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WALNUT NEWS

In This Issue

UCCE Working Remotely
March 20 - April 7

(Check for updates on SacValleyOrchards.com)

Given the State of California's shelter-in-place order to reduce the spread of COVID-19, all UC Cooperative Extension offices are now working remotely. We are still available remotely to answer your questions and address needs during this unprecedented situation.

What Rootstock Would You Choose? Tell Us.

Annette Levi, CSU Fresno & Andreas Westphal, UC Riverside

Selecting the optimal walnut rootstock for your orchard is a critical decision. Making the best rootstock choice can save you money and decrease your per acre costs over the life of your orchard. Currently, a research team from the University of California and Fresno State want to provide walnut growers with the best rootstock choices for their growing conditions. To better understand what rootstock characteristics growers need, these researchers are asking walnut growers to take a ten-minute rootstock survey. The survey results will direct researchers to provide growers with rootstocks that can lead to greater economic sustainability of your orchards.

Thank you for participating at: tiny.cc/walnuts19

California Tree & Crop Herbicide Registration Report

Herbicide Registration on California Tree and Vine Crops - *(updated March 2020 - UC Weed Science)*

	Herbicide-Common Name *(example trade name)*	Site of Action Group[1]	Almond	Pecan	Pistachio	Walnut	Apple	Pear	Apricot	Cherry	Nectarine	Peach	Plum / Prune	Avocado	Citrus	Date	Fig	Grape	Kiwi	Olive	Pomegranate
			----- tree nut -------				- pome -		---------stone fruit ---------												
Preemergence	**dichlobenil** *(Casoron)*	L / 20	N	N	N	N	R	R	N	R	N	N	N	N	N	N	N	R	N	N	N
	diuron *(Karmex,Diurex)*	C2 / 7	N	R	N	R	R	R	N	N	N	R	N	N	R	N	N	R	N	R	N
	EPTC *(Eptam)*	N / 8	R	N	N	R	N	N	N	N	N	N	N	N	R	N	N	N	N	N	N
	flazasulfuron *(Mission)*	B / 2	R	N	R	R	N	N	N	N	N	N	N	N	R	N	N	R	N	N	N
	flumioxazin *(Chateau)*	E / 14	R	R	R	R	R	R	R	R	R	R	R	NB	NB	N	NB	R	N	R	R
	indaziflam *(Alion)*	L / 29	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	R	N
	isoxaben *(Trellis)*	L / 21	R	R	R	R	NB	NB	NB	NB	NB	NB	NB	NB	NB	N	NB	R	NB	NB	NB
	mesotrione *(Broadworks)*	F2/27	R	R	R	R	N	N	N	N	R	N	R	N	R	N	N	N	N	N	N
	napropamide *(Devrinol)*	K3 / 15	R	N	N	N	N	N	N	N	N	N	N	N	N	N	N	R	R	N	N
	norflurazon *(Solicam)*	F1 / 12	R	R	N	R	R	R	R	R	R	R	R	R	R	N	N	R	N	N	N
	oryzalin *(Surflan)*	K1 / 3	R	R	R	R	R	R	R	R	R	R	R	R	R	N	R	R	R	R	R
	oxyfluorfen *(Goal, GoalTender)*	E / 14	R	R	R	R	R	R	R	R	R	R	R	R	NB	R	R	R	R	R	R
	pendimethalin *(Prowl H2O)*	K1 / 3	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	R	R	R
	penoxsulam *(Pindar GT)*	B / 2	R	R	R	R	N	N	N	R	R	R	R	N	N	N	N	N	N	R	R
	pronamide *(Kerb)*	K1 / 3	N	N	N	N	R	R	R	R	R	R	R	N	N	N	N	R	N	N	N
	rimsulfuron *(Matrix)*	B / 2	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	N	N
	sulfentrazone *(Zeus)*	E / 14	N	N	R	R	N	N	N	N	N	N	N	N	R	N	N	R	N	N	N
	simazine *(Princep,Caliber 90)*	C1 / 5	R	R	N	R	R	R	N	R[2]	R	R	N	R	R	N	N	R	N	R	N
	trifluralin *(Treflan)*	K1 / 3	R	R	N	R	N	N	R	N	R	R	R	N	R	N	N	R	N	N	N
Postemergence	**carfentrazone** *(Shark EW)*	E / 14	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	clethodim *(SelectMax)*	A / 1	R	R	R	R	NB	NB	NB	NB	NB	NB	NB	N	R	N	N	NB	N	NB	N
	2,4-D *(Clean-crop, Orchard Master)*	O / 4	R	R	R	R	R	R	R	R	R	R	R	N	N	N	N	R	N	N	N
	diquat *(Diquat)*	D / 22	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB
	fluazifop-p-butyl *(Fusilade)*	A / 1	NB	R	NB	NB	NB	NB	R	R	R	R	R	NB	R	NB	NB	R	N	NB	NB
	glyphosate *(Roundup)*	G / 9	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	glufosinate *(Rely 280)*	H / 10	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	R	N
	halosulfuron *(Sandea)*	B / 2	N	R	R	R	R	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	paraquat *(Gramoxone)*	D / 22	R	R	R	R	R	R	R	R	R	R	R	R	R	N	R	R	R	R	R
	pelargonic acid *(Scythe)*	NC	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	N
	pyraflufen *(Venue)*	E / 14	R	R	R	R	R	R	R	R	R	R	R	N	N	R	R	R	R	R	R
	saflufenacil *(Treevix)*	E / 14	R	N	R	R	R	R	N	N	N	N	N	N	R	N	N	N	N	R	R
	sethoxydim *(Poast)*	A / 1	R	R	R	R	R	R	R	R	R	R	NB	NB	R	NB	NB	R	N	NB	NB
Organic	**ammonium nanoate** *(Axxe)*	NC	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	N
	ammoniated fatty acids *(Final-San-O)*	NC	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	caprilic/Capric acid *(Suppress)*	NC	R	R	R	R	R	R	R	R	R	R	R	R	R	N	N	R	R	N	R
	d-limonene *(AvengerAG)*	NC	R	R	R	R	R	R	R	R	R	R	R	N	R	N	N	R	N	N	N
	eugenol *(Weed Slayer CA)*	NC	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Notes: R = Registered, N = Not registered, NB = nonbearing. This chart is intended as a general guide only. Always consult a current label before using any herbicide as labels change frequently and often contain special restrictions regarding use of a company's product.

[1] Herbicide site of action designations are according to the Herbicide Resistance Action Committee (letters) and the Weed Science Society of America (number) systems. NC = no accepted site of action classification; these contact herbicides are general membrane disruptors. [2] Simazine is registered on only tart cherry in CA.

Weed susceptibility information and the most up to date version of this table can be found at the Weed Research and Information Center (http://wric.ucdavis.edu)

WALNUT: BACTERICIDE AND FUNGICIDE EFFICACY

Material	Resistance risk (FRAC#)[1]	Walnut blight[2]	Phyto-toxicity	Anthrac-nose	Botryosphaeria blight***
Actinovate	low (biological)	++	NP	----	----
Bordeaux[2]	medium (M1)	+++	NP	----	----
Fixed coppers[2]	medium (M1)	+++	++[3]	----	----
Fontelis	high (7)	----	----	ND	+++
Copper-mancozeb (Manzate/ Dithane)	low (M1/M3)	++++	NP	++++	++(+)
Copper-mancozeb–surfactant[4]	low (M1/M3)	+	NP	ND	ND
Kasumin	high (24)	+++	NP	----	----
Kasumin-copper	low (24/M1)	++++	NP	----	----
Kasumin-mancozeb	low (24/M3)	++++	NP	----	-----
K-Phite	low (33)	+	+	ND	++++
Luna Experience	medium (3/7)	----	NP	++++	++++
Luna Sensation	medium (7/11)	----	NP	ND	++++
Luna Privilege	high (7)	----	NP	ND	ND
Merivon	medium (7/11)	----	NP	++++	++++
Mycoshield/FireLine*	high (41)	++	NP	----	----
Pristine	medium (7/11)	----	NP	++++	++++
Ph-D	medium (19)	----	NP	++++	+++
Quadris Top	medium (3/11)	----	NP	++++	+++
Quash	high (3)	----	NP	++++	++++
Rhyme****	high (3)	----	NP	++++	+++(+)
Tebucon/Teb/ Toledo	high (3)	----	NP	ND	+++
Viathon	medium (3/33)	ND	ND	ND	+++
Quilt Xcel	medium (3/11)	----	NP	++++	----
Organic treatments					
Blossom Protect	low (biological)	++/+++	NP	----	----
Various copper products[2,5]	medium (M1)	++	++	----	----
Various Cu[2]+Fixed Copper[2]	medium (M1)	+++	++	----	----
Regalia	low (natural product)	++	NP	ND	----
Regalia-Copper[2]	low (natural product)	++	NP	----	----
Serenade	low (44)	+	NP	ND	----
Zinc-Copper Bordeaux	low (M1)	+++	NP	----	ND

Rating: ++++ = excellent and consistent, +++ = good and reliable, ++ = moderate and variable, + = limited and erratic
---- = ineffective, NP = not phytotoxic, and ND = no data.

*** Registration pending in California**

**** Not registered, label withdrawn or inactive in California**

***** Research is ongoing to determine the most efficacious materials and the optimum timing of treatments for management of Botryosphaeria blight of walnut.**

****** Rhyme applied at 30 to 60% hull split reduced kernel mold on Chandler (1 year's results).**

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action Group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action Group number; for fungicides with other Group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action Group number.

[2] Copper resistance occurs within sub-populations of *Xanthomonas arboricola* pv. *juglandis*.

[3] Phytotoxicity of fixed coppers can be reduced with the addition of lime or agricultural oils to the tank mixture.

[4] A single application with a surfactant is not recommended because of build-up of populations on buds that may increase disease in subsequent years.

[5] Various copper formulations are approved for organic use including Badge, Champ, ChampIon[++], Cueva, CS-2005, Kentan, Kocide 2000-O, 3000-O, Kocide HCu, MasterCop, Nordox, NuCop, etc.

Orchard Management Considerations: Budbreak through Early Summer

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Emily J. Symmes, UC Area IPM Advisor, Sacramento Valley
Luke Milliron, UCCE Orchard Advisor, Glenn, Butte & Tehama Counites
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APRIL

* Timing of your first **walnut blight** spray should depend on the orchard's disease history and forecast weather. If rain is forecast and the orchard has high blight history consider spraying as early as bud break/ or catkin emergence and then following up with a second spray 7-10 days later. If pressure in the block is moderate/low (low disease history or no rain forecasted), consider the timing of 20% prayer stage (ipm.ucanr.edu/PMG/R/S-WA-REPG-BD.001.html). For more details on predicting walnut blight risk, choosing materials, and avoiding common management pitfalls, see: sacvalleyorchards.com/walnuts/diseases/walnut-blight-management/.
* Limbs that have been killed by **Bot canker** are easy to identify between budbreak and full leaf expansion, but wait to prune deadwood until rain is no longer forecast. If timing Bot treatment based on the Leaf Wetness Model, watch for storms that bring ≥ ¼ inch of rain and temperatures ≥ 50°F. The Leaf Wetness Model can be found at: sacvalleyorchards.com/walnuts/diseases-walnuts/the-latest-on-managing-bot-canker-and-blight-in-walnut-2016-research-updates/. New research is finding that controlling hull infections by Botryosphaeria (Bot), Phomopsis, Aspergillus, Alternaria, and Fusarium also helps reduce kernel mold.
* Good spray coverage is critical to management of walnut blight. One of the prerequisites for good spray coverage is a **calibrated sprayer**, see details at: sacvalleyorchards.com/almonds/foliar-diseases/pre-season-airblast-sprayer-calibration/
* **Codling moth** traps should have been put out by mid-March to establish the first flight biofix (typically between mid-March and mid- April), begin tracking degree days, and evaluate pest pressure. Temperatures in February and early March 2020 are pointing to potentially earlier first biofixes this season. If temperatures stay relatively moderate to warm throughout March and April, keep a close eye out for earlier biofixes and generation timings throughout the remainder of the season. Ideal degree day model treatment timings maybe skew to the much earlier side than "normal" this year. For details on monitoring and managing codling moth, visit: ipm.ucanr.edu/agriculture/walnut/Codling-Moth/.
* Consider putting out **navel orangeworm (NOW)** pheromone traps for adult males and traps baited with ground pistachio meal for adult females.
* Monitor for **scale crawlers** by putting out double-sided sticky tape by early- to mid-April if scale has been a problem and you didn't treat for scale during the dormant season.
* For varieties susceptible to **pistillate flower abscission (PFA)** (especially Tulare or Serr), apply first ReTain® spray at 30 to 40% pistillate (female) flower bloom. The percent PFA and rate of bloom determines if a second spray is needed. ReTain® cannot be applied within 2 days of a copper application. PFA often occurs in years when trees have a heavy catkin load and pollen shedding overlaps with pistillate bloom.
* Apply **Foliar Zinc** if needed, based on leaf sample analysis or symptoms. Apply when shoots are 6 to 10 inches long, when zinc can be easily absorbed through the leaf surface. If the deficiency is severe, additional sprays can be applied two more times every 2 to 3 weeks.
* Perform **irrigation system maintenance** now, before irrigation is necessary and system problems could cause tree stress. Check for broken or clogged filters and emitters. See micromaintain.ucanr.edu for more tips on maintaining micro-irrigation systems.
* **Before you start irrigating,** consider plant water stress (pressure chamber) measurements and soil moisture sensor readings. Recent research in the Sacramento Valley has found irrigation can be delayed until June in some years, saving water and pumping costs without negative impacts to yield, size or quality. See the article in this newsletter for more information.

MAY

* Continue monitoring **codling moth** traps to confirm flight activity and determine treatment thresholds and timings.

* **Aphid** sampling should begin this month and continue throughout spring and summer. Collect 5 first sub-terminal leaflets (one back from the last leaflet) from 10 trees, checking the top surface for dusky-veined aphids and the underside for walnut aphids. Make treatment decisions following guidelines at: ipm.ucanr.edu/PMG/r881300511.html.

* Apply the first round of **nitrogen fertilizer** in May, not before. Walnut trees only use stored nitrogen the first month after leaf-out, meaning N applied before May will likely be leached by rain and/or irrigation. Walnut tree nitrogen use is fairly steady over the growing season. Evenly dividing nitrogen application in 3 to 4 doses between May and the end of August will improve N uptake compared to 1 to 2 applications.

* Survey **weeds** to see which weeds were not controlled by fall or winter treatment. The UC Weed ID Tool at weedid.wisc.edu/ca/weedid.php can help with identification. Also see Herbicide Chart in this newsletter.

JUNE

* Hang **Walnut Husk Fly** traps by June 1. Yellow sticky traps charged with an ammonium carbonate lure work best. Check traps 2 to 3 times per week and treat based on detection of eggs in trapped females, overall trap catch numbers, or the first flies caught depending on spray material used, husk fly population, and previous damage. For more details on treatment decision-making, see: sacvalleyorchards.com/walnuts/insects-mites-walnuts/walnut-husk-fly-biology-monitoring-and-spray-timing/.

* Keep monitoring **codling moth** traps, to determine subsequent biofixes. Use trap catches, dropped nut evaluation, canopy counts, and orchard history to determine need to treat (see UC IPM link above).

* Look for **spider mites** and their predators on the leaflets already being examined for aphids. Examine an additional 5 leaflets from higher branches for a total of 10 leaflets from 10 trees. Yellows sticky cards for sixspotted thrips will also inform presence and activity of this spider mite predator. Monitor weekly through August. Treatment guidelines based on spider mite and predator presence, as well as organophosphate or pyrethroid use can be found at ipm.ucanr.edu/PMG/r881400111.html.

* If applying only one fungicide spray for **Bot canker**, a mid-June to mid-July spray timing significantly reduced blighted shoots compared with a no spray treatment. Prune out dead branches to reduce inoculum now that threat of rain has passed.

Irrigation with Roots in Mind

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Bruce Lampinen, Walnut Specialist, UC Davis Plant Sciences

In addition to anchorage, a key role of roots is the uptake of water and nutrients. Although roots are responsible for water uptake, roots do not function well when exposed to too much water and will stop growing and eventually die in stagnant and/or saturated soil conditions. We consider how a better understanding of root biology can inform best irrigation practices.

When do roots grow?

There is a false understanding in walnut production that there is a flush of root growth in both spring and fall. In fact, there's even a figure in the 1996 UC Walnut Production Manual that shows these two flushes of root growth where the fall peak is larger than the spring peak. Recent work in the Chandler variety by Bruce Lampinen and his lab at UC Davis instead showed that in most years, there was a single major root flush that peaked in late June (figure 1). During this period of root growth there is continuous fine root production. These new fine roots are responsible for most nutrient and substantial water uptake. There is a constant turnover in fine root production during this period, with new roots being produced, and older roots dying, or (after about two weeks) suberizing and becoming part of the water and nutrient transport system instead of an active site of uptake. Occasionally there was a small flush of root growth in late summer/early fall, but this amount was substantially lower than the spring flush.

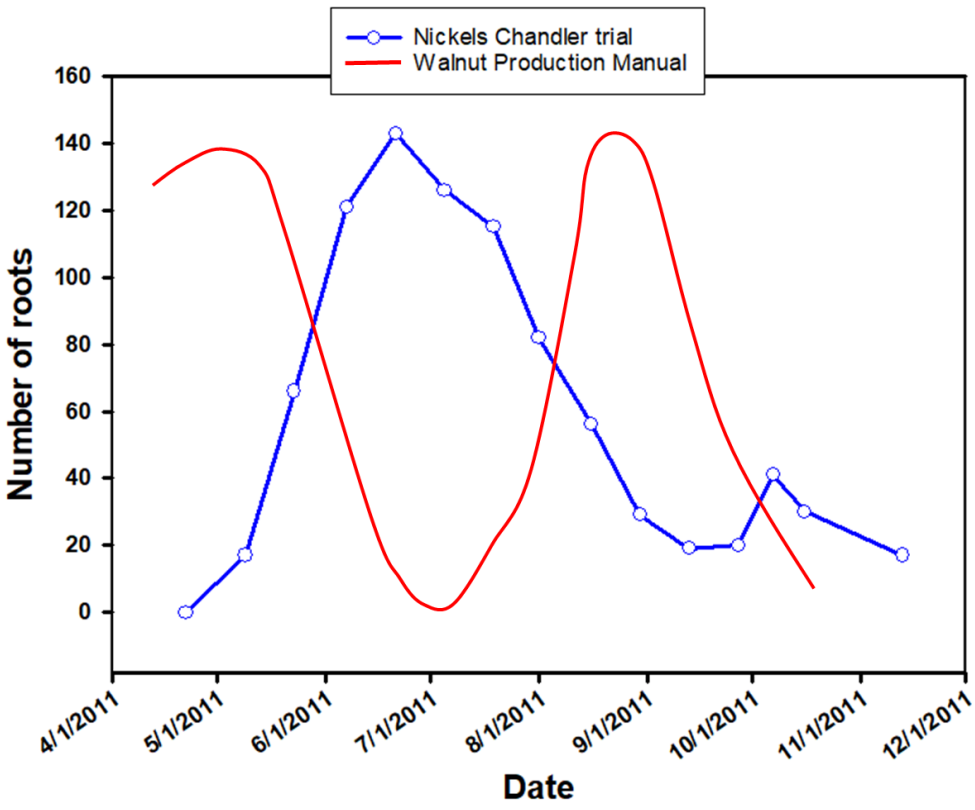

Figure 1. Number of roots over time in Chandler on Paradox Seedling (2011 Nickels Soil Lab in Arbuckle, CA) versus what is shown in the 1996 Walnut Production Manual.

Where are the roots located?

The fine roots are concentrated in the top two feet of soil. However, declines in soil moisture from spring to fall indicate substantial water uptake from roots located in deeper soil layers where moisture is still available when soils allow for deep root growth. If the soil is allowed to dry more near the surface, or there are subsurface sources of water such as water tables, these deep roots can contribute substantially to water uptake. Deeper roots are generally coarser and have longer lifespans than shallower roots.

How are roots affected by wet and dry conditions?
During the single spring root flush there can be tremendous long-term damage to root and tree health from extended saturated/stagnant soil moisture conditions. New root tissue requires lots of oxygen because roots respire by breaking down carbohydrates for energy, just like humans. Carbohydrates are transported from the shoot to the roots and the breakdown of these carbohydrates into energy for root growth and nutrient uptake requires substantial amounts of oxygen. Flooding of soils strongly reduces the amount of oxygen available to the roots. When roots are deprived of oxygen during saturated soil conditions, new root production is the first process to stop. If low oxygen conditions continue, root death and eventually tree death can ensue. Thus, if you saturate the soil during spring conditions, root growth will be limited to the topsoil where oxygen is still somewhat available. Conversely, work by Bruce Lampinen and Astrid Volder showed that a water deficit during root flush promoted a flush of root growth from roots deeper in the profile where soil moisture was still available.

Irrigation Management Implications:
The halting of fine root production and the eventual process of root death due to stagnant and saturated conditions have obvious implications for flooded conditions. We discuss preparing for flooded conditions at: sacvalleyorchards.com/walnuts/flooding/preparing-for-extreme-events-flood. The negative root health impacts of saturated conditions also mean long irrigation run times leading to standing water should be avoided. The negative impacts of sustained wet conditions have been well documented, including the development of leaf damage symptoms: sacvalleyorchards.com/walnuts/irrigation-walnuts/leaf-symptoms-overwatered-walnuts. In such cases it is wasteful to apply more nutrients, the simpler solution is to reduce irrigation and allow root growth to occur. During the 2019 season there were walnut trees in the Sacramento Valley with yellowing and collapsing canopies, most likely due to wet conditions earlier in the season: sacvalleyorchards.com/blog/walnuts-blog/yellowing-collapsing-walnut-trees-pt-1-water-logging.

Conversely, drier, better aerated conditions during the root flush may promote growth from deeper roots with greater water uptake by deep roots. Research has shown that using the pressure chamber to delay the first irrigation until stem water potential readings fall two to three bars below (drier then) the fully watered baseline (typically in June), lead to trees with a healthier appearance that are less water stressed trees at harvest. This beneficial result of delayed irrigation may be due to greater root development and exploration during the May-June root flush, which leads to a greater volume of soil moisture accessible at harvest. Although deep roots can access stored soil moisture and play a critical role early in the season, if you run long irrigation sets in an attempt to replenish deep soil moisture during the irrigation season, the most important roots in the top two feet and tree health overall will likely suffer from poor aeration. You can read more about the study at: sacvalleyorchards.com/walnuts/irrigation-walnuts/pulling-the-trigger-start-of-spring-irrigation. The pressure chamber not only allows for a delay of irrigation early in the season, but it's a great integrated measure of tree water status, especially considering we never know the location of all roots contributing to water uptake. A step by step guide on using the pressure chamber is available at: sacvalleyorchards.com/manuals/

This article is based on a Growing the Valley podcast discussion with Dr. Astrid Volder at UC Davis. You can learn more about roots, including how we should fertilize and prune with roots in mind at: growingthevalleypodcast.com/podcastfeed/roots

Preparing for Extreme Events: Spring Frost

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

An April frost can have potentially devastating results. The last severe spring frost occurred in April 2008. During a frost event, there are many factors that influence whether or not frost damage will occur in a particular orchard. This article provides guidelines should a spring frost occur.

What happened and what damage can be expected?

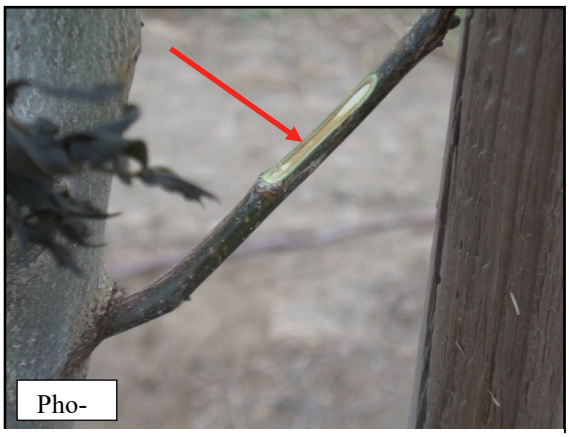
The 2008 event was a radiation frost that caused widespread and substantial damage to fruit and nut crops in Sutter and Yuba Counties. Radiation frosts occur when skies are clear, winds are calm, and humidity is low. Cold air does not move in and replace warmer air. Instead, the existing air mass cools as heat is radiated to the sky. In other words, the tree leaves are radiating (losing heat) to the cold night sky. That is why, for example in walnuts, much of the damage was seen higher up in the trees in 2008. Conversely, advection frosts are associated with wind and typically occur when a large cold air mass moves into an area.

Bearing and young walnut trees suffered damage during the 2008 radiation frost event. For bearing trees, walnut flowers and small nutlets can only endure 30°F for 30 minutes without suffering damage. In 2008, sustained air temperatures below 30°F possibly occurred for as much as two hours. More frost damage was observed on walnuts that were not as leafed out, such as Howard, Chandler, Tulare and Vina compared to earlier walnut varieties like Serr that had hardened more against freezing. More leaves at the tops of the trees probably protected the lower leaves, buds, etc. from exposure to the sky.

Frost damage symptoms. In walnut, where leaves were blackened from frost damage, the flowers and small nutlets should be cut (unless it is evident from outside) to determine damage which will be black to varying degrees (Photos 1-3). Young walnut trees also had variable frost damage in 2008. If a frost event occurs and black leaves are seen, cut inside the limbs to see if there is brownish tissue damage (Photo 4).

Photos 1 – 3: Frost damage on Vina walnut, April 20, 2008. *Photos courtesy of Francisco Paredes*

Frost damaged walnut flowers and nutlets. The green nutlet in center (see red arrow) is undamaged.



Brownish tissue from frost damage (see red arrow) on a two year old Howard walnut tree. Photo by Janine Hasey.

Can damage be prevented? Perhaps not entirely, but some damage may be reduced with a few key actions. Ensuring soil moisture, particularly in the top foot is critical to mitigating frost damage, because this moisture allows for more heat storage during the day. The top foot should be at field capacity (not too wet) and there should be no dry surface crust that prevents heat from being stored during the day and released at night. If rainfall is inadequate to meet these conditions, irrigate before the frost event. Irrigating **three to four days** before the frost event would have helped with the radiation frost we had in 2008.

As for orchard floor management, bare firm moist soil is warmest. Groundcover should be mowed to two inches or less before the frost to allow sunlight to warm the soil during the day. Cover crops, and other groundcover greater than 2 inches tall prevent solar radiation from reaching the soil surface during the day thus storing it for release at night. Another potential impact of groundcover is ice-nucleating (IN) bacteria. These bacteria reside on grasses and weeds which can lead to more IN bacteria on the trees that can also increase frost damage. As the orchard leafs out in full canopy orchards, whether there is groundcover or not, becomes less important since the tree foliage blocks sunlight from reaching the surface. In 2008, the orchard floor management system appeared to have little effect on damage severity.

Can running irrigation during a frost event help? In 2008, several orchards that were irrigated during the night of the frost still had frost damage. Joe Connell, Farm Advisor Emeritus, notes that sprinkler frost protection works best when systems are engineered to provide a flow rate of 40 gpm/ac and there are not advection conditions. Helicopter frost protection may also be helpful in a *radiation* frost event, but not during an advection frost event, when cold air moves through, often on a regional level. To help predict the potential for a frost event, check the dew point temperature before retiring for the night. When the dew point is above 45°, frost is rarely a problem. For more information on frost protection and when to turn on and off under tree sprinklers to prevent frost damage, visit the biometerology website at biomet.ucdavis.edu.

What to do if frost damage occurs? If the frost damage is countywide, estimate the percent frost damage in each orchard and report it to your local agricultural commissioner. If crop damage reaches 30 percent production loss county wide for at least one crop, the Agricultural Commissioner has three months from the end of the disaster to request disaster assistance.

- Do not cut off or remove frost damaged leaves or tissue on young or older trees. Wait to remove any limbs that were frost damaged until mid-summer after new growth has emerged. Young trees that were frost damaged should be painted with a 50:50 white latex paint to protect from sunburn damage. According to UC Plant Pathologist Themis Michailides, frost injured walnut shoots will be more susceptible to colonization by *Botryosphaeria.*
- Continue to apply blight sprays as needed and monitor for codling moth where there is a crop to protect. It takes fewer damaged nuts with light crops to cause a significant percentage increase in off-grade.
- Reduce and delay fertilizer applications where cold damage is evident. Much of the nitrogen demand is from the crop, and therefore should be reduced in relation to the expected yield reduction.
- With less leaf surface, there is less transpiration. Therefore trees have much less capacity to use water, and roots can easily be damaged with over-irrigation. Delay the start of irrigation and monitor trees carefully using a pressure chamber and/or soil moisture measuring devices through the season.

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