UC Cooperative Extension
University of California
Agriculture & Natural Resources

Detecting and Managing Vine Mealybug: Frequently Asked Questions

How do I determine whether vine mealybug is present in my vineyard?

Since its detection in Napa County in 2002, vine mealybug has continued to spread, increasingly putting vineyards at risk from pest incursions. Use pheromone-baited traps to monitor for vine mealybug males or conduct visual scouting for nymphs and females.

The Napa County Pest and Disease Control District funds trapping efforts in areas of the county that are not known to be infested. Trapping is coordinated through the office of the Agricultural Commissioner. Current and historical (to 2012) trap capture data are available in an online map below.

Grape mealybug is the other common mealybug species in Napa County vineyards. Proper identification is important. If you are uncertain, submit samples (adult male or female) to the Agricultural Commissioner's office for verification by CDFA systematists.

Pheromone-baited trap in vineyard



View Napa County VMB trap capture data

VMB risk map for Napa County

Monitoring for Vine Mealybug (Video)

Distinguish between grape and vine mealybug

Identify male vine mealybug

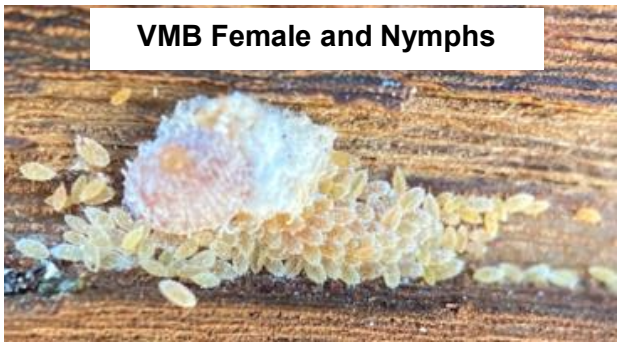
Other small insects caught on traps

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What is the vine mealybug life cycle?

Vine mealybug has three nymphal stages. Males have an additional pre-pupal stage, and the male is the only winged life stage. Mated females can produce up to 500 eggs, which are laid in a waxy, protective ovisac. Vine mealybug nymphs and females typically congregate in protected locations (under the bark) to feed and lay eggs.

In Napa and Sonoma counties, vine mealybug overwinters as nymphs under the bark, at or below the graft union. As the vines begin to grow, vine mealybug moves up the trunk, following the sap flow. During late summer, they may move onto the leaves or clusters, although a portion of the population often remains under the bark. Unlike grape mealybug, vine mealybug does not have a winter diapause (resting state). When conditions are favorable (55 to 93°F), they will continue to develop, including during the vine's dormant season. Due to this, warm weather during the dormant season can result in the build-up of large populations of vine mealybug early in the growing season. Under these conditions, there is a high risk for crop damage and spread of the pest, so interventions should start early to manage populations.



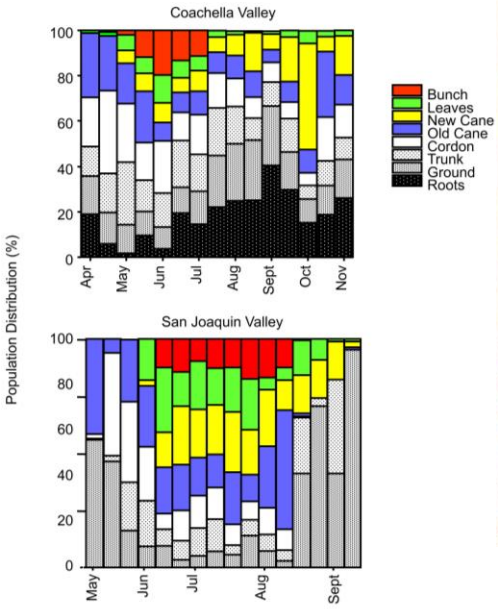


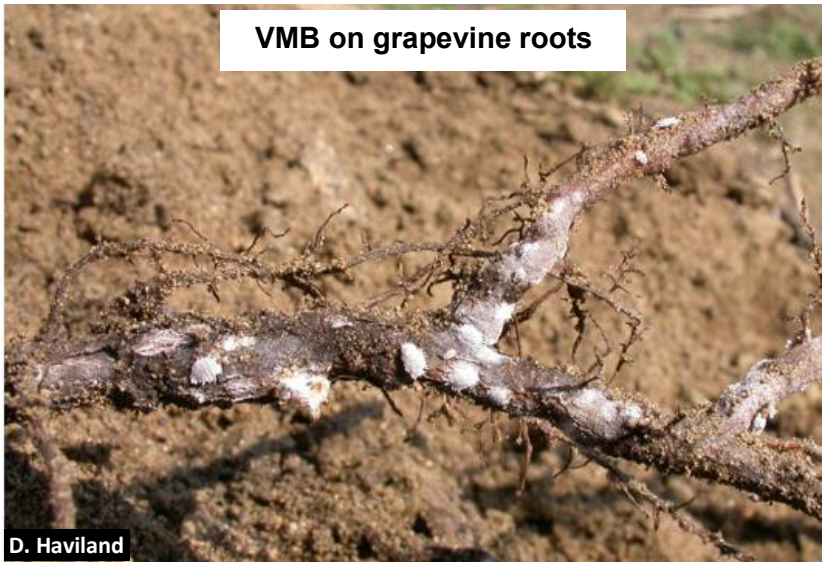
1. Grape Pest Management Manual. UC ANR Publication 3343

Does vine mealybug colonize grapevine roots?

There are strong locational and environmental factors that determine whether vine mealybug will colonize grape roots. Root colonization occurs in the southern interior regions of California, specifically southern Kern County and the Coachella Valley. The driving factors of root colonization are sandy soil, presence of the desert field ant (*Formica perpilosa*), and temperature. High summer temperatures in the Coachella Valley drive mealybugs underground where conditions are cooler and more humid. Mealybugs access the root zone via tunnels in the nests of desert field ants. In the sandy soils of southern Kern County, vine mealybug has been found on roots during the dormant and growing season. In northern Kern County, vine mealybug occurs at the soil level and on shallow roots, whereas in Fresno they overwinter at the soil line but not underground. Similarly, in coastal regions, vine mealybug overwinters on the trunk at the soil line but has not been observed to occur on the roots.

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Does vine mealybug colonize hosts other than grapevine in California?

In California, vine mealybug has not been documented to colonize and sustain populations on hosts other than grapevine. The grass or solanum mealybug (*Phenacoccuss* spp.) is similar morphologically to vine mealybug. It colonizes weedy hosts (such as malva) in and near vineyards, and may be confused with vine mealybug, leading to anecdotal reports of vine mealybug on non-grapevine hosts in California.

Phenacoccus solani
Grass or solanum mealybug





2. Correa et al. 2023. Identifying cryptic species of *Planococcus* infesting vineyards to improve control efforts. https://doi.org/10.1007/s10340-022-01532-1

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Which risk factors influence spread of vine mealybug?

The greatest risk factor for short-distance spread of vine mealybug is “frequency of occurrence”—meaning that the closer a vineyard is to a known pest population, the greater the risk of spread. Based on long-term monitoring data from Napa County, the greatest risk of spread was documented within 250 meters (820 feet) of a known population of vine mealybug.

Infected plant material is a risk for long-distance spread of vine mealybug. During the early colonization phase, vine mealybug was moved around California on dormant bench grafts. Subsequently, a hot water dip protocol for dormant wood was implemented to reduce risk of spread via this pathway. Since then, vine mealybug has been found on shipments of green growing vines, often hidden under the wax at the graft union. Green growing vines can be inspected for presence of vine mealybug. Populations are often small and sporadically distributed so inspections may not uncover any or all infected vines. A canine detection program could be implemented to screen outgoing or incoming nursery shipments, should the resources become available to implement such a program statewide.

Inspecting green-growing vines for vine mealybug (Video)



Inspecting green-growing vines for vine mealybug (Handout)



3. Haviland et al. 2005. Hot water treatments for control of *Planococcus ficus* on dormant grape cuttings. https://doi.org/10.1603/0022-0493-98.4.1109

4. Schartel et al. 2021. Quantifying Planococcus ficus invasion in northern California vineyards to inform management strategy. doi: 10.1093/ee/nvaa141

What management tools are available for vine mealybug?

Mating disruption, biological control and insecticides are the primary tools in an integrated pest management program (IPM) for vine mealybug. In coastal regions, Argentine ants are often associated with vine mealybug. Given their ability to disrupt biocontrol agents, an ant suppression program that uses toxin-laced bait is warranted in order to establish an effective biocontrol program. Mating disruption and biological control (with ant bait) may effectively contain low to moderate populations of vine mealybug. Large populations may require the use of an aggressive insecticide program to reduce populations before implementing other strategies. Organic growers have more limited insecticidal options, so must consider an integrated program of mating disruption and biological control (with ant bait, when necessary).

5. UC IPM. Vine mealybug. Grape Pest Management Guidelines.

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6. Daane et al. 2008. Vineyard managers and researchers seek sustainable solutions for mealybugs, a changing pest complex. https://doi.org/10.3733/ca.v062n04p167

7. Cocco et al. 2021. Sustainable management of vine mealybug in organic vineyards. https://doi.org/10.1007/s10340-020-01305-8

Should bark removal be part of an integrated program for vine mealybug?

Bark removal is a historical practice that was part of the (now defunct) vine mealybug compliance agreement in Napa. However, there is no scientific evidence supporting the use of bark removal for vine mealybug management and it is not included in the UC IPM guidelines. Bark removal was practiced at a time when other management options were limited: before mating disruption was registered, before parasitoids were commercially available for release, and when insecticidal programs were heavily dependent on broad spectrum products.

Although intuitively bark removal exposes hidden populations of vine mealybug, in reality it may have the unintended consequence of dispersing vine mealybug because they begin moving as soon as they lose cover. Parasitoids and predators are attracted to vines that are moderately to highly infested, so bark removal may also remove natural enemies and slow their population expansion. Finally, bark removal tends to focus on highly infested vines but neglects the numerous other vines where vine mealybug is present in low densities and difficult to detect. We lack validated information on the scale of bark removal needed at the vine and block level to accomplish the intended populations reductions.

Bark removal is resource intensive. Investing in validated tools, such as mating disruption, biological control, ant bait and insecticides may deliver greater and more durable returns than bark removal, particularly when the goal is to reduce the risk of spread.

Which insecticides are effective for vine mealybug?

The UC IPM Pest Management Guidelines for vine mealybug contain specific information on insecticides and their application. Always read and follow the label of the product being used.
Be aware of any specific regulatory requirements related to reporting or usage. When designing an insecticidal program for vine mealybug, pay particular attention to the following factors: (1) Insecticide resistance management (mode of action group number). (2) Soil type when considering systemic, soil-applied materials. (3) Specific guidelines related to application of the insecticide, such as the use of a surfactant or the need for sufficient leaf canopy to metabolize the product. (4) Recommended timing of application and whether to expect a delay between uptake and activity of the product. (5) Targeted vine mealybug life stage. For example, when using an insect growth regulator, monitor vine mealybug development and target the application for the young nymph stage.

5. UC IPM. Vine mealybug. Grape Pest Management Guidelines.

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What is a pheromone and how are synthetic pheromones used?

Insects communicate using species-specific pheromones. Common pheromones include *alarm* to communicate potential hazard, *aggregation* to congregate insects of the same species, *trail* to indicate a food resource and *sex* to attract a mate. Once the components of a sex pheromone are identified, it can be synthetized, loaded in a lure and placed in a trap to detect male insects. Synthetic pheromones can also be formulated into products intended to influence or interfere with the target insect's activities, such as mating or trail following.

8. Millar et al. 2002. Development and optimization of methods for using sex pheromone for monitoring the mealybug *Planococcus ficus* in California vineyards. https://doi.org/10.1603/0022-0493-95.4.706

What is mating disruption?

Mating disruption uses a synthetic version of the sex pheromone, and seeks to interrupt or delay mating, thereby reducing subsequent populations by decreasing reproductive capacity. Mating disruption saturates an area with pheromone, interrupting the male insect's ability to navigate to a female. In practice, a synthetic version of the insect's sex pheromone is formulated for foliar or aerosol application or loaded into a dispenser. Dispensers release the synthetic pheromone slowly over a defined period and foliar formulations are applied using a sprayer at a regular interval. The sustained use of mating disruption over multiple growing seasons results in improved control of vine mealybug.

9. Daane et al. 2020. Development of a mating disruption program for a mealybug, *Planococcus ficus*, in vineyards. doi:10.3390/insects11090635

10. Lucchi et al. 2019. Managing the vine mealybug through pheromone-mediated mating disruption. https://doi.org/10.1007/s11356-019-04530-6

How should mating disruption dispensers be deployed?

Mating disruption is not a barrier treatment—it can't be used to keep an insect (vine mealybug) from coming into a block. Therefore, it should not be deployed as a strip treatment around the edge of a property. Instead, aim to deploy mating disruption in large, contiguous areas. For example, working with your neighbors to coordinate mating disruption across a region. Mating disruption tends to break down at the edges, so a strategy of increased density at the edges may be employed. Also consider topography: because the pheromone molecules sink, mating disruption can be less effective at the top versus the bottom of a slope. Increase density or rate of application at the top of a slope to mitigate. Always read and follow the label of the product being used.

11. Hogg et al. 2021. Areawide mating disruption for vine mealybug in California vineyards. https://doi.org/10.1016/j.cropro.2021.105735

12. Daane et al. 2021. Pheromone deployment strategies for mating disruption of a vineyard mealybug. https://doi.org/10.1093/jee/toab198

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When should mating disruption be used?

Pheromone-baited traps can be used to indicate male flight activity and determine optimal timing for dispenser deployment. Place traps in high-pressure vine mealybug areas by March (following a warm winter) or by May (following a cool winter). Follow established trapping protocols and check traps at least once per week. When the traps consistently catch males, commence mating disruption. Historically, males were detected in Napa from May through October. However, changing climatic conditions have advanced phenology and extended the flight period, such that males can be detected from February through November. Be responsive to seasonal conditions when determining when to initiate mating disruption. Always read and follow the label of the product being used.

How long will mating disruption dispensers remain effective?

Always read and follow the label of the product being used. Mating disruption is most effective when vine mealybug populations are low to moderate in size. Season-long and sequential mating disruption can reduce vine mealybug populations over time, and limit spread.

13. Sharon et al. 2016. Mating disruption method against the vine mealybug: effect of sequential treatment on infested vines. DOI: 10.1111/eea.12487

What are the most important biological control organisms for vine mealybug?

Mealybug destroyer beetles (*Cryptolaemus montrouzieri*, *Scymnus* sp., *Hyperaspis* sp.) are the most important predators. *Anagyrus vladimiri* is the most significant parasitoid. *Coccidoxinoides perminutus* is another parasitoid that was released previously in California. Mealybug destroyer beetles may suppress large mealybug populations whereas the establishment of *A. vladimiri* is considered key to a long-term biological control strategy in California.



Anagyrus female with empty mummy



Cryptolaemus adult



Anagyrus male

5. UC IPM. Vine mealybug. Grape Pest Management Guidelines.

14. Gutierrez et al. 2008. Prospective evaluation of the biological control of vine mealybug: refuge effects and climate. doi: 10.1111/j.1365-2664.2007.01356.x

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Why is ant management important for biological control?

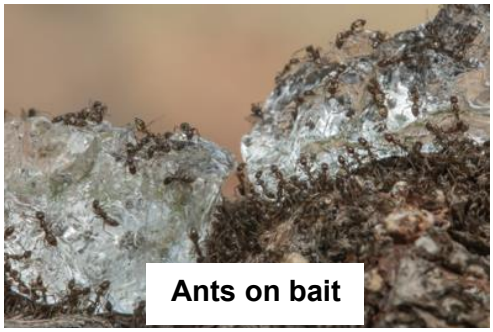
Ants are common in vineyards and include beneficial and pest species. The most common pest ant in coastal California is the Argentine ant, *Linepithema humile*. Argentine ants form mutualistic relationships with sap-feeding insects, such as mealybugs, aphids, and scale insects. The ants feed on nutrient-rich honeydew excreted by sap-feeding insects and in turn protect these insects from natural enemies, including predators and parasitoids. Toxin-laced baits are used to reduce populations of Argentine ant to promote biological control.



Ant tending mealybug



Ant bait on ground



Ants on bait

Argentine ant monitoring (Video)

Argentine ant monitoring (Handout)

Guide to ant identification (Handout)

Gelatinous bait for Argentine ant (Handout)

Gelatinous bait for Argentine ant (Video)

Agar based bait for Argentine ant (Handout)

15. Cooper et al. 2008. Liquid baits control Argentine ants sustainably in coastal vineyards. http://repositories.cdlib.org/anrcs/californiaagriculture/v62/n4/p177

16. Cooper et al. 2019. Argentine ant management: using toxin-laced polyacrylamide crystals to target ant colonies in vineyards. doi: 10.5344/catalyst.2019.18009

17. Le et al. 2024. Field evaluations of biodegradable boric acid hydrogel baits for control of Argentine ants: promising results in vineyards and citrus orchards. https://doi.org/10.3733/001c.120496

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What is the life cycle of *Anagyrus vladimiri*?

Anagyrus vladimiri is a tiny, parasitic wasp (parasitoid) that attacks vine and citrus mealybugs. These wasps do not sting humans or other animals. Using her ovipositor, the female lays an egg in a mealybug nymph. The wasp egg hatches and the developing larva feeds inside the mealybug. This disrupts the mealybug's activities: wax production is reduced, and the mealybug eventually stops feeding and may seek shelter under the bark. By the time the wasp reaches the pupal stage, the mealybug has been killed, although the exoskeleton remains to shelter the wasp pupa. This is referred to as a mummy. To emerge, the adult wasp chews a hole in the pupal case, which is referred to as an empty mummy once the wasp has emerged. The parasitoid has been shown to respond to the sex pheromone of vine mealybug, suggesting that there may be synergistic effects of the use of mating disruption and parasitoid releases to improve management outcomes for vine mealybug.

18. Franco et al. 2007. Kairomonal response of the parasitoid *Anagyrus* to the sex pheromone of the vine mealybug. DOI: 10.1111/j.1570-7458.2007.00643.x

What are the critical thresholds *Anagyrus vladimiri* development?

Under constant temperatures in the laboratory, *A. vladimiri* completed development (from egg to adult emergence) at temperatures ranging from 57 to 93°F. Egg laying by female wasps was reduced or eliminated below 57°F. *Anagyrus vladimiri* completes 2 generations to each vine mealybug generation during the growing season. Parasitism rates may be as high as 90% in coastal vineyards.

19. Daane et al. 2004. Temperature-dependent development of *Anagyrus pseudococci,* as a parasitoid of the vine mealybug. doi:10.1016/j.biocontrol.2004.04.010

20. Gilliéron et al. 2024. Cold tolerance of the mealybug parasitoid, *Anagyrus vladimiri*. https:// doi. org/ 10. 1007/ s10526- 024- 10247-4.

What host stage does *Anagyrus vladimiri* prefer?

Female *A. vladimiri* prefer to lay eggs in 3rd instar vine mealybug nymphs, although they will also lay eggs in 2nd instar nymphs. *A. vladimiri* is host-specific to vine and citrus mealybugs. Other mealybugs found in California vineyards, such as the grape, obscure, longtailed, and Gill's mealybugs, do not host *A. vladimiri,* although they may have their own species-specific parasitoid complexes.

When should I release *Anagyrus vladimiri*?

Monitor vine mealybug populations and air temperature in the spring. Consider releasing *A. vladimiri* when daytime temperatures are forecast to be at or above 60°F for several days, and when 2nd and 3rd instar vine mealybug nymphs are present. If Argentine ants are present, suppress their populations using toxin-laced baits before releasing *A. vladimiri*.

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How many *Anagyrus vladimiri* should I release?

A definitive release rate has not been experimentally determined. As part of an integrated program, an application rate of 500 to 2,000 females released per infested acre per month from April through August suppressed vine mealybug populations. Releases can be centered in areas of the vineyard with known populations of vine mealybug, from which subsequent generations of the parasitoid will disperse. Establishing a resident population of *A. vladimiri* over time through regular releases should be a key objective of a biological control program.

How can I monitor for evidence of *Anagyrus vladimiri* activity in the vineyard?

Because adults and larvae are difficult to detect, monitoring efforts for *A. vladimiri* should focus on the pupal stage. Monitor for mummies and empty mummies. *Anagyrus vladimiri* females may be observed on vines searching for hosts, and they are notable for their white antennae.



Anagyrus female with empty mummy

When should I release the mealybug destroyer beetle, *Cryptolaemus montrouzieri*?

Cryptolaemus montrouzieri feeds on vine mealybug eggs and nymphs. Inoculative releases are an effective strategy to suppress large vine mealybug populations. Both adult and larvae are predaceous. *Cryptolaemus montrouzieri* is a subtropical and tropical species, therefore its activity and development is profoundly affected by cool temperature, and it is not expected to overwinter and establish under typical northern California conditions. Under controlled conditions, *C. montrouzieri* did not complete development between 50 and 62.6°F, and a minimum temperature of 69.8°F was required to feed and lay eggs. Peak larval activity was observed at 82.4°F. Since beetle eggs are laid near vine mealybug eggs, consider timing releases of adult beetles for periods when vine mealybug eggs are present in the vineyard. Work with your purveyor (insectary) to determine release rates of *C. montrouzieri* —since it is likely to depend on vine mealybug populations, time of the season, and local conditions. There are several mealybug destroyer beetle species (*Scymnus* sp. and *Hyperaspis* sp.) that may occur naturally where you find mealybugs in California.



Cryptolaemus feeding on mealybug

21. Kairo et al. 2013. *Cryptolaemus montrouzieri*: a review of biology, ecology, and use in biological control. doi: 10.1079/PAVSNNR20138005

22. Babu and Azam. 1987. Biology of *C. montrouzieri* in relation with temperature. Entomophaga 32: 381-386.

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Reference QR Code Index

1. Grape Pest Management Manual

5. UC IPM. Vine Mealybug. Grape Pest Management Guidelines

2. Correa et al. 2023

3. Haviland et al. 2005

4. Schartel et al. 2021

6. Daane et al. 2008

7. Cocco et al. 2021

8. Millar et al. 2002

9. Daane et al. 2020

10. Lucchi et al. 2019

11. Hogg et al. 2021

12. Daane et al. 2021

13. Sharon et al. 2016

14. Gutierrez et al. 2008

15. Cooper et al. 2008

16. Cooper et al. 2019

17. Le et al. 2024

18. Franco et al. 2007

19. Daane et al. 2004

20. Gilliéron et al. 2024

21. Kairo et al. 2013

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