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FINAL REPORT TO COTTON RESEARCH AND DEVELOPMENT CORPORATION

INVESTIGATION OF MITE ABUNDANCE, ECONOMIC INJURY AND MANAGEMENT.

Project Number: CSP1C

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Aims:

- Use data which relates mite numbers to yield loss in order to derive and test action thresholds.
- Finalise the development of a sampling technique in association with action thresholds and include both into Siratac.
- Initiate developmental studies to determine the effects of temperature, humidity and host plant quality and variety on the rate of development of mite populations.
- Continue studies of the abundance of mites on weeds and sources of infestation into cotton.

Summary of results:

The research undertaken had two main goals, firstly to improve practical aspects of managing mites such as sampling, thresholds and timing of control and secondly to develop a better understanding of the factors influencing mite abundance. In particular, earlier research had shown that the survival of mites through the early season (November/December) strongly influenced the likelihood of later outbreaks. The possibility that early season plant quality influences mite survival was investigated. A summary of key findings is given below.

1. The earlier that mite infestations were initiated and the faster their rate of increase the greater their effect on yield and fibre quality of cotton. The development of a model to estimate yield loss, based on time of mite infestation and rate of population increase, is proposed.

2. Most durable control of mites was achieved if populations were controlled at lower levels (30% of plants infested) than at higher levels. Thresholds for mites in the Siratac program were lowered accordingly.

3. The distribution of mites in fields was highly aggregated and biased toward younger leaves. Options for improving mite sampling were given in the Siratac Manual and the sampling position for mites was changed from the 8th mainstem node below the terminal to the 3rd.

4. Analysis of seasonal abundance data indicates that higher initial infestation levels are correlated with earlier, and potentially more damaging, mite outbreaks. Further, the survival of mites through November and December seems to be pivotal in determining the extent to which this potential is realised.

5. Mites survive winter as actively reproducing colonies on whatever vegetation is available. In reducing the carry over of mites between seasons the aim should be to provide as little suitable vegetation for mites as possible. This should help reduce initial mite infestation levels in cotton.

6. Phenological changes in the suitability of cotton for mite reproduction and development were do not explain the early season decline in mite abundance. Cotton cotyledons were less suitable for mite reproduction than young true leaves. This may slow the early development of mite populations, but only until true leaves appear.

7. The resistance to mites of okra leaf genotypes was investigated. Okra leaves have less surface area suitable for mites which results in density dependent competition between mites occurring earlier than on normal shaped leaves and leads to slower rates of population growth.

Funds provided from other sources

The budget for this project averaged $106,000 per year. This included the salaries for the researcher and a senior technical officer. CSIRO provided office, laboratory and administrative facilities.

Recommendations for future research

1.The factors affecting the early season survival of mites, especially the role of predators and the effect of early season organophosphate applications on them, need further investigation. This should help to better define the impact of various pest management strategies on subsequent mite populations.

2. The potential for augmentation of natural predators with introduced species, such as the predacious mite Phytosieulus persimilis should also be investigated.

3. Plant resistance to mites. If the morphological basis for resistance is correct then super-okra genotypes cultivars may be even more resistant than okra genotypes and this hypothesis should be tested. Tannins have also been implicated in resistance to mites and should be investigated further.

4. The timing of miticide applications in relation to the duration of control, mite population density and yield-loss needs to be studied further in order to better refine recommendation for timing of control.

Application of results to industry

The results provide the basis for developing a model that will allow growers/consultants to assess whether a given mite population is likely to cause economically significant damage or not. They also provide the basis for developing improved sampling protocols for mites. Identification of weeds and other vegetation as the carry-over for mites in winter open the possibility of reducing initial infestation of cotton crops, and thereby reducing the likelihood of later mite outbreaks.

Publications arising from this project.

Wilson, L.J. (1988) Pyrethroids and mites - what do we know? Australian Cottongrower 9(1): 6-7.

Wilson, L.J. (1988) Mites - what have we learnt about them? Proc. 4th Australian Cotton Conference, Surfers Paradise, August 1988. pp 25-33.

Wilson, L.J. (1989) Early season ecology and management of spider mites in cotton. Proc. ICI Cotton Conference, Gold Coast, August 1989.

Wilson, L.J. (1990) Mites - guidelines for management and future prospects. Proc. 5th Australian Cotton Conference, Broadbeach, August 1990, pp 381-388.

Wilson, L. J. and Bauer, L.R. (1990) Mite control: Siokra performs best. Australian Cottongrower 11(3): 14-17.

DETAILED PROJECT REPORT

INVESTIGATION OF MITE ABUNDANCE, ECONOMIC INJURY AND MANAGEMENT. (1988-1990)

L.J. Wilson

Introduction

In Australia the two-spotted spider mite, *Tetranychus urticae* Koch, is regarded as a major pest of cotton. However, neither the pest status nor the ecology of spider mites on cotton has been studied. Consequently management strategies are based on information derived elsewhere, which may not be relevant in Australia. Therefore the pest status of mites, their patterns of distribution and abundance on cotton and associated host plants, and the factors that influence these patterns were investigated. This project produced a large amount of information from a wide range of experiments. Rather than detail experimental methods, presentation is restricted to the key findings and their implications for mite ecology and management.

Pest status and effect of mites on yield and fibre quality of cotton.

Four experiments utilising artificial infestation of plots of cotton with mites at various times through the season showed that mites can cause significant reductions in the yield and fibre quality of cotton. Results of one of these experiments are shown in Table 1. The earlier that mite infestations were initiated and the faster their rate of increase the greater their effect on yield and fibre quality of cotton. The development of a model to estimate yield loss, based on time of mite infestation and rate of population increase, is proposed.This will allow allowing potentially damaging mite populations to be identified and controlled and should save growers from controlling non-economic populations.

Analysis of the components of yield (boll weight and boll number) suggest that mites affect yield primarily by reducing the photosynthetic capacity of leaves. This decreases the amount of assimilate available to meet the needs of developing bolls. Severe mite damage early in the fruiting period enhances competition for assimilate between sinks (i.e. fruit and leaves) causing shedding of fruit (reducing the number of bolls) and limiting boll development (reducing the size of bolls). Infestations occurring later in the season, after the majority of fruit are set, do not reduce the number of bolls set but affect yield by reducing the plants capacity to meet the demands of maturing bolls resulting in smaller bolls.

Table 1. Yield (bales/acre) and % yield reduction for DP90 or Siokra infested with mites on 21st Dec, 23rd Jan or 1st Feb compared with mite free controls. NARS 1990.

Time of infestation	Variety	
	Deltapine 90	**Siokra**
Control	3.5(0%)	3.4(0%)
1st Feb	3.0(-14%)	3.3(-3%)
23rd Jan	2.7(-23%)	3.3(-3%)
21st Dec	0.8(-77%)	2.0(-40%)

Patterns of distribution and abundance

The pattern of seasonal abundance from 4 sites displaying typical patterns of seasonal abundance is shown in Figure 1. Mites colonise cotton at seedling emergence. Populations usually declined though November/December then increased progressively through the remainder of the cotton growing period. Higher initial infestation levels were correlated with earlier, potentially more damaging, mite outbreaks indicating that the damaging populations found later in the season develop from the initial populations found on seedlings (i.e. compare sites A and B with C and D). Survival of mites through November and December appears to be pivotal in determining the extent to which this potential is realised (i.e. compare site B with C).

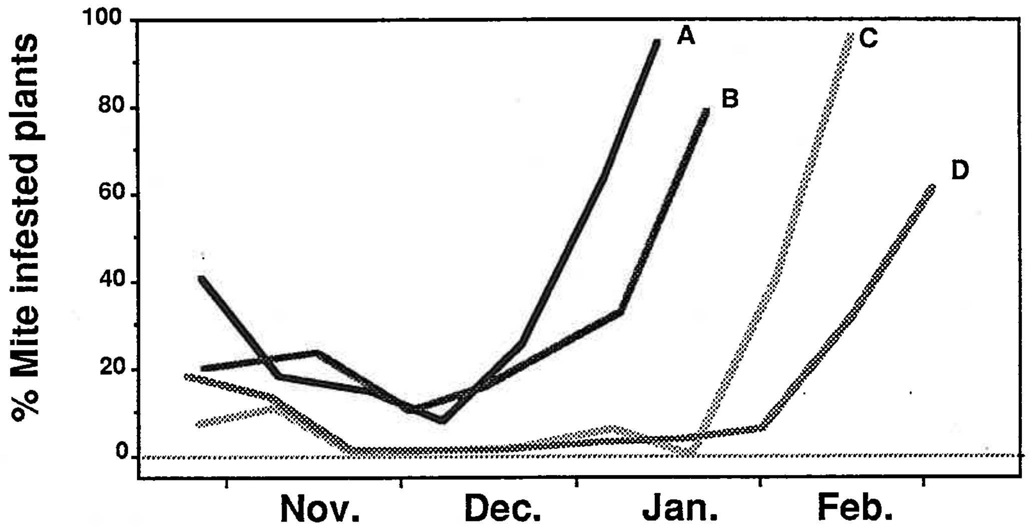

Figure 1. Seasonal abundance of mites at 4 different sites in the Namoi (A, C and D) and Gwydir Valleys (B).

Early in the season the distribution of mites was biased toward the bottom of the plant. As plants grow taller the distribution of mites gradually shifts upward toward younger leaves so that the modal node (node with the most mites) is generally between the third and fifth node below the terminal. This pattern was unaffected by cotton variety or insecticide applications. Leaves from the third to fifth mainstem node leaf below the terminal should be used as the sampling unit for pest management.

Mites populations showed a strong edge effect early in the season (Oct. and Nov.) indicating that mites enter cotton crops from an external source, rather than surviving winter in the soil or litter of the field itself (Table 2). The edge effect diminished with time suggesting a lack of continuous colonisation. Hence the source of the mites colonising cotton would appear to be ephemeral. The only exceptions to this pattern occurred when mites migrated from senescent maize crops into the nearby cotton crops in early January.

Table 2. Percentage of cotton seedlings infested with mites at 0, 30, 60 and greater than 60 metres from the edge of field at seedling emergence.

Metres from Edge	**Site**			
	Wentworth	Norwood	Carsons Block	Cumberdeen
0	13.6	35.5	57.1	79.2
30	0	14.0	33.3	37.9
60	0	12.0	11.0	21.7
60+	0	0	11.5	14.3

Sources of mites infesting cotton

Weeds in the vicinity of cotton fields appear to be the major source of mites infesting seedling cotton. Mites were found, through winter, in actively reproducing colonies on weeds and other vegetation, including cotton regrowth, in the vicinity of cotton fields. The natural senescence of weeds in spring forces mites to disperse, often onto young cotton seedlings, probably explaining the 'edge effect' found early in the season. The cotton/winter cereal crop rotation used in the major cotton growing regions, and lack of cultivated perennial hosts of mites, means that once winter/spring weeds senesce there are few other sources of mites to infest cotton. This explains the lack of continued colonisation of cotton by mites. Mite abundance on weeds at locations remote from cotton was far lower than on the same weed species on cotton farms (i.e. Table 3). Hence weed control on cotton farms through winter/spring could potentially reduce the initial level of mites infesting cotton seedlings in the following cotton season.

Table 3. Comparison of the relative 'mitiness' of the nine highest rated weeds sampled from cotton fields and from vegetation at least 500m away from cotton fields in September 1987. The 'mitiness' rating ranges from 0 (no mites) to 10 (many mites) and takes into account both the abundance of the weed and its level of infestation.

Weed (Common name)	**Relative 'Mitiness' Rating**	
	> 500m away from cotton	Cotton field
Wild Turnip	1	10
Sow Thistle	0.1	4
Wire Weed	0.1	3
Variegated Thistle	0.1	2
Prickly Lettuce	0	2
Burr Medic	0.1	2
Paradoxa Grass	0	1
Dead Nettle	not found	1
Marshmallow	0.1	1

Effect of plant quality on mite reproduction and development.

Phenological changes in the suitability of cotton for mite reproduction and development did not explain the early season decline of mite populations. Cotton cotyledons were found to be less suitable for mite reproduction than young true leaves. This may slow the development of mite populations, but only until true leaves appear.

Mites had higher fecundity and lived longer on young leaves than on old leaves. Furthermore preference tests showed that mites strongly prefer young leaf tissue to old leaf tissue. In the field, mites released near the tops of plants stayed there while those released onto leaves in the middle and bottom of plants tended to move upwards toward younger leaves. It is proposed that the within plant distribution of mites arises as a combination of the ability of mites to assess leaf quality (discriminating in favour of young leaves) and a possible positive photo-taxis which results in mites moving toward younger leaves.

Plant resistance to mites

In the crop loss experiments using artificial infestation with mites the rate of increase of mite populations was consistently lower on Siokra than on Deltapine 90. This resulted in lower yield loss on Siokra (i.e. Table 1). Circumstantial evidence suggests that the micro-environmental conditions in the boundary layer of the leaf are fundamental in determining which parts of the surface of a leaf are most suitable for the development and reproduction of mites. Mites appear to favour protected locations near leaf veins or in leaf folds. It appears that okra leaves, with long thin lobes, have less of their total surface area suitable for mite reproduction and development than normal shaped leaves. This may lead to more rapid exploitation of the acceptable area of okra leaves, resulting in density dependent competition and hence a slower rate of population growth.

Conclusions

This research provides some of the basic information needed to improve the management of mites on cotton in Australia. In particular, sources of mites were identified and means for managing these sources proposed. A sampling protocol for mites is being developed for use in conjunction with an equation for estimating the yield reductions caused by mites. This provides a rational basis for determining if mites warrant control. Finally, in areas prone to mites, selection of okra leaf varieties can substantially reduce the potential yield reductions resulting from mite infestations, and thus the need for control.