td>
<td>To investigate whether there are varietal differences between rootstocks in their response to destructive waterlogging trial.</td>
</tr>
<tr>
<td>‘Guardian’</td>
<td></td>
</tr>
<tr>
<td>‘Flordaguard’</td>
<td></td>
</tr>
<tr>
<td>‘P-22’</td>
<td></td>
</tr>
<tr>
<td>‘MP-29’</td>
<td></td>
</tr>
<tr>
<td>‘R5064-5’</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scion</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘UFSun’</td>
</tr>
</tbody>
</table>
Rootstock selection against waterlogging
Rootstock selection against waterlogging
Rootstock selection against waterlogging

• Photosynthetic parameters, e.g. photosynthetic rate (AN), stomatal conductance (gs), intercellular CO2 concentration (Ci), transpiration rate (E), etc. (LI-6400XT)

• Chlorophyll concentration parameter (SPAD 502)

• Proline content parameter

• Soluble sugar determination

• Electron Microscopy
August 15th, 2019
August 24th, 2019
August 27th, 2019
August 27th, 2019
August 27th, 2019
August 27th, 2019
August 27\textsuperscript{th}, 2019

[Images of plants and plant tissues]

2/26/2020
# Field Waterlogging Rootstock Evaluation

<table>
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<tr>
<td>Flordaguard MP-29</td>
<td>To investigate whether there are varietal</td>
</tr>
<tr>
<td>Nemaguard P-22</td>
<td>differences between rootstocks in their</td>
</tr>
<tr>
<td>R5064-5</td>
<td>response to waterlogging in a field.</td>
</tr>
<tr>
<td>SC3-17-7</td>
<td></td>
</tr>
</tbody>
</table>
Fruit quality and size

- Cv.: UFSun
- Location: Citra and Ft. Pierce

Objectives:
- Determine the influence of fruit location within the canopy on fruit size and quality
- Identify PGRs and biostimulante approaches on fruit size and quality
Determine the influence of fruit location within the canopy.
Identify PGRs and biostimulante approaches

**PGRs:** ReTain {Aviglycine hydrochloride (AVG)} and Mxcel

**Biostimulant:** McExtra 20%K+1%N
Vegetative growth

- Producing high-quality fruit
- Pests management
- Improving spray coverage and penetration
- High density orchard
- Reducing production cost
- Simplify operational practices
Peach diseases

Fungal Gummosis

Peach Scab

Peach Leaf Rust

Brown rot
Peach Insects

Plum Curculio

Citrus root weevil

Peach Tree Borers

Caribbean fruit fly

Stinkbugs

White Peach Scale

San Jose Scale
Thank you

“I cannot do all the good that the world needs. But the world needs all the good that I can do.” - Jana Stanfield