Tropentag, September 18-21, 2016, Vienna, Austria

"Solidarity in a competing world — fair use of resources"

Will Climate Change Threaten Temperate Fruit Trees in Warm Growing Regions?

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Abstract

Many important growing regions of fruit and nut trees of the temperate zone are warmer than the regions of origin of the respective species. Almonds, walnuts, pistachios, peaches, apples, apricots and many other species thrive in California, Chile, Australia, India, China and the Mediterranean region. They are even found in the highlands of Oman, Ethiopia, Kenya and Vietnam. In all these places, growers must carefully select appropriate species and cultivars to ensure that the trees' mandatory chilling requirements are met. If this is not the case, trees can display delayed and protracted bloom, develop growth anomalies and produce yields that are economically unsatisfactory in terms of quantity and quality. Climate change is a concern to growers of temperate trees in warm locations, because increasing temperatures could reduce chill to insufficient levels, putting large investments and many livelihoods at risk. Despite their central importance in fruit production, systematic studies of chilling requirements and temperature responses of trees along climate gradients are scarce. While many growers monitor chill, most of them use outdated models that have long been proven inaccurate.

We have developed methodologies to extract information on temperature responses from long-term bloom records of fruit and nut trees. These procedures are based on Partial Least Squares regression and have been published in an open-source analysis package (chillR for R language). Here we present results from applying these techniques across a wide range of climates, using data from California, China, Tunisia, Germany and the United Kingdom. We show that the response of tree phenophases to warming depends on temperatures during the chill accumulation phase. In cold-winter climates, winter warming advances spring phases, as has been reported for many species. In the warmest locations in our dataset, however, warm winters delayed spring phenology, leading to concerns that additional warming might threaten the productivity of many orchards. We also provide evidence for the inadequacy of commonly used chill models, highlight the currently most reliable model and propose strategies for developing more accurate models. Progress in this field is urgently needed to prepare growers of temperate trees for the impacts of global warming.

Keywords: Chilling requirement, climate change, dormancy, fruit trees, physiology

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