RESEARCH REVIEW

Australian Cotton Cooperative Research Centre

Silverleaf Whitefly in Australian Cotton

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Insects

1.0 Importance

The silverleaf whitefly (SLW), *Bemisia tabaci* B Biotype, was first discovered in Australia in 1994. Hosts of the SLW include at least 500 crops and ornamental plants worldwide and it is a pest on many of them. Cotton growers in the United States are faced with losses of up to $500 million annually, directly and indirectly from the SLW.

Three main types of whitefly are found on cotton in Australia

- **Greenhouse Whitefly** (*Trialeurodes vaporariorum*)

Two strains of Bemisia tabaci

- **Eastern Australian native.** (*Bemisia tabaci* Aus) (EAN)
- **Silverleaf Whitefly** (*Bemisia tabaci* B-Biotype) (SLW)

Greenhouse whitefly and eastern Australian native have traditionally been the most commonly found, but are generally not significant pests of cotton although cotton fields adjacent to sunflowers may sometimes be infested with greenhouse whitefly at the time when the sunflowers finish off.

Greenhouse whitefly is about twice the size of *Bemisia tabaci*. The main distinguishing feature (apart from size) is the way they hold their wings. Silverleaf and eastern Australian Native whitefly have a split down between the wings whereas the greenhouse whitefly has overlapping wings.

Being the same species, Silverleaf whitefly and Australian Native Whitefly cannot be distinguished by eye. A biochemical test such as an esterase or PCR test, is needed to identify the biotype.

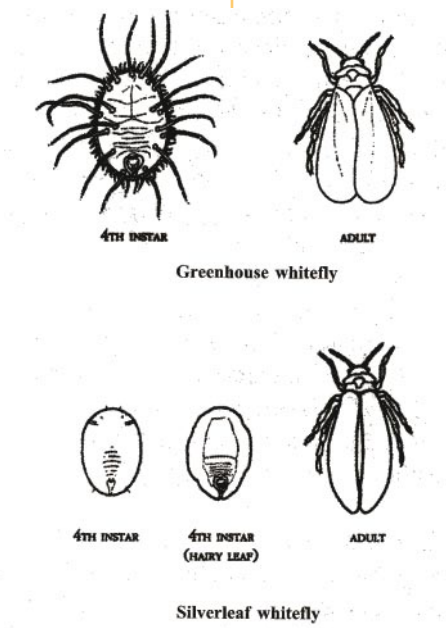

Diagram 1: Differences between the stages of greenhouse whitefly and silverleaf whitefly. Extracted from Flint M.L. (1994)

Silverleaf whitefly poses a greater pest threat than the other two whiteflies because it has a wider host range, higher reproductive rate, develops resistance to insecticides rapidly, and is adaptated to high temperatures. Given the right conditions (see below), these factors allow explosive outbreaks of this pest on an area-wide scale to a point where management is extremely difficult even with the use of insecticides.

When silverleaf whitefly was inadvertently introduced into Australia, it brought with it resistance to most organophosphates, carbamates and synthetic pyrethroids. Since then, resistance has developed to imidacloprid, endosulfan, bifenthrin, insect growth regulators and amitraz in some areas of Australia.

The greenhouse whitefly and the eastern Australian native biotype of *Bemisia tabaci* are both susceptible to most pesticides.

CSIRO[2] - NSW Agriculture[3] - Department of Primary Industries Queensland[1]- NT Department of Primary Industry and Fisheries
Agriculture Western Australia - University of New England - University of Sydney - Cotton Research & Development Corporation
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2.0 Distribution

Silverleaf whitefly has been identified in most major cotton areas in Australia. It is readily found on a range of ornamental plants in nurseries (eg. poinsettia, duranta, hibiscus and lantana) and on ornamental plants and weeds in the field. It has also been identified in cotton crops in most areas.

The first large-scale outbreak of this pest in cotton in Australia occurred in the 2001-02 season in the Emerald irrigation area. The SLW has developed as a significant problem for the horticulture and grains industries, with regular outbreaks from northern coastal NSW through to the Bowen/Burdekin region of north Queensland.

Two critical factors in the occurrence of any SLW outbreak are climate and the provision of a continuous supply of suitable hosts in the cropping system - unless both of these are favourable an outbreak of SLW is unlikely.

Diagram 1: Relative influences of management system and climate on SLW populations modified after Steve Castle, USDA ARS Western Cotton Research Institute.

Climate: SLW does not have an overwintering diapause stage so its distribution is limited to those areas where it can survive winter conditions. In some areas that are too cold in winter, populations can persist in glasshouses and be a recurrent problem.

The growth rate of SLW decreases and generation time increases in cooler weather (See Table 1). It is more likely to be a potential pest in areas where the winter generation time is 80 days or less (as occurs in areas from Biloela north). This is because the warmer winter conditions in these regions allow more generations per year and particularly increase the opportunity for higher numbers to survive through winter and for a faster build-up in spring.

Moving further south (e.g. Macintyre, Gwydir, Lower Namoi), the winter generation time is around 120 days (102 days in St George). The cooler conditions in these regions mean slower generation times, reduced chances of survival and hence less opportunity for a significant population build-up in late spring/ early summer.

Continuity of suitable hosts: A long period of continuous availability of suitable hosts is essential for whitefly outbreaks. These may be weeds or cultivated hosts. The discontinuity of host availability in some Australian cotton producing areas in northern NSW and the Darling Downs is a

Table 1. Numbers of generations for silverleaf whitefly across a range of locations during the peak growing seasons in these areas.

Location	Generations[1] Oct – Mar* Mar – Oct ** Mar –Dec***	Generations per Year	Longest Generation (approx)	
Narrabri*	4-7 (6)	6-9 (8)	122 days	15 Apr - 15 Aug
Goondiwindi*	5-8 (6)	7-10 (8)	118 days	15 May - 10 Sept
St George*	5-8 (7)	7-11 (9)	102 days	1 Jun - 10 Sept
Biloela*	6-8 (7)	7-11 (9)	92 days	1 Jun - 1 Sept
Emerald*	6-8 (7)	9-12 (10)	77 days	15 May - 1 Aug
Richmond**	6-8 (7)	11-15 (13)	61 days	15 May - 15 Jul
Katherine**	7-9 (8)	13-17 (15)	30 days	15 Jun - 15 Jul
Kununurra**	8-10 (9)	14-18 (16)	30 days	15 Jun - 15 Jul
Broome**	9-10 (9)	14-18 (16)	30 days	15 Jun - 15 Jul
Bundaberg***	5-7 (6)	7-11 (9)	87 days	1 Jul – 25 Sept
Bowen***	7-11 (9)	10-14 (12)	45 days	1 Jun – 15 Jul
Ayr***	7-11 (9)	10-14 (12)	45 days	1 Jun – 15 Jul
Gatton***	4-7 (5)	6-10 (8)	108 days	15 May – 1 Sept

[1] Generations from 1st of the month to 1st of the month. (Average in brackets) Source: Paul DeBarro,

major factor in reducing the likelihood of outbreaks. In these regions the predominant cotton/ cereal or cotton/ legume rotation does not particularly favour whitefly as neither the cereals nor the specific legumes grown (particularly vetch) are particularly good hosts. Further-more, in early spring and autumn, there is generally a 'gap' period with few attractive, suitable cultivated hosts. The availability of weed hosts varies seasonally with rainfall but in general the lack of weed hosts through early winter and the cooler climate may mean that the populations do not build quickly.

In contrast, the almost continuous availability of suitable hosts in the Emerald Irrigation Area acts synergistically with climate to make further outbreaks probable. Of particular significance is the availability of horticultural vegetables, particularly cucurbits through much of the year. Weed cucurbits or untended or abandoned cucurbit crops can act as potential reservoirs for whitefly to survive through winter and from which they can develop in spring.

Table 2: Emerald Crop Calender (Crops Effected by SLW)

Emerald Crop Calender (Crops Effected by SLWF)

July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
		Cotton									
	Cucurbits						Cucurbits				
					Soybeans						
					Peanuts						
							Navy Beans				
						Mung Beans					
						Sunflowers					

Source: David Parlato

3.0 Damage caused to plants

The SLW can cause damage in several different ways.

Damage by direct feeding: Having a high reproduction rate and a short generation time the large numbers generated can retard plants simply through insects removing assimilates from the plant that would normally be distributed into plant growth. This creates damage similar to that caused by aphids.

Honeydew: The insect secretes large quantities of sticky honeydew that not only interferes with photosynthesis but also causes problems with cotton fibre processing. Honeydew is the sugar rich waste excreted by feeding whitefly. Growers delivering sticky cotton will receive an immediate discount on the tarnished cotton, but of greater concern is the reputation a district or industry can develop for producing sticky cotton. Whitefly honeydew is considered worse than aphid honeydew because it has a higher boiling point and hence is more difficult to remove in processing. Honeydew production varies with the age complex of the population. Nymphs will produce more honeydew on poorer quality hosts as they need to feed and excrete more to gain adequate nutrition.

Photo 1: Cotton boll tarnished with honeydew (photo, Neil Forrester)

Vector of diseases: The SLW is a highly efficient carrier of viruses. In cotton crops in Pakistan and the USA, whitefly is a vector of cotton geminiviruses (eg. cotton leaf curl in Pakistan). None of these viruses are known to exist in Australia, but should they enter the country the SLW is now present to spread them.

Photo 2: Cotton Leaf Crumple Virus on a crop in California (Photo, Greg Kauter, CSD)

4.0 Lifecycle

Whitefly eggs are generally laid haphazardly on the underside of leaves. The newly laid eggs are yellow/ green, changing color to dark tan as they are about to hatch. They are very small (difficult to see with the naked eye), oval shaped, and sit on top of a pedicel (stalk) that fits into a small slit in the leaf made by the female. The pedicels enable moisture to be drawn from the leaf, preventing dehydration of the eggs. Leaves with high densities of whitefly eggs often have a 'dark' sheen on the underside.

COTTON information sheet

Photo 3: Large SLW egg densities on a leaf (Photo: Neil Forrester)

The first instar 'crawler stage' is the only nymph stage that is mobile. They will travel a few centimeters to find a suitable part of the leaf and start feeding. Once a suitable feeding site is selected, the crawler will insert its mouthparts into the leaf, extracting plant sap.

Instars 2-early 4 continue feeding without moving from the position selected by the crawler. The late 4th instar is a "resting phase" during which the nymph metamorphoses into the winged adult. During this phase, the insect stops feeding and becomes a pupa or 'red eye' (Photo 4), out of which emerges an adult.

Photo 4: Fourth instar or pupa stage SLW (photo: Paul DeBarro, CSIRO)

Female whitefly are produced from fertilized eggs and males from unfertilized eggs. Most of the adults emerge as females and, as females tend to live longer, they make up a significantly higher portion of the population. Each female can lay up to 300 eggs. The lifecycle, from egg to adult can be as short as 18 days in summer; this is longer in cooler weather. See Diagram 2 showing the life cycle at 28ºC

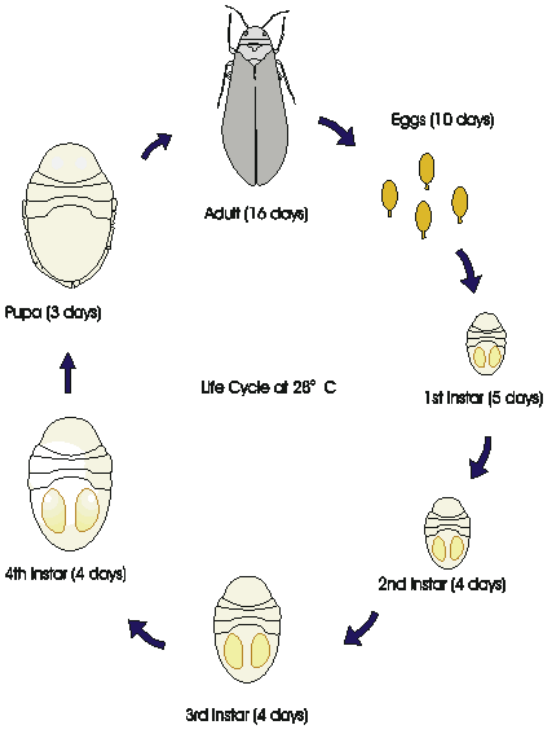

Diagram 2: Silverleaf Whitefly Life Cycle @ 28ºC

5.0 Pest management

In cotton production systems around the world where silverleaf whitefly have been managed effectively, the key has been integrated pest management (IPM) in combination with area-wide management approaches. Core IPM principles are described in the IPM Guidelines for Australian Cotton and these apply to management of SLW. See ENTO pak or web site below. (http:/www.cotton.pi.csiro.au/Publicat/Pest)

Insecticides play an important role in management but, due to resistance and the effects of some of them on beneficial insects, they need to be incorporated into a wider IPM approach.

The key to managing SLW is to apply good IPM principles:

- Reduce the risk of creating a problem
- Conserve beneficial insects that will help provide control
- Early intervention with selective insecticides if required to prevent SLW reaching levels where the selective insecticides are not effective and broad-spectrum insecticides are required.

Whitefly sampling and pest management is covered in detail in the companion document *Strategies to Manage Silverleaf Whitefly in Australian Cotton*. Australian Cotton CRC Research Review.

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