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ORCHARD FACTS



April 8, 2014

Vol. XV, No. 4

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California Walnut Research: Moving The Industry Forward

*Richard P. Buchner UC Farm Advisor Tehama County
Dani M. Lightle UC Farm Advisor Glenn, Butte and Tehama Counties*

California walnut farmers have access to top walnut research, thanks in part to research funds developed and managed by the California Walnut Board. The Walnut Control Board (California Walnut Board) was established back in 1933 under the Agricultural Adjustment Act. Several name changes followed resulting in the current California Walnut Board (CWB). The CWB is responsible for implementing the federal marketing order for California walnuts. Marketing agreements seek orderly marketing, quality control, walnut promotion and market development, prohibition of unfair trade practices, and financing of production and industry research.

The CWB and University of California make all walnut research reports available to walnut producers online at walnutresearch.ucdavis.edu. The cumulative 17-subject index covers research from 1971 through 2013, including: genetic improvement, rootstocks, water management, flower and fruit development, tree growth, harvesting and storage, insect, weed, soil and disease management, tree nutrition, and economics. Examples of the more prominent benefits to walnut farmers of the research relationship between CWB and University of California include cultivar development of Howard and Chandler, as well as clonal Paradox rootstocks. The research support from CWB has created an industry and University of California partnership responsible for developing the valuable information contained in the walnut research reports. Log on to <http://walnutresearch.ucdavis.edu/> to check them out.

New Farm Advisor Introduction

Dani M. Lightle, UC Farm Advisor Glenn, Butte & Tehama Counties

On February 10th, 2014, I began working as the new Orchard Systems farm advisor based in Glenn County. Some of you may have seen me at the Walnut Day/Almond Institute meeting in Chico in February.

I grew up in northern Ohio and earned my bachelor's degree in Biology in 2007. Subsequently, I worked and studied invasive forest insect pests for a year at The Ohio State University. I moved to Corvallis, Oregon in 2008 and switched to research in small fruit agricultural systems. In 2013, I completed my PhD in Entomology with a minor in Plant Pathology from Oregon State University in 2013. From 2008 to 2013 my research focus within small fruit cropping systems included biological control, transmission and control of insect-transmitted plant pathogens, and management of plant viruses.

Throughout my time in Oregon, I strove to maintain a strong working relationship with small fruit producers in order to make sure my research was both relevant and useful. I look forward to creating similar relationships with Sacramento Valley farmers and invite you to contact me with your questions, concerns, or just to introduce yourself. I can be contacted by email at dmlightle@ucanr.edu or by phone by calling the Glenn County Cooperative Extension Office at 530-865-1107.

Understanding and Managing Botryosphaeria and Phomopsis Canker and Blight in Walnut

Janine Hasey, UC Farm Advisor, Sutter/Yuba/Colusa Counties

Rick Buchner, UC Farm Advisor, Tehama County

Themis J. Michailides, Plant Pathologist, UC Kearney Research and Extension Center, Parlier

Over the previous four years, advisors, PCA's, and orchard managers have been observing increased incidence of Botryosphaeria and Phomopsis canker and blight infections in walnut statewide. This article summarizes the practical information and ongoing research presented at the April 2, 2014 UC Cooperative Extension field meetings held in Sutter and Colusa Counties. Since 2012, UC Plant Pathologist Dr. Themis Michailides has been funded by the California Walnut Board to study these pathogens and has made great progress in understanding the cause, spread, and management of these diseases. For information and photos on the fungal pathogens and canker phase of disease, see http://cesutter.ucanr.edu/newsletters/Summer_2010_Sacramento_Valley_Walnut_News36485.pdf

To learn more and see photos of the blight phase (infection of the spurs, foliage, and nuts) of the disease, visit http://cesutter.ucanr.edu/newsletters/Sacramento_Valley_Walnut_News43773.pdf.

The Pathogens, Infection, and Predisposing Factors

- Ten species in the *Botryosphaeria* (Bot) family and at least two species of *Phomopsis* have been associated with disease in walnut. Six of the Bot species can directly infect spurs and shoots whereas all 10 species of Bot and two species of *Phomopsis* can infect the walnut fruit (nut).

- From inoculation studies, Themis has shown that these fungi infect the nut, move into the peduncle (the stem of the nut) and then invade the spurs killing next year's buds (Photo 1). Cankers grow slowly in the winter when temperatures are low. At temperatures above 80°F, this process can occur within one week to 10 days. It is common to see blighted spurs (twig blight) in fall, winter and early spring, but not brown blighted shoots during the season under dry weather conditions in walnut unless sprinkler water is hitting foliage or some other water source is spreading the disease. Most symptoms are seen at harvest and post-harvest.
- Bot in walnut has two spore stages (Figure 1): 1) black fungal fruiting structures called pycnidia produce the more common conidia (pycnidiospores- a toothpaste of sticky spores) that are spread by water and to a lesser extent by insects, and 2) sexual stage fruiting structures called perithecia (ascocarps) produce air-borne ascospores. Pycnidiospores only need 1.5 hours of free water to germinate whereas most fungi need 6-8 hours.
- Fungal inoculum sources on walnut trees include hulls, peduncles, dead buds, dead spurs and cankers. In addition to walnut, there are many hosts of *Botryosphaeria* such as blackberry that can serve as inoculum sources.
- Bot can use wounds such as, leaf scars (Photo 2), bud scars, and peduncle scars, pruning wounds (Photo 3), and blighted fruit as an avenue to infect.
- Scale insects increase the potential for infection and development of cankers. The most common species observed is Walnut Scale.

Managing Bot and Phomopsis Diseases

Because of the large size of walnut trees and the large amount of fruitwood, both cultural and chemical controls are recommended.

- Avoid sprinkler irrigation that wets the canopy.
- Prune dead branches back to healthy green wood. It is practical to remove larger infected limbs.
- Prune mature trees following harvest when deadwood is easier to see, and before heavy rains can spread inoculum coating tissues, pruning wounds, bud scales, etc. Eliminating infected wood reduces the inoculum load.
- It is best to remove prunings and burn them. Smaller wood remaining in the orchard should be shredded or chipped into small pieces, $\frac{1}{2}$ inch or less. In pistachio, bigger pieces can produce viable spores for up to $1\frac{1}{2}$ years.
- Control scale insects.
- Fungicides are preventative only and there must be green susceptible tissues for sprays to be effective. In non-replicated walnut grower trials in 2013, some fungicide sprays during the season showed trends of reducing Bot infections. Spray timing was mid-May, mid-June, and mid-July based on pistachio spray timing (Figure 2). Although we cannot make specific recommendations on materials until further replicated research is done, potential fungicides registered in walnuts include Pristine (replaced by Merivon), Luna Experience, Luna Sensation, Fontelis, Quilt Xcel, Abound, Quadris Top, Bumper, Quash, and Inspire Super. Copper and Manzate used for walnut blight will not control these fungi.

2014 Ongoing Research

We will be able to give better management recommendations next year when the following research is completed:

- Determining how long pruning wounds are susceptible to infection.
- Determining how long pruning pieces stay viable on the ground.
- Performing replicated fungicide experiments with additional spray timing combinations to the in season spray timings listed above. Also evaluate bloom and post-harvest application timing. .
- Testing the effect of fungicide longevity to reduce bud infestation by Bot. (In pistachio we see effects in reducing Bot fungi in buds about 6 months after the last spray.)

- Evaluating bud monitoring to determine if presence and varying levels of the pathogen can be used to predict disease risk.
- Investigate if uninjured green fruit infected in spring but not showing symptoms (latent infections), will develop actual infections close to harvest that affect peduncle and spur.
- Discover if stomata can be directly penetrated by these fungi.

Please visit Walnut Research Reports at the UC Fruit and Nut Research and Information Center for all the 2013 research details: http://walnutresearch.ucdavis.edu/2013/2013_325.pdf.

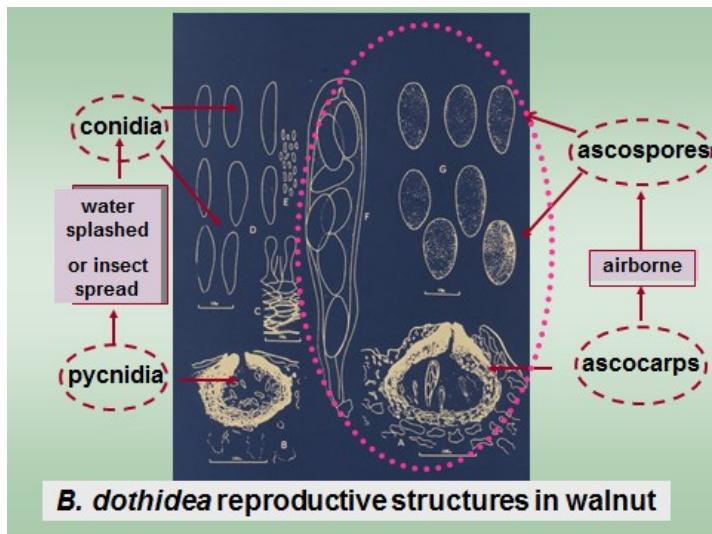


Figure 1. Bot spore types.

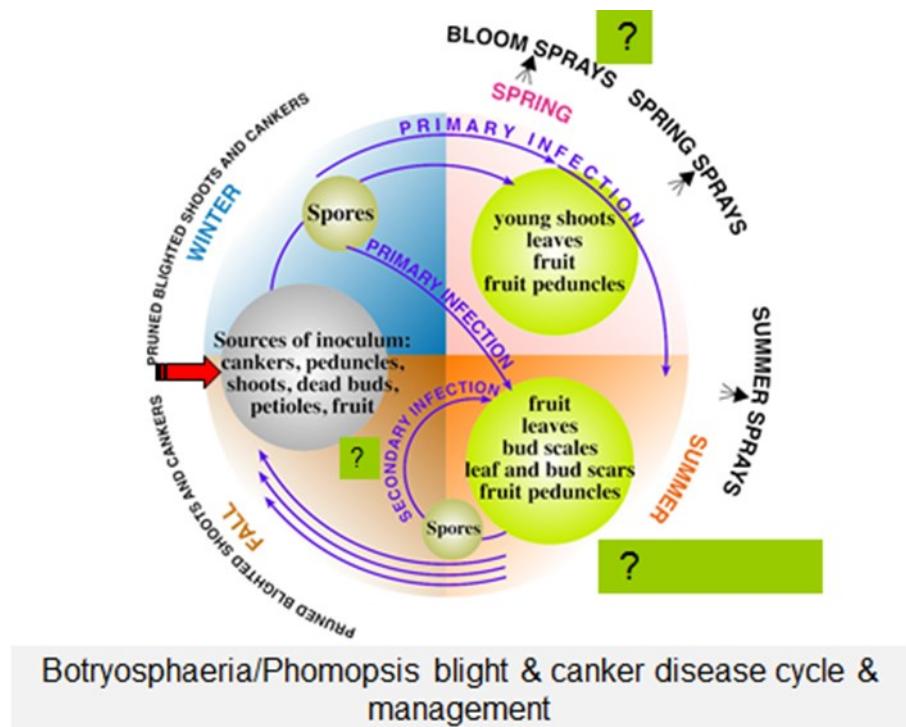


Figure 2. Potential spray timing. ? = unknown whether spray timing effective until further research.



Photo 1. Bot moved from dead peduncle pictured above into spur killing bud. Taken April 2014. Photo by J. Hasey.

Photo 2. Leaf scar infection taken in February 2014. Photo by Themis Michailides.

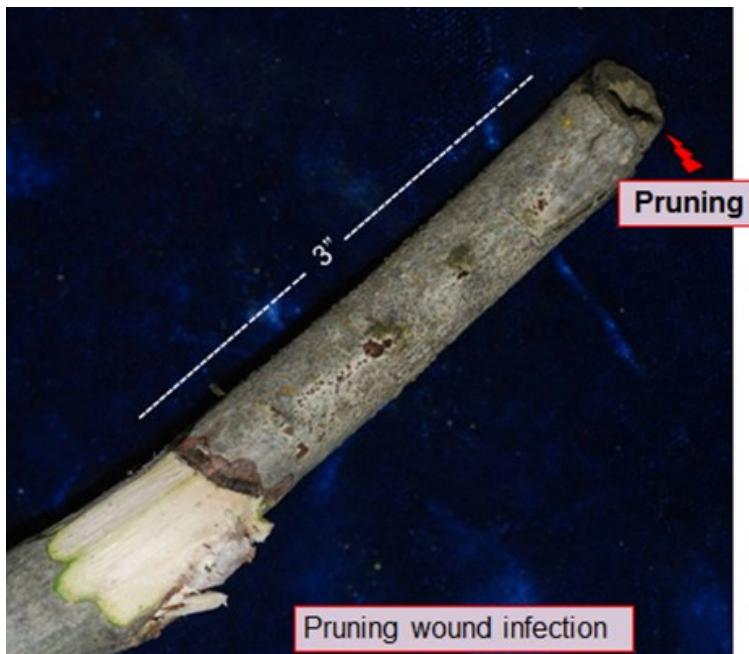


Photo 3. Pruning wound infection covered by pycnidia. Photo by Themis Michailides.

Watch for Early Insect Activity

*Richard P. Buchner UC Farm Advisor Tehama County
Cyndi K. Gilles UC Research Associate Tehama County*

Insects in walnut orchards are responding to the warm weather and starting this season's lifecycle. For review, table 1 provides a historical comparison of the Tehama biofix dates for five insect pests of orchard crops. A biofix indicates the date when insects are consistently caught in traps. Each orchard can be different so get traps out early and monitor accordingly. The primary early/mid season pest of walnut is codling moth. Notice the codling moth biofix for 2014 is distinctly early compared to previous years. An earlier biofix could mean earlier first sprays depending upon the weather. It's still a little early to accurately predict egg hatch and first spray timing so watch for additional updates at the Tehama website <http://cetehama.ucanr.edu>. Click on Orchard Crops then click on Insect Updates, or go directly by using this link: http://cetehama.ucanr.edu/Orchard_Crops/Insect_Updates

INSECT	2008	2009	2010	2011	2012	2013	2014
CODLING MOTH	3/24	3/30	4/26	4/24	4/19	4/8	3/18
ORIENTAL FRUIT MOTH	3/5	3/16	3/15	3/8	2/23	3/4	2/19
PEACH TWIG BORER	4/10	4/20	4/26	4/18	4/23	4/1	3/20
NAVEL ORANGE WORM	-	-	-	-	5/3	4/11	?
SAN JOSE SCALE	4/25	-	-	-	4/16	3/25	3/17

Table 1. Historical Tehama biofix dates for five insect pests. Biofixes indicate the date when these insects are consistently caught in traps.

Perspective on Trends in Orchard Spacing, Pruning and Potential Disease

Joseph Connell, UC Cooperative Extension Farm Advisor, Butte County

Historically, walnut trees were planted to a wide spacing with good sun exposure and air movement between trees. Trees were pruned selectively to stimulate growth, new fruit wood and to prune out dead and diseased limbs. This method of orchard culture and management worked well but yields were less compared to today with lateral bearing varieties and closer tree spacing. Higher yields are attributed to planting configurations that allow trees to capture more sunlight.

Lateral bearing varieties developed by the UC walnut breeding program, such as Chandler, Howard and Tulare, have had a significant impact on increasing yield. When interest rates were high, trees were planted closer together as a strategy to produce a crop more quickly and reduce debt. As these orchards aged, this inevitably led to crowding and shading out of the lower fruit wood. To mitigate the problem, experiments were done on methods of mechanical hedging to improve light penetration and maintain a fruiting wall on lateral bearing varieties. Mechanical hedging helped solve the crowding problem and resulted in good production with less pruning cost. The expensive selective pruning done previously to remove dead, diseased, and broken limbs was largely abandoned in these dense, mechanically hedged orchards.

Botryosphaeria is not a new disease. It has been known on almond as band canker for decades. It has a wide host range (infects many species) and is particularly good at colonizing and producing spores on weak or dead wood. We have observed Botryosphaeria cankers on walnut limbs that were stressed and declining due to heavy walnut scale populations and on dead limbs that have been shaded out. In addition, mechanical hedging leaves dead branch stubs that are easily colonized by Botryosphaeria. Working with Dr. Themis Michailides, we previously documented the spread of band canker in a young almond orchard due to airborne spores coming from interior dead wood in an older adjacent walnut orchard. The incidence of disease in the young almonds was less and less as we moved farther away from the walnut block.

For a pathogen to infect and cause disease you must have a susceptible host, the presence of sufficient disease pressure (inoculum), and the proper environmental conditions to set it off. This was clearly demonstrated in work on almond anthracnose with Dr. Jim Adaskaveg. Almond anthracnose killed branches and then produced spores on the dead wood, which increased the disease pressure. Pruning out dead wood decreased anthracnose infections on almond nuts by about 50% which resulted in a further reduction of dead wood. This was an important advantage and subsequent spray programs were able to hold this disease in check.

When a critical threshold of disease pressure is crossed, a fungus or bacterial disease can become epidemic. This is certainly true for walnut blight if disease control is not maintained at a low level (low inoculum). I believe it is also true for the “new” walnut diseases Botryosphaeria and Phomopsis. These diseases in walnut seem to be an increasing problem where splashing water disperses spores and humidity is higher, where dead wood may not be selectively pruned out, and where hedging results in many dead branch stubs that harbor fungi allowing them to produce more spores. For more specific details on these diseases from recent studies see the article in this newsletter on “Understanding and Managing Botryosphaeria and Phomopsis” by Janine Hasey, Rick Buchner and Themis Michailides.

Planting walnuts at the correct density so trees fill their space without crowding should reduce shading and may help avoid the need for mechanical hedging, both of which should help minimize dead wood and reduce disease pressure. Additionally, there are good reasons to selectively prune walnut trees. One of those is to remove dead or diseased wood and branch stubs where Botryosphaeria fungi can grow and produce spores. Reducing inoculum culturally is the first step in effective disease control. Spraying alone is a less sustainable solution for managing these diseases. The founding cultural principles of good horticulture—pruning to remove dead, diseased, and broken limbs—is likely to pay dividends in helping to manage disease pressure.

Springtime Recovery from Winter Freeze Damage

Janine Hasey, UC Farm Advisor, Sutter/Yuba/Colusa Counties

Starting on December 4, 2013 and continuing for several days throughout the month, many areas in the Sacramento Valley sustained freezing temperatures at 25°F or much colder. There are many factors that will affect the cold hardiness and the temperatures a walnut tree can withstand when a freeze event occurs including hardening against low temperature, moisture level in root zone, tree age and stress level. Using the Verona CIMIS weather station, there were only a few days of temperatures just below 32°F that preceded the really low freezing temperatures. Some young walnut trees may not have been sufficiently hardened off nor had adequate soil moisture to withstand low temperatures without damage particularly if they were dry from lack of rainfall or irrigation. Fortunately, I have seen only limited winter freeze damage this spring.

What does winter freeze damage look like in spring? Buds may be slow to break or may fail to break altogether. Winter kill acts like severe pruning in cases where branches or the young trunk dies; vigorous shoots grow from below the damaged area. Sunburn often accompanies the cold damage increasing the amount of injury. Sunburn can occur during the winter months on damaged tissue especially on the southwest side of unpainted trunks or limbs. If you suspect cold damage:

- **Do NOT prune out the damaged limbs.** The buds may be slow in opening or buds from deep in the bark may grow to rejuvenate the limb.
- Damaged tissue that was not whitewashed last December should be painted now to protect against further sunburn damage.
- In the late summer, prune out the dead wood that did not revive. New scaffolds that grew can be trained to replace the damaged wood.

Reduce or delay spring fertilizer applications where cold damage is evident.

For more information and photos see

http://cesutter.ucanr.edu/newsletters/Spring_2010_Sacramento_Valley_Walnut_News36486.pdf

and visit http://cesutter.ucanr.edu/newsletters/Sacramento_Valley_Walnut_News44408.pdf for managing young trees to avoid freeze damage.