



## Mirid Ecology in Australian Cotton

Outcomes from the Mirid Management Workshop, 15 July 2004

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### Introduction:

Green mirids (*Creontiades dilutus*) have always been considered a significant pest of Australian cotton because of their great mobility and ability to cause very rapid damage. A related species, the brown mirid (*Creontiades pacificus*), is also sometimes found in cotton, but in cotton is generally less abundant than the green mirid. Brown mirids are quite common in pulse crops.

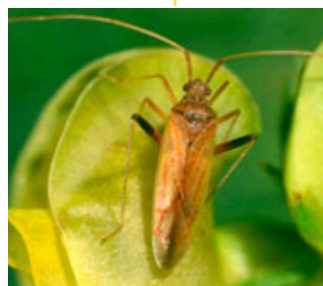
Traditionally, under a conventional insecticide system, mirids were only considered a pest early in the cotton season. Towards the mid to late part of the season the use of broad-spectrum insecticides for *Helicoverpa* spp. gave incidental control of mirids. With the broad scale adoption of cotton varieties that contain the Bollgard II genes (Cry1Ac and Cry IIAb) that offer protection against *Helicoverpa* spp., and the shift towards integrated pest management practices, there has been a marked reduction in insecticide applications and change toward use of more selective insecticides on Australian cotton crops. These changes allow mirids to survive and build up through the season, when before they would have been coincidentally controlled by insecticides applied for other pests early in the season.

### Mirid Ecology

Mirids are native to Australia and are polyphagous insects, meaning they feed and develop on a wide range of host plants, including sunflowers, safflower, lucerne and many legume, and weed species including wild turnips, verbena, common joy weeds and thistles. During the winter months they are often difficult to locate, overwintering as adults or eggs on wild plants in low numbers. However, as temperatures begin to rise in August, their populations increase.



**Figure 1:** Green mirid (*Creontiades dilutus*) Note striped antennae, (Photo J.Wessels)



**Figure 2:** Brown mirid (*Creontiades pacificus*) (Photo J.Wessels)

The primary movement of mirids into cotton crops occurs during November as alternative host plants within the vicinity of cotton crops tend to dry off and insects seek a fresh food source. There is also evidence of long distance migration, possibly from inland areas, associated with weather fronts, although this is not well understood. This may be the cause of some of the widespread and repeated influxes of mirids sometimes observed in cotton growing regions early in the season.

Within a crop, mirids lay eggs singly, preferentially on the leaf petiole. The egg is inserted into the plant tissue with an oval egg cap projecting above the leaf or petiole surface. Eggs hatch after 7-10 days depending on temperature; at 30-32 °C (average temperature) eggs

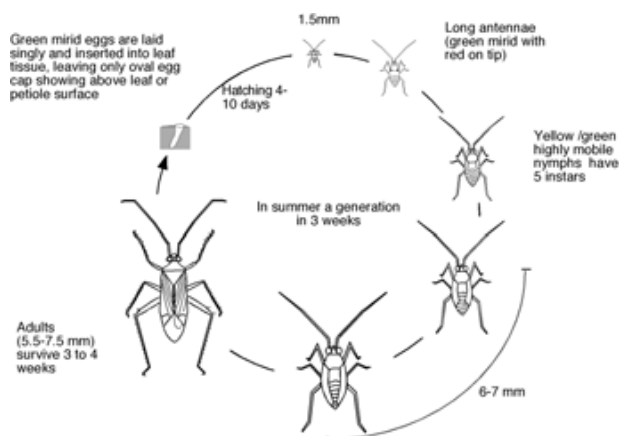
hatch within 4-5 days and there are five nymphal instars, each of about 2-3 days duration



**Figure 3:** Green mirid eggs (arrow) inserted into leaf tissue leaving egg caps visible outside leaf

(Photo M.Khan)

The pale green nymphs range in size from 1.5 mm up to 6.7 mm and all instars are highly mobile (walking) with long antennae (2 – 9 mm). Under summer conditions, a generation (egg to adult) can be completed in about 3 weeks. Adults can live for 3-4 weeks.



**Figure 4** Life cycle of the green mirid

Mirid populations may vary significantly with climatic conditions. In sustained hot weather (3 consecutive days  $>35^{\circ}$  C), numbers may decrease. Numbers will also tend to be lower immediately after heavy rains or storms, though early in the season it is thought that storm fronts may also bring influxes of adults. These factors need to be considered when sampling.

#### Natural Enemies

A number of generalist predators are known to feed on mirids. These include damsel bugs, big-eyed bugs, assassin bugs, predatory shield bugs, spiders and ants. Specific parasitoids that attack mirids have yet to be identified in Australia, though this does not mean they do not exist. Although the effectiveness of beneficial insects at controlling mirid populations is poorly understood, every effort should be made to maintain

beneficial populations for an effective IPM system. Mirids are also predatory and are known to eat mites and *Helicoverpa* spp. eggs, though their predatory activity has not been studied in detail.



**Figure 5:** Mirid damage showing blackened Squares

(Photo C Mares CSIRO)

#### Mirid Damage

During feeding, mirids will pierce the plant tissues with their stylet and release pectinase enzymes and other chemicals that destroy the cells in the feeding zone. The affected area rapidly dulls in colour, then blackens and dies. Favoured plant parts for feeding are the terminals or tip (particularly in seedlings), squares of all sizes, young leaves and small bolls. When feeding on squares, mirids particularly target the ovule and pollen sacs, which are rich in protein. Mirids also feed on the stalk (peduncle) of small squares since they are soft enough to penetrate with their stylets. Similarly, they target the developing seeds of young bolls, also rich in protein.

Mirid damage is cumulative and maximum damage occurs when the insect reaches the 4th and 5th nymphal stages. Adult green mirids cause more damage than the nymphal instars 1-3 and similar levels of damage to the final instars 4 and 5.



**Figure 6:** Wilted Cotton terminal produced by mirid feeding

(Photo M.Khan)

**Tip Damage:** Mirid feeding on the tip of seedling may result in it wilting and in a time delay while the plant produces another dominant growing terminal. No yield loss has been associated with

this type of damage, though with repeated tip damage events there may be a small delay in crop maturity.

**Square Damage:** Mirid damage will vary with the age of the square. Squares produce the enzymes oxene and ethylene. Oxene ensures the square is retained and ethylene causes the square to shed. The balance of these two enzymes is disturbed by mirid feeding. Oxene production sites (the ovules) are destroyed and ethylene production is stimulated at the damage site. Boll shed follows.



**Figure 7:** Cross section of a healthy cotton square showing structures targeted by mirids (Photo L. Wilson)

Small squares will also be shed if mirids feed on the stalk of the squares and destroy the surrounding cells by injecting pectinase at the feeding site. In larger squares, the mirid mouthparts are not long enough to reach the ovule and stalks of the squares are too hard for stylets to penetrate, meaning the square is not shed. However, damage occurs to the developing anthers and can result in deformed bolls due to lack of fertilisation of some ovules. This is often referred to as "parrot beaking". Note that mirids are not the only cause of this deformity as it is also associated with pollen sterility caused by high temperatures and high humidity.



**Figure 8:** Parrot beaking of bolls caused by mirids. (other causes such as pollen sterility following periods of high temperature can also produce this symptom (Photo M.Khan)

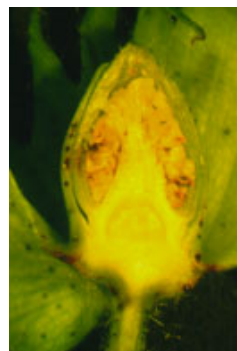
**Boll Damage:** As with squares, damage to bolls varies with age. Damage to young bolls, less than 10 days old will generally result in shedding. As a boll gets older it is less prone to damage to a point where after approximately 20 days bolls are

unlikely to be damaged by mirids due to the tough thick boll coat. In young bolls less than 20 days old, the mirid will pierce the boll wall to feed on developing seeds, which are rich in protein. If the boll is not shed, then the damaged locks may not develop properly, impacting on the pickability of the boll and subsequent lint yield of the boll

Damage caused by mirids cannot be distinguished from damage caused by green vegetable bugs. The damage caused by brown mirids is the same as that of the green mirid.

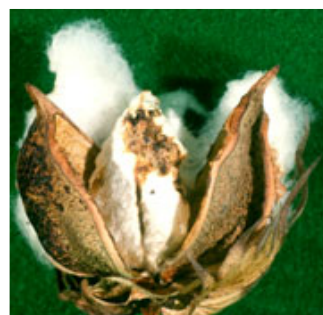
### Determining the Source of Fruit Damage

Squares and young bolls (less than 10 days old) may be aborted for a number of reasons including stress (e.g. heat or cold shock) or insect damage. Cause of shedding can be determined by cutting open freshly shed squares or bolls. The ovule of mirid-damaged squares will be blackened and/or the anthers and pollen sacs will be damaged and brown.



**Figure 9:** Cross section of mirid damaged square with anther damage. Damaged anthers are darker. Some darkening is also visible where petals and sepals have been pierced (Photo D. Larsen)

The locks of mirid-damaged bolls, or those damaged by green vegetable bug, will be stained.



**Figure 10:** Boll Damage typical of mirids. Note this damage is similar to damage caused by green vegetable bug (Photo M. Khan)

Squares or bolls damaged by chewing insects (e.g. *Helicoverpa* spp.) will have evidence of feeding such as a hole or frass, and those shed physiologically will have no apparent damage. Bolls older than 20 days are generally less prone

to mirid damage as the hardening of the boll walls make it more difficult for feeding to take place.

#### Redirection of Plant Resources / Compensation

Cotton has an excellent ability to recover from insect damage through a number of mechanisms. In all of these recovery mechanisms there may be a delay in development.

**Terminal Damage:** When the plant's terminal is removed or damaged prior to squaring, the plant will produce more vegetative branches (or monopodia). This may delay the onset of fruiting but because there are more vegetative branches, each producing fruiting branches, the initial rate of fruit production can be higher allowing damaged plants to catch up.

Extensive research has shown that plants can usually be damaged once or twice and have full recovery in yield with little or no delay in maturity. If the type of tip damage is severe, i.e. the terminal and one or two true leaves are affected, the delay in maturity can be greater (up to 10 days).

**Fruit loss:** A cotton plant will usually only retain <50 % of the total fruit set, with the remainder being physiologically shed. The plant can compensate for fruit shed due to damage by retaining other fruit that would otherwise have been shed (substitution) or by producing new squares either at the top of the plant or as outer position fruit along fruiting branches. When one of the fruits on a particular fruiting branch is lost, the plant will re-direct assimilates to remaining fruit, resulting in larger boll weight. For example, if a first position fruit is lost, then additional assimilates will be directed to the 2nd position fruit on that branch.

**Boll damage:** When seeds in a developing boll are damaged by mirids, the boll's growth will be reduced, requiring less assimilate (the product of photosynthesis). Assimilate that would have gone to the damaged boll can be redirected to undamaged bolls, resulting in an increase weight of these bolls. This mechanism can partially compensate for the loss of yield in the damaged bolls.

The ability for full recovery to take place depends on ideal growing conditions and resources during this process. For example, if a plant puts on

late fruit to recover from earlier square loss, these fruit will require adequate nutrition, water and good seasonal conditions to reach their potential.

Crops planted at high densities may be less able to compensate from square loss and terminal damage as they are less likely to produce vegetative branches or long fruiting branches (with more outer positions).

Damage within the crop is often quite uneven, with some plants suffering far more damage than others. When damage is uneven (not all plants damaged to the same degree), compensation can take place within the row with undamaged plants producing additional fruit at the expense of damaged plants.

#### Further Information

This document is a companion to *Mirid Management in Australian Cotton: Australian Cotton CRC Research Review Number 15*

#### Acknowledgements.

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