COOPERATIVE RESEARCH CENTRE FOR SUSTAINABLE COTTON PRODUCTION

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RESEARCH REVIEW

MITE Ecology on Cotton

Insects

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Summary

Spider mites (Order Acarina) are a major problem in most Australian cotton production areas. Early mite infestations which develop quickly can cause substantial reductions in lint yield, fibre quality (particularly micronaire) and oil production if not controlled. Mites are a true 'secondary pest' in that management of primary pests, especially Helicoverpa, reduces populations of mite predators which in turn allows mite populations to develop to economic levels. The information presented in this review is designed to help growers and consultants manage mites effectively with minimal reliance on acaricides. The accompanying publication, *Managing Mites on Cotton*, covers issues in mite management that may change from year to year.

Key Issues

The integrated approach to mite management can be summarised in the following key points:

- **Reduce mite overwinter survival by ensuring good weed control in and around fields through winter and spring. Rotation crops such as safflower, faba beans and field peas are good hosts for mites which may migrate to cotton seedlings as these crops senesce. Insecticides applied to rotation crops may exacerbate mites by eliminating their predators.**
- **Ensure regular and adequate sampling of mites, even at early stages of crop development.**
- **Conserve and utilise mite predators by adhering to economic thresholds for other pests and avoiding broad spectrum sprays where possible. Predators help to control other important pest species such as Helicoverpa and aphids.**
- **Balance the damage associated with early season thrips infestations (often no yield or earliness penalty) with their role as predators of mite eggs.**
- **Use thresholds or yield-loss tables to determine if mites warrant control.**
- **If mites are likely to cause economic loss, control them at, or close to, 30% of leaves infested. Delaying control may increase the need to respray. If mite control is indicated early in the season, use selective acaricides (i.e. dicofol), if possible, to limit disruption of predator populations.**
- **Use okra leaf varieties if the potential for mite infestation is high.**
- **Avoid planting corn and summer legumes near cotton fields as these crops are good hosts for mites.**

size – 0.5mm Photo:Lewis Wilson

Figure 1: Two spotted spider mite, *Tetranychus urticae*, showing characteristic green spots on either side. Also note the relative size of the mite egg above adult.

Mite Species in Cotton

The two-spotted spider mite, *Tetranychus urticae*, is the major mite pest of Australian cotton (Fig. 1). The bean spider mite, *T. ludeni*, which is deep red, is also occasionally found and causes damage similar to two-spotted spider mite (Fig. 2). *T. lambi*, the strawberry spider mite is also occasionally found in cotton. It is smaller than the others species (about 2/3 the size) with three small spots along either side (Fig. 3), and only causes very slight, non-economic damage. The brown wheat mite, *Petrobia latens*, may be found on seedling cotton, but rarely requires control.

Figure 2:

Tetranychus ludeni – similar in size to *T.urticae* but deep red. Note translucent mite egg in upper right of photo and pale adult male in foreground.
Photo: M Hill (NSW Ag)

size –0.5 mm

Figure 3:

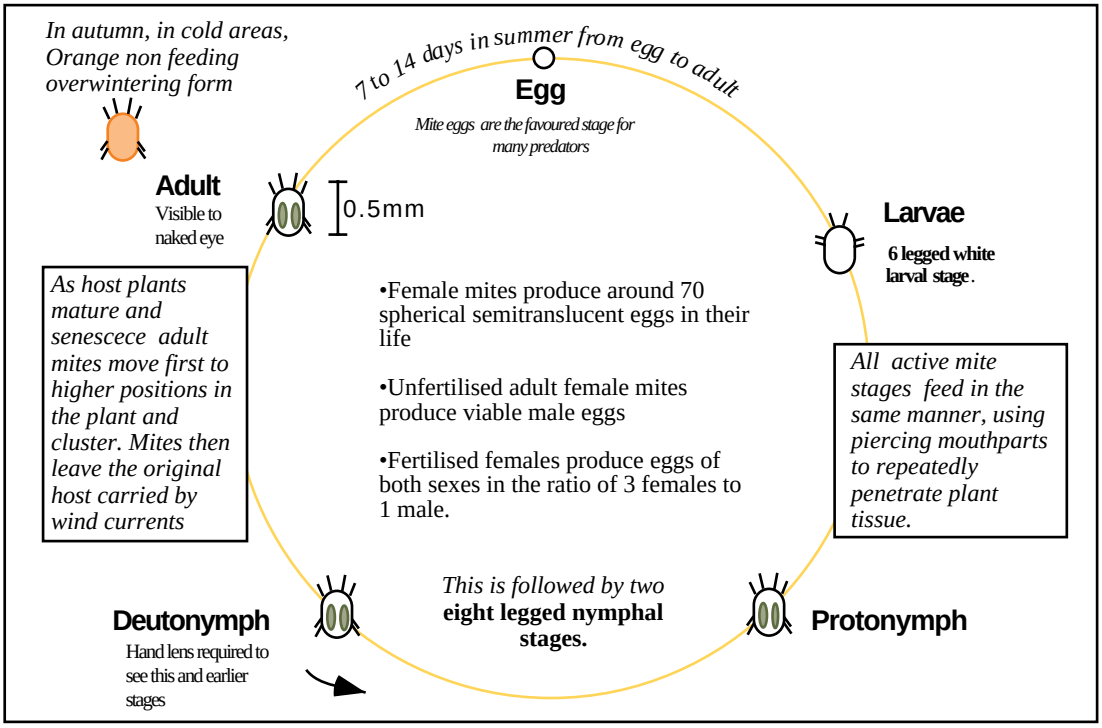
Tetranychus lambi – note smaller size and characteristic spots (6) along sides
Photo: C Mares (CSIRO)

size – 0.3 mm

Mite Biology

The two-spotted spider mite develops from an egg, through three immature stages, and finally becomes an adult (see Fig. 4). Development from egg through to adult take from 7 to 14 days in typical summer conditions. After a further day. female mites will begin to lay eggs at a rate of about 6 - 7 per day for the next two weeks.

Figure 4: Life cycle of *T. urticae*



In regions with cold winters, adult mites developing in autumn change to a bright orange 'diapause' form more tolerant of cold conditions (Fig. 5). They leave the host and seek dark, humid, protected sites to overwinter, such as the crotches of trees and under leaf litter, and do not feed or reproduce.

Figure 5:

Diapause form of Two-spotted spider mite, *T. urticae* – note bright orange colour
Photo: C. Bower (CSIRO)

size –.5 mm

Diapause mites become active as temperatures and daylengths increase in spring and move back onto hosts, resume their normal green colour and commence feeding and reproducing.

In regions with mild winters mites do not diapause and survive on suitable hosts. Intermediate straw coloured forms are often seen in cotton regions. These are not in diapause and will feed and reproduce if they find a host.

Mite Ecology

Mites are adapted to exploit ephemeral hosts, especially weeds, and to produce large numbers of off-

spring to ensure some will migrate successfully to new hosts before the current host dies.

Mated adult females, the main dispersing stage, are ready to start another colony as soon as they settle on a new host. The two-spotted mite in particular has a broad host range, ensuring that at least some migrating mites will find suitable food.

The adaptations for this mode of existence (fast development, broad host range) mean that mites are well equipped to take advantage of highly fertilised and well watered cotton crops.

Mites move to new hosts by crawling (short distances), or are carried passively on wind currents for considerable distances (at least 1.5 km). Movement of chippers, checkers and machinery can also assist in spreading mites which can adhere to clothing, tyres and chassis and thereby transfer to new plants.

Sources of mites entering cotton crops

In cotton regions, mites mostly survive the winter as active colonies on hosts such as winter weeds or rotation crops. Key weed species include: turnip weed, medics, sowthistle, deadnettle, wireweed. Important crops include safflower, faba beans and field peas. In spring, as these hosts senesce, mites are forced to migrate to new hosts, like cotton seedlings. As mites are blown into cotton fields more are intercepted by plants on the edge of a field than reach the interior: resulting in an edge effect. This initial influx of mites forms the 'seed' for populations that develop later.

Mite infestations on seedling cotton tend to be higher in seasons following wet winters when there are more weed hosts, and lower following dry winters. Controlling weeds within fields and along field boundaries helps reduce mite survival through winter.

Irrigated winter rotation crops provide hosts for mites in dry winters when there would otherwise have been few. Winter cereal crops are poor hosts for mites although broadleaved weeds within these crops may be good hosts. Winter cereals are, however, good sources of thrips which are predators of mite eggs. Chickpeas are also poor hosts for mites due to the sticky leaves and stems of these crops.

Mite survival may be increased if rotation crops are sprayed with broad-spectrum insecticides to control other pests, as these sprays reduce mite predators. For example, safflower is a particularly good host for mirids which may migrate to and damage nearby cotton. Insecticides applied to control mirids in either the cotton or the safflower can substantially increase the likelihood of mite outbreaks in cotton due to suppression of predators in the sprayed crop (see Fig. 6).

If cotton crops mature very late, mites may enter diapause and move into leaf litter and trash. Cultivation of the soil, as employed for pupae busting (see *Research Review Vol 3 No 2*), will also help reduce survival of diapause mites.

Avoid planting maize and summer legume crops near cotton. These crops are both good hosts for mites. and there is no effective means of controlling mites on them.

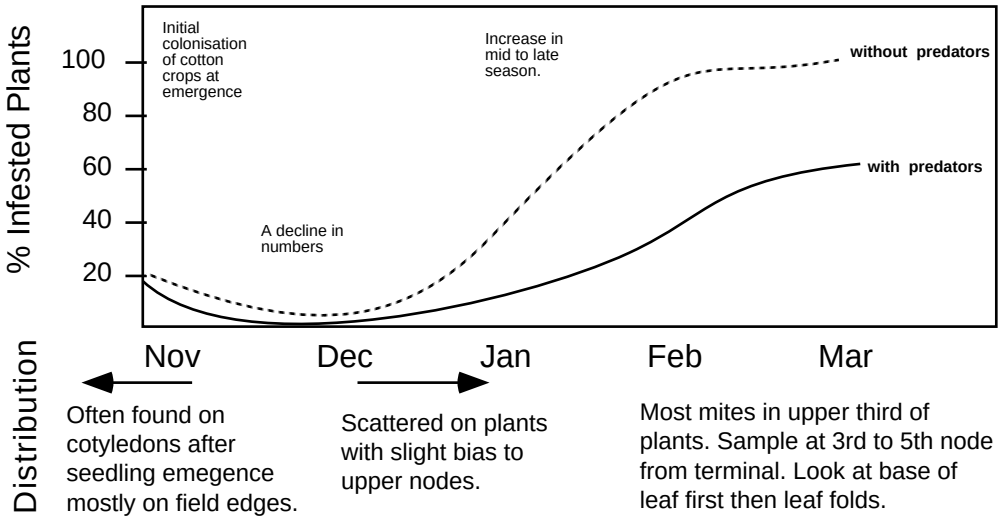
Factors affecting population increase

Fields with high mite infestations at the seedling stage are more likely to suffer mite outbreaks. Sampling cotton crops at this stage is critical for detecting mites and adjusting management strategies to reduce potential losses where necessary.

Survival and development of mite populations on young cotton can be affected by weather (rain and hail can temporarily reduce mite populations), in-furrow insecticides (crops treated with aldicarb or phorate will have fewer mites), and predation.

Mite populations are normally held in check by predators, including thrips, big-eyed bugs, two-spotted

Figure 6: Common population cycle *T. urticae*



ladybeetles and other ladybeetles, tangle web spiders, apple dimpling bugs, brown smudge bugs, pirate bugs and damsel bugs. Early season reductions in predator abundance, due to application of broad spectrum insecticides, allows increased mite survival and earlier development of economically significant outbreaks (see Fig. 6). If control is necessary, adhering to economic thresholds for other pests and selecting the least disruptive insecticide, will help to preserve predators and delay mite outbreaks. The most recent information on the effects of current insecticides on beneficials is available in the accompanying publication *Managing Mites on Cotton*.

Acaricides and Resistance Management

Mites live on the undersides of leaves which makes them difficult to target with acaricides. With all acaricides good coverage, especially underleaf, will give best results.

In many other agricultural and horticultural systems mites have rapidly developed resistance to a wide range of acaricides. A strategy to avoid resistance, based on the lack of cross resistance between any of the acaricide groups, is outlined in the accompanying publication *Managing Mites on Cotton*.

Sampling for Mites on Cotton

The sampling protocol developed for mites is based on their preference for mature active leaves rather than young unfolding leaves, or old senescent leaves and their highly clumped distribution (patchiness) across fields. This patchy distribution is often seen as 'hotspots' or small areas of reddened, mite-damaged plants distributed across a field. Sampling as widely as possible increases the chances of detecting mite outbreaks before they cause economic loss.

1. Walk into the field about 40 m. Early in the season it is also advisable to sample near the field edges to see if significant influxes of mites have occurred.
2. Take a leaf from the first plant on the right or left. The leaf should be from the third, fourth or fifth main-stem node below the terminal. If the plant has less than three leaves, sample the oldest. Note that early in the season, it is simpler to pull out whole plants.
3. Walk five steps and take a leaf from the next plant, on the opposite side to the previous one, and so on until you have 50 leaves.
4. Once all the leaves have been collected score each leaf by turning it over, looking at the underside, first near the stalk, then scanning the rest of the leaf. If mites of any stage (eggs or motiles) are present score the leaf as infested. A hand lens will be needed to see mite eggs.
5. Repeat this simple procedure at several widely separated places in the field to allow for differences in mite abundance within the field. Depending on the size of the field, 4-6 sites are needed to obtain a good estimate of mite abundance. When finished sampling, calculate the overall percentage of leaves infested with mites.

Damage and Thresholds

Spider mites feed by piercing leaf cells and removing the contents of palisade and mesophyll cells, which are the primary sites of photosynthesis. Initially mite feeding has little effect on photosynthesis, though it causes visible signs of damage (Phase I, Fig 7). This is indicated by white 'stippled' areas on the undersurface of the leaf, usually begining at the base of the leaf blade and seen as corresponding small bronzed or reddened areas on the upper leaf surface. As populations increase, leaf damage also increases and photosynthesis is severely reduced (Phase II, Fig. 7). Reductions of photosynthesis at this stage lead to reductions in crop growth, fast leaf senescence, and economically important yield reduction and quality loss (reduced micronaire).

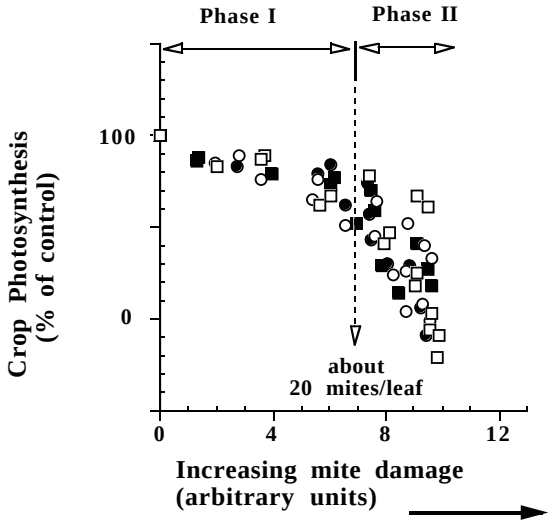


Figure 7: Cumulative mite damage and yield loss

If unchecked by predators or acaricides, mite populations increase exponentially until they eventually cause plant defoliation. Yield loss is a function of the timing of mite population increase and the rate of increase: early, fast increase has the greatest effect, and later, slower increase the least.

General thresholds for mites are given overleaf. Even though mite damage does not begin to affect photosynthesis until populations are quite high, control is difficult if mites are allowed to reach these levels. Optimal control is achieved at lower densities of about 1-2 adult female mites per leaf or about 30% of plants infested.

Tables of yield losses expected from mite outbreaks, based on time and rate of increase (see *Managing mites on Cotton*) provide a more accurate

Figure 8: Stippled and bronzed areas on a cotton leaf indicating moderate and heavy mite infestation.

basis for decision making. **NB** The tables and calculations are built into the entomoLOGIC decision support system. Be aware also that the effect of predators may be altered by recent sprays.

Control of mites is warranted if the value of potential yield loss is double the cost of control (i.e. make money, not just recover costs). The impact of predators is built into these tables as effective predation will lower rates of increase, leading to low yield loss predictions. Similarly mite populations also increase later and more slowly on okra leaf varieties giving lower yield reductions than for comparable normal leaf varieties.

General thresholds for mites on cotton

i. **Seedling emergence to squaring. Mites are normally suppressed by predators, especially by thrips during this period. Mite populations only need to be controlled if they begin to increase, which indicates that natural controls are not keeping them in check.**

ii. **Squaring to first open bolls. Control if mite populations increase at greater than 1% of plants infested/day in two consecutive checks, or if more than 30% of plants are infested.**

iii. **First open bolls to 20% open bolls. Control is only warranted if mites are well established (greater than 60% plants infested) and are increasing rapidly (faster than 3% of plants infested/day).**

iv. **Crop exceeds 20% open bolls. Control is no longer warranted.**

Mites in dryland cotton

Mites are usually less prevalent in dryland cotton. This may be partly because there is often less continuity of mite hosts on dryland farms which do not have a continuous cycle of irrigated crops and associated weeds, and water-stressed crops tend to be less suitable for mite development possibly due to harder leaves. In terms of yield loss, healthy dryland crops with good soil moisture are equivalent to irrigated crops. Crops that are already stressed may suffer less damage from mites than irrigated crops but well established mite populations with fast rates of increase will still cause economic loss (Table 1). Precise recommendation are not yet possible so growers and consultants will need to use their own judgment regarding the need for mite control in dryland crops.

Table 1 Comparative effects of mites on irrigated and dryland cotton. Dryland crops suffered less yield loss due to mites than irrigated crops despite similar levels of mite infestation. Experiments at Narrabri, 1996/97**.**

	Lint yield (b/ha)	
	- mites	+ mites
Irrigated	7.7	0.6
Dryland	5.4	2.1

Companion Publication:

Managing Mites on Cotton

Acknowledgements

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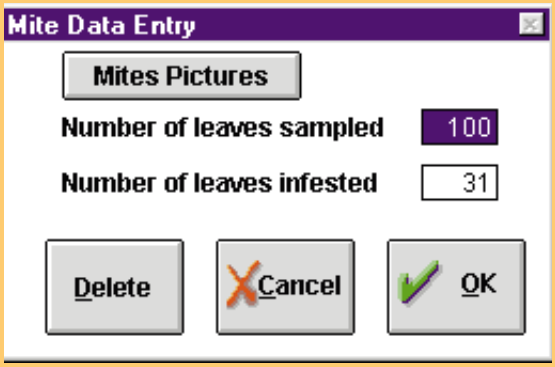
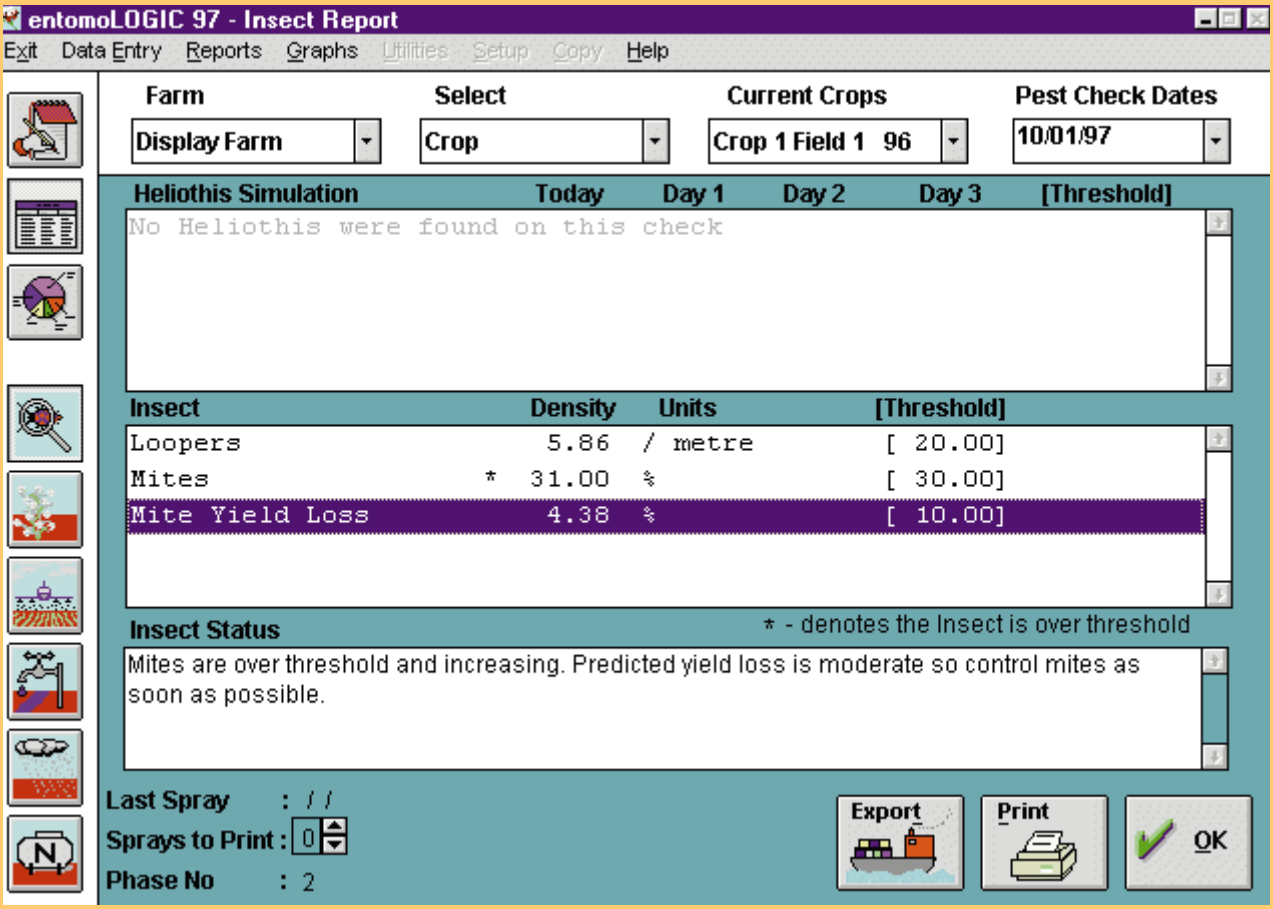
managing MITES with entomoLOGIC



entomoLOGIC – the innovative decision support system devised at the CRC for Sustainable Cotton Production, Narrabri – takes the hassle out of mite control decisions.

Mite counts are used to calculate potential yield loss if they are not controlled. **entomoLOGIC** analyses the mite figures in conjunction with other factors affecting the crop, and provides advice on whether further monitoring is sufficient or control is necessary.



Examples of mite reports: entomoLOGIC compares counts of mites today with previous checks, insecticide sprays, other pests over threshold and time of the season, to calculate mite yield loss and produce a report. Two examples of many possible mite reports follow:

- Mites are increasing and becoming more widespread. Increasing populations early in the season are of concern, even when the predicted yield loss is low. Broad spectrum insecticides may eliminate predators allowing mite populations to increase rapidly. Resample within 7 days and control if increase continues.
- Mites are over the 30% action threshold but decreasing, possibly due to predation or weather events (heavy rain). Control is not yet necessary. Resample within 7 days to confirm any changes to this trend.

For further information on 'entomoLOGIC', contact:
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