APHIDS AND THEIR CONTROL ON ORCHIDS

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Aphids are among the most obnoxious of orchid pests. These insects are global and orchid feeding species are problematic in tropical growing areas as well as in commercial and hobby greenhouses in temperate regions. Rabasse and Wyatt (1985) ranked aphids as one of three most serious greenhouse pests, along with spider mites and whiteflies. These pernicious insects can show themselves on orchids year-around in warm climates, but seem to be mostly autumn and winter problems in temperate regions. Like most other orchid pests the most common routes into plant collections is through either the acquisition of an infested plant or the movement of plants from outdoors to indoors. However, certain reproductive stages of pest species do fly and they will move to orchids from other plants quite readily. Because of their propensity for rapid reproduction any action against aphids should be completed quickly while their populations are still small.

An aphid infestation is often detected by an accumulation of pale-tan colored "skins" that fall beneath the developing colony. These "skins" are the shed integument from the growing and molting immature aphids. All of the common pest species of aphid also secrete honeydew, a feeding by-product exuded by the aphid and composed of concentrated plant fluids, and is rich in carbohydrates. This honeydew drips and accumulates beneath the aphid colony. Because of the carbohydrates honeydew is attractive to ants, flies, bees, other insects including beneficial species, and sooty mold. Some species of ant will herd and protect from parasites and predators certain species of aphid to maintain a supply of honeydew.

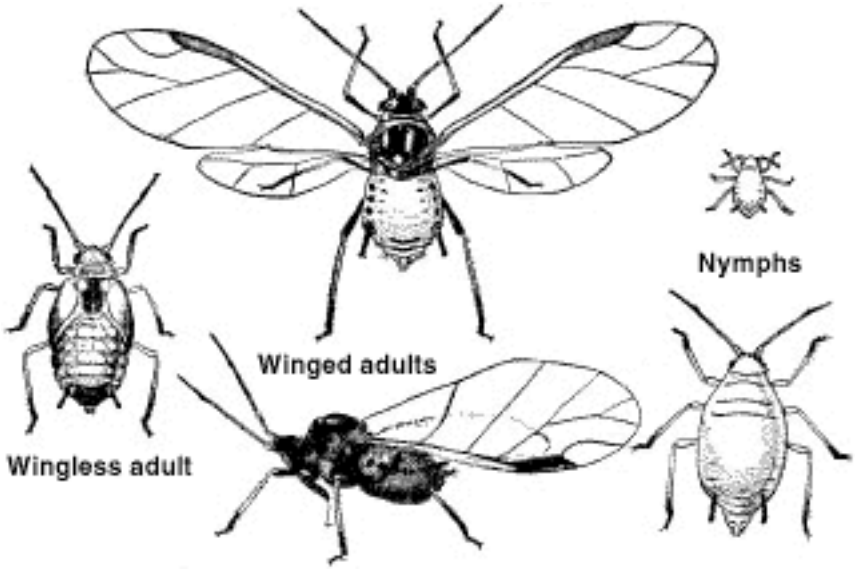
On orchids aphids are found feeding on the buds and flowers, but also on other succulent new and growing tissues such as leaves, sheaths, and the rachis, peduncles, sepals and petals of inflorescences. Aphids have sucking mouthparts that are inserted between, into, or through cells. Actual feeding is by extraction of phloem fluids. Plant damage is done by their mouthparts through repeated insertion and probing as well as fluid removal. Dead tissue zones and distortions develop as new tissues grow around the damaged area. Feeding on leaves and stems debilitates the plant and causes generalized yellowing. Feeding on buds and opening blooms creates distortions or death and drying of tissues. Infested blooms distort and decline rapidly, thus aphids significantly shorten a bloom period.

Many aphid species vector plant viruses. However, of 27 plant viruses reported from orchids only six are vectored by aphids (Lawson 2002) and these can be vectored otherwise. Not all orchid viruses may be vectored by aphids. For example, in a series of experiments Namba and Ishii (1971) were unable to confirm that the *Cymbidium* or *Odontoglossum* mosaic viruses were vectored by the fringed orchid aphid. Rather, mechanical transmission of viruses between plants remains the primary concern for growers. In California, Raabe et al. (2002) note that for *Cymbidium* and other orchids only Bar mottle virus was transmitted by aphids, the green peach aphid. Nevertheless, aphid transmission of cucumber mosaic, turnip mosaic, and bean yellow mosaic, and other viruses to orchids should be a concern to breeders and production growers.

APHID IDENTIFICATION

With nearly 4500 species of aphid and more than 80 species known as crop and ornamentals pests worldwide, aphids can be a daunting group of insects to study. Even restricting our consideration to the dozen or so species that most commonly show themselves on ornamentals and do or may feed on orchids in the home or greenhouse, it can be difficult to identify the species without assistance from an entomologist. For the most part the common species share characteristics that make them easily recognized as a group, and management and control methods are similar. However, for management and control practices for most growers it is essential to have familiarity with their life histories. As an example, the two most common greenhouse pest aphids, the melon aphid and the green peach aphid, are variably susceptible to pyrethroid sprays and occupy plants differently. Consequently, refined and specific management protocols increasingly become dependent upon accurate identification of aphid species.

In general, the pest species of aphids of concern to orchidists come in various shades of green, from light yellow-green to dark blue-green. Most aphids seen in the home are wingless, but as the colony density increases winged individuals will develop and migrate among plants to found new colonies. Greenhouse populations will have plenty of both winged and apterous forms. As insects, aphids have only six legs and a pair of antennae, the mouthparts are formed into a set of thin piercing stylets, the body is a pear-shaped ovoid, and pest aphids are immediately recognizable by the presence of a pair of short tubes (siphunculi or cornicles) protruding from the posterior upper portion of their abdomen. As noted, they have sucking mouthparts, so they do not chew.



In an important early study Pritchard (1949) recorded 24 species of aphid as pests in California greenhouses, but only a few species occur on orchids. Two of the more commonly reported species from

cultivated orchids are the green peach aphid (*Myzus persicae*) and the cotton aphid or melon aphid (*Aphis gossypii*). The lily or arum aphid (*Aulacorthum circumflexum*) was reported from orchids in Connecticut (Anon., undated). The University of Hawaii Extension Service Crop Knowledge Master website (http://www.extento.hawaii.edu) lists the orchid aphid (*Sitobion luteum* as *Macrosiphum luteum*) and the fringed orchid aphid (*Cerataphis orchidearum*) as the main aphid pests on orchids in Hawaii. These latter two species are distributed widely in the tropics, and may be in temperate region greenhouses, having disseminated on plants. Worldwide, Blackman and Eastop (2000) recorded seven species of aphid from orchids: *Aulocorthum solani*, *A. dendrobii*, *A. circumflexum*, *Sitobion anselliae*, *S. indicum*, *S. luteum*, and *Cerataphis orchidearum*.

Additional species may be pests as well but no comprehensive survey of aphids as orchid pests is available. Also, aphid taxonomy has improved considerably in the last 20 years so that aphid identifications of the past may be unreliable.

LIFE HISTORY

Among the most interesting aspects of aphids is the peculiarity of their ecology. In temperate regions many common aphids switch between primary host plants (such as trees or shrubs) and secondary host plants (grasses and forbs), and switch between reproductive modes. These habits occur frequently in native aphid species on natural hosts in temperate regions, as both the host and reproductive switching is a response to seasonal environmental changes and plant phenology. However, most species of aphid that are pests of orchids, especially in greenhouses and indoor growing situations, are weedy species and do not fit these stereotypes. Too, the common pest aphid species out-of-doors in warm climates will behave as if in a greenhouse (Blackman and Eastop, 2000).

Typically, aphids have six life stages: egg or embryo, four nymphal instars, and adult. Birth to reproductive adult may take a few as 7 days in some species. Depending upon the species and environmental conditions, especially temperature, there may be 15-40 generations per year. Of the two main pest species, the green peach aphid reproduces faster at temperatures in the low to mid 70's F, while the melon aphid prefers mid to high 70's F. Reproductively, different species of aphids have some variation of the basic pattern of alternating between normal sexual reproduction and parthenogenesis, or reproduction without fertilization of eggs. Males of many species are unknown.

Parthenogenetic populations of aphids are normal in greenhouses. The pest species of aphids also have generational telescoping, which is the phenomenon where the mother aphid is carrying both her daughter and grand-daughter embryos. It is these traits of parthenogenesis and generational telescoping that allows for the rapid population grow of aphids. Eggs are not laid in greenhouse populations. As each population of aphid increases in numbers of insects then crowding will induce development of winged females that will fly to new hosts. Obviously, with no males and no eggs, the continuous reproduction and population growth is important to consider for management and control decisions.

Aphids prefer the soft and succulent new growth of plants. An excessive use of nitrogen and subsequent growth of soft plant tissues will encourage aphid populations. Aphids are particularly troublesome when there are weeds or other plants that may be sources of aphids moving onto orchids. Although most aphids are host specific, the green peach aphid and the melon aphid are highly polyphagous, feeding on a wide variety of plants.

MANAGEMENT AND CONTROL

Aphids are controlled most effectively through good management of your growing environment. And both chemical and biological control methods are available for successful control in a wide variety of growing situations. It is self-evident that a familiarity with basic aphid biology is important for achieving satisfactory aphid management or control.

Many hobbiests prefer the use of chemicals that do not fit the traditional concept of a pesticide. Yet, there is a decided lack of evidence on the universal value of home remedies based on “household” chemicals for pest control. Expectations of home-based growers seem focused on perceptions involving ease of use, ready availability, comparable pest controllability, and reduced toxicity in relation to pesticides. An often used term is “organic”, but this is a badly misunderstood and misused term, particularly since most of the home remedies use chemicals that are manufactured and as toxic as pesticides. Further, the efficacy of home remedies is in doubt because of the tremendous variability of concoctions and an absence of reliable and unbiased assessments. Ellis and Bradley (1996) provide a good basic introduction to organic pest control.

Pesticides remain important tools in any grower’s management and control options. In general, they are effective and inexpensive for the result gained. However, there are serious health problems when used in a cavalier manner, are general environmental hazards when not used or disposed of properly, may damage the plants, and their overuse quickly produces resistant aphid populations. The pest control needs of a grower of a few plants in the home are considerably different from those of a grower that is selling plants. It seems that the majority of home orchid gardeners are intent on eradication. In contrast, large commercial growers seek the more cost efficient management techniques, yet require pest-free plants for sale. Small and middling sized commercial growers fit

someone in-between these extremes on all factors, including pest control. Evidently, not all pest control methods are satisfactory for all growing situations, and this is an important consideration when choosing management and control methods for aphids.

CONTROL METHODS

Sticky traps will capture the winged, or alate, aphids. Though normally used for monitoring orchid pests the inherent action of the trap does remove some of the pests. Use the standard bright yellow sticky cards that mimic and exaggerate the light reflectance of leaves. Housefly sticky strips will work, too, but are not as attractive to aphids. The cards or strips should be replaced every month or two as dust, water, and captured insects will reduce the effectiveness of the sticky material. Do not use yellow sticky traps when releasing biological control agents, unless you wish to remove these insects as well.

Isopropyl alcohol is readily available as rubbing alcohol in cosmetic and health areas at markets and pharmacies. Isopropyl is normally sold as a 70% solution and this may be diluted considerably for use against insects. A dilution to 35% with 2-3 drops of a mild dishwashing detergent per liter/quart of solution is effective against many insects, including aphids.

The orchid hobbiest should not expect isopropyl alcohol to eliminate an aphid infestation. Adult aphids may not be killed by the alcohol solution and remaining adults will regenerate the infestation. However, when combined with mechanical removal of the insects, rubbing alcohol is very useful in small collections where only one or a few plants may be infestated.

Caution is urged in the use of isopropyl, with or without detergents or soaps. Although the foliage of most orchids is seemly tolerant of such solutions, the flowers may not be so tolerant. Particular care should be taken with thin-leaved orchids, especially members of the Oncidiae whose blooms seem sensitive to isopropyl and detergents. For example, blooms of *Oncidium* species will darken, dry, and senesce quickly from an isopropyl application. Floral or foliar damage from alcohol is often delayed, occurring several to many days after application. Application during lower temperatures and sunlight conditions is recommended to enhance effectiveness and avoid damage from rapid evaporative cooling or sunburn.

Diatomaceous Earth is moderately effective for aphid control when dusted on plants. The sharp edges of the fossilized diatoms irritate and cut the membranes of the insects and they dehydrate. However, diatomaceous earth is not effective when wet and it readily washes from the plant.

Oils come in a variety of light molecular weight, narrow range or horticultural quality of many sorts that are suitable for pest control on orchids. Horticultural oils are generally highly refined mineral oils and work well. Neem and common vegetable oils are also effective, but vegetable oils often become rancid after application. Though this may not harm the orchid, it often smells foul if the plants do not receive a regular foliar irrigation. Garlic, citrus, and capsaicin oils also have insecticidal effects on aphids, but these should be used cautiously around pets. All oils control aphids and other pests by coating the insect, plugging their respiratory spiracles, and killing them by suffocation. Thus, the choice of oil makes little difference, but the application method and frequency does matter.

Oils should be mixed with water and a few drops of liquid detergent, the latter of which acts as an emulsifier. The oil must be allowed to spread over the plant and insects/mites for effective control. To avoid damage to the plants do not apply oils in full sun, when temperatures exceed 85°F, when humidity exceeds 90% for more than 48 hours, or on open blooms. All oils must be used on a regular basis and every 10-14 days, depending upon pest and environmental conditions.

Insecticidal Soaps and Detergents. Technically, soaps are highly alkaline potassium salts of fatty acids, while detergents are synthetic compounds that have similar chemical activity. However, soaps react with

alkaline compounds containing sodium, potassium calcium, or magnesium, while detergents are relatively neutral and do not form the same reactions in hard water.

Insecticidal soaps are specifically formulated to be plant safe as well as effective and efficient agents for killing and controlling aphids and other orchid pests, particularly with home environments and small greenhouses. They are relatively safe, with low toxicity to people and pets, easy to apply, and generally lack the noxious fumes of other insecticides. However, they are only effective in their wet condition, not when dry.

Insecticidal soaps that also have synthetic pyrethrins included in the formula will usually also have piperonyl butoxide as an enhancing agent. Some people are highly allergic to piperonyl butoxide and there is some evidence of phytotoxicity. Too, repeated applications of insecticidals soaps during a short period of time can have phytotoxicity problems, so some caution is urged to avoid excessive use. As with other pesticides do not apply insecticidal soaps in hot weather, high humidity, or on otherwise stressed plants.

Throughout the orchid world there are numerous recommendations to either use dish soaps or such agents variously mixed with isopropyl or other substances. Great caution should be used with dish soaps. Although most, if not all, are effective against immature aphids they are also deleterious to the plants. The harsher detergents will remove the natural protective waxes of the plant cuticle. If dish detergents are used in any manner, then use brands that are known to have the mildest reactions with plants. However, be judicious in their use as different manufacturing batches will differ in their chemical properties. A good rule of thumb is to not use soaps more than three times consecutively; allow the plants to grow and recover before additional applications.

Insecticides. There is a large selection of insecticides available for aphid control. Relatively few are available for use on ornamentals or in greenhouses and most of those have restricted use labels. Only the generally available insecticides and those usable on ornamentals or indoors are mentioned here.

The most popular and effective insecticides for aphid control are malathion, acephate, diazinon, and methiocarb. Oxydemeton-methyl (Metasystox) is an effective alternative in countries other than the United States where the chemical is no longer available due to a voluntary deregistration. All of these chemicals are broad spectrum and are effective on many pests other than aphids. The biggest drawback to these insecticides is that aphids are well documented in their ability to develop resistance to them. Consequently, their use is recommended only on a limited basis and within a rotational program with other insecticides having different modes of action.

Cinnamaldehyde is derived from the bark of *Cinnamomum* trees and is a contact poison. Synthetic formulations (e.g., Cinnamite, Cinnacure) are more commonly available. Effective control of aphids and other pests requires persistent wetting for at least 30 minutes. The chemical volatizes quickly and degrades within a few hours. Powdered cinnamon, as commonly used as a fungicide, lacks sufficient concentrations of cinnamaldehyde and is ineffective as an insecticide.

Imadochloprid is used as a soil drench (Merit) or foliar application (Marathon II) to provide systemic action through the host plant. It has a long environmental life.

Pyridaben (Sanmite) is a metabolic inhibitor affecting electron transport across cellular membranes. It effectiveness against aphids is still being tested, but it appears promising and has the dual benefit of being a miticide.

Abamectin is a mixture of avermectins that are compounds extracted by fermentation of the soil bacterium *Streptomyces avermitilis*. Avermectins are systemic in action but they have an environmental life of only a few days.

Pyrethroids are synthetic forms of the naturally occurring pyrethrum; the latter lacks control ability on aphids. Pyrethroids effective on aphids include **bifenthrin** (e.g., Talstar), **cyfluthrin** (Decathlon), and

fluvalinate (Mavrik). However, much like synthetic insecticides aphids are able to quickly develop resistance to regular and excessive use of a pyrethroid. There use is recommended only as needed. If aphids are persistent pests then a rotational program with at least two other insecticides of different modes of action will be necessary for sustained management.

Insect growth regulators, such as **kinoprene** (Enstar II) and **fenoxycarb** (Award), are synthetic forms of juvenile hormone which is highly important in insects at critical stages of their metamorphosis. The use of growth regulators interrupts the normal development of the insects, including orchid pests such as scales, mealybugs, aphids, and whiteflies. Growth regulators are registered for use in greenhouses and interiorscapes, and are regarded as safe for humans and pets. Their greatest effectiveness is on pest populations that are at low densities and comprised primarily of immatures. Established pests needing a quick control should be subjected to another method that will kill adult insects.

Azadirachtin (Azatin and Neemazad) is a plant derived (neem tree) botanical insecticide, that acts as a chitin inhibitor. Chitin is a primary compound used by insects and mites when developing their integument, or exoskeleton. Azadirachtin reduces the ability of the arthropods to properly develop an integument and causes mortality through incomplete development. There is little information available on this chemical for use on orchids, but it is available on a wide variety of ornamentals and is labeled for greenhouse applications.

Some Aphid Chemical Use Recommendations

Chemical	Site
Abamectin	outdoors
Acephate	greenhouse, outdoors
Azadiractin	greenhouse
Bifenthrin	greenhouse
Carbaryl	outdoors
Cinnamaldehyde	greenhouse
Cyfluthrin	greenhouse, outdoors
Diazinon	outdoors
Fenoxycarb	greenhouse
Fluvilinate	greenhouse, outdoors
Imadichloprid	greenhouse, outdoors
Insecticidal soap	home, greenhouse, outdoors
Isopropyl	home
Kinoprene	home, greenhouse
Malathion	outdoors
Metasystox	outdoors
Oils – hort, neem, veg.	home, greenhouse, outdoors

BIOLOGICAL CONTROL

Biological control, or biocontrol, of orchid pests is a natural control method that does not use pesticides. In fact, the use of pesticides concurrently with biocontrol agents is self-defeating. Rather, management of pests is accomplished by using natural predators and parasites to keep the pest population low. Biocontrol eradicates pests only under carefully manipulated conditions, and for all pests and conditions is most effective in greenhouses. However, initiation of a successful biocontrol program requires the development of large populations of aphids to establish the biocontrol agents. In addition to an avoidance of pesticides, biocontrol users should not use yellow or other sticky traps while predators and parasites are active. Many of the biocontrol insects will be attracted to sticky traps.

Biocontrol of pests is a viable option for the home grower with a greenhouse, or commercial growers seeking an "organic" marketing niche. However, a completely aphid-free organically grown plant may require supplemental applications of insect growth hormone or other acceptable chemicals.

Aphid midge. The aphid midge (*Aphidoletes aphidomyza*) is a small insect and a member of the same family of true flies (Order Diptera, Family Cecidomyiidae) as the Dendrobium blossom midge. It is generally similar in its small and delicate size, dark color, long legs, and slender body. However, the aphid midge has a predatory larva that reportedly may feed on 10-100 aphids depending on the size of the aphids and the environmental conditions. The aphid midge requires high humidity and is most effective with at least a 16 hour day. The larva is a small, yellowish maggot, that is active on plant leaves and shoots where it seeks and attacks aphids. Apparently, this aphid predator is not particular about the prey species. The adult aphid midge feeds on honeydew and other liquids, and is active under reduced light. Each female aphid midge may lay about 70 eggs on the surface of leaves. Pupation occurs in fragile cocoons in the potting media.

Lacewings. The common green lacewings (Order Neuroptera, Family Chrysopidae) familiar to most orchid growers and the brown lacewings (Family Hemerobiidae) are efficient predators of aphids, scale and mealybug crawlers, whitefly immatures, and other pests. There are many species of both green (*Chrysopa* and *Chrysoperla* spp.) and brown lacewings (various genera) useful for biological control, but only a few species of *Chrysoperla* are commercially available. These insects are very useful in greenhouses. Although the adults of *Chrysopa* and brown lacewings are predatory it is generally the larvae of both green and brown lacewings that are important for aphid biocontrol. Larvae are cannibalistic and must be widely spread in a greenhouse, and they are most effective in aphid predation as they grow. Yet, each larva may consume several hundred aphids. Adult lacewings

are attracted to lights and will enter unscreened greenhouses.

Lacewings require only moderate humidity and temperatures. The adults feed on honeydew, sugar water, and other liquids, though some of the brown lacewings may also feed on prey. The spraying of sugar water may help to keep adult lacewings in the proximity of plants.

Ladybeetles. Certain ladybeetles (Order Coleoptera, Family Coccinellidae) are well-known predators of aphids, scales, mealybugs, spider mites, and other pests, but there are some pest species of ladybeetles, too. There are many beneficial species worldwide, but few are commercially available. The convergent ladybeetle (*Hippodamia convergens*) is one of the most common biocontrol species used for aphids, but it is best for outdoor use and large greenhouses. Also, the convergent ladybeetle will disperse widely shortly after release so that their use most effective in a greenhouse that contains a substantial aphid population. Inundating the aphids with ladybeetles will reduce, but not eliminate the aphids. The ladybeetles will remain among plants longer if

sugar water is sprayed lightly on occasion to give the beetles an additional source of water and carbohydrate.

Convergent ladybeetles are a useful and effective management option with other biocontrol agents or judiciously used chemicals, such as kinoprene or pyrethroids. Convergent ladybeetles will also feed on other pests, such as spider mites, thrips, scales, mealybugs, and others, but other ladybeetles are best used for scales and mealybugs.

In recent years the invasive Asian ladybeetle (*Harmonia axyridis*) has distributed widely in northern North America. This species is also an aphid predator, but its use in greenhouses has not been evaluated. Unfortunately, this species has also shown itself to be an ecological and agricultural problem by deleteriously competing against native ladybeetles, disrupting natural communities, feeding on a variety of fruit crops, and becoming a serious nuisance and health pest when large overwintering populations enter buildings.

Syrphid flies, hover flies, flower flies. Syrphidae is a large family of true flies (Order Diptera) with many species familiar to outdoor gardeners as small to medium-sized visitors to flowers. The adult fly typically hovers above the flower before settling to sip nectar or lap pollen. Most of the common syrphid flies have yellow and black bands, or brown patterns, that mimic wasps and bees. Syrphid flies are harmless. However, the larvae of some species are voracious predators of aphids. These larvae, such as *Scaeva pyrastri* who may consume upwards of 500 aphids during its development, are green with a yellowish-white stripe along the midline.and narrowing toward the head. Bugg (1992) reported upon aphid feeding syrphids and noted that at least 49 species are known to feed on the green peach aphid. *Allograpta oblique* is a common North American species in many gardens.

Adults will enter unscreened greenhouses in search of flowers and females will oviposit near aphid colonies. Larvae are sensitive to insecticides and will be preyed upon by other predatory insects such as minute pirate bugs.

Parasitoid wasps. A number of parasitiod wasps (Order Hymenoptera, Families Aphidiidae and Aphelinidae) are used for the biocontrol of aphids. The more common and commercially available species are *Aphelinus abdominalis*., *Aphidius matricarae*, *Aphidius colmani*, *Diaeretiella rapae*, *Lysiphlebus testaceipes*, and many others. All of these tiny wasps (< 1.5 mm) lay eggs inside the aphid and the wasp larva feeds on internal tissues. The effectiveness of these wasps is measured by noting the presence of tan or black colored aphids with large holes in their abdomen from which the wasp emerged. Aphid parasitoids are highly effective when aphid populations are low, but are extremely sensitive to insecticides and traps. Greenhouses should be well screened to prevent escape of the wasps.

Minute Pirate Bugs. Minute pirate bugs are true bugs (Order Hemiptera, Family Anthocoridae). They are dark brown and white, or black and white, small bugs (ca. 1.5-2.5mm in length) that are predacious on many small and soft-bodied arthropods, including aphids, spider mites, thrips, and whiteflies. Although most species are beneficial, two species, *Orius insidiosus* and *Orius tristicolor* are commonly used for biocontrol of aphids and other greenhouse pests. Minute pirate bugs do best with the humidity exceeding 50% and a pollen supply for supplemental feeding. The only drawback of minute pirate bugs is that they are generalist predators and will feed on other beneficial species as well as pest species.

Beauveria bassiana. This naturally occurring soil fungus is highly infectious to aphids and many other pests. Augmenting the natural population is effective for pest control if the proper conditions are maintained. The fungus must be protected from ultraviolet light, but this is usually accomplished with greenhouse glazings. Only moderate humidity is necessary, but a thorough spray coverage is essential. Infected dead and dying aphids will have fine whitish mycelia emerging from the body.

As with the use of predators and other parasites, *B. bassiana* requires several days or more to begin showing an effect on the aphid population. Fungicides should not be used within 48 hours of a *B. bassiana* application.

FINAL CONSIDERATIONS

Effective management and control of aphids requires effort on the part of the grower, particularly if cultural and biocontrol methods are used. The grower must be familiar with the identification and life history of the problem species, as well as anticipated predators and parasites, and have an intimate knowledge of the growing conditions of their plants. Non-pesticide alternatives are more physically and intellectually involved. In contrast, pesticide use is generally less expensive and easier, requires less depth of knowledge and involvement, but retains all the inherent hazards. The most effective pest control is population management using combinations of environmental conditions, biocontrol agents, and different categories of pesticides.

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