

"Mites - What have we learnt about them?"

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The two-spotted spider mite, *Tetranychus urticae*, ranks second to *Heliothis* in importance as a pest of cotton. Mites reduce profitability by reducing the yield and fibre quality of cotton. In order to manage mites we need to know their seasonal pattern of abundance and what factors effect this, how to estimate their abundance, how damaging they are and when to control them. It is also essential to study the biology and ecology of the pest as this knowledge can improve the use of currently available controls and may lead to other non-chemical methods of management.

Seasonal abundance

Mites can be found on cotton from the time of seedling emergence. The edges of the crop are most heavily infested, the level of infestation declines further into the crop. Within a month of seedling emergence mite numbers normally decrease, possibly due to the combined effects of predation by thrips, increased host plant resistance in response to mite feeding and the effects of sprays for other pests. Mites can still be found through November and December, although typically less than 1% of plants are infested. Populations normally begin to increase from January onwards possibly due to a) changes in the cotton plant associated with flowering and fruit formation, which increase its suitability for the development of mites or b) the high temperatures at this time and increased humidity in the crop associated with irrigation and closure of the crop canopy. Studies to define the environmental conditions favouring mite population increase and the effect of plant quality on mite development are planned. These studies will include measurement of nitrogen, tannin and gossypol levels, all of which vary with plant age, to determine whether chemical changes in plants influence population development.

When environmental conditions are suitable the rate of increase of mite populations can be dramatic. Table 1 shows the development times for mite eggs and for complete development from egg to adult for a range of constant temperatures. This illustrates just how quickly they can develop at high temperatures. Female mites normally produce about 6-7 eggs per day and live for 10-15 days.

Table 1. Development times (days) for eggs and for complete development from egg to adult for *T. urticae* on cotton (from, Carey and Bradley, 1982).

	Temp (°C)				
	15.5	18.3	21.1	23.8	29.4
eggs	11.9	6.5	6.0	4.4	2.5
eggs to adults	25.8	16.5	15.0	10.5	6.1

Overwintering and sources of infestation

Where do mites come from? Mites infesting seedling cotton are likely to come from populations from the previous season that have survived through winter. By understanding the survival of overwintering mites we may be able to develop methods to reduce the size of these populations. For these reasons we have carried out studies to locate the overwintering populations. To date we have been unable to find significant populations of mites in the soil within cotton fields, although the difficulties in finding a low number of mites in soil are considerable. However, mite colonies can be found on a wide range of the weeds found on and around cotton farms through winter and these may be important sources of infestation. Mites are easily dispersed by wind and will move to the tops of plants to facilitate dispersal if plant quality declines - as happens in late spring when most winter weeds seed and die. We assessed the 'mitiness' of weeds, both around cotton fields and from bush at least 500m away from cotton fields. The 'mitiness'

rating was calculated by multiplying the relative abundance of each weed species by its level of infestation with mites

Mites were considerably more abundant on weeds from around cotton fields compared with those away from cotton (Table 2). Mites were found on 24 species of weeds around cotton fields but on only 8 weed species sampled away from cotton. These results suggest that mites are highly localized around cotton farms, where suitable hosts for mites may be present year round. Away from cotton farms there are normally few weeds suitable for mite development during the summer.

Table 2. Comparison of the relative 'mitiness' rating of the nine highest rated weeds sampled from around cotton fields and from bush at least 500m away from cotton fields in September 1987. High 'mitiness' ratings indicate greater potential sources of mites.

Common Name	Relative 'Mitiness' Rating	
	Bush	Cotton
Wild Turnip	11.0	102.0
Sow Thistle	1.4	42.3
Wire Weed	0.7	31.9
Variiegated Thistle	1.2	20.0
Prickly Lettuce	0	18.1
Burr Medic	0.4	14.0
Paradoxa Grass	0	3.9
Dead Nettle	-	2.5
Marshmallow	0.7	1.0

Sampling

Mites pose special problems for sampling. Firstly, they are small and difficult to see and often too abundant to count. Mite eggs and larval stages are just visible with a hand lens whilst older nymphs and adults can just be seen with the naked eye. Secondly, they often have very scattered distributions in fields, with populations often developing from widely dispersed 'hotspots'. Our studies have shown that the proportion of plants infested with mites at a particular mainstem leaf node is highly correlated with the mean number of mites per leaf at that node. This relationship can be used to simplify sampling and since the number of mites per leaf is related to the amount of damage done we can

also estimate yield reduction. Presence /absence sampling avoids the need to count mites and allows larger areas of cotton to be sampled quickly, providing better estimates of mite abundance. However, to be used for management the sampling system needs to be linked to action thresholds for control which have yet to be derived and tested.

The distribution of mite populations on plants is biased towards the top of the plant from about January onwards. After completing their development some adult females remain on the leaf where they have developed, whilst others move up and down the plant resulting in a spread of mites as the population grows.

Effects of mites on yield and quality of cotton.

The effects of mites on yield and fibre quality has been studied in the past two seasons but at the time of writing (April 1988) only data for the first season is available. Cotton plots of DP90 and Siokra were artificially infested with mites in early January, early February or late February, or kept free of mites as controls. Yield was assessed with both machine and hand picks.

On DP90 the mite infestations at each occasion caused substantial reductions in yield (Table 3). By contrast Siokra suffered less yield loss, and the late February infestation had virtually no effect. Mite populations developed more slowly on Siokra than on DP90 which partially explains the differences in yield. However, Siokra is also less sensitive to mite damage and suffered less yield loss for a given level of mite infestation. Analysis of the Siratac database for the Macquarie Valley has confirmed these varietal differences. In 1988 Siokra crops had, on average, 1 less miticide and mites were first recorded a week later than DP90 or Sicala crops.

Table 3. Lint yields of Siokra or DP90 infested with two-spotted mites in early January, early February or late February or with no mites (control). Percentage reduction relative to controls is shown in brackets

Infestation Time	Cotton Variety	
	DP90	Siokra
Control	8.74	9.08
Mid-late February	7.62 (12.8%)	9.02 (0.5%)
Early February	5.70 (34.8%)	7.80 (13.9%)
Early January	4.51 (48.4%)	6.94 (23.4%)

The early January and February mite infestations reduced both the number of bolls per meter and boll weight. The late February infestation had no effect on boll number but reduced boll weight for DP90 (Table 4).

Table 4. Mean number of bolls per meter and boll weights for Siokra and DP90 infested with two-spotted mites in early January, early February or late February or with no mites (controls).

Infestation time	DP90		Siokra	
	No. bolls	Boll wt (gms)	No. bolls	Boll wt (gms)
Control	107.5	4.7	132.6	4.1
Late February	114.6	4.2	134.6	4.0
Early February	92.0	3.6	124.4	3.7
Early January	74.1	3.5	110.4	3.2

Overall, mite infestations reduced the micronaire and uniformity of cotton fibre with little effect on the length or strength. The micronaire of all bolls was reduced by mites but the reduction in uniformity was mainly found in the last 40% of bolls opening. These effects were in proportion to the amount of damage mites caused and Siokra was generally less affected than DP90. Mites also reduced size and germination of seeds.

Effects of insecticide usage patterns on mite population development.

The effects of synthetic pyrethroids on mite population increase has been studied at Narrabri. Synthetic pyrethroids caused mites to increase more quickly than they would have otherwise. An outline of this work and the mechanisms thought to cause this increase has already been presented in the *Cottongrower* (Feb-April 1988). Further work is underway, using the Siratac database for the 1986/87 and 1987/88 seasons (since the loss of chlordimeform), to investigate the effects of insecticide usage patterns on the likelihood of inducing mite problems.

Like many arthropod pests mites have developed resistance to a wide range of miticides and insecticides worldwide. The cotton industry is completely dependent on the organophosphates (OP's) for the control of mites. The systemic or translaminar action of these chemicals means they are effective for control of mites when applied aerially. Specific miticides, which have only contact action, have not proven to be effective when applied by air due to poor deposition of droplets on the underside of leaves where mites are found. Mites in cotton are resistant to OP's but these levels have remained relatively constant and have still allowed control to be achieved. However, if the levels of resistance increase the ability of OP's to control mites will be jeopardised. Studies of the resistance of mites to the OP's used for their control, profenofos, monocrotophos and chlorpyrifos, have been undertaken. Samples of mites were submitted to Dr Vic Edge at the Biological and Chemical Research Institute in Sydney, which is the major two-spotted mite resistance testing centre in Australia, but results are not yet available.

Management

The overall aim of this project is improved management of mites. The results presented above suggest some strategies which may help reduce the incidence of damaging mite populations. For example, better control of weeds on and around farms prior to planting will assist in removing local source populations. Particular attention should be paid to any situations where a field which has been heavily infested with mites,

regardless of the crop type (cotton, soybeans, maize), is to be planted to cotton the following season. Attention should also be paid to fields following winter/spring crops such as rape which are potential mite hosts. Weeds in fallow fields and on new country in the vicinity of previous cotton crops are also likely to be infested with mites.

It may be possible to delay the development of mite populations by controlling the early season populations found in late December. However, the application of miticides would have to give excellent control in order to delay development sufficiently to justify the cost of pre-emptive applications. This is particularly true if contact miticides are used. A trial in collaboration with Chris Hogendyke was conducted at Auscott Warren to investigate the effectiveness of using early miticide applications to delay mite buildup. Two applications of Curacron, Calibre or Thiovit (sulphur), one in mid December and the other in early January, were compared with an unsprayed control. A ground rig which had a nozzle above each cotton row and droppers between the rows, each with a nozzle facing upwards into the cotton crop, was used to apply the miticides. Curacron and Calibur delayed the increase of mite populations but this delay was insufficient to justify the additional costs. Better results should be obtained with better application techniques but, until proven, this strategy should be viewed with caution.

Gaining an accurate picture of the level of infestation in a large field is probably impossible without prohibitive amounts of sampling, regardless of the sampling strategy used. Possibly the most effective strategy is to sample the top (5th node and above) of as many plants as possible spread as widely across the field as possible. Score whether plants are infested or not and quickly assess if mites have colonised leaves below the top third of the plant. If a plant has any mites on it at all, of any stage, it should be scored as infested. Given the patchy distribution of mites and the need to sample widely it may pay, in areas with a history of mites, to set aside one day a week specifically to monitor mite levels, rather than trying to combine mite sampling with sampling for other pests.

Further experiments are needed to define more precisely the relationship between mite density and reduction of yield before recommendations for timing of control

can be given with any confidence. However, some commonsense suggestions can be made. The only data available are from one experiment in one season and indicate that economic loss does not occur until about 70-85% of plants are infested with mites. Mites are difficult to control at this level so control should be implemented before this in order to prevent loss from occurring, but when? There needs to be a balance between spraying at very low infestation levels, which will probably result in the use of more miticides than needed, and spraying too late when it is difficult to obtain adequate suppression of mites. Correct application of miticides is of course critical at all times, there is no point in spraying and hoping for the best.

Some clues as to optimum timing can be gleaned by studying the likely effectiveness of miticides. Spray efficacy is in part related to mite abundance and their distribution within the crop. Work by Uk and Courshee (1982) has shown that the top third of plants receive over half of the insecticide applied. Because the canopy suppresses turbulence the penetration of spray into the crop is greatly reduced below 30cm. The efficacy of miticides is therefore likely to be highest if control is applied before many mites are present below the top third. Data available indicate that this is likely to occur at sometime between 40-60% of plants infested. At this level of infestation about 10%-20% of plants will be infested below the top third. These are not absolute figures and may vary among crops and between seasons. The data available also indicate that control is unwarranted once the crop is past 30% open. A final control may be necessary prior to this time if mite populations are causing substantial damage. This level is conservative and may be revised when more information becomes available.

After the application of a miticide the level of control should be assessed. Allow time for eggs to hatch (see Table 1) as many larvae will die after feeding. Check for the presence of mite larvae or nymphs, using a hand lens, and if a high proportion of leaves which were infested pre-spray are still infested further control should be considered before nymphs have time to develop to adults.

The use of pyrethroids should be restricted, within the bounds of the strategy, to periods when the crop is relatively free of mites. Avoid using pyrethroids on developing mite populations, especially those found in January as these have the greatest potential to cause yield loss. Some of the newer pyrethroids being trialled in cotton have high contact miticidal activity and may even reduce mite populations. However, this will need to be proven before their use on mite populations can be recommended.

The development of economic thresholds and sampling plans is aimed at improving the management of mites once they are found in a crop. This may be further assisted by the eventual introduction of some of the potent new miticides available. However, a noticeable aspect of the mite problem in cotton is the variability in the severity of mite infestations between years, between regions and between farms. For example, the Macquarie Valley historically suffers more problems with mites than other valleys. Such differences are not easily explained on the basis of insecticide usage alone and lead to the question, 'Why are mites worse in some years, in some regions and on some farms?'. Answers to this question will only come from a greater understanding of the ecology of mites and this project will have a greater emphasis on the study of mite ecology in future.

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References

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