

September 2018

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sacvalleyorchards.com

Pruning with Bot Infections in Mind

Luke Milliron, UCCE Farm Advisor for Butte, Tehama, and Glenn Counties

Janine Hasey UCCE Farm Advisor, Sutter, Yuba, Colusa Counties

Themis Michailides, UC Davis Plant Pathologist, UC Kearney Research and Extension Center

Often in August, black to dark brown lesions (the blight phase) of *Botryosphaeria* or *Phomopsis* (Bot) infections start appearing on the hull from earlier, latent (symptomless) infections of the nut (Figure 1). *Botryosphaeria* can also cause cankers which can result from pruning wound infections and infections that move from blighted fruit or leaf scars into the spurs. In research conducted by Themis Michailides, UC Davis Plant Pathologist at the Kearney Agricultural Research and Extension Center, winter pruning (February 9-10) resulted in higher infection rates than fall pruning (October 27-28).

- Dr. Michailides found in 2015 that when pruning in February, wounds in medium-to-large wood (3- and 4- year old branches) are susceptible to *Botryosphaeria* infection for at least four months after the pruning cut is made!
- Pruning wound infection rates were compared for winter vs. fall pruning. Pruning cuts were made in either February or October 2015, inoculated with *Botryosphaeria* spores, and evaluated over a year later (March 2016 and November 2016, respectively) for infection.
- **Winter pruning** resulted in infection rates (cankers in shoots) from 78 to 99 percent compared to 28 to 75 percent in **fall pruned** shoots.
- Higher infection rates were seen in 3- and 4-year old wood compared to 1- and 2-year old wood. These results further confirmed 2015 findings showing longer cankers in older wood. It is suspected that the hollow pith inside older walnut branches provides a haven for *Botryosphaeria* infection, spore germination, and pathogen growth. This long susceptibility may be because the pith holds water like a sponge.

Therefore, if pruning or hedging is planned this year, aim for as **early in fall** as you can and when weather is forecast to be dry. Deadwood removal however, is best done through the dry summer months.

To simplify information, trade names of products may be used. No endorsement of named products is intended, nor is criticism implied of similar products which are not mentioned.



Walnut Short Course

November 5-7, 2018

ARC Ballroom, UC Davis

Join UC faculty, Cooperative Extension specialists and farm advisors, and USDA researchers for this integrated orchard management short course. The three days of instruction will provide in-depth and comprehensive study of all phases of walnut culture and production based on the latest information and research. The program will cover the fundamental principles that form the basis for practical decisions and will include question and answer times following each session to ensure time with instructors and networking opportunities.

Who should attend: New and experienced growers as well as other industry members interested in commercial walnut production.

Registration Open in CA September 4

\$825 Registration fee includes:

- ♦ Three full days of instruction with over 45 presentations
- ♦ Binders with presentations
- ♦ DPR & CCA credits
- ♦ Full breakfast, lunch, and refreshments all three days and a social dinner on night one

Sessions will cover:

- ♦ Orchard planning, design and development
- ♦ Walnut variety and rootstock selection
- ♦ Evaluation and modification of water and soils
- ♦ Tree propagation, training, pruning and canopy management
- ♦ Tree and root physiology
- ♦ Bud development and pollination management
- ♦ Irrigation scheduling
- ♦ Proper use and maintenance of irrigation systems
- ♦ Mineral nutrition and fertilization
- ♦ Management of weeds and vertebrate pests
- ♦ Integrated pest management of insects and diseases
- ♦ Considerations for replanting orchards
- ♦ Quality & harvest concerns
- ♦ Economics of walnut farming and marketing
- ♦ Food safety
- ♦ ...and more!

For a full agenda & more information, visit <http://ucanr.edu/sites/WalnutShortCourse/>

Important Deadlines

September 4:

- ♦ **CA residents only**—Registration opens
- ♦ Non-CA residents, fill out this interest form to be notified when registration is available to everyone:
<http://ucanr.edu/walnutinterest>
- ♦ Space is limited! Register quickly to reserve your spot
- ♦ Register at: <http://ucanr.edu/sites/WalnutShortCourse/Registration/>

September 19:

- ♦ Registration available to everyone, including Non-CA residents

Fee will increase October 15!

Sponsored by



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Optimizing Your Orchard Spacing

Dani Lightle, UCCE Orchards Advisor, Glenn, Butte & Tehama Counties

Tree spacing in a new planting is one of the most important decisions you can make. Spacing will influence yield (both early and maximum potential), later pruning and hedging decisions, and possibly orchard longevity. Additionally, if you mess it up, you can't go back and fix it.

What you're trying to achieve:

The ideal spacing is one which maximizes your yield potential. Yield potential is directly related to the amount of sunlight intercepted by the trees. This has been thoroughly documented over the last 10 years by Bruce Lampinen (Walnut Specialist, UC Davis), who has found that photosynthetically active radiation (PAR) – the amount of sunlight able to be used for plant photosynthesis – is directly related to yields (Figure 1).

Each 1% of PAR intercepted by an orchard canopy directly translates into 0.05 tons/ac in-shell (100 pounds/ac in-shell) of walnut yield potential. Thus, a PAR of 90% in an orchard with a mature canopy gives a yield potential of 4.5 tons/ac. Notice, this is yield *potential*. Keep in mind that the yield can be limited by factors other than light, including water, nutrient availability, disease, insects, and weather. 100% PAR is not achievable (highest recorded are around 93%) and denser canopies may lead to other problems with light penetration into the lower canopy or increased humidity and disease pressure.

Consequently, orchard spacing should be selected to optimize canopy light interception while still facilitating orchard operations. A very wide spacing may prevent the canopy from completely filling in, while a very tight spacing may require repeated hedging from a younger age.

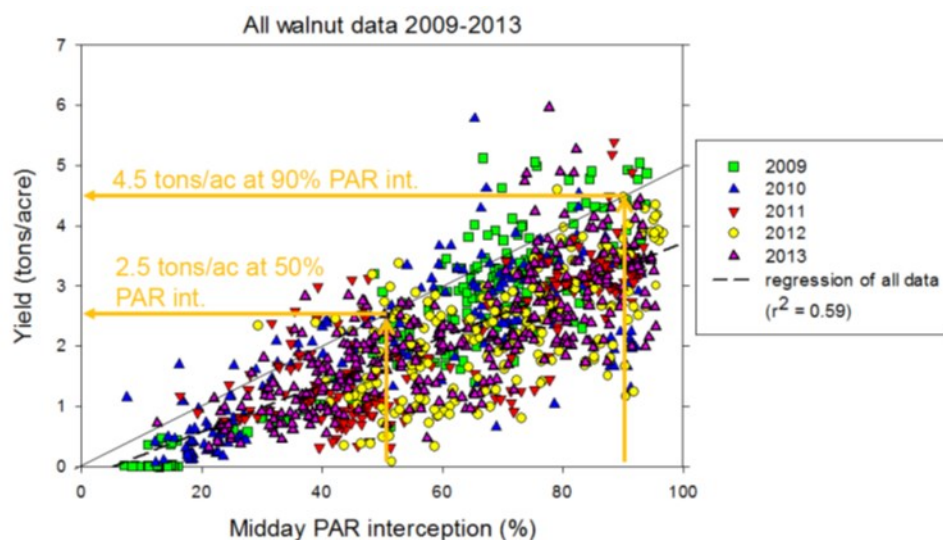


Figure 1. Relationship between PAR and orchard yield. The best orchards produce along the (upper) solid black line.

Factors to consider:

- **Soil type.** The most productive orchards are planted on soils that are uniform, within salinity tolerances and with few barriers to drainage or root development. The best soils should be planted at a wider spacing than more marginal soils, which should be planted at a tighter spacing because soil limitations will lead to smaller trees, regardless of spacing.
- **Rootstock vigor.** Black rootstock is generally less vigorous than seedling or clonal Paradox rootstock and a closer spacing is recommended. The relative vigor of the clonal Paradox rootstocks Vlach, VX211, and RX1 varies by location and continue to be investigated. Information on clonal Paradox rootstock vigor can be viewed at sacvalleyorchards.com/walnuts/orchard-development/walnut-trees-in-the-nursery-trade/
- **Variety (scion) selection.** Chandler trees tend to be larger than Howard trees. If you're considering a hedgerow planting configuration, the smaller statured Howard is a better choice than Chandler.

- **Site, equipment operation and expense.** It should go without saying that you need to stay within your planting area, provide clearance around easements, and allow equipment clearance in order to prevent injuries to field workers. Beyond that, wider row spacings require fewer passes per acre for insecticide and fungicide applications or harvest operations. Establishment costs such as irrigation design – length of irrigation line and risers – increases with a tighter row spacing.
- **Per tree costs.** Any activity performed on a per-tree basis – planting, wrapping, pruning, tying, painting, suckering, etc. will have higher costs with a greater number of trees per acre.
- **Hedging.** A tightly spaced orchard often relies on mechanical hedging to aid light penetration into the lower canopy or maintain a shorter canopy height for effective spray applications. More rows per acre increases the number of passes the hedging crew needs to make. Additionally, the overall impact of hedging is often less in wider-spaced orchards since less wood and smaller diameter branches are being cut.
- **Disease risk.** All pruning cuts are susceptible to *Botryosphaeria* canker, however, the sheer number of indiscriminate cuts created by mechanical hedging can drastically increase disease likelihood and severely impact an orchard's productivity. A denser canopy may have greater humidity, which can exacerbate disease pressure.

Ideal spacing: what's the research show?

PAR levels in a mature standard spaced orchard tend to range between 80-85%, giving a yield potential of approximately 4 tons/ac. In a hedgerow orchard, PAR generally ranges between 65-75% interception. Although this should result in a yield potential of 3.5 tons/ac, it is more commonly 3 to 3.2 tons/acre due to non-productive vegetative growth resulting from the hedging.

The highest yielding orchards ranged from 65-90 trees per acre, which corresponds to a spacing between 22 feet square and 26 feet square (Figure 2). That said, a 22 feet square planting is still quite tight for a standard spaced orchard given the conditions considered above, and we recommend wider plantings.

Table 1. Trees per acre at different row x tree spacings.

Row Spacing x Tree Spacing (ft)	# Trees/Ac
20 x 20	109
22 x 22	90
24 x 24	76
26 x 26	64
28 x 28	56
30 x 30	48

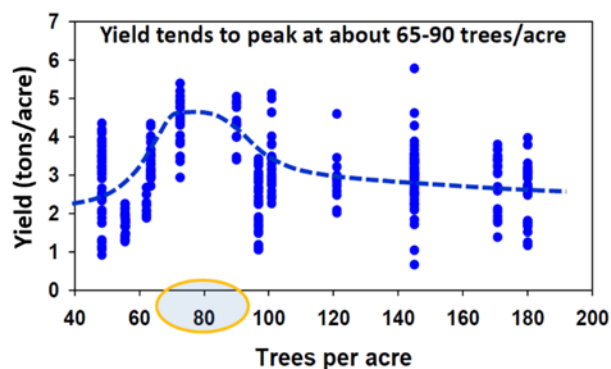


Figure 2. Relationship between number of trees per acre and yield (tons/ac).

Impacts and Recovery on Walnuts from 2017 Flooding

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

Greg Browne, USDA Plant Pathologist, UC Davis

Astrid Volder, Plant Sciences, UC Davis

Bruce Lampinen, UCCE Walnut Specialist, UC Davis

Note: All figures can be seen in the online version of this newsletter. View or subscribe at: http://ceglenn.ucanr.edu/news_408/Orchards_Facts/

2017 brought unprecedented high and fluctuating water flows in the Sacramento and Feather Rivers, damaging orchards from direct flooding and indirectly via under-levee seepage. Many trees had a long exposure to waterlogged conditions through the winter and spring. With this extensive flooding, we expected to see effects through the 2018 season in several orchards. In the Spring 2018 newsletter issue, we reported on results from sampling trunk cankers for *Phytophthora* and roots in a waterlogged young orchard, and key factors/conditions leading to survival or mortality of flooded trees based on observations; the Spring 2018 issue and previous flood articles written in 2017 can be viewed at sacvalleyorchards.com/walnuts. This article details completion of sampling and observations of disease, survival and recovery in 2018, as well as recommendations to minimize losses in flood-impacted orchards.

Research Results and Observations

Flooding results in two potential problems: 1) *Phytophthora* diseases and 2) waterlogging impacts (oxygen starvation) on the root system.

1. 2018 *Phytophthora* results. Partially submerged for prolonged periods in 2017, walnut trees affected by aerial *Phytophthora* in Feather River bottoms were revisited in 2018.
 - Water sampling: Since we know the “water mold” *Phytophthora* is found in surface water and infested soils, we sampled water in the Feather River in two locations in 2018. Several *Phytophthora* species were identified.
 - Tree trunk samples: *Phytophthora citricola* was isolated from bleeding trunk cankers sampled in June. Aerial trunk cankers (Fig. 1) began healing by June and July. Trees differed in severity of infection.
 - Most trees with aerial *Phytophthora* had healthy canopies this summer (Fig. 2) and unless trees were declining, new tissue was forming around cankers by June and July (Fig. 1).
 2. Waterlogging impacts from long-term seepage (January to May 2017) on walnut root health and recovery.
 - Root sampling from flooded trees in a fourth leaf Chandler orchard on RX1 rootstock; trees leafed out about a month late while most failed to push by end of June 2017.
 - Soil cores to a 3 foot depth were collected on June 29, 2017 when trees on higher ground outside of the seepage area had fully leafed out. Standing water was found at a 25” soil depth in the seepage zone.
 - We compared root length distribution of Chandler trees on higher ground (control) to those of trees failing to push in the seepage zone (photos in Spring 2018 issue).
 - Seepage zone Chandler trees that did not push had much lower standing root length in the top 2 feet than control trees (~5 km roots/m³ soil vs. 15 km roots/m³ soil). Failed trees had much coarser roots, suggesting they either produced no new fine roots or their fine roots had a much higher mortality rate. New finer roots generally contribute most to soil exploration and water and nutrient uptake.
 - For many orchards, the extent of flood damage was not evident until 2018. Trees often died or declined in a random pattern, or, they died in areas with shallower water tables or longer periods of flooding.
 - In a 12-year-old orchard with prolonged surface seepage from the Sacramento River, random unhealthy trees were marked in 2017. These trees were topped in May 2018 and photo documented monthly (Fig. 4). Unhealthy trees had crown gall suggesting roots were already compromised before flooding; trees with more severe crown gall did not respond to topping with new shoot growth. Trees without crown gall were growing well a year after flooding.
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Recommendations to minimize losses in flood-impacted orchards:

Trees infected with aerial *Phytophthora*:

- We advocate keeping these trees as long as they are economically productive.
- In previous research, phosphonate (also known as phosphite) treatments were found to suppress canker expansion caused by *Phytophthora citricola*. All orchards we resampled had phosphonate sprays applied in 2017 and 2018 which may have contributed to the new tissue forming around cankers.
- It is advisable to replace trees killed by *Phytophthora* with clonal Paradox RX1 rootstock, which offers resistance to the pathogen. When planting new walnut orchards in flood prone river bottoms, consider using potted RX1 trees and field budding or grafting as high as possible to avoid aerial *Phytophthora* infections from future flood events.

Trees affected by waterlogging:

- In saturated soils, fine roots die, and depending on the extent of flooding, larger roots can die as well. It takes time for the root system to regain functionality and re-start new fine root production after flooding.
- Consider topping trees with vigorous shoot growth on lower limbs. From grower experience and 2018 observations, these trees often recover by producing new shoot growth. It was obvious as early as June this year whether a topped tree will respond and grow or not. By contrast, trees that have very little new shoot growth often don't survive the season after flooding so topping is unlikely to promote tree survival.
- Irrigation: Keep in mind that flooded orchards are most likely dealing with a shallower, less developed root system than in previous years. Some orchards re-flooded in 2018 and/or those continuing to have a high water table created a difficult situation since root growth on surviving trees was rebounding from root death last season. Figure 5 shows the response of 2017 flood damaged 5-year-old trees that were either topped in May 2017 (trees with white trunks) vs. a less affected tree in the foreground that had little pruning. All trees were growing well but in July 2018, many trees showed scorched outer leaf symptoms indicative of too much water from over-irrigating with a high water table (Fig. 6).
- Where water tables remain high, consider the following points:
 - Capillary rise is the process by which water moves up into soil above a water table resulting in soil in this zone being above field capacity. In medium loam to fine clay, expect approx. 3 feet of rise. The finer the soil texture the farther water can move by capillary rise but the slower the rate of movement.
 - It is easy to saturate the soil, particularly when the water table is close, so irrigate judiciously, ideally using both soil moisture monitoring and plant pressure chamber data to aid in determining irrigation duration and frequency.
 - Water management in such settings is very difficult. Carefully monitor soil water levels using Watermark® or other soil moisture sensors installed at different depths. Soil-based monitoring will let you know the level where the soil is saturated as the water level drops, as well as the amount of water that is being moved up above this level of saturation by capillary rise.
- When using pressure chamber measurements, do not irrigate until trees are at least 2-3 bars below the fully watered baseline (more dry) and only irrigate enough to bring the trees back up to about 1 to 1.5 bars below the baseline by applying short sets of irrigation. If the baseline is -4 bars, you should reach -5 to -5.5 bars immediately after irrigation. Be aware that pressure chamber measurements may not be appropriate where roots have been compromised, as the observed water stress in the tree may be the result of the inability of the root system to take up water rather than low water availability in the soil. Irrigating under those conditions would only serve to compromise the root system further.
- Where trees have been topped or have new shoot growth, apply nitrogen fertilizer in small amounts during May through early August when roots are active. Topped trees will have little or no crop until the following year so little nitrogen is being removed.

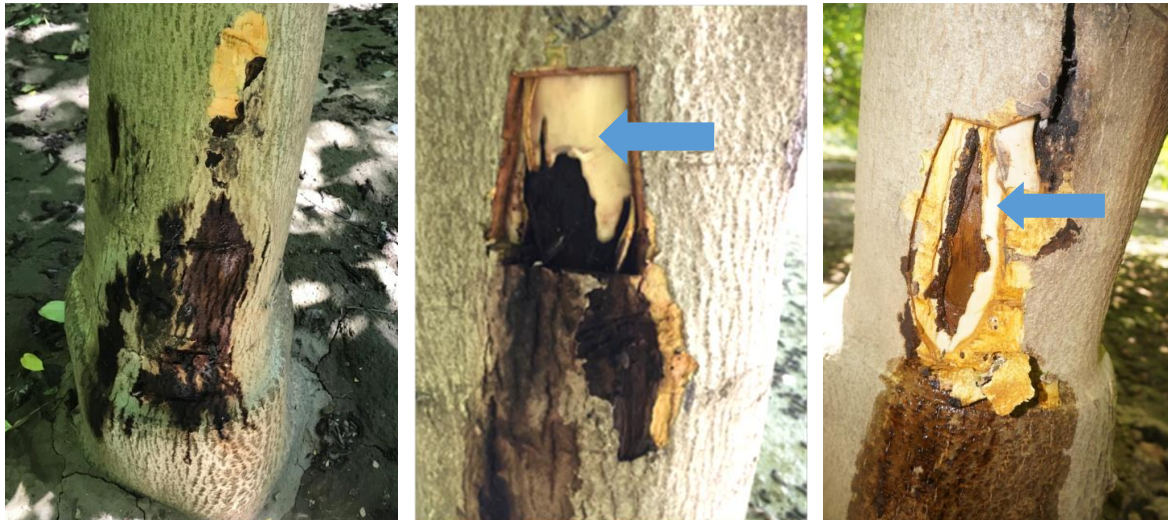


Figure 1. Bleeding cankers associated with aerial *Phytophthora* on river bottom walnut trees in May (left), June (center), and July (right). New tissue is forming around cankers in June and July as indicated by blue arrows. Photo credit - Luke Milliron (left), Janine Hasey (center & right).



Figure 2. Overall tree canopies appear healthy in a severely aerial *Phytophthora* infected river bottom orchard in June 2018. Photo credit - Janine Hasey.



Figure 3. A tree with totally decayed roots that blew over during strong winds in May 2018 in an orchard that experienced prolonged seepage below the soil surface in 2017. Photo credit Janine Hasey.



Figure 4. This Chandler orchard experienced prolonged flooding in 2017. Tree prior to light topping of upper limbs on May 3, 2018 (left). Same tree on August 2, 2018 (right). Photo credit – Janine Hasey.



Figure 5. July 2018 growth response of 2017 flood damaged 5-year-old trees that were topped in May 2017 (trees with white trunks) vs. a less affected tree in the foreground that had little pruning. Photo credit - Janine Hasey.



Figure 6. Scorched outer leaf symptoms in same flooded orchard in July 2018 indicative of too much water due to over irrigating with a high water table. Photo credit - Janine Hasey.

Fall Orchard Management Considerations

Luke Milliron, UCCE Farm Advisor for Butte, Tehama, and Glenn Counties

Janine Hasey, UCCE Farm Advisor, Sutter, Yuba, Colusa Counties

Dani Lightle, UCCE Farm Advisor for Glenn, Butte, and Tehama Counties

Emily Symmes, UCCE Area IPM Advisor, Sacramento Valley

Themis Michailides, UC Davis Plant Pathologist, UC Kearney Agriculture Research and Extension Center

Pre-Harvest:

- **Deadwood:** The dry summer months are the best time for deadwood removal. Chipping prunings reduces the ability for dead wood with *Botryosphaeria* or *Phomopsis* (Bot) to further spread disease. However, completely removing deadwood from the orchard floor in blocks with only light to moderate Bot is a good policy.
- **Wrap-up nitrogen fertilization:** Your nitrogen program should be completed by the end of August. This is critical for young trees to begin the process of hardening off to reduce early frost susceptibility.
- **Carefully manage irrigation:** Despite reduced water demand under recent smoky conditions, it is possible to get behind on irrigation late in the season. Symptoms include pale yellow leaves and defoliation in the interior canopy. However, Sacramento Valley farm advisors most frequently note symptoms of overwatered trees. For leaf symptoms of overwatered trees see: sacvalleyorchards.com/walnuts/irrigation-walnuts/leaf-symptoms-overwatered-walnuts/
- Consider directly measuring tree water status and avoid both under- and over-irrigation consider adopting the pressure chamber. See this introduction to the pressure chamber: sacvalleyorchards.com/manuals/stem-water-potential/
- To reduce the possibility of autumn frost damage in young trees, aim to cut off irrigation by mid-September to reduce growth and harden off the trees. Aim to hold off on irrigation until a terminal vegetative bud has formed on the trunk.
- **Ethephon:** It is critical to wait until the hulls are at 100% packing tissue brown (PTB) before applying ethephon sprays. Due to this spring's straggled bloom conditions, monitoring Chandler PTB that typically occurs around mid-September may be more challenging and may be delayed. For more ethephon considerations see: sacvalleyorchards.com/walnuts/ethephon-for-earlier-harvest/
- **Oilless nuts:** These early splitting nuts with very dark pellicles and white kernels should be avoided when evaluating packing tissue brown (Figure 1). These nuts typically fall to the orchard floor early and can be destroyed during pre-harvest orchard floor prep.



Figure 1. Oilless Chandler walnuts (top) and normal Chandler walnuts (bottom) from the same tree. Photo was taken on 8/26/16. Photo credit: D. Lightle.

Harvest:

- **Harvest Timing:** Harvesting as early as possible can help reduce quality losses due to navel orange-worm, mold development, and darkening kernel color. At harvest, only shake what you can pick up that same day. Walnut quality declines most rapidly during the first 9 hours after shaking.
- **Harvest Sample:** Take harvest samples from the orchard floor to inspect for damage caused by worms and other factors. Differentiate between codling moth and navel orangeworm damage, as well as other sources of damage (e.g., walnut husk fly, sunburn, ants, etc.). Grade sheets often do not provide sufficient detail on specific sources of damage. Performing a crack out of a representative sample from each production block tells a helpful story. Following crack out samples for a block each year allows you to better track the performance of your integrated pest management program. Details on obtaining harvest damage samples and evaluating the sources of damage, along with helpful photos, are available at: sacvalleyorchards.com/walnuts/insects-mites-walnuts/harvest-damage-evaluation-for-walnuts/

Post-Harvest:

- **Clean operation:** Once harvest is complete, ensure that hullers, driers, and areas surrounding orchards are cleared of trash nuts that may be harboring moth larvae. Sanitize orchards as part of your navel orangeworm (NOW) management program by shaking/hand poling, blowing berms, and then flail mowing mummies prior to next season. Err on the early side for these operations in the event that winter or spring rains preclude orchard access. Remember that walnut mummies on the orchard floor (middles and tree rows) provide overwintering survival sites for NOW, so even if you have few mummies remaining in the trees, blowing and destroying mummies on the ground helps reduce carry-over NOW populations.
- **Pruning with Bot infection in mind:** If pruning or hedging is planned this year, aim for as early in fall as you can and when weather is forecast to be dry (see article in this newsletter).
- **Potassium Fertilizer:** If July leaf sampling indicated potassium deficiency, plan to apply potassium (K_2O) fertilizer this fall or winter after about 6 inches of rain has fallen to re-wet the soil. Apply potassium in a narrow band along the tree row in order to improve uptake efficiency, particularly on heavier soils. The two forms of potassium fertilizer are potassium chloride (KCl) and potassium sulfate (K_2SO_4). KCl is less expensive but can cause toxicity if winter rains don't adequately leach the chloride component. For information on potassium fertilizer rate please see apps.cdfa.ca.gov/frep/docs/Walnut.html
- **Planning early for cover crops:** Ensure that the cover crop will be sowed at the correct time by lining up seed and equipment before you are too deep into walnut harvest. Planting typically takes place in October and November once harvest is finished, with young non-bearing orchards being seeded in October.

2018 IPM Breakfast Meetings

Join Area IPM and Farm Advisors to discuss current pest management and production issues. We will largely focus on orchard crops (but everything is on the table for discussion!). These meetings are open to all interested growers, consultants, PCAs, CCAs, and related industry. Please contact Emily Symmes to request topics or bring your questions to the meeting!

Upcoming meetings:

- Tehama County: September 21st (Rockin R Restaurant, Red Bluff), 7:30-9:00am
- Glenn County: October 19th (Berry Patch Restaurant, Orland), 7:30-9:00am

Full 2018 schedule is available on the events page at sacvalleyorchards.com or by contacting UC IPM Advisor Emily Symmes at (530) 538-7201 or esymmes@ucanr.edu.

Seating is limited – please RSVP to Emily prior to the meeting date

****DPR and CCA Continuing Education hours requested****

(No-host breakfast)

UC Cooperative Extension - 2019 Walnut Meetings

Wednesday, January 30 th Time TBA	North Sacramento Valley Almond & Walnut Day Silver Dollar Fairgrounds, Chico UC Cooperative Extension - 2019 Walnut Meetings
Friday, February 8 th Time TBA	Tehama County Walnut Meeting Elks Lodge, 355 Gilmore Rd, Red Bluff
February 20 th or 21 st (TBD) 12:30 p.m. -4:30 p.m.	Sutter-Yuba-Colusa Walnut Day Veterans Memorial Hall, 1425 Veteran's Memorial Circle, Yuba City

3rd Annual Post-Harvest Almond and Walnut IPM Workshop

Join a panel of your Sacramento Valley Area IPM and Farm Advisors to hear about the latest research updates, 2018 field observations, and discuss key pest management issues in almonds and walnuts as we wrap up the season and look toward 2019!

Potential topics include navel orangeworm, water management in IPM programs, recognizing phytotoxicity, flooded orchard updates, and weed management with UCCE Advisors Rick Buchner, Allan Fulton, Mariano Galla, Janine Hasey, Kat Jarvis-Shean, Dani Lightle, Luke Milliron, Franz Niederholzer, and Emily Symmes. David Haviland (UCCE Entomology Advisor, Kern County) will also be on-hand to provide research updates and information on spider mite management and impacts of natural enemies.

Any and all orchard production topics will be on the table for discussion! To request topics or for more information, please contact UC IPM Advisor Emily Symmes at (530) 538-7201 or ejsymmes@ucanr.edu

Friday, November 16th, 2018
8:00 – 11:00am

Chico Veteran's Memorial Hall
554 Rio Lindo Avenue
Chico, CA 95926

Complete agenda and additional details will be available on the events page at sacvalleyorchards.com

****DPR and CCA Continuing Education hours requested****

Coffee and donuts provided by the Support Group of Butte County UCCE