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INSECTS AS VECTORS OF PLANT DISEASE

*Bonnie Bradt
Nevada County
Master Gardener*

It seems that we gardeners are constantly battling. We work hard to have the most glorious flowers or the most prolific veggies and fruit trees. As much as I have been known to rant and rave for the idea that insects can be our allies in this battle, I must admit they can also be annoying members of the opposition. In addition to munching or sucking juices from our plants, they can act as disease vectors between plants, thereby rendering our gardening efforts discouragingly null and void.

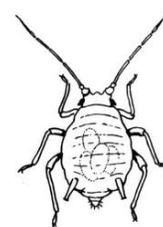
The solutions to the problems of plant diseases transmitted by insects may number as many as the diseases involved. Finding them will require an "army" of scientists (continuing my battle scenario), specializing in entomology, plant

pathology and microbiology, all working together.

Definitions

I'll confess up front. This topic COULD be tedious, especially if you are drowned in terminology. So let's define terms.

First, what is a VECTOR? For our purposes, a vector is an insect that is capable of introducing a pathogen into a plant, which can cause disease in the plant.



What's a PATHOGEN? A pathogen is a bacterium, virus, fungus, etc. that can cause disease in the plant host.

What's a HOST? A host is the plant upon which the "vector" feeds. So, the host is in danger from disease caused by the pathogen spread by the vector. Got it?

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Attention Subscribers!

Effective January 2014, The Curious Gardener newsletter is transitioning to an online newsletter, available only in electronic format.

If you are currently receiving a hard copy of the newsletter in the mail, please log on to <http://ucanr.edu/curiousgardener> to change your subscription to electronic delivery. Thank you!

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THE CURIOUS GARDENER

...A QUARTERLY NEWSLETTER PUBLISHED BY THE UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION AND THE UC MASTER GARDENERS OF PLACER AND NEVADA COUNTIES

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Which insects are vectors?

Most vectors of plant diseases are sucking insects found in the order Hemiptera. (Purcell) The most common culprits would be aphids. They, themselves, are incriminated in the transmission of hundreds of plant viruses. Following, among the Hemipterans are leafhoppers, white-flies, psyllids and mealybugs. Other insects including certain thrips, flies, beetles and even ants and bees along with some non-insect families of mites, also number among the guilty.

How are diseases spread?

Plant pathogens can be transmitted by the vector, either externally (on bodies, legs, or mouthparts) or internally (within the digestive system and salivary glands of the vector). The general mode of transmission is through the following pattern.

The vector feeds upon a host plant that is infected with a pathogen. The vector either becomes coated with the pathogen or takes it into its own digestive system through the feeding process. The vector then moves by some means, to an uninfected plant, and begins to feed there. It can then directly inject the pathogen from its salivary glands into the feeding wound, or passively deposit the pathogen into/onto the host. Pathogens on the surface can enter the host plant, sometimes through the feeding wound(s) caused by the vector.

Depending upon the pathogen involved, the vector can sometimes transmit the infection immediately after feeding on an infected host. Indeed some pathogens only last minutes after being taken up by the vector and must be transmitted immediately.

Some pathogens, however, require a period of incubation and circulation within the vector, before they can be transmitted to a healthy host. Understanding of the life cycle of vector and pathogen is crucial in learning how to fight the specific plant disease.

Here is one example. Aphids can transmit certain viruses immediately after feeding, even briefly, on an infected plant host. Aphids can then fly to other healthy plants. They will often make short probing efforts to feed, moving between several plants, before they settle down to feed continuously and reproduce. All of those plants encountered by the aphid can be infected in a very short time. Therefore, attempting to control the spread of disease by insecticide spray programs is unlikely to succeed as the aphids can move into an area and transmit the virus rapidly. Correct timing of a spray application would be impossible. Early season monitoring programs and treatments for aphids will be more effective.

What diseases can be transmitted by insect vectors?

Insect vectored pathogens include viruses, bacteria (many types), fungi, nematodes and protozoa. As you can imagine, there are so many diseases that could be dealt with in this section, there is not enough room to detail them all, or even list them.

There are massive numbers of websites and published lists of these diseases that Master Gardeners can easily access. So I will try to detail a few of the most famous, that Master Gardeners are most likely to encounter or read about.

Dutch Elm disease- The first North American epidemic began in the 1920s when American furniture makers imported elm logs carrying this fungal disease, from Europe. A native beetle vector that could spread the disease already existed in the U.S. and its European cousin was also accidentally introduced. Both Elm bark beetles can spread the disease from one tree to another. Further epidemics occurred when a more aggressive version of the pathogen was also introduced. The disease spread up and down the U.S. East Coast and west across the continent, reaching the West Coast in 1973. Over 40 million American elm trees have been killed by this disease, and today it is still a very destructive disease of shade trees in the U.S. European elm trees are more resistant than the American Elms so their epidemics have not been as catastrophic.

Fireblight- this bacterial disease is particularly devastating to apples and pears although it is, in fact, a native pathogen of wild rosaceous hosts in Eastern North America. It was first reported in Eastern apples and pears in the late 1780s and in California by 1887. Even today, the threat of Fireblight in pears restricts the commercial U.S. production of pears to certain areas west of the Rockies. Although the pathogen can move within the tree and spread by other means, various pollenizing insects have been implicated in the spread of the bacteria from flower to flower. Unfortunately, this native American pathogen has been accidentally exported to many other countries in the world. As an example, since 1995, the Italian government has destroyed over half a million pear trees in an attempt to eradicate this pathogen.

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Pierce's Disease- This disease was first described by Dr. Pierce, in 1892, on grapes in Southern California. It only really became a serious threat to the multi-kazillion dollar California wine industry about 100 years later, when the insect vector, the Glassy-winged sharpshooter (GWS), a type of leafhopper, showed up in southern California in 1996. Other insect vectors are capable of transmitting this disease but the GWS happens to be better at it than most of the others. This leafhopper has a wide range of host plants upon which it feeds. Therefore, GWS populations can exist in large numbers both in agricultural and urban environments. While feeding, the GWS shower their host plants with droplets of waste, known as "leafhopper rain".

The combination of their messy feeding habits, wide host plant range and high population numbers, makes them excellent vectors of this particularly devastating plant disease.

Since the turn of the 21st century, a scientific army of Universities combined with the California Depart-

ment of Food and Agriculture has focused their research efforts on this problem. The results are an inspiring program of IPM, based on wasp parasitoids; naturally occurring pathogens of the GWS; monitoring programs and highly focused insecticide treatments. They have managed to keep this insect vector and its disease partner, in check, to the great relief of all us California wine lovers.

How to break the cycle

I'd like to say it's simple. But nothing to do with insect control is simple. There's always a catch...a price to pay. So I will just say this. The best way to avoid insect vectored plant disease is to employ normal proper garden cleanliness, sanitation and your best methodologies of pest control, based on the wonderful pest notes available to us.

Vectors can move from host to host by their own ability to fly or crawl, by a helpful breeze, or they can be transported by the unwitting gardener, who uses dirty tools, gloves or his/her own clothing to move insects around the garden. When you do your pruning, clean your

tools between plants or even between branches on a plant. Carry a spray bottle of alcohol or at least some cleaning wipes with you, to use on your pruners between cuts.

Be vigilant! Watch for signs of disease in your garden. Remove diseased plant tissue as soon as you see it, hopefully preventing insects from feeding on it and passing it along. Make sure that new plants are disease free. Plants can be isolated in greenhouses or with row covers. Varying planting dates can be used to avoid peak periods of vector activity, if possible. No one method will work for all. So try them all!

References:

Purcell, AH, Almeida, RPP; Insects as Vectors of Disease Agents; *Encyclopedia of Plant and Crop Science*; DOI: 10.1081/E-EPCS-120010496 Copyright 2005, Taylor & Francis.

Department of Entomology, NC State University website:

<http://www.cals.ncsu.edu/course/ent425/text18/plantvectors.html>

The American Phytopathological Society websites: <http://www.apsnet.org/edcenter/intropp/lessons/fungi/ascomycetes/Pages/DutchElm.aspx>
<http://www.apsnet.org/EDCENTER/INTROPP/LESSONS/PROKARYOTES/Pages/FireBlight.aspx>



Did You Know?

The UC Master Gardener programs of Placer and Nevada Counties are celebrating **30 years** of service this year!!!

For 30 years, trained Master Gardener volunteers in Placer and Nevada Counties have answered your home gardening and composting questions!

BULLETIN BOARD



Support Local Farmers in
Placer and Nevada Counties!

UCCE launches “Eat Local” Website

The University of California Cooperative Extension, through a Specialty Crop Block Grant from the California Department of Food and Agriculture, has launched a new website that will help residents learn more about locally grown fruits and vegetables. The “Eat Local Placer and Nevada” website can be found at:

<http://ucanr.edu/sites/EatLocalPlacerNevada/>

Sierra College Community Education

<http://www.sccommed.org/>

Start Your Own Edible Garden—Online Course

This class start July 17, 2013, ending September 6, 2013, with new lessons released on Wednesdays and Fridays.

“Grow delicious, nutritious fruit and vegetables in your own backyard! In this course, you’ll learn how to give your garden a healthy start and keep it growing strong all season.”

UC DAVIS ARBORETUM ALL-STARS:

PLANTS THAT MAKE GARDENING EASY

Judy Carroll
Placer County
Master Gardener

It's a warm, summer day, and you're ready for some summer blooming plants in your garden, right? Don't despair; there are some tough plants for California gardens that bloom all summer long.

UC Davis Arboretum staff have identified 100 tough, reliable plants, which are the **Arboretum All-Stars**. They have been tested in the UC Davis Arboretum and at various locations around the state, they're easy to grow and don't need a lot of water. All-Stars require little care once they are established, which make for ideal plants for those of us who always wished we had more time to spruce up our garden.

Many All-Stars support native birds and insects, have few problems with pests or diseases, and look good most of the year. All-Stars are easy to grow and are easy to propagate by cuttings, division, layering or seeds and some multiply or may spread a little on their own. The method used to propagate your plant, depends on the species.



Summer Bloomers

Here are a few of my favorite summer blooming All-Stars to make your garden pop with color.

Download the All-Stars booklet to view a complete list of summer bloomers and other plants here: http://arboretum.ucdavis.edu/arboretum_all_stars_redirect.aspx

Lagerstroemia hybrids and cultivars - Crape Myrtle and its showy flowers is a signature plant for our hot summer days. Its blossoms range from white to pink to red and purple. Look for powdery mildew resistant hybrids. Crape myrtle is best planted in full sun, in the back of the garden and away from sidewalks because aphids can be a problem, causing sticky sidewalks. Aphids can be controlled by spraying the foliage with a strong stream of water, every few days. Crape myrtles range in sizes from trees to shrubs and to dwarf forms, so you have several options to choose from. Prune in winter to shape if necessary, and water deeply every one to two weeks.

Salvia gregii and Salvia x jamensis – Autumn Sage, blooms nearly year round. Its showy red blossoms are a magnet for hummingbirds and attract beneficial insects. There is no need to fill a hummingbird feeder with this plant in your garden. Plant this aromatic, evergreen small shrub in a sunny, or a partly sunny location, where you can relax and watch the hummingbirds feeding on the blossoms. Care for your plant by watering deeply every two weeks and it requires little or no pruning.

Salvia microphylla – Mint Bush Sage. The leaves of this evergreen small shrub have a fruity smell and it thrives in sun or part shade. If you have native oak trees, this salvia is good for growing under them. Hummingbirds love these red blossoms. Care for this plant by watering deeply every two weeks and it requires little or no pruning. That's my kind of colorful plant.

Rosa x odorata 'Mutabilis' - Butterfly Rose, is a large rose, with has colorful, single flowers nearly year round. This amazing blossom passes through three distinct color phases (that's why it's called Mutabilis, since the blooms "mutate" in color), beginning with yellow, changing to pink, and finally crimson. It's also known as the Butterfly Rose because its blossoms look like brightly colored butterflies that have landed on the bush. The single blossom attracts pollinating bees and other beneficial insects. Plant in full sun and water deeply every one to two weeks and prune in winter to keep compact, or it will grow very large.

Try some small perennials to pop in color between existing shrubs. **Aster 'Purple Dome'- Purple Dome Michaelmas Daisy** is a dwarf daisy with deep-violet flowers, blooming in late summer. This easy care plant attracts butterflies and beneficial insects and also resists mildew and tolerates wet soils. This plant takes full sun or a partly sunny location. To care for your plant, water deeply every one to two weeks, and cut down to the ground in the winter to renew.

Bulbine frutescens – Cape Balsam is a small perennial with long blooming spikes of delicate star-shaped yellow flowers. Add color, and sculptural interest to your garden with this very tough plant which tolerates drought and poor soils. This bloomer likes full sun or a partly sunny location. Remove the old flower stalks to keep tidy and water deeply once or twice a month.

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Penstemon heterophyllus

‘Margarita B.O.P.’ – Santa Margarita foothill penstemon is a California native plant whose flowers change in color from golden yellow as buds, bright blue as blooms, then change to purple pink. This native thrives in full sun or partly sunny garden conditions.

Wondering about the name? This cultivar comes from Las Pilitas Nursery in the early 1980's, where they say, "Penstemon 'Margarita BOP' was a seedling that was found growing at the "bottom of our front porch". The location was abbreviated to 'BOP' and this perennial is now an All-Star.

It's a heavy bloomer and its small size fits into small spaces, or it can be used as a mass planting.

Sprekia formosissima – Aztec Lily

is a dramatic summer bloomer with deep red blossoms, which attract hummingbirds in spring and summer. Encourage blooming to reoccur through the seasons by withholding and then applying water deeply. This low maintenance lily requires full sun and little or no pruning. Grows in Sunset zones 9 and 12-24, but where winters are colder, such as in zone 7, try growing in pots which can be removed to a protected spot inside during winter. Or, set out bulbs in spring and dig up the bulbs in the fall when foliage yellows, and store in a cool dry place.

Add a wind garden effect with a small, flowering, clumping grass.

Bouteloua gracilis – blue



grama grass has green flowers that age to tan by the end of summer. This 4-6" tufted grass spreads slowly and thrives in full sun or a partly sunny location. Spiked inflorescences rise about 2 feet above the grass in the summer and curl as they fade looking like eyebrows. This grass tolerates foot traffic and is a California native. Water deeply once or twice a month. Try Blue grama grass as a container plant for visual interest.

Try a low growing groundcover with color. **Ceratostigma plumbaginoides – Dwarf Plumbago** has intense blue flowers in summer and continuing into fall. This groundcover thrives in the sun or partial shade. Space this plant 1-1 ½ feet apart for good coverage and water deeply every two weeks.

This plant spreads rapidly with underground stems. The leaves of this deciduous low growing groundcover turn a brilliant maroon in fall. Shear or mow annually before spring growth begins.

Another groundcover is **Teucrium chamaedrys ‘Nanum’ - Dwarf Germander**. Dark pink flowers cover this groundcover beginning in early summer. It's one of those plants that's good for planting under roses, and does well in full sun or part shade. Mow in early spring to maintain a compact form. It's very drought tolerant, requiring a deep watering once or twice a month.

Epilobium canum – California fuchsia is a California native plant with a bright orange or scarlet, but sometimes white or pink, trumpet-shaped blossom, which attract hummingbirds and butterflies.

There are many varieties available

with slightly different looks. The foliage can be green to silver and have narrow or broad leaves.

This low spreading groundcover is good in informal or rock gardens, or to help stabilize banks or hillsides. Cut to the ground after flowering in late fall for a tidy garden appearance. Water deeply once or twice a month.

These tested, tough summer bloomers should make your summer gardening easy and are available at most retail garden centers.



All-Stars will add summer color to your garden and you'll have the enjoyment of watching bees and hummingbirds feeding on their blossoms, while enjoying the lazy days of summer.

References

California Native Plants for the Garden 2009. Bornstein, David Fross and Bart O'Brien. Cachuma Press.

Sunset Western Garden Book 2012. Time Home Entertainment Inc.

http://arboretum.ucdavis.edu/arboretum_all_stars_redirect.aspx

<http://aggie-horticulture.tamu.edu/earthkindroses/cultivars/mutabilis/>

<http://aggie-horticulture.tamu.edu/ornamentals/nativeshrubs/salviagreg.htm>



Trish Grenfell
Placer County
Master Gardener

SUMMER BLOOMS ALL AROUND US

Spring is an explosion of colorful blooms in gardens, orchards, and by the roadside. Summer flowers don't burst into view at every corner, but they are there if you know where to look. So this writer decided to survey the Master Gardeners in Nevada and Placer counties, asking where in our counties they enjoyed colorful summer blooms.

Please be aware that this is NOT a comprehensive list. But Master Gardeners are attracted to flowers like magnets to steel, so you probably will enjoy a tour of these colorful sights. Visitors are welcome at the sites listed.

Auburn

The Bell Road Memorial Rose Garden—1229 Bell Rd.

This is a public garden maintained by Gold Country Rose Society located behind the Bell Road Baptist Church. This lush garden includes many roses and includes a garden for the blind filled with fragrance. Free.



The Grounds at Ceronix—13350 New Airport Rd

For a delightful surprise, drive to this address and park on the side of the road in front of this company's buildings. You can view much of this amazing garden from your car. It's amazing not just for the variety of plants, but for the range of exotic fowl on view.

Be sure to drive your car as far around the building as you can to view the side garden. Free.

Granite Bay

WEL Garden behind San Juan Water District (WEL = Water Efficient Landscape)—9935 Auburn Folsom Rd

This is a xeriscape garden, "beautiful any season", which demonstrates efficient irrigation and ways to use "non-water using material". <http://www.sjwd.org/Water-Efficiency.html> Free.

WEL Garden at the American River Water Education Center (Bureau of Reclamation)—7785 Folsom-Auburn Rd, Folsom

Since this garden is but one block from the WEL garden at San Juan Water District, it is listed here. When compared to the SJWD garden above, this is larger, newer, has more sunlight and therefore grows different plants. Blooming this summer are California fuchsias, crape myrtles, butterfly bushes, rock roses, and several sages. Unique to this garden also is Judy Carroll, Placer County Master Gardener, who is the caretaker. Free.

Lincoln

Turkey Creek Country Club—1525 Highway 193

The grounds are charming enough to attract many weddings. Off the parking lot, you will find a butterfly and hummingbird garden along a dry creek bed; and the restaurant and clubhouse are wonderfully

landscaped for summer color. Free.

Penryn

Maple Rock Garden—Near the intersection of Hwy 193 and Clark Tunnel Road

This is the garden gem of the foothills, now owned by High Hand Nursery in Loomis. Maple Rock is now the exclusive Sunset Western Garden test site. For \$15, 20 or more folks can take a guided 2-3 hour tour of Maple Rock Gardens. Stroll through the mature and lush gardens of Maple Rock. Enjoy the multiple garden styles throughout the multi-acre site. Learn about the many beautiful plant varieties from your guide.

Loomis

The Flower Farm Bed & Breakfast, Nursery and Coffee House—Corner of Auburn-Folsom Rd & Horseshoe Bar Rd

Located in the middle of a working citrus orchard, the Flower Farm is filled with lovely gardens and expansive lawns. There are garden areas near the nursery and surrounding the inn. The farm is filled with flowers of many varieties. Free.

Nisei Garden at Loomis Methodist Church—6414 Brace Rd

This Japanese garden combines Japanese artistry with California influences and the result is lovely. Facing the church, the garden is on the right side. Free.

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Roseville

Mahany Park—1545 Pleasant Grove Blvd.

Visit the small, water-wise demo gardens in back of the event center. The park is a major recreation hub for Roseville and lovely, summer bloomers decorate most areas. Free

The Roseville Utility Exploration Center—1501 Pleasant Grove Blvd

You will find a wonderful display of blooming water-wise plants around the buildings and patios. Free.

Korean Veterans' Memorial Rose Garden in Maidu Park—1550 Maidu Drive—to the right of the Community Center in Maidu Park.

Who said there is no rose garden in Roseville? It's not large, approximately 25 rose bushes, but it is officially a rose garden. And it is very pretty with its setting in Maidu Park. The roses are there to help commemorate the Korean War Veterans; stay awhile and read all the tablets at the back of the garden. Free

Grass Valley

Empire Mine State Historic Park—10791 East Empire St.

13 acres of beautifully tended old gardens surround the Bourn Cottage (built by early mine owner, William Bourn Jr.), the Clubhouse, and the George Starr home ruins. Extensive lawns with fountains, a reflection pool, and gardens with a greenhouse still charm as we step back in time.

Included in the gardens are native trees/plants plus a vast assortment of others from around the world. Some imports include Amur Cork trees (from China), Southern Magnolias, English Laurel, Hawthorne, Weeping Birch, Italian Cypress, and a well-developed hedge of English Holly.

The rose gardens have been restored to the period Circa 1905, with more than 950 antique rose bushes of 56 varieties. Daily hours are 10am-5pm. \$7/adult, \$3/children 6-16, under 6 are free.

Alta Sierra Biblical Gardens—16343 Auburn Road Grass Valley

Most of the flowers here occur in spring, but the oaks, pines, and maples create a lovely woodland retreat. Free but donations are requested.

Nevada County Master Gardener Demo Garden—1036 W. Main on the Nevada Irrigation District grounds

This wonderful garden includes raised beds of roses and veggies, testing areas for UC Davis all-stars, an orchard, children's garden, cottage garden, Mediterranean garden, and an oak woodland.

Open to the public Mon-Fri 6am-5pm, Sat 7am-3pm. While you are there, check out the gardens around the NID parking lot. These were designed by the master gardeners also. Free.

Chapa-De Indian Health Clinic—1350 E Main St

The gardens in front of the clinic are quite incredible - and spacious.. See for yourself. Free.

St Joseph's Cultural Center—410 S Church St.

These historic rose gardens have over 100 rose bushes (some over 100 years old), irises, crepe myrtle trees, three kinds of holly trees, mature shrubs, the only palm trees in Grass Valley, and many perennial beds. Open to the public 10-3 weekdays and volunteers are always needed. Free.

Nevada City

Crystal Hermitage Gardens at Ananda Village—14618 Tyler Foote Rd.

Beautiful terraced gardens, expansive vistas, and peace of mind await all those who visit Crystal Hermitage. They are best known for the millions of tulips in springtime, but summer blooms are abundant here also. From their website, "Guests not lodging overnight are welcome to enjoy the grounds from 8am – 8pm daily." Come enjoy the trails, ponds, orchards and flowers. Free.

More options

Spring wildflowers are long gone at lower elevations, but you can find them again if you drive to the high country this summer. For wildflower trails, go to <http://www.redbud-cnps.org/floras.htm>.

Another website for trails in the Tahoe National Forest: <http://www.fs.usda.gov/activity/tahoe/recreation/hiking/?recid=55444&actid=50>

The hike from the top of the Squaw Valley tram to Shirley Lake is awesomely covered in wildflowers throughout summer. Enjoy!



SUMMER 2013 WORKSHOP CALENDAR



JULY

Saturdays in July from 8am-Noon at North Star House in Grass Valley:
Nevada County Master Gardener Information Table at the Grower's Market

Two Saturdays, July 6th and July 20th from 8am to Noon at Auburn Farmer's Market:
Placer County Master Gardener Information Table at Grower's Market

AUGUST

Two Saturdays, August 3rd and August 17th from 8am to Noon at Auburn Farmer's Market:
Placer County Master Gardener Information Table at Grower's Market

August 7-11—Nevada County Fair—Come Visit the Nevada County Master Gardeners!

Saturday, August 17th from 10am-Noon at NC Master Gardener Garden (1036 W. Main, GV):
Start Your Winter Vegetable Garden Now!

Saturday, August 24th from 10am-Noon at NC Master Gardener Garden (1036 W. Main, GV):
All About Composting, Mulching and More!

Saturday, August 31st from 10am-Noon at NC Master Gardener Garden (1036 W. Main, GV):
A Home Gardener's Guide to Seed Saving

SEPTEMBER

Saturday, September 7th from 10am-1pm at NC Master Gardener Garden (1036 W. Main, GV):
BITE ME!! Tomato Tasting & Open House & 2 workshops (Composting/Edible Landscaping)

Saturday, September 7th from 9am to 11am at Placer MG Demo Garden (11477 E Ave. Auburn):
Composting (9am to 10am) and Vermiculture (10am to 11am)

Saturday, September 14th from 10am-Noon at NC Master Gardener Garden (1036 W. Main, GV):
All About Composting, Mulching and More!

Saturday, September 14th from 9am to 11am at Placer MG Demo Garden (11477 E Ave. Auburn):
Cover Crops—Plant Your Way to a Healthy, Fertile Soil

Saturday, September 21st from 10am-Noon at NC Master Gardener Garden (1036 W. Main, GV):
The Real Dirt: Working with Foothill Soils

Saturday, September 28th from 10am-Noon at NC Master Gardener Garden (1036 W. Main, GV):
Fall Planting of Perennials for Sun and Shade



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UNIVERSITY OF CALIFORNIA
 11477 E AVENUE (BUILDING 306, DEWITT CENTER)
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Kevin Marini

PROGRAM REP: HOME HORT AND COMPOSTNG EDUCATION
 MASTER GARDENER COORDINATOR
 530-889-7399

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