

Whitefly pest management plan for production nurseries

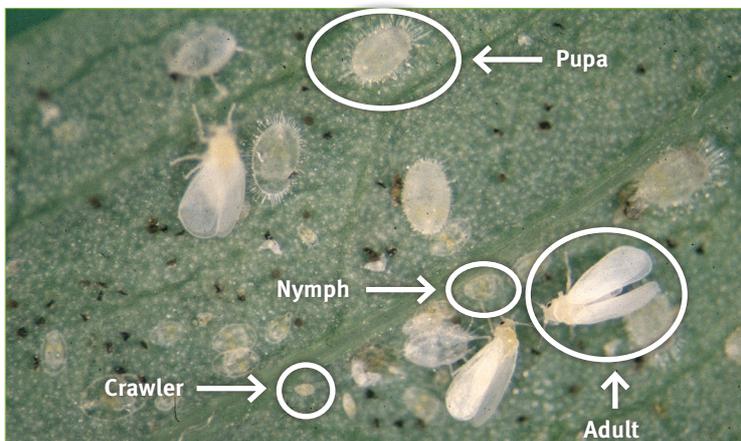
The main whitefly species that are pests of production nurseries in Australia are silverleaf whitefly, greenhouse whitefly, ash whitefly and spiralling whitefly. Other whitefly species may also be pests of certain host plants, particularly Australian native plants. Infestations can cause substantial economic loss and increased costs in production. This pest management plan will summarise aspects of their biology, viruses vectored, cultural management, biological control and pesticides. It is recommended to put in place as many cultural practices as possible to prevent whitefly populations. Use biological control and or pesticides when populations are low to reduce economic impact; do not solely rely on pesticides to manage whiteflies.



BACKGROUND AND GENERAL BIOLOGY

Whiteflies are sap-sucking insects that can reduce the growth rate of plants and cause leaf chlorosis, senescence or death, depending on the level of infestation. As they feed, they excrete honeydew on which black sooty mould grows, resulting in reduced photosynthesis and blemishes that may render plants unmarketable. Their saliva can produce toxic effects that causes the abnormal growth of some plants (e.g. poinsettia) or a silvering effect on the leaves (e.g. cucurbits). They also vector several viruses.

All life stages are found on the undersides of the leaves. The eggs are tiny and laid on young leaves, either singly or in groups. First instar nymphs (known as “crawlers”) hatch and move a short distance from their eggs. Subsequent nymphal instars are circular to oval, flat, and largely immobile. Fourth-instar nymphs develop into pupae from which adults emerge. The adults are small (1–2mm long) with white wings.



Greenhouse whitefly. Photo by Whitney Cranshaw, Colorado State University, www.Bugwood.org

COMMON WHITEFLIES IN AUSTRALIA

SILVERLEAF WHITEFLY

Silverleaf whitefly (SLW, *Bemisia tabaci* biotype B) is found throughout Queensland, New South Wales, northern Western Australia, and the Northern Territory. It has also been recorded in glasshouses in South Australia, Victoria and southern WA (i.e. Perth). Numerous biotypes of SLW are present globally and at least three occur in Australia. These include biotype B and two Australian native biotypes, which probably represent separate species that are morphologically identical. Only biotype B is considered a pest as it has a much broader host range and a much higher tendency to become resistant to insecticides. The presence of SLW may result in restricted market access to certain states (e.g. WA).

About two-thirds of SLW populations are female and they can start laying eggs 24 hours after becoming an adult (depending on the temperature and host plant). SLW can feed and reproduce on over 600 plant species and new hosts are regularly recorded. The host range includes many ornamentals (e.g. poinsettia, hibiscus, chrysanthemum, begonia, nicotiana, fuchsia and aster), herbs, fruit and vegetable seedlings (e.g. tomato, melon, squash, eggplant, cabbage, broccoli and beans), and a range of broadleaf weeds (e.g. sowthistle, turnip weed, mallow and wireweed). SLW will persist at low levels on some hosts, facilitating repeated infestations when more susceptible hosts become available.

Despite the broad host range, there is wide variability in host plant suitability between species and cultivars. For instance, mortality is higher, development time longer and fecundity lower on capsicum than on eggplant, so fewer SLW will develop on capsicum in a given period. Factors such as leaf colour, leaf hair density and nutritional state can all influence host plant selection by SLW. Tolerant varieties have been developed for some vegetable crops.

DISTINGUISHING SLW AND GHW



SLW adults hold their wings tent-like over their body, partially exposing the end of their abdomens and tend to be relatively narrow, compared to GHW.



GHW adults hold their wings in a flatter position, almost parallel to the leaf surface, completely covering the end of their abdomen.



SLW pupae are relatively flat and do not have marginal fringe filaments and few hairs projecting from the upper surface (↶9). They tend to be more of an irregular, shield-like, oval shape.



GHW pupae have vertical, perpendicular sides and a fringe of filaments along the margin. They tend to be more oval shaped and have many wax filaments projecting from the top surface.

GREENHOUSE WHITEFLY

Greenhouse whitefly (GHW, *Trialeuroides vaporariorum*) is extremely polyphagous and has a similar host range to SLW. Likewise, host plant suitability varies substantially, affecting the longevity and mortality of individuals in each host plant species. Some plants or varieties are better hosts for GHW than others and this impacts the numbers of eggs laid and the length of time that adults stay on the host. Some plant species have had varietal resistance studied in detail, e.g. on beans, but it is likely that many plant species have varieties that are more or less susceptible to GHW.

Adults of SLW and GHW are similar in appearance but it is important to differentiate infestations of each species as they transmit different viruses, vary in their resistance to chemicals and require different biological control agents. With practice and a good hand lens or microscope, it is easy to distinguish the pupae of SLW and GHW.

ASH WHITEFLY

Ash whitefly (*Siphoninus phillyreae*) is adapted to temperate and Mediterranean climates. It is mainly a pest of southern Australian states but has also been recorded in Queensland. Adults are similar in size and appearance to SLW and GHW but are lightly dusted with white wax. Pupae are light beige, often with two tufts of white wax and distinctive glassy wax droplets on the end of small hair-like structures. It has a moderate host range, preferring deciduous ash, pomegranate, apple and pear. When these hosts drop their leaves, adults move to their winter hosts (e.g. citrus and other non-deciduous trees). Other hosts include crepe myrtle, star magnolia, ash, lilac, hawthorn, and various pome and stone fruit. Damage from ash whitefly is like that from SLW and GHW, but it is not known to transmit viruses. The parasitoid wasp *Encarsia inaron* manages ash whitefly below economic thresholds overseas, but it is not known to be present in Australia.



Adult and immature ash whitefly. Photo by Lyle J. Buss, University of Florida.

SPIRALLING WHITEFLY

Spiralling whitefly (SPW, *Aleurodicus dispersus*) is adapted to tropical regions and is present in Queensland (as far south as Gladstone) and the NT. Its wide host range includes capsicums, citrus, coconut, *Euphorbia* spp., hibiscus, tomato, mango, avocado, *Prunus* spp., egg fruit, and many ornamentals. Females lay eggs in silken spirals, hence their name. Severe infestations are associated with a heavy wax coating on leaves and can cause premature leaf senescence, although most damage is caused by the growth of black sooty mould and reduced photosynthesis. In Australia, the introduced biological control agent *Encarsia dispersa* manages populations of SPW. Insecticide use is not recommended as its long-term use overseas has had limited success and causes substantial mortality to biocontrol agents.



Typical 'spiral' produced by spiralling whitefly.

TABLE 1. COMPARISON OF VARIOUS ASPECTS OF THE BIOLOGY OF THE FOUR MAIN WHITEFLY SPECIES AFFECTING THE NURSERY PRODUCTION INDUSTRY.

BIOLOGICAL PARAMETER	SILVERLEAF WHITEFLY	GREENHOUSE WHITEFLY	ASH WHITEFLY	SPIRALLING WHITEFLY
Main distribution ^a	Qld, NSW, NT	All states & territories except NT	SA, NSW, Vic	NT, Qld
Ideal temperature	25 – 30°C	18 – 23°C	20 – 25°C	25 – 30°C
Important viruses transmitted	<i>Tomato yellow leaf curl virus</i> ; <i>Tomato torrado virus</i>	<i>Beet pseudo-yellows virus</i> ; <i>Tomato torrado virus</i>	Viruses it can vector are not recorded in Australia	Not known to vector viruses
Biocontrol agents	<i>Eretmocerus hayati</i> ; <i>montdorensis</i>	<i>Encarsia formosa</i> ; <i>montdorensis</i>	No specific predator present in Australia ^{b, c}	<i>Encarsia dispersa</i> ^{c, d}

^a Main distribution where climatic conditions favour populations. Isolated populations may exist in other states, perhaps associated with protected cropping.

^b There are no devoted predators for ash whitefly.

^c Montdorensis may provide control for ash and spiralling whitefly, but should be tested in consultation with suppliers.

^d This wasp is not available commercially but has established in northern Australia.



Symptoms of *Tomato yellow leaf curl virus* on tomato, including leaf curling and interveinal chlorosis. Photo by John Thomas (UQ) and Denis Persley (DAF).

WHITEFLY MONITORING

Monitoring for pests enable infestations to be spotted early, i.e. before obvious symptoms and before plants are damaged. Management is therefore easier and less costly. There are a number of methods to monitor for whitefly described below, including visual inspections, plant beating and sticky traps. It is always recommended to monitor incoming stock, new seedlings, and other new planting material to ensure they are free from pests. Once in the nursery, weekly monitoring is recommended, but can be modified depending on host susceptibility, crop situation and value of the crop. For high risk situations or for high value crops, it is recommended to monitor more regularly. Visual inspections are very important for plants that are susceptible to whiteflies because other methods only detect adults, not nymphs.

- 1. Visually inspect** a small percentage of each plant type by hand (generally 1–10% of the crop, depending upon the number of plants and their susceptibility). Using a x10 hand lens, examine both leaf surfaces of plants, prioritise leaves that look stunted or are chlorotic. Eggs and nymphs are generally found on young growth, whereas older nymphs are found on older leaves. Whiteflies can be more challenging to detect on pale yellow/green leaves.
- 2. Indicator plants** are highly susceptible hosts that show obvious damage from whiteflies. They can be placed around your nursery as part of an early warning system. Whiteflies that enter the nursery will be more likely to land and stay on these plants. Squash and melon seedlings are good indicators for SLW as their leaves turn silver with only a small number of individuals.
- 3. Plant beating** can be undertaken alongside visual inspection, but should not be relied on solely because it does not detect nymphs. Move through the crop and gently but firmly hit foliage against a beating tray. This can be a folder, bucket, or plastic plate of a single colour (preferably white or black to make the insects more visible). Beating plants is an efficient way of monitoring insects and mites that can be knocked from plants, including whitefly adults, herbivorous and predatory mites, aphids, thrips, lady beetles, small caterpillars and other organisms. However, adult whitefly may fly off the beating tray quickly, so take note of insects flying from the plant and tray and investigate more closely. Once something is found, a 10–15x hand lens can be used to inspect the catch. If many individuals fly from plants it is an indication that the population is already relatively high. If populations are frequently first discovered from a cloud of whiteflies flying out of infested plants, then your monitoring technique needs improvement.

4. **Yellow sticky traps** are valuable tools for early detection of whitefly adults. Adults are most attracted to young foliage, so traps should be positioned just above the plant tops. Traps should also be placed near doors, vents and any susceptible crops or areas. At least one trap per 100m² is recommended for greenhouse crops, more in varieties known to be susceptible to whiteflies. Inspect sticky traps at least weekly, counting the number of whiteflies and other target pests on a column of the trap and change every 2–4 weeks. While sticky traps are useful monitoring tools. However, if you do not count the number of pests present on a regular basis they become an expense that has no return; they are not mass trapping devices. Refer to the [nursery paper on sticky traps](#) for more information.

It is recommended to record and store your monitoring data electronically. The benefit of electronic data is that it can be searched and sorted to build patterns at your nursery. Long-term patterns can help identify plant variety susceptibility, seasons of the year that have high pest pressure, and perhaps even areas of your nursery that are more prone to pest infestations. In turn, knowledge of high-risk seasons and crops can allow for more targeted search effort (i.e. greater monitoring effort for higher risk lines). It is also recommended to closely monitor plants after insecticide applications or the release of beneficials to evaluate their efficacy.

CULTURAL MANAGEMENT PRACTICES

Whitefly populations can build up quickly and may be difficult to control. Prevention and early action are crucial to minimise economic impact. The management actions can vary depending on the host plant, extent of the infestation, the presence of viruses, other pests or predators in the crop, and environmental conditions. It is crucial to determine which whitefly species is in the crop. Different limits on insecticidal applications are in place for GHW and SLW (as SLW has higher levels of pesticide resistance) and some biocontrol agents are only effective against certain whitefly species. The following strategies can be incorporated into a tailored management plan for your nursery situation. Since many pestiferous whiteflies may develop pesticide resistance, this pest management plan focuses on controlling whiteflies with beneficial insects and cultural controls.

The following cultural management practices can be used to reduce whitefly populations:

1. **Control broadleaf weeds** and reduce other alternative hosts in the production area and nursery surrounds. Weedy species, particularly from the families Euphorbiaceae, Asteraceae and some Malvaceae, can harbour viruses and remain non-symptomatic. Weed matting, plastic and gravel, or short, managed grasses or turf can help exclude broadleaf weeds. Good weed management will also reduce various other pest problems (e.g. aphids, thrips, mites, mealybugs and plant viruses).
2. **Use resistant or tolerant varieties** whenever possible and grow virus-resistant plants in areas and seasons for which the virus is likely to be a problem.
3. **Practice good crop hygiene to avoid contamination between greenhouses or production sites.** Disturbed vegetation causes adult whiteflies to disperse, spreading the infestation to other areas of the nursery. Use signs or flags to mark areas with known infestations so workers can avoid moving through that area.
4. **Use protected cropping structures** to grow high risk crops. Keeping doors closed and having screens over vents can reduce pest pressure in the structure. Ensure sufficient ventilation for the size of the screens present and clean them as required. Very small mesh (that can sometimes be used to eliminate all whiteflies from entering can produce ventilation problems, however, even larger sized screens can reduce pest pressure.
5. **Clean growing areas** after each crop to remove crop debris. Whitefly pupae may be present on fallen leaves that could reinfest subsequent crops.
6. **Do not transport plants from areas with whiteflies** and viruses to areas with healthy plants.
7. **Promptly remove and destroy heavily infested stock.** Retaining unsaleable stock provides a source of further infestation. Leaving unbagged, infested plants or cuttings in the bin encourages pests to reinfest the nursery, particularly as the plant material starts to wilt and die. Infested material should be deep buried or placed in a black bag in the sun for several hours to kill pests. If necessary, apply an insecticide or oil spray to kill adults before moving the crops for destruction.
8. If infestations persist for long periods in a particular area or glasshouse, **grow plants that are not whitefly hosts** for a significant period to break the lifecycle.

BIOLOGICAL CONTROL

There are four commercially available biological control agents for use against whiteflies including two parasitoid wasps, a predatory mite and green lacewings. Many factors can influence the success of predators and parasitoids (e.g. climate, host plant and whitefly species targeted for control). Best practice guidelines for the release of each agent are found on the website of each producer; also refer to the factsheet on managing beneficials in production nurseries. Each species has different strengths and may be best suited to certain situations or pest whiteflies.



Hayati parasitoid wasp. Photo by Paul DeBarro, CSIRO.



Montdorensis predatory mite and whitefly nymphs.



Encarsia formosa adult wasp.

TABLE 2. COMPARISON OF VARIOUS ASPECTS OF THE BIOLOGY OF THE FOUR AVAILABLE BIOLOGICAL CONTROL AGENTS FOR WHITEFLY SPECIES AFFECTING THE NURSERY PRODUCTION INDUSTRY.

COMMON NAME	HAYATI	ENCARSIA	MONTDORENSIS	GREEN LACEWING
Scientific name	<i>Eretmocerus hayati</i>	<i>Encarsia formosa</i>	<i>Typhlodromips montdorensis</i>	<i>Mallada signata</i>
Description	Yellow wasp ~0.5mm	Black head, yellow abdomen, wasp ~0.5mm	Opaque white or yellow teardrop shaped mite <1mm	Larvae have large mandibles and carry trophies on back. Adults are green with transparent wings held tentlike over their back
Diet	SLW only	Mainly GHW, sometimes SLW	Whiteflies (including SLW and GHW), thrips larvae, broad mites, variety of other small insects and mites, pollen and honeydew	Whiteflies, aphids, spider mites, various scales, mealybugs, moth eggs, small caterpillars, pollen and nectar
Supplier	Bugs for Bugs and Biological Services	Biological Services	Bugs for Bugs and Biological Services	Bugs for Bugs

There are other whitefly parasitoids and predators that have not been commercialised, but will colonise a growing area. For example, [SPW is parasitised heavily by Encarsia dispersa](#), a wasp released in the Torres Strait, which colonised north Queensland naturally. Since its arrival, it has spread and often controls SPW in commercial growing situations. Other naturally occurring predators, such as

big-eyed bugs, various species of lacewing larvae and [lady beetles](#), may also help to keep whitefly populations in check. To encourage natural parasitism of whiteflies in your nursery, limit broad spectrum, systemic and highly residual insecticide applications as all these parasitoids are very sensitive to such products.



Larvae of the green lacewing grow to about 8 mm (left). Eggs are laid in clusters (b), each on a thin stalk (right). Photos by Dan Papacek.

CHEMICAL CONTROL AND INSECTICIDE RESISTANCE

While we recommend the release of beneficial insects as the best practice method to manage whiteflies, chemical control may be needed when whitefly numbers are too high for effective biological control. If this occurs, insecticides should be used in a targeted, strategic manner to reduce high-level infestations. A low residual product is recommended so predators and parasitoids can be introduced soon after the insecticide application.

Other situations that may prevent the release of biological control agents include practical constraints, adverse/ extreme climatic conditions, or recent applications of highly

toxic and residual pesticides that would kill beneficial insects. The cost of some biological control agents is very low, making them economically viable even for relatively small batches of plants.

Regardless, if pesticides are required it is recommended to rotated between different mode of action groups (the number in brackets) when populations are relatively low. Rotations can be generated based on products in Table 3 and 4.

TABLE 3. ACTIVE INGREDIENTS AVAILABLE FOR USE AGAINST ALL WHITEFLIES AND SPECIFICALLY AGAINST SLW AND GHW SPLIT ACCORDING TO THEIR IMPACT ON PREDATORS, PARASITIDS AND POLLINATORS (BENEFICIALS).

	ALL WHITEFLIES	SLW	GHW
Relatively low impact on beneficials	Pyriproxyfen (7C)	Pyriproxyfen (7C)	Pyriproxyfen (7C)
	Diafenthiuron (12A)	Pymetrozine (9B)	Pymetrozine (9B)
	Azadirachtin (22A)	Afidopyropen (9D)	Afidopyropen (9D)
	Spirotetramat (23)	Diafenthiuron (12A)	Diafenthiuron (12A)
	Potassium salts of fatty acids	Buprofezin (16)	Buprofezin (16)
	Paraffinic oil	Azadirachtin (22A)	Azadirachtin (22A)
		Spirotetramat (23)	Spirotetramat (23)
Relatively high impact on beneficials		Fonicamid (29)	Botanical oils
	Omethoate (1B)	Bifenthrin (3A)	Dimethoate (1B)
	Pyrethrins (3A)	Acetamiprid (4A)	Bifenthrin (3A)
	Chlorantraniliprole+ thiamethoxam (28+4A)	Imidacloprid (4A)	Acetamiprid (4A)
			Imidacloprid (4A)
		Sulfoxaflor (4C)	

The use of organophosphate (1B products), synthetic pyrethroids (3A products) or neonicotinoids (4A products) is not recommended unless all other options have been unsuccessful. These products can preclude the use of biological controls for a considerable period (Table 4). If in doubt, talk to your biological control agent producer. Furthermore, certain retailers do not accept plants if they have had neonicotinoid products applied to them during production.

As whiteflies are found on the undersides of leaves, take care to ensure thorough coverage. Use a translaminar or systemic product where necessary, e.g. when it is difficult to get thorough coverage of the underside of leaves.

SLW is notorious for developing resistance to overused chemicals. This includes cross-resistance between pyrethroids (3A products), most organophosphates (1B products), carbamates (1A products) and some insect growth regulators. Do not apply insecticides from the same mode of action group (MOA) consecutively or continue to apply insecticides that are ineffective in controlling SLW as this will increase insecticide resistance. Carefully follow label instructions to ensure insecticides are used correctly and for maximum efficacy. If your business is near broad acre cropping that often has SLW infestations you may encounter very high levels of pesticide resistance to basically all commonly used pesticides.

Specific levels of GHW pesticide resistance are not known in Australia. But overseas reports have demonstrated that GHW can develop resistance reasonably rapidly, particularly if the same product is used multiple times without rotating. Limited information is available on insecticide resistance for ash whitefly and spiralling whitefly. However, there are unconfirmed reports of ash whitefly resistance to imidacloprid when injected in established street trees in the southern states of Australia. Refer to the nursery paper for more information on [insecticide resistance management](#).

To assist growers in management decisions, all insecticides which are registered, or that have permits for use in nursery crops (or for use on ornamentals), are summarised in Table 4. The table summarises their effect on beneficial species, the systemicity of the product and list major restrictions for their use. Tables are current as of December 2021. Check the APVMA website for all [registrations](#) and permits. All [nursery minor use permits](#) are also found on the Australian Plant Production Standard website.

ACTION THRESHOLDS

Action thresholds indicated here are somewhat broad, focusing on actions that should be taken when whitefly populations are absent, low, moderate and high. The exact number of whiteflies per leaf which characterises low, moderate, and high is not defined here as each host plant will have differing levels of susceptibility. Furthermore, regional differences and the species of whitefly infesting the crop will also modify threshold levels. Regular monitoring, record keeping and evaluation of the efficacy of each treatment and the amount of damage incurred (if any) under different scenarios will help growers determine what constitutes low, moderate and high. It is recommended to modify the below guidelines as necessary to gain successful management of whiteflies.

The below guidelines assume that you have identified the species of whitefly present. Incorrect identification of the whitefly may cause biological control to fail if you release the wrong species of parasitoid wasp. Also ensure that the environmental conditions are suitable for the species to successfully control whitefly; extreme cool or hot temperatures will preclude the option of releasing biological control agents successfully. If in doubt, talk to your biological control agent producer before ordering a predator or parasitoid.

LEVEL OF INFESTATION	ACTION
Absent	Continue monitoring. If a particular whitefly species consistently attacks plants at the same time each year, release beneficials at preventative rates.
Low	Release at standard rate weekly until 80% of whiteflies are consumed or parasitised (black individuals have been parasitised). If hot spots occur within otherwise low levels of whitefly, add high rates to the hotspot.
Moderate	Release at high rates weekly until 80% of whiteflies are parasitised or consumed. If the plant species is highly susceptible to damage, applying a low-risk insecticide may be warranted before release.
High	Apply a low-risk insecticide to knock down whitefly numbers to a manageable level. Be aware of how long the product will be active against biocontrol agents used in the crop. Release beneficials when safe and numbers of whiteflies are low.

This pest management plan 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 2021. It was originally written in 2013 as part of NY11001.

TABLE 4. PESTICIDES CURRENTLY REGISTERED OR WITH MINOR USE PERMIT IN AUSTRALIA FOR USE AGAINST WHITEFLIES, INCLUDING SLW, GHW AND OTHER SPECIES IN PRODUCTION NURSERIES. RESULTS PRESENTED WERE FROM APVMA PUBCRIS AND PERMIT SEARCHES. NOTES ARE ALSO INCLUDED ON THEIR USE AND TOXICITY TO BENEFICIAL ORGANISMS. ALWAYS CHECK FULL PRODUCT LABELS AND/OR PERMITS TO DETERMINE SUITABILITY OF USE. TO THE BEST OF OUR KNOWLEDGE, THIS INFORMATION IS ACCURATE AS AT DECEMBER 2021.

MODE OF ACTION GROUP	ACTIVE INGREDIENT	EXAMPLE PRODUCT NAME	REGISTRATION INFORMATION	LIMITS ON APPLICATIONS PER SEASON	ACTION ¹	OTHER INFORMATION	TOXICITY TO BENEFICIALS ²
1B	Dimethoate	Dimethoate	Label for ornamentals against GHW; PER86930 for non-food nursery stock against SPW only.	10 per year; none specified on some labels	C, S	Highly toxic to human health.	H – 8 – 12 weeks
1B	Omethoate	Folimat	All whiteflies on flowers, ornamental trees and shrubs	No specified limit	C, S, I	Highly toxic to human health.	H – 8 – 12 weeks
3A	Bifenthrin	Bifenthrin, Talstar	Ornamentals against SLW and GHW	No specified limit	C, I		H – 8 – 12 weeks residual
3A	Garlic, chilli, pyrethrins and piperonyl butoxide	Beat-a-bug Insect spray	Nursery plants and ornamentals against GHW only	No specified limit	C, I	Ensure thorough coverage.	M–H – 2 weeks residual
3A	Pyrethrins+Piperonyl butoxide	PY-Omni, Pyzap, PY-Bo	Ornamental registration against all whitefly species.	No specified limit.	C, I	Ensure thorough coverage	H – 1 – 3 weeks residual
4A	Acetamiprid	Crown	Ornamental registration for SLW and GHW.	No specified limit.	C, I, S, T	Neonicotinoid products. Some retailers do not purchase plants that have had these products applied to them.	H – 8 – 12 weeks residual
4A	Imidacloprid	Confidor	Ornamentals against SLW, not all labels. PER81707 for non-food nursery stock (granular growing media product against SLW and GHW).	May vary with label	C, I, S		H – 2 – 12 weeks residual depending on predator
4C	Sulfoxaflor	Transform	PER85011 for non-food nursery stock against GHW only.	2 per crop	C, I, S	Not to be applied when bees are foraging.	L – H depending on species, probably 1 – 2 weeks residual
7C	Pyriproxyfen	Admiral	Non-food nursery stock against all whiteflies. Also PER81707 .	2 per season	C, T	IGR ³	L – M on adult wasps; H with 4 week residual on wasp pupae; unknown on <i>T. montdorensis</i> .
9B	Pymetrozine	Chess	Non-food nursery stock against SLW and GHW only and all whiteflies in PER81707	Non-listed	C, S	IGR ³	L – 1 week residual
9D	Afidopyropen	Versys	Non-food nursery stock against SLW and GHW	4 per crop	C, T		L – H depending on beneficial. Probably 1 week residual.
12A	Diafenthiuron	Pegasus	PER81707 for non-food nursery stock against all whiteflies	2 per annual production cycle	C, I, T		Unknown, probably L – M, with 1 – 3 week residual
16	Buprofezin	Applaud	PER81707 for non-food nursery stock against SLW and GHW.	2 per annual production cycle	C, T, V	IGR ³ – apply when nymph stages are prevalent above threshold levels, particularly crawlers. Not very active against adults.	L – 0 – 1 week residual

MODE OF ACTION GROUP	ACTIVE INGREDIENT	EXAMPLE PRODUCT NAME	REGISTRATION INFORMATION	LIMITS ON APPLICATIONS PER SEASON	ACTION ¹	OTHER INFORMATION	TOXICITY TO BENEFICIALS ²
22A	Azadirachtin	Azamax, Eco-neem	All whitefly species on ornamental plants.		C, I, S	Complex mode of action , antifeedant and IGR activity. It is systemic through the roots.	L – M – 1 week residual
23	Spirotetramat	Movento	PER81707 for non-food nursery stock against all whiteflies	3 per crop per year	C, S	IGR ³	L – M depending on species, <1 week residual
28+4A	Chlorantraniliprole + thiamethoxam	Durivo	PER81707 for non-food nursery stock against all whiteflies	1 soil application per crop cycle	C, S		H – 1 – 12 weeks depending on the species
29	Fonicamid	Flonicamid	PER83964 for non-food nursery stock against SLW.	3 per year	C, S, T		L – no residual
NA	Clitoria ternatea extract	Sero-X	PER87445 for non-food nursery stock against SLW only.	5 per year	C	Requires very good coverage	Unknown
NA	Botanical oil	Eco-oil	Cut flower, vegetables and ornamental crops against GHW only.	3 per crop, none specified on some labels	C		L – M – No residual
NA	Potassium salts of fatty acids	Bugguard, Natrasoap	Registered against all whitefly species vegetables, fruit trees, pot plants and ornamentals.	No specified limit.	C	Complete coverage is necessary on both leaf surfaces, apply morning or evening when temperatures are cooler, addition of a petroleum oil may assist control. Use lower rates when using IPM. Not suitable for delicate ferns, mosses, flowers and plants under stress.	L – no residual against <i>T. montdorensis</i> , L – H – 1 week residual for wasps, depending on species.
NA	Paraffinic oil	isoClear SACOA BioPest	Various ornamentals and trees against all immature whitefly species. State registration varies with host plant and label.		C	Test a small number of plants for phytotoxicity before spraying over a widespread area.	L – M – No residual
NA	<i>Beauveria bassiana</i> PPRI539	Broadband OD	Protected vegetables and ornamentals against SLW and GHW	No limit specified	C	This is a fungal biopesticide. Fungicides may reduce efficacy of this product. Generally requires 3 consecutive weekly applications. Best only used at relatively low pest pressure.	Unknown

¹ Action: C = contact; S = systemic; I = ingestion; T = translaminar; V = vapour

² In the context of the table, beneficials refers to *E. formosa*, *Eretmocerus spp.* and *T. montdorensis*. Summarised primarily from *The Good Bug Book*, [Koppert](#), and [Biobest](#).

³ Immature Growth Regulator (IGR). These products control juvenile stages only. Apply when nymphal whiteflies are present above economic threshold. These products will have limited, if any, effect against adults.