How Potential Changes in Climate Could Affect Pistachio Production

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Sacramento, Solano & Yolo Counties
Outline of Talk

• Introduction to winter chill
• Central Valley winters in the future?
• What warmer winters could mean for pistachio production.
Three Take Aways

• We will experience more “low chill” winters in the future.

• Kerman will not be appropriate for many parts of the San Joaquin Valley in 30-40 years.

• Dormancy breaking chemicals *may* help in the short term. New low chill varieties will be necessary long term.
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Why is winter chill important?

Photo: D. Doll
Chill models work very differently

**Chill Hours**
- 1 hour between 32-45°F = 1 chill hour

**Chill Portions (Dynamic Model)**
- Different temps have dif. ‘chill value.’
  - Max: hours at 43-47°F.
  - No chill value at 32°F and 54°F.
- Expands the range of temps considered effective for chill accumulation.
- Warm temperatures can subtract from chill accumulation.
2013-2014: Hours vs. Portions

**Chill Hours:**
Average winter.

**Chill Portions:**
Unusually Warm.

Cumulative Chilling Hours - Westlands

Cumulative Chilling Portions - Westlands

Figures: fruitsandnuts.ucdavis.edu
Outline of Talk

• Introduction to winter chill
• **Central Valley winters in the future?**
• What warmer winters could mean for pistachio production.
Have California winters been getting warmer?
Yes. Especially in the last 40 years.

- Lots of variability year-to-year
- Different weather networks & datasets differ on exact change trends.
- All records show trend of increased Max & Min Temps from 1970-2014

Wang et al. (2017)
Have Central Valley winters been getting warmer? Yes.

Wang et al. (2017)
Winters have also been getting less foggy

Baldocchi & Waller (2014)
Winters have also been getting less foggy

Time fogged in

1981–1999

2001–2012
Climate models project winters will keep getting warmer.

Change in temperature from 1985–1994 to 2060–2069

• 16 different global “general circulation models”
• 5 different ways to scale down to regional level
• Sac Valley: ↑ 3.1°F (1.7°C)
• San Joaquin Valley: ↑ 3.2°F (1.8°C)

Pierce et al. (2013)
Climate models project winters will continue to vary a lot from year to year.

- Winter-to-Winter variability will be 2x the expected shift in temperature.
- So, we’ll still experience some cold winters, and winters that we now consider average.
- But we’ll also experience more “low chill” winters AND lower chill winters than before.

Blue bars: Natural climate variability across all models.
Green bars: Average warming projected in period 2060–2069.
Red line: 90 % CI projected warming across models.

Pierce et al. (2013)
Chill Projections 90% of years, for Mid, End of Century

<table>
<thead>
<tr>
<th></th>
<th>Turn of the Century</th>
<th>Mid 21\textsuperscript{st} Century</th>
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<tbody>
<tr>
<td>Sac Valley</td>
<td>70</td>
<td>59 (↓ 16%)</td>
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<td>64</td>
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Luedeling et al. (2009)
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Chill requirements of current cultivars

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<thead>
<tr>
<th>Crop (CA Cv.’s)</th>
<th>Chill Portions Requ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerman*</td>
<td>54-58</td>
</tr>
<tr>
<td>Peters*</td>
<td>60-65</td>
</tr>
<tr>
<td>Lost Hills</td>
<td></td>
</tr>
<tr>
<td>Golden Hills</td>
<td></td>
</tr>
<tr>
<td>Gumdrop</td>
<td></td>
</tr>
<tr>
<td>Randy</td>
<td></td>
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*Based on how chill & harvest, 2014
Chill Projections 90% of years, for Mid, End of Century

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Luedeling et al. (2009)
Chill compensating/dormancy breaking products could help with 10-20% chill decrease

- Kaolin clay in winter decreases bud heat (Doll)
- Dormant/Horticultural Oil can increase budbreak, make it earlier (Beede, Ferguson)
- Hydrogen cyanamide can increase budbreak, make earlier. Not reg’d (Beede, Ferguson, Intl)
- New research on the physiology of dormancy may help generate other solutions (Dr. Z)
Lower chill varieties will be necessary production in many areas after mid-Century

<table>
<thead>
<tr>
<th>Type</th>
<th>Cultivar</th>
<th>Chill Hours (&gt;7 C)</th>
<th>Country of Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>Mateur</td>
<td>206 (36 CP)</td>
<td>Tunisia</td>
</tr>
<tr>
<td></td>
<td>Uzun</td>
<td>600</td>
<td>Turkey</td>
</tr>
<tr>
<td></td>
<td>Halebi</td>
<td>650</td>
<td>Turkey</td>
</tr>
<tr>
<td></td>
<td>Siirt</td>
<td>700</td>
<td>Turkey</td>
</tr>
<tr>
<td></td>
<td>Kale-Ghuchi</td>
<td>775</td>
<td>Iran</td>
</tr>
<tr>
<td></td>
<td>Kerman</td>
<td>800</td>
<td>California</td>
</tr>
<tr>
<td>Male</td>
<td>Male-1</td>
<td>500</td>
<td>Turkey</td>
</tr>
<tr>
<td></td>
<td>Male-2</td>
<td>750</td>
<td>Turkey</td>
</tr>
<tr>
<td></td>
<td>Peters</td>
<td>900</td>
<td>California</td>
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</tbody>
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Three Take Aways

• We will experience more “low chill” winters in the future.
• Kerman will not be appropriate for many parts of the San Joaquin Valley in 30-40 years.
• Dormancy breaking chemicals may help in the short term. New low chill varieties will be necessary long term.
Thank you! Questions?