



University of California Cooperative Extension

Fresno, Kern, Madera, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, Tulare, & Ventura Counties

News from the Subtropical Tree Crop Farm Advisors in California

Volume 10 No. 2

Farm Advisors

Gary Bender – Subtropical Horticulture, San Diego

Phone: (760) 752-4711

Email: gsbender@ucdavis.edu

Website: <http://cesandiego.ucdavis.edu>

Mary Bianchi – Horticulture/Water Management, San Luis Obispo

Phone: (805) 781-5949

Email: mlbianchi@ucdavis.edu

Website: <http://cesanluisobispo.ucdavis.edu>

Ben Faber – Subtropical Horticulture, Ventura/Santa Barbara

Phone: (805) 645-1462

Email: bafaber@ucanr.edu

Website: <http://ceventura.ucdavis.edu>

Neil O'Connell – Citrus/Avocado, Tulare

Phone: (559) 684-3312

Email: nvoconnell@ucanr.edu

Website: <http://cetulare.ucdavis.edu>

Craig Kallsen – Subtropical Horticulture & Pistachios, Kern

Phone: (661) 868-6221

Email: cekallsen@ucdavis.edu

Website: <http://cekern.ucdavis.edu>

Eta Takele – Area Ag Economics Advisor

Phone: (951) 683-6491, ext 243

Email: ettakele@ucanr.edu

Website: <http://ceriverside.ucdavis.edu>

Elizabeth Fichtner - Orchard Systems, Tulare

Phone: (559) 684-3310

Email to: ejfichtner@ucanr.edu

Website: <http://cetulare.ucdavis.edu>

Stephen Vasquez – Citrus & Nut Crops, Fresno/Madera

Phone: (559) 456-7285

Email: skvasquez@ucanr.edu

Website: <http://cefresno.ucdavis.edu/viticulture>

In This Issue

- Simazine Degradation in CA Citrus Orchards
- Lime-induced Iron Chlorosis
- Avocado Trunk Cankers
- Asphyxiation
- Tree Wraps
- Stem and Leaf Blight



Editor's Note:

Please let us know if your mailing address has changed, or you would like to add someone else to the mailing list. Call or e-mail the farm advisor in the county where you live.

Please also let us know if there are specific topics that you would like addressed in subtropical crop production. Copies of Topics in Subtropics may also be downloaded from the Cooperative Extension websites of the Farm Advisors listed.

Also, visit our blog website for timely happenings in the subtropical fruit tree field:
<http://ucanr.org/blogs/Topics/>

Ben Faber
Editor

Simazine Degradation in California Citrus Orchards

By: Brad Hanson, UCCE Davis

Today I thought I'd share a recent research report on the the phenomenon of "enhanced" degradation of the herbicide simazine in citrus orchard soils. Click [here for a link to the publication](#) in the open-source journal, Air, Soil, and Water Research (Abit et al. 2012. Air Soil and Water Research 5:69-78). The lead author was a UC Davis post doctoral researcher and her coauthors include UC Davis, USDA-ARS, Fresno State, and UC Cooperative Extension folks.

This work was started several years ago in response to some questions from San Joaquin Valley orchard and vineyardists poor weed control with simazine. They suspected herbicide resistance, which is certainly a possibility given the number of weed biotypes resistant to photosystem II inhibitors reported worldwide (69 biotypes at latest count according to <http://www.weedscience.org>). However, when we visited some of the fields, it just didn't look like resistance or poor applications - too many species affected, good early control but poor residual perfor-



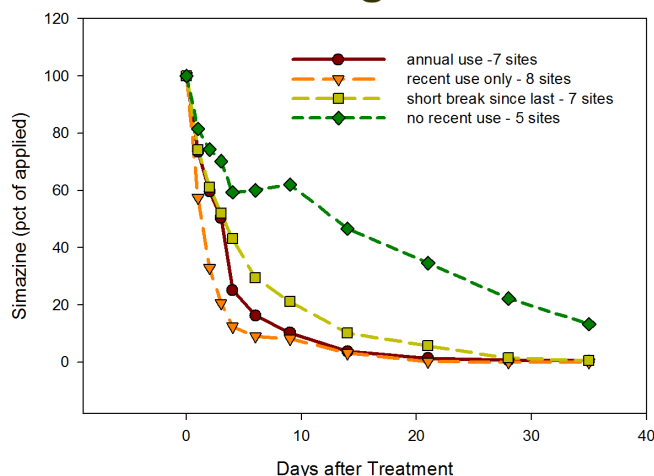
mance, affected some orchards but not others, no clear application problems.

Some colleagues in Colorado and Mississippi were conducting research on faster-than-normal degradation of atrazine, a related triazine herbicide. We decided to conduct laboratory studies to determine if the poor residual performance in our orchard systems could also be due to the so-called "enhanced degradation".

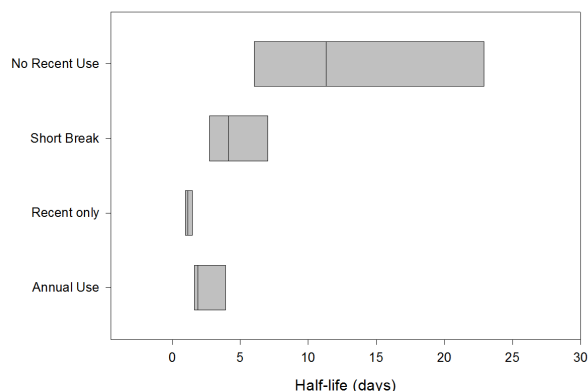
First, some background. To a large degree, all herbicides degrade in soil - a complex molecule is eventually broken

down into component elements; however the rate of degradation can vary greatly. The two biggest contributors to herbicide degradation are "chemical processes" that include all sorts of ways that chemical bonds are broken and "microbial processes" in which soil microorganisms use the molecule as a carbon source (ie "food"). Generally, microbial processes are the most important but are usually not specific to a particular herbicide. Sometimes, however, a microbial population with a special ability to degrade a particular herbicide (or chemically related compounds) can build up in the population and very rapidly

Simazine Degradation



Simazine Half-Life



degrade all of the herbicide. [analogy: a bowl of candy on your desk that lasts for weeks if you eat one or two per day but lasts only a few seconds when your hungry teenager and his friends show up!].

To determine if there were differences in simazine degradation rates among orchards, we collected soil from 27 citrus orchards in Tulare and Ventura counties. The orchards had a range of simazine use histories ranging from being treated every year for decades to having no sima-

zine for at least the past 15 years.

1. In one set of experiments, we found that the soils that had not been exposed to simazine for at least 15 years degraded the herbicide much more slowly and that annual use (for the past 5 years, or longer) tended to be associated with faster degradation.
2. In a second set of experiments, we autoclaved (heat sterilized) soil to kill any microbes present to determine if the herbicide degradation was due to microbial activity. This study showed that the degradation was almost completely due to microbial degradation - simazine degradation was almost non-existent in autoclaved soils. Some soils have the the specialized microbial population while others do not.

The conclusions of the study were that repeated use of simazine can lead to more rapid degradation of the herbicide but that the correlation was not perfect. The correlations were better in the Tulare County sites than in the Ventura County soils. Some soils with long-term use of the herbicide continued to degrade simazine at a "normal" rate while other degraded it faster than predicted.

Overall, this is an interesting phenomenon that growers and pest control advisors should be aware of when making weed control decisions. Simazine can provide very effective and economical weed control in many situations but, as always, we recommend monitoring orchard conditions and adjusting weed control strategies accordingly. This research was partially supported by funding from the California Citrus Research Board and USDA-ARS.

A couple of my previous posts on herbicide degradation at the [UC Weed Science Blog](http://ucanr.org/blogs/blogcore/postdetail.cfm?postnum=5929) can be found at: <http://ucanr.org/blogs/blogcore/postdetail.cfm?postnum=5929> and <http://ucanr.org/blogs/blogcore/postdetail.cfm?postnum=3923>

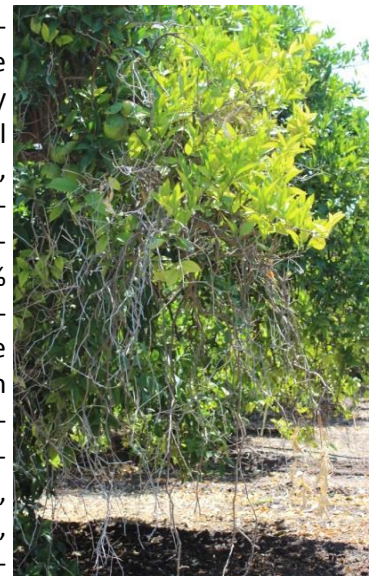


The University of California prohibits discrimination or harassment of any person in any of its programs or activities. (Complete nondiscrimination policy statement can be found at http://groups.ucanr.org/ANR_AA/files/54634.pdf) Direct inquiries regarding the University's nondiscrimination policies to the Affirmative Action Director, University of California, ANR, 1111 Franklin St., 6th Floor, Oakland, CA 94607, (510) 987-0096.

Lime-induced Iron Chlorosis: a nutritional challenge in the culture of several subtropical perennial crops in California

Elizabeth Fichtner, UCCE Tulare County and Rachel Elkins, UCCE Lake and Mendocino Counties

Although iron (Fe) is the 4th most abundant element in the lithosphere, Fe deficiency is among the most common plant micronutrient deficiencies. Fe deficiency in plants is common in calcareous soils, waterlogged soils, sandy soils low in total Fe, and in peat and muck soils where organic matter chelates Fe, rendering the element unavailable for plant uptake. In California, lime-induced Fe deficiency is often observed in soils and irrigation water containing free lime, and is exacerbated by conditions that impede soil drainage (ie. compaction, high clay content), resulting in reductive conditions. Given that over 30% of the world's soils are calcareous, lime-induced Fe deficiency is a challenge in numerous perennial cropping systems including: grapes, pears, apple, citrus, avocado, pecans, and stone fruit (prune, almond, apricot, peach, nectarine, cherry).



Shoot dieback in citrus

In most soils, Fe oxides are the common source of Fe for plant nutrition. Solubility of Fe oxides is pH dependant; as pH increases, the free ionic forms of the micronutrient are changed to the hydroxy ions, and finally to the insoluble hydroxides or oxides. In calcareous soils, the bicarbonate ion inhibits mobilization of accumulated Fe from roots to foliage and directly affects availability of Fe in soil by buffering soil pH. When irrigation water is also high in bicarbonate, probability of Fe deficiency is enhanced because bicarbonate is continuously supplied to the soil, and more importantly, the roots may become crusted with lime as water evaporates, thus inhibiting root growth and function. Inside the plant, bicarbonate inhibits nutrient translocation from roots to aboveground plant parts. The adverse effects of high bicarbonate levels are exacerbated in very saturated, very dry, or compact soils, where bicarbonate levels increase concurrent with diminished root growth and nutrient uptake.

Symptoms of Fe deficiency in plants

Fe is immobile in plants; therefore, symptoms appear in young leaves. Interveinal chlorosis (Figure 1) is the main



Interveinal chlorosis in citrus

symptom associated with Fe deficiency, followed by reduced shoot and root growth, complete foliar chlorosis, defoliation, shoot dieback, and under severe

conditions may result in tree mortality. Overall productivity (yield) is reduced, mainly from a reduced number of fruiting points.

Plant Adaptation

Plant species and cultivars vary in their sensitivity to Fe deficiency, and are categorized as either "Fe-efficient" or "Fe-inefficient". Fe-efficient plants have Fe uptake systems that are switched on under conditions of Fe deficiency. Fe-inefficient plants are unable to respond to Fe deficient conditions. All Fe-efficient plants, except grasses, utilize a Fe-uptake mechanism known as Strategy 1. Strategy 1 plants decrease rhizosphere pH by release of protons, thus increasing Fe solubility. Some plants may excrete organic compounds in the rhizosphere that reforms or form soluble complexes that maintain Fe in solution. Additionally, roots of Strategy 1 plants have specialized mechanisms for reduction, uptake, and transfer of Fe within the plant. Strategy 2 plants (grasses) produce low molecular weight compounds called phytosiderophores which chelate Fe and take up the chelated Fe with a specific transport system.

Amelioration of Fe chlorosis

Planting sites in calcareous soils should be well drained to provide optimal conditions for root growth and nutrient uptake. Waterlogged and compact soils contain more carbon dioxide, which reacts with lime to form even more bicarbonate. These conditions, as well as very dry soils, also inhibit microbial activity which aids in solubilization and chelation of Fe. Prior to planting, soils and water should be tested to determine the pH, lime equivalent, and bicarbonate concentration. Bicarbonate concentrations greater than 3 meq/L in irrigation water increase the hazard of lime accumulation on and around roots. If high bicarbonate water must be used, the pH must be adjusted to 6.0-6.5 to dissolve the bicarbonate and prevent it from

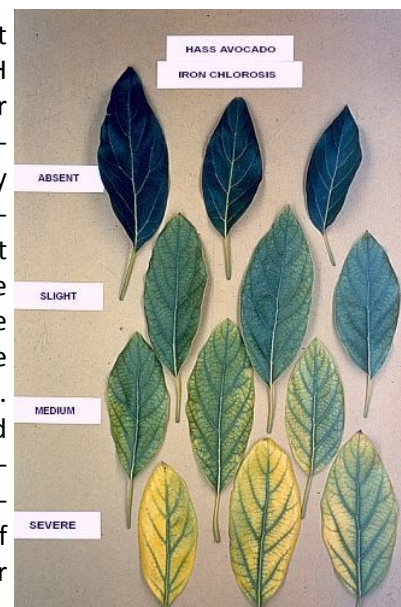
negating the effects of soil-based treatments. In microsprinkler and drip systems, acidification of irrigation water will also reduce the risk of emitter clogging, a common problem at bicarbonate levels over 2 meq/L. The cost of reducing the pH of irrigation water will more than compensate for the savings incurred from avoiding wasted investment in failed soil- and plant-based remedies. Systems can be set up to continuously and safely inject water with acids such as sulfuric, urea-sulfuric, or phosphoric during irrigations. Specific choice and rate will depend on crop, soil type, other nutrient needs, availability, and cost. Downstream pH meters are available to continuously adjust rate of acid use. Acetic and citric acid can be utilized by organic growers.

Soil based pre-plant treatments to reduce pH include elemental sulfur (S) and acids as mentioned above. It is only necessary to treat a limited area near the root zone to ameliorate symptoms because the tree only needs to take up a small amount of Fe. Material can be shanked in or banded and incorporated in the prospective tree row. One ton of elemental sulfur per treated acre is needed to mitigate three tons of lime, and may need to be re-applied every 3

to 5 years after planting. The addition of organic matter such as well-composted manures will benefit poorly drained or compact soils by increasing aeration for better root growth, fostering chelation of nutrient cations, and reducing pH (depending on source material).

If possible, choose a Fe efficient species or cultivar. In perennial systems, lime-tolerant rootstocks may be the first line of defense in combating Fe deficiency. Some rootstocks mentioned are peach-almond and Krymsk-86 for stone fruit, Gisela 5 for cherry, and *Pyrus communis* for pear. Ongoing research studies in Europe focus on screening rootstocks of grape and olive for lime tolerance.

Once soil and water quality improvements are made, post-plant management strategies may also be implemented to ameliorate lime-induced Fe chlorosis in the short term. Soil can be acidified as described above. Individual trees



Various stages of iron chlorosis in avocado

can be treated by digging four to six 12-24 inch holes around the drip line and burying a mixture of sulfur and Fe fertilizer. Historically, two principal methods have been utilized: 1) foliar application of inorganic Fe salts (ie. ferrous sulfate), and 2) soil or foliar application of synthetic chelates. Application of Fe salts to foliage may have mixed results due to limited penetration of Fe into leaves and inadequate mobilization within the plant. Use of Fe chelates may be of benefit; however, they are expensive and pose an environmental concern due to their mobility within the soil profile. Because soil lime interferes with Fe mobility with the plant, repeat application of inorganic Fe salts or Fe chelates may be necessary throughout the growing season.

Choice of nitrogen (N) fertilizer may also influence solubility of rhizosphere Fe. When N is applied in the ammonium form (NH_4^+), the root releases a proton (H^+) to maintain a charge balance, thus reducing rhizosphere pH. Alternately, fertilization with nitrate (NO_3^-) results in root release of hydroxyl ions (OH^-), resulting in an increase in rhizosphere pH. Solubility of Fe^{3+} increases 1000 fold with each one unit decrease in pH; therefore, fertility-induced rhizosphere pH changes may significantly influence Fe availability.

New methods for amelioration of Fe chlorosis are under investigation. For example, container studies have demonstrated that inter-planting sheep's fescue, a Strategy 2 plant, with a Fe-inefficient grape rootstock may ameliorate Fe chlorosis in grape. In this system, the grass produces a phytosiderophore that enhances Fe availability to the grape. Additionally, soil amendment with $\text{Fe}_3(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}$, a synthetic iron(II)-phosphate analogous to the mineral vivianite, has been effective at preventing Fe chlorosis in lemon, pear, olive, kiwi, and peach. Vivianite has a high Fe content (~30%) and serves as a slow release source of Fe in calcareous soils.

Avocado Trunk Cankers

By: Ben Faber, UCCE Ventura and Santa Barbara Counties

This has been a low rainfall year, and often with the low rainfall, cankers will seem to suddenly appear on the woody parts of the tree. There are a number of causes for the white exudate from cankers on the trunk and limbs of avocado. Any wound will cause the tree sap to run and crystalize on the surface. It is a seven carbon sugar of mannoheptulose, or its alcohol form perseitol. It's sweet. So any wound that might be caused by woodpeckers or little kids climbing the trees will damage the bark, and where the damage has occurred, the sugar will

form. There are also diseases that can cause a wound that will exude the sugar. Three of these are due to water stress of some form that allows infection to occur. One of these is bacterial – Bacterial Canker. Another is caused by a fungus which in the past was called Dothiorella Canker. We now know it by a different name and a UCR plant pathologist has actually identified seven different species of fungus that invade the wood and can eventually weaken the tree so limbs can break and the tree becomes unthrifty. In

Black streak can occur on trunks or branches as small, scattered cankers. The name comes from the blackening that occurs around the infected area.



the case of very young trees, they can be killed by the fungus. A third cause of sugary cankers is Black Streak, the cause of which was unclear until recently when Dr. Akif Eskalen possibly identified it. It was coming from a similar set of fungi that cause Dothiorella Canker. It makes sense, because in all three of these cases, they most often appear after a low rainfall year,



where pressures in irrigation systems are insufficient, where emitters have clogged and where water or salinity stress have occurred. The bacteria and fungi that cause these cankers are

Bacterial canker causing discrete silver dollar-sized cankers. The exudate running down from the bottom edge results when a knife is poked into it. The cankers tend to run in a line up the trunk or branch.

widely distributed in most orchards and are just waiting for the stressed tree to appear. The grower just needs to identify where this stress is occurring, correct the problem (clogging, low pressure, poor irrigation design, infrequent scheduling, inadequate leaching, etc.) and if the damage is not too extensive, often these symptoms will disappear with time.

The fourth cause of canker is caused by *Phytophthora citricola*, a relative of avocado root rot. This is caused by a moist trunk, either from irrigation water hitting the trunk, or on the north side of the tree that doesn't dry out from morning dew. This is a much slower acting disease than root rot, although it can rapidly kill young trees. The cankers occur at about 18 inches from the ground and gradually girdle the tree. The first thing to do



before ever seeing this disease is to make sure irrigation water isn't hitting the trunks. If cankers appear, they respond to the same materials used for root rot, but should actually be sprayed right on the canker.

Citricola crown rot with the cankers girdling the trunk. It appears near the ground



Dothiorella canker (soon to have a new name) can occur anywhere on the trunk or branches.

Asphyxiation

Ben Faber, UCCE Ventura and Santa Barbara

Asphyxiation is a physiological problem that may affect certain branches, whole limbs or the entire tree. Leaves wilt and may fall, the fruit withers and drops and the branches die back to a greater or lesser extent. The condition develops so rapidly that it may be regarded as a form of collapse. Usually, the larger stems and branches remain alive, and after a time, vigorous new growth is put out so that the tree tends to recover.

Asphyxiation is related to the air and water conditions of the soil. The trouble appears mainly in fine-textured or shallow soils with impervious sub-soils. In 1997-98, this even occurred on slopes with normally good drainage because the rains were so frequent. When such soils are over-irrigated or wetted by rains, the water displaces the soil oxygen. The smaller roots die when deprived of oxygen. When the stress of water shortage develops, the

impaired roots are unable to supply water to the leaves rapidly enough and the tree collapses. The condition is accentuated when rainy weather is followed by winds or warm conditions.

Canopy treatment in less severe instances consists of cutting back the dead branches to live wood. If leaf drop has been excessive, the tree should be whitewashed to prevent sunburn. Fruit, if mature should be harvested as soon as possible to prevent loss. In the case of young trees, less than two years of age, recovery sometimes does not occur, and replanting should be considered if vigorous regrowth does not occur by July.

Asphyxiation can be reduced by proper planting and grading. If an impervious layer is identified, it should be ripped prior to planting. The field should be graded so that water has somewhere to run off the field during high rainfall years. Heavier soils might require planting on berms or mounds so that the crown roots have a better chance of being aerated.

Post-plant, if an impervious layer can be identified and is shallow enough to break through, ripping along side the tree or drilling 4-6 inch post holes at the corners of the tree can improve drainage. It is important that the ripper blade or auger gets below the impervious layer for this technique to be effective.



UC Statewide IPM Program
© 2005 Regents, University of California

Standing water can lead to asphyxiation

Tree Wraps

Neil O'Connell, UCCE Tulare

Installing tree wraps on young trees provides protection to the trunk from applications of herbicides during weed management operations. Additionally, the wraps minimize light interception by trunk tissue thereby reducing sucker growth. During hot weather tree wraps provide shade to the trunk and reduce the incidence of sunburn. With the increasing incidence of earwigs, damage to young trees and the tendency for the insect to congregate under the wraps, tree wraps are being removed in some cases. Recent laboratory data from Dr. Beth Grafton-Cardwell (confirmed by observations in the field) suggests that as the season progresses adults become less and less interested in feeding on leaves (peak of feeding in March and April, declines to next to nothing by June). So, a management consideration would be to check the earwigs in the wraps in the summer, and if there are only adults present there is less concern than if there are immatures present. Another point would be to consider treatment with an insecticide such as Lorsban if wraps are to be left on for sunburn protection.



European earwig



Wrap removed-whitewashed

If wraps are removed a uniform coating of sun protective material should be applied to the trunk to protect against sun damage. Trunk surfaces should be monitored to ensure that a uniform coating is in place. Sun damage to unprotected trunk tissue can result in partial or complete girdling of the tree

Stem and Leaf Blight

By: Ben Faber, UCCE Ventura and Santa Barbara

In both avocado and citrus there can be a rapid collapse of tissue brought on by a host of related fungi. The pathogen was once lumped as *Dothiorella*, but lately University of California extension plant pathologist Akif Eskalen has been able to tweeze out more species which mainly belong to the *Botryosphaeria* genus. The collapse can be quite rapid, so fast that the leaves continue to hang on to the tree. This disease is more common in years of low rainfall, where inadequate water is being applied (especially when Santa Ana winds are blowing), and where salinity build up has occurred. In the last 2 months, I have been called out to diagnose this problem five times. In each case, they were trees that had been sidelined and neglected or the grower was trying to save money by saving water. Luckily for a mature tree, there can be recovery as long the tree is protected from sunburn that occurs with defoliation. White wash the exposed parts, and wait for recovery. When it is clear what part is recovering, cut into fresh wood to remove the dead parts. For a more detailed discussion of this blight, see our 2009 *Topics in Subtropics*.



Blight on avocado



Blight on avocado