

Challenges and Solutions for Managing Citrus Mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) in Greenhouse Production Systems

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Abstract

Citrus mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae), is an important insect pest of greenhouse-grown horticultural crops worldwide. Management of *P. citri* in greenhouses is challenging due to biological and behavioral traits that inhibit the ability of greenhouse producers to maintain populations below plant-damaging levels. These traits include: 1) eggs are not susceptible to insecticide sprays because they are protected by an ovisac; 2) third- and fourth-instar nymphs, and adults have a water-repellent covering that reduces spray efficacy; and 3) *P. citri* populations are protected from insecticide exposure because they feed in concealed areas of plants. In addition, few commercially available biological control agents are suitable for release in greenhouses to maintain *P. citri* populations below plant-damaging levels. Greenhouse producers can overcome these challenges by: 1) inspecting incoming plant material before introduction into greenhouses, 2) scouting crops regularly during the growing season to detect *P. citri* infestations, 3) disposing of infested plants, and 4) applying contact insecticides frequently when *P. citri* nymphs are present.

Introduction

Citrus mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae), is an important insect pest of greenhouse-grown horticultural crops worldwide (Blumberg & Van Driesche, 2001; Cadée & van Alphen, 1997; Copland et al., 1985; Cox, 1981; Dreistadt, 2001), including herbaceous annuals and perennials, herbs, foliage plants, orchids, and vegetables (Hennekam et al., 1987; Pillai, 2016). This review discusses the biology, behavior, movement, and damage associated with *P. citri*. In addition, it addresses the challenges of managing *P. citri* and provides solutions to help greenhouse producers maintain populations below plant-damaging levels.

Biology and Behavior

The *P. citri* life cycle includes the egg, nymphal instars (crawlers), and the adult stage. Egg-to-adult development can be completed in 30–60 days, depending on temperature and host plant (Mani & Shivaraju, 2016a; Meyers, 1932). *Planococcus citri* is elliptical with a dis-

tinct gray stripe extending along the top of the body. White, waxy protrusions project around the body periphery (Mani & Shivaraju, 2016a; Pritchard, 1949). Third- and fourth-instar nymphs, as well as adults possess a waxy, water-repellent covering (Copland et al., 1985; Dean et al., 1971; Williams & Watson, 1988). In general, *P. citri* populations consist of equal numbers of females and males (Copland et al., 1985; Mani & Shivaraju, 2016a).

Planococcus citri adult females are 3–5 mm long (Hajer & Hrubá, 2007; Mani & Shivaraju, 2016a; Pritchard, 1949), white, and wingless (Copland et al., 1985; Dreistadt, 2001). Adult males are winged and smaller than females (Dreistadt, 2001; Mani & Shivaraju, 2016a). Adult females may lay up to 800 eggs beneath the body cavity in an egg sac (ovisac) (Copland et al., 1985; Hajer & Hrubá, 2007; Mani & Shivaraju, 2016a; Meyers, 1932; Moore, 1988), a white mass that protects the eggs from desiccation (Mani & Shivaraju, 2016a; Venkatesan et al., 2016). Egg laying can occur over a 10-day period (Pritchard, 1949). Newly emerged (eclosed) nymphs are initially yellow-orange, turn white after successive molts,

and eventually develop a waxy covering. Nymphs search for feeding sites on plants (Copland et al., 1985). Once nymphs locate a suitable site, they begin feeding, with later instars becoming less mobile. Nymphs progress through several stages before becoming adults (Cloyd, 2011).

Planococcus citri females have five developmental stages: egg, three nymphal instars (crawlers), and adult. Males undergo six developmental stages, including a prepupal stage. *Planococcus citri* males create a cottony cocoon and pupate (Mani & Shivaraju, 2016a). Adult males are winged, mate with females, and then die shortly after. The female citrus mealybug lifespan is 40 days, which includes development and molting before dying. The eggs remain beneath the body of the dead female covered by a fluffy white mass (Cloyd, 2011).

Planococcus citri nymphs and adults feed at leaf junctures where the petiole attaches to the stem, on leaf undersides, on terminal growth, and beneath the leaf sheaths of orchids and foliage plants (Mani & Shivaraju, 2016a). *Planococcus citri* can undergo several generations per year, with egg-to-adult development taking 30 to 60 days, depending on temperature (Dreistadt, 2001). Overlapping generations of different life stages (eggs, nymphs, and adults) may occur simultaneously (Franco et al., 2009; Pritchard, 1949; Shrewsbury et al., 2002)

Damage

Planococcus citri causes plant damage by feeding on leaves, stems, flowers, and fruits (Franco et al., 2009; McKenzie, 1967). Nymphs and adults feed on plant fluids in the phloem, mesophyll, or both (Franco et al., 2009). During feeding, they inject toxic saliva, which results in stunted plant growth, leaf yellowing, wilting, chlorosis, leaf drop, premature fruit drop, and plant death (Copland et al., 1985; Demirci et al., 2011; Dreistadt, 2001; Mani & Shivaraju, 2016b; McKenzie, 1967). During feeding, *P. citri* nymphs and adults excrete honeydew (Hajer & Hrubá, 2007; Mani & Shivaraju, 2016b) that serves as a substrate for black sooty mold (Copland et al., 1985; Dreistadt, 2001), which can obstruct photosynthesis and reduce the aesthetic quality of plants (Charles, 1982; Copland et al., 1985; Pillai, 2016; Pritchard, 1949).

Movement

Planococcus citri nymphs can move within a greenhouse via air currents from horizontal airflow fans (Beardsley, 1960) and workers handling infested plants that inadvertently transfer individuals to noninfested plants (Cloyd, 2011). In addition, nymphs can disperse among greenhouse plants when spaced close together with leaves touching (Tanwar et al., 2007; Williams & Granara de Willink, 1992). *Planococcus citri* populations may also be introduced into new greenhouses or locations through

movement of infested plant material (Copland et al., 1985; Mani & Shivaraju, 2016d; Parrella, 1999).

Management

Management of *P. citri* populations in greenhouses involves inspecting incoming plant material for infestations before introduction into greenhouse production systems, scouting crops regularly twice per week, implementing proper cultural practices, applying insecticides, and releasing biological control agents (Cloyd, 2011). Once *P. citri* establish on plants, it is too late to implement management strategies (Cloyd, 2011).

A. Scouting

Greenhouse producers must ensure that incoming plant material is inspected for populations of *P. citri* before introduction into greenhouse production systems (Dreistadt, 2001) because low populations early in production can increase to damaging levels later (Parrella, 1999). The primary method for early detection is visual inspection of plants (Cloyd, 2011; Pillai, 2016). However, visual inspection is labor intensive, impractical, and nymphs are difficult to detect during the early stages of an infestation (Moore, 1988) because the first- and second-instar nymphs are only 2–3 mm in length. In addition, *P. citri* populations tend to reside in concealed areas on plants, such as leaf undersides and base of leaf petioles (Moore, 1988).

Planococcus citri populations typically are clumped, meaning nymphs and adults are aggregated on specific areas of plants (Mani & Shivaraju, 2016c). Consequently, scouting efforts should focus on these areas, as well as plant species susceptible to infestation (Cloyd, 2011). A designated number of plants should be flagged and inspected twice per week for early detection of *P. citri* nymphs during the growing season (Cloyd, 2011).

B. Cultural Practices

Cultural practices include removing weeds, properly fertilizing plants, and disposing of infested plants and old plant material. *Planococcus citri* feeds on plants in more than 27 plant families (Gill et al., 2019). Consequently, weeds should be removed from within and around the greenhouse perimeter because they may harbor *P. citri*, including common mallow (*Malva sylvestris*), redroot pigweed (*Amaranthus retroflexus*), black nightshade (*Solanum nigrum*), and common purslane (*Portulaca oleracea*) (Celepci et al., 2017; Mani & Shivaraju, 2016c), which can move onto the main crop. Plant nutrition can influence the reproduction of *P. citri* females (Franco et al., 2009). For example, females feeding on coleus (*Solenostemon scutellarioides*) receiving 200 and 400 ppm nitrogen from a water-soluble fertilizer laid

265–312 eggs, significantly more than females feeding on coleus plants receiving 25, 50, and 100 ppm (Hogendorp et al., 2006). Therefore, greenhouse producers should only provide the amount of fertilizer required based on information from plant suppliers. Plants infested with *P. citri* should be disposed of immediately to avoid infesting other plants in the greenhouse (Dreistadt, 2001; Mani & Shivaraju, 2016c). Infested plants should be placed into refuse containers or dumpsters located outside the greenhouse (Cloyd, 2016).

C. Insecticides

Insecticides are commonly used in greenhouse production systems to manage *P. citri* (Parrella, 1999). However, systemic insecticides are not effective in maintaining *P. citri* populations below plant-damaging levels on greenhouse-grown horticultural crops. This reduced efficacy may be due to insufficient ingestion of lethal concentrations of the active ingredient, since *P. citri* feeds within the mesophyll tissues and on plant stems (Herrick & Cloyd, 2017; Herrick & Cloyd, 2023; Herrick et al., 2019; Moore, 1988; Pillai, 2016). Consequently, greenhouse producers must rely primarily on foliar applications of contact insecticides to maintain populations below plant-damaging levels.

Contact insecticides also have limited effectiveness against *P. citri* because 1) eggs are not susceptible to insecticide sprays as they are protected by the ovisac; 2) populations are often not exposed to insecticide spray applications when feeding in concealed areas of plants (Charles, 1982; Copland et al., 1985; Franco et al., 2009; Herrick & Cloyd, 2017; Mani & Shivaraju, 2016c); and 3) third- and fourth-instar nymphs, as well as adults, possess a water-repellent waxy covering, which protects them from insecticide spray applications (Copland et al., 1985; Dreistadt, 2001; Franco et al., 2009; Greathead, 1986; Mani & Shivaraju, 2016c; Pillai, 2016; Venkatesan et al., 2016; Walton et al., 2004). The addition of a surfactant to spray solutions may not increase the effectiveness of insecticides (Herrick & Cloyd, 2023). However, first- and second-instar nymphs are susceptible to insecticide applications because they do not have a water-repellent waxy covering (Ahmed & Abd-Rabou, 2010; Charles, 1982; Dreistadt, 2001; Franco et al., 2009; Venkatesan et al., 2016).

Factors influencing the efficacy of contact insecticides against *P. citri* include spray coverage and application frequency. Thorough insecticide applications are important for maintaining populations below plant-damaging levels (Venkatesan et al., 2016). For example, Radosevich and Cloyd (2021) demonstrated that a total spray volume of 75 ml per coleus plant resulted in mortality >60% of *P. citri*, which was higher than spray volumes of 25 or 50 ml. In addition to spray coverage and application frequency, insecticides must be applied when nymphs

are present to maximize mortality before they develop into adults (Radosevich & Cloyd, 2021). Repeated applications are required to target nymphs that were in the egg stage during previous applications (Dreistadt, 2001). Once adult females begin laying eggs, insecticides are minimally effective at maintaining populations below plant-damaging levels. Furthermore, insecticides with different modes of action should be rotated during the growing season to mitigate the risk of insecticide resistance development in *P. citri* populations (Flaherty et al., 1982; Franco et al., 2009; Mendel et al., 1999). Cloyd (2021) provides information on how to rotate insecticides with different modes of action, including a list of products suitable for rotation programs against *P. citri*.

D. Biological Control Agents

Biological control agents, including parasitoids and predators, have been used to manage *P. citri* populations in greenhouse production systems (Doutt, 1952; Moore, 1988). However, the commercial availability of biological control agents for use against *P. citri* is currently limited. Available biological control agents include the predatory ladybird beetle *Cryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae), commonly known as the “mealybug destroyer” (Afifi et al., 2010; Copland et al., 1985; Moore, 1988; Whitcomb, 1940); the green lacewings, *Chrysopa carnea* (Stephens) (Neuroptera: Chrysopidae) and *Chrysoperla rufilabris* (Burmeister) (Neuroptera: Chrysopidae) (Afifi et al., 2010); and the parasitoid, *Leptomastix dactylopii* (Howard) (Hymenoptera: Encyrtidae) (de Jong & van Alphen, 1989; Doutt, 1952; Mani et al., 2011).

Leptomastix dactylopii is no longer commercially available. The parasitoid, *Anagyrus vladimiri* Triapitsyn (Hymenoptera: Encyrtidae) is commercially available from biological control suppliers, and *P. citri* is one of its primary hosts (Andreason et al., 2019). Increased availability of commercial biological control agents would provide greenhouse producers with additional management options.

However, the water-repellent covering and waxy protrusions surrounding the body can protect *P. citri* from biological control agents (Franco et al., 2009). Moreover, biological control agents generally do not maintain *P. citri* populations below plant-damaging levels, which may be related to greenhouse temperatures that are either above or below the optimal activity range of biological control agents (Doutt, 1951).

Discussion

Planococcus citri is an insect pest that is difficult for greenhouse producers to manage due to its biological and behavioral attributes, including 1) eggs not being susceptible to insecticide sprays because they are protected

by an ovisac; 2) third- and fourth-instar nymphs, as well as adults having a water-repellent covering that reduces exposure to insecticide spray applications; and 3) populations are often protected from exposure to insecticide spray applications when feeding in concealed areas of plants (Charles, 1982; Copland et al., 1985; Dreistadt, 2001; Franco et al., 2009; Greathead, 1986; Herrick & Cloyd, 2017; Mani & Shivaraju, 2016c; Pillai, 2016; Venkatesan et al., 2016).

Another challenge is that the presence of *P. citri* can disrupt biological control programs. For example, biological control programs have been developed for poinsettia (*Euphorbia pulcherrima*) using the parasitoid, *Eretmocerus eremicus* Rose & Zolnerowich (Hymenoptera: Aphelinidae) to maintain sweetpotato whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), populations below plant-damaging levels. However, the presence of *P. citri* populations on poinsettia may require insecticide applications that disrupt biological control programs for sweetpotato whitefly (R. A. Cloyd, personal observation).

Despite these challenges, greenhouse producers can overcome them by implementing the following practices: 1) inspecting incoming plant material to prevent *P. citri* introduction into greenhouse production systems; 2) scouting plants regularly twice per week during the growing season to detect infestations; 3) disposing of infested plants; and 4) applying contact insecticides when nymphs are detected – ensuring thorough spray coverage of all plant parts with spray solutions and frequent applications to maintain populations below plant-damaging levels (Radosevich & Cloyd, 2021); and 5) continuing to evaluate additional integrated pest management strategies that are effective for greenhouse production systems.

References

- Afifi, A. I., El Arnaouty, S. A., Attia, A. R., & Abd Alla, A. E.-M. (2010). Biological control of citrus mealybug, *Planococcus citri* (Risso) using coccinellid predator, *Cryptolaemus montrouzieri* Muls. *Pakistan Journal of Biological Sciences*, 13(5), 216–222. doi: [10.3923/pjbs.2010.216.222](https://doi.org/10.3923/pjbs.2010.216.222).
- Ahmed, N. H., & Abd-Rabou, S. M. (2010). Host plants, geographical distribution, natural enemies and biological studies of the citrus mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae). *Egyptian Academic Journal of Biological Sciences*, 3(1), 39–47. doi: [10.21608/EA-JBSA.2010.15207](https://doi.org/10.21608/EA-JBSA.2010.15207).
- Andreason, S. A., Triapitsyn, S. V., & Perring, T. M. (2019). Untangling the *Anagyrus pseudococci* complex (Hymenoptera: Encyrtidae), parasitoids of worldwide importance for biological control of mealybugs (Hemiptera: Pseudococcidae): genetic data corroborates separation of two new, previously misidentified species. *Biological Control*, 129, 65–82. doi: [10.1016/j.biocontrol.2018.09.010](https://doi.org/10.1016/j.biocontrol.2018.09.010).
- Beardsley, J. W. (1960). Observations on sugarcane mealybugs in Hawaii. *Proceedings of the International Society of Sugar Cane Technologists*, 10, 41–51.
- Blumberg, D., & Van Driesche, R. G. (2001). Encapsulation rates of three encyrtid parasitoids by three mealybug species (Homoptera: Pseudococcidae) found commonly as pests in commercial greenhouses. *Biological Control*, 22(2), 191–199. doi: [10.1006/bcon.2001.0966](https://doi.org/10.1006/bcon.2001.0966).
- Cadée, N., & van Alphen, J. J. M. (1997). Host selection and sex allocation in *Leptomastidea abnormis*, a parasitoid of the citrus mealybug *Planococcus citri*. *Entomologia Experimentalis et Applicata*, 83, 277–284. <https://www.bookstore.ksre.ksu.edu/pubs/MF3001.pdf>
- Celepci, E., Uygur, S., Bora Kaydan, M., & Nezihi Uygur, F. (2017). Mealybug (Hemiptera: Pseudococcidae) species on weeds in *Citrus* (Rutaceae) plantations in Cukurova Plain, Turkey. *Turkish Bulletin of Entomology*, 7(1), 15–21. doi: [10.16969/teb.14076](https://doi.org/10.16969/teb.14076).
- Charles, J. G. (1982). Economic damage and preliminary economic thresholds for mealybugs (*Pseudococcus longispinus* T.T.) in Auckland vineyards. *New Zealand Journal of Agricultural Research*, 25(3), 415–420. doi: [10.1080/00288233.1982.10417905](https://doi.org/10.1080/00288233.1982.10417905).
- Cloyd, R. A. (2011). *Mealybug management in greenhouses and interiorscapes* (tech. rep. No. MF3001). Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Manhattan, KS.
- Cloyd, R. A. (2016). Cultural control and sanitation. In *Greenhouse Pest Management* (pp. 79–89). CRC Press.
- Cloyd, R. A. (2021). *Resistance management of arthropod pests in greenhouse production systems* (tech. rep. No. MF3564). Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Manhattan, KS.
- Copland, M. J. W., Tingle, C. C. D., Saynor, M., & Panis, A. (1985). Biology of glasshouse mealybugs and their predators and parasitoids. In N. W. Hussey & N. Scopes (Eds.), *Biological Control: The Glasshouse Experience* (pp. 82–86). Cornell University Press.
- Cox, J. M. (1981). Identification of *Planococcus citri* (Risso) (Homoptera: Pseudococcidae) and the description of a new species. *Systematic Entomology*, 6(1), 47–53. doi: [10.1111/j.1365-3113.1981.tb00012.x](https://doi.org/10.1111/j.1365-3113.1981.tb00012.x).

- de Jong, P. W., & van Alphen, J. J. M. (1989). Host size selection and sex allocation in *Leptomastix dactylopii*, a parasitoid of *Planococcus citri*. *Entomologia Experimentalis et Applicata*, 50, 161–169. doi: [10.1111/j.1570-7458.1989.tb02385x](https://doi.org/10.1111/j.1570-7458.1989.tb02385x).
- Dean, H. A., Hart, W. G., & Ingle, S. J. (1971). Citrus mealybug, a potential problem on Texas grapefruit. *Journal of Rio Grande Valley Horticultural Society*, 15, 46–53.
- Demirci, F., Mustu, M., Bora Kaydan, M., & Ulgentürk, D. (2011). Laboratory evaluation of the effectiveness of the entomopathogen *Isaria farinosa* on citrus mealybug, *Planococcus citri*. *Journal of Pest Science*, 84(3), 337–342. doi: [10.1007/s10340-011-0350-9](https://doi.org/10.1007/s10340-011-0350-9).
- Doutt, R. L. (1951). Biological control of mealybugs infesting commercial greenhouse gardenias. *Journal of Economic Entomology*, 44(1), 37–40. doi: [10.1093/jee/44.1.37](https://doi.org/10.1093/jee/44.1.37).
- Doutt, R. L. (1952). Biological control of *Planococcus citri* on commercial greenhouse *Stephanotis*. *Journal of Economic Entomology*, 45(2), 343–344. doi: [10.1093/jee/45.2.343](https://doi.org/10.1093/jee/45.2.343).
- Dreistadt, S. H. (2001). *Integrated pest management for floriculture and nurseries* (tech. rep. No. Publication 3402). University of California Statewide Integrated Pest Management Project, Division of Agriculture and Natural Resources. Oakland, CA.
- Flaherty, D. L., Peacock, W. L., Bettiga, L., & Leavitt, G. M. (1982). Chemicals losing effect against grape mealybug. *California Agriculture*, 36(5), 15–16.
- Franco, J. C., Zada, A., & Mendel, Z. (2009). Novel approaches for the management of mealybugs pests. In I. Ishaaya & A. R. Horowitz (Eds.), *Biorational Control of Arthropod Pests: Application and Resistance Management* (pp. 233–278). Springer Science+Business Media.
- Gill, H. K., Goyal, G., & Gillett-Kaufman, J. (2019). *Citrus mealybug Planococcus citri (Risso) (Insecta: Hemiptera: Pseudococcidae)* (tech. rep. No. EENY-537). UF/IFAS Extension, Entomology and Nematology Department. Gainesville, FL.
- Greathead, D. J. (1986). Parasitoids in classical biological control. In J. Waage & D. Greathead (Eds.), *Insect Parasitoids: 13th Symposium of the Royal Society of London* (pp. 289–318). Academic Press.
- Hajer, J., & Hrubá, L. (2007). Wrap attack of the spider *Achaearanea tepidariorum* (Araneae: Theridiidae) by preying on mealybugs *Planococcus citri* (Homoptera: Pseudococcidae). *Journal of Ethology*, 25(1), 9–20. doi: [10.1007/s10164-006-0198-2](https://doi.org/10.1007/s10164-006-0198-2).
- Hennekam, M. M. B., Kole, M., van Opzeeland, K., & van Alphen, J. J. M. (1987). Biological control of citrus mealy bug in a commercial crop of ornamental plants in the Netherlands. *Mededelingen van de Faculteit Landbouwwetenschappen Rijksuniversiteit Gent*, 52, 329–338.
- Herrick, N. J., & Cloyd, R. A. (2017). Effect of systemic insecticides on the citrus mealybug (Hemiptera: Pseudococcidae) feeding on coleus. *Journal of Entomological Science*, 52(2), 104–118. doi: [10.18474/JES16-39-1](https://doi.org/10.18474/JES16-39-1).
- Herrick, N. J., & Cloyd, R. A. (2023). Performance of entomopathogenic fungal-based insecticides against the citrus mealybug (Hemiptera: Pseudococcidae) on coleus (Lamiales: Lamiaceae) plants under greenhouse conditions. *Journal of Entomological Science*, 58(2), 187–200. doi: [10.18474/JES22-33](https://doi.org/10.18474/JES22-33).
- Herrick, N. J., Cloyd, R. A., & Raudenbush, A. L. (2019). Systemic insecticide applications: effects on citrus mealybug (Hemiptera: Pseudococcidae) populations under greenhouse conditions. *Journal of Economic Entomology*, 112(1), 266–276. doi: [10.1093/jee/toy352](https://doi.org/10.1093/jee/toy352).
- Hogendorp, B. K., Cloyd, R. A., & Swiader, J. M. (2006). Effect of nitrogen fertility on reproduction and development of citrus mealybug, *Planococcus citri* Risso (Homoptera: Pseudococcidae), feeding on two colors of coleus, *Solenostemon scutellarioides* L. Codd. *Environmental Entomology*, 35(2), 201–211. doi: [10.1603/0046-225X-35.2.201](https://doi.org/10.1603/0046-225X-35.2.201).
- Mani, M., Krishnamoorthy, A., & Shivaraju, C. (2011). Biological suppression of major mealybug species on horticultural crops in India. *Journal of Horticultural Science*, 6(2), 85–100. doi: [10.24154/jhs.v6i2.412](https://doi.org/10.24154/jhs.v6i2.412).
- Mani, M., & Shivaraju, C. (2016a). Biology. In M. Mani & C. Shivaraju (Eds.), *Mealybugs and their Management in Agricultural and Horticultural Crops* (pp. 87–106). Springer. doi: [10.1007/978-81-322-2677-2_6](https://doi.org/10.1007/978-81-322-2677-2_6).
- Mani, M., & Shivaraju, C. (2016b). Damage. In M. Mani & C. Shivaraju (Eds.), *Mealybugs and their Management in Agricultural and Horticultural Crops* (pp. 117–122). Springer. doi: [10.1007/978-81-322-2677-2_9](https://doi.org/10.1007/978-81-322-2677-2_9).
- Mani, M., & Shivaraju, C. (2016c). Methods of control. In M. Mani & C. Shivaraju (Eds.), *Mealybugs and Their Management in Agricultural and Horticultural Crops* (pp. 209–222). Springer. doi: [10.1007/978-81-322-2677-2_16](https://doi.org/10.1007/978-81-322-2677-2_16).
- Mani, M., & Shivaraju, C. (2016d). Mode of spread of mealybugs. In M. Mani & C. Shivaraju (Eds.), *Mealybugs and their Management in Agricultural and Horticultural Crops* (pp. 113–116). Springer. doi: [10.1007/978-81-322-2677-2_8](https://doi.org/10.1007/978-81-322-2677-2_8).

- McKenzie, H. L. (1967). *Mealybugs of California: with taxonomy, biology, and control of North American species*. University of California Press. doi: [10.1525/9780520338227](https://doi.org/10.1525/9780520338227).
- Mendel, Z., Gross, S., Steinberg, S., Cohen, M., & Blumberg, D. (1999). Trials for the control of the citrus mealybug in citrus orchards by augmentative release of two encyrtid parasitoids. *Entomologica*, 33, 251–265. doi: [10.15162/0425-1016/843](https://doi.org/10.15162/0425-1016/843).
- Meyers, L. E. (1932). Two economic greenhouse mealybugs of Mississippi. The citrus mealybug and the Mexican mealybug. *Journal of Economic Entomology*, 25(4), 891–896. doi: [10.1093/jee/25.4.891](https://doi.org/10.1093/jee/25.4.891).
- Moore, D. (1988). Agents used for biological control of mealybugs (Pseudococcidae). *Biocontrol News and Information*, 9(4), 209–225.
- Parrella, M. P. (1999). Arthropod fauna. In G. Stanhill & H. Z. Enoch (Eds.), *Ecosystems of the World 20: Greenhouse Ecosystems* (pp. 213–250). Elsevier.
- Pillai, K. G. (2016). Glasshouse, greenhouse and polyhouse crops. In M. Mani & C. Shivaraju (Eds.), *Mealybugs and their Management in Agricultural and Horticultural Crops* (pp. 621–628). Springer. doi: [10.1007/978-81-322-2677-2_68](https://doi.org/10.1007/978-81-322-2677-2_68).
- Pritchard, A. E. (1949). *California greenhouse pests and their control* (tech. rep. No. Bulletin 713). California Agricultural Experiment Station, The College of Agriculture, University of California. Berkeley, CA. doi: [10.5962/bhl.title.59279](https://doi.org/10.5962/bhl.title.59279).
- Radosevich, D. L., & Cloyd, R. A. (2021). Spray volume and frequency impacts on insecticide efficacy against citrus mealybug (Hemiptera: Pseudococcidae) on coleus under greenhouse conditions. *Journal of Entomological Science*, 56(3), 305–320. doi: [10.18474/JES20-40](https://doi.org/10.18474/JES20-40).
- Shrewsbury, P. M., Bejleri, K., & Lea-Cox, J. D. (2002). Integrating cultural management practices and biological control to suppress citrus mealybug. In A. P. Papadopoulos (Ed.), *Proceedings of the XXVI IHC-Protected Cultivation, International Society for Horticultural Science* (pp. 425–434, Vol. 633). Acta Horticulturae. doi: [10.17660/ActaHortic.2004.633.52](https://doi.org/10.17660/ActaHortic.2004.633.52).
- Tanwar, R. K., Jeyakumar, P., & Monga, D. (2007). *Mealybugs and their management* (tech. rep. No. Technical Bulletin 19). National Centre for Integrated Pest Management. New Delhi, India.
- Venkatesan, T., Jalali, S. K., Ramya, S. L., & Prathibha, M. (2016). Insecticide resistance and its management in mealybugs. In M. Mani & C. Shivaraju (Eds.), *Mealybugs and Their Management in Agricultural and Horticultural Crops* (pp. 223–229). Springer. doi: [10.1007/978-81-322-2677-2](https://doi.org/10.1007/978-81-322-2677-2).
- Walton, V. M., Daane, K. M., & Pringle, K. L. (2004). Monitoring *Planococcus ficus* in South African vineyards with sex pheromone-baited traps. *Crop Protection*, 23(11), 1089–1096. doi: [10.1016/j.cropro.2004.03.016](https://doi.org/10.1016/j.cropro.2004.03.016).
- Whitcomb, W. D. (1940). *Biological control of mealybugs in greenhouses* (tech. rep. No. Bulletin 375). Massachusetts Agricultural Experiment Station. Amherst, MA.
- Williams, D. J., & Granara de Willink, M. C. (1992). *Mealybugs of Central and South America*. CABI International.
- Williams, D. J., & Watson, G. W. (1988). *The scale insects of the tropical South Pacific region, part 2: the mealybugs (Pseudococcidae)*. CAB International, Institute of Entomology.