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Distribution of chlorosis in almond orchards may help assess potential irrigation-related issue

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The first step in assessing the cause of canopy chlorosis and decline in an orchard is mapping the distribution of the symptoms. If a pattern of chlorosis is similar across irrigation lines, then the cause of the problem may be related to over- or under-watering. Two scenarios present themselves regularly during summer farm calls: a) terminal tree chlorosis, and b) within row tree chlorosis (Figures 1 and 2).

Terminal Tree Chlorosis. In some orchards, the terminal tree along the irrigation line may become chlorotic and decline in advance of mortality. If terminal tree chlorosis is a trend throughout the orchard, it is worth assessing the sprinkler distribution at the end of the irrigation lines. In some orchards, the terminal tree is outfitted with a sprinkler that is not shared with a neighboring tree (Figure 2A). This terminal tree receives 1.5 x the amount of water as the other 'healthy' trees down the irrigation line. In an otherwise adequately-irrigated orchard, these terminal trees are over-irrigated and develop chlorosis and decline. Sometimes the terminal sprinkler is positioned adjacent to the trunk (Figure 3), resulting in direct wetting of the trunk, a condition that predisposes the tree to *Phytophthora* infection, particularly when surface water is utilized.

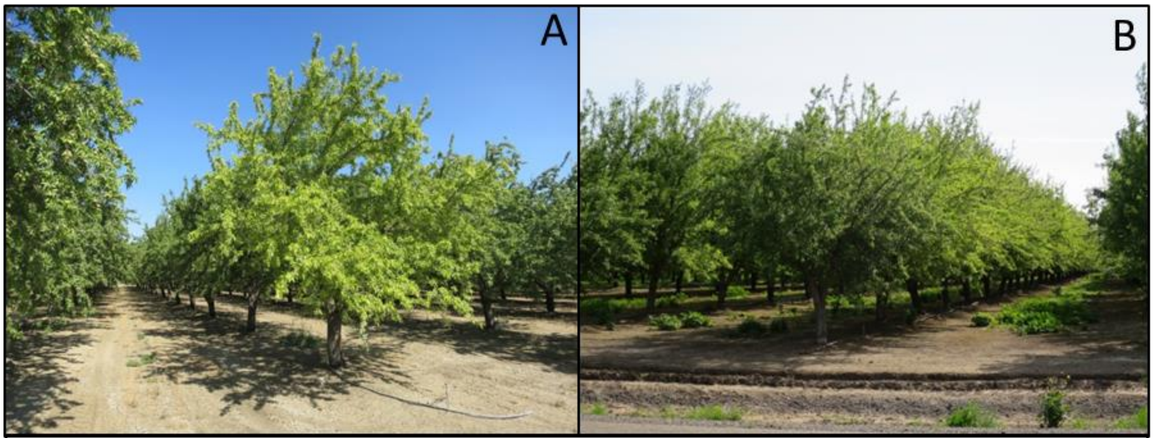
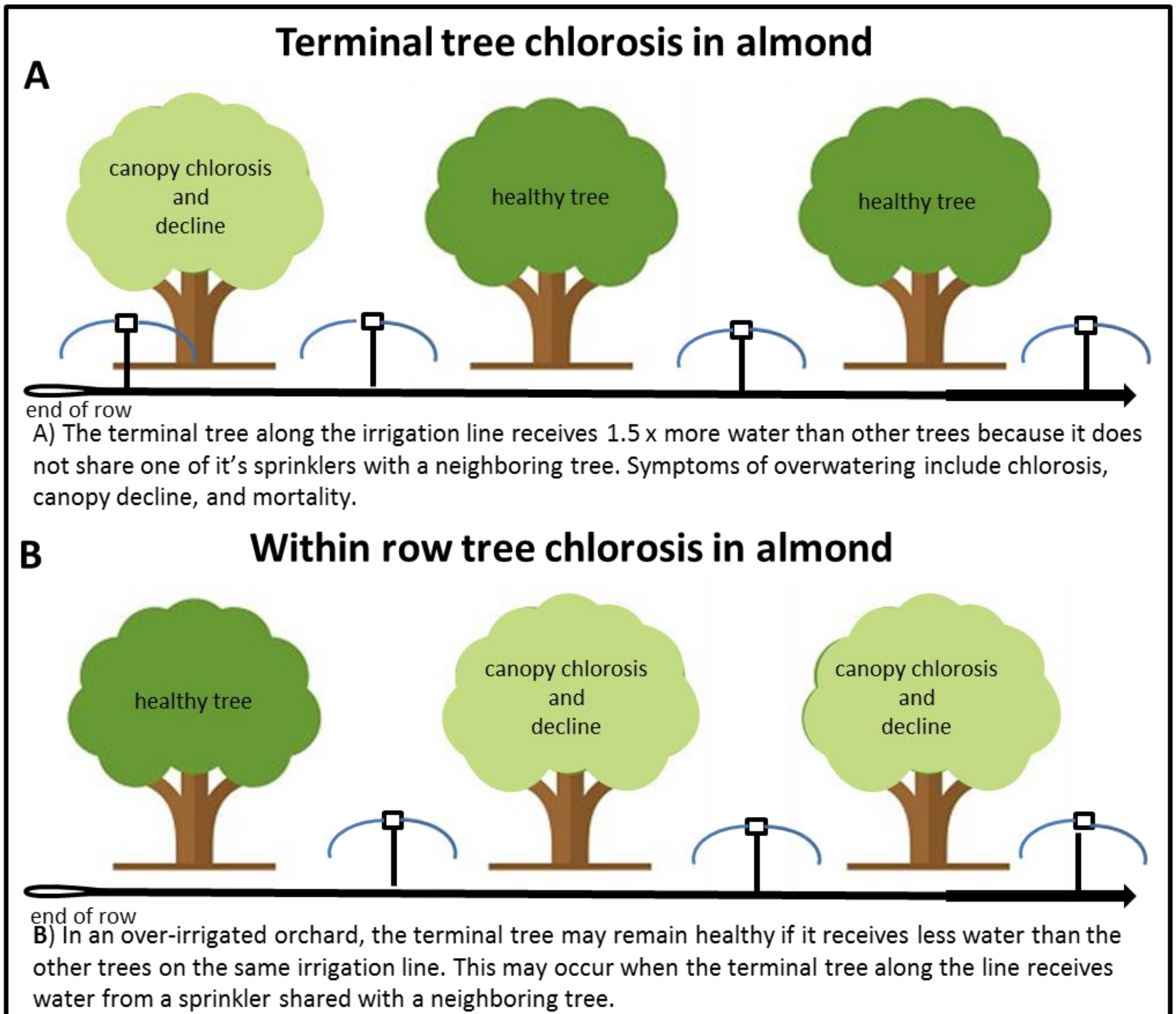


Figure 1. A) Chlorosis of end tree indicates excessive water on last tree in row; B) Chlorosis of overall orchard with healthy tree at end of row indicates overwatering at orchard level, and appropriate water to end tree. (Photos: B. Lampinen)

Correcting terminal tree chlorosis: To correct the over-irrigation of the terminal tree, the microsprinkler head can be changed to a lower flow rate. Sprinklers should be placed away from the base of trees to prevent direct contact of the trunk with the stream of water. Additionally, when replanting dead or declining trees at the end of rows, consider that the irrigation needs of the replant are considerably lower than that of the neighboring older tree in the row.

Within-row chlorosis. If canopy chlorosis is consistent throughout the orchard, but terminal trees appear healthy, assess the distribution of sprinklers around the terminal tree in comparison to the trees along the irrigation line. If the terminal tree receives less water (Figures 1B and 2B) than adjacent chlorotic trees, consider the potential that the orchard, as a whole, is over-irrigated.



A) The terminal tree along the irrigation line receives 1.5 x more water than other trees because it does not share one of it's sprinklers with a neighboring tree. Symptoms of overwatering include chlorosis, canopy decline, and mortality.

B) In an over-irrigated orchard, the terminal tree may remain healthy if it receives less water than the other trees on the same irrigation line. This may occur when the terminal tree along the line receives water from a sprinkler shared with a neighboring tree.

Figure 2. To determine whether chlorosis and tree decline are related to over- or under-watering, look for consistent patterns across rows.

To test this hypothesis, growers and orchard managers can use a pressure chamber to assess the midday stem water potential of the trees. Almond trees maintained from $^{-}6$-$^{-}10$ bar are under low water stress, but may be more susceptible to disease. Maintenance of almonds at -10--14 bar (mild stress) from mid-June through hull split, minimizes risk of disease (ie. hull rot) and supports shoot growth. For information on use of a pressure chamber for enhanced irrigation management of almond, walnut and prune, download UC ANR Publication #8503 (http://ucanr.edu/datastoreFiles/391-761.pdf).

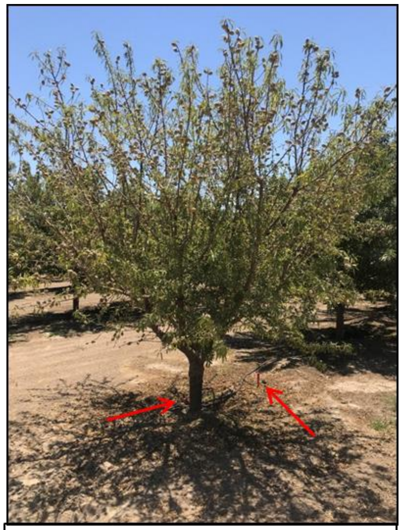


Figure 3. The terminal tree has a microsprinkler adjacent to the trunk that is not shared with an adjacent tree. The chlorosis and subsequent decline of the terminal tree is consistent across the orchard. Red arrows point to microsprinklers.

Correcting within-row chlorosis: If the orchard at large is over-irrigated, a change in the overall irrigation strategy is warranted. A combination of pressure chamber use to measure tree water stress, and consideration of weekly crop transpiration may enhance irrigation scheduling. The California Department of Water Resources and UCCE have teamed up to provide Weekly ET Reports to agricultural water users to assist with irrigation scheduling. The reports include water use information for a variety of crops including almonds, pistachios, walnuts, grapevines, citrus, and stone fruit of mature bearing age. Adjusted on a weekly basis, water use estimates account for the changing growth stage and weather conditions at the Madera, Parlier, Lindcove, Stratford, Panoche, and Five-Points CIMIS weather stations. Each report gives crop-specific evapotranspiration (ETc, total crop water use including soil evaporation) estimates for the previous and coming week. To learn how to use these reports, please refer to the following article: http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=26858. Crop ET reports can be found online (ie: http://cetulare.ucanr.edu/Agriculture782/Custom_Program911/).

The dynamic state of spurs in almond

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Over 80% of the almond crop is borne on short, compact vegetative shoots called spurs. Each season, however, only a portion of the spur population on a given tree supports fruit production. Because of their role in supporting productivity and yield, maintenance of a healthy spur population contributes to the economic sustainability of an orchard. Understanding the dynamic states of spurs between seasons and the conditions promoting spur productivity and survival may enhance orchard management practices to maintain or increase yields in future years.

What are spurs? Spurs are short, compact vegetative shoots (approximately 0.5-2 inches long) that are borne on the prior season's wood. Spurs are either formed from lateral buds on vegetative shoots (Figure 1A) or from vegetative buds on spurs (Figure 1B). When spurs give rise to further spur growth over sequential years, it may be difficult to visually evaluate the age of a spur due to the compact nature of growth (Figure 2). The apical bud on a spur is always vegetative (Figure 1B); however, spurs can also support up to 6 flower buds in a season (Figure 3B). The duration of spur growth on almond is short and generally complete in April or early May.

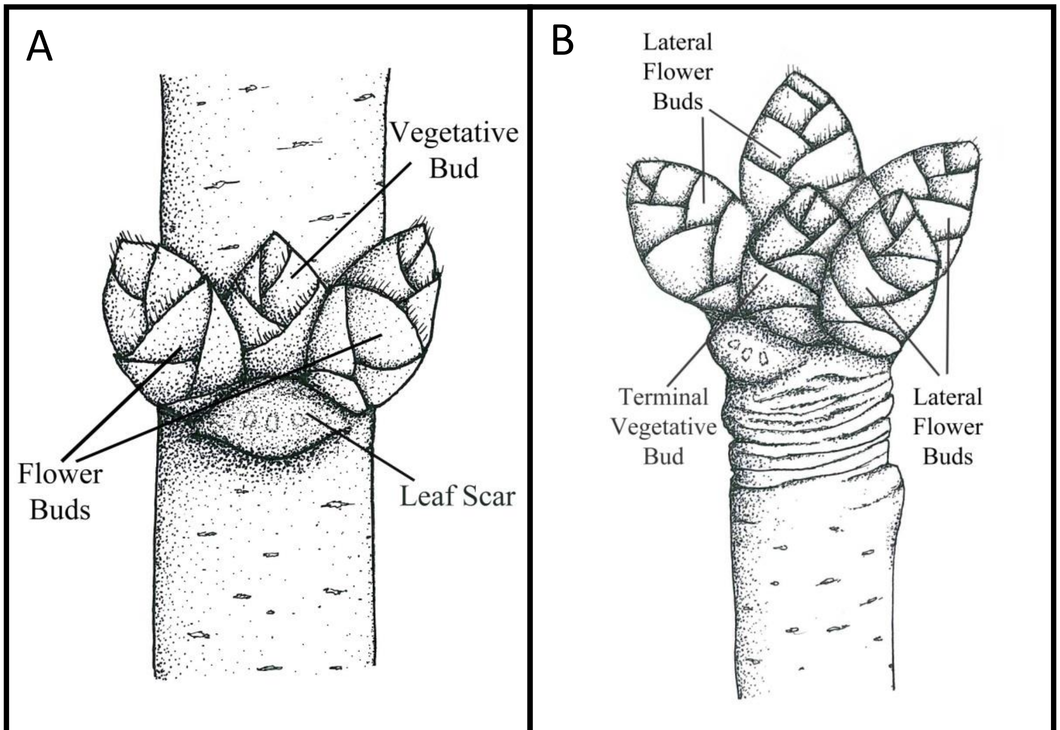

Figure 1. Buds form in leaf scars on vegetative shoots; a vegetative bud is generally positioned between two flower buds (A). On spurs, the terminal bud is always vegetative; the lateral buds may be either vegetative or floral buds (B).

Spurs exhibit a localized carbon economy. Spurs are considered semi-autonomous with respect to carbon supply, meaning that spurs serve as both the main source and sink of carbohydrates utilized in vegetative and reproductive growth. As a result, spurs remain vegetative (Figure 3A) for 1-2 years prior to flowering. Although not immediately productive, vegetative spurs with adequate leaf area produce and store carbohydrates for support of future flowering and nut development. In fact, the leaf area of spurs is a better predictor of potential for flower bud development than the number of leaves per spur. Spurs with less than 10 cm^2 leaf area are unlikely to support viable buds (floral or vegetative); spurs with 10-12.3 cm^2 leaf area are likely to support only vegetative buds; and spurs with >12.3 cm^2 have a higher probability of supporting flower buds. Due to the carbohydrate demand of setting fruit, few spurs flower the year after bearing.

Spur leaf area influences flower bud development. Flower buds can be differentiated from vegetative buds by both shape and position. Flower buds are generally positioned on either side of a vegetative bud on shoots (Figure 1A), or in lateral positions on spurs (Figure 1B). Vegetative buds are triangular and pointy, whereas flower buds are thicker and more oval than vegetative counterparts. In early summer, buds manifest in leaf axils, but it is impossible to differentiate between floral and vegetative buds until late August or early September. Even in late summer, identification of flower versus vegetative buds may require bud dissection and microscopy.

Flower bud development does not proceed at a uniform rate in a given block or tree, but varies dramatically between spurs. The rate of floral bud development is positively related to leaf area. Consequently, spurs supporting high leaf areas exhibit more rapid flower bud development than spurs with lower leaf areas.

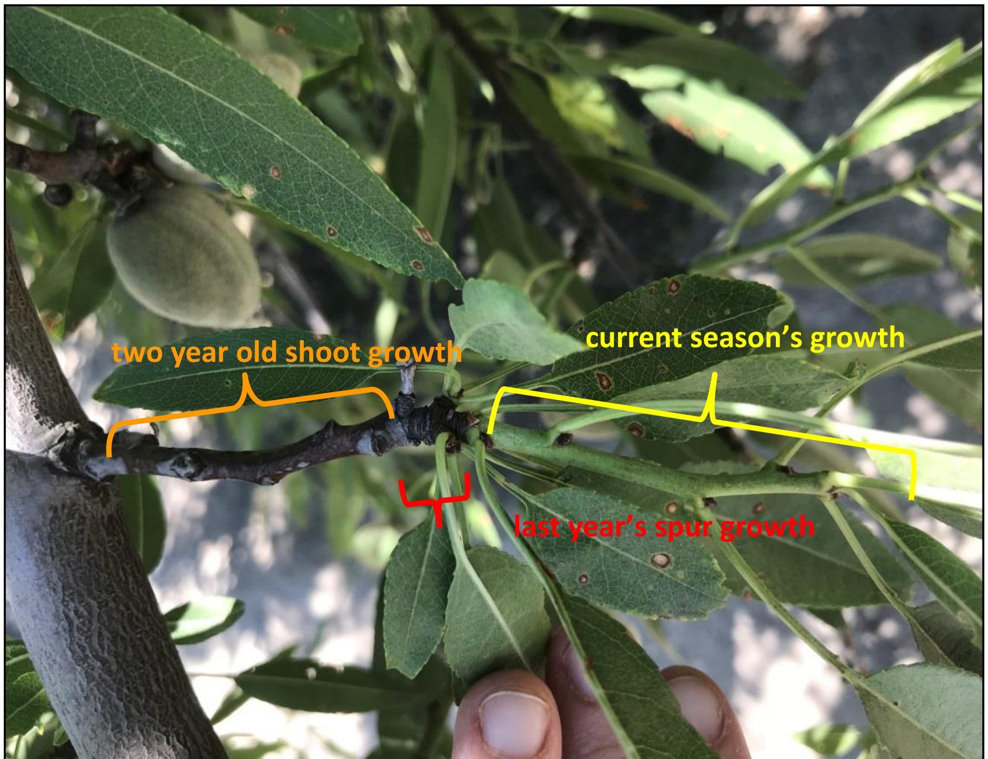

Figure 2. The probable life history of this shoot started two years ago, with a short shoot giving rise to a spur last year. In the current year, the apical bud on the spur gave rise to a vegetative shoot, suggesting that the spur was in a light-exposed position in the canopy.

Prior year spur leaf area affects flowering and nut set. Spurs supporting high leaf area in a given year have enhanced potential to support flowering and nut set in the subsequent year. In fact, non-bearing spurs with >50 cm^2 leaf area have over an 80% probability of flowering the following year. Non-bearing spurs in lower light positions in the interior of the canopy may require more years in a vegetative state prior to supporting flower and fruit production.

Spur survival is influenced by prior year leaf area and exposure to light. The literature suggests that spurs remain viable for 3-5 years; however, the survival potential of individual spurs is related to light exposure, bearing status, and prior season leaf area. We have found that spurs in well managed orchards in outer canopy positions can remain productive for more than 10 years. Regardless of bearing status, spurs with higher leaf areas are more likely to survive into the following season. Bearing spurs are more likely to survive into the following season when occupying light-exposed positions in the canopy. Conversely, the mortality of non-bearing spurs is generally not influenced by light interception in the canopy. These relationships are all explained by the reliance of spurs on a localized carbon economy.

Orchard management for enhanced spur survival and productivity. Following best orchard practices, particularly in irrigation scheduling and nutrient management, will allow for canopy development and maintenance of tree health. However, consider that practices supporting excessive growth may cause shading, which may be limiting to spur survival. Promotion of modest annual growth will allow for production of new spurs, but be patient because new spurs may take 2 years to support flowers. Last, when managing the tree canopy, overlapping branches and dead wood should be removed to prevent shading and promote spur survival and productivity.

Figure 3. Approximately 80% of spurs remain vegetative (A) in a given year. Floral spurs (B) may support up to 6 flower buds in a year, but not all flower buds give rise to fruit. Photos: B. Lampinen

Select References:

Lamp, B.M., Connell, J.H., Duncan, R., Viveros, A.M., Polito, V.S. 2001. Almond flower development: Floral initiation and organogenesis. Journal of the American Society for Horticultural Science. 126: 689-696.

Lampinen, B.D., Tombesi, S., Metcalf, S.G., DeJong, T.M. 2011. Spur behavior in almond trees: relationships between previous year spur leaf area, fruit bearing and mortality. Tree Physiology 31: 700-706. Online: https://doi.org/10.1093/treephys/tpr069

Polito, V.S., Pinney, K., Heerema, R., Weinbaum, S.A. 2002. Flower differentiation and spur leaf area in almond. Journal of Horticultural Science and Biotechnology. 77: 474-478.

Tombesi, S., Lampinen, B.D., Metcalf, S., DeJong, T.M. 2016. Yield in almond related more to the abundance of flowers than the relative number of flowers that set fruit. California Agriculture 71: 68-74. Online: https://doi.org/10.3733/ca.2016a0024

Postharvest N applications for almonds

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I know, I know, it's a bit early to be thinking about postharvest tasks in August (unless you're a stone fruit grower, in which case I'm way too late!) – as I'm writing this article, only a few early almond orchards in Madera county have even had their first shake. However, it's not too late to take a 'July' leaf sample. At this point, the vast majority of tree crops have finished fruit development (figs and pomegranates are some of the only exceptions I can think of), so all the nutrients that are going to be shipped out of the leaves and into the fruit has already been moved there. There are a few nutrients that will continue to accumulate in leaves as the season wraps up, such as calcium, and boron in pistachios and walnuts, but for the purposes of this article, nutrient concentrations will be stable until a few weeks before leaves start changing colors. If you've only done the early season leaf sampling protocol developed by Patrick Brown's lab, you should still do a mid-season leaf test.

Your postharvest nitrogen application is going to be based on two inputs: the difference between your predicted and actual yield, and your July leaf tissue samples. As a refresher, early season N use is based on your predicted yield, which you calculate with your past five years of yield data, excluding any unusually bad years. The postharvest application is the only yearly N application based on your actual yield. Pistachios and walnuts both take up very little nitrogen between harvest and leaf senescence, so all nitrogen applications should be applied from mid to late March through August.

If your predicted yield was above your actual yield, you probably won't need to apply any postharvest nitrogen. You will need to back this up with your July leaf samples; if your leaf tissues show they are 2.2% nitrogen or above (adequate levels range from 2.2-2.5%) *you don't need to apply nitrogen*. Again, at the time of sampling all nutrients that the nuts need are already there. Most of the remaining nitrogen in plant tissues will be stored, and if your trees are at adequate levels, this will be enough for early season growth. At that point, you'll be starting to apply nitrogen for the following year, and anything taken up before May will directly impact that season's yield. If your predicted yield is the same or below your actual yield, you may need to apply postharvest nitrogen. Again, check your leaf samples, but there's a higher likelihood that your trees will need fertilizer.

There are two ways to apply postharvest nitrogen: through the soil, or through foliar applications. If you apply nitrogen to the soil, make the applications before mid-October. Nutrient uptake is dependent on root activity, and as soils cool, roots slow down their metabolic rates, and nutrient uptake slows and then ceases. It's why we don't recommend heavy nitrogen applications over the winter. In general, the closer that you can apply nitrogen after harvest, the better.

Foliar applications should be done before leaf senescence, and at rates low enough to prevent phytotoxicity, which is typically around 20-30 pounds of N/acre. Anything more can result in defoliation, which is fine if you have an orchard with rust, high mites, or aphids (which are a problem in prunes and other fruit trees). Either way, apply before the leaves enter senescence. Mid to late October is a good target date for defoliation.

There are a few products available, potassium nitrate and low-biuret urea are two examples. Potassium nitrate is a nice product to use in potassium hungry crops such as almonds and prunes, especially in heavy or potassium fixing soils. It also has the added benefit of knocking down mite populations. If you apply at the right time, it can be a stopgap measure to keep leaves on the trees.

Foliar nitrogen applications are also a great tool in young *Prunus* orchards in conditions conducive to bacterial canker. This would be for trees planted in sandier soils, with high populations or a history of high populations of ring nematode, and on Hansen 536 or other peach-almond hybrid rootstocks. These nitrogen applications are not a bactericide, nor are they a prophylactic. Bacterial canker is associated with tree stress, including nitrogen stress, so these sprays can reduce the trees' susceptibility to bacterial canker. Applications of 100 lbs low-biuret urea *per acre* applied to peach trees have been shown by Roger Duncan to reduce susceptibility. This application rate is far above late-season nitrogen needs, so these the trees. If you're applying nitrogen, it's likely you're wasting your money. It's a great time to apply non-soil mobile nutrients, however. sprays are not needed in areas with low risk of know it's not uncommon to apply winter-specific nutrient mixes (I've definitely been asked about various formulations as a farm advisor as well as an agronomist in my previous job). It has been consistently shown that there is very little nutrient uptake when leaves are off the trees. If you're applying nitrogen, it's likely you're wasting your money. It's a great time to apply non-soil mobile nutrients, however.

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