

# Monitoring Fruiting Factors as a Tool in Insect Management

Dallas Gibb<sup>1</sup>, Mark Hickman<sup>2</sup> and Ian MacPherson<sup>3</sup>

Written on behalf of the Australian Cotton CRC Extension Team

1. NSW Agriculture, Australian Cotton CRC, Australian Cotton Research Institute, Narrabri.
2. NSW Agriculture, Australian Cotton CRC, Gunnedah, Narrabri.
3. MacPherson Agricultural Consultants Pty Ltd, Goondiwindi.

## Introduction

In developing strategies for insect pest management growers and consultants have demonstrated that adopting a more dynamic approach to insect thresholds is more important than using any predetermined threshold. In combining dynamic thresholds with the use of less disruptive insecticides and the conservation of beneficial insects growers have been able to improve farm profits.

When adopting a flexible approach to insect pest management it is important to monitor crop growth rates and fruit development to avoid excessive periods of crop damage. Acceptable damage levels will vary depending on growers yield expectations and climatic conditions, which will determine the seasonal length. Assessing fruit load in conjunction with regular insect monitoring provides significant benefit when making insect management decisions. This is particularly valuable when a range of insect pests are present in the crop such as mirids and *Helicoverpa*.

Fruit load is obviously a key aspect in determining crop yield and maturity. The loss of fruit during squaring and early flowering is less critical to yield than fruit loss later in the season. It is well documented that excessive early fruit loss can delay final maturity, however it is also known that holding too much fruit can reduce crop growth, cause premature cut out, and thereby reduce yield.

Growers and consultants have used a number of techniques to measure or estimate a crop's fruit load. These include fruit retention and total fruit counts. A new technique investigated over the last 3 years is called 'Fruiting Factors'.

The concept of fruiting factors was developed in 2000 in response to comments from growers and consultants that monitoring first position fruit retention by itself was not providing an effective guide to crop performance. Particularly in situations where a combination of high early season fruit loss, excessive vegetative damage and tipping out has occurred. It was felt that because first position retention didn't consider secondary fruit, it underestimated the ability of a crop to compensate for fruit loss and this could in turn cause an unnecessary reduction in pest thresholds. This paper discusses the use of fruiting factors in monitoring a crop's fruit load to assist in insect pest management.

To assess the use of fruiting factors a number of small plot trials were conducted by Cotton CRC extension staff in 2001/02 across each of the major cotton growing districts. Results of these trials validate data collected from commercial fields in the MacIntyre Valley.

## Fruiting Factors – How to measure it

Fruiting factors have been developed to consider both fruit counts and the number of fruiting branches. To determine a crop's fruiting factor, simply divide the fruit count by the number of fruiting branches.

$$\text{Fruiting Factor} = \frac{\text{total fruit count per metre}}{\text{Total number of fruiting branches per meter}}$$

The simplest way to estimate fruiting factors is to count all fruit and fruiting branches in a meter of row. This includes vegetative branches within that meter. It is recommended that at least 4 meters be conducted per field.

### **Fruit counts, retention and fruiting factors - What's the difference**

Total fruit counts provide growers with the basic tool to estimate final crop yield. Conversion factors have been developed for each variety to provide more effective yield estimates. Fruit counts are generally used at the end of the season but can be used throughout the year to give an indication that a crop will reach original yield targets.

Fruit retention and fruiting factors do not provide growers with an estimate of final crop yield. They are used to provide a guide of yield potential, irrespective of final yield. That is, they consider a crops fruiting capacity. Values used for retention or fruiting factors can be use for all crops, whether they are dryland, or irrigated.

Fruiting factors provide an advantage over retention in that they can be used throughout the reason and are easier to determine in crops that have been heavily tipped out. First position retention is a useful tool up to flowering but its value declines after flowering. Retention monitoring also doesn't consider secondary fruit that can make significant contributes to yield particularly in situations of low first position retention. Fruiting factors consider all fruit positions.

Fruiting factors provide an indication of the amount of fruit a plant is holding relative to its stage in vegetative growth, (fruiting branches). Fruit counts by them self cannot do this.

Details relating to monitoring first position fruit retention and fruiting factors can be found in the IPM guidelines and the Cotton Pest management guide.

### **Using fruiting factors**

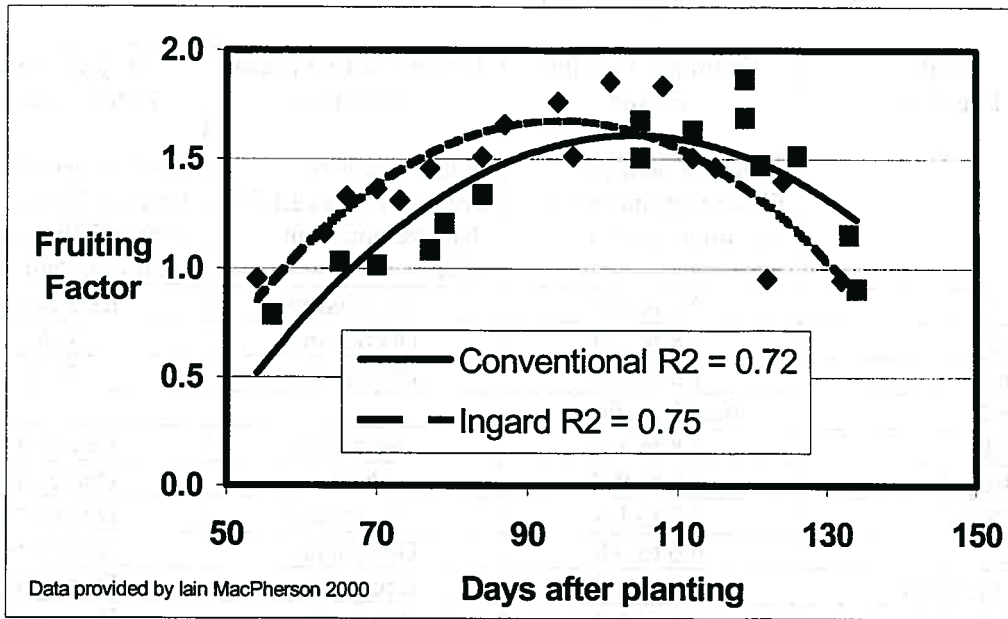
Monitoring first position fruit retention is a technique that is best used early in the season during squaring and prior to or just after flowering. It is quicker than total fruit counts and can provide an early sign for insect damage. Fruiting factor can be used throughout the season and allow total fruit load to be monitored. Fruiting factor should be used when first position retention falls below recommended levels (i.e. 50% to 60%), to ensure excessive fruit loss has not occurred or in situations where a crop is tipped out and retention is difficult to determine.

### **Changing Fruit Loads**

Data collected from more than 150 fields during the 1999/2000 season has indicted that fruiting factors change throughout the life of the crop. During squaring, values of 0.8 to 1.0 are normal for high yielding crops. The fruiting factor will increase throughout flowering as the crop produces a large number of squares. Fruiting factors decline after peak flowering and as the crop matures. This decline coincides with the natural reduction in fruit numbers. Eventually, at maturity, fruiting factors approach levels of 0.8 to 1.0, which represents the natural fruiting load - plants can carry through to yield (Figure 1)

Figure 1 demonstrates that fruiting factors in Ingard® crops can be higher in the first half of the season compared with conventional crops. This is in line with higher levels of early fruit retention in Ingard® crops due to reduced heliothis damage compared with conventional crops. These higher levels of early fruit load result in fruiting factors peaking earlier than conventional crops and sub sequencing declining to finish earlier.

Figure 1 Change in Fruiting Factor throughout the season



**Fruiting factor and yield**

A key period for measuring fruiting factors is at flowering. Figure 2 compares fruiting factors at flowering with final yield using the data collected from commercial fields. It is indicated that values between 1.1 and 1.3 will provide optimum yield potential. Values less than 0.8 or greater than 1.5 can cause yield reductions.

To validate these results 11 replicated small plot trails were conducted in 2001/02 by industry development officers across each of the key cotton growing regions. Table 1 summarises the results of these trials. Results are shown on the basis of what fruiting factor at flowering (7 to 10 days post first flower) resulted in maximum yield and what was the general trend in yield for fruiting factors less or greater than this value.

Figure 2 Fruiting Factors at flowering vs Yield (Data from Commercial Fields)

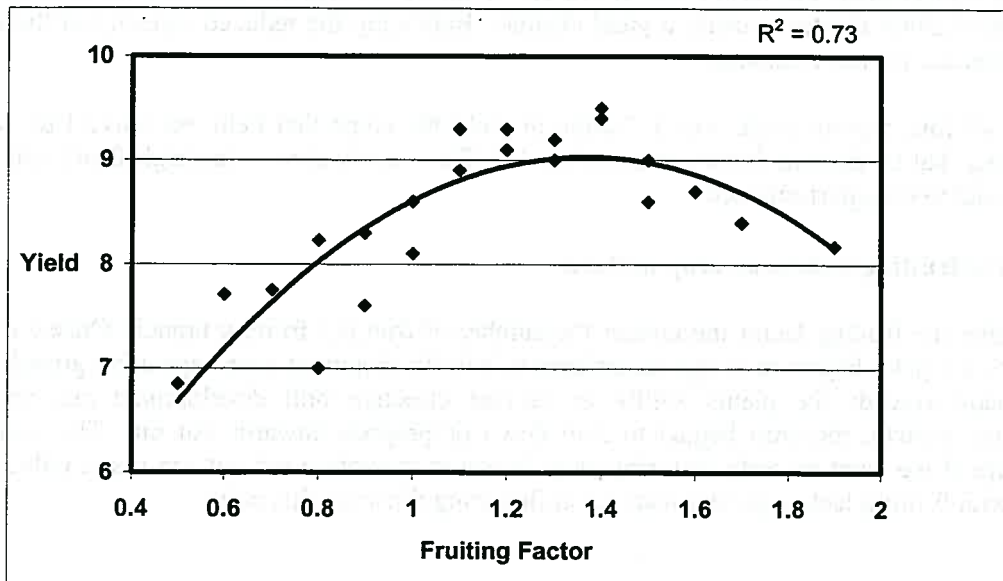


Table 1 Fruiting factors at Flowering\*\* and effect of yield.  
(results from small plot trials)

Trial Location	Optimum Fruiting Factor (Fruiting factor at Flowering that gave maximum yield)	Lower Fruiting Factor and Yield (Yield trends for Fruiting factors LESS than the optimum value)	Higher Fruiting Factors and Yield (Yield trends for Fruiting factors GREATER than the optimum value)
Moree 1	0.9 to 1.2	Decreasing	Decreasing
Moree 2	1.8 to 2.0	Decreasing	N/A*
Warren 1	1.5 to 1.6	Decreasing	N/A
Warren 2	Not Significant		
Emerald	0.8 to 1.0	No effect	Decreasing
Goondiwindi	0.6 to 0.7	N/A	Decreasing
Upper Namoi	1.2 to 1.4	Decreasing	Decreasing
Hillston	0.6 to 0.8	Decreasing	Decreasing
Darling Downs	1.1 to 1.4	Decreasing	Decreasing
Narrabri	1.1 to 1.4	Decreasing	Decreasing
St George	1.0 to 1.2	Decreasing	Decreasing
<b>AVERAGE</b>	<b>1.1 to 1.3</b>		

\* No data to determine effect.

\*\* Flowering refers to crops 7 to 10 days after first flower

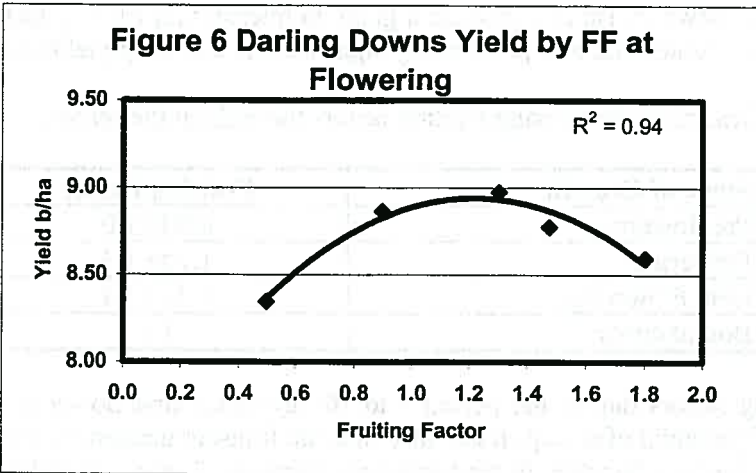
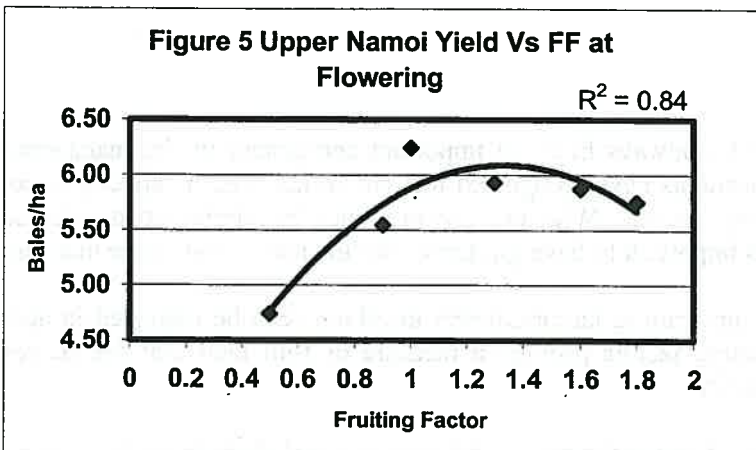
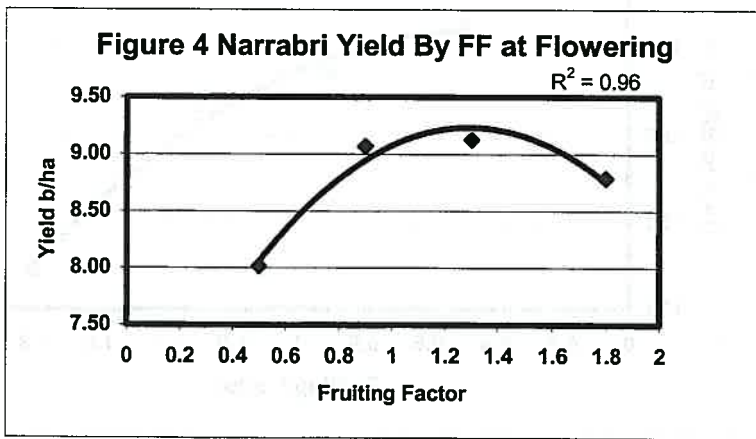
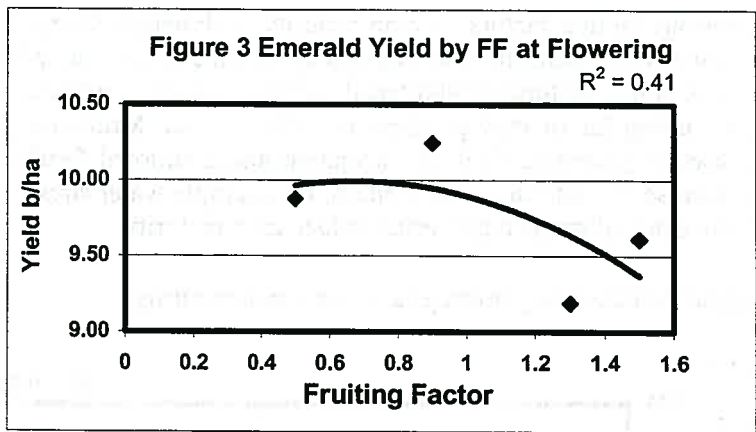
In assessing the average fruiting factor across all the trials, maximum yield was generally produced with a fruiting factor range between 1.1 to 1.3. This confirms the general guide provided from data collected in the 1999-2000 season from commercial fields. The general trend was for yields to decline for values less or greater than optimum, however the degree of impact varied across the different regions.

Figures 3, 4, 5 and 6 show the effects of fruiting factor on yields at Emerald (hot, longer season region), Narrabri (warm season region), and in the Upper Namoi and Darling Downs (cooler shorter season regions). At Emerald there was no relationship between lower fruiting factors at flowering and yield. This demonstrates the capacity of crops to compensate for early season damage in those areas that have a longer season. In the cooler regions there was an increased trend for lower fruiting factors to cause a yield decline. Reflecting the reduced capacity of these crops to compensate for early damage.

Across all four regions there was a decline in yield for crops that held excessive fruit loads at flowering, that is, fruiting factors greater than 1.5. This clearly shows that high fruit loads can be detrimental to crop performance.

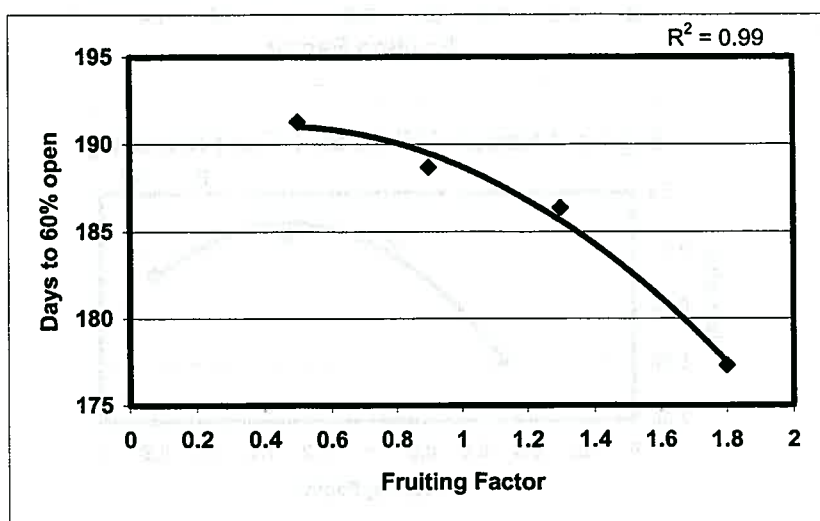
#### Impact of fruiting factors on crop maturity

The higher the fruiting factor the greater the number of fruit per fruiting branch. Once a crop has flowered the plant begins to assign assimilates to boll development over vegetative growth. When fruit loads exceeds the plants ability to support effective boll development and additional vegetative growth, the crop begins to shut down or progress towards cut out. This can be an advantage if we want an early maturing crop, however premature cut out can result reduce yield. Crops with fruiting factors greater than 1.5 at flowering illustrate this point.



The impact of increasing fruiting factors on crop maturity is shown in figure 7. The data is based on the Narrabri trial site where maturity was assessed as the time taken from planting to reach 60% open bolls. It can be seen that maturity is shortened as fruiting factors increase. In recognising that a crop with a high fruiting factor may progress to early cut out. Monitoring fruiting factors at flowering may be used to prioritise fields for irrigation and additional fertiliser if required. The aim would be to minimise any additional crop stress, for example water stress, on crops with high fruiting factors as any external stress may further reduce crop maturity.

Figure 7 Impact of increasing fruiting factors on crop maturity



### Conclusion

Plant monitoring has always been an important component in the management of insect pests. Growers and consultants have recognised that cotton has a high capacity to compensate for early vegetative and fruit damage. With the aim to reduce insecticide costs without affecting yield or crop maturity it is important to have guidelines for the levels of damage that can be tolerated.

Through monitoring fruiting factors, insect thresholds can be managed in accordance with yield expectations. Fruiting factors provide a measure of fruit load that can be related to crop yield potential and maturity.

Table 2 details how fruiting factors can be used as a tool throughout the season to assess crop fruit loads. The values shown in Table 1 provide a guide to interpreting fruiting factors throughout the season and indicate values that will prevent any significant risk to crop yield or maturity.

Table 2 General guide to using fruiting factors throughout the season.

Stage of Growth	Fruiting Factor
Pre flowering	0.8 to 1.0
Flowering	1.1 to 1.3
Peak Flowering	1.3 to 1.4
Boll maturity	1.0

Assessing fruiting factors during the period 7 to 10 days after first flower can provide a useful guide to the yield potential of a crop. It can also indicate if insect thresholds need to be changed or if additional care needs to be taken in the timing of irrigations. Table 3 provides a general guide to fruiting factors at flowering.

Table 3 General guide to using fruiting factors at flowering

<b>Fruiting Factor at Flowering</b>	<b>Impact on yield and maturity</b>
Less than 0.8	Risk of high yield decline and maturity delay. Particularly in cooler regions
1.1 to 1.3	Optimum for yield
More than 1.5	Risk of premature cut out and yield decline.

### **Using Fruit Monitoring in Insect Control Strategies**

IPM Guidelines published by the Australian Cotton CRC, highlight how monitoring fruit damage can assist in using dynamic thresholds. When using fruit retention and fruiting factors the objective is not to replace insect thresholds with damage thresholds. The objective is to use this information in conjunction with information on pest abundance to make more informed decisions regarding the need to control pests.

First position fruit retention and fruiting factors can best be used when making a decision of whether or not to control insects that are just under or over threshold limits. Alternatively, this monitoring can be used in situations where consistent low insect pressure is occurring. For example, there is no value in controlling a pest infestation that is just over threshold if the crop is fruiting well and some damage can be tolerated without effecting yield. Another example is where the combination of below threshold populations of heliothis and mirids can reduce fruit retention if present in a crop for an expended period. By monitoring fruit loss though measuring retention or fruiting factors a decision can be made if such populations are worth controlling.

### **Acknowledgments**

Developing the guidelines for fruiting factors discussed in this paper would not have been possible without the extensive field data provided by Dave Kelly, Sarah Kerlin, Annie Spora, Jenelle Hare, Greg Salmond, Julie O'Halloran, Ingrid Christiansen, Kirrily Rourke, and Evan Brown.

1. The first step in the process of identifying a problem is to define the problem clearly.

Step	Description
1	Identify the problem
2	Analyze the problem
3	Generate solutions
4	Evaluate solutions
5	Implement the solution

2. The second step is to analyze the problem, which involves identifying the causes and effects of the problem.

3. The third step is to generate solutions, which involves brainstorming ideas and evaluating them based on their feasibility and effectiveness.

4. The fourth step is to evaluate solutions, which involves comparing the different solutions and selecting the best one based on the criteria established in the previous step.

5. The final step is to implement the solution, which involves putting the chosen solution into action and monitoring its progress.

6. The process of identifying a problem is a continuous one, as new problems may arise at any time, and the solution to one problem may lead to another.

7. The process of identifying a problem is a critical one, as it determines the direction of the entire project.