

CURRENT STATUS OF THE VINE MEALYBUG, *PLANOCOCCUS FICUS*, IN CALIFORNIA

A Report from the Division of Plant Health and Pest Prevention Services
March 25, 2003

ABSTRACT

The vine mealybug, *Planococcus ficus*, is an exotic pest first found in the Coachella Valley, Riverside County in 1994. Since then, the pest has spread to an additional 12 counties including El Dorado, Fresno, Kern, Napa, San Joaquin, San Luis Obispo, Santa Barbara and Sonoma. The vine mealybug is easily distinguished from other mealybugs in California in the nymph and adult female stages. The males are indistinguishable from the widespread citrus mealybug. The vine mealybug feeds on grape, fig, pomegranate, avocado, date palm, apple and quince in addition to several ornamental plants such as dahlia. The pest feeds on plant sap and can reduce vine vigor, fruit set and growth at high densities. The vine mealybug excretes large amounts of honeydew as they feed that foul the plant, provide a food source for sooty mold and reduce the quality of the harvested grapes. The vine mealybug feeds on all the parts of the vine, especially roots and under loose bark. This makes it difficult to detect the pest using visual surveys. The pest has limited powers of dispersal and most movement throughout California appears to be via infested nursery stock, workers or field equipment. A sex pheromone is available to detect the male vine mealybug but visual surveys are required to confirm an infestation in the vineyard because of possible confusion with citrus mealybug males. Several parasites are attacking the vine mealybug in California including *Anagyrus pseudococci*, the primary parasite of the citrus mealybug. Additional parasites have been imported into California and further exploration for vine mealybug parasites is planned. The parasites can attack up to 80 percent of the pest but the rate of attack of the mealybugs on the roots or under bark is very low. Cultural practices are available to reduce vine mealybug numbers in vineyards and to reduce their spread to un-infested vineyards including rapid destruction of prunings, cleaning of field equipment and workers before they leave the vineyard, and washing trucks after they deliver grapes. A spray program using chlorpyrifos at bud break, and imidacloprid during the growing season appears to provide adequate control of the pest. At present there are no quarantines against the pest, but Mexico has inquired about its status and other countries are likely to also ask. A regime of six, five-minute hot water (125°F) treatments killed 100 percent of the treated vine mealybugs on nursery stock. At present we have no reliable techniques or technology to certify that a commodity is free of vine mealybug.

INTRODUCTION

The vine mealybug, *Planococcus ficus*, is an exotic pest first found in California in the Coachella Valley, Riverside County in 1994. Since that time, the insect has spread to at least 12 additional counties. Growers are reporting considerable damage caused by this mealybug. Their concerns have caused the California Department of Food and Agriculture (CDFA) to develop this report detailing the status of our knowledge about this pest as a first step in deciding how best to help the industry cope with this exotic invader.

IDENTIFICATION OF THE VINE MEALYBUG

The vine mealybug is easily distinguished from other mealybugs in California in the adult female stage. The males of the vine mealybug are easily distinguished from mealybugs in other genera but they are indistinguishable from those of the citrus mealybug that is in the same genus. The

vine and citrus mealybugs have different host plant preferences. We are able to separate the nymphs of the vine mealybug from other mealybugs that occur on grapes.

BIOLOGY OF VINE MEALYBUG

All life stages of vine mealybug are found throughout the vine, including on the roots, under bark on the trunk and cordons, and on canes, leaves, and clusters (Attachments, Figures 1 to 4). There is no overwintering stage, rather all life stages can be found throughout the year. There are perhaps three to seven generations per year. During the winter months, eggs, crawlers (first instar nymphs), nymphs (second or larger instar nymphs), and adults can be found under the bark, within developing buds, and on the roots. As temperatures warm in the spring, the density of vine mealybug increases, and the mealybugs move out to the cordons and aerial parts of the vine. Vine mealybug can be found on all parts of the vine including leaves and clusters by late spring and summer. Shortly after harvest, the density of vine mealybug declines. This generalized biology fits most vine mealybug populations, however, it varies slightly with location and cultivar.

In the Coachella Valley, the peak in density occurs in mid to late spring, followed by a dramatic decline in density in the summer. This decline is perhaps due to increased mortality due to high temperature. There is a second smaller peak in density that occurs in September and October.

In the San Joaquin Valley, two peaks in density occur during the summer months (end of June through the first of August). Again, there is a dramatic decline in density in August and September, possibly caused by increased mortality imparted by the parasite *Anagyrus pseudococci*. In October, a third smaller peak in density occurs.

There are similarities and differences in vine mealybug biology between the two valleys. For both valleys, the increase in density in the spring is probably due to increased reproduction and movement outward on the vine. In addition, the first peak in density in the growing season is greater than the peak in density in the fall.

The differences in vine mealybug biology between the two valleys include density and distribution on the vine. The numbers of peaks in adult density from spring through fall are two in the Coachella Valley and three in the San Joaquin Valley. The decline in density in the summer also differs between the valleys. In the Coachella Valley, the decline is probably due to high temperatures. In the San Joaquin Valley, the decline is probably due to parasitism.

The general distribution of vine mealybug on the vine throughout the season varies between valleys. In the San Joaquin Valley, the vine mealybug population on the lower trunk (near the soil line) remains large throughout the season. In the Coachella Valley, this population declines in the summer. More vine mealybugs remain on the canes and leaves throughout the growing season in the San Joaquin Valley than in the Coachella Valley.

Only male vine mealybugs have wings and can fly; the females are wingless. This mealybug is difficult to see because of its small size (largest life stage is 2.5 to three millimeters in length) and cryptic nature (i.e., living beneath the bark and on the roots). Adult females can survive up to a month with little or no food if protected from extremes in temperature.

PROPOSED WORK FOR 2003

Dr. Kent Daane and others will continue studies on vine mealybug biology in the Coachella Valley and the San Joaquin Valley. Emphasis will be placed on the causes of changes in density through the season in an attempt to determine if there may be ways of manipulating the environment to reduce vine mealybug densities. In addition, vine mealybug densities will be compared among raisin, table, and wine grape vineyards. Each type of vineyard has cultural practices unique to the type of grape grown, and there may be cultural practices that can reduce vine mealybug densities. Studies to determine the effect of temperature on development will continue for vine mealybug.

HOST PLANTS OF THE VINE MEALYBUG

In addition to grapes, this pest has been reported feeding on mango, oleander, dahlia, bamboo, walnut, avocado, *Dichrostachys glomerata*, mesquite, *Tephrosia purpurea*, ornamental and commercial fig, date palm, sycamore, pomegranate, jujube, apple, quince, willow, cacao, and styrax.

IMPACT OF THE VINE MEALYBUG ON THE GRAPE PLANT

Vine mealybugs feed by sucking the sap out of the grape plant phloem cells much like aphids and scale insects. At high densities the vine mealybugs can reduce plant vigor by removing large amounts of sap, which carries the food to the grape roots and growing tissues including the grape bunches. The vine mealybugs excrete large amounts of fluids that have high concentrations of sugars. This "honeydew" can foul the grape vine with a layer of sticky sap as it dries. In addition, a fungus called "sooty mold" grows on the honeydew. This black fungus covers the grape leaves interfering with photosynthesis and fouling the grape bunches. Honeydew covered grapes must be washed, which is difficult before being sold (Attachments, Figures, 1 to 3). Most sooty mold-fouled bunches will either not be sold or will be sold at a reduced price. The presence of vine mealybugs on grape clusters renders them unmarketable (Attachments, Figures 1 to 3). The vine mealybug is known to transmit leaf roll virus in grapes. As a phloem feeder, it will not transmit Pierce's Disease that inhabits the xylem tissues of the grape vine.

DISPERSAL OF THE VINE MEALYBUG

Vine mealybugs can disperse by crawling, being blown in the wind, or being carried on plant trash, equipment or nursery stock. The nymphs can crawl from plant to plant within a vineyard. The first instar nymphs, those newly hatched, can be blown from the infested plant onto nearby plants by strong breezes. The nymphs can be carried on plant trash including leaves, cuttings, grape bunches, etc. by people moving from an infested vineyard to another vineyard. Equipment can also move nymphs or adult females from vineyard to vineyard either with plant trash or as individuals on the equipment. Nursery stock can move the insects from infested nurseries (Attachments, Figures 5 to 8). All large distance movement of the pest is likely human aided on equipment, people or nursery stock. More local movement is also likely human aided but also includes wind-blown first instar nymphs.

DISTRIBUTION AND SPREAD IN CALIFORNIA

At the time of its detection in California, the vine mealybug was infesting about 6,000 acres of grapes in the Coachella Valley, Riverside County. This acreage had increased to 15,000 by 1997. In 1998, the pest was detected in Arvin, Lerdo Highway, Kern County and Del Rey, Fresno County. Delano, Kern County was found infested in 1999. Subsequent infestations have been discovered in eight additional counties spread from Santa Barbara County in the south to Sacramento and El Dorado counties in the north (Table 1). There are unconfirmed infestations in additional three counties (Attachment, Figure 9) that are supposedly known to University of California scientists. These will remain unofficial until verified by experts in the CDFA's Plant Pest Diagnostic Center as required by the CDFA policy. In the rest of the world, vine mealybug is widely distributed throughout southern Europe, and the Middle East. It can also be found in parts of Africa, South America, and in Alabama.

DETECTION OF VINE MEALYBUG

Dr. Jacelyn Millar of the University of California, Riverside (UCR) has isolated the female pheromone of the vine mealybug. The synthetic pheromone is very attractive to vine mealybug males for a period of up to two months. It has an effective range (area from which the vine mealybug males would respond) of 300 feet, and the numbers of males caught in the pheromone-baited traps are correlated with actual vine mealybug densities in the trapped vineyards. More importantly, very small densities of vine mealybug can now be detected with the pheromone traps.

When put on a sticky trap, the pheromone attracts the males of the vine mealybug in addition to males of several other species of mealybugs. These pheromone-baited traps can be used to detect potential vine mealybugs in grape vineyards as was done in 2002 in the North Coast area. Because vine mealybug males cannot be distinguished from citrus mealybug males, a secondary visual survey is needed to confirm the presence of the vine mealybug. This visual survey looks for vine mealybug nymphs or females in the vineyard. Infested vineyards are those in which vine mealybug nymphs or females, identified by the CDFA's Plant Pest Diagnostic Center professionals have been found.

There is a limited amount of the natural pheromone developed by Dr. Millar available for use in detection programs in 2003. A synthetic pheromone is available for the vine mealybug. It is undergoing testing to insure that it is as effective as the natural material developed by Dr. Millar.

WORK PROPOSED FOR 2003

Dr. Daane will continue to coordinate a statewide effort in identifying vine mealybug-infested vineyards. Under his direction, University of California Cooperative Extension (UCCE) Farm Advisors and other interested parties will conduct pheromone trapping in all grape-growing regions of California. Initially, traps will be placed in "at-risk" vineyards. In addition to pheromone trapping, the location of each vine mealybug infested vineyard will be mapped with a Global Positioning System (GPS) unit. The Kearney Agricultural Center Geographic Information System (GIS) Facility will produce an interactive, web-based map of known infested areas. For some areas, the levels of infestation will simply be "presence" or "absence." In other areas, vine mealybug density estimates will be made, and the information will be added to the GIS map and database. All of the information collected in this research will be used to develop economic thresholds for vine mealybug based on pheromone trap catches. In addition, testing

will be done to compare a commercially available vine mealybug pheromone to that produced in Dr. Millar's lab (known to be active).

Table 1. Vine Mealybug Infestations Confirmed by the CDFA Records Through February 2003

YEAR	LOCATION	COUNTY
1994	Oasis/Thermal	Riverside
1998	Arvin	Kern
1998/1999	Lerdo Highway/ Delano	Kern
1998	Del Rey	Fresno
2000	Santa Maria	Santa Barbara
2001	Creston	San Luis Obispo
2002	Galt	Sacramento
2002	Healdsburg	Sonoma
2002	St. Helena	Napa
2002	Windsor	Sonoma
2002	Clarksburg	Yolk
2002	San Ardor	Monterey
2002	Placerville	El Dorado
2003	Gilroy	Santa Clara
2003	King City	Monterey
2003	Linden	San Joaquin

At present, the vine mealybug has successfully invaded all major grape-growing regions of California. It is present in areas like El Dorado County where the glassy-winged sharp shooter is not expected to survive due to the severity of the winter weather.

BIOLOGICAL CONTROL OF THE VINE MEALYBUG

Natural enemies appear to be an important source of mortality for vine mealybug in other parts of the world. In 1994, a cooperative project between the CDFA Biological Control Program, UCR, and Riverside County Department of Agriculture was established to develop biological control programs for vine mealybug in the Coachella Valley. Drs. Joe Ball and Kris Godfrey (CDFA), and Eldon Reeves (Riverside County Department of Agriculture) conducted surveys of indigenous natural enemies attacking vine mealybug in the Coachella Valley and later assisted in some parasite releases. Dr. Dan Gonzalez (UCR) was responsible for foreign exploration and importation of new parasites.

The survey of indigenous natural enemies of vine mealybug in the Coachella Valley revealed low levels of parasitism. The primary parasite, *Anagyrus pseudococci*, was recovered from all vineyards sampled. This parasite had been introduced in California in the 1940's against a close relative of vine mealybug, the citrus mealybug. Although generally low, the amount of parasitism varied with exposure of the mealybug. For vine mealybug, with few places to hide such as on leaves and clusters, parasitism rates were as high as 22 percent and 13 percent, respectively. For those vine mealybugs that were hidden or protected such as on roots, parasitism rates rarely exceeded one percent. The parasitized vine mealybug on roots were probably either parasitized elsewhere on the vine and then moved to the roots before succumbing, or were moved to the roots by ants that tend vine mealybug for honeydew.

The foreign exploration undertaken by Dr. Dan Gonzalez resulted in the importation of five species of parasites, *Anagyrus pseudococci*, *Leptomastidea abnormis*, *Leptomastix flavus*, *Leptomastix dactylopii*, and *Coccidoxenoides peregrinus*, from the Mediterranean region of Europe and the Middle East. Of these parasites, releases of *Leptomastix dactylopii*, *Anagyrus pseudococci*, and *Leptomastidea abnormis* were made in the Coachella Valley beginning in 1997. In 1998, a project using augmentative releases of *Anagyrus pseudococci* and *Leptomastidea abnormis* began in the Coachella Valley. The parasites were produced by Foothill Agricultural Research (FAR) Insectaries (and are still commercially available from FAR Insectaries). Both parasites were recovered from the augmentative releases with *Anagyrus pseudococci* being recovered earlier in the season than *Leptomastidea abnormis*. Many growers in the Coachella Valley still purchase and release these parasites as a part of their vine mealybug management program.

In the San Joaquin Valley, Dr. Daane found *Anagyrus pseudococci* attacking vine mealybugs. The levels of parasitism were much higher (up to 80 percent in mid-August) than that found in the Coachella Valley. Exposed vine mealybugs (i.e., those on leaves and canes) were more vulnerable to attack by the parasites than those that were hidden (i.e., under bark or on roots).

In additional studies on *Anagyrus pseudococci* and *Leptomastidea abnormis*, Dr. Daane released *Leptomastidea abnormis* into a vine mealybug-infested vineyard in Fresno County in 2001. The parasite was recovered from that vineyard in 2001, although the parasitism rate was low (six percent or less). *Anagyrus pseudococci* were still the dominant primary parasite within the vineyard. Laboratory studies on possible competition between the two parasite species revealed that when vine mealybug were exposed simultaneously to the two parasites, the rate of species-specific parasitism was lower, but the combined rate of parasitism was higher. When *Anagyrus pseudococci* was added four days after *Leptomastidea abnormis*, the level of parasitism by *Leptomastidea abnormis* remained unchanged, but the rate of parasitism by *Anagyrus pseudococci* and by both parasites combined was lower. These studies indicate that the introduction of parasites must be done with care to insure the parasite species compliment one another and not compete excessively with one another.

PROPOSED WORK FOR 2003

Dr. Daane and his laboratory will conduct studies on the augmentative releases of *Anagyrus pseudococci*. These studies will be conducted in commercial vineyards in Fresno, Kern or Madera counties. The parasites will be released at different times and in differing densities to determine the optimal strategy for augmentation (e.g., multiple small releases over the season, several large releases in late spring, etc.). The release rates will range from 5,000 to 10,000 *Anagyrus pseudococci* per acre. Additional studies will be conducted to determine if a combination of carefully timed insecticide applications and parasite releases can improve vine mealybug control.

Drs. Daane and Serquei Triapitsyn will continue importation of vine mealybug parasites. The first importations were done for vine mealybug in the Coachella Valley that has a different climate, different management practices, and surrounding vegetation than the other grape growing regions of California. The first parasite to be imported will be *Coccidoxenoides peregrinus*, the most important parasite of vine mealybug in South Africa. Researchers in South Africa have agreed to supply this parasite for only the cost of shipping. Plans are also being made to travel to Egypt to collect a new species of *Neoplatycerus* that attacks vine mealybug. Both researchers have contacts in Egypt, but the trip will be delayed until the current situation in

the Middle East is resolved. Studies to determine the effect of temperature on development of the parasites will continue.

MANAGEMENT OF VINE MEALYBUG INFESTATIONS

Cultural control is very important in slowing the spread of vine mealybug. The following tactics should be used for vine mealybug infested vineyards:

1. Crews (e.g., irrigators, pruners, pickers, etc.) should be scheduled such that once they work in an infested vineyard; they are finished for the day. Alternatively, crews may be allowed to shower and change clothes before entering an uninfested vineyard. The showering and the change in clothing are necessary because all life stages of vine mealybug (crawlers, in particular) can be carried on the workers skin, clothing and hair. The mealybugs can survive for eight to 24 hours (temperature dependent) on the workers or their clothing if the cleaning protocol is not followed.
2. The prunings from an infested vineyard should be treated in one of the following ways:
 - Take the prunings out of the vineyard and burn them within a few days of cane removal.
 - Shred and mulch the prunings in the middle of the row away from the root zone of the vine. Shredding makes very small pieces out of the prunings. Vine mealybug can survive on pieces of cane about one to two inches in length. Allow the shreadings to decompose for two to three weeks then disk them under. If the weather does not look like it will cooperate, disk shortly after pruning. Remember to keep the prunings away from the root zone of the vine.
 - Bag the prunings, seal the bag and take them to a landfill very shortly after pruning. Use heavy-duty construction disposal bags.
 - Push the prunings out of the vineyard and let them rot or compost away from the root zone of the vines.
 - Bag the prunings, seal the bags, and allow them to rot in the bags in the vineyard. Use heavy-duty construction disposal bags.
 - In circumstances where the weather has warmed quickly or the winter chill barely happened and the vines are beginning to break bud, leave the prunings in the middle of the row and treat them with Lorsban® when the vines are treated. This is an untested strategy that is not recommended at this time and should be used when there are no other alternatives.
3. Steam clean any equipment that has contact with the infested vineyard. Be sure to remove all plant material.
4. Grapes from infested vineyards should be hand harvested. Mechanical harvesters spread vine mealybug.

5. For table grapes, once grapes are bagged and boxed, the truck bed on which the boxes are loaded should be cleaned of any plant debris before leaving the vineyard. The truck should go directly to the storage facility to unload. The truck should then be steam cleaned at the storage facility before returning to any vineyard.
6. For wine grapes and other grapes transported in gondolas, the gondolas should be covered with a plastic tarp to avoid infested plant material from being blown out of the gondola during transport. If the grapes are for wine production, the infested grapes should be crushed as soon as they arrive at the winery to avoid further spread of vine mealybug. All gondolas and tarps should be steam cleaned before picking up more grapes.

The following management program using insecticides has been developed:

- In spring, prior to bud break in late March, an application of Lorsban® (chlorpyrifos) should be applied using four pints per acre in a minimum of 200 gallons per acre of water. Cover the vine and contact the base of the plant. This treatment is more effective if applied on a warm day (70 degrees Fahrenheit). This is a contact insecticide that targets crawlers that are actively moving about the vine
- During bloom (May), an Admire® (imidacloprid) application should be made. This is a systemic insecticide and works best when put through the drip system. The Admire® can also be applied in flood-irrigated vineyards, but it is not nearly as effective as when applied through the drip system as the drip system concentrates the insecticide in the root zone. There is a Special Local Need label for this application. The 32 ounces per acre rate of Admire® gives the best control of vine mealybug. Although, the 24 ounces per acre rate provides reasonable control. For the 32 ounces rate, two applications (each 16 ounces) can be made. The first application should be made during bloom, and the second approximately eight to 10 weeks later, depending upon the pre-harvest interval. Do not exceed 0.5 pound per acre active ingredient of imidachloprid (Admire® plus Provado®) per acre per year.
- At harvest, if a vineyard is heavily infested, the vines should be treated with Provado® (imidachloprid) prior to harvest. This treatment will give short-term kill of the above ground life stages and reduce the possibility of accidentally spreading vine mealybug to other areas. Provado® will not give long term residual required to kill newly hatching eggs later in the fall.

In 2002, insecticide trials were conducted to determine what foliar insecticides could be used when vine mealybug densities were large on leaves prior to harvest. The insecticide regime given above provides the best control. From these trials, it was found that either Lannate® SP (methomyl; one pound per acre) or Dimethoate® E267 (dimethoate; five pints per acre) would provide quick kill of vine mealybug. However, for longer-term population reduction, Applaud® (buprofezin; an insect growth regulator; 0.4 pound per acre) or Dimethoate® should be used.

PROPOSED WORK FOR 2003

Dr. Walt Bentley and Dr. Daane will conduct additional insecticide trials. They will probably involve a few farm advisors as well, to investigate the ability of other products to kill vine mealybug and to confirm the timing and rates of these applications. The studies will also investigate methods to incorporate parasite releases with the insecticide applications to enhance vine mealybug mortality.

REGULATORY IMPLICATIONS OF THE VINE MEALYBUG

Presently there are no quarantines against vine mealybug, but any commodity can be rejected at port of entry if organisms are found. Mexico, however, has just inquired on the status of vine mealybug in California. It seems reasonable that other trading partners who lack this pest will soon be making additional inquiries about the status of this pest in California.

County agricultural commissioners' can adopt local ordinances to prevent the movement of this pest into their counties on grapes, nursery stock, grape equipment, etc.

REGULATORY TREATMENTS FOR THE VINE MEALYBUG

In the fall of 2002, Dr. Bentley began studies to determine if hot water dips could be used on nursery stock to kill vine mealybug. In trials at Kearney Agriculture Center, six five-minute hot water dips (complete immersion in water bath; water temperature 125 degrees Fahrenheit) resulted in 100 percent mortality of all life stages of vine mealybug. Other series of hot water dips (four cycles, two cycles, etc.) were tried, and mortality ranged from 71.4 percent to 100 percent. Data are available upon request from either Dr. Godfrey or Dr. Bentley. In trials conducted at Sunridge Nursery in Kern County, dipping the infested grapevines for four five-minute intervals in 127 degrees Fahrenheit water provided 100 percent mortality of all life stages of vine mealybug, except for crawlers, which had 99.7 percent mortality.

PROPOSED WORK FOR 2003

Dr. Bentley will continue studies on methods to kill vine mealybug on nursery stock.

REGULATORY CONSIDERATION TO CONTROLLING MOVEMENT OF VINE MEALYBUG HOST MATERIAL

Detection Certification - for certification as free from vine mealybug:

- Production nurseries or producing vineyards.

The detection of vine mealybug is complicated. All stages of the insect (eggs, crawlers, nymphs and adults) may be found on various parts of the plant, including leaves, berry clusters, canes, under the bark, as well as on roots.

The presence of vine mealybug can escape detection during visual inspections when they are present in the cracks of the bark, under the bark, or below soil surface on the roots. Male pheromone traps can be used to detect potential infestations in an area; the population must be confirmed visually.

Each individual plant cannot be inspected when pulled from the growing grounds for shipment. If vine mealybug is on the roots of a few plants it will be missed.

Vineyards: Male pheromone traps can be utilized to detect potential infestations in a vineyard; the population must be located visually. Minimum trap density/acre for reliable detection is being researched.

Regulation/Certification - as free form vine mealybug:

1. Inter and Intra-county movement.

To prevent artificial movement within a county, the county agricultural commissioner may issue a hold order on an infested property and require the owner to sign a compliance agreement to follow certain procedures to prevent/reduce the artificial spread of vine mealybug.

An un-infested county may protect its growers from vine mealybug by:

- Inspection of arriving shipments from infested counties. Rejection is possible only if the insect is found.
- Adoption of regulations requiring certain procedures or treatments be made to the commodity at origin and certified by the county. These regulations are possible only after the un-infested county presents proof to the Secretary of the CDFA that the insect is not present, and how vine mealybug will be eradicated if found, etc. If approved, the regulations have legal authority. Then shipments from vine mealybug infested counties can be made to the un-infested county using a Certificate of Quarantine Compliance.

2. Chemical Treatment - the county agricultural commissioner in an infested county could certify that an approved commodity treatment has been performed.

- Foliar applications can be effective if properly applied.
- Systemic applications may prove to be effective against vine mealybug.

At this point in time there are no reliable techniques or technology available to a county agricultural commissioner to certify a commodity as being free from vine mealybug.

OUTREACH

Outreach for the vine mealybug has been conducted since 1995 with presentations to growers, field days, radio and television programs, and newsletters. In the past two years, grower meetings specifically for vine mealybug have been occurring in all grape-growing regions of California. Written information is available from the following sources:

UC Publication 21612, "Mealybugs in California Vineyards" available for purchase at local Cooperative Extension offices, by phoning 800-994-8849, or on the Internet at <http://anrcatalog.ucdavis.edu>. Price \$7.00.

Newsletter called Grapes Notes (multiple issues with color photos), available at http://cesanluisobispo.ucdavis.edu/newsletterfiles/Grape_Notes.

UC Publication IPM 6-00; "Vine Mealybug," available for free at <http://cetulare.ucdavis.edu/pubgrape/ipm600.pdf>.

UC Pest Management Guidelines for Vine Mealybug, available at <http://www.ipm.ucdavis.edu/PMG/r302301911.html>.

Poster about vine mealybug in English and Spanish available for a small cost through local Cooperative Extension offices.

PowerPoint Presentation on vine mealybug by Dr. K. Daane is available by contacting Dr. K. Daane. (Most local Cooperative Extension Offices have this presentation).

PowerPoint Presentation on vine mealybug taxonomy, distribution, and basic biology by Kris Godfrey and Ray Gill is available by contacting Kris Godfrey.

PROPOSED FOR 2003

Drs. Daane and Bentley will finish the web site on vine mealybug that is to be hosted by Kearney Agricultural Center. The site is currently under construction, but may be viewed at <http://vinemealybug.uckac.edu>. Grower meetings and field days will continue throughout the year. Additional newsletters and other informational brochures will be developed at necessary.

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REFERENCES

- Bentley, W. J., L. A. Martin, R. Malakar-Kuenen, R. Coviello, S. Vasquez, K. M. Daane and Millar, J. 2002. Researching management techniques for vine mealybug in San Joaquin Valley grapes. *In* 2000-2001 Viticulture Research Report. California Table Grape Commission Annual Report, Vol. 30, Annual Report. Vol. 30, 9 pages.
- Berlinger, M. J. 1977. The Mediterranean vine mealybug and its natural enemies in Southern Israel. *Phytoparasitica*. 5: 3-14.
- Cadee, N. and J. M. J. van Alphen. 1997. Host selection and sex allocation in *Leptomastidea abnormis*, a parasitoid of the citrus mealybug *Planococcus citri*. *Entomol. exp. appl.* 83: 277-284.
- Daane, K. M., R. Malakar-Kuenen, M. Guillén, W. J. Bentley, L. A. Martin and G. Y. Yokota. 2003. Population dynamics of the vine mealybug and its natural enemies in the Coachella and San Joaquin Valleys. *In*. 2001-2002 Viticulture Research Report. California Table Grape Commission Annual Report, Vol. 31, 15 pages.
- Duso, C. 1989. Bioecological study on *Planococcus ficus* (Sign.) in Veneto. *Boll. Lab. Entomol. Agraria "Filippo Silvestri"* 46: 3-20.
- Godfrey, K., J. Ball, D. Gonzalez, and E. Reeves. Biology of the vine mealybug in vineyards in the Coachella Valley, California. *Southwestern Entomol.* (submitted).
- Godfrey, K. E., Daane, K. M., Bentley, W. J., Gill, R. J, and Malakar-Kuenen, R. 2002. Mealybugs in California vineyards. UC DANR Publ. 21612. Oakland, CA.
- González, D. 1998. Biological control of the vine mealybug in the Coachella Valley. *Calif. Table Grape Comm. Ann. Rep.* Vol. Vol. 26: 4 pages
- Griffiths, H. Barcinas, J., González, D. and J. Klotz. 2000. Mass release of parasites of vine mealybug (VINE MEALYBUG) colonization or augmentation strategies. *Calif. Table Grape Comm. Ann. Rep.* Vol. 28: 12 pages.
- Hinkens, D., J. McElfresh, and J. Millar. 2001. Identification and synthesis of the sex attractant pheromone of the vine mealybug, *Planococcus ficus*. *Tetrahedr. Lett.* 42: 1619 –1621.
- Malakar-Kuenen, R., K. M. Daane, W. J. Bentley, G. Y. Yokota, L. Martin, K. E. Godfrey and J. C. Ball. 2001. Population dynamics of the vine mealybug and its natural enemies in the Coachella and San Joaquin Valleys. *University of California, Kearney Plant Protection Group, Plant Protection Quarterly* 11(2): 1-3.
- Malakar-Kuenen, R., K. M. Daane, M. Guillén, W. J. Bentley, G. Y. Yokota, L. A. Martin and K. E. Godfrey. 2002. Population dynamics of the vine mealybug and its natural enemies in the Coachella and San Joaquin Valleys. *In*. 2000-2001 Viticulture Research Report. California Table Grape Commission Annual Report, Vol. 30, 22 pages.

- Millar, J. G., K. M. Daane, J. S. McElfresh, J. Moreira, R. Malakar-Kuenen, M. Guillen and W. J. Bentley. 2002. Development and optimization of methods for using sex pheromone for monitoring the mealybug *Planococcus ficus* (Homoptera: Pseudococcidae) in California vineyards. *J. Econ. Entomol.* 95(4): 706-714.
- Tingle, C.C.D. and M.J.W. Copland. 1989. Predicting development of the mealybug parasitoids *Anagyrus pseudococci*, *Leptomastix dactylopii*, and *Leptomastidea abnormis* under glasshouse conditions. *Entomol. Exp. Appl.* 46:19-28.
- Triapitsyn, V. A. 2002. A new species of *Neoplatycerus* (Hymenoptera: Encyrtidae) from Egypt, parasitoid of the vine mealybug, *Planococcus ficus* (Homoptera: Pseudococcidae). *Entomological News* 113: 203-210.
- UC IPM. 2002. Pest Management Guidelines for Grapes. <http://www.ipm.ucdavis.edu/PDF/PMG/index.html>.
- Walton, V. M., and K. L. Pringle. 1999. Effects of pesticides used on table grapes on the mealybug parasitoid *Coccidoxenoides peregrinus* (Timberlake) (Hymenoptera: Encyrtidae). *South African J. Enology and Viticulture* 20: 31-34.
- Walton, V. M. (submitted) development of an integrated pest management system for vine mealybug, *Planococcus ficus* (Signoret) in vineyards in the Western Cape Province, South Africa. PhD Thesis, University of Stellenbosch, Matieland, South Africa.

ATTACHMENTS

(In a Vineyard)



(Figure 1) Photo by D. A. Mayhew, CDFA



(Figure 2) Photo by K. Godfrey, CDFA

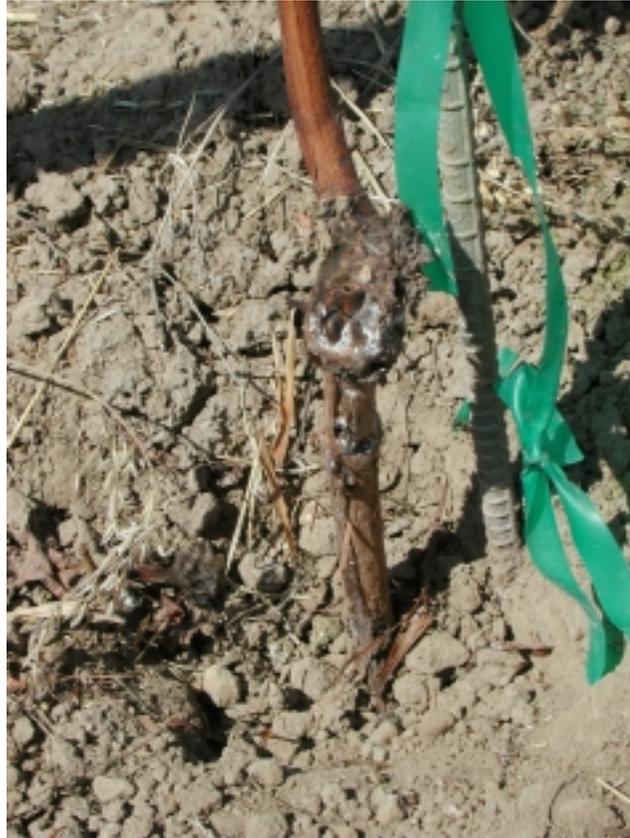


(Figure 3) Photo by K. Godfrey, CDFA

ATTACHMENTS

(Early Infestation)

Vine Mealybug Damage



(Figure 4) Photo by K. Godfrey, CDFA

ATTACHMENTS

(In Nursery Stock)

Vine Mealybug Damage



(Figure 5) Photo by L. Varela, UCCE



(Figure 6) Photo by L. Varela, UCCE

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(Figure 7) Photo by L. Varela, UCCE



(Figure 8) Photo by L. Varela, UCCE

