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GINNING AND SPINNING SMALL SEEDED UPLAND COTTON

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Abstract

A laboratory ginning test was conducted to compare the ginning performance, fiber quality, and spinning properties of a newly developed small-seeded variety (DP 555 BG/RR) against a larger-seeded standard commercial variety (DP 451 B/RR). Ginning tests concentrated on 1) evaluating seed loss and seedcoat fragment generation during ginning and any effects on spinning performance, and 2) evaluating an experimental ginning rib's effect on seed loss and seedcoat fragment generation. Fiber and spinning tests indicated that, even though DP 451 was somewhat longer, had fewer neps, and had lower seed loss rates, DP 555 made yarn whose properties were as good as or better than that made from DP 451. Evaluation of the experimental rib indicated that it had positive results on fiber and yarn properties for DP 451 but negative results on those same properties for DP 555. These data indicate that further tests need to be conducted to better understand the interaction of seed size and gin stand design, particularly on very small-seeded varieties.

Introduction

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 (Hughs, 2002). Excessive seed loss means a loss of a valuable gin product to the cotton producer. Seedcoat fragments in ginned lint have long been known to be a factor in yarn quality (Pearson, 1955). Pearson (1955) stated that seedcoat fragments and neps account for most yarn imperfections. Also, seed coats and neps tend to get lumped together and are all called "neps". Failure to distinguish between seedcoats and neps, which are small knots of immature fiber (Bogdan, 1950), could lead to erroneous conclusions about the source of yarn and cloth imperfections. Bogdan (1950) also stated that these neps were made more numerous by machine processing, such as occurs in ginning or textile processing.

Research has also shown that, compared to roller-gin stands, saw-type gin stands increase seed damage and seedcoat fragments (Watson and Helmer, 1964; Moore and Shaw, 1967). Bargeron and Garner (1989) concluded that seedcoat fragments were correlated with small seed diameter and potential interactions between small seed and gin-rib geometry. Other research (Hughs et al., 1992) has reported statistically significant relationships between the levels of seedcoat fragments in greige cloth and the corresponding light specks in finished cloth. The particular cotton variety and the saw-gin-stand rib gap also had an effect on the levels of observed seedcoat fragments in these tests.

These earlier research results then led to the development and testing of a modified ginning rib designed to hold the gin saws in the middle of the ginning rib gaps (Hughs, 2002). The research was aimed at improved ginning of small-seeded varieties and reduced seed loss and seed damage. Laboratory tests showed that the guides significantly reduced seed damage, improved gin turnout and improved ginned fiber length. The fiber ginned with the experimental ribs also yielded significantly stronger and more uniform yarn. This report is of further research utilizing the experimental gin ribs with a newly released small-seeded cotton variety.

Materials and Methods

DP 555 BG/RR is a newly released small-seeded variety. This variety has approximately 6,000 to 6,500 seeds per pound. DP 451 B/RR is an established variety that is larger-seeded (approximately 5,000 seeds per pound). These two varieties of cotton were grown and harvested by the Delta and Pine Land Company in Arizona and shipped to the USDA, ARS, Southwestern Cotton Ginning Research Laboratory in large bags. A total of 1300 pounds of seed cotton from each variety was supplied for the test. A 100 pounds of seed cotton from each variety was shipped to Stoneville, MS for small scale testing. The remaining 1200 pounds of seed cotton from each variety was divided into six ginning lots of 200 pounds each. The ginning test consisted of four treatments of two varieties, DP 451 and DP 555, and two ginning conditions, with and without experimental ribs, and with three replications of each treatment for a total of twelve ginning lots.

Table 1 below shows the ginning treatments. Each ginning lot was processed through two 6-cylinder cleaners, one stick machine and no drying for seed cotton cleaning. Ginning was done on a cut down 47 saw Continental Double Eagle gin stand followed by one stage of saw-type lint cleaning. Seed cotton samples for trash analysis and moisture were taken at the wagon suction. Ginned lint samples for quality analysis were taken before and after lint cleaning and lint moisture samples were taken before lint cleaning. Trash samples were taken from the gin stand lower moting section and the lint cleaner for seed loss analysis. Each ginning lot resulted in approximately 60 pounds of ginned lint that was baled and sent to the USDA, ARS, Pilot Spinning Plant, Clemson, SC for fiber and spinning tests.

Results and Discussion

Tables 2 through 15 present the fiber and spinning data from this study. The different variables were statistically evaluated against the treatments using the SAS general linear model (GLM) procedure. The observed significance level (OSL) reported in each table was the test statistic used to determine significance differences between independent variable averages. Average variable values were termed non-significant (NS) if the OSL was greater than 5% (0.05). The actual OSL's as determined by SAS GLM are shown at the bottom of Tables 2 through 15 for all variable averages that were determined to be significantly different.

Tables 2, 3, and 4 show selected raw fiber properties as affected by variety, gin stand treatment, and level of lint cleaning. These results are fairly typical of what would be expected in this type of test. Micronaire levels depend primarily on varietal levels. Length is significantly affected by lint cleaning. Strength and uniformity are affected by both variety and lint cleaning. Earlier test results have shown that current HVI measurements of micronaire, length, strength and uniformity were not significantly affected by the experimental gin ribs and this test confirms that. The levels of fiber length and strength for both varieties appear to be fairly normal, but the uniformity levels for both varieties and ginning treatments is very low.

Tables 5 and 6 show moisture levels, seed loss and lint trash contents analyzed for variety and gin stand treatment respectively. Seed cotton and lint moisture contents, even though significantly different in both tables, were within the recommended range and were unlikely to have caused any practical quality or spinning effects. No seed cotton drying was done and test results indicated that none was needed. Seed loss into the trash was significantly higher for the smaller-seeded variety DP 555 (Table 5) as was expected. What was unexpected, was that the experimental gin ribs, analyzed across all treatments, had significantly higher seed loss than did the standard ribs (Table 6). Previous tests have shown just the opposite result, although previous tests have not included a variety whose seed size was as small as are DP 555 seed. There may be an interaction with the small seed size and gin stand geometry occurring here that needs further investigation.

DP 555 after ginning was significantly shorter and had a higher short fiber and neps content as measured by AFIS than did DP 451 (Table 7). Visible foreign matter content was not significantly different between varieties nor between ginning treatments (Table 8). Table 8 also shows that the ginning treatment did not make any significant difference in fiber length or nep content. The significant differences in length and neps between varieties carried through to the card sliver (Table 9). DP 555 continued to be significantly shorter in length, have higher short fiber content, and higher neps than did the DP 451. The higher short fiber content of DP 555 also probably contributed to its significantly higher opening and cleaning waste. Even though there was no significant difference in raw fiber length and nep content due to gin treatment, Table 10 shows mixed results for card sliver, with the experimental treatment resulting in significantly more short fiber and more total card waste, and less opening and cleaning waste.

Tables 11, 12, 13, and 14 give yarn spinning performance and quality data as affected by variety and ginning treatment. There were no significant differences between the experimental and standard ginning ribs in any of the data reported in Tables 12 and 14. Earlier studies (Hughs, 2002) had indicated that the experimental ginning ribs would result in significantly stronger and more uniform yarn, but that was not the case for this test. However, there were significant quality differences due to variety. DP 555

produced significantly stronger and more uniform yarn than did the DP 451. The shorter ginned fiber length and higher neps content of DP 555 mentioned earlier did not result in inferior yarn quality when compared to DP 451.

Table 15 shows the averages and a statistical comparison of calculated ends down across both variety and ginning treatment. This table shows that, for DP 451, the experimental ginning ribs resulted in fewer ends down when compared to the standard rib. The results for DP 555 are just the reverse, with the experimental ribs resulting in much higher ends down when compared to the standard ginning rib. This reversal resulted in a significant statistical interaction between variety and ginning treatment.

Conclusions

There were significant differences due to variety between DP 451 and DP 555 as shown in this test report. DP 555 raw fiber was significantly shorter, and had higher neps content than did DP 451 as measured by AFIS. DP 555 also lost more seed into the ginning waste than did DP 451. HVI data showed that, while the DP 555 was significantly lower in uniformity, it was significantly stronger than was DP 451 and showed no difference in fiber length. The HVI measurements indicated that both varieties had low uniformity overall. Spinning performance data generally indicated that the yarn made from DP 555 raw fiber was significantly stronger and more uniform than the yarn made from DP 451. The stronger yarn from DP 555 seems contradictory to the somewhat lower raw fiber properties of DP 555 compared to DP 451. Never-the-less these data do not indicate that there should be any textile processing concerns with the smaller-seeded DP 555 variety as compared to the DP 451.

Earlier ginning and spinning tests of the experimental ginning ribs had indicated a statistically significant advantage in fiber length, turnout and yarn quality for cotton processed using the experimental ribs. This test does not indicate any such advantage. These data do indicate significant interaction between variety and ginning treatment, at least in spinning efficiency as indicated by calculated ends down. There needs to be further work done to establish what this interaction involves, particularly with very small-seeded cotton varieties.

References

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Table 1. Ginning Treatments.

Treatment Number	Variety	Gin Ribs
1	DP 555	experimental
2	DP 451	experimental
3	DP 555	standard
4	DP 451	standard

Table 2. Average HVI Fiber Properties per Variety.

Variety	Mike	Length, in.	Strength, g/tex	Uniformity
DP 451	4.5	1.16	26.6	76.8
DP 555	3.9	1.15	28.0	72.8
OSL	0.0001	NS	0.0006	0.0001

Table 3. Average HVI Fiber Properties per Ginning Treatment.

Gin Ribs	Mike	Length, in.	Strength, g/tex	Uniformity
Standard	4.2	1.16	27.3	74.9
Experimental	4.2	1.16	27.3	74.7
OSL	NS	NS	NS	NS

Table 4. Average HVI Fiber Properties per Lint Cleaning Treatment.

Lint Cleaning	Mike	Length, in.	Strength, g/tex	Uniformity
0	4.2	1.17	27.7	76.0
1	4.1	1.14	26.8	73.7
OSL	NS	0.0001	0.0234	0.0001

Table 5. Average Fiber Moisture & Trash Properties per Variety.

Variety	Seed Cotton Moisture, % dry basis	Lint Moisture, % dry basis	Gin Seed Loss, No./100 g. trash	Lint Shirley Visible Trash, %
DP 451	7.3	6.4	171	3.2
DP 555	8.0	6.7	193	3.5
OSL	0.0001	0.0284	0.0016	NS

Table 6. Average Fiber Moisture & Trash Properties per Ginning Treatment.

Gin Ribs	Seed Cotton Moisture, % dry basis	Lint Moisture, % dry basis	Gin Seed Loss, No./100 g. trash	Lint Shirley Visible Trash, %
standard	7.6	6.7	113	3.6
experimental	7.7	6.5	251	3.1
OSL	NS	NS	0.0016	0.0274

Table 7 - Average AFIS Lint Data per Variety

Variety	UQL, in.	Short Fiber, %	Neps, No./g.	Visible Foreign Matter, %
DP 451	1.24	8.3	201	3.0
DP 555	1.21	10.7	249	3.2
OSL	0.0018	0.0037	0.0053	NS

Table 8. Average AFIS Lint Data per Ginning Treatment.

Gin Ribs	UQL, in.	Short Fiber, %	Neps, No./g.	Visible Foreign Matter, %
standard	1.23	9.5	223	3.0
experimental	1.22	9.6	226	3.2
OSL	NS	NS	NS	NS

Table 9. Average AFIS Card Sliver Measurements per Variety.

Variety	UQL, in.	Short Fiber, %	Neps, No./g.	Opening & Cleaning Waste, %	Total Card Waste, %
DP 451	1.23	9.9	63	2.4	3.2
DP 555	1.20	13.5	93	2.8	3.3
OSL	0.0030	0.0001	0.0390	0.0001	NS

Table 10. Average AFIS Card Sliver Data per Ginning Treatment.

Gin Ribs	UQL, in.	Short Fiber, %	Neps, No./g.	Opening & Cleaning Waste, %	Total Card Waste, %
standard	1.21	11.2	67	2.7	3.2
experimental	1.22	12.2	89	2.5	3.3
OSL	NS	0.0217	NS	0.0019	0.0091

Table 11. Average Spinning Data per Variety.

Variety	Ends Down, #/1000 hrs	Single Strand Strength, g/tex	Single Strand Strength CV, %
DP 451	112	9.7	10.8
DP 555	213	11.0	9.9
OSL	NS	0.0001	NS

Table 12. Average Spinning Data per Ginning Treatment.

Gin Ribs	Ends Down, #/1000 hrs	Single Strand Strength, g/tex	Single Strand Strength CV, %
standard	130	10.3	10.3
experimental	195	10.3	10.4
OSL	NS	NS	NS

Table 13. Average Uster and Classimat Data per Variety.

Variety	Neps, #/1000 yds	Thick Places, #/1000 yds	Thin Places, #/1000 yds	Minor Faults, number
DP 451	11.5	81.5	42.8	28.0
DP 555	6.0	52.7	21.2	16.8
OSL	0.0001	0.0001	0.0001	NS

Table 14. Average Uster and Classimat Data per Ginning Treatment.

Gin Ribs	Neps, #/1000 yds	Thick Places, #/1000 yds	Thin Places, #/1000 yds	Minor Faults, number
standard	8.5	70.3	32.7	20.8
experimental	9.0	63.8	31.3	24.0
OSL	NS	NS	NS	NS

Table 15. Average Calculated Ends Down.

Variety	Gin Ribs	Ends Down, No./1000 rotor hrs
DP 451	standard	134
DP 451	experimental	91
DP 555	standard	126
DP 555	experimental	299
OSL (variety X gin)		0.0276