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GINNING A FRAGILE SEED COAT COTTON

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Abstract

An experiment was conducted to determine the interactions of saw and roller ginning with a variety that is known to have fragile seed coats. Three ginning treatments were investigated: 1) standard saw gin stand, 2) experimental saw gin stand with auxiliary rib guides, and 3) standard roller gin stand. The treatments were applied to two varieties, a commercial upland used as a control, and the experimental upland that contained fragile seed coats. As expected, many fiber properties were favorable to the roller gin stand including: color grade, length, uniformity, nep count, short fiber content, and turnout. The experimental saw gin stand with attached rib guides did not impact any fiber properties when compared to the unmodified saw gin. The experimental cotton variety with fragile seed coats had many fiber quality parameters superior to the control variety: cottonseed grade, short fiber content, immature fiber content, nep count, micronaire, strength, uniformity, and turnout. However, seed coat nep count in the experimental cotton was about three times higher than the control cotton.

Introduction

Development of cotton varieties is an ongoing process. Breeders strive to develop cotton varieties that satisfy the expectations of both producers and textile mills. Recently, an experimental high-yielding high-quality cotton variety was developed that has potential to be commercialized. However, the variety's seed coat is fragile and breaks easily. Seed coat fragments that remain in the lint after the ginning process cause problems during the spinning process (Pilsbury, 1992), and ultimately affect the quality of finished goods.

The ginning plant may be able to alleviate the problem of seed coat fragments. Past research has investigated the relationship between lint cleaning and seed coat fragments (Mangialardi, 1987). Mangialardi (1987) concluded that lint cleaning was not a reliable method to reduce seed coat fragments, and in some cases, lint cleaning increased fragment counts due to fragments breaking into smaller pieces. Another potential opportunity in the ginning process to reduce seed coat damage is at the actual ginning point where the fiber is separated from the seed. This could be accomplished by modifications to a saw gin or by using an entirely different ginning process, such as roller ginning.

The objective of this research was to determine the interactions of saw and roller ginning with a variety that is known to have fragile seed coats. Conventional saw and roller gin stands were used. The saw gin stand was tested with and without experimental rib guides. Hughs (2002) determined that rib guides reduced the level of cottonseed damage and improved the yarn quality; however, those studies were not conducted with a cotton variety known to have a fragile seed coat. The experiment included a conventional upland cotton to compare against the cotton that contains fragile seed coats.

Materials and Methods

Figure 1 is a sketch of a conventional saw gin stand showing the saw ginning principle. Figure 2 is a sketch of the experimental rib guides. The conventional ginning ribs normally have a gap of about 0.110 inches between ribs. With the rib guides installed, the gap decreases to about 0.037 inches, allowing less room for the saw to "wander" or "flex". By keeping the saw more constrained between the ginning ribs with the rib guides, there is less of a chance that cottonseed will be pulled through the gap and continue with the lint. Figure 3 is a sketch of a conventional roller gin stand showing the roller ginning principle.

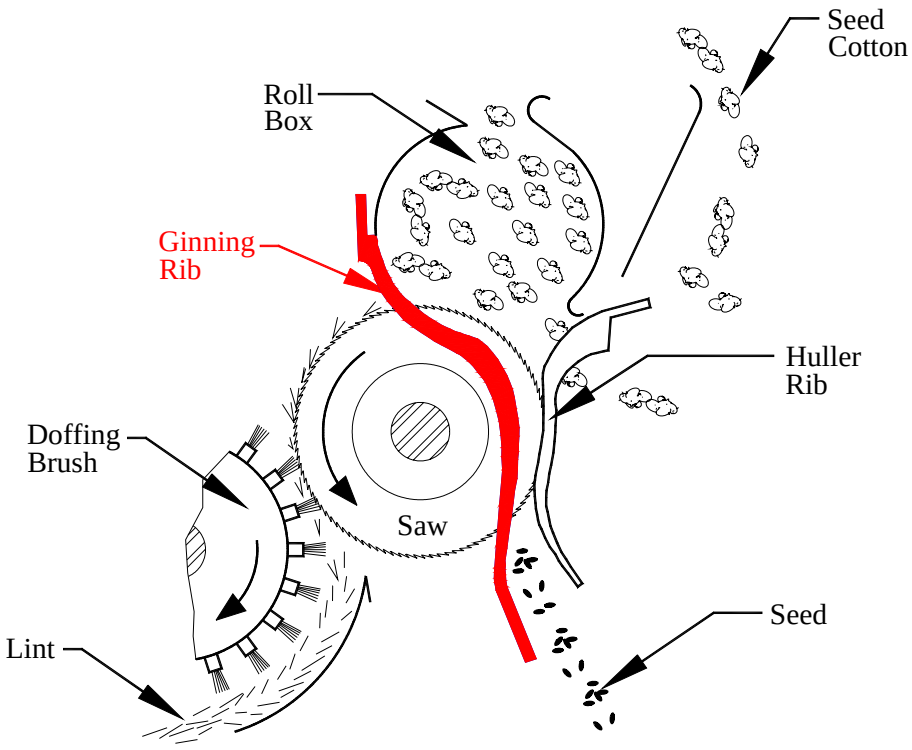

Figure 1. Conventional saw gin stand.

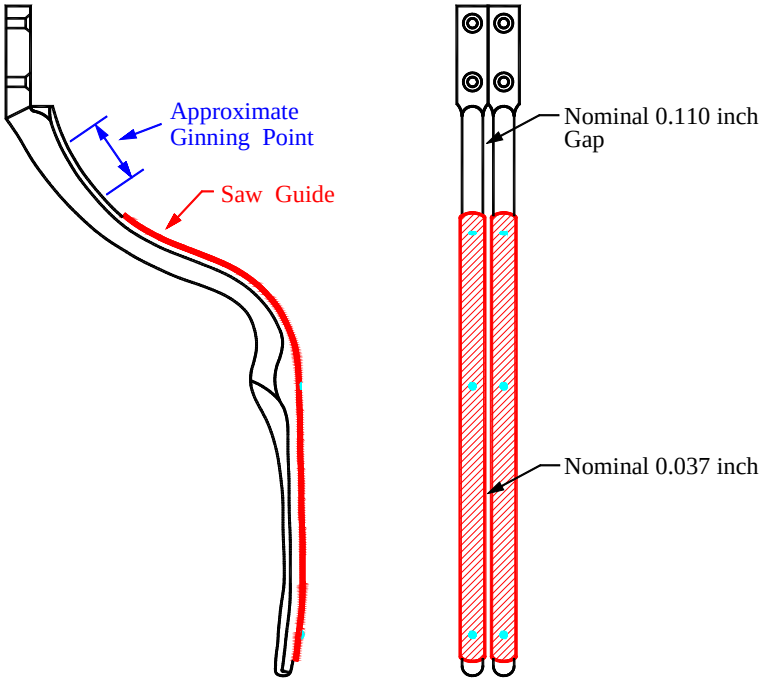

Figure 2. Experimental rib guides which attach to the ginning rib.

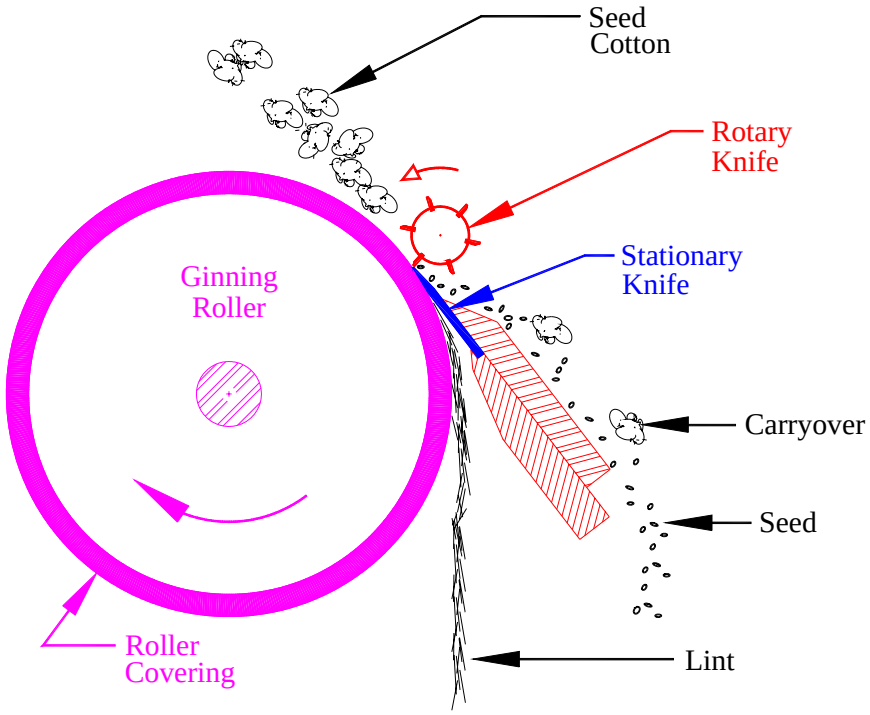

Figure 3. Conventional roller gin stand.

The experiment was conducted during March 2004. It consisted of three ginning treatments and two varieties, replicated three times for a total of 18 lots. The ginning treatments included: 1) 46-saw Continental Double Eagle gin stand in original configuration, 2) 46-saw Continental Double Eagle gin stand with the experimental rib guides installed, and 3) Lummus roller gin stand in original configuration. The varieties consisted of a conventional upland cotton and the experimental upland cotton. The ginning treatments and varieties were randomized within replication.

Because the cottonseed from the experimental cotton was to be used for planting seed, all of the experimental cotton was pre-cleaned at one time (and placed back into trailers) to prevent seed contamination. Pre-cleaning consisted of two 6-cylinder incline cleaners, one stick machine, and no drying. Lint cleaning in the saw gin consisted of two Continental/Moss Gordin Lodestar lint cleaners, and lint cleaning in the roller gin consisted of two Aldrich mill-type/air-jet combination cleaners.

Results

Data analyses were performed with PC-SAS (SAS Institute, Inc. 1989) with a 5% level of significance. Because the experiment was focused on ginning treatments, the results in Tables 1-6 will center on fiber and cottonseed properties immediately after the gin stand (no lint cleaning). Table 1 shows that ginning rate and turnout were different due to gin type (saw versus roller), but were not different due to rib guide design. Turnout averaged 38.8 and 40.0 % on the saw and roller gin stand, respectively. Turnout was different due to variety, averaging 35.4 and 43.3 % on the control and experimental cotton, respectively. The higher turnout on the experimental cotton is one of the attractions of this variety. The other measurements of test conditions in Table 1 were non-consequential.

Table 1. Means and statistical analysis of ginning rate, turnout, moisture content at the wagon and press, and gin plant conditions, by gin treatment and variety.

	Ginning rate[a]	Turnout[a]	Moisture content @ wagon	Moisture content @ press	Ambient temp	Relative humidity	Barometric pressure[a]
	bales/h	%	%	%	deg C	%	in Hg
Gin Treatment[b]							
Saw Gin, Std	2.95 a	38.8 b	7.21	5.12	20.3	28.5	26.3 a
Saw Gin, Exp	3.08 a	38.8 b	6.85	5.09	18.4	34.7	26.2 b
Roller Gin	1.05 b	40.4 a	7.05	5.28	19.6	33.4	26.3 a
Variety							
Control	2.34	35.4 b	7.09	5.06	19.6	31.2	26.2
Experimental	2.37	43.3 a	6.98	5.27	19.3	33.2	26.2
Observed Significance Level[c]							
Gin Treatment	<.0001	0.0005	NS	NS	NS	NS	0.0113
Variety	NS	<.0001	NS	NS	NS	NS	NS
GTxVAR	NS	NS	NS	NS	NS	NS	NS

[a] Means followed by the same letter or group of letters are not different based on Duncan's Multiple Range Test (P≤0.05).
[b] Std = standard, Exp = experimental (ginning ribs)
[c] NS = not statistically significant at (P>0.05).

Table 2 shows the seed-cotton foreign matter content at the wagon and feeder (after seed-cotton conditioning). Foreign matter content at the wagon was not different due to variety and averaged 6.3 %. There were differences due to ginning treatment after seed-cotton conditioning, but because the ginning treatment had nothing to do with seed-cotton conditioning, these differences are an anomaly. Total foreign matter content after seed-cotton conditioning was not different due to variety and averaged 1.51 %.

Table 2. Means and statistical analysis of foreign matter content at the wagon and feeder, by gin treatment and variety.

	Wagon					Feeder				
	hulls	sticks	motes	fine	total	hulls[a]	sticks[a]	motes[a]	fine	total[a]
	%	%	%	%	%	%	%	%	%	%
Gin Treatment[b]										
Saw Gin, Std	1.46	0.46	1.87	2.12	5.91	0.12 b	0.10 b	0.66 b	0.30	1.18 b
Saw Gin, Exp	0.97	0.74	2.23	2.78	6.71	0.12 b	0.13 b	0.66 b	0.31	1.22 b
Roller Gin	1.31	0.50	2.08	2.50	6.39	0.53 a	0.27 a	0.99 a	0.36	2.14 a
Variety										
Control	1.15	0.59	2.19	2.66	6.59	0.38 a	0.19	0.63 b	0.34	1.54
Experimental	1.35	0.54	1.93	2.28	6.09	0.13 b	0.14	0.90 a	0.30	1.48
Observed Significance Level[c]										
Gin Treatment	NS	NS	NS	NS	NS	0.0002	0.0043	0.0001	NS	<.0001
Variety	NS	NS	NS	NS	NS	0.0024	NS	0.0001	NS	NS
GTxVAR	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a] Means followed by the same letter or group of letters are not different based on Duncan's Multiple Range Test (P≤0.05).
[b] Std = standard, Exp = experimental (ginning ribs)
[c] NS = not statistically significant at (P>0.05).

Cottonseed properties by treatment are presented in Table 3. Linters content was not different due to gin treatment or variety and averaged 10.5 % overall. Total foreign matter content was different due to gin type; the saw gin averaged 0.3 % and the roller gin averaged 2.1 %. Having a higher amount of trash in the cottonseed of the roller gin is expected. The experimental rib guides did not make any difference in foreign matter content. Cottonseed grade was different due to variety; the control and experimental cotton averaged 110 and 114, respectively.

Table 3. Means and statistical analysis of cottonseed properties, by gin treatment and variety.

	Linters	Total foreign matter[a]	Moisture[a]	Free fatty acids	Oil[a]	Ammonia[a]	Net quality Index[a]	Quantity Index[a]	Grade[a]
	%	%	%	%	%	%	Index	Index	Index
Gin Treatment[b]									
Saw Gin, Std	10.7	0.26 b	7.03	0.73	20.0	4.50	100 a	112	112
Saw Gin, Exp	10.8	0.26 b	7.00	0.75	20.2	4.50	100 a	113	113
Roller Gin	10.0	2.13 a	7.33	0.73	20.1	4.50	98.9 b	112	111
Variety									
Control	10.3	0.78	6.78 b	0.73	20.3 a	4.01 b	99.7	110 b	110 b
Experimental	10.7	0.98	7.46 a	0.73	19.8 b	4.98 a	99.5	114 a	114 a
Observed Significance Level[c]									
Gin Treatment	NS	<.0001	NS	NS	NS	NS	<.0001	NS	NS
Variety	NS	NS	0.0002	NS	0.0045	<.0001	NS	<.0001	<.0001
GTxVAR	NS	NS	NS	0.0097	NS	NS	NS	NS	NS

[a] Means followed by the same letter or group of letters are not different based on Duncan's Multiple Range Test ($P \leq 0.05$).
[b] Std = standard, Exp = experimental (ginning ribs)
[c] NS = not statistically significant at ($P > 0.05$).

A summary of the AFIS data is presented in Tables 4 and 5. There are several measurements that are different due to ginning treatment, but as before, the differences are between the saw and roller gin, and not between the standard saw gin stand and the experimental saw gin with the attached rib guides. As expected, fiber length, short fiber content, and nep count were favorable to the roller gin. Upper quartile length averaged 31.5 and 32.1 mm on the saw and roller gin, respectively, while short fiber content averaged 8.5 and 6.4 % on the saw and roller gin, respectively. Nep count averaged 225 and 166 counts per gram for the saw and roller gin, respectively.

Differences due to variety are prevalent throughout the AFIS results. In general, the experimental cotton was slightly shorter, but had a smaller amount of short fibers and neps. Upper quartile length averaged 32.8 and 30.5 mm on the control and experimental cotton, respectively, while short fiber content averaged 8.6 and 7.0 % on the control and experimental cotton, respectively. Nep count averaged 230 and 180 on the control and experimental cotton, respectively.

The AFIS seed coat nep count (Table 5) was not different due to ginning treatment, but was different due to variety. Seed coat nep count averaged 23.4 and 59.4 counts per gram for the control and experimental cotton, respectively. The three-fold increase in seed coat neps of the experimental over conventional variety verifies the fragile nature of the seed coat of the experimental variety. However, none of the ginning treatments were able to reduce seed coat nep counts by a statistically significant amount. Trash count and visible foreign matter was also higher in the experimental cotton; trash count averaged 104 and 156, and visible foreign matter averaged 2.3 and 5.1 % on the control and experimental cotton, respectively.

Table 4. Means and statistical analysis of fiber properties measured by the Advanced Fiber Information System (AFIS) on samples before lint cleaning (just after ginning), by gin treatment and variety.

	Length[a]	Length CV[a]	Upper Quartile length[a]	Short fiber content[a]	Fineness[a]	Immature Fiber Content[a]	Maturity ratio[a]	Nep count[a]	Nep size[a]
	mm	%	Mm	%	m-tex	%	-	per g	µm
Gin Treatment[b]									
Saw Gin, Std	25.9 b	35.1 a	31.5 b	8.48 a	168	11.9	0.83 b	231 a	781 b
Saw Gin, Exp	25.9 b	35.1 a	31.5 b	8.43 a	165	12.1	0.83 b	218 a	782 b
Roller Gin	27.0 a	32.6 b	32.1 a	6.40 b	168	11.3	0.85 a	166 b	823 a
Variety									
Control	26.8 a	35.5 a	32.8 a	8.57 a	161 b	13.0 a	0.80 b	230 a	720 b
Experimental	25.8 b	33.0 b	30.5 b	6.97 b	173 a	10.5 b	0.87 a	180 b	871 a
Observed Significance Level[c]									
Gin Treatment	<.0001	0.0004	0.0003	0.0002	NS	NS	0.0405	0.0009	0.0013
Variety	<.0001	<.0001	<.0001	0.0003	<.0001	<.0001	<.0001	0.0007	<.0001
GTxVAR	NS	NS	NS	NS	NS	NS	NS	NS	0.0005

[a] Means followed by the same letter or group of letters are not different based on Duncan's Multiple Range Test (P≤0.05).
[b] Std = standard, Exp = experimental (ginning ribs)
[c] NS = not statistically significant at (P>0.05).

Table 5. Means and statistical analysis of fiber properties measured by the Advanced Fiber Information System (AFIS) on samples taken before lint cleaning (just after ginning), by gin treatment and variety.

	Seed coat nep count[a]	Seed coat nep size[a]	Dust count	Trash count[a]	Total trash count	Trash size[a]	Visible foreign matter[a]
	per g	µm	per g	per g	per g	µm	%
Gin Treatment[b]							
Saw Gin, Std	43.2	1228	661	129	790	335 b	3.54 ab
Saw Gin, Exp	38.6	1221	664	144	808	359 a	4.42 a
Roller Gin	42.5	1220	864	117	981	294 c	3.26 b
Variety							
Control	23.4 b	1166 b	714	104 b	818	294 b	2.34 b
Experimental	59.4 a	1281 a	745	156 a	901	364 a	5.14 a
Observed Significance Level[c]							
Gin Treatment	NS	NS	NS	NS	NS	<.0001	0.0377
Variety	<.0001	0.0032	NS	0.0002	NS	<.0001	<.0001
GTxVAR	NS	NS	NS	NS	NS	NS	NS

[a] Means followed by the same letter or group of letters are not different based on Duncan's Multiple Range Test (P≤0.05).
[b] Std = standard, Exp = experimental (ginning ribs)
[c] NS = not statistically significant at (P>0.05).

Table 6 is a summary of the HVI results. Similar to the AFIS results, quality attributes as measured by the HVI of fiber processed by the roller gin were superior to fiber processed by saw ginning treatments. Upper half mean length averaged 29.8 and 31.0 mm on the saw and roller gin, respectively. Uniformity averaged 83.0 and 84.6 % on the saw and roller gin, respectively. Color grade averaged 102 and 103 (old code), and short fiber content averaged

8.7 and 7.4 % on the saw and roller gin respectively. There were no differences between the standard and experimental saw gins. The HVI results also show that the experimental cotton compared favorably to the control cotton. Micronaire averaged 3.4 and 4.8 for the control and experimental cotton, respectively. A micronaire of 3.4 is low enough to carry a discount. Uniformity averaged 82.6 and 84.4 %, and strength averaged 28.8 and 32.3 g/tex for the control and experimental cotton, respectively. Short fiber content was lower with the experimental cotton, averaging 7.9 % compared to 8.7 % on the control cotton.

Table 6. Means and statistical analysis of High Volume Instrument (HVI) results on samples taken just before lint cleaning (just after ginning), by gin treatment and variety.

	Micron-aire[a]	Upper half mean length[a]	Unifor-mity[a]	Stre-ngth[a]	Elonga-tion[a]	Reflec-tance[a]	Yellow-ness	Color grade[a] [b]	Short fiber content[a]
	Reading	mm	%	g/tex	%	Rd	+b	Index	%
Gin Treatment[c]									
Saw Gin, Std	4.13	29.6 b	82.9 b	30.2	5.00	76.8 b	8.88	101 b	8.88 a
Saw Gin, Exp	4.09	29.9 b	83.0 b	30.9	4.99	76.4 b	8.97	102 b	8.60 a
Roller Gin	4.10	31.0 a	84.6 a	30.5	4.83	78.0 a	8.94	103 a	7.39 b
Variety									
Control	3.40 b	31.2 a	82.6 b	28.8 b	5.36 a	78.0 a	9.01	103 a	8.67 a
Experimental	4.81 a	29.2 b	84.4 a	32.3 a	4.52 b	76.1 b	8.85	100 b	7.91 b
Observed Significance Level[d]									
Gin Treatment	NS	0.0002	0.0033	NS	NS	<.0001	NS	0.0288	0.0023
Variety	<.0001	<.0001	0.0003	<.0001	0.0002	<.0001	NS	<.0001	0.0184
GTxVAR	NS	NS	NS	NS	NS	NS	NS	NS	NS

[a] Means followed by the same letter or group of letters are not different based on Duncan's Multiple Range Test ($P \leq 0.05$).
[b] Old code, 100=31, 104=21, 105=11
[c] Std = standard, Exp = experimental (ginning ribs)
[d] NS = not statistically significant at ($P > 0.05$).

Conclusions

Turnout, color grade, length, uniformity, nep count and short fiber content were improved by roller ginning as compared to either saw ginning treatment. There were no differences in all other fiber properties, including linters content and seed coat nep count, due to any type of ginning treatment. Therefore, the experimental rib guides did not have a statistically significant difference on fiber characteristics.

There were many fiber measurements that indicated the experimental cotton was of greater quality than the standard variety considered in this study. Turnout, cottonseed grade, short fiber content, immature fiber content, nep count, micronaire, strength, and uniformity all favored the experimental cotton. However, seed coat nep count and visible foreign matter did not favor the experimental cotton. Seed coat nep counts were about three times higher in the experimental cotton.

Future work includes adding three harvester treatments to the experiment on new crop cotton. The harvester treatments will include 1) an International Harvester 2-row picker using 1/2-inch spindles and run at standard ground speed, 2) a Farmall 1-row picker using 5/8-inch spindles run at standard (2,000 rpm) spindle speed, and 3) a Farmall 1-row picker using 5/8-inch spindles run at a high (2,900 rpm) spindle speed. The experiment will again contain different ginning treatments, but the particular treatments have not yet been finalized.

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