Insects Pests & Diseases

The CCA Cherimoya Handbook

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Introduction

The cherimoya (*Annona cherimola*) is relatively free of pests and diseases in California. Certain pests of Annona found in Florida and some foreign countries, such as Chalcid fly (seed borer), Queensland fruit fly and burrowing nematode, have the potential to cause great damage to the fruit and/or the trees. However these pests have so far been successfully excluded or eradicated from the state due to stringent federal and state quarantine laws.

In addition, many of the leaf and fruit fungal pathogens common in high rainfall climates are of little importance in California due to the relatively dry climate. Currently, the most worrisome pest problems include mealybugs, exacerbated by Argentine ants, and Armillaria trunk and root rot.

Fruit rots caused by fungi can become a problem during years of high rainfall, or in orchards that are poorly irrigated. Other pests of cherimoya culture, including weeds, gophers, squirrels, rats, and deer, can be pests of all orchard crops grown in California.

Pests and Diseases of Cherimoyas

Insect Pests

Mealybug-Ant Complex

The most commonly seen problem in orchards are infestations of long-tailed mealybug (Pseudococcus adonidum) (Phillips et al. 1987). The mealybugs usually attack the stem-end of the fruit first and eventually cover the entire surface of the fruit.

Mealybug colonies may also start at the contact point between two fruit touching each other, or between a leaf-fruit contact. Sooty mold fungi, (*Cladosporium sp.*) will grow on the honeydew exudate from the mealybugs, soiling the surface of the fruit. The sooty mold is difficult to remove by brushing without tearing the fragile skin of the fruit.

The mealybugs are generally under good biological control in California orchards, except where Argentine ants (*Iridomyrmex humilis*) are foraging for honeydew as a food source.

The aggresive nature of the ants discourages parasites and predators of the mealybugs, leading to a complete breakdown in biological control.

An ant management trial was conducted in a Santa Barbara County orchard in 1984 in order to determine the effect on mealybug infestations of fruit (Phillips et al. 1987). The treatments in the experiment were:

(1) a sticky band of Tangletrap® aerosol sprayed in a 3-inch width around the trunk,
(2) a bait station filled with a sugar/carboxymethylcellulose bait and Ambro® (registered only for fire ant control outside California),
(3) a spray of Lorsban 4E® (chlorpyrifos, not registered for this use in California) around the base of the trunk, and the untreated control. Ant trail intensity on the trunk was measured over the course of six months after initial application; it was concluded that Tangletrap and Lorsban both decreased ant activity significantly compared to the control.

Long-Tailed Mealybug on cherimoya fruit

Mealybugs concentrated at the stem end of fruit. An entire fruit may eventually become covered with a colony of mealybug.

Argentine Ant

Long-Tailed Mealybug

Tangletrap was significantly better at controlling the ants than Lorsban, although the sticky band required several reapplications. The Ambro bait station did not control the ants. The least amount of mealybug activity was correlated with the effectiveness of the ant control method; levels of mealybugs were least on the trees treated with Tangletrap.

Phillips et al. concluded that skirt pruning with a Lorsban application on the lower trunk would be the preferred method for ant control because the application of Tangletrap was labor intensive.

Data was provided for registration of Lorsban on cherimoya through the IR-4 program, but registration in California has still not been attained.

Since there are no chemicals registered for ant control on cherimoya in California, perhaps the best method of control at this point is to apply a sticky band on the lower trunk, but only on mature trees and with the sticky material not exposed to sunlight.

For maximum effectiveness, the sticky band should be stirred with a stick every six weeks to keep the band from "dusting over".

The grower may wish to augment the biological control in the orchard. The larvae of a small ladybird beetle (*Cryptolaemus montrouzieri*), commonly known as the "mealybug destroyer", is available for purchase from some insectaries in California.

These beetles can be released on trees infested with mealybugs, but only after the ants are under control because the ants will feed on the beetle larvae (Rincon-Vitova, 1985). The female Cryptolaemus will lay eggs singly into egg masses of the mealybugs. The eggs hatch within 8 or 9 days and the young larvae attack mealybug eggs and young nymphs.

With long waxy filaments, the larvae closely resemble the mealybugs, but they are about twice the size of an adult mealybug and they move faster. The adults will feed as soon as they are released. The life cycle of Cryptolaemus is approximately 30 days at 80° F.

Research has not been conducted on the proper release rate for Cryptolaemus in cherimoya, but the insectaries recommend a release rate of 1 or 2 per 2 sq. ft. of plant canopy in an area of mealybug infestation. Cryptolaemus should be released early in the morning or late afternoom to avoid heat stress. The beetles will also feed on aphids and crawlers of scale insects.

Other Minor Pests

At certain times, aphids, whiteflies, thrips, caterpillars and mites may become a significant problem on cherimoyas. If the damage is unacceptable, especially if sooty mold is spoiling the surface of the fruit, Pyrellin® may be used to control the problem. Pyrellin is composed of a mixture of the natural plant- derived insecticides known as pyrethrins and rotenone, and is registered in Callifornia for use on most tree crops, including cherimoyas.

Trunk and Root Diseases

Armillaria Root Rot

Armillaria root rot, commonly known as oak root fungus, will occasionally kill cherimoya trees in California. However, under the right conditions and left to spread unchecked, the fungus has been observed to kill blocks of 30 to 40 trees in San Diego County (Bender, unpublished).

The disease is caused by the mushroom fungus Armillariella mellea. The fungus is native to California oak trees and can spread to a wide range of tree crops planted in former riverbeds and floodplanes.

The first symptoms of a tree infected by the fungus include poor growth, shoot dieback, small yellowing leaves and excessive leaf drop followed by canopy collapse and tree death. Diagnosis of the disease is accomplished by removing a section of bark down to the cambium layer at the soil line or just below the soil.

The most reliable sign of infection is a white, fan-shaped growth of the fungus mycellium under the bark spreading in the cambium; the odor of the bark is very "mushroomy" (Ohr et. al 1994). Purplish-brown cord-like strands will be seen on the surface of the infected bark of the lower trunk and upper scaffold roots.

Occasionally clusters of mushrooms will be observed around the base of the infected tree. The mushroom caps are variable in color from honey-yellow to almost black.

Spread of the Fungus

Spores produced from the mushroom caps are not considered to be important in the spread of the fungus. The main source of spread is from the fungal strands, or "rhizomorphs", growing through the soil away from the infected wood base.

Encountering a susceptible woody host, such as a cherimoya root, the rhizomorphs penetrate into the bark to establish the infection. by this method the fungus can easily spread down a row of trees in an orchard.

Some growers in San Diego county have experienced a sud-

den onslaught of infected trees after they had brought mulch into their groves from nearby streambeds. It is suspected that the fungus may have been introduced into the orchard via large chunks of wood in the mulch which served as a food base for the growth of rhizomorphs. Due to the sesitivity of cherimoya to Armillaria, growers should be wary of introducing woody mulches into their groves.

Control

Once a tree is infected, it is currently impossible to cure the tree. Therefore, control is based on preventing infection of new trees. Trees should only be planted into sites that are not infested. In previous years the University recommended soil fumigation with methyl bromide prior to planting, but this effective biocide is likely to be lost due to EPA regulations.

There does not appear to be an effective replacement fumigant for use in the near future.

If there are are infected trees in your orchard, remove and burn them and the neighboring apparently healthy trees; once symptoms appear on a tree, the disease has probably already spread to the roots of the surrounding trees (Kobbe, 1991). In order to prolong the life of an infected tree, exposing the base of the tree to air has been shown to be somewhat effective for control of Armillaria in citrus, but this practice has not yet been tried in cherimoya (Ohr et.al, 1994).

As far as can be determined, varieties of cherimoya rootstocks have not been tested for possible resistance to Armillaria.

Phytophthora Root Rot

Phytophthora sp. has been isolated from declining cherimoya trees in California's northern central valley (W. Gubler, U. C. Davis, personal communication). In this instance, the soils were not well drained and the cherimoya trees were frost damaged.

In contrast, cherimoya is often planted successfully in areas of San Diego county where avocados have died from infection by Phytophthora cinnamomi. As long as the soil drains reasonably well, Phtophthora is apparently not a problem for cherimoya in southern California.

Verticillium Wilt

The fungus Verticillium dahliae has been isolated from declining trees in California's northern central valley (French, 1989). The disease is characterized by a rapid wilting and branch dieback. This is a consequence of the fungus plugging the xylem (water-conducting) elements. Fine black streaking in the wood of the affected branch is usually diagnostic for this disease.

This disease is very rare in commercial production, but the California Rare Fruit Growers recommend that cherimoya should not be planted near old vegetable gardens that may have had Verticillium hosts such as tomatoes, eggplant and asters (Anonymous,).

Minor Trunk, Branch, and Leaf Diseases

Dothiorella sp. and *Phomopsis diospyri* have been reported to have been isolated from branch and twig cankers in California (French, 1989). *Colletotrichum sp.*, the cause of anthracnose disease, has been isolated from leaf spots during years of excessive rain (French, 1989), and *Alternaria sp.* and *Phomopsis sp.* have been isolated from leaf spots in California (Farr et. al 1989). *Pythium sp.* and *Rhizoctonia solani* have been reported as diseases of seedling cherimoya trees (French, 1989). In most cases, these diseases are of little concern to the grower.

Fruit Spotting Diseases

Black Canker - Phomopsis Lesion

Phomopsis sp. was determined to be the cause of lesions found on the surface of fruit grown in Santa Barbara county following a summer with unseasonable summer rains (Opgenorth et. al 1984). The fungus was reported to be similar if not identical to *Phomopsis anonacerum*, isolated from similar lesions of cherimoya in Australia.

The spots were usually found near the apical portion of the fruit, but lesions would also develop on the shoulders of the fruit. The spots would initially appear as light brown to black lesions, which later developed into deep purple to black lesions covering up to 25% of the fruit surface.

Lesions were shallow, extending to only 1 to 2 mm in depth. Older lesions caused the skin of

the fruit to become hard and cracked, exposing the flesh of the fruit to invasion by secondary pathogens.

Research has not been conducted on the control of this pathogen, but it is expected that sanitation (removal and disposal of infected fruit from the grove) would reduce the spore load in the grove and should reduce the amount of initial infection.

Australian scientists recommend control of weeds under the trees and removal of mummified fruit and dead twigs from the trees, commenting that this is usually sufficient for control (Mayers and Sanewski, 1985). There are no chemicals registered for the control of this pathogen on cherimoya in California.

Observations in the field indicated that the reticulated varieties 'Spain' and 'White' had a greater incidence of disease than the smooth skinned 'Bays' variety (Opgenorth et. al 1984).

Minor Diseases

Alternaria sp., *Penicillium sp.* (French, 1989), *Dothierella sp.* and *Colletotrichum sp.* (Farr et. al, 1989) have been reported to have been isolated from fruit rots in California.

No information is available in the literature that describes symptoms for these fungal infections in cherimoya. Some or all of these fungi may be secondary pathogens, having gained entrance into wounds and cracks in the fruit.

Growers that try to hold fruit late on the tree, or let the trees become too dry between irrigations, often have more problems with fruit cracking, with the resultant secondary rots.

Colletotrichum sp. has been more prevalent in California cherimoya groves during 1994 and 1995, years with exceptional rainfall. The fungus causes infection in leaves and fruit during a period of extended moisture; the fruit lesions remain small, usually brown to black spots around lenticels, until the fruit starts to ripen after harvest.

At this time the lesions expand to make unsalable fruit. There is no practical control for this problem, although pruning to open the tree canopy for better ventilation may improve drying of the foliage and fruit. It is important to store harvested fruit at a cool temperature as soon as possible.

As mentioned previously, good sanitation should be practiced in the grove. This includes weed control, removal of mummified and rotting fruit from the tree, removal of dead wood and twigs, skirt pruning to avoid fruit hanging low to the ground, and avoidance of late harvesting.

Weed Control

Weeds growing on the orchard floor compete with trees for water and nutrients, and add to the frost hazard in the grove by not allowing the midday sun to warm the soil. Weeds increase the humidity in the orchard and this may increase the incidence of twig and fruit diseases, although this is not well documented in the literature.

Some weeds, such as bermuda grass, are so invasive that they will chloke out young trees. Weeds interfere with the distribution of water from minisprinklers under the trees, one of the leading causes of an inefficient irrigation system.

For these reasons, some form of vegetation mangement is necessary in the grove. The California cherimoya grower is limited in options for vegetation management since there is only one herbicide (glyphosate) registered for use on cherimoyas in California; the application of glyphosate should be integrated with non-herbicidal systems of weed management.

Non-Herbicide Systems

Few if any cherimoya growers till orchard floors. The disadvantages of tillage include soil compaction from repeated use of heavy equipment, reduced water infiltration, and root injury. Mowing strips six feet in width between the rows of trees is a fairly common practice.

The advantages of mowing include reduction of soil erosion during winter rains, better soil tilth due to increased soil organic matter, and increased water penetration into the soil. Some experiments in other crops such as almonds have indicated that beneficial insects and mites have a higher survival rate in orchards with cover crops and/or mowed strips.

Weed control by mowing is best done early in the season before the weeds become too big and go to seed. Mowing may have to be repeated several times during the growing season. On steep slopes mowing can be done by hand-held gasoline-powered weed whips. Care must be taken that all personnel performing these tasks use eye and ear protection.

By locating the mini-sprinklers under the tree canopies, water deposition between the trees (in open sun-lit areas) can be reduced, hopefully to keep weed growth to a minimum. By practicing good water management, most growers only have to mow two or three times a year.

In orchards which are not yet mature, and which have a fair amount of soil still exposed to

open sun, a planted cover crop may be useful. The legume cover crops fix nitrogen from the air and, when mowed, serve as a source of a slow-release nitrogen fertilizer.

Where water costs are high, the clovers are generally recommended because they germinate in the fall, utilyzing rainwater for growth in the winter, and die out naturally in the beginning of summer. The clovers reseed just beneath the surface of the soil to await germination in the fall. Clovers recommended for cover crops include crimson clover (*Trifolium incarnatum*), rose clover (*T. hirtum*), and subterranean clover (*T subterranean*).

Other types of cover crops are discussed in U. C. publication 21521 "Protecting Ground Water Quality in Citrus Production" (Ingels, 1994). Although the clovers reseed themselves, the grower should reseed every year to achieve a good stand.

As mentioned, weeds and cover crops may increase the frost hazard in the orchard by reducing the amount of solar radiation reaching the soil during daylight hours. by sowing the cover crop late in the season (late November or early December), the plants will only be a few centimeters high with little vegetational cover by the time of frost in January and February. The lack of cover may afford more soil warming during the day.

Mulches are also useful for weed control. Thick mulches of woody greenwaste have been shown to suppress up to 95% of germinating weed seed, but the few weeds that are able to grow through the mulch have fairly active growth (Downer and Faber, 1996).

These survivor weeds can be easily controlled by an application of glyphosate. Greenwaste can usually be obtained for free from the county landfills, but the grower may have to pay for the cost of transportation. Likewise, straw and horse manure is often available for free from horse stables and this material is often used as a mulch to suppress weeds.

Although not documented in the literature, caution should be taken when applying greenwaste; the potential exists to introduce a fungal pathogen into the grove if the material is not partially composted. A temperature of 145F for four hours in the compost pile should be sufficient to kill fungal plant pathogens.

Herbicidal Control

Soil applied residual herbicides are not registered for use in cherimoya groves in California. A foliar applied systemic herbicide, glyphosate, is registered for use in California and can be useful to control low-growing invasive weeds such as bermuda grass, or many other types of weeds growing betwwen the trees and/or around the mini-sprinklers or drippers.

Glyphosate controls emerged weeds only. The chemical is often applied with a back-pack hand pump sprayer, or applied as a concentrate through an ultra low-volume sprayer, such as a Herbi sprayer. The latter emmits a fine mist which can blow into the trees on windy days; this sprayer should be used in the morning when the air is still.

While glyphosate effectively controls most weeds, some weeds such as cheeseweed, nutsedge and filaree are only partially controlled (Fischer, et al., 1996). These weeds, if grown too large, may have to be chopped down. Nutsedge may require several applications as new nutlets germinate and start to grow.

Glyphosate is less effective on water-stressed or unvigorous plants.

Better weed control can be achieved by watering and fertilizing difficult-to-kill weeds before spraying with glyphosate.

Spraying the trunks of young trees can cause injury. Young trees should be protected from spray drift by trunk protectors, or weeds should be hand removed from the base of the tree during the first two years of growth.

Vertabrate Pest Control

Gophers

Pocket gophers are stout-bodied rodents, 6-8 inches long, that build extensive underground tunnel systems in orchards. Tunnels are usually found 10 to 12 inches underground, but some tunnels are deeper leading to food storage compartments, nests, and drain tunnels. Openings at the end of the burrows are plugged with soil.

Evidence of gopher activity is indicated by fresh mounds of dirt, often seen during the spring and fall when the soil is moist (Marsh and Salmon, 1996).

Gophers are solitary and antisocial except during breeding season and when young are being raised. Young gophers are eventually forced out of the burrows to establish their own burrows. During the brief period when they travel avove ground they can be victims of hunting by hawks or owls.

Each gopher establishes its own territory covering from 200 sq. ft. for a youg gopher to 2,200 sq. ft. for an old established gopher. A gopher rarely lives beyond three years in age.

Gophers cause damage to trees by girdling the roots or

crown at or below the soil level. Sometimes wood rotting fungi can enter these wounds and cause a slow die-back in the tree. In order to be successful in cherimoya production, gophers must be controlled or the trees will eventually be killed.

Gopher Control

Control is achieved by persistent baiting and/ or trapping. Some growers erect 20 foot tall hawk roosts or barn owl nesting boxes on tall poles; these have been shown to attract predator birds which can reduce, but not eliminate, the gopher population.

No chemical or mechanical repellents have been effective against gophers. The so-called gopher repellent plants are also ineffective.

Baits

Single feeding poison baits placed in the burrow are most commonly used to control gophers. Hand baiting is done by using a 1/4 inch metal probe to locate the burrow, usually near a fresh mound or between two fresh mounds.

Once the burrow has been located the hole is enlarged with a larger rod or a broom handle and a tablespoon of the grain-bait is placed in the burrow. A rock should be placed over the open hole to discourage the gopher from quickly plugging the hole.

Baiting

Baiting can also be done with a hand operated mechanical bait dispenser that will permit probing and bait dispensing in one operation. Heavy gopher populations may be better controlled with a mechanical bait applicator that is tractor-drawn between the tree rows.

This device creates an artificial tunnel that intersects crisscrossing gopher tunnels in the grove and inserts the bait automatically at preset inetervals. This device causes root pruning and should not be used when the trees are mature. The device is best used in loamy soils with few rocks; sandy soils tend to collapse without holding the tunnel structure. Care must be taken that the device does not cut through irrigation lines.

Trapping

Trapping is labor intensive and is usually used only where there are just a few gophers. Gophers can be caught in either box traps or wire traps, such as the Macabee trap. In order to trap the gopher, the burrow should be located with the steel rod a short distance in front of the low side of the fresh nound, or between two fresh mounds.

A hole is then dug to intercept the burrow, the burrow is cleaned out and two traps are set into the runway, one facing each direction. Each trap should be wired to a stake son the captured gopher cannot drag them down the tunnel. A rock or clump of grass should be placed over the hole, followed by the soil to shut out the light.

Habitat Modification.

As discussed under weed control, permanent ground covers provide food and cover for gophers. A persistant gopher problem may require removal of the ground cover followed by clean culture with herbicides.

Drip irrigation and mini-sprinkler irrigation systems favor gopher survival, whereas flood irrigation kills many of the young gophers and forces the older ones to the surface to be susceptible to hawks and owls.

If water is not too expensive, a several flood irrigations will drastically reduce the gopher population.

Ground Squirrels

Ground squirrels (*Spermophilus beecheyi*) occasionally dig burrows under trees and gnaw on bark or polyethelene irrigation lines. They may feed on fruit near the ground.

Ground squirrels should be controlled not only because of tree damage, but also because their large burrows make the orchard floor hazardous for walking and because they can harbor fleas which can transfer infectious diseases to man.

Squirrels hibernate during the winter, emerging about late January. The females have one litter of six to eight young in the spring. About six weeks after birth, the young evege from their burrows to feed above ground. Squirrels feed on green vegetation in the spring, and on seeds, grins, fruits and nuts during the summer and fall.

Bait stations using multiple dose anti-coagulant baits are commonly used to control ground squirrels. A bait station can be made from plastic pipe that is large enough to allow the entrance of a squirrel, but small enough to exclude other animals.

The bait station should be placed near the entrance of the burrow. The squirrel must feed on the bait for several days in a row; if the feeding is interrupted for longer that 48 hours, the animal will recover and the accumulated toxic effects will be lost.

The stations should be inspected daily, adding bait until feeding stops. baiting may take 1 to 4 weeks to control the squirrels because some squirrels may not start feeding immediately,

and some squirrels are more resistant to bait than others. baiting is best done during late summer and fall.

Care must be taken to make sure that small dogs do not have access to the baits, and the baits must be kept out of the reach of children.

For a few squirrels, trapping may be effective. A pair of box-type gopher traps can be used if modified. To use them in pairs, the back of each trap is removed and the two traps are connected with wire mesh, attaching the traps and wire to a wooden board. Trapping is best done during spring and early summer, and fall.

Deer Control

Groves that are near brush or woodlands may experience browsing by deer. If left unchecked, deer can completely defoliate young trees. Deer usually feed at night, or in the early morning or late afternoon.

Deer are best controlled by erecting a 7 foot high wire fence completely around the grove (Marsh and Salmon, 1996). Taste or odor repellents are rarely effective, especially if the deer are hungry. If repellents are used, the trees should be re-treated as new foliage appears, or after rain or irrigation water washes the repellent of off the foliage.

Rat Control

The roof rat (*Rattus rattus*) and the Norwegian rat (*Rattus norvegicus*) occasionally build nests in trees and eat the pulp out of mature cherimoya fruits. The roof rat has a tail longer than its head and body combined whereas the Norwegian rat has a tail shorter than its head and body. Rats breed several times a year and average six to eight per litter.

Baiting

Anti-coagulant baits are used to control rats, supplied either in a bait box or in paraffin blocks tied to the limbs of trees. The paraffin blocks should be tied to the branch at least six feet off the ground to avoid feeding from other animals.

Anti-coagulant baits must be eaten at several feedings on five or more successive days with no periods longer than 48 hours between feedings. Four to sixteen ounces of bait should be placed in a protected bait station and the station should be checked daily.

When the rats start to take the bait, fresh bait should be added to the station daily. An uninterrupeted supply of bait should be maintained as long as any bait is taken which may be two to four weeks. Paraffin bait blocks are probably more useful in the orchard because the paraffing protects the bait from becomming moldy.

Trapping

Trapping can also be effective. Use baits such as citrus, raisins, prunes or nut meats to attract the rat to the trap; after bait acceptance, set the trap with the bait. Fasten the rat snap trap into the tree, at least six feet off the ground.

Rat populations can be reduced by burying or disposing of dropped fruit and cull fruit, and by covering garbadge cans.

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