Tunisia's Temperate Fruits and Nuts are Threatened by Climate Change

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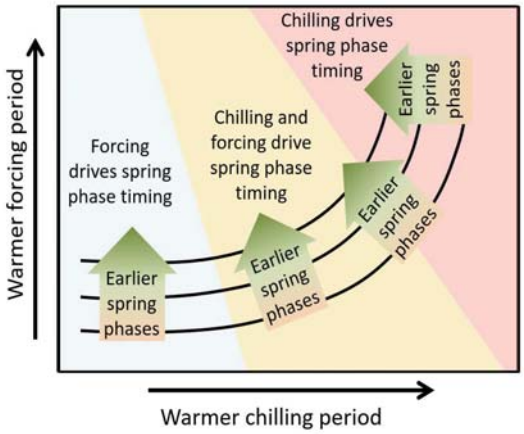
Temperate-zone trees in a warming climate

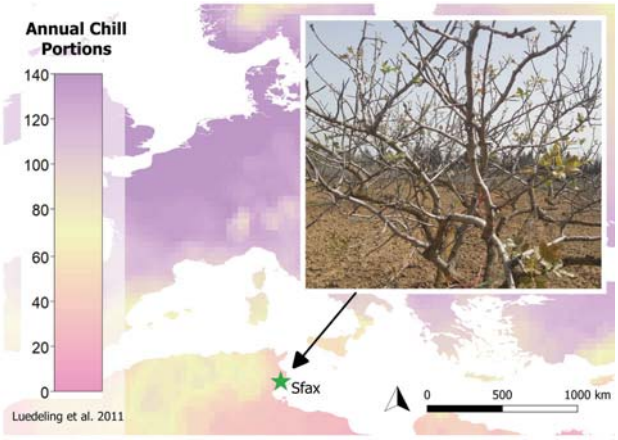
- Temperate-zone fruit and nut trees need winter chill to break dormancy
- Without sufficient chill, commercial production is not viable
- Tree response to climate warming appears to depend on temperatures during the chilling and forcing phases:



Warming responses of temperate tree bloom (Guo et al. 2015)

Tree responses in the world's warmest orchards

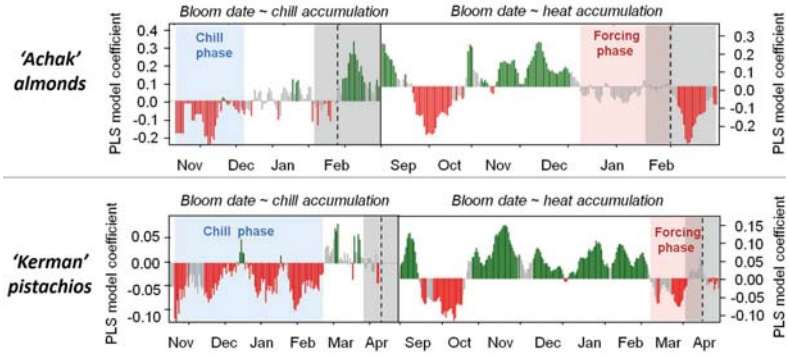
- One of the warmest-winter locations, where temperate-zone fruit and nut trees are commercially grown
- Often experiences 30 Chill Portions or less during the winter (see map below)
- Recent crop failures (bud fall, no bloom, low/zero production, physiological disorder and bad fruit quality) after warm winters during the last decades indicate that chill is a limiting factor in this region.
- Do trees show extreme bloom responses to warming?
- We analyzed long-term bloom records for 37 almond and 7 pistachio cultivars from Sfax, Tunisia



Incomplete and very late dormancy break for 'Mateur' pistachios in Sfax, Tunisia in 2016 (inset), and distribution of annual winter chill across Europe and the Mediterranean region (Luedeling et al. 2011). Sfax is one of the lowest-chill sites, where temperate fruit trees are grown.

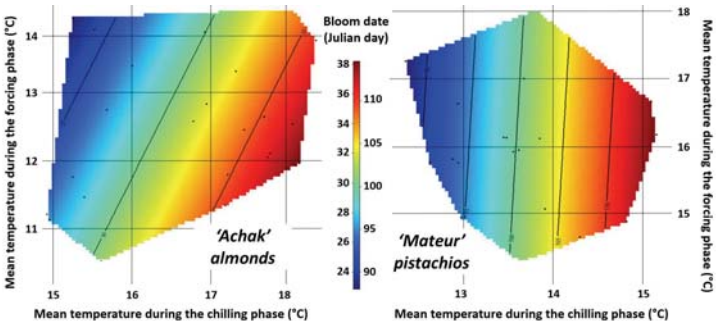
Temperature response phase delineation

- Partial Least Squares regression of daily chill and heat accumulation against bloom dates
- Variable importance and model coefficients allow delineating response phases



Results from PLS regression of bloom dates against daily chill and heat accumulation. Green bars indicate positive and red bars negative correlations between bloom date and chill/heat accumulation; grey bars show 'unimportant' relationships

Bloom date response to temperature



Bloom date response to temperature during the chilling and forcing phases for 'Achak' almonds and 'Mateur' pistachios

- All almond and pistachio cultivars showed similar response patterns
- Near-vertical contour lines support hypothesis by Guo et al. (2015; see diagram in the left column).
- Further warming during the chilling phase is likely to cause severe yield losses'

Conclusion

- High risk for temperate-zone fruit production in Tunisia
- Urgent need for (possibly transformational) adaptation strategies

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References:

- Guo, L., Dai, J., Wang, M., Xu, J., Luedeling, E., 2015. For. Meteorol. 201, 1–7.
- Luedeling, E., Girvetz, E.H., Semenov, M.A., Brown, P.H., 2011. PLoS One 6(5): e20155.
- For more information see
  - Benmoussa, H., Ghrab, M., Ben Mimoun, M. and Luedeling E. 2017. Agric. For. Meteorol. 239, 34-46
  - Benmoussa, H., Luedeling E, Ghrab M, Ben Yahmed J, Ben Mimoun M, 2017. Environ. Exper. Bot. 140, 76-85.