COMPARISON OF HIGH-SPEED ROLLER AND SAW GINNING ON TEXAS HIGH PLAINS COTTON

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Abstract

New high-quality cotton cultivars have been adopted in the Southern High Plains recently and, as a result, interest has grown in finding harvest and ginning practices that better preserve fiber quality. Advancements in roller ginning technology have increased the ginning rate of some roller gins to that of saw gins. Thus, there is renewed interest in roller ginning for upland cotton. The objective of this work was to compare fiber quality and turnout of upland cotton produced in the Southern High Plains, harvested using a spindle picker or a brush-roll stripper, and ginned using saw or high-speed roller ginning (HSRG) systems. The findings of this work indicate that the HSRG substantially improved the length characteristics of the upland cultivar used regardless of harvest method. Turnout was higher for the HSRG cotton and for picker harvested cotton. Nep content was reduced for picker harvested cotton and HSRG cotton. Loan value for HSRG cotton was reduced slightly compared to the saw ginned cotton due to reduced fiber reflectance values. The fiber length distribution and nep content improvements afforded by the HSRG make this fiber more attractive to ring spinning mills which produce high count yarns for high value products.

Introduction

Compared to saw ginning, increased ginning costs associated with conventional roller ginning due to low production rates prevented the widespread application of roller ginning for upland cultivars (Thomas et al., 2008, Armijo and Gillum, 2010). Advances in roller ginning technology have increased gin stand production rates to levels comparable to saw gin stands (Armijo and Gillum, 2007). These advancements have lead to new interest in roller ginning upland cultivars in several areas of the US, including the Southern High Plains. Earlier work comparing saw and roller ginned upland cotton indicates that fiber length and length uniformity properties can be substantially improved with roller ginning (Hughs and Leonard, 1986, Mangialardi, 1991, Armijo and Gillum, 2007, Armijo and Gillum, 2010). The objective of this work is to compare fiber quality and turnout of upland cotton produced in the Southern High Plains, harvested using a spindle picker or a brush-roll stripper, and ginned using saw and high-speed roller ginning (HSRG) systems.

Methods

One cotton cultivar (FiberMax 9180 B2F, Bayer CropScience) was produced on a drip irrigated farm in Lubbock, TX, during 2010, for this project. Half of the cotton was harvested using a brush-roll cotton stripper (John Deere 7445, Moline, IL), while the remaining half was harvested with a spindle picker (John Deere 9996, Moline, IL). The stripper harvested cotton was processed through a field cleaner mounted on the harvester to help reduce the amount

of foreign matter contained in the seed-cotton. The field average lint yield was 1486 kg/ha (1325 lb/acre). The harvested seed-cotton was compressed into 114-kg (250-lb) bales for shipment to the Southwestern Cotton Ginning Lab in Mesilla Park, NM, where the cotton was ginned. Prior to ginning, 160-kg (375-lb) seed-cotton lots were processed through different seed-cotton cleaning machine sequences based on harvest method. The picker harvested cotton passed through the following seed-cotton cleaner sequence: suction, green boll/rock trap, #1 inclined cleaner (6 cylinders), #1 stick machine (3 saw), and #2 inclined cleaner. The stripper harvested cotton passed through the same sequence with an additional stick machine (3 saw) after the #2 inclined cleaner. Half of the seed-cotton lots from each harvest method were ginned on a HSRG system while the remaining lots were ginned on a saw ginning system. The HSRG system consisted of a 1-m (40-in) wide Consolidated HGM roller gin stand with a spiked-cylinder feeder (Consolidated HGM, Lubbock, TX). The roller ginned cotton passed through one stage of lint cleaning consisting of a mill-type lint cleaner similar to the Guardian™ lint cleaner (Lummus, Savannah, GA). The saw ginning system consisted of a 46-saw Continental/Murray Double Eagle (Continental Eagle Corp., Prattville, AL) gin stand and Continental/Moss Gordin Galaxy (Continental Eagle Corp., Prattville, AL) extractor-feeder. The saw ginned cotton passed through one stage of saw type lint cleaning on a Continental/Moss-Gordin Lodestar (Continental Eagle Corp., Prattville, AL) lint cleaner with 41-cm (16-in) saw diameter and five grid bars.

Seed-cotton samples were collected at the suction and feeder apron (prior to ginning) for fractionation analysis and gravimetric moisture content analysis. Lint samples were collected before and after the lint cleaner used after each ginning system for high volume instrument (HVI) and advanced fiber information system (AFIS) fiber analysis and an additional lint sample was collected after lint cleaning for gravimetric moisture content analysis. The foreign material removed by each seed-cotton and lint cleaner was collected and weighed. Seed samples were collected after ginning for visible mechanical damage (VMD) and seed grade analyses. Seed-cotton, lint, and seed weights were recorded for each lot.

Results

Foreign matter removed by the seed-cotton cleaners (not including the gin feeders) was only different by harvest method and averaged 41.4 kg/bale (91 lb/bale) for the picker harvested cotton and 86 kg/bale (189 lb/bale) for the stripper harvested cotton. Total foreign matter removed by the cleaning equipment before the gin stands was different by harvest and ginning method since the gin feeders were different for each ginning system. The spiked cylinder feeder before the HSRG removed an additional 3.5 and 3.7 kg/bale (7.7 and 8.1 lb/bale) from the picked and stripped cotton, respectively while the extractor-feeder before the saw gin removed 23.9 and 36.5 kg/bale (52.6 and 80.4 lb/bale) more trash from the picked and stripped cotton, respectively. Ginning rate for the HSRG averaged 3.2 bales/hr-m (0.98 bales/hr-ft) and was lower than the saw gin processing rate of 4.4 bales/hr-m (1.34 bales/hr-ft). The HSRG controller was configured to begin feeding the gin stand slowly and gradually increase the feeding rate up to the steady-state ginning rate where the rotary knife power reaches 1200 W. The start-up period duration of the HSRG increased total ginning time such that average ginning rates for the roller gin were reported much lower than the steady-state ginning rate. It is anticipated that using larger lot sizes or logging gin stand power consumption during the ginning period would help to better characterize ginning rate. The start-up period duration for the saw gin was much shorter than the HSRG and did not substantially reduce the average ginning rate.

Turnout was different by both harvest and ginning method. Picked-HSRG, picked-saw, stripped-HSRG, and stripped-saw turnout values were 34.5, 32.0, 31.3, and 29.2%, respectively (treatments identified as harvest method-ginning method). HVI upper half mean length was different by ginning method and averaged 31.2 and 30.2 mm (1.23 and 1.19 in) for the HSRG and saw gin, respectively. HVI length uniformity was increased substantially by the HSRG where uniformity averaged 84.4% compared to 82.3% for the saw gin. AFIS short fiber content by number was lower for the HSRG and averaged 24.1% compared to 27.6% for the saw gin. The AFIS length by number distributions, shown in Figure 1, indicate a distinct difference in length properties between ginning systems that is independent of harvest method. The length distributions for the HSRG cotton indicate a higher portion of fibers longer than 25.4 mm (1 in) and lower portion of fibers shorter than 12.7 mm (0.5 in) compared to the distributions for the saw ginned cotton. Nep content, as shown in Figure 2, before lint cleaning was lower for HSRG (164 cnt./g) compared to saw ginned cotton (206 cnt./g). After lint cleaning, nep content increased to 179 and 252 cnt./g for the HSRG and saw gins, respectively. The more aggressive cleaning action of the saw type lint cleaner used with the saw gin increased nep content more so than the gentler mill-type lint cleaner used with the HSRG. Nep content was lower for picker harvested cotton before (176 vs. 194 cnt./g, picker vs. stripper) and after (206 vs. 224 cnt./g, picker vs. stripper) lint cleaning (Figure 2). Micronaire was higher for picked cotton (4.36) compared to

stripped (4.25) which follows the findings of previous research comparing picker and stripper based harvest systems (Faulkner et al., 2011 and Boman et al., 2011). Unexpectedly, micronaire averaged 4.38 and 4.23 for the HSRG and saw gin, respectively. Leaf grade and AFIS total foreign matter content were both higher for the HSRG compared to the saw gin (Leaf: 2.38 vs. 1.06, AFIS Total FM: 560 vs. 325 cnt/g) and could have affected higher micronaire readings for the HSRG. Differences in AFIS maturity ratio by ginning method were observed and follow the trends observed in micronaire. However, the difference in maturity ratio by ginning method is small (HSRG = 0.88, saw = 0.87) and likely of little practical significance. Commodity Credit Corporation loan rates were lower for the HSRG cotton at 1.252 $/kg (0.5682 $/lb) compared to the saw ginned cotton at 1.263 $/kg (0.5734 $/lb), primarily as a result of lower color grades (predominate color grades: HSRG – 31, Saw – 21). No differences by harvest or ginning method were observed for high, medium, or low classifications of seed VMD but total VMD was higher for picked cotton compared to stripped (11.86 vs. 9.82%). Linter content of the ginned seed was not different by harvest method or ginning method. Seed quality index was higher for the picker harvest method (98.4 vs. 96.6, picked vs. stripped) and saw ginning method (100 vs. 94.96, saw vs. HSRG). Seed quantity index was higher for the saw ginning method which averaged 109.83 compared to 105.61 for the HSRG. Composite seed grade was higher for picked cotton (106.53 vs. 103.59, picker vs. stripper) and saw ginning (109.88 vs. 100.25, saw vs. HSRG).

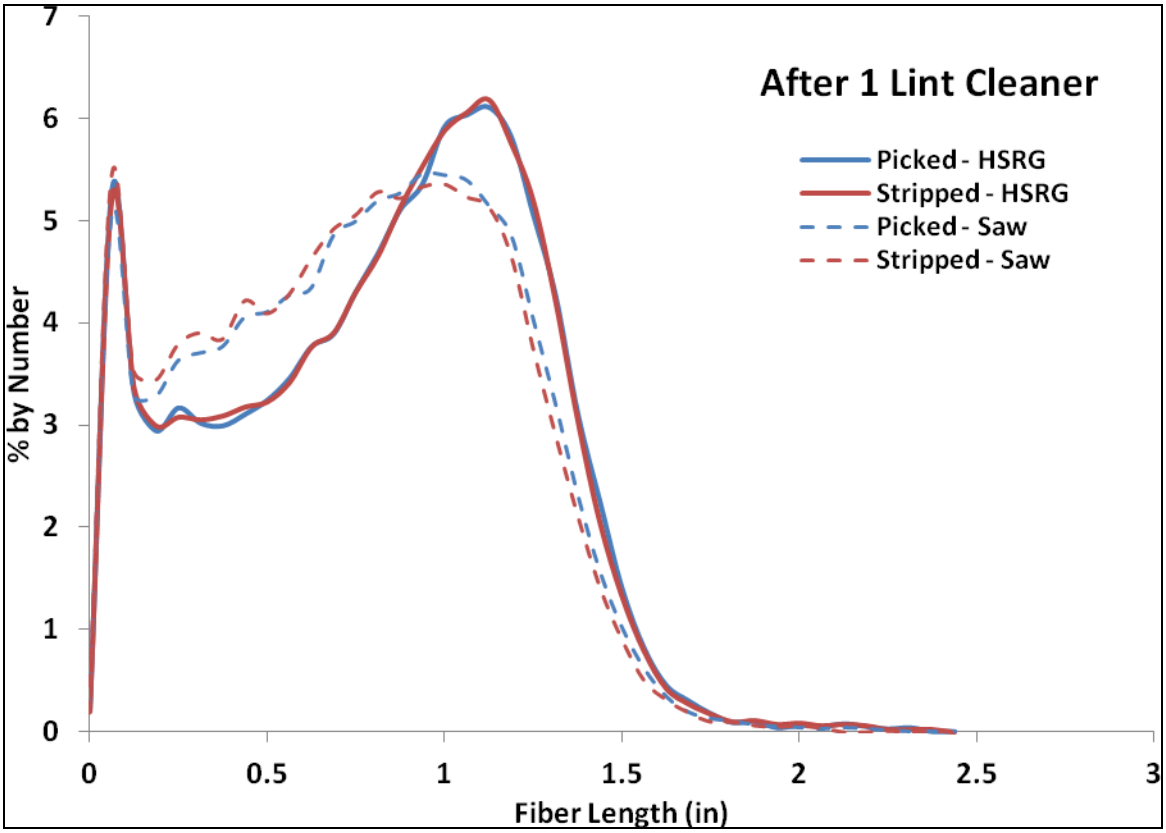

Figure 1. AFIS length by number distributions for the four harvest method-ginning method treatments.

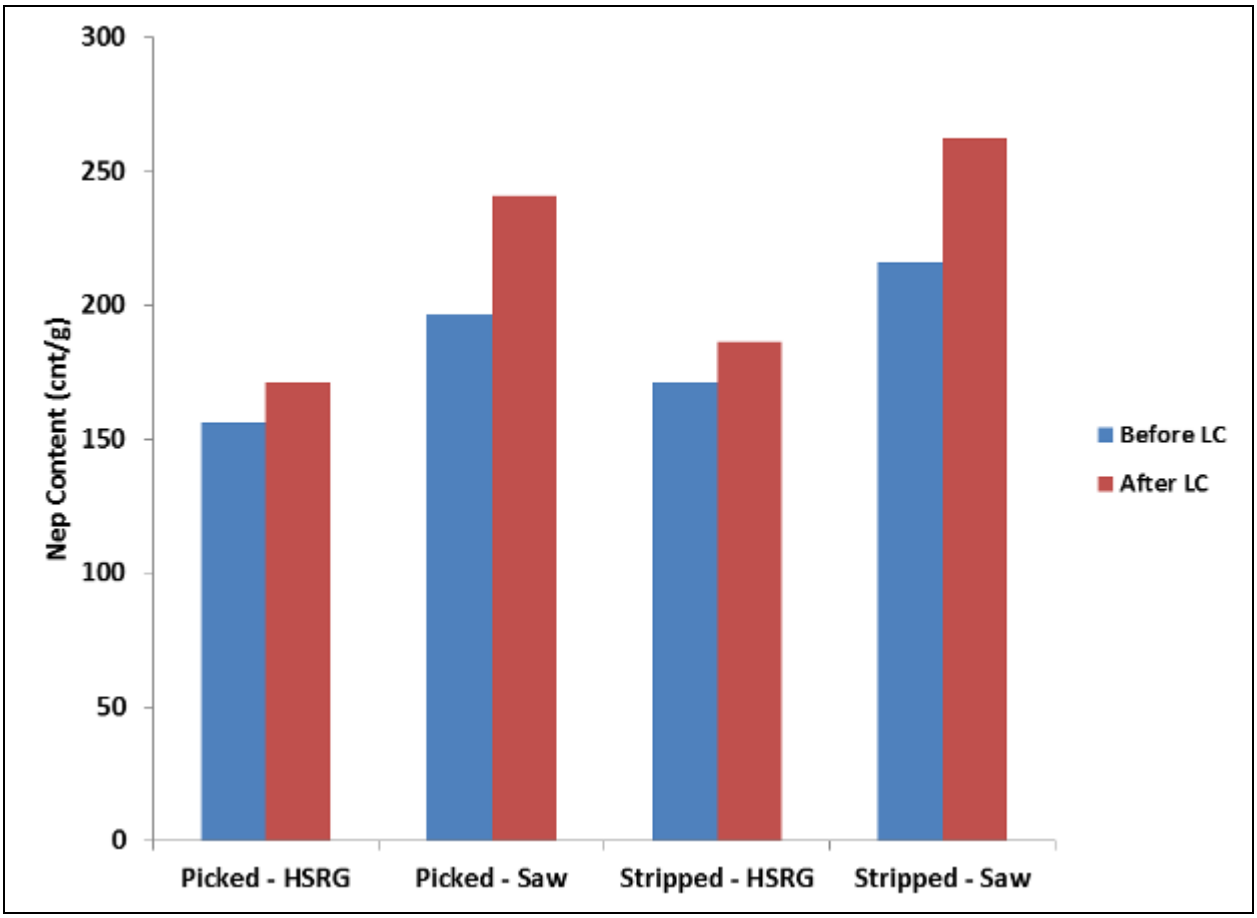

Figure 2. Nep content before lint cleaning (Before LC) and after lint cleaning (After LC) for the four harvest method – ginning method treatments.

Conclusions

Findings from the first year of this project indicate that the HSRG is capable of significantly improving fiber length, length uniformity, short fiber content, turnout, and nep content, regardless of harvest method. Increased foreign matter content and reduced color grades for HSRG cotton may be improved with additional stages of seed cotton or lint cleaning. Although loan values for HSRG cotton were slightly reduced compared to saw ginned cotton, it is likely that the loan chart does not properly account for the ring spinning efficiency and yarn quality improvements afforded by the HSRG process on upland cotton.

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