Announcing Central Valley Almond Day!

Friday, June 9th

Fresno Fairgrounds Commerce Building
1121 S. Chance Ave, Fresno, CA 93702
7:30 AM – 1:30 PM

Central Valley Almond Day is a new free event that will feature UC Cooperative Extension educational presentations, important updates on laws and regulations from the Fresno Ag. Commissioner's Office, and a tradeshow featuring new commercial innovations to help growers reach their greatest production potential. The meeting is aimed at new and experienced almond growers, production managers, and pest control consultants. The event will wrap up with a free Tri-tip lunch!

2.5 CE Credits (0.5 Laws, 2.0 Other) and 3.5 CCA Credits (1.5 Nutrient Management, 0.5 Soil & Water Management, Integrated Pest Management) will be offered.
Registration at: WEST COAST NUT http://www.wcngg.com/events

7:00 AM **Registration, Coffee, and Donuts**

7:30 **Trade Show**

8:00 **Micro-irrigation System Design, Maintenance and Management for Almonds**
Dan Munk, UCCE Irrigation and Water

8:30 **Laws and Regulations Update**
Gilbert Urquiza, County Ag. Commissioner's Office

9:00 **Zinc: The Mighty Micronutrient!**
Bob Beede, (Retired) UCCE Farm Advisor Emeritus

9:30 **Identification of Pest and Non-Pest Ant Species for Management Decisions**
Kris Tollerup, UCCE IPM Advisor

10:00 **Break**

10:30 **Whole Orchard Recycling and the Effect on Second Generation Tree Growth and Soil Fertility** Brent Holtz, UCCE Farm Advisor

11:00 **Management of Almond Replant Disease & Anaerobic Soil Disinfestation**
Mohammad Yaghmour, UCCE Orchard Systems Advisor

11:30 **Weed Control Update for Tree Nut Orchards**
Brad Hanson, UCCE Weed Specialist

12:00 PM **Industry Tri-tip Lunch**
Yara Sponsored Presentation: Benefit of Calcium Nutrition for Almond Production

Daniel Cathey, Farmer Engagement Manager

1:30 Adjourn

Tips for Better Orchard Irrigation Scheduling

May 12th, 2017

By Mae Culumber, UCCE Fresno Nut Crop Advisor

Abundant precipitation during the 2016 to 2017 winter and spring has been a return of good fortune for agriculture in the Southern San Joaquin Valley. The much-needed rain has recharged aquifers, restored 100 percent water supply allocation, and drained damaging salts from the root zone in areas throughout the Valley. Alas even with water, too much of a good thing can be bad. Soon after leaf out this spring, many growers in our area saw their tree canopies yellow. This is an indication of wet anoxic soil, conditions that kill feeder roots and inhibit the uptake of nutrients. Orchards on heavier soils could do little to avoid these situations, and in the extreme cases many farms have lost trees to wet feet this spring. Still, these symptoms have been observed across a variety of soil types and crops, suggesting some growers started irrigating far too early this season. Improper irrigation scheduling can be at the core of many orchard maladies. Over or under irrigating can be detrimental to tree health, growth, orchard uniformity, yield, and nut quality. Getting irrigation right (or at least in the ballpark!) is one of the single most important management aspect for which a grower has control. Several tools are available to guide decisions about when to irrigate and how much water should be applied. Accurate scheduling requires familiarity with 1) the irrigation system's output rate, and 2) how much water the orchard needs and when. An abundance of information is available from UC ANR publications on how to properly irrigate orchards. This article provides a summary with titles and corresponding UC ANR article codes listed in the references.

The Irrigation System

A system's output can vary greatly depending on if you are using micro or flood irrigation. Surface water is widely available from irrigation districts this year. Flood irrigating without too much guesswork requires knowledge of the pump discharge (gpm) at the well-head or the orchard in-flow point, the length of the orchard run, and the number of trees per acre block (see UC ANR pub 8230). Information about a micro-irrigation system's application rate can be found in the blueprints for the system. If this is not available, determine the per tree output of your system by determining the number of trees on a planted acre, emitter gallon per hour (gph) output, and the number of emitters per tree. (see UC ANR pubs 8212, 8230).

How Much Water and When?

How much water and the timing of application is dependent on several factors including orchard age, the amount of water trees use, and how much water the soil can hold. The best way to determine when to irrigate is to use indicators of plant water status and soil moisture monitoring. Plant pressure chambers provide the best indication trees are beginning to stress and need water. The current UC recommendations are to withhold irrigation until plant water stress falls -2 bars below the baseline (UC ANR pub 8503). Dendrometers are another commercially available tool that continuously monitors the shrink and swell of the tree trunk in response to water status. The electronic sensors indicate when the trees exceed a predetermined threshold for water stress.

In addition to tree water status, the texture of the soil should be considered to determine the frequency and duration of sets. Different soils can hold different levels of moisture, which will influence the appropriate time interval between irrigation events. There are many different types of sensors available to track soil moisture depletion to guide irrigation decisions, but to be useful the user needs to understand what the numbers and trends indicate about soil moisture status. Guidelines for interpretation of the data provided by soil moisture sensors can be found at:
http://cetehama.ucanr.edu/Water___Irrigation_Program/On-farm_Irrigation_Sceduling_Tools/

First-leaf almond, walnuts, and pistachios use roughly one-third the volume of water used by mature bearing trees. During the first year, water needs change in response to canopy growth, root expansion, and hot temperatures during the middle of the growing season. The "Young Orchard Handbook" provides some average annual estimates of changing water for first through third leaf almond and walnut trees. (ccfruitandnuts.ucanr.edu/files/238596.pdf).

Water use in mature bearing orchards can be estimated with evapotranspiration (ETc). Evapotranspiration is an estimate of the combined water loss from the soil to plant transpiration and surface evaporation. Growers can use this information to determine how much water has been lost from the orchard between irrigation cycles, and how much is needed to refill the profile. Some water managers find using ETc for irrigation scheduling to be confusing because evapotranspiration is expressed in terms of inches per day (in/day), whereas micro-irrigation systems use gallons per hour (gph). To accurately schedule, you need to convert the tree water use (ETc) information to gallons per day of tree water use. The following formula shows an example of how to convert from inches to gallons:

Water use by the tree (ETc) = tree spacing x use (ETc) x 0.623 (gal/day) (ft^2) (in/day)
Example:
Tree spacing = 20 ft. × 20 ft. = 400 ft^2
Tree water use = 0.25 in./day
Water use by the tree = 400 ft^2 x 0.25 in/day x 0.623 (gal/day) = 63 gal/day

The California Department of Water Resources and the University of California Cooperative Extension have joined efforts to provide weekly ET reports. To receive weekly updates for the Southern San Joaquin Valley in Kern County contact Blake Sanden blsanden@ucanr.edu, for areas of Madera, Fresno, Kings, and Tulare Counties visit http://ucanr.edu/sites/Nut_Crops/ or email Mae Culumber cmculumer@ucanr.edu.

More information can be found at:
"Young Orchard Handbook" ccfruitandnuts.ucanr.edu/files/238596.pdf
"Monitoring Soil Moisture Status in Orchard Crops"
http://cetehama.ucanr.edu/files/20513.pdf
UC ANR Catalogs: http://anrcatalog.ucanr.edu
"Understanding Your Orchard's Water Requirements" ANR publication 8212
"Measuring Applied Water in Surface-Irrigated Orchards" ANR publication 8230
"Using the Pressure Chamber for Irrigation Management in Almond, Walnut, and Prune" ANR publication 8503

Considering New Orchard Replacement Options: Whole Orchard Recycling and Anaerobic Soil Disinfestation

By: Mohammad Yaghmour UCCE Kern and Kings Counties, Brent Holtz UCCE San Joaquin County, and Greg Browne USDA-ARS Davis, CA

With more than a million estimated acres of bearing and non-bearing acres of almonds in California, and tens of thousands of these acres reaching unproductive ages each year, the almond industry is thinking strategically about the process of orchard replacement and how it can best be done, given current and future needs and environmental considerations. The expected lifespan of an almond orchard is approximately 20 to 25 years, and when growers decide it is time for orchard replacement, several management issues come to the forefront.

Among the key orchard replacement challenges is what to do with all the wood from the old trees. Old almond orchards may contain up to 80 tons of woody biomass per acre, depending on tree size and spacing, and burning restrictions and closure of several co-generation plants that previously processed orchard waste has forced some growers to consider new possibilities for dealing with the residues. Another key challenge in orchard replacement practices is how to manage replant problems. Growers face restrictions on soil fumigation, changes in rootstock usage, and new orchard residue management practices, etc., all of which can affect management of replant problems. Among these problems are Prunus replant disease (PRD), which is a specific soilborne microbe-induced suppression of early tree growth and yields (affects successive plantings of stone fruits, including almond); plant parasitic nematodes (several damaging species that can reduce orchard productivity over its lifetime); aggressive pathogens such as *Phytophthora* and *Armillaria*, which cause crown and root rots; and physical and chemical soil problems related to previous crop production (e.g., compaction, salinity, herbicide residues, etc.).

In this article, we highlight two practices, whole orchard recycling (WOR) and anaerobic soil disinfestation (ASD), as potential elements in new orchard replacement strategies. We consider promising aspects WOR and ASD based on results from trials completed to date and mention newly established WOR and ASD trials. Special reference is made to potential impacts of the WOR and ASD on management of replant problems. Finally, we mention a few of the important contributions being made by fellow researchers, growers, fumigation specialists, and equipment manufacturers in the new trials.

Whole Orchard Recycling (WOR)

WOR has recently gained traction. In the past, most growers would push the trees of removed orchards into piles and burn them. This option became less viable due to increased regulations to improve air quality after the 2002 Clean Air Act. Thereafter, growers started to grind the trees into small wood chips and haul them to co-generation plants to produce energy. In both previous cases, carbon dioxide (CO_2) is released into the atmosphere, and CO_2 is considered one of the greenhouse gases that contribute to air pollution. The number of acres to be replanted is expected to increase significantly in the coming years, and there are limitations for burning the biomass in orchards or sending it to the co-generation plants. WOR, i.e., the grinding and incorporation of almond biomass back into the soil, is a sustainable alternative to biomass burning that could improve air and soil quality. In 2008, an experiment was established at UC Kearney Agricultural Research and Extension (KARE) Center to compare standard tree removal and burning to whole orchard grinding and incorporation into the soil using the "Iron Wolf," a 100,000-pound rock crusher, that incorporated 30 tons per acre. Almond trees were replanted into the burn and grind treatments in February 2009. Effects of the burn and grind treatments on tree growth and soil physical and chemical properties (e.g., water holding capacity, soil organic matter, nitrogen to carbon ratio, and plant nutrients) were evaluated over time. Initially, soil analysis revealed significantly higher organic matter, electrical conductivity, cation exchange capacity, and higher carbon, calcium, and sodium in the burn treatment, compared to the grind treatment. It is likely that these responses resulted from the immediate degradation of wood structure that results from burning. However, after six growing seasons, the grinding treatment actually resulted in higher levels of soil organic matter, electrical conductivity, total carbon, and soil nutrients compared to the burn treatment. Also, trees had higher yields in the grind treatment compared to the burn treatment (Table 1), and, by the 5th leaf in 2013, petiole analysis exhibited significantly higher macro nutrients content (nitrogen, phosphorus, potassium) in the grinding treatment, except for magnesium, which was significantly lower in grind plots. In the same way, trees in the grinding treatment accumulated significantly less sodium and more iron and manganese. The early WOR experiments provided an alternative solution to manage generated tree biomass, and this management practice appears to improve soil physical and chemical qualities available for newly replanted trees. Given the intriguing responses in the initial WOR trial, new trials were designed and established, as previewed below (see "New replant trials…").

Anaerobic soil disinfestation (ASD)

Although new to perennial crop systems, anaerobic soil disinfestation (ASD) has been researched and used commercially in annual cropping systems in Japan, The Netherlands, and the U.S. ASD is now being adapted for strawberry production in California and vegetable and floriculture systems in the southeastern U.S. In annual cropping systems, ASD generally has provided broad-spectrum control of many soilborne pathogens in diverse soils, but less is known about its effectiveness for orchard crops. Researchers have found that ASD mechanisms may be multiple and complex, including the generation of organic acids, metal ions, volatiles, and microbial population shifts that are lethal or suppressive to soil pests. ASD is implemented for several weeks and requires readily available carbon substrate(s), moist soil conditions, and coverage with plastic mulch, which raises soil temperature, retains moisture, and retards gas exchange. High soil temperatures favor ASD while low temperatures limit it.

In four previous trials conducted at KARE during 2013-2016, we found that ASD was as effective as preplant strip fumigation with Telone C35 in controlling PRD and stimulating tree growth (Figure 1) and yield. Damaging plant parasitic nematodes were not present in the initial four ASD trials at KARE. Given the technical efficacy of ASD in these "first generation trials", we established "second generation" trials to optimize the ASD carbon sources and application methods (ASD was expensive as implemented in first generation trials) and test ASD with nematodes as well as with PRD, as previewed below.

New replant trials testing WOR and ASD.

Currently, there are six WOR replant trials throughout major almond producing regions in California to refine the life cycle assessment model for evaluation of carbon dynamics and balance, as well to examine effects of WOR on soil physical, chemical, and biological properties and their impact on replanted trees growth and health. Also, six new ASD trials were established in the San Joaquin Valley in 2016 to examine economical ASD carbon sources, test streamlined ASD application procedures, and test the practice in soil where PRD and nematodes are both present as replant problems. Amelie Gaudin, Plant Sciences UC Davis; Andreas Westphal, Nematology UC Riverside; and others have joined our efforts in WOR and ASD testing.

Among the new trials, four of the most extensive ones were established at two orchard replant sites in Kern County in collaboration with Wonderful Orchards. Both sites are expected to express PRD, and one of them harbors damaging plant parasitic nematodes. In two of the four trials (one at each orchard), the main treatments are wood chips (WOR) vs. no-chips (residue hauled away). Wood chips were placed back on the soil surface at the same rate the trees were removed with approximately 39 and 65 tons per acre in the first and second sites, respectively (Figure 2). Embedded in each replicate wood chip and no-chip plot, there were four additional subplot treatments: 1) a non-fumigated control, 2) spot fumigation with Telone C35, 3) strip fumigation with Telone C35, and 4) ASD using ground almond hulls and shells as a substrate and carbon source (Figure 3). Wood chips and ASD material were incorporated in the soil using a stubble disk. However, using a disk to incorporate a high rate of wood chips at the second site was a challenge. Wood chips and ASD materials were successfully incorporated into the soil using a rototiller from Northwest Tillers (Figure 4). ASD treatments received irrigation water through drip lines covered with totally impermeable film (TIF) tarp (Figure 5). In the other two trials (one at each orchard) treatments were assigned to test the importance of each ASD component, i.e., carbon substrate, tarp, and soil moisture. Rice bran was used as the carbon source in the additional ASD trials, and, for comparison, treatments of a non-treated control, spot-fumigation, and strip fumigation (Telone C35) were included. Finally, each of the four new WOR and ASD trials in Kern County is being replanted with two key rootstocks, Hansen 536 (a peach x almond hybrid) and Nemaguard peach. Peach x almond and additional hybrids have become popular rootstock choices in the San Joaquin Valley, and it is important to learn more about their response to PRD and plant parasitic nematodes in WOR and ASD contexts, with and without soil fumigation. Our trials will address some key rootstock questions that surface in relation to WOR, ASD, and management of almond replant problems.

The efforts in executing the trials in Kern County would not have been possible without the collaboration and generous contributions of Wonderful Orchards, TriCal, Inc., the Almond Board of California, the

California Department of Food and Agriculture, and the California Department of Pesticide Regulation. We would also like to thank Northwest Tillers for their kind incorporation of WOR residues in one of the Kern County trials.

Table 1. Almond kernel weight (lbs/acre) for grind verses burn treatments

Year	Grind	Burn	Difference
2011	1,007.3 lbs/ac	925.0 lbs/ac	82.3 lbs/ac
2012	1,618.4 lbs/ac	1,533.1 lbs/ac	85.3 lbs/ac
2013	2,100.6 lbs/ac	1,853.1 lbs/ac	247.5 lbs/ac
2014	2,829.5 lbs/ac	2,331.1 lbs/ac	498.4 lbs/ac
2015	1,599.6 lbs/ac	1,427.1 lbs/ac	172.5 lbs/ac
2016	1,603.2 lbs/ac	1,504.6 lbs/ac	98.6 lbs/ac
Total	**10,758.6 lbs/ac**	**9,574 lbs/ac**	**1,184.6 lbs/ac**

Figure 1. Responses of trees to preplant treatments in one of the initial ASD trials at the UC Kearney Research and Extension Center. Foreground, stunted trees exhibiting PRD in a non-fumigated control plot; left and right backgrounds, vigorously growing trees in preplant fumigated and preplant ASD plots, respectively.

Pistachio nut phenology studies in California address crop development as a function of heat unit accumulation

Elizabeth Fichtner, UCANR Advisor, Tulare and Kings Cos; Louise Ferguson, CE Specialist, UC Davis, Narges Moosavi Mahvelati, Jr. Specialist, UC Davis and UC ANR; Lu Zhang, Post-doctoral researcher, UC Davis.

California pistachio growers have likely noticed the influence of the cool 2017 spring on crop development. This observation illustrates the limitations of modeling anticipated crop development based on calendar date. Nut development trends will also vary based on geographic area or local microclimates in which pistachios are planted, and are subject to influence from large-scale trends such as global climate change. As a consequence, scientists utilize alternate methods to define developmental growth stages as a function of heat unit accumulation. This allows for comparisons of crop development between cultivars across sites, years, and even decades. Thermal unit modeling may also be used to facilitate pest control, irrigation scheduling, and prediction of harvest time.

Some variability may exist between various model types; however, the unifying concept is that they strive to correlate milestones of plant development with accumulated heat. The time of fruit set is a biofix at which thermal unit (TU) accumulation is equal to zero. Heat unit measurements are determined by tracking hourly data using data loggers installed in the field. Thermal units are calculated by taking a daily average temperature and subtracting the base temperature threshold. In pistachio models, 7°C is utilized to indicate the base temperature beneath which growth does not occur. The work of Allan et al. 2014, focused on relating 6 variables (nut length, width, height, volume, penetrability, embryo size) to accumulated heat in each of 5 cultivars of pistachio.

Pistachio nut development is defined in three overlapping stages. Stage 1 is defined by the growth of the pericarp to its final size; stage 2 is defined by the hardening of the endocarp (ie. shell); stage 3 is characterized by growth of the embryo (Figure 1). In pistachio, Stages 1 and Stages 2 and 3 have overlapping curves, indicating that portions of these developmental phases occur simultaneously (Allan et al 2014). Stages 1 and 3, however, are mutually exclusive of each other such that the pericarp is fully formed before embryo development is initiated (Figure 1). The final volume of the pericarp is achieved after accumulation of approximately 670 TU (Figure 2). In 2016, this would have occurred around the beginning of June in the southern San Joaquin Valley (SSJV). Stage 2, the process of shell hardening, requires approximately 2423 TU. Embryo growth (Stage 3) is initiated after around 900-1000 TU accumulated (mid-June in 2016; SSJV) and maximum embryo length requires approximately 1880 TU (mid-August in 2016; SSJV). Stage 2 requires more heat units for completion then Stage 3. The variability of these mean values is largely contributed by differences in cultivars.

This year, we are building the pistachio nut growth models and strengthening the prediction ability of the model by continuing weekly fruit sampling from early fruit set to harvest. In addition to current equation of TU accumulation, we are also improving the method of calculating heat units using Asymmetric Curvilinear Growth Degree Hours (GDH) Model, as well as to predict the base, optimum and critical temperatures for pistachio growth in California. Our final objective is development of a model that predicts the number of heat units to complete all three growth stages in the Kerman, Lost Hills, Golden Hills, Kaleghouchi and Pete1 cultivars and to develop the software to convert calendar dates to thermal units based on historical temperature records and two weeks weather forecast. Growers will be able to predict optimal harvest date conveniently by logging into our website and inputting the location, cultivar and blooming date.

Select References

Allan, C.A., Ferguson, L., Bourgeois, G., Cristosto, C., Thur, K., Ramacho, F.A., Jiminez, F.J., Saracoglu, T. Pistachio nut phenology and development in five cultivars as a function of heat units. Report to the California Pistachio Research Board. www.calpistachioresearch.org.