

Pest Profile

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Managing Silverleaf Whitefly

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This document provides recommendations for effective monitoring and best management of Silverleaf Whitefly (SLW) in Australian cotton. Management of SLW aims to minimise the need for pesticides by using cultural, agronomic and biological controls to reduce the survival of SLW in the farming system. These recommendations incorporate recent findings from local research undertaken in central Queensland.



Photo: Marilyn Steiner, NSW DPI.

In Summary

Cultural Management

Remove host weed plants in and around cotton fields.

In crop rotations, allow a host-free period over winter. Do not plant cotton near other source crops.

Destroy crop residues after harvest.

Agronomic Management

Aim for tight planting window across the district.

Avoid hairy-leaved varieties.

Plant okra-leaved varieties as they are less suitable for whitefly population growth.

Avoid moisture stress.

Optimise N fertiliser applications.

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Biological Control

Conserve beneficial insects by avoiding or delaying the use of broad spectrum chemistry for as long as possible.

Species Verification

Determine whether SLW (*Bemisia tabaci*) or greenhouse whitefly are present. If the population is rapidly increasing assume SLW (*B. tabaci* – biotype B).

Sampling

Sample twice weekly from peak flowering using presence/absence sampling. Sample at least 20 leaves per 20–25 ha.

Sampling aims to estimate the proportion of leaves (at the

3rd, 4th or 5th leaf nodes from the terminal) infested with ≥ 2 adults/leaf.

Insecticidal Control

Do not attempt to control whiteflies before 1300 day degrees (peak flowering) to limit the risk of pest resurgence.

Use appropriate chemistry (refer to SLW Threshold Matrix).

Adhere to the Insecticide Resistance Management Strategy (IRMS).



Cotton Catchment Communities CRC

Whitefly Predators



Whitefly Parasitoids



Information on the impact of insecticides on key beneficial insect groups can be found on the Cotton CRC website <http://www.cottoncrc.org.au/Publicat/Pest> and from the Beneficial Disruption Index table in the Cotton Pest Management Guide.

Cultural Management

Follow good IPM principles to reduce the continuity and abundance of hosts that are favourable to silverleaf whitefly (SLW) population build-up.

Destroy crop residue from all susceptible crops immediately after harvest. This is critical for cucurbit crops that may regrow and act as whitefly reservoirs.

Remove farm weeds that are hosts, particularly through the winter period. Favoured weed host species include: *Bladder ketmia*, native rosella, *Rhynchosia*, vines (cow, bell, potato), sow thistle, rattle-pod, native jute, burr gherkin and other Cucurbitaceae weeds, Josephine burr, sunflowers when young, *Euphorbia* weeds, *Poinsettia*, and volunteer cotton.

Where possible allow a host-free period within the cropping rotation. Non-host crops include sorghum, maize, winter cereals and chickpeas. Consider co-ordinating host free periods with neighbours to enhance their effectiveness.

Do not plant cotton in close proximity to good SLW host crops such as melons. The greater the isolation from susceptible crops, the less likely there will be mass movement of populations between crops.

Agronomic Management

Aim for a tight cotton planting window. This will limit the availability of young, attractive crops late in the season when whitefly populations are at their maximum. It will also help to minimise the number of whitefly generations in the season and consequently the scale to which the population can build up.

Plant smooth-leafed varieties. Hairy-leaf cotton varieties are more susceptible to SLW than smooth-leaf varieties. Okra-

Remove crop volunteers and weed hosts



leaved varieties are generally less susceptible than normal leaf.

Schedule irrigations to avoid moisture stress. Moisture stress increases whitefly severity and honeydew production. Avoid unnecessary late season irrigations that prolong unproductive growth.

Optimise nitrogen fertiliser applications. Avoid applying excessive amounts of nitrogen which result in large vegetative crops with delayed maturity.

Monitor day degree accumulation for the crop. In-crop control options for SLW are very limited, meaning the timing of any spray is critical. The premise of SLW thresholds is to monitor day degree accumulation along with SLW populations so that spray decisions can be triggered according to the development of the whitefly population relative to the amount of time remaining in the season.

Biological Control

A sound management strategy needs to preserve and promote the activity of natural enemies (predators and parasitoids).

Incorporate crop residues soon after harvest



Photo: Dallas King, Cotton CRC

Natural enemies play a vital role in successful management of SLW. A complex of predators and at least 14 species of parasitoids (sometimes giving high parasitism rates) have been found in Australia. Parasitoids of whitefly include several species of *Encarsia* and *Eretmocerus* wasps. Whitefly nymphs are also preyed upon by big-eyed bugs, pirate bugs, lacewing larvae, and lady beetles. Having these beneficials in the crop can slow the rate of population growth, delaying or preventing thresholds from being reached. To preserve beneficials, avoid early season use of broad-spectrum insecticides, particularly synthetic pyrethroids and organophosphates.

Using Insecticides

SLW rapidly develop resistance to insecticides. Management should aim to minimise insecticide use by following the recommended sampling protocols and spray thresholds presented here.

SLW hide underneath leaves and within the canopy of a plant, making them a difficult target to spray. Good coverage to all

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parts of the plant is important to maximise product efficacy. Spray coverage under leaf surfaces is less critical for the insect growth regulator (IGR), Admiral®, because of trans-laminar activity of the product. Techniques to give improved coverage need to be weighed against the risk associated with drift.

Applications in the morning when SLW populations are most active may achieve better results. During the heat of the day, whitefly tend to shelter lower in the crop.

Using of any of the currently registered seed treatments has limited impact on SLW. These products are typically active for only 6–8 weeks after planting. Whitefly populations build up in later crop stages when these products are no longer active.

Area Wide Management

SLW is best managed on an area-wide basis within an IPM framework. An AWM approach for SLW will require:

- Communication among all growers of susceptible crops.
- A window in which host crops are not grown.
- Implementation of a resistance management protocol.
- Reduction of weed hosts all year round, but particularly in spring, at the time when populations begin to build.
- Commitment to using the appropriate products at the recommended crop stage and pest density and under the right environmental conditions.
- Preservation of beneficials by avoiding broad spectrum insecticides early season.
- Tight planting windows to reduce the availability of hosts.
- Communication between industries to ensure complementary practices (eg crop residue destruction) are being undertaken.

Include non-host crops in the crop rotation



Barley



Chickpea



Sorghum



Maize



Wheat

Species Verification

Identifying which whitefly species are present is very important before management strategies are implemented.

Three main types of whitefly are found in Australian cotton fields:

Silverleaf Whitefly (SLW)

Bemisia tabaci – biotype B

Eastern Australian Native (EAN)

Bemisia tabaci – biotype EAN

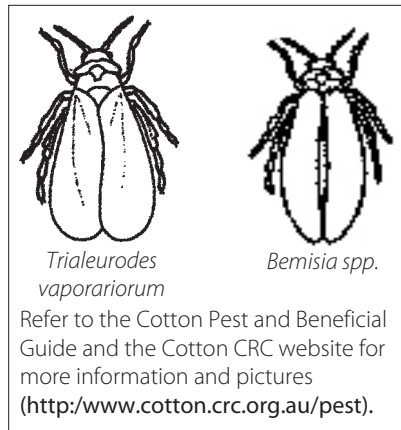
Greenhouse whitefly

Trialeurodes vaporariorum.

Greenhouse whitefly can be easily distinguished by eye from the two *Bemisia tabaci* biotypes on the basis of size and wing positioning, shown in the drawings above.

The two *Bemisia tabaci* biotypes (SLW & EAN) cannot be distinguished by eye. A sample of the population must be collected and sent for biochemical testing.

EAN biotype whiteflies will not generally reproduce rapidly



Refer to the Cotton Pest and Beneficial Guide and the Cotton CRC website for more information and pictures (<http://www.cotton.crc.org.au/pest>).

in cotton. If rapid increases in population occur and they are not Greenhouse whitefly, this probably indicates the predominance of SLW biotype B.

Species composition within a field may change rapidly during the season due to factors such as insecticide applications and climate. If greenhouse whitefly are identified early in the season, continue to monitor for the arrival of *Bemisia tabaci* biotypes.

Biosecurity

The Australian Cotton Industry Biosecurity Plan identifies 12 key organisms that are threats to the industry. These are based on the economic risk they present should they become established in Australia. Exotic whiteflies are one of the 12 key threats.

Although the biotype B whitefly is present in Australia there is a risk of other biotype B strains and other biotypes, with different insecticide resistance profiles, e.g. biotype Q, entering the country. Whiteflies can also be vectors of damaging exotic viruses such as cotton leaf curl disease. As exotic whitefly strains and biotypes cannot be distinguished by eye, sending collections for species verification and resistance testing will also assist in early detection if such a population was to make it into Australia.

SAMPLING FOR SPECIES VERIFICATION AND RESISTANCE MONITORING

In fields where whitefly have been seen, collect 200 leaves from random plants throughout the crop (i.e. don't try to select leaves that have whitefly present). Whitefly can be identified from both the adults and nymphs.

Collect only 1 mainstem leaf /plant, from between 5 and 8 nodes below the plant terminal.

Pack the leaves 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.

Label the collection and send to QDPI&F Toowoomba by overnight courier;

Richard Lloyd
Queensland Department of Primary Industries & Fisheries
203 Tor Street,
Toowoomba QLD 4350
Phone (07) 4688 1315

Ensure samples are clearly labelled and include the following information:

Collector's Name.....

Farm Name.....

Field..... Postcode.....

Phone No.

Fax No.

Email address.....

.....

Region (e.g. Gwydir).....

Date of collection /..... /.....

Comments.....

.....

.....

Sampling

Once you have confirmed the presence of SLW, effective sampling is the key to successful management.

Define your management unit. This can be a whole field or part of a large field – no larger than 25 ha. Each management unit should have a minimum of 2 sampling sites. At each of the 2 sites sample at least 10 leaves (minimum of 20 leaves / management unit).

Sample at weekly intervals from first flower (777 day degrees) and **twice-weekly from peak flowering** (1300 day degrees).

To maximise product efficacy and minimise the risks of insecticide resistance, all decisions to control SLW should be made between 1300 and 1800 day degrees (peak flowering and 60% open bolls).

Choosing plants to sample

Move at least 10m into the field before sampling. Choose healthy plants at random, taking only one leaf from each plant.

Choose a mainstem leaf from the 3rd, 4th or preferably the 5th node below the plant terminal, shown in Diagram 1.

Sample through the field along a diagonal or zigzag line. Move over several rows taking 5–10 steps before selecting a new plant.

Assessing leaves for whitefly abundance

Adults

Use presence/absence assessment, (sometimes referred to as binomial sampling). Compared to using averages it is less prone to bias and therefore highly recommended.

Keep shadow off the plant. Carefully turn each leaf over by the tip of the leaf blade or the petiole, as in Photo 1. Score a leaf with 2 or more whitefly

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adults as infested. Score a leaf with 0 or 1 adult as uninfested. Calculate the percentage of infested leaves. Calculate crop age in day degrees (DD).

Nymphs

Nymph abundance is not used in the Threshold Matrix for making control decisions. Use data on nymph abundance only as supporting information.

Check for presence or absence of large (3rd and 4th instar) nymphs. Large nymphs appear as flattened, oval discs or ‘scales’ visible to the naked eye. The presence of large nymphs on leaves at nodes 6, 7 or 8 below the terminal validates the assumptions about population dynamics that underpin the strategy for managing SLW.

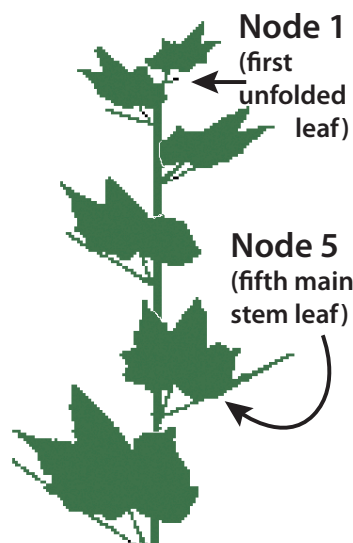


Diagram 1. Sample one mainstem leaf per plant from the 3rd, 4th or 5th node below the plant terminal. Using the leaf from the 4th node allows these same leaves to be collected and scored for aphids and mites.

Why is presence/absence sampling recommended?

SLW populations in the field are not evenly distributed but rather tend to be clumped. When sampling individual leaves sequentially for adults (or nymphs) it is not uncommon to find just one or none on several leaves and then one leaf with an unusually large number.

A sequence of 20 leaves sampled for adult SLW might yield the following result:

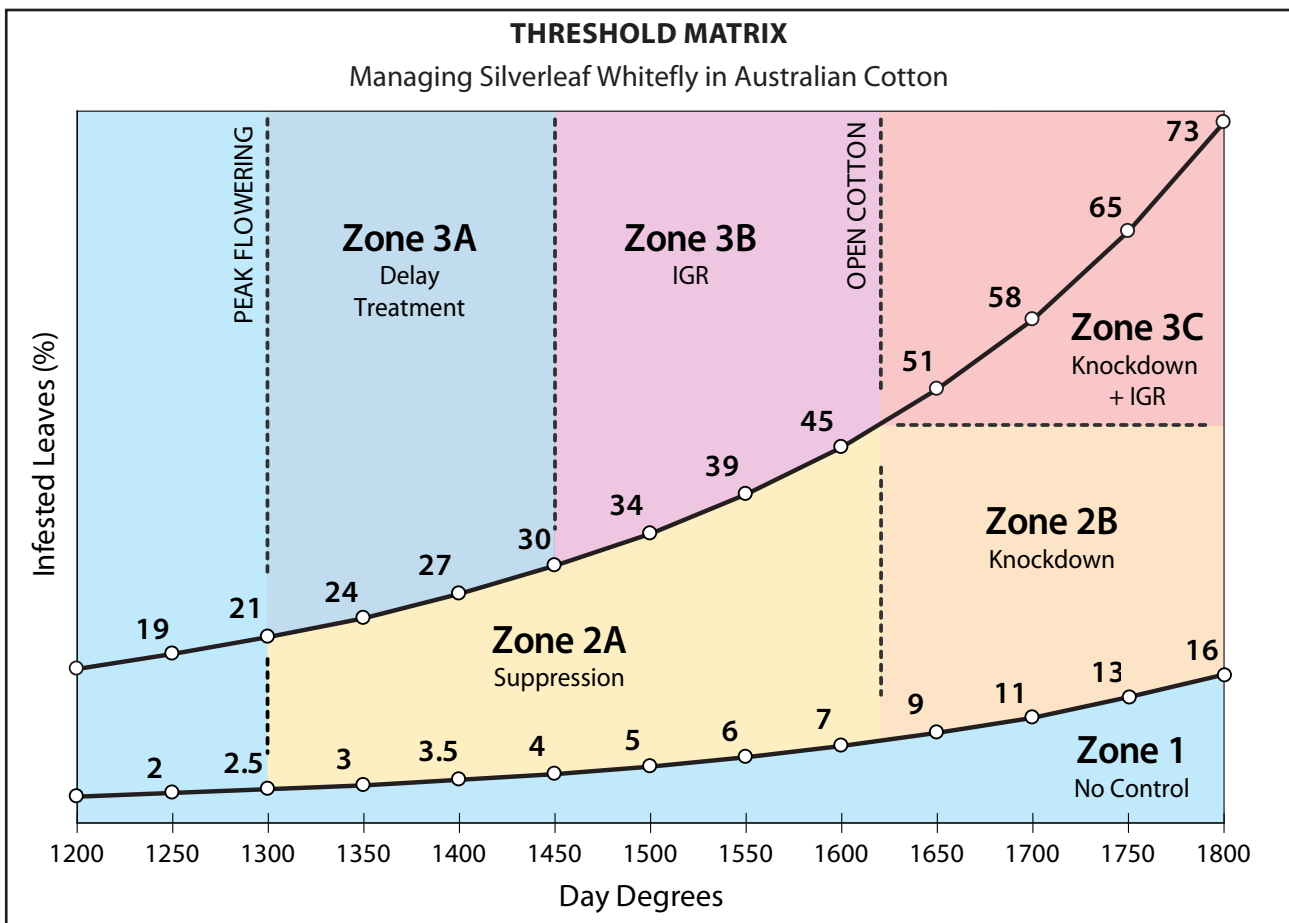
0 0 1 1 0 0 8 1 0 0 0 1 0 10
1 0 0 0 0 1

If the data is averaged, this sequence gives us a mean of 1.2 adults/leaf, but with a standard deviation of 2.7 adults/leaf, which is higher than the mean. The value of the mean is being biased by the presence of 1 heavily infested leaf. Using the recommended presence/absence sampling with a tally threshold of 2 adults/leaf, the proportion of infested leaves in the sequence is 10%. This equates to less than 0.5 adults/leaf, demonstrating how this method can overcome the limitations imposed on sampling from uneven distributions of insects in the field. Presence/absence sampling gives more accurate information about SLW abundance for the purposes of making spray decisions.



Photo: Richard Sequeria., QDPI&F

Photo 1. To score a leaf, carefully turn it over by the tip of the leaf blade. Use the binomial method to score leaves with 2 or more adult whitefly as ‘infested’ and leaves with 0 or 1 adult as ‘uninfested’.



Using the Threshold Matrix

Use the Threshold Matrix to compare the % of leaves infested (derived from sampling) with thresholds relevant to the crop's age (day degrees). Regular sampling is required in order to compare the rates of population development.

Decisions to control SLW should only be based on the presence of adults at levels above the recommended thresholds.

For example, sampling may reveal 3% at 1400 DD, 5% at 1500 DD, 6% at 1550 DD and then 16% of leaves infested at 1600 DD. At 1600 DD the rate at which the population is increasing has changed, exceeding the 'No control' threshold. At this point management should be based on the recommendations for Zone 2A. Local information such as weather forecasts, presence of beneficials and other pests, should also influence the SLW control decision.

The Threshold Matrix is based on detailed assessment of field populations of SLW in cotton between 2002/03 and 2005/06. Consistencies were observed in the way populations developed on cotton. There was a pattern of gradual build up over many weeks through a combination of low-level immigration and endogenous growth. An increase in the rate of population growth tended to occur when crops reached peak flowering. The recommendation for twice weekly sampling from this point forward aims to detect this change and intervene only if required at the time when products can be most effective.

The Threshold Matrix does not apply in situations of population explosion due to mass migration.

Zone 1

Insecticide application is not warranted for fields with low SLW densities. In this Zone, the risk of

yield loss or lint contamination is negligible, even when populations are sustained throughout flowering and boll fill. Slow rates of population development suggest important contributions from beneficial insects. Carefully consider the disruption of predators and parasitoids if making a spray decision for any other pest in the field.

Zone 2A

Zone 2A provides a wide window of opportunity, from peak flowering until first open boll, for the most economic and low-risk control of SLW. At this time conventional (non-IGR) insecticides, such as diafenthiuron (Pegasus®), can control or provide useful suppression of low-medium density populations. To maximise the efficacy of diafenthiuron, apply before the SLW population density exceeds 45% infested leaves.

Monitor Day Degree Accumulation

Daily Day Degrees (DD) are calculated using the formula;

$$DD = [(Max\ ^\circ C - 12) + (Min\ ^\circ C - 12)] \div 2$$

Access the cumulative day degree information for your nearest SILO weather station from the Cotton CRC website – www.cottoncrc.org.au

Long term average Day Degree accumulation provides an estimate of the duration of each threshold Zone.

Region (planting date)	St George (Oct 15)	Dalby (Oct 15)	Emerald (Sep 15)	Burdekin (Dec 10)
Zone 1 1200–1800 DD	44 days 4 Jan–17 Feb	46 days 25 Jan–12 Mar	37 days 15 Dec–21 Jan	42 days 26 Feb–9 April
Zone 2A 1300–1625 DD	20 days 21 Dec–21 Jan	25 days 1 Feb–26 Feb	20 days 21 Dec–10 Jan	21 days 5 Mar–26 Mar
Zone 2B 1625–1800 DD	11 days 6 Feb–17 Feb	14 days 26 Feb–12 Mar	11 days 10 Jan–21 Jan	15 days 26 Mar–9 Apr
Zone 3A 1300–1450 DD	8 days 17 Jan–25 Jan	12 days 1 Feb–13 Feb	9 days 21 Dec–30 Dec	7 days 5 Mar–12 Mar
Zone 3B 1450–1625 DD	12 days 25 Jan–6 Feb	13 days 13 Feb–26 Feb	11 days 30 Dec–10 Jan	14 days 12 Mar–26 Mar
Zone 3C 1625–1800 DD	11 days 6 Feb–17 Feb	14 days 26 Feb–12 Mar	11 days 10 Jan–21 Jan	15 days 26 Mar–9 Apr

This information is meant as a guide only. The commencement and duration of each threshold Zone is strongly influenced by planting date and will vary from season to season and region to region.

(NOTE: The Pegasus® label indicates that the product may not give satisfactory control at population densities above 25% infested leaves. This is based on an overseas sampling model. For Australian conditions this equates to around 45% infested leaves with 2 or more adults/leaf).

In early sown crops, endosulfan may be used to control aphids and some other pests through until flowering. When used for these purposes, endosulfan can suppress the development of low-medium SLW populations. The window for endosulfan application by ground rig closes on the 15 January. Refer to label directions and the IRMS.

Zone 2B

Depending on environmental conditions, varying levels of lint www.cottoncrc.org.au

contamination can result from uncontrolled medium density populations in Zone 2B (crops with open bolls). Early detection of SLW and preventative action in earlier stages (Zone 2A) can prevent the need for higher-risk remedial action in Zone 2B. Pegasus® may be effective for remedial control (knockdown) of population densities up to 45% infested leaves in Zone 2B. Efficacy will depend upon coverage and environmental conditions. For higher densities approaching the Zone’s upper boundary, an application of IGR may ultimately be required.

Zone 3A

Control of high density populations prior to about 1450 DD is not recommended due to the possibility of SLW population

resurgence and the need for additional intervention in later stages of the crop. There is no evidence of yield loss occurring as a result of delaying control until the commencement of Zone 3B.

Zone 3B

Application of IGR is recommended for control of high density populations between 1450 and 1650 DD prior to the onset of boll opening.

Pyriproxifen, trade name Admiral®, is highly effective against SLW, giving excellent control across a broad range of population densities. It is the keystone of effective SLW management in cotton as it is also very selective, allowing survival of predators and parasitoids.

The optimal application window for IGR is between 1450 and 1650 DD. Delaying application of IGR beyond 1650 DD and > 50% infested leaves (> 2 adults/leaf) could result in yield loss, lower efficacy of the IGR, substantial lint contamination or all of the above.

ENSURE ONLY A SINGLE APPLICATION OF ADMIRAL® OCCURS WITHIN A SEASON.

There is a very high risk of SLW developing resistance to pyriproxifen where more than one application is used within a season. Resistance levels causing spray failure have already occurred in horticultural situations as a consequence of multiple uses within a season.

Zone 3C

Delaying control of high density populations (>50% infested leaves) beyond 1650 DDs (zone 3C) increases the probability of substantial lint contamination, yield loss or both. In Zone 3C the use of an IGR by itself is unlikely to prevent lint contamination

due to the inherent time delay in population decline following application. Rapid knockdown of the population using a conventional insecticide is required before applying the IGR. At the time of publication, no conventional product gives satisfactory knockdown control of SLW at high densities. A number of products give low to moderate levels of knockdown control, for example, Talstar+PBO. Due to the lack of registered control options, Zone 3C is considered 'high risk'.

Further Information

Visit the Cotton CRC website;

www.cottoncrc.org.au

Silverleaf Whitefly In Australian Cotton Research Review 12, November 2002 (companion document);

Cotton Insect ID tool;

Mobile Pest & Beneficial eGuide;

Day Degree Calculator;

link to: Cotton Pest Management Guide, NSW DPI.

Contact the researchers;

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Important: Use of Pesticides

Only ever use pesticides in accordance with the current label and permit. Pesticides must only be used for the purpose for which they are registered and must not be used in any other situation or in any manner contrary to the directions on the label.

Some chemical products have more than one retail name. All retail products containing the same chemical may not be registered for use on the same crops. Check carefully that the label on the retail product carries information on the crop to be sprayed.

This publication is only a guide to the use of pesticides. The correct choice of chemical, selection of rate, and method of application is the responsibility of the user.

Pesticides may contaminate the environment. When spraying, care must be taken to avoid spray drift on to adjoining land or waterways.

Residues may accumulate in animals fed any crop product, including crop residues, which have been sprayed with pesticides. In the absence of any specified grazing withholding period(s), grazing of any treated crop is at the owner's risk. Pesticide residues may also contaminate grains, oils and other plant products for human use and consumption. Growers should observe harvest withholding periods as directed on the label.

Follow the Insecticide Resistance Management Strategy. To be effective, resistance management needs to be undertaken on an area-wide basis. Avoid the use of broad-spectrum insecticides early season to maintain predator and parasitoid populations.

Spotted anything unusual?



Image courtesy CSIRO

LOOK. BE ALERT. CALL AN EXPERT.

Cotton growers are the key to protecting Australia's crops from exotic insects and diseases like cotton leaf curl virus.

It is important that you are aware of the risk, and if you spot anything unusual on your crop you should always check it out and call your local entomologist, pathologist or the Exotic Plant Pest Hotline on 1800 084 881. The call is free (except from mobiles) and early detection will help protect your industry.

Visit www.planthealthaustralia.com.au for further information.



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RESEARCH ASSOCIATION INC.

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1800 084 881