FIELD EVALUATION OF HIGH-PERFORMANCE LUMMUS GIN MACHINERY – 2015

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Abstract

Two installations (one in Texas and one in the Brazil) featuring late-model Lummus ginning and lint cleaning machinery were sampled in order to evaluate machinery performance in a variety of areas. Performance measures such as residual lint on ginned seed, along with fiber properties of the cleaned lint after various stages of lint cleaning are presented. The purpose of these tests is to provide tangible data as to how Lummus machinery performs in different regions of the world. New cotton cultivars offer a continual opportunity for process improvement, which necessitates ongoing testing. Understanding the effects of processing rates upon both throughput and fiber quality will guide new machinery developments to maximize the value of the ginned cotton to both the upstream and downstream customers.

Introduction

This paper covers independent test programs at two separate ginning facilities (Central Rolling Plains Coop Gin in Texas and SLC Agrícola Fazenda Planalto Gin in Brazil). Each will be discussed separately, since the tests covered different evaluations.

Central Rolling Plains Coop Gin

Central Rolling Plains Coop Gin is located in Roscoe, Texas. Originally constructed in 1981, the machinery configuration has evolved over the last thirty-five years. The gin plant currently features two stages of drying and split 120" wide precleaning, five ginning/lint cleaning lines with centrifugal-type lint cleaning followed by tandem (2) saw-type lint cleaning, and an up-packing Lummus Gin Dor-Les® U.D. baling press. Ginning lines 1 through 4 feature Cherokee Avenger extractor feeders over 174-Saw Avenger gin stands, centrifugal-type lint cleaners, and two Horn Super 86 controlled-batt saw-type lint cleaners. Ginning line 5 features all-Lummus machinery, including a 96" wide Model 700™ II extractor feeder over a 170-Saw Imperial™ III gin stand, followed by a Super-Jet® centrifugal-type lint cleaner and two 108" wide Sentinel™ II saw-type lint cleaners.

Samples were taken during two ginning seasons – the 2014/15 season (January of 2015) and the 2015/16 season (November of 2015). The main purpose of testing at Central Rolling Plains was to evaluate the performance of the all-Lummus machinery in the fifth ginning/lint cleaning line. An added benefit was to be able to compare these results to those of the fourth line that featured machinery from other manufacturers.

SLC Agrícola – Fazenda Planalto Gin

SLC Agrícola constructed an all-new Lummus gin plant on their Fazenda Planalto complex in the Brazilian state of Mato Grosso do Sul in 2008. This plant features two stages of drying and split 144" wide precleaning, stacked (2) 96" wide Model 700™ II extractor feeders over 170-Saw Imperial™ III gin stands, Super-Jet® centrifugal-type and tandem (2) saw-type lint cleaners, and down-packing High-Capacity Lift-Box™ Dor-Les® U.D. baling press. Each tandem saw-type lint cleaning configuration features a 108" wide Sentinel™ II lint cleaner followed by a Model 108 controlled-batt saw-type lint cleaner.

The primary purpose for testing at Fazenda Planalto was to evaluate the performance of the saw-type lint cleaning in each of the three lines: a Model 108 lint cleaner (line 1) and a Sentinel™ lint cleaner (line 2) with saw speeds of

1000 revolutions per minute (RPM) and a Sentinel™ lint cleaner (line 3) with a saw speed of 1200-RPM. This testing was essentially an expansion of similar study that was conducted at Carson County Gin in White Deer, Texas in 2014 and reported at the 2015 Beltwide Cotton Conference (Rutherford, et. al., 2015).

A photo featuring both the Central Rolling Plains Coop Gin and SLC Agrícola Fazenda Planalto Gin can be seen in Figure 1.

Figure 1. Central Rolling Plains Coop Gin (left) and SLC Agrícola Fazenda Planalto Gin (right).

Materials and Methods

Central Rolling Plains – Testing Protocol and Data Analysis

For both the January 2015 and November 2015 sampling at Central Rolling Plains, two (2) conventional stripper-harvested, burr-extracted seed cotton modules were tested. The sampling locations are shown in Figure 2.

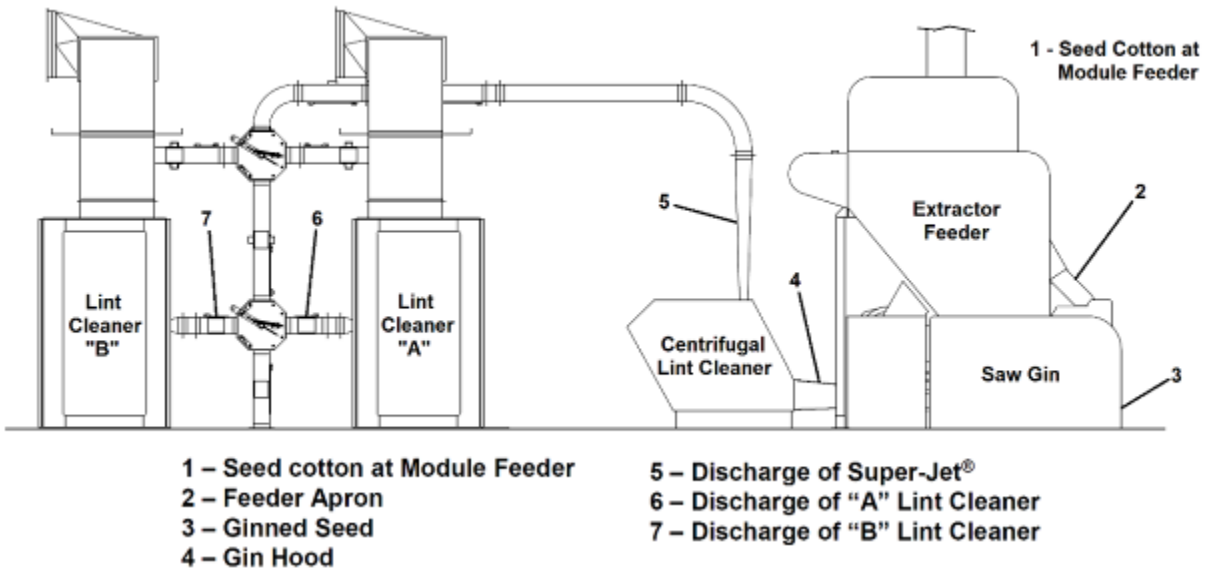

Figure 2. Sampling points for Central Rolling Plains Coop Gin (January and November of 2015).

Three seed cotton or lint cotton samples were obtained for each sampling point. Ginned seed was collected for residual lint analysis. For the seed cotton, incoming (module) and final (feeder apron) moisture contents were

determined, and fractionation analyses performed by the USDA, ARS, Cotton Ginning Research Unit in Lubbock, Texas. Oven moisture content determinations were performed according to the ASTM-D2495 method. Residual lint analyses on the ginned seed samples were performed by Mid-Continent Laboratories, Inc. in Memphis, Tennessee. The Fiber & Biopolymer Research Institute in Lubbock, Texas, performed both HVI and AFIS tests on all lint samples.

Fazenda Planalto – Testing Protocol and Data Analysis

This facility processed exclusively the new-style round modules, so four (4) "rounds" served to represent one module. The sampling locations can be seen in Figure 3.

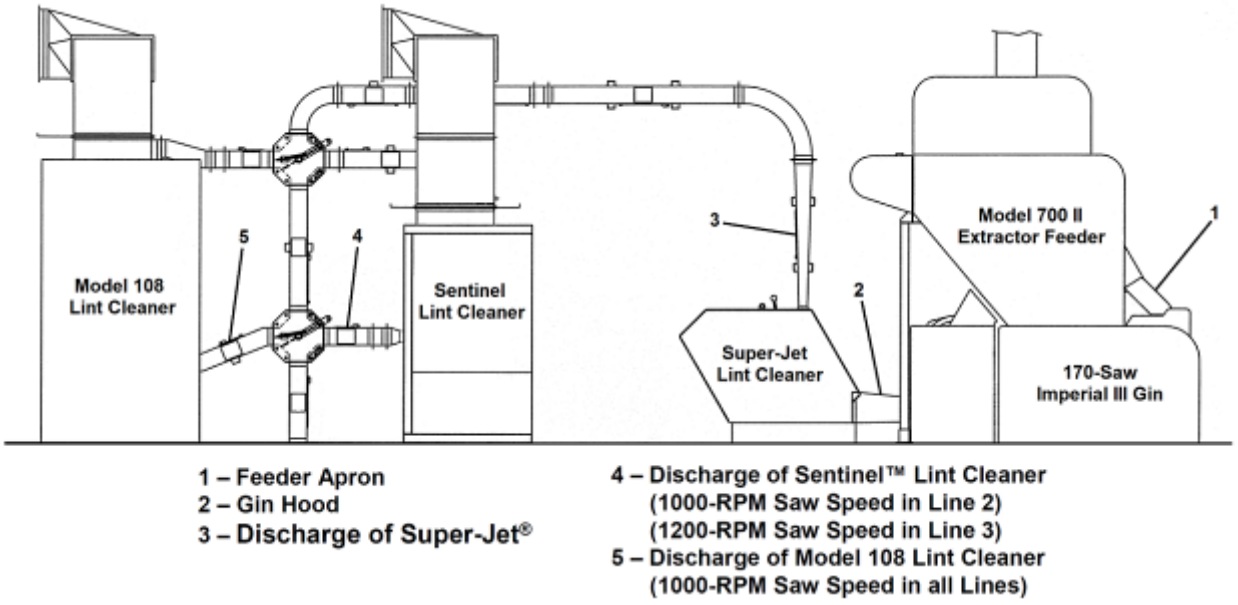

Figure 3. Sampling points for SLC Agrícola Fazenda Planalto Gin.

Two modules (each comprised of four "rounds") were tested. The bypass valves in each lint cleaning line were adjusted so that the first stage of saw-type lint cleaning would feature the machine being evaluated. Line 1 featured a Model 108 conventional controlled-batt saw-type lint cleaner (1000-RPM saw speed), while Lines 2 and 3 featured Sentinel™ lint cleaners running at 1000-RPM and 1200-RPM saw speeds, respectively. Four different feed rates (extractor feeder feed roller speed) were used: 80%, 70%, 60% and 50% of maximum speed. The same sampling protocol was used for each feed rate.

HVI testing on the lint was performed at Unicoton in Primavera do Leste, Mato Grosso, Brazil, while AFIS testing was done at Fundação Blumenauense de Estudos Têxteis in Blumenau, Santa Catarina, Brazil

Results and Discussion

Central Rolling Plains

Seed cotton moisture content results from both testing dates are shown in Figure 4, while fractionation results from January 2015 and November 2015 are found in Figures 5 and 6, respectively. Seed moisture and residual lint data are displayed in Figure 7. HVI Leaf results are found in Figure 8, and AFIS Short Fiber Content and Neps results are in Figures 9 and 10, respectively.

Seed Cotton Moisture Content

January 2015

	Module 661 (% wb)	Module 662 (% wb)	Module 661 (% db)	Module 662 (% db)
Module	**9.82**	**8.92**	**10.89**	**9.79**
Feeder Apron	**6.98**	**7.66**	**7.50**	**8.29**

November 2015

	Module 5939 (% wb)	Module 5941 (% wb)	Module 5939 (% db)	Module 5941 (% db)
Module	**8.50**	**11.65**	**9.29**	**13.19**
Feeder Apron	**9.24**	**8.56**	**10.18**	**9.37**

Figure 4. Seed cotton moisture content results for Central Rolling Plains Coop Gin.

Seed cotton moisture contents (incoming and final) in the January testing were more as what would be expected (drying of the cotton from the module to the feeder apron); however, in one case, the November sample (as it turned out) was higher moisture at the feeder apron than in the module itself – certainly an outlier. Regardless, all the seed cotton was being ginned at moisture contents in excess of 7% (sometimes nearly 10%). Although it is typical (and recommended) to gin at much lower moisture (5-7%), testing that was performed at Silver Creek Gin in 2013 (Rutherford, et. al., 2014) showed that fiber quality could be preserved even when ginning at higher moisture levels at the feeder apron.

Seed Cotton Fractionation Analysis January 2015

Module	Location	Burrs	Sticks & Stems	Fine Trash	Seed Cotton	Total Trash
661	Module	4.11%	3.73%	2.85%	83.56%	16.44%
661	Feeder Apron 4	3.84%	2.73%	1.94%	86.35%	13.65%
661	Feeder Apron 5	1.69%	1.00%	0.23%	95.47%	4.53%
662	Module	4.60%	3.23%	2.63%	83.42%	16.58%
662	Feeder Apron 4	3.35%	2.90%	0.23%	92.08%	7.92%
662	Feeder Apron 5	1.27%	1.30%	1.24%	93.84%	6.16%

Figure 5. Seed cotton fractionation results for Central Rolling Plains Coop Gin – January 2015.

Seed Cotton Fractionation Analysis November 2015

Module	Location	Burrs	Sticks & Stems	Fine Trash	Seed Cotton	Total Trash
5939	Module	2.42%	1.85%	0.26%	93.83%	6.17%
5939	Feeder Apron 4	2.35%	1.05%	0.08%	95.49%	4.51%
5939	Feeder Apron 5	1.58%	1.44%	0.15%	95.45%	4.55%
5941	Module	2.67%	1.68%	1.07%	92.65%	7.35%
5941	Feeder Apron 4	3.32%	1.74%	0.13%	93.12%	6.88%
5941	Feeder Apron 5	3.22%	1.92%	0.17%	92.74%	7.26%

Figure 6. Seed cotton fractionation results for Central Rolling Plains Coop Gin – November 2015.

In both the January and November testing, the Model 700™ II feeder (Line 5) was more effective in cleaning than the other feeder (Line 4). This was much more evident in the January data than in November, when the lines performed comparably.

Residual Lint – Ginned Seed January 2015

MODULE 661	Seed Moisture Content (%)	Residual Lint (%)
GIN 4	10.20	9.13
GIN 5	9.23	8.17

MODULE 662	Seed Moisture Content (%)	Residual Lint (%)
GIN 4	11.07	7.90
GIN 5	10.73	7.93

Residual Lint – Ginned Seed November 2015

MODULE 5939	Seed Moisture Content (%)	Residual Lint (%)
GIN 4	11.80	14.70
GIN 5	11.80	14.00

MODULE 5941	Seed Moisture Content (%)	Residual Lint (%)
GIN 4	11.50	12.63
GIN 5	11.70	12.03

Figure 7. Seed moisture and residual lint results for Central Rolling Plains Coop Gin.

The January residual lint numbers were much more in line with effective seed cleaning (levels from 8 to 10%). In the case of Module 662, the residual lint came in at what are really somewhat lower values than typical. Conversely, for whatever reason (most likely worn saws on both gin stands), the November residual lint percentages were much less impressive. While the Lummus gin performed better on both modules than the other gin, such residual lint percentages are too high, and they point toward the need to change saws.

HVI Leaf Analysis

	January 2015		November 2015	
	Module 661	Module 662	Module 5939	Module 5941
Line 4 Gin Hood	6.0	8.0	3.7	4.0
Line 4 Post L/C	3.0	2.7	1.7	1.7
Reduction	3.0	5.3	2.0	2.3
Line 5 Gin Hood	5.0	5.3	4.3	5.7
Line 5 Post L/C	3.0	4.7	2.3	3.0
Reduction	2.0	0.7	2.0	2.7

Figure 8. HVI leaf analysis for Central Rolling Plains Coop Gin.

Typical leaf reduction ranged from 2 to 4 grades, and actual leaf grades across the board were good for both lines. In fact, though they are not be disclosed in this paper, the actual leaf grades of the finished bales in these modules were all better than those of these hand-pulled samples.

AFIS Short Fiber Content (SFC) (w) [%]

	January 2015		November 2015	
	Module 661	Module 662	Module 5939	Module 5941
Line 4 Gin Hood	7.5	7.4	12.5	10.5
Line 4 Post L/C	9.0	9.1	10.8	10.4
Change	-1.5	-1.6	1.7	0.2
Line 5 Gin Hood	6.6	7.9	11.3	8.6
Line 5 Post L/C	7.4	7.9	11.2	9.4
Change	-0.8	-0.1	0.1	-0.8

Figure 9. AFIS Short Fiber Content for Central Rolling Plains Coop Gin.

Short Fiber Content (SFC) typically increases in saw-type lint cleaning, especially tandem lint cleaning. In these tests, there were some instances where the SFC actually was reduced. This could be attributable in some cases to heavier moting (throwing off more lint with the trash) in the Horn Super 86 lint cleaners, which was visually observed during the testing. However, in a typical operating gin plant, it is extremely difficult (and really not practical) to isolate moting rates by lint cleaner in order to evaluate quantity and quality (amount of fiber versus trash) within the lint cleaner trash. In the case of the Sentinel™ II lint cleaners, the method by which the fiber tufts are fed onto the saw (via a high-speed air stream) results in a larger percentage of short fiber (fibers less than ½" in length) being expelled in the exhaust air, rather than being condensed into the cotton batt and fed onto the saw (like is normal within a controlled-batt saw-type lint cleaner).

AFIS Neps (Neps/Gm)

	January 2015		November 2015	
	Module 661	Module 662	Module 5939	Module 5941
Line 4 Post L/C	298	375	475	428
Line 5 Post L/C	276	309	364	350

Figure 10. AFIS Nep results for Central Rolling Plains Coop Gin.

In all cases during the tests at Central Rolling Plains, the Sentinel™ lint cleaners produced fewer neps than the traditional controlled-batt saw-type Horn Super 86 lint cleaners. These results are consistent with other comparison tests run between the Sentinel™ lint cleaner and any competitors' controlled-batt saw-type lint cleaners since the Sentinel™ was introduced in 1999.

Fazenda Planalto

Key HVI and AFIS results for Module A and Module B are shown in Figures 11 and 12, respectively. HVI Uniformity Index followed no specific trend either by lint cleaner type or as a function of the feed rate. In fact, the highest UI in the sample lot came from the Model 108 lint cleaner, which is somewhat surprising in that the Sentinel™ lint cleaner has showed over many years a tendency to produce less short fiber, which leads to higher uniformity.

Another interesting result was that most of the AFIS properties showed not specific trend based on either lint cleaner type (Model 108 versus Sentinel™), feed rate, or lint cleaner saw speed. AFIS Length (L), being below 1" in all the samples indicated that the quality of the fiber coming to the gin was not very good – this could have many causes, a large number of which have nothing to do with the gin plant and the machinery. The conventional wisdom of "slowing down to minimize fiber damage" appeared to have no merit.

Fiber Analysis – Fazenda Planalto – Module A

Sample Point	Feed Rate	HVI	AFIS				
		UI	L (w) [in]	UQL (w) [in]	SFC (w) %<1/2"	Nep Cnt/g	SCN Cnt/g
After Model 108 L/C (1000-RPM)	80%	83.3	0.94	1.16	10.8	387	34
After Sentinel (1000-RPM)	80%	80.6	0.96	1.17	9.5	371	45
After Sentinel (1200-RPM)	80%	82.0	0.93	1.15	11.1	419	32
After Model 108 L/C (1000-RPM)	70%	81.9	0.93	1.15	11.6	369	43
After Sentinel (1000-RPM)	70%	81.4	0.94	1.15	11.1	378	45
After Sentinel (1200-RPM)	70%	81.8	0.98	1.19	8.8	301	31
After Model 108 L/C (1000-RPM)	60%	79.9	0.94	1.16	10.3	385	49
After Sentinel (1000-RPM)	60%	79.6	0.95	1.17	10.3	331	25
After Sentinel (1200-RPM)	60%	80.0	0.96	1.16	10.1	452	46
After Model 108 L/C (1000-RPM)	50%	82.2	0.97	1.18	8.9	338	40
After Sentinel (1000-RPM)	50%	80.5	0.96	1.18	9.8	341	34
After Sentinel (1200-RPM)	50%	81.7	0.94	1.16	11.0	428	44

Figure 11. HVI and AFIS results for Module A at SLC Agrícola Fazenda Planalto.

Fiber Analysis – Fazenda Planalto – Module B

Sample Point	Feed Rate	HVI	AFIS				
		UI	L (w) [in]	UQL (w) [in]	SFC (w) %<1/2"	Nep Cnt/g	SCN Cnt/g
After Model 108 L/C (1000-RPM)	80%	81.1	0.95	1.17	11.0	453	39
After Sentinel (1000-RPM)	80%	81.8	0.96	1.17	10.0	336	43
After Sentinel (1200-RPM)	80%	81.3	0.98	1.18	8.9	359	45
After Model 108 L/C (1000-RPM)	70%	83.0	0.96	1.18	10.5	328	43
After Sentinel (1000-RPM)	70%	83.9	0.98	1.19	8.7	299	29
After Sentinel (1200-RPM)	70%	82.7	0.94	1.16	11.1	383	47
After Model 108 L/C (1000-RPM)	60%	79.7	0.94	1.16	10.8	353	44
After Sentinel (1000-RPM)	60%	82.0	0.93	1.15	12.8	297	36
After Sentinel (1200-RPM)	60%	80.3	0.94	1.17	10.7	426	55
After Model 108 L/C (1000-RPM)	50%	80.6	0.94	1.16	10.1	362	37
After Sentinel (1000-RPM)	50%	82.4	0.93	1.15	11.9	425	53
After Sentinel (1200-RPM)	50%	81.5	0.96	1.17	10.2	364	39

Figure 12. HVI and AFIS results for Module B at SLC Agrícola Fazenda Planalto.

Summary

Central Rolling Plains

While none of the results can be considered statistically significant, due to small sample sizes, there were some general trends that should be considered. First, the residual lint on the Lummus 170-Saw gin was better or equal to that of the other gin stand. Second, the Sentinel™ II lint cleaning yielded a smaller increase in short fiber content than the other lint cleaner. Finally, the Sentinel™ II lint cleaner consistently produced less neps than the other lint cleaner.

Fazenda Planalto

Like Central Rolling Plains, none of the results presented in this paper can be considered statistically significant. Nevertheless, there were two general conclusions that were derived, based on the results of this testing. First, decreasing the feed rate does not appear to cause any favorable effect on lint cleaner performance. Also, increasing the Sentinel™ II lint cleaner saw speed from 1000-RPM to 1200-RPM did not appear to have any substantial effect (either positively or negatively) on fiber quality.

As new cotton cultivars are developed, the various performance characteristics of modern ginning machinery will have to be continually monitored, so as to maximize performance while preserving the best possible fiber quality for the market. Smaller seed, coupled with more brittleness in both the seed coat and seed itself have already resulted in new machinery adaptations and developments. Additional testing to evaluate what improvements can and should be made to the numerous machines within the ginning system should and will continue at Lummus.

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