

## **The impact of early defoliation on neps**

Michael Bange, Robert Long, Greg Constable and Stuart Gordon

CSIRO Plant Industry (Narrabri) and CSIRO Materials Science and Engineering (Geelong)  
Cotton Catchment Communities Cooperative Research Centre. Narrabri

*Significant amounts of immature fibres and neps in ginned cotton will affect textile quality and thus can affect Australia's reputation for high quality. A study conducted in three seasons varied the timing of defoliation to determine what crop conditions (e.g. % open bolls) at the time of application contribute to differences in the amount of immature fibre and levels of neps in crops at harvest. We also investigated the impact of 0, 1, 2 lint cleaning passes at ginning on fibre quality. Earlier defoliation treatments resulted in fibre with lower linear density (fineness – a component of fibre micronaire) and increased neps. Extra lint cleaning passes substantially increased neps when fibre was very immature. Crop condition (% open bolls) at the time of defoliation related well to fibre quality at harvest and supported the current recommendation of applying defoliant at 60% open bolls to minimize yield losses and neps. We make suggestions on how to manage to avoid low micronaire (high neps).*

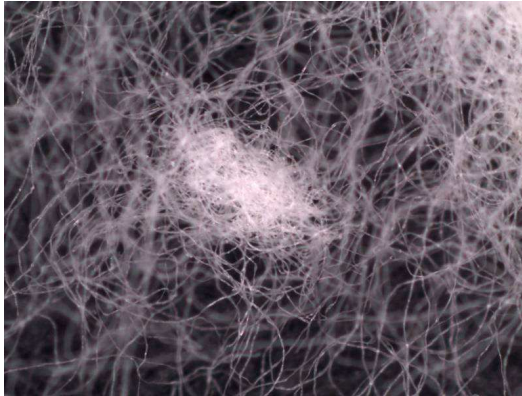


Figure: A nep is an entanglement of fibres resulting from mechanical processing. More neps can occur if cotton is immature (Photo: CSIRO)

### **Introduction**

Immature bolls will usually contain immature cotton fibres which are prone to the formation of neps. Neps are small entanglements of cotton fibres that are created during mechanical processes like machine harvesting and ginning. Immature fibre and neps even in small amounts are undesirable as they decrease mill processing efficiency and ruin the appearance of finished yarns and fabrics. Immature fibres and neps absorb less dye and reflect light differently, and consequently appear as under-dyed patterns and/or 'flecks' on finished fabrics. Their presence in large quantities can negatively affect an industry's reputation when cotton arrives at spinning mills.

The number of immature bolls in a crop at harvest can increase as a result of actively growing crops experiencing an abrupt end to the season caused by cold temperatures and/or premature applications of defoliant that force immature bolls to open. Both situations may lead to less mature fibres and increased chances of neps once cotton is harvested and ginned.



Figure: Too early defoliation (earlier than 60% open bolls; 29% immature bolls) can result in increased neps. (Photo: CSIRO).

Many studies have also reported reductions in micronaire (an indirect measurement of both fibre linear density (fineness) and maturity) with premature applications of defoliant and have related this to crop development such as % open bolls and Nodes Above Cracked Boll (NACB). No studies however have attempted to relate crop condition at the time of defoliation to the direct level of immature fibre in the crop and the consequences of this immaturity on differences in neps. This study used the timing of defoliant application to vary the amount of immature fibre and levels of neps in the crop to ascertain the crop conditions that contribute to neps and assess whether these outcomes are influenced by the number of lint cleaning passes. This information will be valuable in refining crop monitoring and harvest preparation strategies that aim to optimize both lint yield and fibre quality (including the reduction in neps).

## Methods

Defoliation timing field experiments were conducted over three seasons at the Australian Cotton Research Institute (ACRI) at Narrabri from 2005 to 2008. Replicated experiments (four reps per experiment) consisted of five to seven defoliation application dates with a control which allowed all bolls to fully mature. A mixture of leaf defoliant (0.2 L/ha Dropp Liquid®) and a boll opener (3 L/ha Prep 720®) with 2 L/ha D-C Tron® was applied at approximately 5 d intervals in 2005/2006 (Sicot 71BR), 2006/2007 (Sicot 71BR), and 7 d intervals in 2007/2008 (Sicot 71) from low to high % open bolls. Initiation of defoliant treatments was targeted to generate treatments with increased immature fibre, so the first defoliant treatment was at 5% to 20% open bolls. To establish crop condition when defoliant treatments were applied % open bolls were recorded on control plots.

Yield was determined from machine picking. Samples were ginned and HVI tested at CSIRO Narrabri and then subjected to lint cleaning and fibre quality testing at CSIRO Geelong (neps (AFIS), maturity ratio (SiroMat), linear density (CSIRO Cottonscan™)). Lint cleaning treatments (0, 1 and 2 lint cleaning passes) employed a purpose built experimental lint cleaner. Fibre maturity and linear density (fineness) are components of micronaire.



Figure: The experimental lint cleaner in Geelong used in this study. (Photo: CSIRO).

## Results

### *Lint Yield*

Yields in control plots at harvest were 2781 kg/ha (12.3 b/ha) in 2006, 2803 kg/ha (12.3 b/ha) in 2007, and 2580 kg/ha (11.3 b/ha) in 2008. In all Experiments lint yield was significantly affected by defoliant treatments with the greatest yield reduction occurring with the earlier treatments and was due to smaller boll sizes (seed cotton per boll) and lower gin turnout. The change in lint yield from the control with defoliant timing could be related to % open bolls, ( $r^2 = 0.75$ ) (Figure 1). Lint yield was reduced by 68 kg/ha (0.3 bale/ha) when defoliant treatments were applied at 40% open bolls from 60% open bolls.

### *Micronaire (Maturity ratio and linear density)*

In all Experiments earlier defoliation significantly lowered micronaire, fibre maturity ratio and linear density (Table 1) while the levels of fibre neps were increased (Table 2). Micronaire in the late defoliation treatments of the 2006/2007 season was high ( $> 5.0$ ) and was low ( $< 3.8$ ) in all treatments of the 2007/2008 season. These values would have attracted price discounts for growers, although earlier defoliation in 2007/2008 would have prevented price discounts.

The level of neps from cotton with no lint cleaning in some of the early defoliation treatments either exceeded or was close to unacceptable levels ( $< 250$  neps/g). Cotton that had been processed by lint cleaners following ginning had very few instances where levels did not exceed 250 count/g. Only treatments in 2006/2007 and 2007/2008 with late defoliation following 1 lint cleaning pass had levels similar or lower than 250 count/g. If high levels of neps are detected, spinners incur losses during processing and the final yarn appearance is reduced. The number of neps was related to lower fibre linear density ( $r = -0.83$ ), maturity ratio ( $r = -0.63$ ) and micronaire ( $r = -0.74$ ) indicating that production of immature or low linear density fibre was most likely the reason for increased neps. Upland cotton fibre with maturity ratios less than 0.85 or a micronaire-value less than 3.5 are generally considered immature.

Across seasons and with treatments, the reduction in micronaire and increase in and neps were related to % open bolls (Figure 1). Like yield, fibre attributes were only substantially affected once defoliation treatments were applied prior to 60% open bolls. For example, the level of neps in fibre with no lint cleaning was increased by 29 counts/g when defoliants were applied at 40% open bolls over applications at 60% open bolls. This increase was also associated with a 0.10

reduction in micronaire, a 0.01 reduction in maturity ratio, and a 3.6 mtex reduction in linear density.

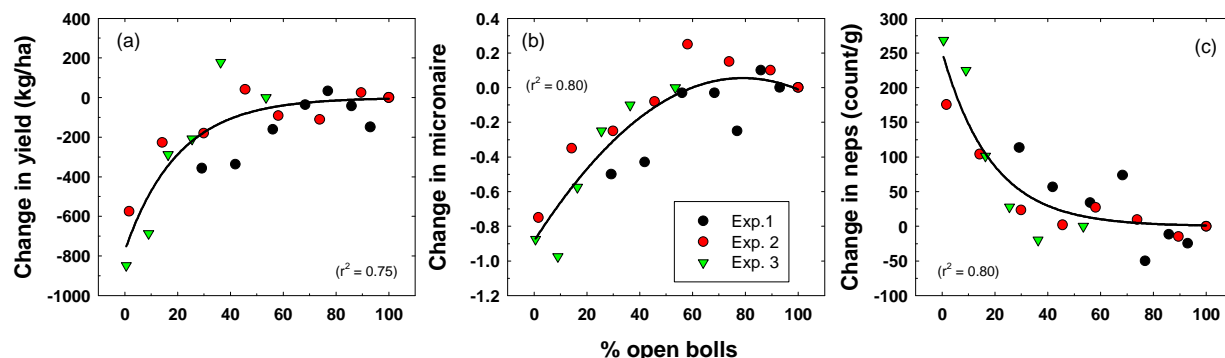


Figure 1. An example of response of changes in (a) lint yield, (b) micronaire, (c) neps with % open bolls at defoliation treatment across all experiments (Exp.). The change in variable is calculated as the change from the control defoliation treatment for each experiment. Nep change is for 1 lint cleaning pass.

### *Lint Cleaning and Neps*

Similar to other studies the number of lint cleaning passes had significant effects on nep levels. On average across experiments 144 neps/g more neps were measured for 1 lint cleaning pass and another 181 more neps for a second pass. To account for the effect of lint cleaners on the level of neps across seasons the change in nep count of each defoliation treatment and lint cleaning passes from the control treatment with 0 lint cleaning was related to % open bolls (Fig. 2). These responses highlighted a consistent decline in neps with more open bolls, and the relative stability in the extra contribution of lint cleaners. Although at around 40% open bolls and earlier the significant amounts of immature cotton (caused by very early defoliation) substantially increased neps with extra lint cleaning passes.

### **Outcomes**

On the basis of yield, micronaire, fibre maturity and neps the results here support the current recommendation of applying defoliants at 60% open bolls or around 4 NACB in uniformly maturing cotton crops. This study showed across three different seasons that all these attributes were consistently affected prior to 60% open bolls. The decision on whether to apply defoliants earlier than 60% open bolls is often affected by yield and quality losses from crop weathering and/or the overall maturity of the crop. If seasons have been cooler and crops are delayed (as was the case with 2008/2009 in this study) fibres will already be less mature and the risk of harvesting immature fibre and creating neps is already inherently greater. Therefore applying defoliation prior to 60% open bolls only increases the chances of lowering micronaire, harvesting more immature fibre and generating more neps, attracting discounts and affecting quality of textiles produced from this cotton. This is especially made more important when lint cleaning is applied in the gin (Fig. 2). Ensuring that cotton is as mature as possible when delivered to the gin will help to contain these issues. The ability to predict whole of seasonal effects on micronaire/maturity at the time of defoliation will assist in determining the risks and costs of earlier applications. This is a subject of ongoing research.

We conclude that to avoid potential discounts for low micronaire and to minimize neps, it would be advantageous to know the likely micronaire of a crop before defoliation so that appropriate management can be deployed. Under circumstances where a low micronaire was expected, actions such as delaying defoliation to 70% open bolls (or more) and reducing the rate of (or omitting) boll opener from the first defoliation application would reduce the amount of immature harvested. To target a premium fibre outcome, it is desirable that ginning is customized to ensure as much moisture is maintained in the lint (ideally greater than 6% but less than 7%) during ginning and only necessary lint cleaning is done. These options are detailed in FIBREpak which can be ordered online at the Cotton CRC's website [www.cottoncrc.org.au/content/Industry/Publications/Fibre\\_Quality/FIBREpak/](http://www.cottoncrc.org.au/content/Industry/Publications/Fibre_Quality/FIBREpak/)

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## References

Bange M.P., Long R.L., Constable G.A., Gordon S.G. (2010) Minimizing Immature Fibre and Neps in Upland Cotton. *Agronomy Journal* 102:781-789.

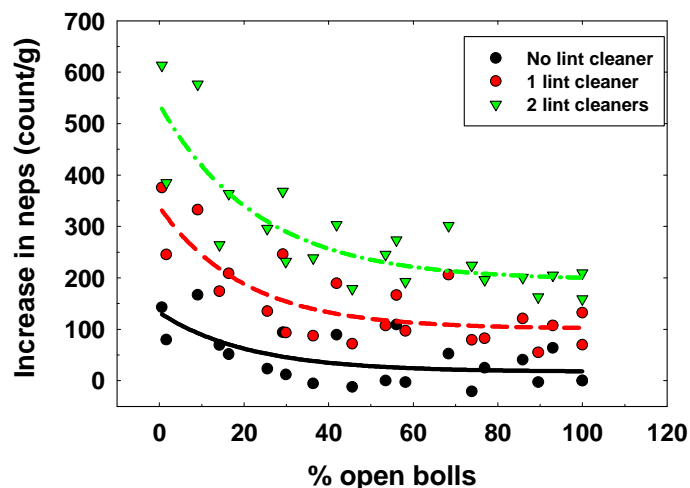


Figure 2. The response of change in lint neps with crop condition at defoliation associated with 0, 1, and 2 lint cleaning passes across all experiments. Change in neps is calculated as the change in neps from the control treatment with no lint cleaning for each experiment.

Table 1: Impact of defoliation timing on fibre upper half mean length (UHML), bundle strength, micronaire, fibre maturity ratio and linear density for all experiments. Neps are for samples with no lint cleaning.

| Defoliation treatment | open bolls | Micronaire | Maturity ratio | Linear density | Neps           |
|-----------------------|------------|------------|----------------|----------------|----------------|
| Experiment 1          | --- % ---  |            |                | --- mtex ---   | --- count/g--- |
| 1                     | 29.2       | 4.08       | 0.88           | 171.50         | 247.8          |
| 2                     | 41.9       | 4.15       | 0.91           | 180.50         | 243.3          |
| 3                     | 56.0       | 4.55       | 0.98           | 194.00         | 262.8          |
| 4                     | 68.4       | 4.55       | 0.91           | 190.75         | 206.0          |

|              |       |       |       |        |       |
|--------------|-------|-------|-------|--------|-------|
| 5            | 76.9  | 4.33  | 0.95  | 183.25 | 178.8 |
| 6            | 85.9  | 4.68  | 0.91  | 195.00 | 194.5 |
| 7            | 93.0  | 4.58  | 0.95  | 195.50 | 217.8 |
| Control      | 100.0 | 4.58  | 0.95  | 193.25 | 153.8 |
| LSD (0.05)   |       | 0.36* | n.s.  | 12.22* | 63.0* |
| Experiment 2 |       |       |       |        |       |
| 1            | 1.6   | 4.18  | 0.82  | 179.00 | 263.0 |
| 2            | 14.2  | 4.58  | 0.85  | 187.75 | 233.8 |
| 3            | 29.9  | 4.68  | 0.90  | 195.75 | 195.3 |
| 4            | 45.6  | 4.85  | 0.95  | 202.00 | 171.3 |
| 5            | 58.2  | 5.18  | 0.91  | 207.25 | 199.5 |
| 6            | 73.8  | 5.08  | 0.95  | 204.50 | 162.5 |
| 7            | 89.5  | 5.03  | 0.99  | 209.50 | 180.8 |
| Control      | 100.0 | 4.93  | 0.90  | 200.50 | 342.2 |
| LSD (0.05)   |       | 0.36* | 0.10* | 10.72* | 46.0* |
| Experiment 3 |       |       |       |        |       |
| 1            | 0.6   | 2.95  | 0.53  | 158.50 | 340.2 |
| 2            | 9.0   | 2.85  | 0.69  | 151.50 | 364.3 |
| 3            | 16.4  | 3.25  | 0.63  | 173.00 | 249.0 |
| 4            | 25.5  | 3.58  | 0.65  | 178.20 | 220.7 |
| 5            | 36.3  | 3.73  | 0.75  | 182.00 | 192.0 |
| Control      | 53.5  | 3.83  | 0.75  | 191.20 | 197.5 |
| LSD (0.05)   |       | 0.26* | 0.15* | 9.26*  |       |

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\* Significant differences across treatments