

Managing Whitefly & Scale Insects



Admiral[®]

Insect Growth Regulator

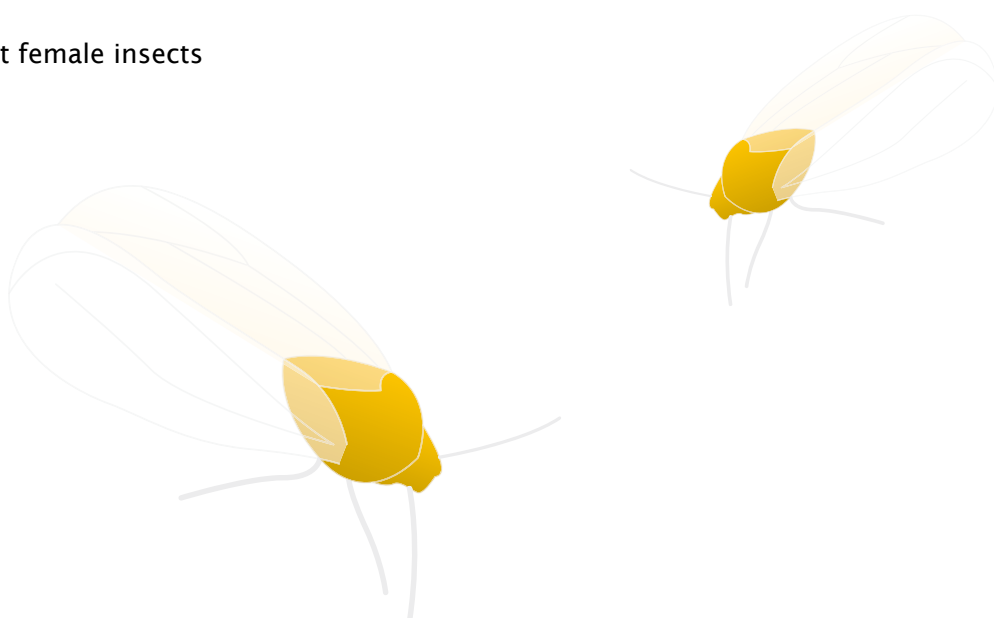
M ANAGEMENT OF WHITEFLY & SCALE INSECTS

Unlike those insect pests where a single or well-defined life stage (e.g. larva or beetle) cause damage that can be controlled by a single insecticide spray, whiteflies and scale insects are more problematic because of generational overlaps and multiple life stages present. Armoured and waxy scales, in particular, are difficult to control because their scales protect their offspring by shielding them against penetrating insecticides. Containment of these pests should be viewed as pest management, rather than control in the traditional sense.

ADMIRAL® is a novel insecticide product with attributes that are well-suited to managing whitefly and scale populations. It is not a conventional insecticide but an Insect growth regulator (IGR) that interferes with the reproduction and normal development of hemi-metabolous insects. The active ingredient in ADMIRAL is Pyriproxyfen which is a juvenile hormone mimic. Juvenile hormone (JH) is secreted naturally in the early larval stages of insects and is responsible for maintaining larval characteristics. As the level of JH in the insect decrease and disappear over time, the insect progresses on to later instars and ultimately pupates and emerges as an adult insect. JH is also involved in the reproductive process by controlling the development of insect ovaries.

ADMIRAL contributes to the reduction in pest numbers by:

- Artificially increasing the JH levels in insects – preventing progression of the insect from the larval to the adult stage
- Causing inhibition of insect egg-hatch
- Inhibition of insect metamorphosis
- Sterilising adult female insects





THE IMPORTANCE OF TIMING

Given its very specific mode of action it is logical that application of ADMIRAL should be timed to coincide with peaks in juvenile or immature insect activity. These vary from insect to insect, but include egg-hatch, release of crawlers and early larval stages. Best results in terms of pest reduction will be obtained when ADMIRAL is applied to a population consisting mostly of susceptible juveniles.

On the other hand, the result from ADMIRAL will be delayed when applied to a pest population consisting mainly of adult females. In the latter instance, the effect of ADMIRAL will only become evident in the next generation. To maximise the effect of this management tool, ADMIRAL users should familiarise themselves with the life-cycle of the pest they wish to control.

Due to its mode of action, ADMIRAL should be regarded as a population disruptor – not a knockdown insecticide. It is slow acting, with no apparent activity for 14 days after application. If used correctly though, it's effect is dramatic and long lasting.

ACTIVITY POINTS IN A TYPICAL WHITEFLY LIFE CYCLE



FEATURES & BENEFITS OF ADMIRAL

| Feature | Benefit |
|--|--|
| Multiple points of activity in the insect life cycle | Reduces pest numbers by preventing egg hatch and/or establishment of large adult colonies |
| Narrow activity spectrum and IPM compatible | Highly effective against susceptible pests, but with nominal impact on beneficial and non-target species |
| Translaminar movement through the leaf | Controls pests on both sides of the leaf where good coverage is not always possible |
| Long residual control | Controls late-emerging crawlers |
| Non-toxic to bees | No effect on pollination or fruit set |
| Compatible with oils in certain crops | Ideal for use with mineral oils in non-bearing situations |
| Short withholding intervals in most crops | Can be used close to harvest to improve presentation and appearance |
| No cross resistance with other insecticides* | Suitable for use in insect resistance management strategies |
| Low toxicity and low environmental impact | Favourable worker safety and environment profile |

* With the exception of silverleaf whitefly (*Bemisia tabaci* Biotype B) in the Bowen area of north Queensland. Ongoing monitoring indicates that pest populations in this location are becoming increasingly resistant to products from multiple insecticide groups including ADMIRAL. Strict adherence to suggested resistance management strategies is advised.

MANAGEMENT OF WHITEFLY POPULATIONS

ADMIRAL is registered for the control of Silverleaf Whitefly *Bemisia tabaci* Biotype B in cotton, rockmelon, capsicum and tomatoes, and for the control of greenhouse whitefly in tomatoes as per Directions of Use below. Please refer to the registered label for full details.

| CROP | INSECT | RATE | CRITICAL COMMENTS |
|--|--|-----------|---|
| Cotton | Silverleaf whitefly (<i>Bemisia tabaci</i> Biotype B) | 500 mL/ha | Ensure thorough coverage (See APPLICATION). Apply when industry recommended thresholds of silverleaf whitefly (SLW) are exceeded. If a second spray is required, a minimum re-treatment interval of two weeks must be observed. DO NOT apply more than twice in any one season. Apply as per current Cotton Industry Insecticide Resistance Management Strategy. |
| Rockmelon, Tomato, Capsicum (field and greenhouse) | Silverleaf whitefly (<i>Bemisia tabaci</i> Biotype B) Greenhouse whitefly (<i>Trialeurodes vaporariorum</i>) | | Ensure thorough coverage (See APPLICATION). Apply in 100 - 150 L water per hectare. Use high water volume 500 - 1000 L/ha for dense crops. If applying more than 1000 L/ha use a rate of 50 mL/100 L water. Apply at first appearance of whitefly. If a second spray is required, a minimum re-treatment interval of two weeks must be observed. DO NOT apply more than twice in any one season. To avoid the resistance build-up, the product must be rotated with other approved products. Apply in accordance with the SLW Resistance Management Strategy. |

Silverleaf whitefly (SLW) in cotton

There are two ways in which SLW can cause damage to cotton

- Large numbers of whiteflies from multiple overlapping generations cause retardation of growth through feeding
- Feeding results in secretion of large quantities of honeydew that affects photosynthesis and causes problems with fibre processing



(Fig.1)

WHITEFLIES & INSECTICIDE RESISTANCE

Development of resistance against ADMIRAL and other effective insecticides is the key threat to successful management of whiteflies. Whiteflies have short and overlapping generations, and are notorious for developing resistance to insecticides quickly. The numbers in which they occur, particularly in greenhouses, contributes to selection for resistant individuals. Strict adherence to industry resistance management guidelines and the recommendations in this brochure is advised to delay the development of resistance.

- A reduction in efficacy of ADMIRAL and other insecticides against SLW has already been documented from Queensland and Northern NSW. DO NOT deviate from resistance management guidelines in these areas.
- DO NOT use ADMIRAL more than twice in any one season, and allow at least two weeks between applications.
- Alternate ADMIRAL sprays with chemicals from a different chemical group (e.g. Chess®, Confidor®, Talstar®). Applaud®, also an IGR product, is in the same resistance management group as ADMIRAL and should never be used immediately before or after ADMIRAL in the rotation.
- Best results will be obtained when whitefly numbers are low. Adhere to industry thresholds or apply at first appearance of the pest.
- Where possible, use petroleum oils and not insecticides to control low populations.

In addition, the following cultural practices are recommended to delay the development of resistance.

- Promote the establishment of parasitic wasps and other beneficial insects early in the crop cycle, if applicable.
- Implement seasonal production breaks by not cropping for a period of time, or planting crops to which whiteflies are not attracted.
- Clean up whitefly-infested crops and remove alternate host plants or weeds.



SLW and Greenhouse whitefly in tomatoes and other crops

- Symptoms include wilting and stunting of young and susceptible shoots, discoloration of leaves, uneven ripening of the crop and even death of the plant. Honeydew and the associated sooty mould impairs growth, affect photosynthesis and blackens the fruit
- SLW has been documented to transmit Tomato Yellow Leaf Curl Virus

(Fig.2)

MANAGEMENT OF RED SCALE & BLACK SCALE IN CITRUS

ADMIRAL is registered for the control of Red Scale and Black Scale in Citrus, as per Directions of Use below. Please refer to the registered label for full details.

| CROP | INSECT | RATE | CRITICAL COMMENTS |
|--------|---|-------------------|--|
| Citrus | Red scale (<i>Aonidiella aurantii</i>) | 50 mL/100 L water | Ensure thorough coverage (See APPLICATION). |
| | Black scale (<i>Saissetia oleae</i>) | | <p>Red scale: Apply at the time of crawler release. There are usually multiple periods of crawler release from spring through to autumn. Ideally ADMIRAL should be applied to control the first generation but if the infestation persists and there is significant crawler release later in the season then ADMIRAL can be applied again. DO NOT apply more than twice in any one season on tree crops.</p> <p>Black scale: Apply at the time of crawler release which is usually December to January but also may occur in autumn. DO NOT apply more than twice in any one season.</p> |

Red scale (a.k.a. California Red Scale) is the most important scale pest of citrus in Australia. The severity of red scale infestation varies on different citrus cultivars, of which lemons, grapefruit, navels, Valencia oranges and mandarins are all susceptible, in descending order.

Armoured scales do not produce honeydew but their feeding can blemish fruit, cause leaf drop and, by injecting toxins, damage plant tissue. The most characteristic damage they cause is downgrading of fruit due to pitting, green spotting or the physical presence of scale on mature fruit.

Parasitic wasps, particularly *Aphytis* and *Comperiella* spp., are important natural enemies of Red Scale.



(Fig.3)

IMPORTANT CONSIDERATIONS WHEN USING ADMIRAL IN CITRUS

- Timing is critical. Apply at crawler release (or ideally just prior to), which may occur at different times for different scale pests. Ideally ADMIRAL should be applied to control the first generation of crawlers but if infestation persists and there is significant crawler release later in the season, then ADMIRAL can be applied again.
- DO NOT apply more than two ADMIRAL sprays per season.
- Good coverage is essential because effective control is dependent on scale crawlers coming into contact with spray residues wherever they move or settle on the tree – apply in sufficient water to ensure thorough coverage. For young trees this will be approximately 1000 L/ha. DO NOT apply less than 1000 L/ha on bearing trees.
- It is highly desirable to use ADMIRAL in conjunction with good ant control, which tend and protect the scale from predators and parasitoids.
- For more information on the effect of ADMIRAL on beneficial insects, refer to the section on Integrated Pest Management at the back of this brochure.



(Fig.4)

Black scale is one of the soft scales. It is a pest of sporadic importance in Victoria and NSW, and also occurs in QLD and Western Australia. Feeding by black scale affects tree vigor and can cause leaf and/or fruit drop. Excreted honeydew also supports the growth of sooty mould causing superficial blemishes on fruit.

In the southern citrus-producing regions hatching of eggs and subsequent crawler movement occurs from December to January and again in autumn.

For all citrus varieties except mandarins, the recommended spray threshold for black scale is when 10% or more of green twigs are infested with one or more scales. The threshold for mandarins is 5%.

M ANAGEMENT OF MANGO SCALE & PINK WAX SCALE ON MANGOES

ADMIRAL is registered for the control of Mango scale and Pink Wax scale in Mangoes, as per Directions of Use below. Please refer to the registered label for full details.

| CROP | INSECT | RATE | CRITICAL COMMENTS |
|-------|--|-------------------|--|
| Mango | Mango scale (<i>Aulacaspis tubercularis</i>) Pink wax scale (<i>Ceroplastes rubens</i>) | 50 mL/100 L water | Ensure thorough coverage (See APPLICATION). Mango scale: Apply at the time of crawler release. There are usually multiple periods of crawler release from spring through to autumn. Ideally ADMIRAL should be applied to control the first generation but if the infestation persists and there is significant crawler release later in the season then ADMIRAL can be applied again. DO NOT apply more than twice in any one season. Pink wax scale: Apply at the time of crawler release in early spring to early summer. There are usually two periods of crawler release in Queensland, with crawlers of the second generation emerging in mid summer to mid autumn. Ideally ADMIRAL should be applied to control the first generation but if the infestation persists and there is significant second generation crawler release then ADMIRAL can be applied again. DO NOT apply more than twice in any one season. |

Mango scale is a pest because its presence can result in downgrading of fruit. Feeding by mango scale causes a conspicuous pink blemish on fruits, and when they occur in large numbers mango scale can retard growth of young trees in the nursery and field.

There is a low tolerance for blemished fruit in the Australian and export markets and even low levels of infestation can lead to downgrading of produce.



(Fig.5)

IMPORTANT CONSIDERATIONS WHEN USING ADMIRAL IN MANGOES

- In North Queensland, Mango scale breeds continuously throughout the year and multiple, overlapping generations can occur on the tree at any one time. As such there is no specific identifiable application timing recommendation for ADMIRAL other than to aim for the first generation in spring. A second application may be required later in the season if the infestation remains significant.
- Ideally, ADMIRAL should be applied to control the first generation of crawlers of the season, at the time of crawler release. If necessary a second application can be made later in the season, but never apply more than two applications of ADMIRAL in one season.
- Do not apply in less than 1000 L water per ha for bearing trees.
- For more information on the effect of ADMIRAL on beneficial insects, refer to the section on Integrated Pest Management at the back of this brochure.



(Fig.6)

Pink wax scale can cover shoots, fruit stalks, and parts of the fruit. Adult scales are pink to light brown in colour and almost globular in shape. Both adults and nymphs feed by sucking sap from the tree, with adverse effect on tree vigor and fruit size.

Being a soft scale, this pest secretes honeydew which becomes the food source for sooty mould. The presence of sooty mould on the leaves affects photosynthesis and may cause fruit quality to be downgraded.

In tropical North Queensland, first generations crawlers emerge in August to September. Crawlers from the subsequent generation emerge in February, approximately at the same timing as the summer growth flush.

MANAGEMENT OF BLACK SCALE IN OLIVES

ADMIRAL is registered for the control of Black scale in Olives, as per Directions of Use below. Please refer to the registered label for full details.

| CROP | INSECT | RATE | CRITICAL COMMENTS |
|--------|---|-------------------|---|
| Olives | Black scale (<i>Saissetia oleae</i>) | 50 mL/100 L water | Ensure thorough coverage (See APPLICATION). Black scale: Apply at the time of crawler release which is usually December to January but also may occur in autumn. DO NOT apply more than twice in any one season. |

Black scale has one or two generations per year. Adult females can be up to 5mm in diameter and are hemispherical in shape. They congregate on the twigs and leaves of olive trees. Crawlers are typically wind dispersed, resulting in this pest occurring in all areas where olives are grown.

As the scale feeds, they excrete honeydew on which sooty mould forms. These black areas can cover the leaves of an entire tree, impairing photosynthesis and affecting growth. Severe infection can lead to leaf drop, dieback of twigs and branches and even death of the tree.

The presence of scales and honeydew attracts ants, which in turn disrupt the activities of parasitoid wasps and predatory insects such as lady beetles and lacewings.



(Fig.7)



(Fig.8)

IMPORTANT CONSIDERATIONS WHEN USING ADMIRAL IN OLIVES

- ADMIRAL should be targeted at egg, crawler and early nymphal stages to eliminate the next generation.
- ADMIRAL is not an adulticide and won't visually reduce the number of adult scales on the tree. It will, however, sterilise adult female scales with significant effect on the following generation. This product is population management tool, not a conventional control treatment.

APPLICATION

- Do not apply if rain is forecast within 6 hours. For optimal translocational effect, ADMIRAL should be allowed to penetrate the leaves.
- Good coverage is essential because effective control is dependent on scale crawlers coming into contact with spray residues wherever they move or settle on the tree – apply in sufficient water to ensure thorough coverage. For young trees this will be approximately 1000 L/ha. DO NOT apply less than 1000 L/ha on bearing trees.
- In certain situations ADMIRAL can be mixed with oils. However, caution is advised when applying such mixtures to bearing mango and citrus trees because the addition of oil to ADMIRAL may have a detrimental effect on fruit colour. To minimise this possibility, restrict application to healthy, well-irrigated orchards only and do not spray if the temperature is above 30°C.



I INTEGRATED PEST MANAGEMENT

ADMIRAL has not been tested against all beneficial insects in all crops in Australia. However, from the global summary overleaf potential ADMIRAL users should be able to ascertain the likely effect of ADMIRAL on beneficial species.

It is worth noting that predator and parasite impact studies are often conducted under controlled conditions in the laboratory, presenting a worst case situation. In practice however, adverse effects (if any) are often not as pronounced due to factors like insect migration, unsprayed refuges within the crop, new or untreated growth and the presence of multiple life stages – all contributing to dilute the effect a product may have on beneficial populations.

Growers should also make a distinction between those predators or parasites which are released (e.g. *Aphytis* wasps in citrus), and those which occur naturally. Needless to say, products which have the potential to affect introduced species should not be used or should be applied at a time when their impact will be smallest. With regard to naturally occurring species, the benefit from the use of ADMIRAL should be weighed against the benefit from the beneficial insect – in relative comparison with older, broad spectrum insecticides.



(Fig.9)



(Fig.10)

SUMMARY

| BENEFICIAL SPECIES | USEFULNESS | EFFECT OF PYRIPROXYFEN | STATUS |
|--|---|--|---|
| Predatory bugs | | | |
| e.g. <i>Orius</i> and <i>Anthocoris</i> spp. Damsel bugs <i>Nabis kingbergii</i> and Big-eyed bug <i>Geocris</i> spp. Predatory shield bug <i>Oechalia</i> spp. | Predators of thrips, psylla and other pests | Little or no impact. In laboratory and green house studies, pyriproxyfen had no significant effect on fecundity, egg hatch or metamorphosis. Treatment with ADMIRAL had no effect on numbers. | Safe. Potential impact is nominal. |
| Parasitic wasps | | | |
| e.g. <i>Aphytis holoxanthus</i> , <i>Eretmocerus</i> spp., <i>Encarsia</i> spp., <i>Trichogramma</i> spp. | Scale and whitefly parasitoids | No effect on adult emergence or fecundity at field rates. | Safe. Potential impact is nominal. |
| Lady beetles | | | |
| e.g. <i>Coccinella septempunctata</i> , <i>Cryptolaemus montrouzierri</i> , <i>Chilocorus</i> spp. | Predatory Coccinellid beetles | In the controlled environment of laboratory and greenhouse studies, pyriproxyfen was shown to affect most life stages, although the effect on adult beetles was negligible. The effects observed resulted from exposure to treated foliage and/or ingestion of treated scales. The effects were inconsistent and varied between species. However, in three out of four Australian field studies, pyriproxyfen had no effect on lady beetle populations. This probably relates to the presence of new foliage and adjacent crops which serves to dilute the effect of pyriproxyfen in a less controlled environment. | Potentially harmful at field rates. A waiting period of 45 days is advised between application of ADMIRAL and commercial release of lady beetles. |
| Pollinators | | | |
| Honeybees and bumble bees | | No effect on the emergence rate of broods or development of colonies in honeybees. However, bumble bees appear to be more sensitive, with higher mortality than the untreated recorded after consumption of pyriproxyfen-treated sugar solution. | Safe against honey bees. It is advisable to delay application to a time of day when bumble bees are not actively foraging. |
| Lacewings | | | |
| e.g. <i>Chrysopa carnea</i> | Common predator of aphids | Some effect on emergence if exposed at the pupal stage. Predatory activity of larvae was not affected. | ADMIRAL may reduce the population size but will not affect predatory activity. |
| Predatory mites | | | |
| e.g. <i>Phytoseiulus persimilis</i> | Predator of mites | No reduction in population density observed after treatment with pyriproxyfen. | No effect. |
| Various other beneficial species | | | |
| Brachonid wasp, Green hoverfly, Tachinid flies, praying mantis and spiders | Common predators | Little to no effect observed in Australian field studies. | Safe. Potential impact is nominal. |



(Fig.11)

Admiral®



(Fig.12)



(Fig.13)



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