EVALUATION OF IN-FIELD MONITORING METHODS TO REDUCE NEPS (IN AUSTRALIAN COTTON)

Michael Bange
CSIRO Plant Industry
Narrabri, NSW, Australia
Robert Long
CSIRO Materials Science & Engineering
Belmont, VIC, Australia
Greg Constable
CSIRO Plant Industry
Narrabri, NSW, Australia
Stuart Gordon
SIRO Materials Science & Engineering
Belmont, VIC, Australia

Abstract

For Australian cotton issues that have been highlighted as concerns by spinners including: neps (small entanglements of cotton fibers), short fiber (fibers shorter than 12.5 mm), rising contamination and micronaire greater than 4.5. Significant research efforts are being undertaken seeking to optimize cotton fiber quality and enhance the value of Australian cotton through research into direct influences of on-farm agronomic management and climate on fiber development and post-harvest research that investigate the degree of these influences on textile performance in the mill. This paper presents research which is developing in-field monitoring techniques to identify circumstances when crops may have increased levels of neps so these instances maybe avoided. Field experiments were conducted that measured neps in harvested cotton taken from treatments that had harvest aids systematically applied to force bolls open from 1.6% open bolls to full harvest maturity (100% open bolls). The amount of neps (count/g) was significantly related the proportion of bolls open (%), nodes above cracked boll (NACB), and % immature bolls (as defined by the color of the seed coats in cut bolls). The most reliable relationship in predicting change in the amount of neps was % open bolls followed by % immature bolls then NACB. Application of harvest aids after 60% open bolls reduced chances of increasing neps and lowering yield. Substantial increases in neps were avoided despite crops being harvested with 20% immature bolls present. Current research is investigating the feasibility of these monitoring techniques to predict neps in crops that have plants variable in their maturity, and how these treatments impact on textile performance (yarn strength and dye uptake).

Introduction

In recent years in the Australian cotton industry there have been concerns relating to high micronaire (a measure of fiber fineness and maturity), short fiber content and high incidence of neps (small entanglements of cotton fibers) in Australian cotton (Gordon et al. 2004). Practices aimed at increasing yield or attempts to reduce micronaire by forcing open the last few immature bolls growing at the end of the season to include in the harvest may lead to less mature fibers and increased neps. These issues will be especially exaggerated when crops remain actively growing at the end of a season and then experience an abrupt end caused by a cold finish. Premature application of harvest aids will also cause the same effect.

Immature bolls may contain immature cotton fibers which can lower micronaire and make the fibers more prone to the incidence of neps (Gordon 2007). Specifically neps are small entanglements of cotton fibers resulting from dead or immature fibers exaggerated by mechanical processing (Hebert 1988). They are undesirable as they decrease mill processing efficiency and typically absorb less dye and reflect light differently and appear as ‘flecks’ on finished fabrics (Goynes et al. 1997; Anthony et al. 1988).

Many studies have shown reductions in micronaire (an indirect measurement of both fiber fineness and maturity) with premature applications of harvest aids (Faircloth et al. 2004a; Bednarz et al. 2002). This study uses timing of harvest aids to explicitly attempt to vary the amount of immature fiber to generate different levels of neps and relate this to various measure of crop status. In identifying these relationships it is anticipated that this information be used to develop crop monitoring strategies that aim to optimize yield and fiber quality (including reduction in neps).

Two field studies were conducted over two consecutive seasons that systematically varied the timing of harvest aids to generate different amounts of immature fiber and neps.

Methods

Cultural details

Two field experiments that systematically imposed different timings of harvest aids was conducted at the Australian Cotton Research Institute (ACRI), Narrabri (30º S 150º E) in the 2005/06 (Experiment 1 (Exp. 1)) and 2006/07 (Experiment 2 (Exp. 2)) seasons. This is a semi-arid environment with a uniform grey cracking clay (USDA Soil Taxonomy: Typic Haplustert). Both experiments were sown with a commercial row crop planter using the Bollgard II® Roundup Ready® (Monsanto®) *Gossypium hirsutum* cultivar Sicot 71BR (CSIRO, Australia). Exp. 1 was sown on 15 Oct. 2005 while Exp. 2 was sown 20 Oct. 2006. Experiments were established and grown with full irrigation using non-limiting nitrogen and thorough insect control. Nitrogen was applied as anhydrous ammonia, injected below and to the side of the plant line, implemented 4 weeks before sowing at a rate of 200 kg N ha^{-1}.

Treatment plots (9 m by 4 m), contained four rows spaced at 1 m. In the center two rows of each plot harvest aid (Defoliant and a boll opener) were applied at approximately 5 d intervals from 143 d after sowing in Exp. 1 and 136 d after sowing in Exp. 2 until full crop harvest maturity (100% bolls open). This resulted in eight harvest aid treatments for both experiments (Table 1) including the mature control. The experiment was a randomized complete block design (RCBD) replicated four times. Harvest aids were sprayed with a calibrated CO_2 pressurized 2.0 m hand boom using a flat fan nozzles (110-01) at 200 k Pa delivering 100 L ha^{-1} of spray solution. The chemical and rates were: 0.2 L ha^{-1} Dropp Liquid® (Bayer CropScience, active constituent 500g L^{-1} Thidiazuron); 3 L ha^{-1} Prep 720® (Bayer CropScience, active constituent 720g L^{-1} Ethephon); and 2 L ha^{-1} D-C Tron® (Caltex, active constituent 991ml L^{-1} Petroleum Oil).

Crop Measurements

To determine crop status when harvest aid treatments were applied, a fixed area of 1 m^2 of row in each control plot was monitored to determine the percentage of bolls open. In addition at each time of harvest aid treatment a 1 m^2 area of plants were harvested. Nodes above cracked boll (NACB) were measured on all plants, while five plants were taken to determine % immature bolls. Immature bolls were determined using a boll cutting technique that defines a boll as 'physiologically mature' when the seeds contained in the bolls have black coats. Percentage of immature bolls were monitored to account for any potential 'fruiting gaps' that can affect % open bolls and NACB as techniques to assess overall crop maturity (Faircloth et al. 2004b).

To determine lint yield the third row (9 m) of each plot was harvested with a spindle picker and the seed cotton was weighed. A sub-sample of approximately 400 g of seed cotton was taken from each plot and ginned to determine gin turnout (% lint) used to calculate lint yield. Samples were saw ginned using a 20 saw gin located at the ACRI. Sub-samples were then subjected to one lint cleaning passage. Lint cleaning was conducted with an experimental lint cleaner with a sample feed loading ratio of 100g m^{-2}, a saw speed of 855 rpm and a combing ratio of 23. The lint cleaner had four grid bars each located at a distance of 0.5mm from the saw. These samples were then subjected to Uster HVI and AFIS PRO fiber quality analyses. Samples for the quality analysis were passively conditioned for at least 48 hours under standard conditions and tested according to the manufacturer's instructions. For AFIS PRO measurements five replicates were tested per experimental sample. Regression analyses were conducted using Sigma Plot ver. 10.

Results and Discussion

Similar to other studies both yield and micronaire were reduced by earlier applications of harvest aids to maturing cotton (Kerby et al. 1992; Supak et al. 1993, Snipes and Baskin 1994; Bednarz et al. 2002; Faircloth et al. 2004a; Siebert and Stewart 2006). In this study the change in yield and micronaire was related to % open bolls using a quadratic response (Fig. 1). Yield and micronaire were substantially reduced when harvest aids were applied prior to 60% open bolls. These results were consistent with the results of Snipes and Baskin (1994) that also showed that yield and quality were only significantly affected when harvest aids were applied prior to 60% open bolls.

Conversely the levels of neps were increased with earlier applications of harvest aids (Fig. 2). Significant quadratic relationships were fitted to % open bolls, NACB, and % immature bolls. Of these variables, % open bolls (r^2= 0.74) best described the level of neps, followed by % immature bolls (r^2= 0.69) and then NACB (r^2=0.52). The level of neps was increased when harvest aids were applied prior to 60% open bolls, and when the crop had more than approximately 8 NACB and 20% immature bolls. The intention of developing a relationship of neps to % immature bolls (using a boll cutting technique) was to account for any potential 'fruiting gaps' that may limit the use of % open bolls and NACB (Faircloth et al. 2004b).

Current recommendations for harvest preparation using harvest aids suggest their timing of application occur once crops have reached 60% open bolls or 4 NACB in uniformly maturing crops. While earlier applications may reduce micronaire that sometimes lowers the risks of cotton growers receiving price discounts for quality, there is increased risk that yields are reduced and the level of neps increased. It also appears that if harvest aids force open bolls even when the crop has 20% or less immature bolls this has little affect on contributing to the overall level of neps following harvest, ginning and one lint cleaning passage. This study is also investigating in detail the level of neps that will impact on textile performance resulting from changes in timing in harvest aids to help better refine management recommendations for reducing neps (Long et al. 2008). Preliminary results highlight that moderate increases in neps have little effect on yarn performance and fabric dye uptake.

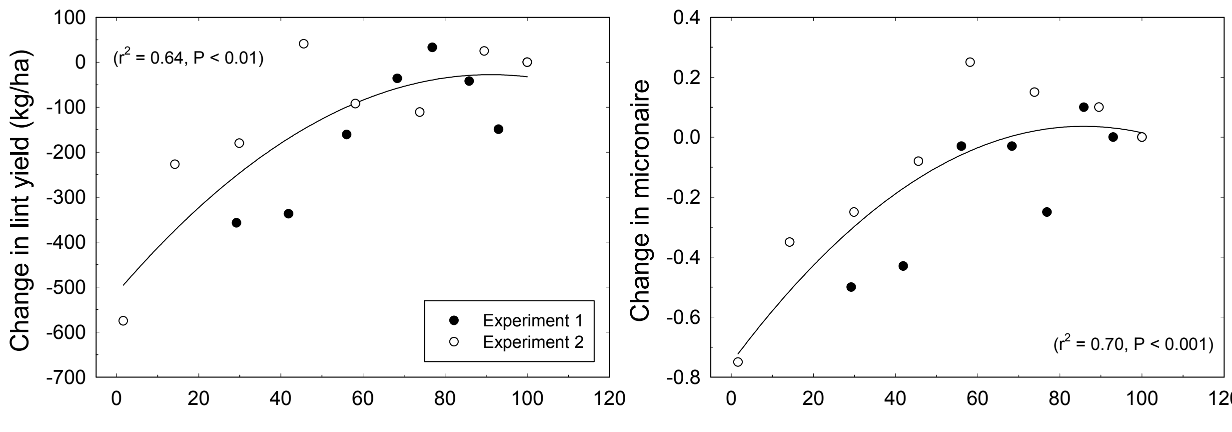

Fig. 1. Quadratic relationships describing the change in lint yield and micronaire from control treatments with % open bolls measured at the time application of harvest aid treatments. Data points are the average of the four replicates.

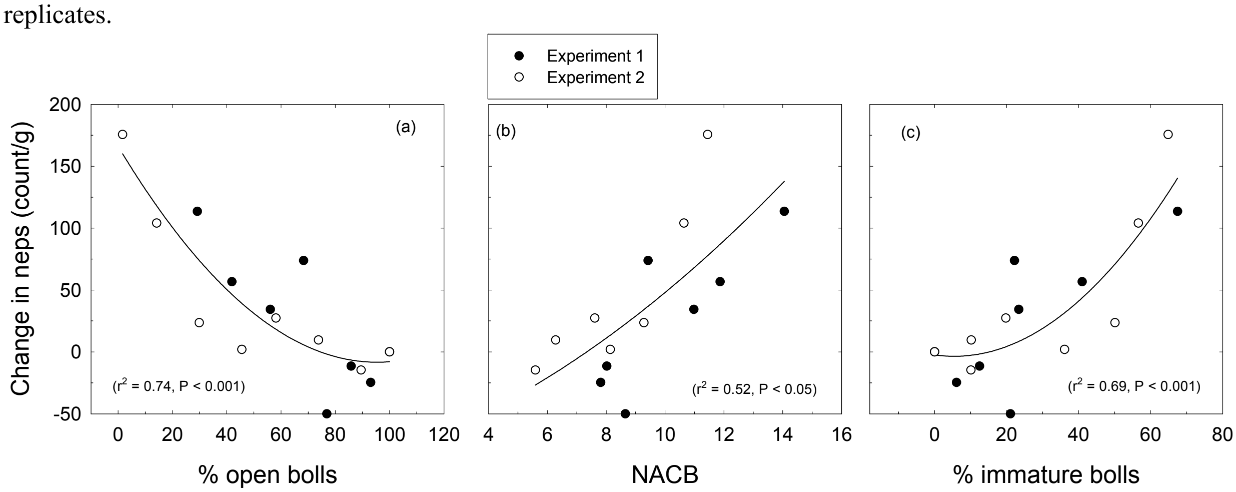

Fig. 2. Quadratic relationships describing the change in the level of neps from control treatments with (a) % open bolls, (b) NACB, and (c) % immature bolls measured at the time application of harvest aid treatments. Data points are the average of the four replicates. The proportion of open bolls is not analogous to % immature bolls as the boll cutting technique identifies bolls that are mature but not open.

Conclusion

This paper presents results of ongoing efforts being undertaken seeking to optimize cotton fiber quality and enhance commercial value of Australian cotton through research into direct influences of on-farm agronomic management and climate on fiber development. Specifically this paper introduces research which is developing in-field monitoring techniques to identify circumstances when crops may have increased levels of neps so these instances maybe avoided. Like micronaire, the level of neps could be related to different measures of crop maturity. The best monitoring strategy to establish whether increased levels of neps were present in maturing cotton was using % open bolls. Further research is continuing to assess a range of monitoring strategies to establish levels of neps on cotton crops that contain more immature fiber and have known fruiting gaps

Acknowledgments

Thanks to Jane Caton, Darin Hodgson, Rebecca Giles, Sue Miller and Geni Kozdra for assistance in the field and with AFIS measurements. This work was partially funded by the Cotton Research and Development Corporation and the Australian Cotton Cooperative Research Centre.

References

Anthony WS, Meredith WR, Williford JR (1988) Neps in ginned lint: The effect of varieties, harvesting, and ginning practices. Textile Research Journal 58, 633-639.

Bednarz CW, Shurley DW, Anthony WS (2002) Losses in yield, quality, and profitability of cotton from improper harvest timing. Agronomy Journal 94, 1004-1011.

Faircloth JC, Edmisten KL, Wells R, Stewart AM (2004a) The influence of defoliation timing on yields and quality of two cotton cultivars. Crop Science 44, 165-172.

Faircloth JC, Edmisten KL, Wells R, Stewart AM (2004b) Timing defoliation applications for maximum yields and optimum quality in cotton containing a fruit gap. Crop Science 44, 158-164.

Gordon SG, van der Sluijs MHJ, Prins MW (2004) Quality issues for Australian cotton from a mill perspective. (Australian Cotton Cooperative Research Centre, Narrabri).

Gordon SG (2007) Cotton fiber quality. In' Cotton: Science and technology'. Gordon SG, Hsieh Y-L. (eds), (Woodhead Publishing Ltd., Cambridge, England) pp. 68-100.

Goynes WR, Ingber BF, Bel-Berger PD (1997) A simple method for detecting white speck potential in undyed cotton. Proceedings Beltwide Cotton Conference, New Orleans, LA 7-10 Jan. 1997. pp. 155-156. (National Cotton Council of America, Memphis, TN).

Hebert JJ, Boylston EK, Thibodeaux DP (1998) Anatomy of a nep. Textile Research Journal 58, 380-382.

Kerby TA, Supak J, Banks JC, Snipes C (1992) Timing defoliation using nodes above cracked boll. Proceedings Beltwide Cotton Conference, Nashville, TN 6-10 Jan. 1992. pp. 155-156. (National Cotton Council of America, Memphis, TN).

Long R, Bange MP (2008) Assessing the impact of harvest aid timing on fiber quality and textile performance. In Proceedings Beltwide Cotton Conference January, Nashville, TN 8-11 Jan. 2008. (National Cotton Council of America, Memphis, TN).

Siebert JD, Stewart AM (2006) Correlation of defoliation timing methods to optimize cotton yield, quality, and revenue. Journal of Cotton Science 10, 146-154.

Snipes CE, Baskin CC (1994) Influence of early defoliation on cotton yield, seed quality, and fiber properties. Field Crops Research 37, 137-143.

Supak J, Kerby TA, Banks JC, Snipes C (1993) Use of plant monitoring to schedule chemical crop termination. Proceedings Beltwide Cotton Conference, New Orleans, TN 10-14 Jan. 1993. pp. 1194-1196. (National Cotton Council of America, Memphis, TN).