Eriophyid mites in Production Nurseries

All mites are small, but eriophyid mites are so tiny that they cannot be observed without a microscope; a ×10 hand lens will rarely detect them. Mites from the family Eriophyidae (pronounced: air-ee-oh-fy-i-dee) have many common names including erinose mite, rust mite, blister mite and gall mite, depending on the type of damage they cause to their host plant. They are worm-like, white, opaque, or greyish in colour and have only two pairs of legs throughout their lifecycle. Since they are very easily overlooked, low-level populations producing minimal damage often go undetected, unless they are a species that produce very distinctive symptoms. Damage caused by eriophyid mites can sometimes be mistaken for that caused by other factors, such as nutrient deficiency, environmental conditions, other pest damage (particularly from thrips, psyllids or broad mite), treatment with plant hormones, or accidental herbicide damage. Therefore, misidentification is a common problem that can lead to mismanagement and increased damage or losses. Many species of eriophyids are of economic importance to specific plant species, causing abnormal growth or sufficient damage to render plants unsaleable. High infestations in some fruit and vegetable crops can also cause significant yield reductions, and in rare occasions, even plant death.

Acacia suaveolens with eriophyid infestation causing galls and deformed leaves. Eriophyids are present inside the gall and over the leaves as shown in the close-up section. The mites are about 50–100µm (i.e. about a tenth of a millimetre in length or less).

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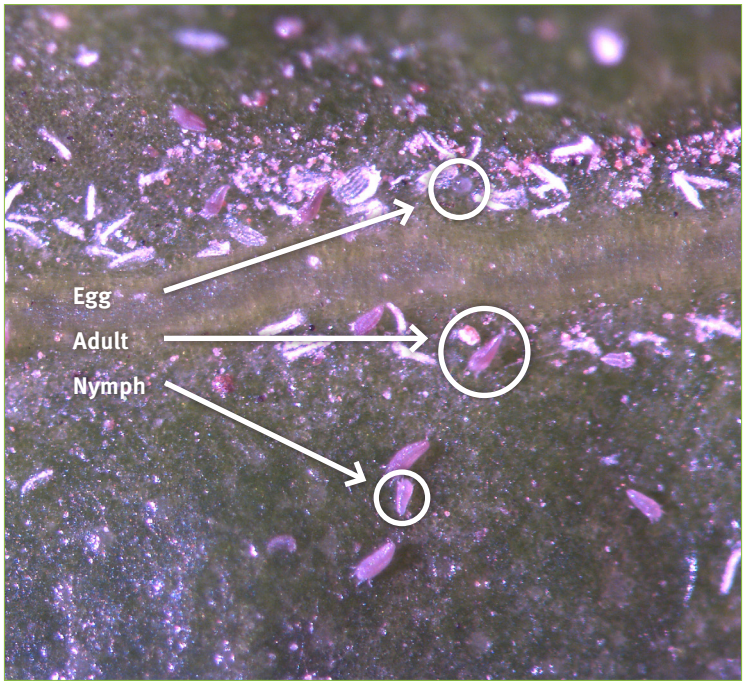
BIOLOGY

Eriophyid mites are typically about 0.1mm long, and rarely more than 0.2mm long. Individual mites cannot be observed without magnification (at least a ×20 hand lens is required), but a devoted microscope with at least ×30-40 magnification is best. They can occasionally be observed using USB microscopes, but digital devices often lack the resolution required to confidently detect them, particularly when only low numbers are present.

Eriophyid mites are worm-like or tubular in shape and often tapered at one or both ends. They are almost always white to light grey in colour and have two pairs of legs at the head end. There are about 3,000 described species in this family (from over 200 genera), but many more species and genera exist that are not yet described.

Eriophyids develop through egg, larva, nymph, and adult stages and complete their development in about one week at 25°C. Females can lay up to three eggs per day for a month under good conditions. Their oval shaped eggs are about half the size of adults and are generally white or opaque in colour.



Close up of eriophyids including each stage in their lifecycle.

ERIOPHYID DISPERSAL

The main natural dispersal mechanism is by wind, although they can also be spread by other organisms, such as insects, other mites, and birds. In production nurseries, movement of infested plants is by far the most common method for dispersal by these organisms. Healthy plants with foliage touching infested plants may also become infested. In comparison with other microscopic organisms, eriophyid mites can walk surprising distances relatively quickly (i.e. several centimetres over a few minutes).

They are also amazingly robust for soft-bodied microscopic organisms. In fact, they have been collected alive from fresh snowfalls, indicating that they were in the atmosphere and brought back to earth with falling snow. They are so small that ice crystals cannot form within their bodies.

ERIOPHYID DAMAGE AND HOST RANGE

The presence of eriophyid mites often goes completely unnoticed until populations are high enough to cause significant visible damage. Each species is generally quite host specific, being adapted to one or a few relatively closely related host plant species. For example, tomato russet mite (*Aculops lycopersici*) causes damage to several solanaceous plants including tomatoes, potatoes, tobacco, pepper, and petunia, whereas most species only cause damage to one host plant species.

Each species of eriophyid mite generally feeds on one area of the plant such as expanded leaves, young leaves and growing tips, flower buds or fruit. Some species produce galls or masses of unusual plant growth, in which they live. The type of damage produced on a particular host plant species can provide a clue as to the species causing it. Keep in mind that there are many species of eriophyid mites that have not been described, even if they are well recognised, e.g. galls formed on banksia seed pods are caused by at least one undescribed species from the genus *Aceria*.

Deformed new growth of *Eucalyptus leucoxylon* caused by eriophyids present in the new growth.

Feeding on the growing tips tends to cause small and deformed new growth like that caused by broad mites. Some species may cause growing tips to become necrotic and die. Damage to flowers and flower buds can cause bud distortion, stunting or russeting. Feeding on growing fruit can cause bronzing/russeting damage, fruit deformity or premature fruit/nut drop. In addition, some species inject a toxin into the plant that can stop the ripening of certain berries.

Eriophyids feeding on mature leaves of *Corymbia maculata* causing chlorotic spots and a close up of eriophyids on the spot.

Feeding on mature leaves may cause silver or brown discolouration (often referred to as russeting, bronzing or silvering), leaf spotting, leaf curling, chlorotic spots and or premature leaf drop. Some species may induce the development of outgrowths on leaves or petioles. Outgrowths are dense areas of leaf hairs (called erinea) in which mites take shelter. Erinea are generally bright pink, glossy crimson or sometimes other earthy colours and cause only minimal pocketing of the leaf. Mites are not always easy to observe within erinea, as they tend to shelter deep within the mass of hairs. Low level heat (e.g. from a lamp), will often cause individuals to move out of the erinea to be more easily observed or collected. Blisters are similar to erinea but cause the leaf to cup or pucker in some way. Blisters can also become necrotic over time as the plant cells die.

Many species of eriophyids may produce **true galls**. Galls are produced by the plant in reaction to feeding. Galls range in size and shape depending on the host plant, plant part and mite species in question. The galls are typically green, pink, or red and may be bright or dull in colour. Some galls are more yellow or orange in colour and some may be green with a tinge of red. Most commonly, galls appear on upper leaves, but may also occur on petioles, stems, flower buds and flowers. Galls present on the upper surface of leaves will have a tiny entrance on the lower leaf surface. Mites within the gall have an ideal environment to live and are relatively protected from predators and contact pesticides. Galls can be long and finger-like, with a pointed or rounded tip. Others are dome, bladder, dimple or wart-like in shape. Sometimes the galls are very irregular and globular, others are quite discrete and regular. They often appear clumped and may almost completely cover the leaf, sometimes causing it to be grossly contorted. The gall itself is produced as the immature leaf expands and will not change once the leaf is mature, even if mites are killed using pesticides. In most instances, galls on leaves do not affect the growth rate or production of their host, but can change their appearance such that they are no longer saleable.

Slight cupping of grape leaves and red colouration caused by eriophyids.

ERIOPHYIDS AS VECTORS FOR PLANT DISEASES

Specific species of eriophyid mites are known to vector fungal, viral and even bacterial pathogens, many of which are not known to be present in Australia or have restricted geographic range. For example, mango bud mite may vector the mango malformation pathogen, *Fusarium mangiferae*, a fungus that causes severe distortion and dwarfing of new growth. It has been reported in the Northern Territory and Queensland, but infected trees were destroyed, and the disease has not reoccurred. *Rose rosette* virus, which is transmitted by the eriophyid mite, *Phyllocoptes fructiphilus*, causes severe dwarfing of all commercial cultivars in North America. Several other species of eriophyids occur on roses, at least one of which is present in Australia. Recently, several eriophyids are known to transmit wheat and other grain crop viruses. Other eriophyid species are considered to vector a pathogen to their host plant, but in many cases the exact pathogen is not currently known.

MANAGEMENT

Eriophyid mites should be managed using a range of preventative, cultural practices as well as biological control and pesticides, where necessary. It is not recommended to rely solely on pesticides to manage any pest.

MONITORING

Good management starts with monitoring. The importance of regular monitoring cannot be emphasised strongly enough for all pests, diseases and crop health issues. Management actions are best implemented at low populations before

significant damage has occurred. Monitoring before and after management actions provides information about their efficacy. Furthermore, when evaluating the efficacy of new products, it can be worthwhile leaving some areas of the nursery without the management action as a point of comparison (e.g. applying a pesticide to most plants, but leaving a small number untreated). In other words, there is strong evidence that the treatment was effective if treated plants become healthy and no longer have the pest present and untreated plants continue to have mites and damage.

Plant material must be examined under a microscope to observe eriophyid mites. Collect symptomatic leaves into a zip lock bag and examine under the microscope, ensuring that leaves are searched at around ×30–40 magnification. Fine forceps are often helpful to tease apart closely growing leaves in the tips or flower buds. They are also helpful for dissecting soft plant tissue suspected to be an eriophyid gall. If plants are regularly becoming infested and receiving significant damage, it may beneficial to examine healthy leaves under the microscope to detect populations of eriophyids early, at least during high-risk periods. In addition, monitor incoming stock of highly susceptible plant species and mother stock plants prior to taking cuttings. These practices can be used to develop a quality assurance process that reduces the likelihood of a severe infestation.

Deformed growth on tomato caused by a severe eriophyid infestation.

CULTURAL MANAGEMENT

Cultural practices prevent pest populations passively, reducing the likelihood that eriophyid mites will infest or reinfest your crop. These practices must be implemented consistently as part of business as usual to gain maximum efficacy.

» Always inspect incoming stock. Preferably hold all stock in a separate area for a period before incorporating with the rest of your nursery stock. High-risk or highly valuable stock should be inspected with greater effort. The exact length will depend on the value of the stock, size of plants, space available, pests and diseases known to occur and other factors. For eriophyid mites it is important to train staff to recognise early symptoms and have them inspected under a microscope before plants are incorporated with the rest of the nursery.

» Quarantine infested plants to reduce the spread of mites to nearby plants.

» Remove unsalable plants from the growing area. Prune unsightly growth where possible. Dispose in a covered bin or closed bag prior to removal from the site. Do not dispose of infested plants in a compost heap or rubbish pile as eriophyids can find a way back into the growing area.

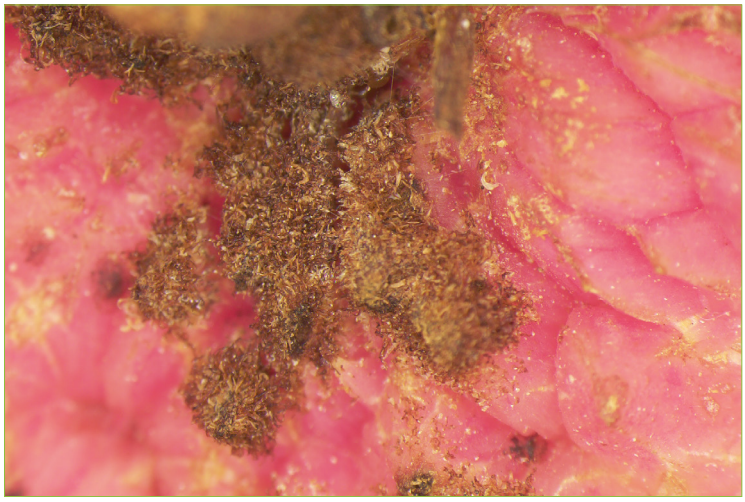
» If possible, grow highly susceptible plants under protected cropping that may be modified to exclude a wide range of pests and may reduce wind dispersed individuals. Screens excluding eriophyid mites are not always necessary, even closing doors of protected cropping structures can reduce pest populations.

» Establish patterns of eriophyid infestations in your nursery by identifying time periods that are more at risk, and host plant species and varieties that may be susceptible/tolerant to mite damage.

PURCHASING A MICROSCOPE

Your nursery will have the best chance of identifying mites (and other pests and diseases) early if a stereo (dissecting) microscope is used. It should have a good lighting source and camera. A basic microscope with a camera can be purchased for less than a thousand dollars and can ensure that you can observe very small individuals with ease. Digital microscopes often do not have the resolution required to distinguish eriophyid mites from leaf hairs and other structures. Ensure that it is trinocular or has a camera built in, has a zoom ratio between about ×5–40 (a larger range is also helpful but not necessary) and has a light source (LED lamps on a flexible neck also function well and are readily available). Purchasing from a reputable and professional microscope supplier (e.g. Olympus, Nikon, Zeiss and Leica) will likely cost more, but the microscope will have higher quality optics and superior camera software. These companies often provide on-site technical support that may include training staff to use the equipment. This may be beneficial for staff that consistently use microscopes and require it for quality assurance programs.

- If possible, grow varieties that receive less damage. Where possible, grow plants outside of high-risk seasons.
- Conserve natural enemies by only spraying pesticides when monitoring indicates that numbers will reach damaging levels. Preferably, only apply products that have a small impact on predator populations (i.e. avoid applying organophosphate, pyrethroid, neonicotinoid and similar products). Refer to the pesticide section below for more details.
- If pesticides are required, apply to hot-spot areas and high-risk plants; avoid blanket applications. This will help conserve natural enemies.
- Remove weeds from within and around the growing area that could be acting as alternative hosts. For eriophyids, this would normally be very closely related species.
- Mature plants of stock lines that occur outside the nursery growing area could be a source of mites that may cause regular reinfestations, even if they do not have obvious symptoms. This is particularly important for native plant nurseries growing plant species that occur naturally nearby. Understanding the seasonal peaks of such species is valuable and should influence monitoring efforts and other management actions.
- Only propagate from clean material. Monitor mother stock plants carefully under a microscope if plants are regularly becoming infested. Ensure that mother stock is free from eriophyid mites (and other pests and diseases) prior to taking propagative material.



Brown erinea on lychee fruit.

Bladder galls caused by eriophyids, photo by M. Zubrik, Forest Research Institute - Slovakia, Bugwood.org.

BIOLOGICAL CONTROL

Many predatory mites and insects that feed on eriophyid mites occur in production nurseries naturally. These can be preserved by avoiding the use of broad spectrum pesticides and providing alternative food sources (for more information refer to the factsheet on managing predators in production nurseries). There are limited numbers of commercially available predators) that will feed on eriophyid mites and only one is specifically recommended to manage eriophyid populations (Doreen). These predators are available through Biological Services and or Bugs for Bugs.

Doreen is a relatively new commercially available predator that appears to manage eriophyid mites and broad mites. Trials to more fully understand how to best use this predator are still on-going. Therefore, it is recommended to consult Biological Services prior to releasing it in your nursery for advice on the best way to use it. Californicus, cucumeris and montdorensis may feed on eriophyid mites incidentally and assist managing low level populations. However, it may not be possible to to use them as the primary method of managing eriophyid mites in all cases. The efficacy of predators against eriophyids that form true galls may be reduced in some cases.

There are several advantages to using predators over pesticides. Predators move between plants in search of mites, and feed on many stages of the pest, including eggs. They can provide long term management of mites under good environmental conditions and never damage plants. Biological control can also be used on short term crops, particularly those that are susceptible to mite damage.

The application of commercially available predators may not always be possible. Predators may not be effective in very hot conditions (above about 35°C) or at very low temperatures (below about 10°C). When only a few plants

are infested it may not be economically feasible, though some suppliers have small packs suitable for treating small areas that are relatively cost effective. The application of highly residual and broad-spectrum pesticides (insecticides, miticides and fungicides) will also preclude the successful release of almost all predator species. Until you are relatively experienced with the predator, discussions with the biological control agent producer (prior to release) will ensure the best possible outcome.

Refer to the factsheet for more information on preserving predators in production nurseries.

CHEMICAL CONTROL

There are a few pesticide products that can be used against eriophyid mites in production nurseries (Table 1). More products may be available for use on selected crops (e.g. grape, citrus and tomato). Preserve their use for periods when economic damage is likely to be experienced; do not solely rely on pesticides to manage any pest.

Only apply pesticides when eriophyid mites have been observed on the plant; do not assume that symptoms have been caused by eriophyid mites unless they were seen under a microscope. The exception to this occurs when the symptoms they produce are very distinctive and unmistakable (e.g. when they produce galls and erinea). A variety of other pests can produce symptoms similar to eriophyid mites including broad mites, other galling insects, thrips, flat mites and sometimes even spider mites. Some disorders can also cause symptoms easily mistaken for those produced by eriophyids including those caused by inappropriate pH, nutrient disorders, low dose herbicide damage and other pesticide phytotoxicities. Applying pesticides to plants that do not have pests can increase the problem and will never solve it.

TABLE 1. PESTICIDES WITH A REGISTRATION OR MINOR USE PERMIT FOR USE AGAINST ERIOPHYID MITES ON NURSERY STOCK. MOA STANDS FOR MODE OF ACTION GROUP AND APPEARS ON THE LABEL OF MOST PESTICIDES. ACTION REFERS TO THE MOVEMENT OF THE PRODUCT IN THE PLANT, C = CONTACT, T = TRANSLAMINAR, S = SYSTEMIC.

MOA	ACTIVE	EXAMPLE TRADE NAME	ACTION	NOTES	TOXICITY TO BENEFICIALS
1B	Dimethoate	Dimethoate	S	For use against 'mites' on ornamental shrubs, farm and forest trees.	High toxicity with 6–9+ week residual.
6 & 28	Abamectin & Chlorantraniliprole	Volium targo	T & S	For use against all mites on non-food nursery crops. PER88695 & PER91810	Moderate toxicity when applied. Predators can be released after several days.
6	Emamectin	Proclaim	T	For use against all mites on non-food nursery crops. PER91810	Moderate toxicity when applied. Predators can be released after several days.
NA	Petroleum oil	Various	C	For use against all mites on non-food nursery crops. PER91810	Increasing toxicity towards predators with regular applications. Predators can be released 1–2 days after application.
NA	Wettable sulphur	Flosol	C	Certain rust mites on selected crops, e.g. vegetables, citrus and grape. Do not apply 21 days before or after an oil spray. Do not apply during high heat conditions.	Low to moderate (spray): 0–1 week residual. High (dust): 6–9 week residual.

The use of chemicals against eriophyid mites is likely to be unavoidable, at least on limited occasions, however regular, scheduled use is not recommended. Monitor plant health regularly to detect pest populations early and reduce the need to apply pesticides. Pesticide application can be warranted under a variety of circumstances including:

- When pest numbers are very high it is recommended to apply an appropriate product, preferably after having removed unsaleable stock or pruned heavily damaged stems. After pesticide application, a suitable biological control agent may be released to clean up the remaining pest mites.

- Under environmental conditions that are not conducive to the success of predators (e.g. very hot or cold conditions).
- When broad spectrum or long residual products have been applied that will reduce the efficacy or completely kill predators. The exact time frame depends on the product in question, but many organophosphate (1B) and synthetic pyrethroid (3A) products can impact predator populations even 3 months after they were applied. In these cases, low residual products should be used until biological control agents can be released (Table 1).
- In most cases, infestations that occur just prior to the sale of a product will require a pesticide application.

It is important to understand the mode of action for each product used to manage pest mites. Some products have a contact mode of action, only being effective when they directly contact the mite. Other products are systemic, entering and moving through the plant and entering the mite after they ingest the plant tissue. Translaminar products have limited systemic effects, moving across the leaf from one side to the other, but do not move from one leaf to another. When choosing a product be aware of its mode of action as it can impact efficacy. Eriophyid mites present in a growing tip that is somewhat protected may require a translaminar or systemic product, whereas eriophyids that are on the underside of an expanded leaf may only require a contact product. However, if eriophyids are present in a gall, a systemic product may be required, or at least a translaminar product.

It can often be valuable to prune out significant damage prior to application of pesticides. This reduces the number of individuals in the crop and will make the application more effective. It also may remove unusual growth that may reduce the quality of the plant.

CONCLUSION

Managing eriophyids relies on putting in place as many cultural practices as possible. Identify high risk periods and susceptible crops and monitor these diligently. Manage eriophyids proactively with predators and or pesticides depending upon the situation. If possible, grow species that are not damaged or are otherwise tolerant.

Pink erinea caused by eriophyid mites on *Elaeocarpus eumundi*.

This factsheet was written by Andrew Manners and Emily Lancaster (Queensland Government, Department of Agriculture and Fisheries — DAF) as part of the Hort Innovation, Nursery Levy and DAF funded project "Resourcing, supporting, and assessing biosecurity in nursery production (NY20000)" in 2023. It was originally written as part of a mite pest management plan in 2015 as part of NY11001.