SIRATAC FOR ALL REGIONS

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One of the notable features of the SIRATAC pest management system is that its use commercially followed extremely quickly on its initial formulation. Most of SIRATAC's development, therefore, has occurred in the commercial environment. As users of the program now range from the Macquarie Valley to Emerald much work has gone into making the program regional specific.

In each of the major cotton growing regions the program was tested for two years before it became commercially available. This allowed data gathering and indicated areas in the program which required further development. This process has continued with commercial crops.

Operating a pest management program over such a wide area allows all users to be potential beneficiaries of changes made to the program in response to a localized pest problem. Furthermore, it assists those making the changes to gain an overall perspective of the attitudes to pest control strategies and the relative importance of pests between regions.

Although the program has been adapted to each region, the important pest management principles which are incorporated in SIRATAC remain unchanged.

Basis for SIRATAC's flexibility

The information required by the SIRATAC program provides a description of crop development and insect activity in each managed field. The use of local daily maximum and minimum temperatures enables the calculation of daily day degrees. By summing the daily day degrees from sowing and by using the numbers of counted fruit an age profile (i.e. number and size) of the individual crops fruit is built up. Similarly, the *Heliothis* population is developed through the various age classes on the basis of accumulated day degrees.

The prediction of new fruit is based on the average long term maximum and minimum temperatures received in each region.

Use of Local Data to Predict Square Production and Fruit Shedding

The expansion of SIRATAC has led to the accumulation of a large quantity of information from all cotton growing regions. Fruit counts from the different regions have been used to analyse crop development on a regional basis.

In the SIRATAC fruiting model the rate of production of new squares (per day degree) and the physiological shedding of squares and bolls are related in that they are both dependent on the plant size (i.e. the number of fruiting sites) and the plant boll load. A full season of fruit counts can be used to define a fruit shedding curve and therefore an estimate of square production for any location.

Full season fruit counts from a number of fields over a number of years within each major region were grouped together. Care was taken to avoid fields which had suffered unusual damage. Analysis based on fruit counts showed that square production and shedding differed regionally. Figure 1(a) shows how the rate of square production is affected by boll load for two plant sizes (early and mid flowering) for the different regions. For light boll loads, there is a trend for the rate of square production to increase as you go north from the Macquarie Valley to Emerald and Biloela. As the boll load increases the drop in the rate of square production is greater for Emerald, Biloela and the Lockyer Valley, so that the boll load required for cutout (i.e. that required to cease square production) is less for these regions. For medium and heavy boll loads, square production is highest for the Downs.

A similar comparison between regions for fruit survival is shown in Figure 1(b). For a given plant size, the percentage of surviving fruit decreases as the boll load approaches the boll carrying capacity (i.e. the boll load required to prevent further boll setting). For a given boll load, percent survival is highest on the Downs and lowest at Emerald and Biloela.

Crop performance at Emerald, Biloela and the Lockyer Valley is associated with a greater likelihood of rank vegetative growth in these areas. Excessive mutual leaf shading in rank crops will increase fruit shedding. Climatic factors likely to be important in reducing fruit survival are reduced radiation due to reduced daylight hours and more frequent cloudy weather. Higher night temperatures will also mean increased night respiration thereby reducing carbon supply to fruit and therefore increasing shedding. Efforts are under way to include these effects in a new version of the fruit model, which is also sensitive to water and nitrogen.

Analysis of pre-flowering square production indicates that non-climatic factors such as soil type and condition may be just as important as climatic factors in obtaining good establishment.

Heliothis Development and Feeding

Field counted *Heliothis* are predicted for three days into the future based on local temperatures. The program is capable of developing the insects from any field counted life stage from white eggs through to pupae. As the temperature increases, the larvae and eggs develop more quickly, i.e. the percentage of their development on any day is a function of the average temperature for that day. For example, after 20% of the total egg development has elapsed, the newly laid egg will have become a brown egg and after 100% it will become a larva.

Both heat stress (above 35°C) and cold stress (below 12°C) affect development and these are taken into account accordingly. The insect numbers in each stage are reduced by the effects of weather (e.g. wind, rain) and predators. The number of emerging larvae are adjusted for any insecticide residue calculated to be still on the leaf.

Estimates of the number and type of *Heliothis* and fruit are used to determine the effect of insect attack. Account is taken of the preference of the various insect life stages for certain fruit classes. The rate of attack is determined by the proportion of the larval stage's life, in terms of day degrees, that elapse on a given day.

Start and End of Boll Setting Dates

The dates for both the start and finish of boll setting are estimated from long term temperature data for each region. For each year, 750 day degrees, plus 5.2 day degrees for each day when the minimum temperature drops below 11° C, is required from sowing to first flower. Bolls of an acceptable size require 750 day degrees from flowering to opening but only about 650 day degrees before they reach a size whereby their weight will not be appreciably affected by frost damage. Thus, for each region the mean dates of the start and finish of boll setting have been derived (Table 1). The date of the finish of boll setting also represents the date whereby in 50% of the years a flower will just mature before frost. After this date, the probability of a flower maturing decreases rapidly.

<u>Table 1</u>

Region	Sowing	Start of Boll Set	End of Boll Set
Emerald	1 Oct	3 Dec	6 Apr
Biloela		13 Dec	23 Mar
Darling Downs		25 Dec	6 Mar
Lockyer Valley		22 Dec	[illegible] Mar
St George		10 Dec	15 Mar
Boggabilla		15 Dec	13 Mar
Gwydir Valley		21 Dec	7 Mar
Namoi Valley		25 Dec	4 Mar
Macquarie Valley		7 Jan	19 Feb

<u>Pest Management Concept</u>

SIRATAC pest management is based on the concept of maintaining the number of bolls throughout the season at or above a minimum progressive level required to reach a specified target yield. This minimum level is called the yield development threshold (YDT) and is decided by the grower when he selects the dates of the start and end of boll set and a target yield. The predicted number of bolls surviving an insect attack can be compared with the minimum number of bolls required as specified by the YDT. If the predicted number falls below the minimum requirement fewer insects can be tolerated.

Dates of the start and end of boll set and the target yield should be selected on the basis that they are biologically realistic (refer to the previous table) and consistent with the growers agronomic and economic aims. A more rapid or different pattern of fruit setting may be sought by specifying earlier boll setting dates. Earlier boll setting dates should increase the amount of early season control.

Heliothis Management

Spraying thresholds for Heliothis may be increased (i.e. a larger infestation tolerated) above a base level when the following situations arise :

i) in squaring cotton where the crop is early relative to the YDT, and the predicted result of an infestation is a yield increase. In some circumstances, moderate early season damage causes the plant to compensate, setting more fruit than it would have otherwise.

ii) in pre-squaring cotton where the predicted start of boll set date is likely to be ahead of that specified. For the start of boll setting dates in the above table, this will happen in a better than average season. Early season terminal damage causes a delay of approximately 7 days, therefore the crop must be 7 days early before the threshold is raised.

Development of Management Systems for Other Pests

All the thresholds for pre-squaring pests are now dynamic and depend on the seasonal conditions and the manager's expectation of crop development and his pest management strategy. All of the complexity of the research into other pests has been integrated into the computer program. The result is a comprehensive management system for pre-squaring pests.

Thrips :

Trial results from areas such as the Darling Downs where establishment is often restricted by cold nights, showed how the management system for thrips control could be improved.

The predisposition of the cotton plant to thrips damage is due to a complex of interrelated factors. The current version assesses the coolness of the season as described for Heliothis but also integrates the effect of poor stand conditions and current damage levels. SIRATAC asks users to rate their crop stand for seedling disease and herbicide damage. The current level of tipping out is used to indicate that thrips damage is occurring and previous tip damage is used to assess the previous amount of delay the crop will be experiencing.

Tipworm :

Cotton tipworm was incorporated into SIRATAC as a result of SIRATAC trials in south east Queensland. As well as considering the pest alone, a tipfeeder threshold was used to test the combined effects of Heliothis and cotton tipworm.

The tipworm plague of 1983 affected most of the southern cotton growing areas. SIRATAC has now refined its tipworm management from the research work of Graeme Hamilton at Queensland University. A cotton tipworm development model (similar to that used for Heliothis) now predicts when counted tipworm eggs will hatch and accounts for overlap in counts from the previous check. Insecticide applications are now timed to maximize the kill by application to the neonate larvae. This allows control of small tipworm that are very difficult to observe in the field. Results of insecticide trials and the SIRATAC database have been used to determine efficacious control chemicals.

Mirids :

Mirids rose to prominence as a serious pest of cotton during the 1981/82 cotton season. Damage to terminal buds and particularly pin-head squares was observed. SIRATAC fruit counts indicated that the square production plateaued out in the phase normally associated with rapid square production or the crop simply failed to square. Sweep netting indicated that the culprits were from a mirid complex which had probably arisen due to reduced spray applications because of low Heliothis pressure.

In 1982/83, the SIRATAC fruit counts were used to monitor the progress of the crop. If the rate of square increase did not occur normally or the crop was unlikely to flower by the day planned for the YDT, the user was warned to check for mirid damage.

Following trial results from Forest Hill and Biloela by Bruce Pyke, Grant Adams and Mike Stone, initial thresholds for mirid control have been determined for this season. More damage is now attributed to the green mirid nymphs than to the adults. Sweep netting has been replaced with more efficient shake sheet sampling and mirids will now be sampled for on a regular basis.

Combined early season pests :

Control may be necessary for sub-threshold populations of *Heliothis*, mirids, tipworm and thrips in cotton before peak squaring. Control is recommended if the weighted total (proportional to their respective thresholds) of these pests exceeds the *Heliothis* threshold.

Users Attitudes to Pests and Pest Management

Many pest problems are common to all cotton growing regions, but some are confined to one or a few areas, or differ between areas. The types of insecticides preferred, the levels of pests thought to be significant, and the strategy for managing pests varies according to local experience and folklore, as well as biological reality.

For example, many growers in the Namoi, Gwydir and MacIntyre Valleys experienced an unusually bad mite control problem in the 1983/84 season. A survey amongst SIRATAC users from the Gwydir and Namoi Valleys indicated that of the growers in these areas, 10 thought that the SIRATAC mite threshold was too high, and only 3 thought it was correct. In the Macquarie Valley, however, where mites are a perennial problem, 1 grower thought that the threshold was too high, compared to 8 who thought it was correct. It seems that the Macquarie Valley growers have grown to accept levels of mites which would be regarded as a major problem in the regions to their north.

Another difference highlighted in the 1983/84 season was the use of endosulfan. The SIRATAC database indicated that in NSW, endosulfan was frequently applied with an ovicide, whereas in Queensland, endosulfan was normally applied alone. Again, this reflects a difference in attitude to the chemical rather than any difference in the target pest, there being no prior evidence that the field effectiveness of endosulfan differed between Qld. and NSW.

Summary

A large part of the development of SIRATAC has occurred in response to a continually changing pest complex, and to its use over a wide area. Aspects of the program which have been included to make it regional specific are

(1) Rate of square production and fruit shedding has been derived from past SIRATAC fruit counts for each region.

(2) Prediction of temperatures based on long term averages for each region.

(3) Climatic dates as guides for start and end of boll setting.

(4) Local temperatures for fruit and insect development.

(5) Insect spraying thresholds adjusted according to the timeliness of the crop relative to the desired pattern of fruit setting.

These features, together with the grower's ability to select a pattern of fruit setting to suit his needs, gives the program the flexibility needed for pest management in many regions. The database has given SIRATAC a regional perspective, and interaction with growers outside the Namoi Valley has allowed the program's developers to appreciate different attitudes and problems in cotton growing.

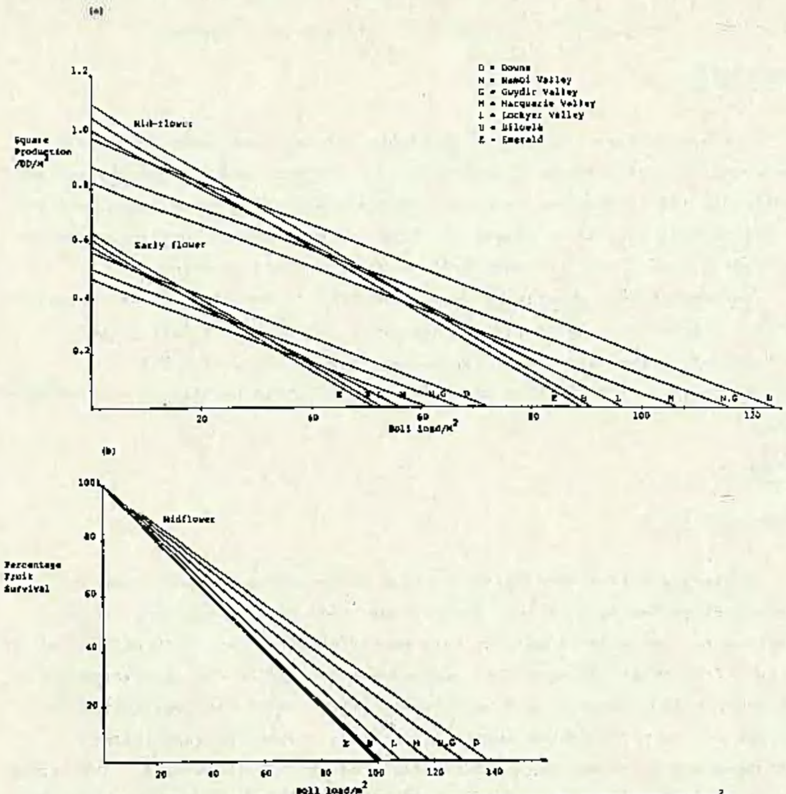

Fig 2. Changes in (a) rate of square production at early and mid-flowering (100 and 300 fruiting sites/m²), (b) fruit survival at mid-flowering, with boll load for each region.