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Almond Orchard Management Considerations – March & April

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IRRIGATION

This will be an interesting irrigation season. Rainfall and snow pack at the end of December 2021 were ahead of the previous year, but January was dry enough to erase those gains and the reservoirs are still low. The best way forward, as we see it, is to:

- Perform a thorough checkup of your well, pump and irrigation system components. A pump test will identify possible problems such as substantial pressure or flow rate reductions. Learn to monitor standing and pumping groundwater levels to track changes in groundwater conditions. Check the Well Completion Report for your well available at: water.ca.gov/Programs/Groundwater-Management/Wells/Well-Completion-Reports. If available, this site will provide information regarding the well construction and conditions at completion of drilling, submitted by the driller as required by regulation. Use the completion reports to find out how deep the well perforations or screens were installed relative to pumping water levels. This will provide a sense of whether the pumping water levels are close to going below the well perforations, screens, or bottom of the well and if the well is at risk of going dry any time soon. Locate records of the most recent pump installation or repair work. It should provide pump bowl depth information and assure the groundwater level will not drop below the pump. Thoroughly check filters, pressure gauges, screens and lines to make sure there are no plugs or leaks.
- If you farm in Tehama, Butte, Colusa, Glenn, Shasta or Yolo Counties you can apply for a free system evaluation from the Tehama Resource Conservation District Mobile Irrigation Lab. For more information, or to schedule a free evaluation, please contact: Kevin Greer (530) 727–1297, kevin@tehamacountyrcd.org.
- Ready your soil or tree moisture monitoring tools. Have plant water status (pressure chamber, etc.) and soil moisture sensor equipment ready to go for the season. New batteries or other equipment required? Ensure that data collection points align with the known variations within your orchard.

WEED MANAGEMENT

- If not done already, talk with your PCA about a preemergence herbicide program for weed control in tree rows (strip sprays) before chances of rain pass completely. Some rain (up to an inch) is needed to incorporate preemergent herbicides within one to four weeks after application (check the label and/or with your PCA). Prepare for sprays by removing leaves or dead weed cover from strips. Applications made to clean soil will last longer and be more effective.
- Weed management can be particularly difficult in newly planted and young orchards, as weeds get plenty of sun, water, and fertilizer. See the article in this newsletter on young orchard weed management.

- White paint alone, does NOT protect young tree trunks from herbicide damage. Trunk cartons can provide protection from herbicide injury for young trees. See the article in this newsletter on trunk protection/cartons. Learn more at: ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=38701 or growingthevalleypodcast.com/podcastfeed/trunkprotection

FROST PROTECTION

- Days before freezing conditions are predicted, close mow your orchard middles (vegetation should be < 2 inches tall). Once a freeze is forecast, irrigate to wet the top foot of soil one to two days ahead of the event. Moist, firm, and bare/close mowed orchard floor stores and releases more heat on cold nights than orchards with taller vegetation or recent cultivation. Check your irrigation system to make sure it can function at bloom in case freezing temperatures are forecast.
- If sprinkler irrigation is available and a freeze is forecast, turn on irrigation before wet bulb temperatures reach the critical crop values; turn off water once the wet bulb temperature is above the critical values (or when all the ice melts). See the critical crop temperatures at different growth stages at: sacvalleyorchards.com/blog/almonds-blog/low-temperatures-in-the-forecast/ and more details on sprinkler on/off info at: biomet.ucdavis.edu/when-to-turn-sprinklers-on-and-off-for-frost-protection/
- Drip irrigation provides no benefit when run during frost, but irrigating a day or two ahead of cold (especially with the greater wetting surface of double line drip) gives time for wet soil to warm with sunlight and store more heat to release on a frosty night. A dry soil surface crust can prevent heat storage during the day and its release at night; re-irrigate the surface few inches of soil if the surface dries out.
- National Weather Service has a web-based calculator that calculates wet-bulb temperature from dry bulb temperature and relative humidity. See it at: weather.gov/epz/wxcalc_rh. Assume 1013 millibars atmospheric pressure – that is the pressure used to develop tables. Know the soil type areas within your orchard and set irrigation rates accordingly.

INSECT PESTS

- If mating disruption is part of your IPM program for NOW, deploy dispensers by late March or early April. NOW pheromone traps should be shut down (catching no male moths) with good dispenser placement, so make sure your monitoring includes egg and bait bag traps to follow NOW activity. For more information on navel orangeworm from UC IPM visit; www2.ipm.ucanr.edu/agriculture/almond/Navel-Orangeworm/.
- Tell your almond, walnut, and pistachio neighbors if you are using mating disruption, as NOW pheromone trap catches may be affected in areas outside of the treated orchard. With NOW, the more effective your neighbors' management programs are, the better off you will be.

NUTRIENTS

- Crop load determines most fertilizer need in mature orchards. The 2021 crop/acre in the Sacramento Valley was generally light and experience suggests that, weather permitting, the 2022 crop should be heavier. This means extra attention to nitrogen and potassium timing and rates. A potentially larger crop, uncertain nut prices and higher fertilizer prices makes nutrient planning a challenge.
- The Almond Board of CA has a valuable publication on Nitrogen Best Management Practices in Almond based on Almond Board funded UC research. Visit: almonds.com/sites/default/files/2020-12/ABC_Nitrogen_8.5x11_vmags.pdf to see (or download) that document.
- Apply approximately 20% of the year's predicted nitrogen (N) by late February or March (no later than full spur leaf out). For mature trees that have filled their space, some portion, likely roughly in keeping with the timing of demand of the crop, of the N for vegetative growth (see the table of annual N budget through the life of an orchard) should be applied at this same timing to support growth of new fruiting wood.
- Start your K fertigation program in March or early April if dry fertilizer was not applied at all in the fall/winter.
- In areas where high boron is not a problem, 1 to 2 lbs Solubor®/acre as a canopy spray (equal to 0.2 to 0.4 lbs actual boron/acre) applied before bloom (no later than pink bud) can increase nut set and yield if a fall spray wasn't used and previous year hull samples showed low boron (B) levels. Even if hull B levels were up last

year (but less than 200 ppm B), growers should consider a light rate (0.2 lb actual B) if nothing has been done to date. If planning a pink bud boron spray, spray late in the day to avoid direct spraying of any wandering bees.

Links to online resources for almond orchard management:

- Almond Board of CA Nitrogen Best Management Practice (BMPs): almonds.com/sites/default/files/2020-12/ABC_Nitrogen_8.5x11_vmags.pdf
- Almond Board of CA Bee BMPs: almonds.com/sites/default/files/ALM_189395_HBBrochure_8_5x11_Website_F.pdf
- UC IPM Guidelines for Almond: ipm.ucanr.edu/agriculture/almond/
- UCCE Sacramento Valley Orchard Source: sacvalleyorchards.com/almonds/
- UC Davis LAWR Frost protection/Sprinkler on/off: biomet.ucdavis.edu/frostprotection/Start&StopSprinklers/FP001.htm.

Potted tree irrigation after planting: Getting the first year right

Franz Niederholzer, UCCE Farm Advisor, Colusa and Sutter/Yuba Counties
Dani Lightle, Former UCCE Farm Advisor
This is a revision of an article originally published in Almond Newsletters and SacValleyOrchards.com in 2016

Potted nursery trees are here to stay, but they have challenges and a learning curve for growers accustomed to planting bare root trees. One of the major challenges is irrigating during the orchard's first year. If your orchard is planted by tearing open the root ball of potted trees at planting, spreading the roots, and turning your trees into an almost bare root condition, then disregard the rest of this article!

Leafed out trees are actively growing and begin using water immediately after planting. The challenge is irrigation water must go directly into the potted soil media. After roughly 30 days, when the tree roots have grown out of the potting media into the surrounding native soil, irrigation water delivery must shift from the original potted root ball to the native soil.

Why this complete shift in irrigating potted trees after the first month in the ground? It's because very little water will move across the large difference in textures between the potted soil media and the surrounding native soil – especially when the local soil is a fine textured soil (loam, clay loam, etc.) common to the Sacramento Valley prune growing regions (Figure 1). Water applied to the native soil after planting will be drawn to the continuous small pores of the dry native soil away from the newly planted tree, and not into the larger pores of the potting media. Water applied directly to the top of the potted soil media will move freely in the potted media but won't drain out of the potted media until the potting material is saturated, again because the water won't move easily between the two soils. In both situations, water does not move readily across the boundary between the native soil and the potting media due to textural differences.

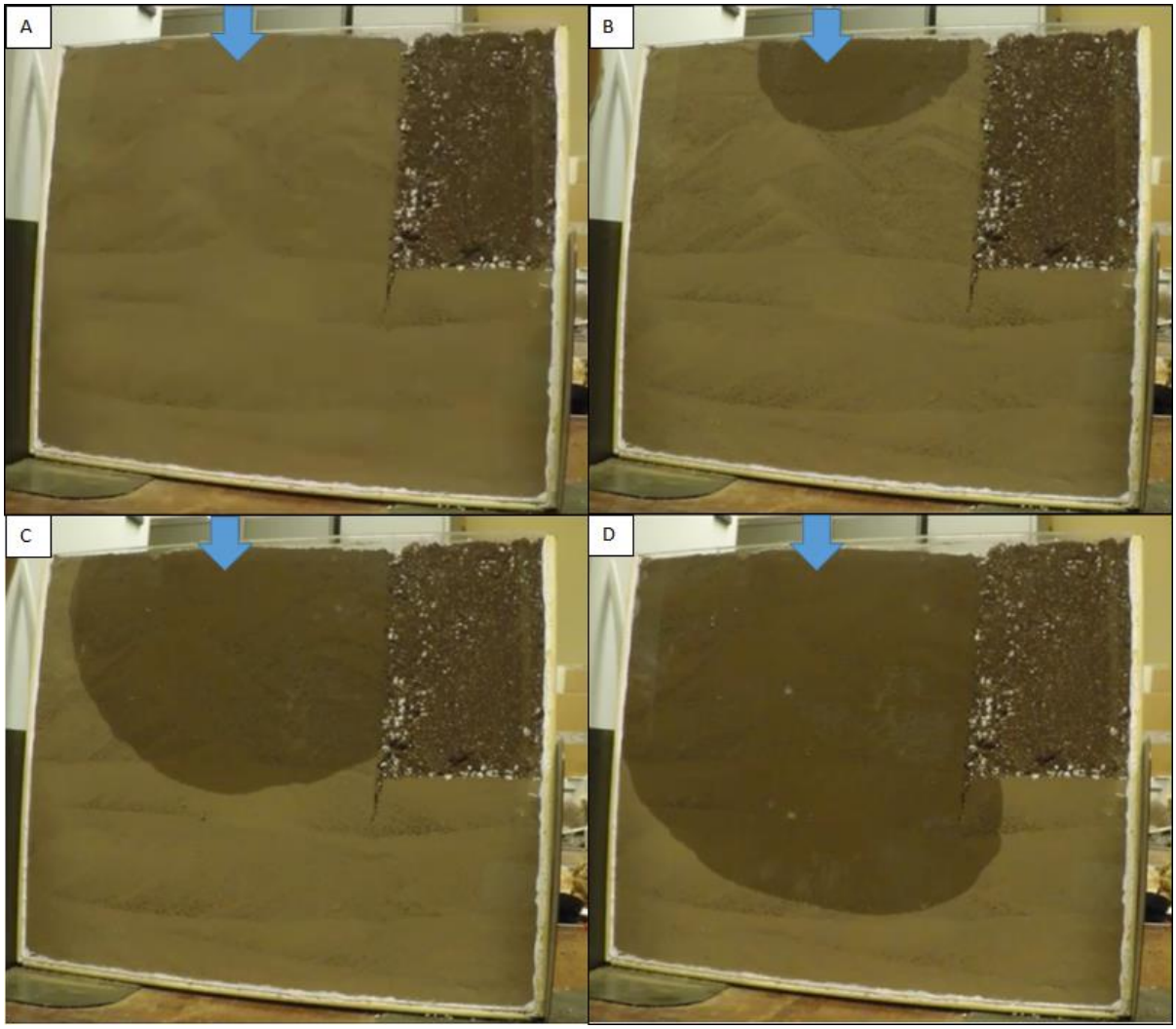

Figure 1. This sequence of photos shows the movement of water applied to Tehama series silty-loam soil. Water was applied at the blue arrow, approximately 4 inches from the potting soil. Total elapsed time was 51 minutes. Water moved downwards and laterally but did not cross the boundary into the potting soil. More details sacvalleyorchards.com/blog/almonds-blog/why-you-should-irrigate-potted-trees-directly-onto-potting-media/ (photos by D. Lightle).

It takes about 30 days for tree roots to grow out of the pot and into the surrounding soil under good growing conditions. So, water the potting media for the first 30 days, then check to make sure roots have grown out into the surrounding native soil (yes, you will need to dig a hole!). If they have, move the water source, drip hose(s) or microsprinklers away from the tree. At first, put the water delivery within about a foot of the trunk, then, as the roots extend more, move the water source to its permanent location. Properly irrigating newly planted potted trees on flood irrigation (or furrow irrigation in the first year or two) is challenging unless you can individually irrigate ("tank") trees several times during the first 30 days while the roots grow out of the potting media.

How can water be delivered directly to the potting soil and then shifted away? Here are some ideas (but not all options) offered by experienced nursery representatives:

- Stake a microsprinkler by the trunk and cap it to direct water downwards onto the potting soil. Once the roots have grown out beyond the potting media, take the cap off and move the sprinkler to a permanent location.
- Stagger a double-hose drip system so the emitters are evenly spaced along the tree row – basically making a big single line drip hose with emitters at half the distance apart along the row compared to

each single hose. Throw a shovel of soil on top of the hose to keep water from running along the hose away from the tree, especially when trees are planted on cut-out berms ("islands").

- Cut a shallow "V" in the top of the berm or island before the trees are planted and lay drip hose in the "V", reducing the risk of water running down the hose away from the tree.

We've had numerous encounters that required troubleshooting irrigation problems with newly planted potted trees, and we've consistently observed some common errors.

- Short irrigation sets are essential to meet tree water needs while also avoiding saturated conditions in the potting media immediately after planting.
- For the first month after planting, growers should not time irrigation using soil moisture sensors set in the soil outside the potted media area. These measurements don't show the water status of the roots in the potting media. Irrigate by water status of the root ball (dig down and feel it) and/or the estimations of ET use by small trees (sacvalleyorchards.com/blog/young-orchards and cesutter.ucanr.edu/files/102712.pdf).
- When calculating water delivery volume, use only the water delivered by the emitters close to the roots, don't include water applied out between the trees. Water delivered by a microsprinkler or drip emitter halfway between two, newly planted potted trees is not being used by either tree.
- Don't continue adding a large amount of water to the potting soil region for an extended period of time. This will saturate the potting soil and encourage crown rot (see photo) – even in plum rooted trees (M29C, M40, M2624), or part plum rooted trees (Krymsk 86, Rootpac R) that are generally tolerant of "wet feet". This is extremely important for rootstocks that require well drained soils (hybrids like 'Atlas' and 'Viking', peach seedlings like 'Lovell').

Adequate root zone moisture is essential to good, sustained tree growth and root health – especially in the first leaf. Excessive soil water will drown the roots or invite *Phytophthora* infection in the crown and/or roots. Dry soil limits tree growth and eventually, survival. The extra effort to get potted tree irrigation right the first year will pay off with the best possible start for the orchard.

Photo. Failure to move microsprinklers away from the trunk led to trunk disease and tree death.
Photo: D. Lightle.

Protecting Young Almond Trunks with Cartons

Luke Milliron, UCCE Orchard Advisor Butte, Glenn, & Tehama Counties

It can be difficult to know when to replace or remove tree cartons. Being too early (photo 1) or late (photo 2) with carton removal has been the source of numerous farm advisor calls over the years.

Problems with removing cartons too EARLY:
The orchard is a harsh new environment for a potted or bareroot tree from the nursery. The paper carton (aka tree protector, trunk wrap) that comes with the tree from the nursery, along with diluted white latex paint help protect trees from sunburn, and Pacific Flatheaded Borer. However, UCCE research has recently shown that white interior latex paint (diluted 50/50 with water) may provide little, if any, benefit in protecting the truck from herbicide damage. See the research report at: ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=38701. Instead, the physical barrier of the carton is needed to protect young, green bark from self-inflicted herbicide drift damage.

From planting onwards, there are a few key decision/action points for trunk cartons. At planting, cartons provide continuous coverage, are easy to apply and settle with the soil. If the trees are not painted, trunk protecting boxes should be flattened (look like ◊ this from the top, not this □) to avoid "box burn". Now, some nursery tree carton interiors are black at the top of the carton to help avoid box burn. For more "at planting" considerations visit: sacvalleyorchards.com/almonds/horticulture/planting-almonds/.

There is the concern that the paper carton will disintegrate before trunks are sufficiently hardened off to be resistant to herbicide injury. There needs to be more research on when you can safely remove cartons and not worry about trunks being damaged by herbicide. Former UCCE advisor David Doll (aka The Almond Doctor) suggests "…keeping them on through the summer of the second year as it provides protection for the late spring burn down while still giving an opportunity to remove them before debris and tree growth makes it more difficult." In their research showing that paint did not protect trunks former UCCE intern Drew Wolter and advisor Dani Lightle found that nine weeks of hardening off (i.e. time between carton removal and herbicide application to the trunk) significantly reduced herbicide damage. Therefore, there are both orchard age (late in 2nd leaf) and hardening off (maximize time between carton removal and next herbicide application) components to preventing herbicide damage to young almond trunks. Of course, avoid self-inflicted herbicide injury by following best practices, including avoiding spraying near tree trunks when possible, considering a strip spray program with materials that don't have a green bark label warning (see a list in the article at sacvalleyorchards.com/almonds/weed-control/young-orchard-weed-management, and avoiding spraying during windy conditions. More information on herbicide management in young orchards can be found in the article in this newsletter.

Problems with removing cartons too LATE:
Keeping wraps on too long is also asking for problems! You always want open air between the carton and the tree trunk. What you don't want is water trapped between the carton that's pressed against the enlarging trunk -- that's asking for a *Phytophthora* infection, and there are several ways that can happen. Debris like leaf litter may accumulate between the trunk and the carton over time and trap moisture against the trunk/crown of the tree. If you have higher angle sprinkler irrigation or heavy rainfall, mud can seal the bottom of the carton to the soil and the carton will fill with water. It's a good practice to periodically go through and gently lift each carton a few inches, ensuring that it hasn't become sealed to the soil surface or had the bottom couple of inches buried by soil and pressed against the trunk – just watch out for wasps when doing this! If the carton is not occasionally lifted from the soil line, there's a risk that when the carton is removed, the portion of the carton buried below the soil surface remains. Although the paper component of the buried carton quickly disintegrates, the plastic film coating remains and traps water against the crown of the tree. A final practice to avoid is waiting to remove the carton until after the trunk has grown snug to the carton (photo 2). When the carton and trunk are snug, every time the carton gets wet, it keeps the trunk wet for a prolonged period and risks disease infection.

Photo 2. Trunk cartons were left on the trees in this orchard until the trees had grown snug to the carton. Although there were no Phytophthora infections seen in this orchard at the time of the photo (August 30, 2021), the longer the cartons are left on, the higher the risk of problems. Photo: Luke Milliron.

Side note: **Carton or no-carton, we want to keep water off tree trunks and crowns!** The one exception to this guidance is those roughly 30 days after planting a potted orchard (see article in this newsletter). However, going forward, the best practice for all orchard crops is to keep water OFF the trunks. There are no roots taking up water at the base of the trunk and it's a high risk for fungal and bacterial canker infections that can severely shorten the life of your orchard. Use emitter location and type as well as sprinkler stream-splitters to keep trunks and tree crowns dry and disease free!

Late Winter to Early Spring is the Most Effective Time for Gopher Management

Katherine Jarvis-Shean, Orchard Systems Advisor
Roger Baldwin, Human-Wildlife Conflict Resolution Extension Specialist

As Valentine's Day approaches, folks may be feeling the romance in the air. Unfortunately for almond trees, humans aren't the only ones in an amorous mood this time of year. Late winter to early spring (roughly December through early March, depending on climate) is also the time of year that pocket gophers are usually cranking up their Barry White playlist. This reproductive pulse generally results in three to five young per litter, roughly doubling to tripling the population of gophers that feed on almond roots and crown. That's one reason why reducing gopher populations ahead of this reproductive pulse is the most time-effective way to reduce gopher damage in your orchard. Soil is also generally moister this time of year. This means gophers are more likely to be making fresh mounds, making them easier to find. It also makes the necessary management easier when digging and probing, and safer and more effective when fumigants are used. Three commonly used tools in an integrated gopher management program include trapping, rodenticides and burrow fumigants.

Trapping is highly effective for controlling gophers. Though trapping can be time-consuming, the cost is generally offset by the effectiveness. Research has found ways to reduce time spent deploying and checking each trap, and increase effectiveness. Recommendations for gophers include:

- *Set traps in active burrows*. Look for mounds with darker, freshly disturbed soil.
- *Use the most effective trap*. Head-to-head research found the Gophinator, available online, caught more gophers than the more widely used Macabee trap. This appeared to be because the Gophinator out-performed the Macabee with mid-sized and larger gophers. To modify a Macabee trap to catch large gophers, place a cable restraint (0.06 inch in diameter, 9 inch in length) to the front of the trap. However, even with this adaptation, the Gophinator has been found to be more effective.
- *Don't spend time covering trap holes*. Trials found covering trap holes slightly increased gopher trap efficiency in spring and summer, but did not increase the number of gophers captured per day given the increased amount of time spent setting and checking covered traps.
- *Don't worry about scent with pocket gophers.* Wearing gloves to avoid transferring human scent to the trap has not been found to affect trap catch rates.

See Dr. Baldwin demonstrate setting gopher traps at: youtube.com/watch?v=iDW0l6eeG0M

Rodenticides can be used by inserting into gopher tunnel systems. Strychnine is by far the most effective rodenticide for pocket gopher control, but it has become less available in recent years. Application is made through direct placement into the burrow system via hand application, an all-in-one probe and bait dispenser, or through a tractor-drawn burrow builder. Pocket gophers can become resistant to strychnine if it is used repeatedly as the only management tactic, so be sure to mix other tools in occasionally when using a strychnine baiting program. All rodenticides are considered restricted-use products when used in production agriculture settings. Zinc phosphide may be an easier rodenticide to find and purchase. However, it is sometimes avoided by gophers, and as such, may not be the most effective strategy. First-generation anticoagulants (e.g. chlorophacinone, diphacinone) can be used to manage gophers, although they are often not very effective because they require multiple feedings by the target pest.

Burrow fumigation. Fumigant gases must stay in the burrow system to be effective, so proper soil moisture and no soil cracking are critical, making this the key time of year for using this approach. There are several fumigant options which have varying degrees of efficacy.

Aluminum phosphide is effective in controlling pocket gophers, but is a restricted use material that can only be used by or under the direct supervision of a Certified Applicator. Pellets or tablets dropped into tunnels react with moisture in the tunnel to create a toxic gas. This means success is contingent upon finding active tunnels, not tunnels that have been backfilled. If the applicator is new to gopher management, or a little rusty, it's good practice to probe the suspected tunnel area, paying attention to the level of resistance once the probe hits the tunnel, then dig out the tunnel to check whether it's hollow or has been somewhat back-filled, and repeat this testing until the applicator can tell the difference between tunnel types at least four out of five times. Note that these pellets or tablets will only turn to gas if soil moisture is relatively high. If you can ball up a clump of soil at the burrow depth and it maintains that ball in your hand, then soil moisture is high enough to fumigate; if the clump falls apart in your hand, it is too dry. If properly applied, this is often the most efficacious mode for decreasing gopher populations, however it can require more effort because of associated applicator and posting regulations. If there is a large population in an orchard, fumigation with aluminum phosphide is likely worth the effort, but for smaller populations baiting or trapping is likely more time and cost-effective.

Carbon monoxide-generating machines such as the PERC, Burrow Rx, and CO-Jack inject pressurized carbon monoxide exhaust into the burrow system which asphyxiates the pest. Research has shown the PERC machine to be moderately to highly effective against ground squirrels but only moderately effective for pocket gophers. Other pressurized exhaust machines have not been thoroughly tested. Lower effectiveness and higher costs may potentially be offset by the speed at which acreage can be treated, especially for large orchards or high pest populations. For smaller acreage, custom service providers that offer use of these machines as a service may also be an option.

The most appropriate approach for a given orchard will depend on the size of the gopher population, the availability of the material and time, as well as number of acres that the cost of equipment can be shared across. When comparing

efficacy of gopher removal and cost of labor and other inputs (Figure 1), the Baldwin lab found that for infrequent control (e.g. small acreage), fumigation with aluminum phosphide may be the most cost-effective approach. Trapping can be more cost effective after more than a few rounds of use because the traps are re-useable, whereas aluminum phosphide has to be purchased anew each time. Carbon monoxide becomes cost-effective after many more days of application, assuming a machine is purchased. Hiring as a service may be more cost-effective than shown here. Rodenticides were not used in this side-by-side comparison, but would likely be relatively comparable to aluminum phosphide applications if strychnine is applied via an all-in-one probe and bait dispenser.

Whichever approach is used, the most effective population control comes with waiting one to two weeks, then making a second clean-up pass to remove gophers that weren't killed in the first round of treatment. Waiting one to two weeks after the initial treatment period allows you to target remaining gophers that might have been missed the first time given variable mounding efforts by gophers; it can be a week or more between gopher mounding events. A little waiting will make the gophers you missed the first time easier to find the second time.

For more in-depth information on managing pocket gopher, see the Pocket Gopher section of the Vertebrate Pest Control Handbook at http://vpcrac.org/files/3514/7612/1315/Pocket_gopher_chapter.pdf

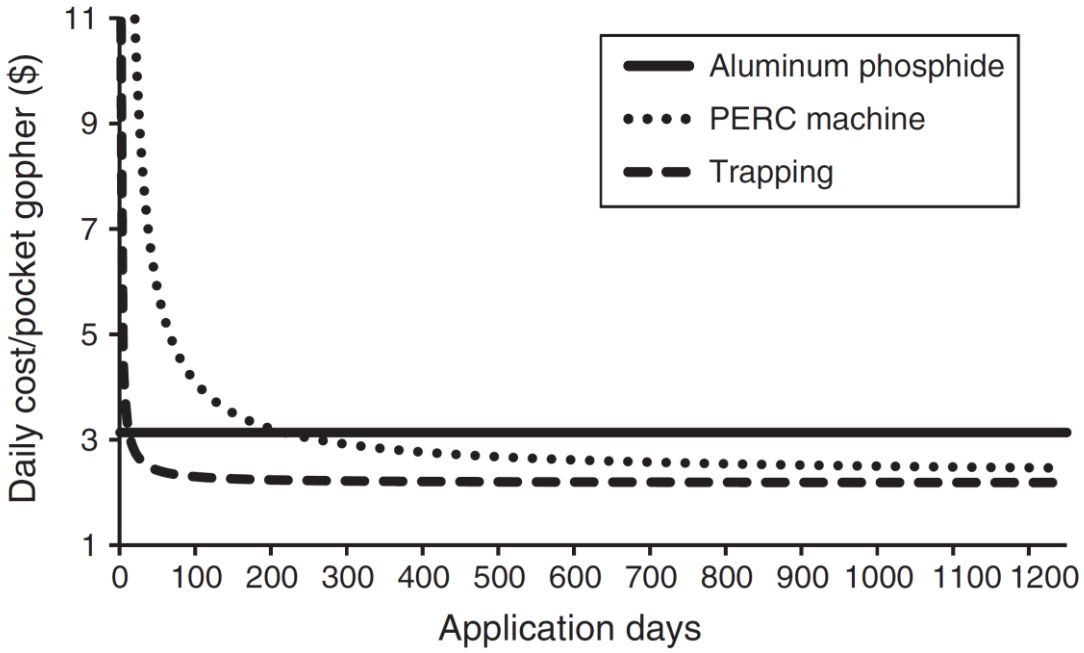

Figure 1. The amortized daily fixed cost plus labor cost per pocket gopher removed for three management tools in alfalfa fields during winter in northern California. These calculations assumed an 8-hour work day at $12 per hour.

Weed management in young almond orchards

Franz Niederholzer, UCCE Farm Advisor, Colusa and Sutter/Yuba Counties

Successful new plantings are key to the economic future of an almond growing operation. Development costs and income expectations are high. Any setbacks in new, non-bearing orchard growth or health can be costly, distracting and stressful.

Weed management is a major management focus and potential stress point in young orchard development. Driven by full sunlight and regular water and nutrient deliveries, rapid weed growth is often much more of a concern in non-bearing blocks than foliar/nut diseases and insects. The journey to a successful, bearing orchard can be rough if weeds get out of control. The following are some considerations to contribute to a smooth(er) trip.

Uncontrolled or poorly controlled weeds use water and nutrients intended for developing trees, hide tree-damaging voles and gophers from predators, and require extra labor to clean up. Heat (propane flamers, etc.) can control weeds, but requires repeat applications and is rough on plastic irrigation hose. Weed cloth controls weeds, but hides vole and gopher activity. Given the current lack of viable alternatives, cost effective weed control practices are largely limited to herbicide use – preemergent, postemergent or both. Both practices (pre or post emergence) can deliver effective weed control, but as challenges (herbicide-resistant weeds) and costs (labor and herbicide) grow, reconsidering costs and benefits of each approach is worth doing. Considerations differ for different aged plantings, so they are addressed by year.

Always consult with a licensed PCA regarding materials, rates and timings before applying a pesticide. Always read the label.

> Know the players in your weed management program. Scout and ID the weeds in an orchard to help determine what materials to use. Not all herbicides control the same weeds equally well. Match the herbicide(s) to the weed(s).

Preplant: Have a weed management plan before planting. Know, if you can, the history of weeds in a block and work to limit those when planting. Pre plant timing use of preemergent herbicides is allowed on a handful of labels ahead of planting. If a preemergent is used ahead of planting, use extra caution when planting, being careful not to place soil with residual herbicide (top couple inches of soil) back into the planting hole after the baby tree has been placed.

First leaf: Staying on top of weeds in the first year after planting is important to get early growth. A strong weed control program in first leaf also helps prevent rodents, especially voles, from damaging the bark. Either pre- or postemergent herbicides can be used in the first leaf (if allowed by the label).

Applying preemergent herbicide(s) helps control weeds without the need for repeated postemergent herbicides through the season, although a small amount of rain or irrigation water is needed within several weeks of application to incorporate these materials. Preemergent herbicide application before or shortly after planting can help reduce risk of weeds out of control in a wet spring when the grower can't get in to spray burndown (postemergent) herbicides. There are only a handful of registered preemergent herbicides for first year use (e.g. Prowl, Surflan, Trellis and Goal), but they are effective on many weeds (see the link to "UC IPM Susceptibility of Weeds in Almond to Herbicide Control" chart at the end of this article). Most of these preemergent herbicides work on the roots of seedling weeds and have limited uptake by aboveground parts of weeds or trees contributing to the margin of crop safety.

Postemergent herbicides such as Rely 280, Treevix, Roundup, Gramoxone, etc., are effective on weeds through the first leaf where trunk protectors (nursery cartons) are in place and in good shape. Without protective cartons/trunk guards, postemergent herbicides can damage vulnerable green bark on first leaf trees. For best results, include surfactant and/or activators on the label at the rates and mixing order listed. Repeat applications are needed when using a " Postemergent only" plan for weed management in the first leaf. As always, match the herbicide to the weeds present and follow the label. For best results, include surfactant and/or activators on the label at the rates and mixing order listed.

Intact trunk protectors (nursery cartons) are a critical part of first leaf weed control. Tree exposures to herbicides should be fairly limited as long as the spray stays below the top of the carton and off low branches. Smooth out row middles wherever possible to keep boom bounce down and the spray away from lower branches.

Second leaf: Postemergent herbicide use in second leaf trees is tricky as protective nursery cartons may have been removed but young trunk bark is still sensitive to certain herbicides. In recent UC research results, trunk protection practices, ranked from worst to best protection, were fresh 50/50 white latex paint/water < 9-week-old 50/50 paint < no paint, 9 weeks after nursery boxes pulled < nursery boxes still on the trees. The somewhat unexpected results about the latex paint was attributed primarily to hardening of the bark after carton removal rather than directly to the paint treatment.

Many preemergent labels allow application after trees have spent a year in the ground. Prior to second leaf, consider applying a preemergent (with postemergent for control of existing weeds) in the winter or early spring while nursery cartons are still protecting the trunks, then remove the cartons and allow the trunk to harden before following up with any postemergent spray(s) in the summer if needed.

Third leaf: The bark on trunks should be tougher at this time, so more options are registered for use at this time due to lower risk of crop injury, but efficacy still hinges on building a strategy based on the particular species you want to manage, when it is most vulnerable.

For the best postemergent herbicide for fleabane control, in research by Dr. Brad Hanson's Lab at UC Davis, Rely 280 (and similar products) or Treevix were the most effective. Tank mixing with glyphosate (Roundup) often delivers the best control across weed species in an orchard. Field bindweed (morning glory) can be controlled with glyphosate but care should be taken to mnimize spray drift and almond trunk exposure because of potential crop injury. Timing is critical to effective weed control with postemergent herbicides. Early is better than later as smaller weeds are easier to control than larger ones. For example, once fleabane "bolts" (changes from the low growing rosette to a more upright form), herbicide control is very difficult.

- Consider managing weeds in the row middles in young blocks so those areas don't become a huge seed bank for the critical zones down the tree row. Cover crops can shade out summer weeds. Other strategies for killing young weeds in the row middle before they set seed include light tilling or herbicide spray(s).
- How a herbicide is applied is important for good results. Spray application of herbicides must be done carefully to put the herbicide where it works on the weeds, not your trees. Smooth row middles reduce chances of boom bounce. This, along with low spray pressure and low-drift nozzles, reduce off-target spraying. Careful training of applicators and setup of spray rigs is also important to a safe and effective spray.
- Systems that trigger sprayer nozzles to spot spray scattered weeds are used effectively in field cropping systems. To my knowledge, this technology is little used in orchards. In a year where herbicide availability is possibly limited, automated spot spraying could be a way to stretch materials while spraying problem weeds that are young and more vulnerable.

Rising costs of labor and postemergent herbicides and an increasing number of glyphosate-resistant weeds makes young orchard weed management an ever-increasing challenge. When looking for successful, cost-effective weed management solutions, consult with your PCA and consider all the timing, material and technological options available.

Online resources for weed management

- Weed ID page: weedid.wisc.edu/ca/weedid.php
- UC IPM Susceptibility of Weeds in Almond to Herbicide Control: ipm.ucanr.edu/agriculture/almond/Susceptibility-of-Weeds-in-Almond-to-Herbicide-Control/
- Weed article: sacvalleyorchards.com/almonds/weed-control/building-an-effective-orchard-weed-management-program/
- UC IPM Integrated Weed Management in Almond https://www2.ipm.ucanr.edu/agriculture/almond/Integrated-Weed-Management/
- UC Weed Sci Blog: ucanr.edu/blogs/UCDWeedScience/
- UC Weed Research and Information Center: wric.ucdavis.edu/
- Paint does not protect young almond trunks: ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=38701

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ALMOND: FUNGICIDE EFFICACY – CONVENTIONAL

Fungicide	Resistance risk (FRAC)[1]	Brown rot	Jacket rot	Anthrac-nose	Shot hole	Scab[3]	Rust[3]	Leaf blight	Alternaria leaf spot [3]	PM-like[5]	Hull rot[16]
Adament	medium (3/11)	5	4	5	5	5	5	ND	5	4	4
Bumper, Tilt, Propicure, Propiconazole[4]	high (3)	5	1	5	3	3	4	ND	3	4	3
Cevya	high (3)	5	1	5	5	3/4	4	ND	4	ND	4
Fontelis[3]	high (7)	5	5	•	5	3	3	ND	4	ND	0
Kenja[4]	high (7)	5	5	•	5	4	0	ND	4	ND	0
Indar	high (3)	5	1	4	3	3	NL	ND	2	ND	0
Inspire	high (3)	5	3	5	3	4	5	ND	5	ND	4
Protocol[2]	med.-high (1/3)	5	5	ND	4	4	5	ND	3	ND	2
Inspire Super[4]	medium (3/9)	5	5	ND	4	4	5	ND	5	ND	4
Luna Experience[3]	medium (3/7)	5	4	5	4	5	5	ND	5	4	4
Fervent	medium (3/7)	5	4	5	4	5	5	ND	5	4	4
Luna Sensation[3,7]	medium (7/11)	5	5	5	5	5	5	ND	5	4	4
Miravis Duo	medium (3/7)	5	4	5	4	5	5	ND	5	4	4
Miravis Prime*	medium (7/12)	5	4	5	5	5	5	ND	5	5	4
Merivon[3,7]	medium (7/11)	5	5	5	5	5	4	ND	5	5	4
Pristine[3,7]	medium (7/11)	5	5	5	5	5	4	ND	4	4	4
Quadris Top[3]	medium (3/11)	5	5	5	4	5	5	ND	4	4	4
Quilt Xcel, Avaris 2XS[3]	medium (3/11)	5	4	5	4	5	5	ND	4	4	4
Quash[4]	high (3)	5	3	5	4	4	5	ND	5	4	4
Rovral oil[8, 9]	low (2)	5	5	0	4	1	3	ND	4	ND	0
Scala[3, 7, 10]	high (9)	5	5	ND	3	0	ND	ND	2	0	0
Tebucon,Toledo, Teb, Tebuconazole	high (3)	5	1	4	3	3	4	ND	2	ND	3
Viathon	medium (3/ P07,33)	5	1	4	3	3	4	ND	2	ND	3
Topsin-M, T-Methyl, Incognito, Cercobin[2,6,7,8]	high (1)	5	5	0	0	4	2	4	0	3	0
Vangard[3, 7,9, 10]	high (9)	5	5	ND	3	0	ND	ND	2	0	0
Abound	high (11)	4	2	•	4	5	5	4	4	4	4
Aproach[3,4,7]	high (11)	4	2	•	4	5	5	4	4	4	4
CaptEvate*	low (M4/17)	4	4	4	4	4	0	4	2	0	0
Elevate[7]	high (17)	4	5	0	2	ND	ND	ND	ND	ND	0
Gem[3,4, 7]	high (11)	4	0	5	4	5	5	4	4	4	4
Laredo, Rally[13]	high (3)	4	0	3	3	0	2	4	0	4	0
Luna Privilege	high (7)	4	3	3	3	4	4	ND	4	3	3
Rovral, Iprodione, Nevado[9]	low (2)	4	4	0	4	0	0	ND	3	0	0
Regev	high (3/BM 02)	5	2	4	3	4	4	ND	4	ND	4
Rhyme	high (3)	4	1	ND	2	3	ND	ND	3	ND	ND
Bravo, Chlorothalonil, Echo[11, 12, 15] (Equus**)	low (M5)	3	NL	4	4	4	5	NL	NL	0	0
Captan[4, 6, 12]	low (M4)	3	3	4	4	3	0	4	2	0	0
ProBLAD Verde	low (BM 01)	3	2	0	0	0	0	0	0	0	0
Mancozeb	low (M3)	3	3	4	4	3	4	4	2	0	0
Ph-D	medium (19)	3	4	0	3	4	4	ND	5	ND	4
Ziram	low (M3)	3	2	4	4	4	0	3	2	0	0
Syllit	medium (U12)	2	0	ND	4	5	ND	ND	2	ND	0
Copper[14,15]	low (M1)	1	1	0	2	2	0	0	ND	0	0
Lime sulfur[12,15]	low (M2)	1	NL	0	1	3	3	NL	NL	0	0
Sulfur[4,12]	low (M2)	1	1	0	0	3	3	0	0	4	0
PlantShield[17]	low (BM 02)	0	0	0	0	0	0	0	0	0	0
Copper 2 oil[14,15]	low (M1)	ND	ND	0	2	4	0	0	ND	0	0

FUNGICIDE EFFICACY - PHYTOPTHORA ROOT AND CROWN ROT (PRCR) USING CONVENTIONAL TREATMENTS

Fungicide	Resistance risk (FRAC Code)[1]	PRCR
Orondis	high (49)	5
Revus**	high (40)	5
Presidio	high (43)	4
Ridomil, Metalaxyl	high (4)	3
Ridomil Gold, Mefenoxam	high (4)	4
Aliette, ProPhyt, Fungi-Phite, K-Phite	low-medium (P07, 33)	4

Rating: 5 = excellent and consistent, 4 = good and reliable, 3 = moderate and variable, 2 = limited and/or erratic, 1 = minimal and often ineffective, 0 = ineffective, NL = not on label, and ND = no data.

*** Registration pending in California. **Not registered, label withdrawn or inactive in California.**

Almond: Fungicide Efficacy, continued

[1] Code 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 Code number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-actions (MOA) with high resistance risk before rotating to a fungicide with a different MOA (Code number); for other fungicides, make no more than two consecutive applications before rotating to fungicide with a different MOA (Code number).

[2] Strains of the brown rot fungi *Monilinia laxa* and *M. fructicola* resistant to Topsin-M and T-Methyl have been found in some California almond orchards. MBC-resistant strains of the jacket rot fungus, *Botrytis cinerea* and powdery mildew fungi, have been reported in California on crops other than almond and stone fruits and may have the potential to develop in almonds with overuse of fungicides with similar chemistry. MBC-resistant strains of the scab fungus, *Venturia* (*Fusicladium, Cladosporium*) *carpophila*, have been found in California.

[3] Field resistance of *Alternaria* sp. and *Fusicladium carpophilum* to QoI and SDHI fungicides has been detected in almond orchards. AP-resistant populations of *Monilinia* spp. have been found on other stone fruit crops in California.

[4] Of the materials listed, only sulfur, Abound, Gem, and some of the DMI fungicides (FRAC Code No. 3) are registered for use in late spring and early summer when treatment is recommended.

[5] PM-like refers to a powdery mildew-like disease on almond fruit. Information suggests an *Acremonium* species is involved.

[6] Excellent control obtained when combinations of Topsin-M or T-Methyl and Captan are used.

[7] To reduce the risk of resistance development, start treatments with a fungicide with a multi-site mode of action; rotate or mix fungicides with different mode of action FRAC numbers for subsequent applications, use labeled rates (preferably the upper range), and limit the total number of applications per season.

[8] Oils recommended include "light" summer oil, 1-2% volume/volume.

[9] Not registered for use later than 5 weeks after petal fall.

[10] Efficacy reduced at high temperatures and relative humidity.

[11] Bravo Ultrex, Bravo WeatherStik, Echo, Echo Ultimate, and Chlorothalonil are currently registered.

[12] Dormant applications with oil are highly effective against scab, Do not use in-season combinations with oil or shortly before or after oil treatment.

[13] Efficacy is better in concentrate (80-100 gal/acre) than in dilute sprays.

[14] The low rates necessary to avoid phytotoxicity in spring reduce the efficacy of copper.

[15] "Burns out" scab twig lesions when applied at delayed dormant. (Chlorothalonil can be applied with dormant oil during tree dormancy).

[16] Hull rot ratings are for the disease caused by *Rhizopus stolonifer*. Ratings for the disease caused by *Monilinia* or *Aspergillus* spp. will be provided in the future.

[17] PlantShield is best used for wood-exposing wounds to prevent silverleaf and wood decay.

ALMOND: FUNGICIDE EFFICACY - BIOCONTROLS AND NATURAL PRODUCTS

Trade name	Biological or natural product (FRAC Code)[1]	Brown rot	Jacket rot	Anthrac-nose	Shot hole	Scab	Rust	ALS	Hull rot	PM-like	Silver leaf	Bac. Spot
Botector	*Aureobasidium pullulans* (BM 02)	3	2	NL	NL	NL	NL	NL	NL	NL	NL	NL
Double Nickel 55	*Bacillus amyloliquefaciens* D747 (BM 02)	2	2	ND	2	NL	NL	NL	NL	NL	NL	2
Serifel	*B. amyloliquefaciens* MBI600 (BM 02)	2	2	NL	2	2	1	1	1	ND	ND	2
Taegro 2**	*B. amyloliquefaciens* FZB (BM 02)	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
Sonata	*B. pumilis* QST2808 (BM 02)	2	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL
Serenade	*B. subtilis* QST 713 (BM 02)	3	3	2	2	1	1	1	NL	ND	NL	3
Aviv	*B. subtilis* IAB/BS03 (BM 02)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dart*	capric and caprylic acids (BM 01)	3	2	ND	2	1	1	2	2	ND	0	3
Cinnacure	cinnamaldehyde (BM 01)	1	1	NL	NL	NL	NL	NL	NL	NL	NL	NL
EF400	clove, rosemary, peppermint oils (BM 01)	1	2	1	NL	ND	NL	NL	NL	NL	NL	NL
BVT CR-7	*Clonostachys rosea* CR-7 (experimental)	4	2	ND	2	ND	ND	ND	ND	ND	ND	ND
BacStop	essential oils (BM 01)	1	1	1	NL	ND	NL	NL	NL	NL	NL	3
Messenger**	harpin (P unspecified)	NL	1	NL	NL	NL	NL	NL	NL	NL	NL	NL
Kasumin	kasugamycin (24)[1]	0	0	0	0	0	0	0	0	0	0	4
ProBLAD Verde*	*Lupinus albus* (BM 01)	3	2	NL	NL	NL	NL	NL	NL	NL	NL	NL
Timorex (Act, Gold)	natural oil (BM 01)	1	1	2	1	2	2	1	ND	2	NL	NL
Trilogy, Rango	neem oil (BM 01)	1	1	1	1	1	2	1	ND	2	NL	NL
Oxidate, Perasan	peroxyacetic acid (oxidizer)	1	2	1	1	NL	NL	1	ND	ND	NL	2
Armicarb**, Milstop	potassium bicarbonate (NC)	NL	NL	NL	NL	1	NL	NL	ND	3	NL	NL
All Phase	potassium sorbate/sodium lauryl sulfate (NC)	NL	NL	NL	NL	2	NL	NL	NL	NL	NL	NL
Howler	*Pseudomonas chlororaphis* strain AFS009 (BM 02)	2	1	NL	NL	NL	NL	NL	NL	NL	NL	3
Regalia	*Reynoutria sachalinensis* (P 05, BM 01)	2	2	1	1	1	1	1	ND	2	NL	3

Actinovate AG	*Streptomyces lydicus* (BM 02)	1	1	NL	NL	NL	NL	NL	NL	1	NL	2
EcoSwing	*Swinglea glutinosa* (BM 01)	3	2	NL	NL	1	NL	1	NL	ND	NL	ND
PlantShield	*Trichoderma harzianum* (BM 02)	NL	NL	NL	NL	NL	NL	NL	NL	NL	4	0
Vintec	*Trichoderma atroverde* (BM 02)[6]	NL	NL	NL	NL	NL	NL	NL	NL	NL	4	0
Procidic	citric acid	ND	ND	ND	NL	NL	NL	ND	NL	NL	NL	NL

Rating: 5 = excellent and consistent, 4 = good and reliable, 3 = moderate and variable, 2 = limited and/or erratic, 1 = minimal and often ineffective, 0 = ineffective, NL = not on label, and ND = no data.

*** Registration pending in California.**

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

[1] Alphabetically arranged organic treatments. Note that kasugamycin is a fermentation (natural) product, but not an organic treatment.

[2] ALS = Alternaria Leaf Spot caused by *Alternaria alternata* and *A. arboresscens*.

[3] PM refers to a powdery mildew disease.

[4] Hull rot ratings are for the disease caused by *Rhizopus stolonifer*.

[5] FRAC Codes are also provided as BM- or P-number codes. In general, sulfur compounds are fungicidal and may affect applications of fungal biocontrols (e.g., Botector); whereas copper may affect applications of bacterial biocontrols (e.g., Actinovate, Double Nickel 55, and Serenade). Rotations must consider these factors.

[6] Labeled for *Eutypa* sp., *Botryosphaeria* sp., *Cytospora* sp., and other trunk diseases of almond.

ALMOND: TREATMENT TIMING

Note: Not all indicated timings may be necessary for disease control.

		Bloom			Spring[1]		Summer	
Disease	**Dormant**	**Pink bud**	**Full bloom**	**Petal fall**	**2 wks**	**5 wks**	**May**	**June/ July**
Alternaria	----	----	----	----	----	++	+++	+++
Anthracnose[2]	----	++	+++	+++	+++	+++	+++	++
Bacterial spot	+	----	++	+++	+++	++	+	----
Brown rot	----	++	+++	+	----	----	----	----
Green fruit rot	----	----	+++	++	----	----	----	----
Hull rot[7]	----	----	----	----	----	----	----	+++
Leaf blight	----	----	+++	++	+	----	----	----
Rust	----	----	----	----	----	+++	+++	+[6]
Scab[3]	++	----	----	++	+++	+++	+	----
Shot hole[4]	+[5]	+	++	+++	+++	++	----	----

Disease	**At planting**	**Spring root flush**	**Summer**	**Fall root flush**
Phytophthora root and crown rot	+++	+++	++	+++

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

[1] Two and five weeks after petal fall are general timings to represent early postbloom and the latest time that most fungicides can be applied. The exact timing is not critical but depends on the occurrence of rainfall.

[2] If anthracnose was damaging in previous years and temperatures are moderate (63°F or higher) during bloom, make the first application at pink bud. Otherwise, treatment can begin at or shortly after petal fall. In all cases, application should be repeated at 7- to 10-day intervals when rains occur during periods of moderate temperatures. Treatment should, if possible, precede any late spring and early summer rains. Rotate fungicides, using different fungicide classes, as a resistance management strategy.

[3] Early treatments (during bloom) have minimal effect on scab; the 5-week treatment usually is most effective. Treatments after 5 weeks are useful in northern areas where late spring and early summer rains occur. Dormant treatment with liquid lime sulfur improves efficacy of spring control programs.

[4] If pathogen spores were found during fall leaf monitoring, apply a shot hole fungicide during bloom, preferably at petal fall or when young leaves first appear. Reapply when spores are found on new leaves or if heavy, persistent spring rains occur. If pathogen spores were not present the previous fall, shot hole control may be delayed until spores are seen on new leaves in spring.

[5] Dormant copper treatment seldom reduces shot hole infection but may be useful in severely affected orchards and must be followed by a good spring program.

[6] Treatment in June is important only if late spring and early summer rains occur.

[7] Make application at 1 to 5% hull split to manage hull rot caused by *Rhizopus stolonifer*; use earlier June timings for hull rot caused by *M. fructicola.* Apply a second application, mid-way through hull split especially if hull split is progressing slowly.

ALMOND: SUGGESTED DISEASE MANAGEMENT PROGRAMS BY FRAC[1] CODES - CONVENTIONAL GROWERS

Note: Not all indicated timings may be necessary for disease control (*see* Treatment Timing Table). If treatments are needed based on host phenology, weather monitoring, inoculum models, or environmental-disease forecasting models, suggested fungicide Codes are listed for each timing.

How to use this table:

1) Identify the disease(s) that need(s) to be managed. Know the disease history of the orchard, especially from the last season.
2) Select one of the suggested fungicide Codes. *Numbers separated by slashes are pre-mixtures, whereas numbers separated by pluses are tank mixtures.* If several diseases need to be managed, select a Code that is effective against all diseases. Refer to the fungicide efficacy table for fungicides belonging to each FRAC Code. Code numbers are listed in numerical order within the suggested disease management program.
3) Rotate Codes for each application within a season and, if possible, use each Code only once per season, except for multi-site mode-of-action materials (e.g., M2).

Disease	Dormant	Bloom			Spring		Summer	
		Pink bud	Full bloom	Petal fall	2 weeks	5 weeks	May	June/July
Alternaria	----	----	----	----	----	2	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, 19	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, 19
Anthracnose	----	3, 3/7, 3/9, 3/11, 3/33, 7	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11	3, 3/9, 3/7, 3/11, 3/33, 11, M3, M4, M5	3, 3/9, 3/11, 3/7, 3/33, 7, 7/11, 11, M3, M4, M5	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11 M3, M4, M5	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, M4	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 11, M4
Bacterial spot	M1, M1+M3	----	M1, M1+M3	M1, M1+M3	M1, M1+M3	M1, M1+M3	M1	----
Brown rot	----	1[2], 2 +oil, 3, 3/7, 3/9, 3/11, 3/33, 9	1[2], 2 +oil, 3, 3/7, 3/9, 3/11, 3/33, 7, 7/11, 9, 11, 19	1[2], 2 +oil, 3/11, 3/33 7, 7/11, 9, 19	----	----	----	----
Jacket rot	----	----	1[2], 2 +oil, 3/7, 3/9, 3/11, 7, 7/11, 9, 19	1[2], 2 +oil, 3/7, 3/9, 3/11, 7, 7/11, 9, 19	----	----	----	----
Hull rot[5]	----	----	----	----	----	----	3, 3/7, 3/9, 3/11, 7/11, 11, 19	3, 3/7, 3/9, 3/11, 7/11 11, 19
Leaf blight	----	----	1[2], 2, 3, 3/7, 3/9, 3/11, 3/33, 11	1[2], 2, 3, 3/7, 3/9, 3/11, 3/33, 11, M3, M4, M5	3, 3/7, 3/9, 3/11, 3/33, 11, M3, M4, M5	----	----	----
Rust	----	----	----	----	----	3, 3/7, 3/11,3/33[1], 7, 7/11, 11, 19 M3	3, 3/7, 3/11, 3/33, 7, 7/11, 11, 19	3, 3/7, 3/11, 3/33, 7, 7/11, 11, 19
Scab[4]	M1+oil, M2[3], M5+oil	----	----	1[2], 3/7, 3/9, 3/11, 3/33, 7, 7/11[2], 11[2] M3, M4, M5	1[2], 3/7, 3/9, 3/11, 3/33, 7, 7/11[2], 11[2] M3, M4, M5	3, 3/7, 3/9, 3/11, 3/33, 7, 7/11[2], 11[2] M2[3], M3, M4	M2[3], M4	----
Shot hole	M1	2, 3, 3/7, 3/9, 3/11, 7, 9, 11	2, 3, 3/7, 3/9, 3/11,7, 7/11, 9, 11, 19	2, 3, 3/7, 3/9, 3/11, 7, 7/11 9, 11, 19	7, 7/11, 11, 19, M3, M4, M5	7, 7/11,11, 19, M3, M4, M5	----	----

[1] Code numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Code numbers are listed in numerical order within the suggested disease management program. Fungicides with a different Code number are suitable to alternate in a resistance management program. Refer to the fungicide efficacy table for fungicides belonging to each FRAC Code. Note: FC 33 is currently P 07.

[2] Strains of *Monilinia fructicola* and *M. laxa* resistant to Topsin-M and T-Methyl are present in some California almond orchards. Resistant strains of the jacket rot fungus, *Botrytis cinerea*, and powdery mildew fungi have been reported in California on crops other than almond and stone fruits and may have the potential to develop in almond with overuse of fungicides with similar chemistry.

[3] Use liquid lime sulfur in dormant applications and wettable sulfur at and after pre-bloom.
[4] Apply petal-fall treatments based on twig-infection sporulation model.
[5] Effective hull rot management is dependent on integrated strategies including dust control, reduced irrigation, and limiting nitrogen fertilization prior to and during hull split, as well as ensuring adequate air circulation (appropriate pruning or hedging practices) in the orchard.

ALMOND: SUGGESTED DISEASE MANAGEMENT PROGRAMS BY FRAC[1] CODES - ORGANIC GROWERS

Note: Not all indicated timings may be necessary for disease control (*see* Treatment Timing Table). If treatments are needed based on host phenology, weather monitoring, inoculum models, or environmental-disease forecasting models, suggested fungicide Codes are listed for each timing.

How to use this table:

1) Identify the disease(s) that need(s) to be managed. Know the disease history of the orchard, especially from the last season.
2) Select one of the suggested fungicide Codes. If several diseases need to be managed, select a Code that is effective against all diseases. Refer to the fungicide efficacy table for fungicides belonging to each FRAC Code. Code numbers are listed in numerical order within the suggested disease management program.
3) Rotate Codes for each application within a season and, if possible, use each Code minimally per season.

Disease	Dormant	Bloom			Spring		Summer	
		Pink bud	Full bloom	Petal fall	2 weeks	5 weeks	May	June/July
Alternaria	----	----	----	----	----	BM 01, BM 02, oxidizer	BM 01, BM 02, oxidizer	BM 01, BM 02, oxidizer
Anthracnose	----	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer
Bacterial spot	M1 + BM 01 (oil)	----	BM 01, BM 02, M1, oxidizer	BM 01, BM 02, M1, oxidizer	BM 01, BM 02, M1, oxidizer	BM 01, BM 02, M1, oxidizer	BM 01, BM 02, M1, oxidizer	----
Brown rot	----	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	----	----	----	----
Jacket rot	----	----	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02 P 05, oxidizer	----	----	----	----
Hull rot[2]	----	----	----	----	----	----	----	BM 01, BM 02
Leaf blight	----	----	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	----	----	----
Rust	----	----	----	----	----	BM 01, BM 02, P 05, M2	BM 01, BM 02, P 05, M2	BM 01, BM 02, P 05, M2
Scab[3,4]	M1 + BM 01 (oil), M2	----	----	BM 01, BM 02, P 05, NC	BM 01, BM 02, P 05, NC	BM 01, BM 02, P 05, NC	BM 01, BM 02, P 05, NC	----
Shot hole	M1 + BM 01 (oil)	M1+BM 01 (oil)	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	BM 01, BM 02, P 05, oxidizer	----	----

[1] Code numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://www.frac.info/). Code numbers are listed in numerical order within the suggested disease management program. Fungicides with a different Code number are suitable to alternate in a resistance management program. Refer to the fungicide efficacy table for fungicides belonging to each FRAC Code.
[2] Effective hull rot management is dependent on integrated strategies including dust control, reduced irrigation, and limiting nitrogen fertilization prior to and during hull split, as well as ensuring adequate air circulation (appropriate pruning or hedging practices) in the orchard.
[3] Use liquid lime sulfur in dormant applications and wettable sulfur at and after pre-bloom.
[4] Apply petal-fall treatments based on twig-infection sporulation model.