



In This Issue



- Why are some individual trees turning yellow and not growing?
- 2015 In-season naval orangeworm update
- Almond canopy cankers
- Non-infectious bud failure management
- Weak areas in orchards . . . dead roots?
- Pre-harvest almond orchard management considerations

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Why are some individual trees turning yellow and not growing?

Joseph Connell, UCCE Farm Advisor Emeritus, Butte County

When an individual tree turns yellow compared to all of its neighbors it often indicates there is something going wrong in the root system. The yellowing often shows up at the time the weather turns hot and the compromised roots are unable to keep up with the water needs of the tree. There are a variety of potential causes for these symptoms and they can't all be fully explained here but I'll comment on some of the main things we see on farm calls.

Soil borne diseases. The two most common diseases affecting the crown and root system are *Phytophthora* and *Armillaria*. Both diseases cause similar above ground symptoms: poor terminal growth, small chlorotic leaves, premature defoliation, and decreased productivity, branch dieback and ultimately, tree death.

For *Phytophthora*, disease severity depends upon *Phytophthora* species, soil type, climatic conditions and tree age. *Phytophthora* affects the inner bark and cambium and typical root or crown cankers will be brownish with a fairly distinct margin as the fungus advances. Removal of the outer bark often reveals brown tissue with a water soaked zonate appearance near the margin between healthy white and infected tissues if the fungus is active. Excessive soil moisture and saturation such as occurred in the two heavy storms last winter favors infection.

Armillaria mellea or oak root fungus is identified by cutting into crown or root tissue and looking for whitish fungal plaques growing between the bark and wood. Whitish fungal strands and gumming are also commonly found in infected bark. Finding rhizomorphs, fungus signs that resemble brown to black shoestrings adhering to the outer bark of infected roots is a positive confirmation of *Armillaria*. They develop best in moist soil. *Armillaria* often produces clusters of mushrooms around the base of infected trees following rainfall from November to February. When newly planted in an infected site it usually takes about four years for a susceptible tree to show symptoms of *Armillaria*. Infected trees may die suddenly when the heat of summer arrives.

Another soil borne disease that can weaken trees, crown gall, is caused by the bacterium *Agrobacterium tumefaciens* and is relatively easy to identify. Galls are made up of undifferentiated, disorganized tissue growths on roots and/or the tree crown. Galls most often develop on root or crown tissue underground and may not be noticed. As galls enlarge, the center of the gall dies creating a dead wood area that can be infected by wood rotting fungi. These galls and wood rots were shown to be related to 85% of the trees lost in windstorms in surveys previously conducted in the Chico area. Trees with severe crown gall infection and girdling may be stunted and may display poor growth and yellow foliage. Before almond trees succumb to crown gall itself they often topple over from structural weakening related to the wood rots.

compatible with almond, a young orchard planted on heavy clay adobe soil displayed interveinal yellowing symptomatic of manganese deficiency. Micronutrient deficiencies occur in soil related areas and are more prevalent when soils are cold or too wet thus reducing feeder root activity and nutrient uptake.

When soils are too wet during the growing season due to late rains or over irrigation, young trees on Krymsk 86 may turn yellow similar to the union mild etch (UME) problem that occurs on Marianna 2624 plum rootstock. In addition to yellowing, more severe symptoms can include rolled drooping leaves and a cessation of shoot growth. When the problem is recognized and irrigation is optimized, some affected trees will put out a new flush of growth. Other trees will remain stalled for the current season but recover over winter and resume normal growth the following year.

Vertebrates. Pocket gophers are serious pests especially in young orchards. Root damage results in a yellow, stressed canopy, and poor tree growth. Gopher girdling on the crown mimics *Phytophthora* root rot, oak root fungus, union mild etch on Marianna 2624 rootstock, or the yellow tree problem on Krymsk 86 rootstock. Trees die when completely girdled. Gophers can easily kill two to four year old trees, but I've seen 10 year old trees girdled and killed by gophers as well. Look for missing bark and parallel tooth marks on the wood at feeding sites about 6 inches below ground where the bark has been chewed away in a girdle about 4 to 6 inches wide.

Voies, also called meadow voles or meadow mice, may move into orchards and feed on the bark of young trees at the ground surface particularly if vegetation around tree trunks offers cover and protection. Mainly a problem on first year trees, their girdling produces symptoms similar to gopher damage. Rodents are potential pests in all orchards, but they are more likely to invade orchards that provide good cover with a cover crop or where they can migrate in from rangeland or unmanaged areas.



2015 In-season navel orangeworm update

*Emily J. Symmes, UCCE Area IPM Advisor, Sacramento Valley
Franz Niederholzer, UCCE Farm Advisor, Colusa, Sutter and Yuba Counties*

As traditional Nonpareil hullsplit treatments for navel orangeworm (NOW) have come and gone and we are hurling toward Nonpareil harvest, an update on this season's unusual NOW observations is warranted. NOW pressure has been considerably higher in 2015 than typical for the Sacramento Valley. Like last year, earlier than usual third and fourth NOW generations may necessitate additional management considerations leading into harvest of both Nonpareil and pollinizers. These additional considerations are particularly important given high nut prices. In short, heads up for NOW this year or it could cost you dearly.

Navel orangeworm populations build from generation to generation through a growing season, with increasing risk of nut damage from each successive flight. Joe Connell, UCCE Farm Advisor Emeritus in Butte County, recently told a group of farm advisors that in his 38-year career, the worst years for NOW damage were those with dry winters and at least a partial fourth generation. We are on track for that in the Sacramento Valley this year.

What happened? Biofix was early – late March in many locations, not the “normal” early to mid-April. On top of that, second generation eggs were observed in many locations beginning around 750 degree days (DD) from spring biofix, not the 1050 DD predicted for first generation NOW developing on mummy nuts. This underscores the importance of continuing to monitor egg traps after establishing spring biofix to verify what is happening in the orchard, rather than relying on degree days alone.

Why the more rapid developmental time on mummy nuts this year? The shorter development time (750 DD) is predicted for worms feeding on new crop nuts (generations 2, 3, and 4). Possibly the lack of winter moisture, which typically leads to mold growth and kernel deterioration, resulted in more mummy nuts with nutritional

characteristics similar to new nuts. This would have provided a “better” quality diet leading to more rapid larval development of the first generation.

Based on earlier than normal biofix, quicker development of the first generation, and the extreme temperatures recorded in June, third generation egg laying is likely occurring as this article goes to press (mid-July). Fourth generation egg laying is anticipated to begin within the next month (in August!) depending on temperatures, possibly before NPs are out of the orchard, and will certainly impact pollinizers.

With high pressure and high nut value, what can growers do to deliver the highest quality product this year? The following are several suggestions:

- Consult with an experienced PCA regarding flight timings and harvest schedule.
- Shake all varieties as quickly as possible after 100% hullsplit. Nuts on the orchard floor are less likely to have eggs laid on them than those still in the tree. Make sure that hullsplit is complete across the entire orchard before shaking to reduce tree injury from longer shakes and damage at the huller.
- Continue monitoring egg laying to gauge the threat during harvest operations and help time late season insecticide applications if necessary. Crack out early maturing nuts to see how much damage is present to help with decisions for stockpile fumigation and pollinizer protection. Growers with little external NOW pressure, located at least a quarter of a mile away from other nut orchards and with solid NOW control programs in their own orchards (sanitation + effective Nonpareil hullsplit sprays + timely harvest) should see less pressure and may not need further sprays.
- Growers with significant outside NOW pressure, even with strong NOW control programs in their own orchard(s) may need to spray their pollinizers after Nonpareil pickup to reduce NOW damage.
- If additional insecticide sprays are needed after Nonpareil pickup, rotate insecticide chemistry or tank mix products to reduce the risk of insecticide resistance in NOW. *Bacillus thuringiensis* (Bt) sprays have 4-hour reentry and 0-day pre-harvest intervals if the spray window is very short.



Almond canopy cankers

Dani Lightle, UCCE Farm Advisor, Glenn, Butte & Tehama Cos.

I have made several farm calls this year to orchards with copious gumming on main scaffolds (Fig1). Peeling back the bark reveals large cankers (Fig2). It is too soon to say whether these particular trees will outgrow these infections or if the scaffolds will be lost. This disease is a more newly described phase of band canker known as the canopy phase. Band canker and the canopy phase shown in Figs 1-2 can be caused by any one of several species of fungi in the *Botryosphaeriaceae* family that are pathogenic to almonds.

Young, vigorous almonds tend to be the most susceptible to band canker. The pathogen utilizes entry points such as growth cracks and wind cracks, lenticels, and broken shoots or pruning wounds. Other known risk factors for band canker include proximity of the orchard to alternate host plant species, including riparian areas, eucalyptus trees, or walnut orchards that have high levels of inoculum on dead wood that has not been removed. Previous research by UC plant pathologist Themis Michailides showed infection rates were greatest on almond trees closest to riparian areas or to an old walnut orchard, with rates declining throughout the orchard when moving away from these alternate hosts.

The best management approach for reducing the size and incidence of cankers is to use splitters to prevent water from hitting tree trunks and, when using solid set systems, out of the canopy. Growers with young orchards planted on vigorous rootstocks like Hansen or Nickels may want to moderate tree growth to minimize growth cracks. Do not prune ahead of forecast rain. Tying trees to prevent wind cracks may also help reduce infections.

Once a tree has cankers there is no cure other than pruning out branches if the canopy phase is present. Previous work by Dr. Michailides was not able to reduce canker damage by spraying, painting, or injecting the cankers

with fungicides or other biological agents. Depending on the site of infection, cankers can be removed by pruning 3"-6" below the canker margin. Diseased wood should be removed from the orchard to remove inoculum that can cause infections in future years. In general, trees begin to outgrow susceptibility once they are beyond 6th leaf.

Figure 1. Black arrows point to amber gumming on multiple scaffolds of this tree.



Figure 2. Peeling away the bark on this primary scaffold reveals dark cankers.

Non-infectious bud failure management

Joseph Connell, UCCE Farm Advisor Emeritus, Butte County

It's well known that non-infectious bud failure (also known as crazy top, fig. 1) is a genetic disorder that occurs in many almond varieties in California. Nonpareil or any variety with Nonpareil parentage in its genetic background can be affected by the disorder, most notably Carmel. This year was a bad one for the expression of non-infectious bud failure (BF) symptoms. We had a heat wave in June 2014 as we did in June again this year. Since BF is more severe in warmer areas of California and following a hot June the previous year, expect BF to be expressed clearly once again in spring 2016.

BF does not affect the flower buds. Flowers form and bloom normally although the bloom time is usually delayed by four to seven days. It is the vegetative shoot buds that actually fail. Yield losses occur because fruit wood development is reduced and possibly because more limited leaf surface reduces carbohydrate production. On individual shoots affected by BF the basal or terminal buds are more likely to survive since they grow during cooler times of the season. Pruning won't eliminate the problem. Re-growth that occurs following pruning has at least the same potential to develop BF as the tree had prior to pruning.

Various sources of a variety have different BF potential. The key element of control is the selection of single-tree sources whose low BF potential is determined by growing progeny trees under orchard conditions in a high temperature area. If BF is initially expressed in trees early in their training stage (up to 4 years), expression is severe because a large part of the tree is affected. If symptoms are initiated later, lesser expression results and affected parts are confined to smaller areas in the top or periphery of the tree. This is the basis of recommending BF trees be removed if symptoms develop during the early orchard development period.



Fig. 1. Young almond tree expressing non-infectious bud failure.

There are three options for dealing with a BF problem in your orchard. First, you can simply continue to maintain the BF trees (this is usually the best option in older trees). Second, it's possible to top work the affected trees by budding or grafting using wood with a lower BF potential but this takes considerable attention to detail. Finally, replacing the tree by replanting is another option. Top working or replanting is a good choice if the trees are noticed in the second to fourth leaf (the sooner the better). **So, make a major effort to detect BF in the second to fourth leaf.** Once trees are mature, replacing the tree should be done only if there is sufficient time left in the orchard's life to recoup the cost of the new tree and the yield lost from the BF tree while the replacement tree is coming into bearing. Generally, the orchard must have more than 10 years of life remaining to justify replacing a BF tree.

Early BF diagnosis is critical in reducing the time to a break-even yield. The first opportunity to observe BF in a new orchard is the spring of the second leaf. Observations must be made in March or April when symptoms are clearly visible since new growth from the surviving buds can mask BF later in the season. If trees are long pruned in the first dormant season the symptoms will be more obvious in the second leaf. Short pruning tends to mask the symptoms until pruning is reduced in the second or third dormant season.

BF has the greatest impact on future productivity when second through fourth leaf trees are affected. Replanting or top working any tree showing even mild symptoms at that time should have beneficial yield effects in four to five years. Mild BF symptom expression after the fourth leaf may not warrant tree replacement. Severe BF may continue to warrant replacement until about the eighth or ninth leaf.

For trees five to six years old, replace the trees only if BF is affecting the main framework of the tree. If you find trees like this it means you probably overlooked them when they first showed subtle signs of the disorder in their second or third leaf. Mild BF affecting only the upper canopy may not seriously affect yield.

When older trees become affected, do nothing. The cost of replacement and the yield loss following tree removal will not be offset by increased production before the orchard is removed. When BF is restricted to upper portions of the canopy there's less impact on productivity.

Avoid any stress in the orchard that can raise canopy temperatures. Anything that can cause defoliation such as water stress, mites, scab, or leaf rust could contribute to higher canopy temperatures and potentially aggravate BF expression.



Weak areas in orchards...dead roots?

Joseph Connell, UCCE Farm Advisor Emeritus, Butte County

Many orchards may have a spot where trees are weaker or dying for one reason or another. Nematode feeding sometimes results in weaker areas and oak root fungus can kill trees on susceptible rootstocks when it's present. Most often the weak area is related to a soil type or a soil profile that's different from the rest of the orchard. When we see weak trees that are pale in color, have little new growth, or have more dead wood or branch dieback, it's usually an indication the roots are not healthy. When I have an opportunity to examine the root system of such trees by looking at roots in a backhoe trench there is often some sort of restrictive soil layer that limits the depth of rooting, often to only a couple of feet deep.

Sometimes these soil layers are an obvious change in texture from a sandy loam to a clay loam or from a sandy loam to a sandy or gravelly layer. Frequently, the change is much more subtle and may only be a slight but abrupt change in soil density, color, or texture. In the backhoe trench you can often feel the density change by probing the soil with a knife. Whatever the case, when roots stop at a certain depth the roots can tell the difference and their growth is limited by the soil profile change whether it's a restrictive layer or a more permeable layer.

These changes usually affect the way water moves through the root zone. Right above a profile change, drainage may be poor and the soil can remain saturated long enough to create waterlogging and root asphyxiation. Exploring the root system, you may find a few dead roots in the profile just above the soil change. Most of the roots, especially those closer to the surface are usually healthy, but waterlogged roots can die from lack of oxygen (saturated soil can also lead to phytophthora infection and root or crown rot). Even a few significantly compromised roots can be enough of a problem to create weak growth in the trees and a weak area in the orchard.

So why does this occur in what might once have been a healthy orchard? It's the extreme weather events that initiate this type of decline. An example would be times when it rains heavily and constantly for a week such as the storms last December. This type of saturation can drown out some roots in the profile without killing the whole tree. *It may be a year or two after extreme events before the affected area is weak enough to be noticed.* Once tree root systems are injured by excessive rainfall it's easy for the weak areas to be overwatered when irrigating. This compounds the problem making it difficult to overcome. Reducing nozzle sizes in weak areas in an orchard may help mitigate over-irrigation.

Trees in such a weak area may gradually decline in vigor until it becomes obvious they need to be removed. The key to solving this problem when replanting is to understand it in the first place. Simply pulling out a weak tree and replanting won't usually solve the problem. Identifying the problem by looking at the root system in the soil profile before the tree is pulled out and recognizing the limitation is the first step. Then, when removing the tree, be sure to backhoe deep and wide enough to disrupt any restrictions present and give the new tree a chance to grow without encountering the same problem. Sometimes using a different, more vigorous rootstock or one that is more resistant to waterlogging or root rot may help a new tree overcome the problem.

Remember, you'll need to take the time to correctly diagnose the problem and understand what's needed if you expect to fix it successfully. Contact your local Farm Advisor if necessary.



Pre-harvest almond orchard management considerations

Luke Milliron, UCCE Horticulture Intern, Yuba, Sutter and San Joaquin Counties.

Water Management:

- ✓ A strategy for hull split deficit irrigation, proper irrigation leading into harvest and avoiding postharvest water stress can be found at thealmonddoctor.com/2012/08/05/irrigating-from-hull-split-to-harvest.

Nutrition Management:

- ✓ Take a hull sample for boron analysis.
See thealmonddoctor.com/2014/07/12/hull-sampling-for-boron for more information.
- ✓ Plan for proper postharvest nutrient application.
See thealmonddoctor.com/2013/08/17/postharvest-fertilization-qa for more.

Harvest:

- ✓ Concerned about rain at harvest? See “Coping with Rain at Harvest” on page 6 of cete.hama.ucanr.edu/newsletters/Fruit - Nut Newsletters43816.pdf for a decision rubric across a range of current orchard conditions and 5-day weather forecasts.
- ✓ Collect and freeze a sample of at least 100 nuts per orchard after shaking, but before sweeping. Sampling allows you to monitor pest levels for informed pest management decisions next year and to compare damage levels to your grade sheets. Sampling and pest damage diagnosis help can be found at: ipm.ucdavis.edu/PMG/C003/m003hcharvstsmpl.html
- ✓ Assess trunk damage following shaking operations.

Insect Management:

- ✓ Concerns about navel orangeworm (NOW) are high this season. Information on timing sprays and harvest can be found in “2015 In-Season Navel Orangeworm Update” (*see article in this newsletter*).
- ✓ Sweep and pick up nuts as soon as possible to avoid damage from protein-feeding ants. Apply a bait application if warranted by May and June monitoring levels. Control information at: ipm.ucdavis.edu/PMG/r3300411.html
- ✓ Continue monitoring at least weekly for spider mites and their predators through August. Use UC IPM thresholds to determine if a miticide is necessary. Monitoring and control information at: ipm.ucdavis.edu/PMG/r3400211.html

Disease Management:

- ✓ Assess the effectiveness of hull rot cultural controls (avoiding excessive nitrogen fertilization and imposing moderate water stress at hull split) after harvest. Hull rot is indicated by dead, stuck-on leaves, shoot dieback and black fungal growth on the inside of the hull or tan fungal growth on the inside or outside of the hull. More identification help can be found at: ipm.ucdavis.edu/PMG/r3101811.html.
- ✓ Monitor for rust and shot hole after harvest. Carefully monitor for black specked (fruiting body) leaf lesions of shot hole fungus. These indicate a build-up of overwintering spores, increasing potential spring disease pressure. If a zinc sulfate spray is applied for zinc nutrition, the resulting defoliation may also reduce rust and shot hole disease pressure. Monitoring and control information can be found at: Rust: ipm.ucdavis.edu/PMG/r3100711.html

Shot Hole: ipm.ucdavis.edu/PMG/r3100211.html

Weed Management:

- ✓ A postharvest weed survey allows you to identify weeds that have escaped your control program this season, as well as identify newly emerging winter weeds. The weed survey form and weed identification links are at: ipm.ucdavis.edu/PMG/C003/m003pcweeds02.html