



Managing Silverleaf Whitefly in Australian cotton

Introduction

Silverleaf Whitefly (*Bemisia tabaci* B-Biotype) is a major pest in cotton. It has the ability to contaminate cotton lint with honeydew, has a large host range, can rapidly reproduce and can develop resistance to many insecticides.

Silverleaf Whitefly (SLW) feed on the phloem vessels that transport the sugar rich products of photosynthesis around the plant. During digestion, a proportion of plant sugars (sucrose, glucose, fructose) are altered into new sugars e.g. trehalulose and melezitose, resulting in a combination of sugars passed out of the SLW in the form of honeydew.

Compared with aphid honeydew, which is evident as thick, wet, sticky honeydew coating leaves and bolls, SLW honeydew often dries to an almost lacquer-like consistency and though visible on the leaves and bolls, may be dry to touch. This is deceptive – the main sugar, trehalulose, has a low melting point and is hydroscopic (attracts moisture).

In the spinning mills, visually “clean” cotton can cause problems as heat generated through friction causes the trehalulose to melt. It then attracts moisture and sticks to machinery, eventually necessitating shut-down for cleaning. Consequently, cotton producing regions that develop a reputation for supplying honeydew contaminated lint risk incurring significant discounts. It is important that the Australian cotton industry upholds best management of SLW to maintain its reputation for



Control decisions should focus on avoiding lint contamination.

producing uncontaminated, high quality cotton.

Greenhouse whitefly (*Trialeurodes vaporariorum*) and Australian Native Whitefly (*Bemisia tabaci*) are present in cotton but not considered pests as they rarely build to significant populations and are easily controlled, often by insecticides targeted against other pests. As a consequence, SLW tends to dominate in sprayed cotton crops.

Management of SLW requires a year round Integrated Pest Management (IPM) approach as SLW numbers can rapidly increase, especially if natural enemies are reduced by insecticides and hot seasonal conditions favour fast SLW development.

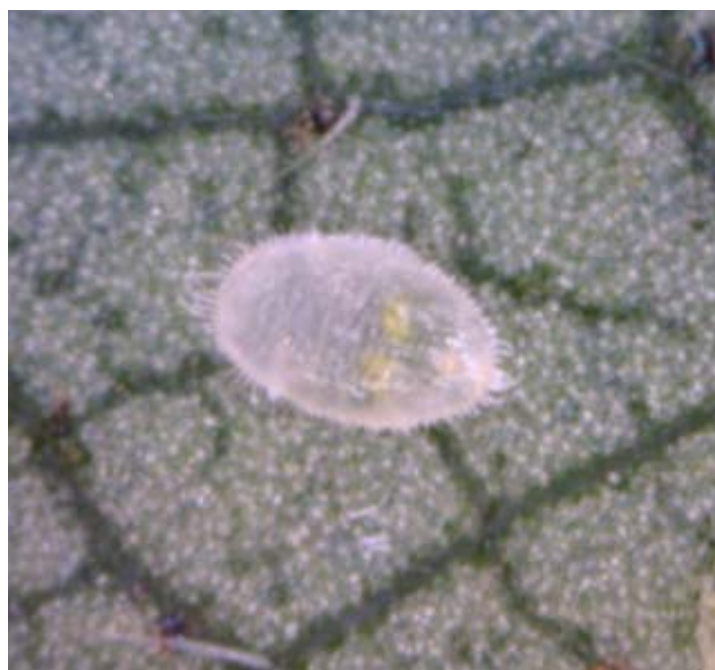
This booklet provides recommendations for effective monitoring and best management of SLW in Australian cotton.

Identification

Whitefly are tiny sap sucking insects related to aphids, mealybugs, leafhoppers and scales. They belong to the family of insects called Aleyrodidae. The adults have two pairs of wings which are coated in white powdery wax and fly readily when disturbed – hence the name whitefly. They use a fine stylet to puncture the leaf surface and locate and penetrate phloem vessels which carry sugar rich sap. SLW must

consume a lot of phloem sap to obtain enough amino acids and other nutrients for their growth. This means they also consume a lot of sugar which is secreted as honeydew and can contaminate leaves and bolls.

Correctly identifying which whitefly species are present is very important before implementing any management strategies.



(ZARA HALL, QLD DAF)

Note absence of hairs on *Bemisia tabaci* nymph (left) compared to presence on *Trialeurodes vaporariorum* (right).



(RICHARD LLOYD, QLD DAF)

Note the gap between the wings for *Bemisia tabaci* (left) compared with overlapping wings for *Trialeurodes vaporariorum* (right).

Two species of whitefly are found in Australian cotton fields:

- *Bemisia tabaci* – this species has two biotypes
 - (i) the Silverleaf Whitefly (SLW) or B-biotype (also referred to as Middle East-Asia Minor 1 (MEAM1)). This biotype is a significant pest of cotton.
 - (ii) the Eastern Australian Native Whitefly (known as EAN or AUS1). This biotype is not a problem.
- *Trialeurodes vaporariorum* – commonly known as Greenhouse whitefly. This species is only very occasionally a problem.

Characteristics

Bemisia tabaci

The B-biotype and EAN are identical and cannot be distinguished using morphological features. Biochemical tests such as an esterase or PCR are needed to identify the biotype. Adults are small 0.8 to 1.2 mm long, have white wings and yellow bodies. Adults hold their white powdery wings at an angle more like the pitched roof of a house. However, the wings do not meet at the peak, so when viewed from above the body can be seen between the wings. Nymphs are pale yellow-green and flat scale-like insects that attach to the underside of the leaves of their host plant (see photographs on pg 2).

Greenhouse whitefly

Greenhouse whitefly is about twice the size of *Bemisia tabaci*. Greenhouse whitefly hold their wings flat and slightly overlapping, so they have a slight heart shape when viewed from above. This is a key visual difference between greenhouse whitefly and the two *Bemisia tabaci* biotypes (SLW and EAN). Nymphs are similar to *B. tabaci* but are covered in fine hairs (see photographs on pg 2).

What species have I got?

There will normally be a mix of whitefly species present in a cotton field. Species composition within a field may change rapidly during the season due to factors such as insecticide applications, proximity of

SLW will usually dominate sprayed fields as the other species are controlled by insecticides used against other pests.

other host plants and climate. As described above it is straightforward to distinguish between green house whitefly and the two *Bemisia tabaci* biotypes (EAN and B-Biotype) using morphological features. If Greenhouse whitefly are identified early in the season, continue to monitor for the arrival of *Bemisia tabaci*.

Unfortunately it is not possible to distinguish between the two *Bemisia tabaci* biotypes without a biochemical test. However, in sprayed fields SLW will usually dominate as both greenhouse and EAN are usually controlled by insecticides used against other pests. Further, if whitefly numbers build quickly it is most likely to be B-biotype as the EAN has a much slower growth rate.

Formal verification of the species

If identification of species is proving difficult, sampled leaves can be placed in a paper bag and then inside a plastic bag. Pack this in an esky with an ice brick that has been wrapped in newspaper. Ensure samples are clearly labelled including: collector's name and contact details, farm & field, region, date of collection as well as any other relevant information (such as insecticide usage) as the sample will also be used for resistance monitoring.

Send by overnight courier to; Jamie Hopkinson, Qld DAF, 203 Tor Street, Toowoomba QLD 4350. Phone (07) 4688 1315

SLW Lifecycle and Ecology

In warm weather the SLW life cycle takes 18 to 28 days, but is much longer in winter. From Biloela north, the winter generation time is about 80 days, while in the Macintyre, Gwydir and Namoi valleys, generation time increases to about 120 days. The diagram represents a lifecycle at an average temperature of 28°C.

Eggs

Very small spindle shaped eggs are laid on the underside of leaves. These are very hard to see by eye. SLW eggs sit on a stalk that fits into a small slit in the leaf made by the female. Eggs hatch in 7-10 days (in warmer weather).

Nymphs

The 1st instar ('crawler stage') is the only mobile nymphal stage. They will move a small distance over several hours to find a suitable feeding site. Once the crawlers settle they don't move again. Instars 2 to 4, have non-functional legs, so they continue to feed in the same spot without moving. The late 4th instar stops feeding and becomes a pupa (or 'red eye') out of which emerges an adult. A pupa from which an adult SLW emerges successfully will have a 'T' shaped split in the back, while a pupa from which a parasite emerges will have a small circular hole.

Adults

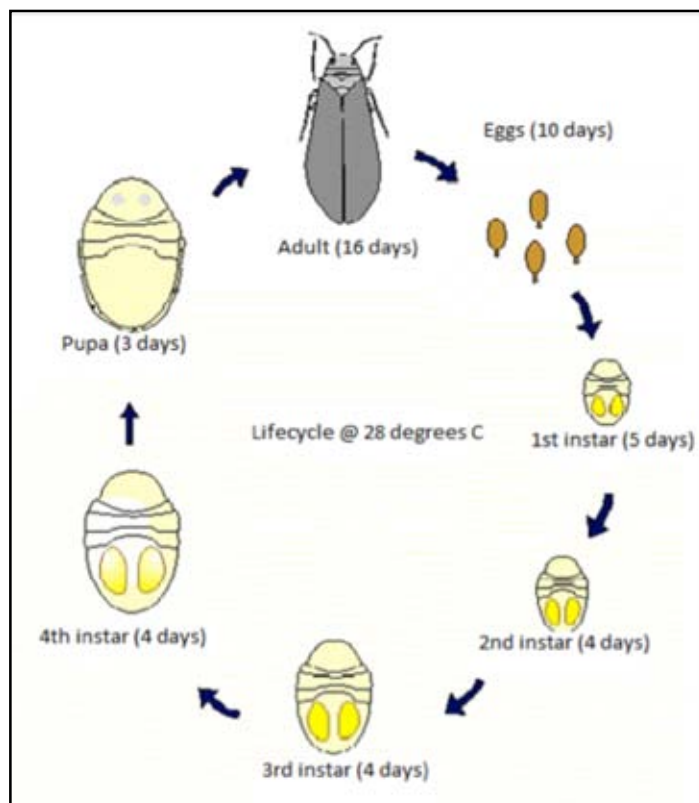
Adult females are produced from fertilised eggs and males from unfertilised eggs. In warm conditions, mating can take place within a few hours of emergence from the 'red eye' pupal stage. Consequently, most SLW females are mated, resulting in a sex ratio biased toward females. Each female whitefly can lay up to 300 eggs over about a two week life span. Like the nymphs, adults feed on sap from the phloem tissue. Adults are capable of flying for 2 or more hours and may be carried long distances by wind, but they usually only make short flights from plant to plant and to adjoining fields.

Honeydew production

Honeydew production varies with the different life stages. In general, the adult female will produce the most honeydew and nymphs will produce more honeydew when feeding on a poor quality host as they need to consume more phloem sap to maintain their nutrition levels.

Host range

SLW does not have an overwintering diapause stage. It relies on alternative host plants to survive.



Therefore the availability of a continuous source of hosts is the major contributing factor to a severe SLW problem. Even a small area of a favored host can maintain a significant pest population.

Preferred **weed hosts** include; sow thistle, melons, bladder ketmia, turnip weed, native rosella, burr medic, anoda, rhynchosia, vines (cow, bell and potato), rattlepod, native jute, burr gerkin, blackberry nightshade, other Cucurbitaceae weeds, Josephine burr, young volunteer sunflowers, Euphorbia weeds, poinsettia and volunteer cotton. In winter and spring sowthistle is a key host.

In cotton growing areas the important alternative **crop hosts** are soybeans, sunflowers and all cucurbit crops. Spring plantings of these crops may provide a haven for SLW populations to build up in and then move into cotton. Conversely, autumn plantings of these crops may be affected by large populations moving out of cotton.

Natural enemies

Several species of whitefly parasitoids and parasites

have been observed in Australia including several species of *Encarsia* and *Eretmocerus*. These beneficials are sometimes overlooked because they are very small and secretive. Whitefly nymphs parasitised by *Encarsia* turn dark brown or black, whereas whitefly parasitised by *Eretmocerus* turn yellow/brown with red to green eyes visible within the whitefly shell just prior to emergence. Whitefly nymphs have two yellowish structures inside them that are visible. These are called mycetosomes.

Non-parasitised whitefly nymphs have mycetosomes

which are symmetrically aligned whereas mycetosomes in a parasitised whitefly nymph are displaced and often appear as a yellow squiggle. See table below.

A wide range of predatory insects and spiders are also very important in helping to prevent SLW populations from increasing quickly. These predators include; big-eyed bugs, minute pirate bugs, lacewing larvae, ladybeetles, brown smudge bugs and apple dimpling bugs. Pest thrips species have also been found to attack SLW eggs and nymphs.

Healthy SLW <small>Photos Qld DAFF</small>						
	Healthy mycetosomes	Red eye nymph	Wing bud development	Adult silverleaf whitefly	Empty nymph case (white)	
	Parasitised SLW <small>Photos Qld DAFF</small>					
		Displaced mycetosomes (asymmetrical)	Red faecal waste (top) & parasitoid larva (bottom)	Parasitoid pupae and adults: <i>Eretmocerus</i> sp (top) & <i>Encarsia</i> sp (bottom)		
		SLW Predators				
Big-eyed bug Photo M.Dillon	Minute pirate bug Photo L.Wilson, CSIRO	Lacewing larva Photo: J Wessels	3 Banded ladybird Photo: D McClenaghan			

Managing SLW

Sampling SLW

Good sampling is the key to successful management of any pest. SLW populations will naturally fluctuate so it is essential to conduct frequent population monitoring. Sampling should commence at flowering and occur twice weekly from peak flowering (1300 Day Degrees). Once bolls begin to open, monitoring for the presence of honeydew 'sheen' on lower leaves is also informative. Once lower leaves appear to have a 'honeydew sheen' then generally corrective action needs to be implemented.

Below are some important sampling considerations.

1. Time of sampling

During the heat of the day, whitefly tend to shelter lower in the crop canopy. Aim to sample fields at a similar time each morning before it gets too hot.

2. Define your management unit

A management unit can be a whole field or part of a field – no larger than 25 ha. Each management unit should have a minimum of 2 sampling sites. Sample 10 leaves/site (20 leaves/management unit). For example a 50ha field should have 40 leaves sampled from 4 sampling sites (2 management units).

3. Choose a plant to sample

Move at least 10 m into the field before choosing a plant to sample. Choose healthy plants at random, avoiding plants that have already been disturbed by other types of sampling. Take only one leaf from each plant. Sample along a diagonal or zigzag line. Move over several rows, taking 5–10 steps before selecting a new plant.

4. Choose a leaf

From each plant choose a mainstem leaf from either the 3rd, 4th or preferably the 5th node below the terminal of the plant, as shown in the diagram. Sampling these leaves has proven to be accurate in predicting SLW population growth beyond cutout (~1450dd). Using the leaf from the 4th node allows these same leaves to be collected and scored for aphids and mites as well.

Adult whitefly are extremely mobile, so turn the leaf over very gently by holding it at the tip of the leaf or by gently rotating the petiole.

5. Score leaf

Binomial sampling (presence/absence) is recommended as it is less prone to bias than counting and averaging the number of whitefly/leaf.

Score leaves with 2 or more whitefly adults as 'infested'

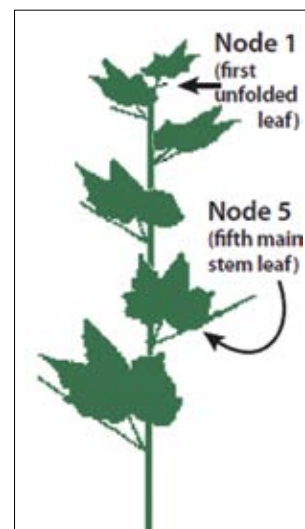
and leaves with 0 or 1 whitefly adults as 'uninfested'.

6. Calculate percentage infested

Either manually calculate percentage of infested leaves or enter sample data into the CottASSIST SLW Threshold tool at www.cottassist.com.au

Other sampling considerations

- Temperature is a major driver of SLW populations. Cool conditions slow population increase. Heavy rainfall may temporarily reduce adult SLW numbers but does not have a lasting impact on population growth, as nymph populations are unlikely to be affected. Make sure sampling continues after rainfall even if the first sample after rain shows low adult numbers.
- During the season, SLW change preference for location within the canopy and this needs to be considered when interpreting sampling results. The bulk of the SLW population will be lower in the canopy in pre-flowering and flowering stages and gradually moves upwards until cutout. As a consequence, when monitoring the 5th node it is not unusual to experience a rapid increase in population around cutout as this population moves up the canopy.
- To better understand how the population is building, it can be informative to also monitor the 8th, 9th or 10th node below the plant terminal for nymphs and adults up until about



cutout (~1450dd). Based on knowledge of SLW's change of preference through the season for location within the canopy, it could be expected that adult density at nodes 8 or 9 in the period from squaring to a little after peak flowering will be around 1.5-2 times the density of nodes 4 or 5. However after cutout, nodes 4 and 5 become more accurate in predicting population growth whereas the densities lower in the canopy (at nodes 8, 9 or 10) will fall sharply.

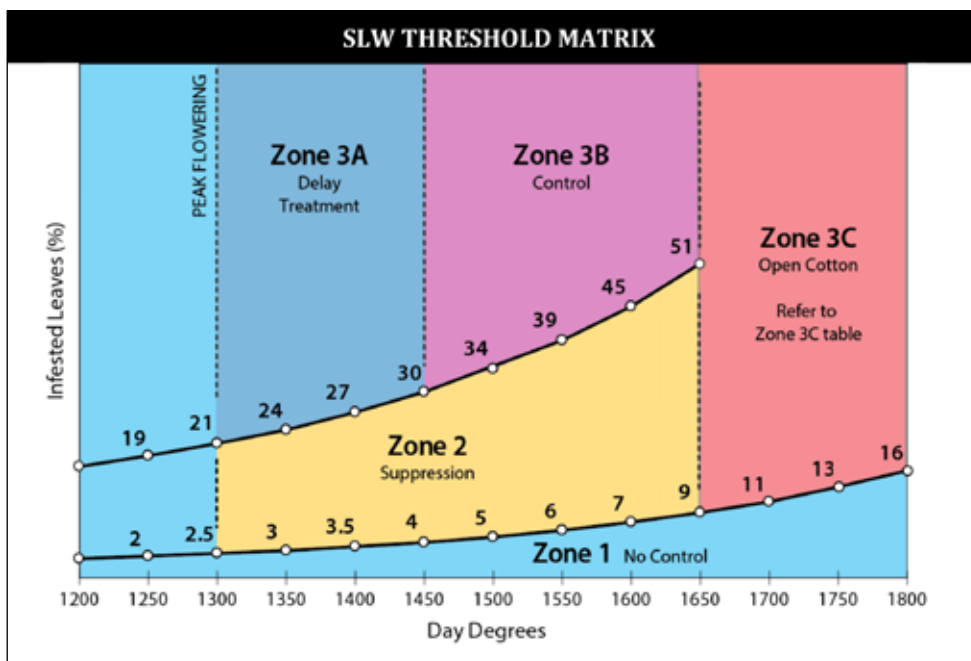
- SLW population dynamics can be quite cyclic – with peaks and troughs in adult numbers. While nymphs are not used in the threshold, the presence of nymphs indicates that the population is reproducing. A sudden increase in adult numbers in the absence of a nymph population indicates that the adults have recently migrated into the field from another source.

Deciding if intervention for SLW control is required

The ultimate aim of all management options should be to minimise the risk of honeydew contamination on lint. Each management option will reflect the compromise between wanting to delay treatment, reducing the risk of reinfestation and need for re-treatment whilst targeting populations that are small enough for products to provide effective control.

The SLW Threshold Matrix

The threshold matrix is a tool to assist in making management decisions that are appropriate for a range of pest density and crop stage situations. It has been designed to manage populations that build gradually in the crop and provides a framework for using sampling information to (a) determine if intervention is required, and (b) make optimal use of currently registered products for **population**



control (i.e. intervention to bring a well-established population to low levels over a sustained period) or **suppression** (i.e. early intervention to delay buildup). There are separate thresholds for early season suppression and control. Thresholds are based on rates of population increase relative to the accumulation of day deg rees and crop development. Frequent population monitoring is essential in order to use the matrix effectively. The CottASSIST SLW Threshold tool at www.cottassist.com.au is an easy way to use this matrix.

Zone 1 – No Control

Where the SLW population is low and increasing very slowly, there is a low risk of contamination and no control is necessary. Continue to monitor as (i) large numbers of adult SLW could move in from other hosts or (ii) sprays applied for other pests could reduce beneficial abundance allowing SLW population to increase more quickly.

Zone 2 - Suppression

Registered, non-insect growth regulator (IGR) type products can be used for suppression within a wide application window at lower population densities prior to boll opening (refer to lower density curve/line in matrix). Sustained low SLW populations can contribute to lint contamination. Where populations

are maintained in Zone 2 over several weeks, consider applying a suitable 'Suppression' product, especially if a honeydew sheen is observed on lower leaves (see visual diagnostic images below). This tactic is best used in conjunction with the need to control other pests by the use of insecticides that will control the target pest but also have a significant suppressive effect on SLW. A number of products, including those with good knockdown efficacy (i.e. give a quick reduction in SLW numbers) can be useful for population suppression when used early in this zone (see Product Selection section on pg 11). However, due to the potentially significant impact of suppressive/knockdown products on beneficial insect populations, subsequent re-treatment of resurgent SLW populations is a possibility that must be taken into consideration when utilising this tactic.

Zone 3A – Delay Treatment

Controlling high density populations before 1450 dd is not recommended due to the likely resurgence of the population and need for additional control to protect lint from honeydew.

Zone 3B – Control

Where populations are maintained in Zone 3B over several checks, control is warranted and IGR-type products are expected to provide the most effective control. The duration of control offered by IGRs depends significantly on the contribution of beneficial insects to the control of post-IGR SLW population growth. Management practices that disrupt beneficial insects will limit the longevity of control provided by IGR application.

Early use of an IGR-type product in Zone 3B (at or around 1450 dd) is a valid option but is not recommended in most instances due to a considerable risk of population resurgence and the need for re-treatment prior to defoliation. More often, **the ideal time to apply an IGR-type product is between 1550 and 1650 Day Degrees**, i.e. before a significant proportion of bolls have opened. This tactic minimises the potential for lint contamination as well as the risk of population resurgence and the

SLW numbers can rapidly increase if natural enemies are reduced by insecticides.

need for re-treatment prior to defoliation.

Zone 3C – Open Cotton

Once there is open cotton, the ideal period for control has passed and the risk of honeydew contamination is heightened. Management decisions should be based on:

- time-to-defoliation
- lint contamination level, and
- population growth rate and size

This three-pronged approach, presented in the Zone 3C Table (see page 9), is designed to support greater confidence in decision making in a range of situations including late maturing crops and those with an extended period of maturity.

It is important to note that SLW abundance can change significantly between checks as a result of adult emigration due to rapidly declining host quality and/or mass immigration from other fields. Weather conditions and some management practices can also influence adult behaviour and within-plant distribution. This means that, in some situations, sampling estimates of SLW abundance at the 5th node below the terminal may not reflect the level of lint contamination and/or SLW abundance within the crop that is evident from observation or other means. This can be due to factors such as high temperatures encouraging adult SLW to remain lower in the canopy or sprays that reduce adult abundance in the upper canopy. In such circumstances, monitoring adult and nymph population density changes on lower nodes (refer to Sampling SLW section on pg 6) can be informative.

All weather-related and population processes that can influence SLW abundance in Zone 3C (e.g. mass immigration and/or emigration of adults, etc.) fit into the categories presented in the Zone 3C

Table. For a given time-to-defoliation and level of lint contamination, the table presents clear guidelines for action depending upon the **growth rate of the adult population** (the change in % infested leaves between checks) regardless of whether it is due to immigration or from within the crop, and, where appropriate, supporting information on **overall abundance** (mean % infested leaves over one or more checks).

by use of a knockdown product in the first 7 days if SLW abundance warrants intervention (see Zone 3C Table). Situations in which defoliation is 15-21 days away may be managed by a knockdown spray in the first 7 days and continued monitoring; defoliation as early as 50% open bolls may be warranted if significant population resurgence is evident within 7 days of treatment.

Time to defoliation of up to 14 days is best managed

Time to defoliation ≥ 21 days (under February-

Zone 3C table (supporting SLW management options for Zone 3C of the Threshold Matrix).

Refer to the visual diagnostics panel and text for details.

Time to defoliation (days)	Contamination level (visual diagnostic)	Adult population growth rate**	Action recommended
14 or less	No or light contamination	$\leq 3\%$ per 50 dd (every 3-4 days)	No action; continue monitoring
		$> 3\%$ per 50 dd (every 3-4 days)	Knockdown in first 7 days if % infested leaves $\geq 10\%$ and/or large nymphs present on most lower canopy leaves and/or consider early defoliation; otherwise, no action and continue monitoring
	Moderate contamination	$\leq 3\%$ per 50 dd (every 3-4 days)	Knockdown in first 7 days if % infested leaves $\geq 10\%$ and/or large nymphs present on lower canopy leaves; otherwise, no action and consider early defoliation if contamination level increasing
		$> 3\%$ per 50 dd (every 3-4 days)	Knockdown in first 7 days; consider early defoliation.
15-21	No or light contamination	$\leq 3\%$ per 50 dd (every 3-4 days)	No action; continue monitoring
		$> 3\%$ per 50 dd (every 3-4 days)	Knockdown in first 7-14 days if % infested leaves $\geq 10\%$ and/or large nymphs present on most lower canopy leaves; otherwise, no action and continue monitoring
	Moderate contamination	$\leq 3\%$ per 50 dd (every 3-4 days)	Knockdown in first 7-14 days if % infested leaves $\geq 10\%$ and/or large nymphs present on lower canopy leaves; otherwise, no action and consider early defoliation if contamination level increasing
		$> 3\%$ per 50 dd (every 3-4 days)	Knockdown in first 7 days & defoliate early if resurgence is evident
> 21	No or light contamination	$\leq 3\%$ per 50 dd (every 3-4 days)	No action; continue monitoring
		$> 3\%$ per 50 dd (every 3-4 days)	Use IGR in first 7 days if % infested leaves $\geq 10\%$ and/or large nymphs present on most lower canopy leaves; otherwise, no action and continue monitoring
	Moderate contamination	$\leq 3\%$ per 50 dd (every 3-4 days)	Use IGR in first 7 days if % infested leaves $\geq 10\%$ and/or large nymphs present on lower canopy leaves; otherwise, no action and consider early defoliation if contamination level increasing
		$> 3\%$ per 50 dd (every 3-4 days)	Use IGR in first 7 days; consider early defoliation if honeydew level appears to be increasing beyond 14 days after IGR application
Severe contamination			Salvage: Knockdown &/or defoliate asap; delay picking – rain will help remove honeydew from bolls.

**Population growth rate measured as the change in % infested leaves between checks (every 3-4 days) at node 3, 4 or 5 (first fully unfurled terminal leaf = node 1); dd = day degrees.

March weather conditions in most Qld and NSW cotton growing areas) would allow most juvenile SLW developing within the crop to complete their development, but from a control perspective, would also allow an IGR sufficient time to work, thereby

making the use of an IGR cost effective and the product of choice for such situations.

When it is too late - cotton lint is contaminated

In the worst case scenario, where cotton lint has

Visual diagnostics for SLW management in Zone 3C of the threshold matrix

Light contamination



Honeydew on Middle Leaves



Middle Main Stem Bolls



Bottom 25% Main Stem Bolls

Moderate contamination



Honeydew on Middle Leaves



Middle Main Stem Bolls



Bottom 25% Main Stem Bolls

Severe contamination



Honeydew on Middle Leaves



Middle Main Stem Bolls



Bottom 25% Main Stem Bolls

been severely contaminated with honeydew, delaying harvest may assist in providing an opportunity for the amount of contamination to reduce. Rainfall in excess of 15-20 mm either in a single fall or spread over 2 or 3 falls will wash-off most honeydew (>80%). Honeydew breakdown can also occur through the action of sooty moulds that grow in the presence of dew or high humidity though the rate of breakdown is slow and there is a risk of penalties from the resultant black sooty mould spores that occur. If conditions remain dry, reductions in the amount of honeydew on bolls will be slow, and there is a risk that contaminated cotton may still have sufficient honeydew to result in substantial penalties if harvested. It is also suggested that after harvest, leave the module/s in the field for as long as possible to potentially reduce the level of honeydew contamination through breakdown.

Product selection

Knowledge of the registered products can help to improve management decisions. Slower acting products with longer residuals (such as an IGR) require up to 14 days to be fully effective, whereas knockdown products provide quick but limited control.

The following is a summary of products registered for use in cotton for SLW. For more information on details for use and rates [please refer to the individual product labels.](#)

- Bifenthrin (pyrethroid) (**Knockdown**)– provides some knockdown of adults, however is highly disruptive to beneficials, and resistance levels are high and widespread.
- Diafenthiuron (**Knockdown & Suppression**) – is most effective at targeting low, early season populations and has contact, translaminar and vapour activity. It is activated by light as well as insect enzymes so will be less effective in cloudy weather. If applied during the later half of Zone 2A (refer to matrix), it may collapse the population sufficiently that no further sprays will be required.

However if conditions are suitable for SLW, a follow up control product such as pyriproxyfen or another suppression product may be required to see the crop through to defoliation.

- Pyriproxyfen (**IGR, Control**) – It does not kill adult SLW, but provides population control by preventing eggs from hatching and the progression to adult stage, as well as sterilising adult female insects. This means it will take 10-14 days before the population declines. The threshold matrix accounts for this delay. Pyriproxyfen provides up to 2 weeks residual and has been shown to be effective even on high populations of SLW. It would be expected to give 4-6 weeks of control. However, as pyriproxyfen is strictly one use per season, using this option early will preclude its use again later in the season.
- Spirotetramat (**IGR, Control (higher rate) & Suppression (lower rate)**) – is a highly systemic, slow acting compound that targets the nymphal development stage, and has little direct activity against adults or eggs. Nymphs and pupae stop feeding shortly after application. Control of these life cycle stages is expected 5- 7 days after application, with control extending 3-5 weeks, depending on rate. Control in stressed cotton (drought, waterlogged) will be adversely affected due to poor translocation of the product.
- Cyantraniliprole (**Knockdown, Control (if used twice in succession within 10-15 days) and Suppression (single application)**) – is a new mode of action for SLW control which rapidly stops the pest feeding on the cotton plant. This product has activity on multiple life stages, although the most impact occurs when targeted at the early nymph stages. This product is restricted to two applications per season.

Insecticide Resistance Management

When SLW was first identified in Australia in 1994 it already possessed resistance to many older insecticide groups. The risk of further building resistant SLW populations is high. Consequently, it

is important to follow the Insecticide Resistance Management Strategy (IRMS) described in the Cotton Pest Management Guide which details when and how many times each control option can be used. This needs to be complemented with an effective Integrated Pest Management (IPM) approach to reduce the need to control SLW while ensuring that contamination of lint is prevented. Compliance with the IRMS will ensure that the limited products available for SLW control will remain effective into the future.

- Avoid repeated applications of products from the same mode of action group.
- Do not apply more than the maximum number of applications.
- Do not apply pyriproxyfen more than once within a season.
- Refer to SLW Threshold matrix and IRMS.

Integrated Pest Management

Take a year round approach

Seasonal conditions and farming practices during winter and early spring can have a big influence on summer SLW population. For a SLW outbreak to occur, SLW require a suitable climate (especially mild winters), a sequence of hosts (winter weeds or alternative crops) and management that disrupts natural SLW enemies (use of broad spectrum insecticides against other pests). A year round approach can allow development of a strategy to reduce the potential for SLW outbreaks to occur.

Area Wide Management (AWM)

Think of the farm and surrounding vegetation as a whole system. SLW numbers can build rapidly, and adults can move around the farm and between farms to find suitable hosts. Consider all potential hosts in cropping and non cropping areas. Area wide management (AWM) involves sharing and coordinating tactics with neighbours, and has been found to be effective in management of SLW. Strategies may include coordinated planting windows, weed management, consensus about delaying the

use of disruptive insecticides to conserve beneficials, shared adherence to IRMS, and enhancement of native vegetation areas, such as coordinated weed and pest animal control or tree planting.

Coordinated planting

Late maturing cotton crops face a higher risk for sticky cotton as they will 'inherit' SLW populations displaced from defoliated earlier maturing crops. Timing planting and adjusting crop management to limit the availability of attractive crops late in the season will reduce this risk. It will also help to minimise the number of whitefly generations in the season and consequently the scale to which the population can build.

Maintaining beneficial numbers

Natural enemies or beneficials can play a vital role in the successful management of SLW. If beneficial populations are disrupted, SLW populations will build much faster.

Build beneficials across the farm, by using an IPM approach to manage all crops, not just cotton. This includes using thresholds to avoid unnecessary sprays, avoiding the early season use of broad spectrum insecticides, particularly synthetic pyrethroids and organophosphates and managing weed hosts across the whole farm. Native vegetation both on farms and in the region can also be an important source of beneficials.

Healthy cotton

Growing a healthy cotton crop optimises both its yield potential and capacity to compensate for pest damage.

If possible, schedule irrigations to avoid moisture stress. Moisture stress increases whitefly severity and honeydew production, as they need to consume more poorer quality host to maintain their nutrition levels. Optimise nutrition and water inputs to avoid delaying maturity, or extended unproductive growth at the end of the season.

Varietal selection

SLW tend to develop later and more slowly on varieties with okra leaf shape.

Field selection

If cotton is planted in close proximity to other good SLW hosts, such as melons or soybeans, the risk of mass movement of adult SLW to the later maturing crop may be similar to late planted cotton. The greater the isolation from susceptible crops, the less likely there will be mass movement of SLW between crops.

Host free period

As SLW have a wide host range and spend their winter on plants, removing hosts and maintaining a host free period during this time will reduce the starting population for next season. Non-host crops include sorghum, maize, winter cereals and chickpeas. Consider co-ordinating host free periods with neighbours to enhance their effectiveness.

Farm hygiene

Control farm weeds all year round. Maintain a zero tolerance of volunteer/ratoon cotton throughout the year. Destroy crop residue from all susceptible crops immediately after harvest. This is critical for cucurbit crops that may regrow and act as whitefly reservoirs.

Biosecurity

Although biotype B whitefly is present in Australia there is a risk of other biotype B strains and other biotypes e.g. biotype Q, with different insecticide resistance profiles, entering the country. Whitefly can also be vectors of damaging exotic viruses such as cotton leaf curl disease. Monitor for any unusual plant symptoms, pests or abnormal responses to pesticide. If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

Further information

- Visit www.cottoninfo.net.au
- Contact Sandra Williams, CottonInfo's IPM technical specialist: 02 6799 1585; sandra.williams@csiro.au
- Calculate percentage of infested leaves or enter sample data into the CottASSIST SLW Threshold tool on www.cottassist.com.au
- Cotton Pest Management Guide (contains Insecticide Resistance Management Strategy (IRMS)) www.cottoninfo.com.au/publications/2014-15-cotton-pest-management-guide