walnuts.org

EFFECTIVENESS AND MECHANISMS OF DORMANCY BREAKING TREATMENTS FOR WALNUTS

PROJECT LEADER: Katherine Jarvis-Shean, UC Cooperative Extension, Division of Agriculture & Natural Resources (UCANR)

COLLABORATORS: Kevin Fort, Maciej Zwieniecki, and Giulia Marino

Objectives

1. Create a field-based, whole tree system that can predictably and stably manipulate winter chill accumulation below ambient conditions (Year 1, 2019-2020).
2. Test the impact of dormancy breaking treatments to phenology, physiology, and yield under different levels of winter chill accumulation (Years 2-4, 2020-2023).
3. Develop understanding of physiological thresholds necessary for consistent dormancy breaking results (Years 1-4, 2019-2023).

Background

Walnuts are one of the highest chill requirement tree crops in California. Symptoms of inadequate winter chill have been seen in orchards in multiple recent springs (e.g., 2014 and 2015), including scattered/prolonged bloom and buds on southern sides of branches never breaking. The latter mostly impacted young trees' architecture. Prolonged bloom in many cases resulted in a wider variety in nut size, more small nuts, and multiple harvests, as well as potentially more sprays for blight control or husk split pests.

Scientists expect such winters to be more frequent in the future. Though lower chill varieties are in development, the industry needs tools to support varieties that are currently in the ground for the next 20-40 years. Many products have been shown to compensate for inadequate chill in other crops and other countries but need to be tested in California conditions. The challenge will be not just to find a chemistry that can break walnut dormancy, but understanding how to do so consistently and predictably. Fortunately, great strides have recently been made to track signals of dormancy's progression, including work by the Carbohydrate Observatory in the Zwieniecki lab. This project aims to harness that progress to give consistent treatment results by understanding the changes that occur inside the plant during dormancy and after chemical applications.

Recent research is showing that dormancy emergence involves whole tree transport, indicating that studying effects on shoots (the traditional dormancy breaking trial approach) rather than whole trees would only tell us part of the physiological story, while also limiting phytotoxicity and fruit set measurements. Temperature manipulation in the field will enable us to study the efficacy of dormancy breaking material during a warm winter without having to wait for a 1-in-10-years warm winter to finally arrive, or try to come to low chill efficacy conclusions based on measurements during adequate chill years.

Results & Discussion

So far, four custom whole tree enclosures with transparent vinyl panels have been successfully designed and installed around selected heat-treated trees and paired with neighboring unheated control trees. Heated air was generated using indirect-fired mobile heaters run with diesel fuel. The warm air stream was ducted into the open top chambers using insulated ducting and ultimately distributed with convection tubes with openings every foot (see figure).

Chemical treatments have been chosen based on a review of more than thirty trials of dormancy breaking treatments in orchard systems around the globe over the last 35 years and consultation with industry practitioners. The three chosen treatments are hydrogen cyanamide (e.g., Dormex®), Erger® (a blend of nitrogen compounds), and forchlorfenuron (CPPU), an analogue of the plant hormone cytokinin. These will be applied 30 days before anticipated budbreak in early March 2021. Subsequent measurements will be taken for phenology timing, fruit set, and phytotoxicity. Tissue samples will be collected and analyzed leading up to budbreak and analyzed for carbohydrates and reactive oxygen species to understand internal metrics of dormancy progress and dormancy breaking.

In the coming two years, we plan to continue heating and chemical treatments, as well as physiology and phenology tracking for two more winters. With these three winters of data, our goal is to hone in on what treatments are effective at breaking dormancy in walnuts, and to improve application timing based on winter chill accumulation and internal physiology metrics, if this proves to be a more effective approach than a calendar-based timing.

FIGURE: Transparent tent panels and heating system: (left) Inflated convection tubes delivering heated air into tree compartment, (middle) infrared image of heated air flow, (right) infrared image of heated tree compartment adjacent to unheated tree compartment.