Early season pest management - Can it make a difference?

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INTRODUCTION

Since 1992, CSIRO Cotton Research Unit has conducted large scale insect management trials in the upper and lower Namoi Valley. The trials have utilised large field areas on privately owned farms, generally in collaboration with a commercial consultant. Over the past 4 seasons, an average of 3 trials per season have been conducted, covering both long and short season irrigation areas and dryland production.

The primary aim of the trials has been to field test and validate the insect management decision support system entomoLOGIC. This included testing the functionality of the program and also establishing its value as a tool for monitoring field trials. The second aim of the work was to compare different pest management approaches, including a range of "hard" and "soft" options. The aim of the "soft option" was to preserve beneficial insects for as long as possible to determine whether their impact on pest numbers was sufficient to reduce the total number of sprays.

In all cases, the aim was to produce the maximum possible yield and earliness, regardless of the treatments imposed. This was important considering that the trials were conducted on a commercial scale on private farms.

METHOD

Treatments and management

The pest management strategies included (i) commercial management using the full range of chemical options, (ii) using entomoLOGIC to set thresholds and assist with spray decisions, using the full range of available chemistry and (iii) using entomoLOGIC for spray decisions with a restricted set of selective insecticides ("Soft Sprays").

There was some variation over the 4 years of the trials in the details of the hard treatment, depending on the circumstances and the degree of interaction with the consultant. In all

cases the hard comprised either option (i) or (ii) above, which meant that it was managed with standard or lower thresholds and the full range of chemical options.

The soft treatment was always managed as outlined in (iii), using the entomoLOGIC models for Heliothis and mites and the presence-absence sampling system to assist with spray decisions. Wherever possible, selective insecticides were used to minimise the effects on beneficial insects, particularly pre-flowering when beneficials were more abundant. These soft insecticides included *Bacillus thuringiensis* (Bt), endosulfan, chlorfluazuron (before it was withdrawn) and low rates of thiodicarb. Excluded were chemicals belonging to the organophosphate and systhetic pyrethroid groups.

Trial Design

The trial sites in general covered an entire field on the farm, enabling each plot to be wide enough to minimise the effects of spray drift. Each trial field was divided into four plots with two replicates of each treatment. Where practicable to minimise the impact of spray drift on beneficial insects, the two 'soft' plots were located together in the middle of the field with the two 'hard' treatments on either end.

Crop Checking

The trials were checked for insects (Heliothis, Mites, other pests and beneficials) twice weekly and spray decisions made using standard thresholds in entomoLOGIC. The Heliothis Development Model in entomoLOGIC was applied to determine present and future insect populations in the three days following the check. The Mite model showed the percentage of infestation and yield loss, and an indication of whether a spray was required.

Fruit counting commenced about 2 months after planting and gave a good indication of the crops progression, an early fruit comparison between the two treatments and predicted dates for defoliation and harvest.

Maturity Assessment

After boll opening commenced, the maturity of each treatment was measured to the nearest day using specially hand-picked maturity plots. Four 2 metre sections of row

were marked out from each replicate and each week all fully open bolls were hand picked. These were later ginned to calculate average turn out % and boll weights for each sample. The relative earliness or maturity of each treatment was also assessed, determining the number of days from planting to 60% open. The ginned samples were then tested for quality using an HVI. The fibre characteristics recorded included length (inches), uniformity, strength (g/tex), elongation and micronair (an indication of fibre fineness and maturity).

Harvesting and Yield Assessment

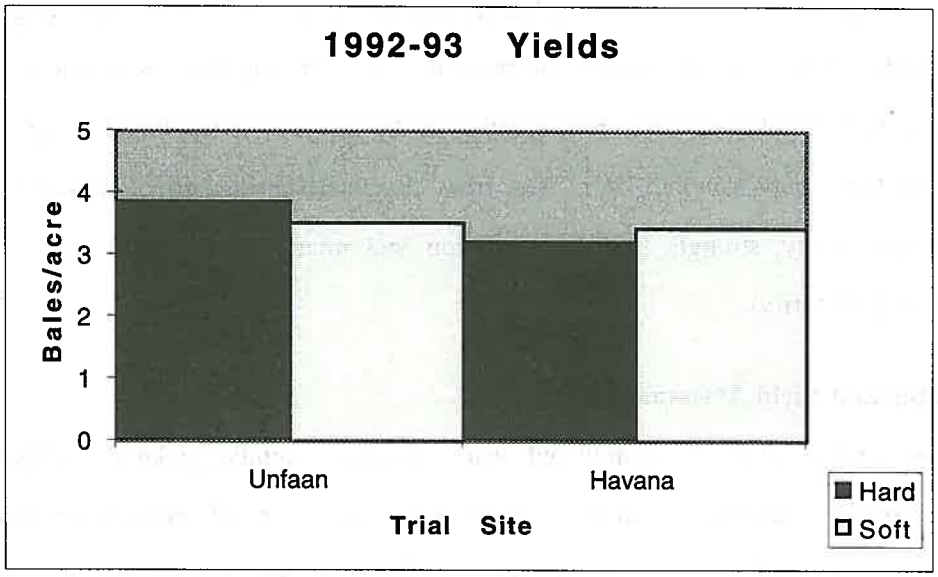
Harvesting of the trials was completed using machine spindle pickers (irrigation) or machine strippers (dryland). Enough cotton was picked to build one module from each plot. Each basket picked was weighed using portable scales and the weights recorded. The areas picked were measured using a trundle wheel enabling yields to be calculated. The module numbers were recorded and each module was weighed and ginned separately to give another assessment of turn out % and quality.

RESULTS

1992/93 SEASON

Two replicated trials were completed in the **1992/93** season (the first season of trials). Both were high yielding crops, but showed significant differences in yield between the 'soft' and the 'hard' treatments. On one site the 'hard' (9 sprays) treatment out-yielded the 'soft' (8 sprays) treatment by 8%, while on the other site the 'soft' (7 sprays) out-yielded the 'hard' (11 sprays) by 7% (See Figure 1).

Figure 1. Yield summary from 1992-93 trials.



No significant differences in maturity were measured between the treatments (see Table 1 below).

Table 1. 1992/93 trial summary

Trial Site and treatment	HAVANA -HARD	HAVANA -SOFT	UNFAAN -HARD	UNFAAN -SOFT
Sprays	11	7	9	8
MATURITY(DAYS FROM PLANT)	192	190	175	180
AVE BOLL WEIGHT (Grams)	4.5	4.8	5.2	4.9
AVERAGE BOLL NO. (/2M)	168	181	207	224
TURN-OUT PERCENTAGE	36	35	37	37
YIELD (BALES/acre)	3.44	3.20*	3.81	3.52*

* significant difference

During the season it was difficult to assess beneficial activity as spray drift from the conventionally sprayed cotton reduced predator numbers over the whole field. The sites had been carefully chosen to minimise drift from the other fields, but not within the trial field. In the following year, measures where taken to further reduce the effects of spray

drift which included, having the treatments sufficiently wide, positioning both of the 'soft' plots in the centre of the field and using a ground rig where possible.

1993/94 Season

During the **1993/94** season, four trials were conducted including a dryland trial. Two out of the four sites showed significant differences in yield between treatments. The yield difference on the *Havana* trial was the result of a soil condition affecting of the two adjoining 'soft' plots in the centre of the field. The *Waiwera* trial experienced high mite pressure, with the mites on the 'hard' treatment clearly requiring control before those on the 'soft'. Unfortunately when the 'soft' eventually required spraying for mites, supplies of Comite ®, the only suitable miticide, had run out. Therefore the effects of mites on the 'soft' treatment resulted in a 20% difference in yield.

The maximum difference in maturity between treatments in any of the trials was 4 days. This also tends to discount insect management as a major factor in the yield differences observed.

An irrigated trial was conducted at *Kilmarnock*, near Boggabri, providing an opportunity to test the soft approach in a shorter-season area. There was only 4 days difference in maturity and no significant difference in yield.

While unforseen factors complicated the interpretation of treatment effects on the long season irrigated sites, results on the dryland site at *Calatoota* were very encouraging. Good yields (around 1.6 bales/acre) were obtained with chemical costs of only $75/ha. There was a clear difference of 2 sprays between the hard and soft treatments which can be directly attributed to the loss of beneficial insects after an early organophosphate spray on the hard.

Figure 2. Yield summary for 1993/94 trials.

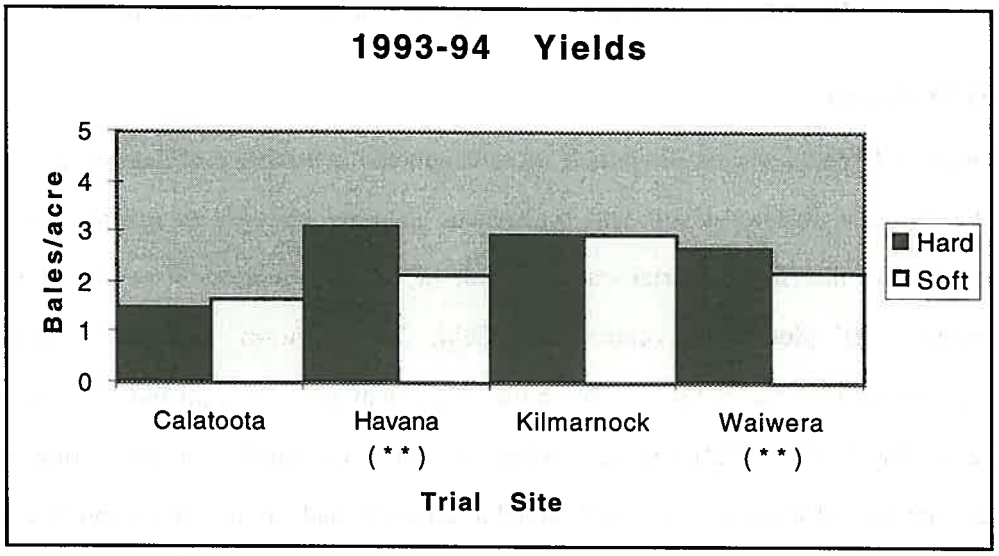


Table 2. 1993/94 trial summary

Trial Site	Havana		Waiwera		Kilmarnock (Upper Namoi)		Calatoota (dryland)	
Treatment	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft
Sprays	8	8	8	7	6	6	6	4
MATURITY(DAYS)	176	178	170	168*	179	183*	150	151
AVE BOLL WEIGHT (g)	4.55	4.10*	4.44	4.13*	4.11	3.88	5.09	4.79*
AVE BOLL NO. (/2M)	196	176	223	192*	244	193	149	123*
TURNOUT (%)	39.6	39.9*	41.4	41.6	41.9	41.0*	41.3	41.2
YIELD (BALES/acre)	3.11	2.16*	2.71	2.19*	2.94	2.95	1.51	1.64

* significant difference

1994/95 Season

Despite the drought conditions, a further 4 trials were conducted in the 1994/95 season, with 2 in the long season irrigation area, 1 short season at Boggabri and 1 dryland near Edgeroi. The **1994/95** season presented no significant difference in yield between the 'hard' and 'soft' treatments at any of the sites (see Figure 3).

Maturity data from *Willapunga* and *Glencoe* both showed significant differences of 7 and 3 days respectively. The 'hard' treatments in both cases were slightly earlier. The

loss of Helix (Chlorfluazuron) after the 1993/94 season, reduced the number of 'soft' options available at the end of the season.

Figure 3. Yield summary for the 1994/95 trials.

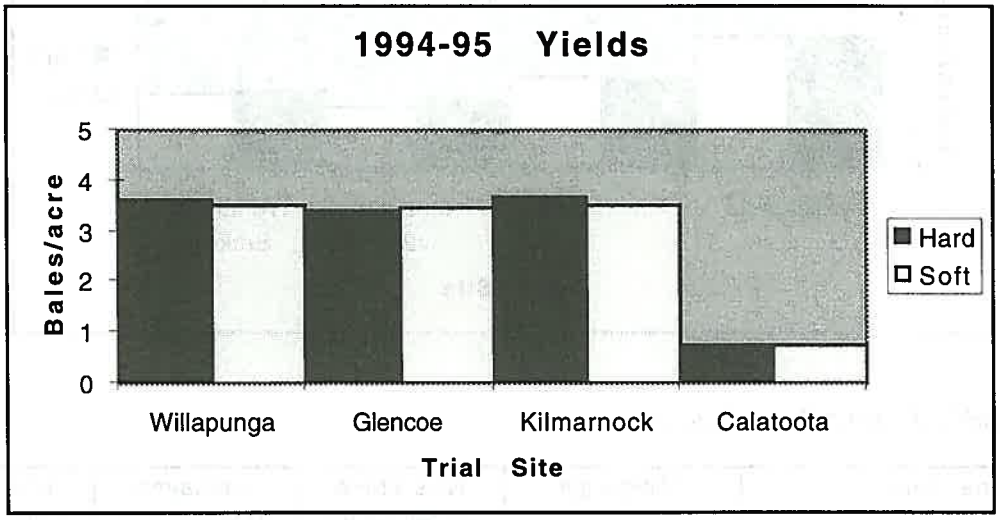


Table 3. 1994/95 trial summary

Trial Site	Willapunga		Glencoe		Kilmarnock (Upper Namoi)		Calatoota (dryland)	
Treatment	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft
Sprays	11	6	5	4	5	4	6	4
MATURITY(DAYS)	177	184*	161	164	181	182	n/a	n/a
AVE BOLL WEIGHT (Grams)	4.68	4.62	4.47	4.40	5.88	5.81	n/a	n/a
AVERAGE BOLL NO. (/M)	127	117*	118	120	104	84*	n/a	n/a
TURNOUT PERCENTAGE	41.0	39.9	42.4	42.3	39.8	38.3	n/a	n/a
YIELD (BALES/acre)	3.63	3.52	3.40	3.48	3.67	3.51	0.72	0.76

* significant difference

1995/96 Season

Results from the **1995/96** trials showed no significant difference in yield between the 'hard' and the 'soft' treatments at any of the sites (as shown in Figure 4 below).

Figure 4. Yield summary for 1995/96 trials.

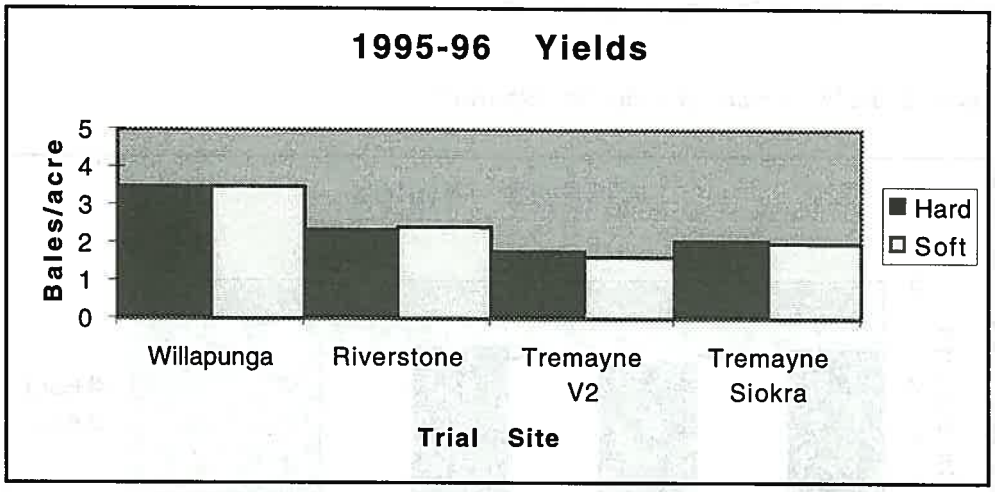


Table 4. 1995/96 trial summary

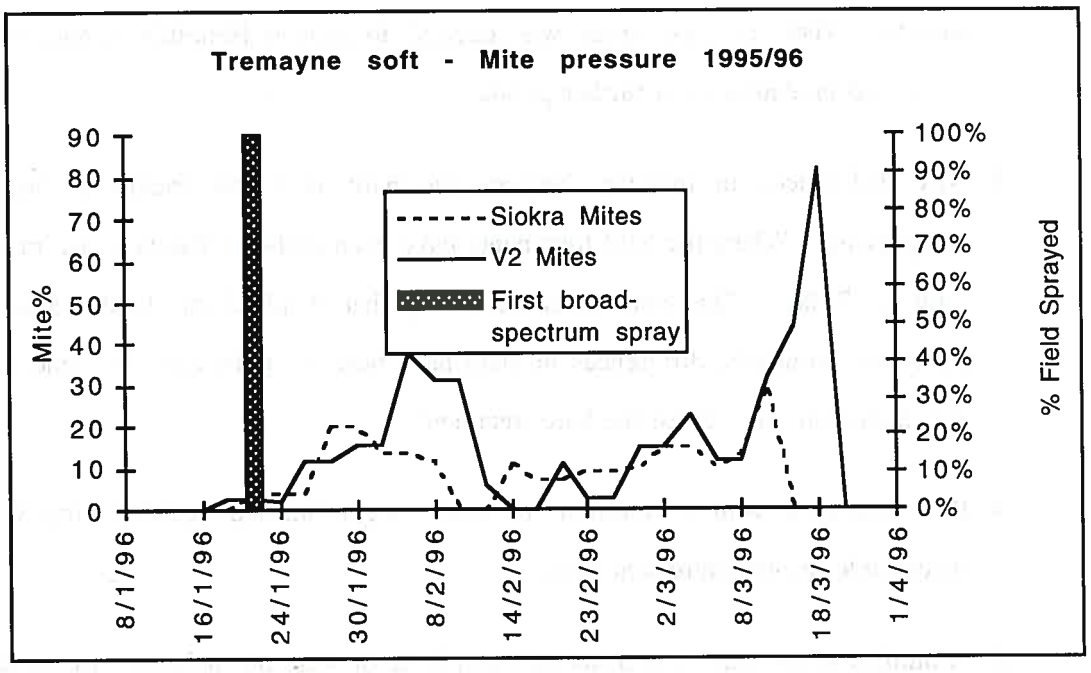
Trial Site	Willapunga		Riverstone (Upper Namoi)		Tremayne (dryland V2)		Tremayne (dryland 1-4)	
Treatment	Hard	Soft	Hard	Soft	Hard	Soft	Hard	Soft
Sprays	9	9	7	6	10	10	10	10
MATURITY(DAYS)	182	184	194	193	174	179	161	174*
AVE BOLL WEIGHT (g)	5.68	5.88	5.76	5.80	5.12	5.17	4.97	4.85
AVE BOLL NO. (/m)	95	89	66	48	53	58	75	86
TURNOUT (%)	37.9	38.2	38.3	38.4	n/a	n/a	n/a	n/a
YIELD (BALES/acre)+	3.49	3.48	2.39	2.41	1.77	1.62	2.06	1.97

* significant difference + Turnout assumed 39% picked, 32% stripped

There was however a yield difference between the Siokra 1-4 and the Sicala V2 on *Tremayne* dryland trial. After the January/February rainfall, the dryland crop on Tremayne grew vigorously and Heliothis pressure increased. Poor spray penetration was experienced on the V2 section, which resulted in the use of more 'harder' broad-spectrum insecticides and an increase in mite populations. Other recent work has found that overuse of broad-spectrum insecticides early in the season can lead to dramatic and highly damaging outbreaks of mites (Wilson, 1993).

The following graph shows a dramatic increase in mite numbers after the third spray on 20/01/96 (which was the first broad-spectrum insecticide used). It also shows the distinct difference in mite populations between the Siokra (okra leaf) and Sicala (normal leaf) cotton grown. Apart from plant resistance to mites, the more open canopy of okra leaf cultivars also allows better penetration of pesticides into the crop (Jones et al. 1986).

Figure 5. Tremayne mites 1995/96.



DISCUSSION

Over the four years of work, differences in yield and maturity between the "hard" and "soft" treatments have been insignificant. An IPM approach, using standard thresholds and preserving beneficial insects early in the season, has been demonstrated to produce early, high yielding crops under long season, short season, irrigated and dryland conditions. This approach has often led to a reduction in the overall number of sprays and the cost to the grower. It has also helped reduce dependence on particular chemical groups. This will assist growers to avoid chemical shortages and reduce selection for resistance.

Some other observations from the trials deserve mention.

1. Over the four years of the trials no loss of yield or earliness has been experienced due to thrips or mirids, whether controlled or not. This of course may not be the case in all valleys for all seasons.

2. In all of the trials, sprays were rarely required before Christmas, due to low early pressure, the use of the standard threshold (2 small/m) and the action of beneficial insects. Where an early spray was required to control Heliothis, application of Bt preserved predators for a further period.

3. Any differences in maturity between the hard and soft treatments have been insignificant. Where the hard treatments have been earlier it has been by margins of only 2 - 7 days. This contradicts the theory that standard thresholds cause loss of earliness. Similarly, differences in yield have been insignificant. In some trials the soft treatment out-yielded the hard treatment.

4. Plots managed with a minimum of hard sprays finished healthier and were less susceptible to premature senescence.

5. A number of the trials could not be completed or were inconclusive for reasons not related to the trial. Yield losses and problems were experienced for the following reasons: drought conditions or delayed irrigation, soil conditions, errors in spray application or ordering, poor plant establishment, verticillium wilt, inappropriate choice of variety, herbicide damage, weed problems and chemical shortages. This shows how important it is for growers and consultants to ensure that all of these factors are under control before worrying about crop protection.

CONCLUSIONS

The field trials have demonstrated that entomoLOGIC can be used effectively to manage insect pests on cotton with either conventional or 'soft' insecticides. Yield, maturity or quality differences between conventional and 'soft' insect management over four seasons of field trials have been insignificant. This work has shown that using 'soft' chemicals when possible to control Heliothis is not only economically viable but a more sustainable approach to insect management.

The easy recording and available reporting facilities in entomoLOGIC 95 made monitoring pest and predator numbers an uncomplicated task. This valuable tool can model the development of Heliothis pests and the growth of mite populations with associated yield losses. Many improvements and additions to the program have created a decision support system capable of assisting in many facets of cotton agronomy.

ACKNOWLEDGEMENTS

The authors wish to thank the staff of the Australian Cotton Research Institute who have assisted with checking, testing samples or who have contributed advice. We would like to acknowledge the contributions of Warwick Madden, Robert Eveleigh and Mike Mennell to this work.

We particularly acknowledge the enormous contribution of the growers and consultants who have collaborated in the trials, and are now too numerous to list individually. Thanks also to the growers and consultants who have discussed the results at field days, grower groups and resistance meetings. We hope they have added value to your business.

References

Jones, J.E., James, F.C. Sistler & S. J. Stringer. 1986. Spray penetration of cotton canopies as effected by leaf and bract isolines. La. Agric. 30: 14-17.

Wilson, L. J. 1993. The Australian Cotton Grower 14 (6): 26 - 29.