SAW GIN MODIFICATIONS TO REDUCE SEEDCOAT FRAGMENTS

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Abstract

Seed loss and seedcoat-fragment generation and contamination of ginned lint during the ginning process can be a problem with newer, small-seeded cotton varieties. Excessive seed loss means a loss of a valuable gin product. Also, seedcoats in ginned fiber cause textile quality problems during the spinning and weaving process. Tests were conducted on a method of holding the gin saws in the middle of the gap between the ginning ribs and its effect on seed damage and seedcoat-fragment generation. Results indicated that the experimental saw guides significantly reduced seed damage. The guides also decreased the level of seedcoats in the ginned fiber, as indicated by significantly higher quality yarn for the experimental method. Other benefits of the guides included a higher gin turnout and longer fiber. Further tests will be done to further improve and understand the somewhat complex interaction of gin saws, saw guides, and cottonseed at the ginning point.

Introduction

Imperfections in dyed cloth and their origins have been a subject of study for the U. S. textile industry for quite a while. Depending on their level, dyeing imperfections can seriously affect the appearance and therefore the value of the fabric. Bogdan (1950) blamed neps, small knots of immature fiber, as the culprit for many of the imperfections in finished cloth. Bogdan also stated that these neps were made more numerous by machine processing, such as occurs in ginning or textile processing.

Pearson (1955) reported that seedcoat fragments are a factor in yarn quality; that seedcoat fragments and neps form most yarn imperfections; and that seedcoats and neps tend to be grouped together and called "neps". Not distinguishing between seedcoats and neps could lead to erroneous conclusions about the source of yarn and cloth imperfections.

Research has also shown that the saw-gin stand damages a percentage of the seed and creates seedcoat fragments (Watson and Helmer, 1964, and Moore and Shaw, 1967). Bargeron and Garner (1989) concluded that seedcoat fragments were correlated with small seed diameter, and that there was a possible interaction between small seed and gin-rib geometry. Hughs el al. (1992) reported that levels of seedcoat fragments in gray cloth and corresponding light specks in finished cloth seem to be related. The variety of cotton affected the levels of seedcoat fragments and the number of white specks in dyed cloth. Saw-gin-stand rib gap also had an effect on the level of seedcoat fragments observed.

It has been established that different cotton varieties, as well as the action of the saw-gin stand, have a significant effect of the level of seed loss and seed damage during ginning, as well as seedcoat fragments in ginned lint. This report is about tests done to modified saw-gin ribs to determine if the level of seedcoat fragments can be reduced.

Materials and Methods

Some preliminary work on modified ribs had been done earlier by Jim Makey of J. G. Boswell Co., Corcoran, CA. The purpose of the work was to reduce seed damage, seedcoat-fragment contamination of the ginned lint, and the amount of seed that was lost ginning small seeded cotton varieties. Preliminary results looked promising, and so the work was continued at the USDA, ARS, Southwestern Cotton Ginning Research Laboratory, Mesilla Park, NM.

A reduced-width Continental Double Eagle gin stand was the experimental gin. All machine dimensions and speeds were standard from the factory, except that the stand is reduced in width to 47 saws. The control ginning treatment was the standard gin rib adjusted to factory specifications. A second set of standard ginning ribs was modified with saw guides, as shown in Figure 1, and used as the experimental treatment. All of the ribs were modified, except the half ribs on each end of the roll box that were left standard. The half ribs were not wide enough to reliably attach the saw guides and so were left unmodified.

Figure 1 shows the saw guides and gives some of the nominal clearance dimensions for two typical experimental ribs. The guides were made of ultra-high molecular weight (UHMW) plastic, trade name TIVAR 1000, obtained from Dallas/Fort Worth Plastics, Inc., Arlington, Texas. All of the guides were cut from a single 4-foot square sheet that was 1/8-inch thick. Dynamic frictional properties on polished steel of the material was 0.14 - 0.17. The plastic guide was mounted on the gin rib at three points for mechanical stability. Nominal gap between Double Eagle gin ribs is 0.110 inch. Each guide was cut so that, when the ribs were mounted in the gin stand, nominal clearance between the guides was 0.037 inch, as shown in Figure 1. Gin saws used in the Double Eagle gin are 0.037-inch thick, so that the 0.037-inch gap between guides gave a running clearance to the saws. The guides were mounted so that the upper end was approximately 0.5 inch below the bottom portion of the ginning point. The

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upper end of each guide was smoothed and rounded to prevent tagging of lint and snagging of gin saws when the gin breast was moved in and out.

The primary purpose of the plastic guides was to keep each gin saw centered in the gap between the ribs at the ginning point. When the gin saws are in the ginning position without the guides, each gin saw can be deflected relatively easily by hand from side-to-side, touching the gin ribs. With the guides in place, the saw is much "stiffer" and cannot be manually deflected easily from the center of the rib gap to touch the ginning ribs. The hypothesis is that the deflection of the gin saw in the gap allows an opening large enough for small cottonseed to get wedged into and pulled through with the ginned lint. Keeping the saw centered in the gap will not allow small seed to be pulled through as readily.

A range of cottons was selected that varied from smaller to larger seeded varieties for testing. Varieties used were Acala 1517-95, DP5415, DP35, and DP90RR. The DP5415 was from a module that was obtained from a cooperating gin experiencing seedcoat fragment problems during ginning. The other varieties were added to the test to give a relatively wide range of seed and fiber properties.

Seed-cotton cleaning for all varieties consisted of a combination of a 6-cylinder cleaner, stick machine, 6-cylinder cleaner, and a Continental Galaxie feeder over the gin stand. All ginned lint was cleaned by two saw-type lint cleaners. All of the seed cotton was in the 5 to 8% moisture range at the wagon suction, so no drying was used for any of the ginning lots. There was a total of 32 ginning lots for the test (two rib designs X four cottons X four replications). Each ginning lot consisted of 350 pounds of seed cotton weighed at the trailer scales, resulting in approximately 120 pounds of ginned lint at the bale press. The four cotton varieties were randomly selected and processed within each replication. Because of the difficulty in changing and adjusting gin ribs, the standard and experimental gin ribs were not randomly tested. The experimental ribs were used for the first 16 ginning lots and the standard ribs for the remaining 16 ginning lots. All of the ginning was completed over approximately one week. During this time, daily weather conditions were fairly uniform.

Sampling during the ginning test included samples of both the first lint- cleaner trash and ginned seed. The lint-cleaner trash was analyzed for crude protein content as a possible indicator of cottonseed content. The seed samples were manually analyzed for the percentage of damaged seed from each lot. Other seed-cotton and lint samples were analyzed for moisture, trash, and other standard properties.

All of the ginned lint from each of the 32 ginning lots was sent to the USDA, ARS, Clemson Pilot Spinning Plant to be made into yarn and fabric for further testing. Spinning tests consisted of making a 40-singles yarn and obtaining the processing waste, spinning parameters, strength, appearance, and Uster evenness data for all the lots. Yarn from each lot was then made into a knitted fabric and dyed to obtain dye speck counts.

Results and Discussion

Table 1 lists many of the average fiber and spinning quality factors as determined by variety. Variety DP5415 was included in the test because it was thought to have more problems with seedcoat fragments and seed loss than the other three varieties. If measurements such as ends down, yarn strength, yarn evenness, and yarn appearance are an indication of possible seedcoat problems, then DP5415 is significantly higher than the other varieties. Lint-cleaner trash from DP5415 also had the highest crude protein content, which might be an indication of loss of seed and seed meats into the lint. However, the lint-cleaner trash of Acala 1517-95 had a crude protein content not significantly different from DP5415. The Acala variety does not have a reputation for excessive seed loss or seedcoat-fragment generation during ginning. Crude protein content might not be a reliable indicator of seed loss or should be interpreted in light of other measurements, such as yarn evenness. DP5415 also had an intermediate level of seed damage, as shown in Table 1. Along with crude protein level, seed damage may not be in itself an indicator of a seedcoat-fragment problem. Smaller seeded varieties may tend to get pulled through the ribs whole instead of being broken apart. Overall, the data shown in Table 1 indicates a fairly wide range of individual quality factors represented by the four test varieties.

Many of the same quality factors presented in Table 1 are also present in Table 2. There were no significant differences in any of the HVI measurements due to ginning treatment, so none of these data were shown in Table 2. The experimental ginning ribs had a highly significant 3-percentage-points difference in the level of seed damage in comparison to the standard ginning ribs. Gin turnout was also 0.6%, or about 3 pounds per bale higher with the experimental ribs. Seed damage could be associated with seedcoat-fragment generation during ginning and would indicate the experimental rib reduced the level of seedcoat fragments in the ginned lint (even though crude protein content of gin trash, or Shirley analyzer visible trash content were not significantly different). Higher gin turnout could possibly indicate that the gin stand with the experimental ribs cleaned the fiber off the seed more effectively. This would indicate a more complex action at the ginning point than simply not allowing seed to be pulled through the ribs. More investigation is needed of what is occurring at the gin point with the experimental rib, as far as fiber removal from the seed is concerned.

Levels of short fiber and the upper quartile length in the ginned lint is significantly improved with the experimental rib, as indicated by both the Peyer and the AFIS measurements by weight. It is unclear how this ties in with seed damage levels and turnout, but is another indicator of a complex action at the ginning point that warrants further investigation.

The only negative quality factor attributed to the experimental rib in Table 2 is the AFIS nep measurement. An average nep measurement of 295 neps/gram was determined for the experimental rib versus 277 neps/gram for the standard rib. This difference was significantly different at the 0.5% level as shown by the OSL. Raw fiber nep levels will have to be further verified in any future work on the experimental rib design.

All of the yarn measurements in Table 2 of ends down, strength, evenness, and grade significantly favor the experimental rib. It is not clear that the difference is solely from lower seedcoat-fragment levels using the experimental rib, but is probably part of the reason. Significantly better short fiber and length properties of the fiber ginned using the experimental rib probably also contribute to the overall result.

The level of dye specks in finished cloth is not significantly different using the two rib designs. Table 2 shows that the level is very low for both treatments, but may trend slightly higher with the experimental rib. Table 1 shows that for this same measurement, the Acala cotton is significantly higher for dye specks than the other three cottons. Dyeing performance is a quality variable that will have to be closely followed during future tests.

Operationally, the saw guides performed well. Over 20 bales were processed through the gin stand with the saw guides in place. This number is very small compared to what a commercial gin stand would process, even in a day's time. However, when the experimental ginning ribs were removed, there was no apparent wear or damage of any kind to the edges or top faces of the plastic guides. The guides are not involved with the ginning point and so would not receive wear at that point. Also, the saws only touch the edges (the bearing surfaces) of the guides whenever they are deflected, which is probably not continuously, leading to a low wear rate. Long-term testing of the guides would have to be done in a commercial gin plant processing through a season, in order to do a thorough test of the guide's physical durability.

Conclusions

Tests conducted on the effects of using gin saw guides in a high-capacity saw-gin stand showed that the guides met the objective of significantly reducing seed damage. It can also be inferred from yarn data that the guides also significantly reduced seedcoats in ginned lint. Yarn made from cotton fiber processed using the plastic guides was of significantly higher quality for strength, evenness, and appearance. Evaluation of overall seed loss during ginning was inconclusive on the relatively small amount of seed-cotton used per lot. Evaluation of seed loss will have to be done on larger ginning lots.

Gin turnout and fiber length measurements showed additional quantity and quality advantages using the experimental saw guides. These measurements are an indication that the change in the process at the ginning point caused by the guides is more complex than simply not allowing some seed to slip by the saws into the lint. These results lead to the conclusion that other factors should be investigated, such as saw-tooth design relative to the action of the guides.

Durability data for the saw guides can only be considered preliminary because of the relatively small number of bales processed. However, early indications are that the guides and their mounting method are able to stand the mechanical loading and do not suffer excessively rapid wear. Wear properties of the guides will have to be further studied in a commercial setting.

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Disclaimer

Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the USDA or an endorsement by the Department over other products not mentioned.

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Table 1. Average quality factors by variety.

	Cotton Varieties			
Measurement*	**Acala 1517-95**	**DP5415**	**DP35**	**DP90RR**
Seed Damage, %	8.5 a	6.0 bc	5.3 c	7.4 ab
Seed Moisture, %	6.6 b	6.7 a	6.4 c	6.3 d
Trash Crude Protein, %	9.1 a	9.7 a	7.3 b	7.3 b
HVI Leaf Grade	3.1 a	3.0 a	1.8 b	2.0 b
HVI Micronaire	3.9 c	4.3 a	3.7 d	4.2 b
HVI Length, in.	1.12 a	1.04 c	1.11 a	1.07 b
HVI Strength, g/tex	31.5 a	30.2 b	31.1 a	30.1 b
HVI Uniformity, %	82.0 a	79.1 d	79.9 c	80.5 b
Ends Down, No./1000 yd	6 b	123 a	19 b	15 b
Skein Break Factor	2564 a	1717 d	2171 b	1982 c
Single Strand Strength, g/tex	16.3 a	12.3 d	14.4 b	13.1 c
Uster Neps, No./1000 yd	703 b	1120 a	755 b	756 b
Uster Thick Places, No./1000 yd	1158 c	2347 a	1620 b	1690 b
Uster Low Places, No./1000 yd	109 c	735 a	340 b	382 b
Yarn Grade	71 a	61 b	70 a	70 a
Dye Specks, No./40 sq. in.	2.9 a	1.4 b	1.9 b	1.5 b

* Averages followed by different letters are significantly different at the 5% level using Duncan's multiple range test.

Table 2. Average quality measurements by gin treatment.

	Ginning Treatments		Observed Significance
Measurement	**Experimental**	**Standard**	**Level**
Seed Damage, %	5.39	8.33	0.0001
Trash Crude Protein, %	8.64	8.04	NS*
Gin Turnout, %	35.01	34.41	0.0651
Shirley Analyzer Visible, %	1.51	1.52	NS
Peyer Short Fiber, %	16.8	17.8	0.0960
AFIS Short Fiber (w), %	8.06	9.90	0.0001
AFIS UQL (w), in.	1.19	1.16	0.0035
AFIS Neps, No./g	295	277	0.0041
Ends Down, No./1000 hr	27	82	0.1280
Skein Break Factor	2134	2083	0.0096
Single Strand Strength, g/tex	14.1	13.9	0.0564
Uster Neps, No./1000 yd	812	854	0.0239
Uster Thick Places, No./1000 yd	1654	1754	0.0294
Uster Low Places, No./1000 yd	367	416	0.0228
Yarn Grade	70	66	0.0096
Dye Specks, No./40 sq. in.	2.1	1.8	NS

* Statistically not significant (NS).

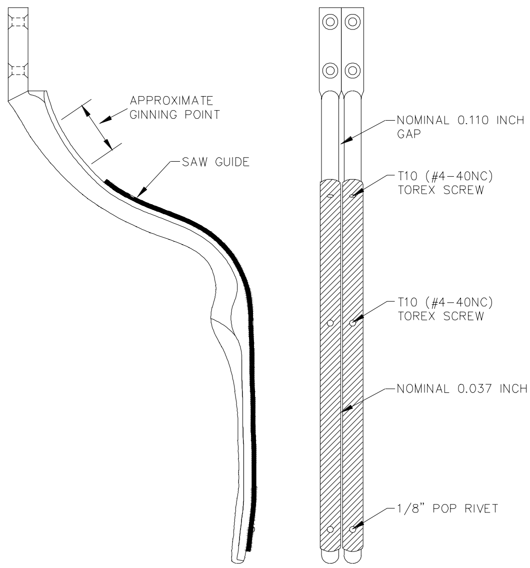

Figure 1. Configuration of Gin Ribs and Saw Guides.