PRELIMINARY COMPARISON OF THE IMPACT OF MODERN GIN STANDS ON SHORT FIBER CONTENT AND NEPS

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Abstract

A preliminary evaluation of the effects of modern gin stands on neps and short fiber content was conducted. The study consisted of 350-pound replicated lots of one cotton variety ginned on five different gin stands at normal ginning rates. Fiber moisture contents averaged 6.6% for the study. Total nep count per gram from gin stand A was significantly higher than those attained from stand D. Short fiber content by weight was significantly higher for stand E as compared to stand D and short fiber content by number was significantly higher for stands A and E than those attained from stand D. In essence, different gin stands produce different levels of neps and short fiber. Further studies will be conducted to substantiate these results on a broader spectrum of cottons and gin stand operating parameters, and to isolate the causative factors.

Introduction

Short fiber content (SFC) and neps have been a topic of concern since the days of the conventional gin stand. Neps are small knots of tangled fibers, which are created during boll development, harvesting, ginning, and yarn manufacturing (Mangialardi, 1985). Neps may affect manufacturing, cause non-uniform dying, and affect the appearance of woven fabrics. The percentage of fibers less than ½" in length by weight (ASTM D1440) defines SFC. The SFC of a cotton is inversely related to yarn strength and can directly affect the quality of a finished product (Anthony, 1985).

Several studies have focused on the formation of neps and SFC in conventional and high-capacity gin stands. Pre-1958 gin stands (conventional) have about 90 saws set on ¾-inch centers and turned at 700 rpm. These stands have an optimum ginning rate of 1 ½ to 2 bales per hour (Griffin, 1977). High-capacity gin stands became readily available in the early 1960's. Some of these stands incorporated either larger diameter saws (16- or 18-inch diameter), redesigned roll boxes, reciprocating seed roll actions, or dual saw cylinders and achieved ginning rates of 3 ½ to 7 bales per hour (Wilmot and Watson, 1966).

High-capacity gin stands have been compared to conventional gin stands in terms of SFC and showed no significant difference between treatments (Griffin, 1979). Griffin (1979) suggests that high-capacity gin stands do not create an abnormal quantity of SFC when ginning at manufacturers recommended rates (the recommend rate in his study was 5.2 bales per hour). It was further concluded that ginning at higher than recommended rates for a given gin stand (7.2 bales per hour) caused a significant increase in SFC.

Studies from the 1950's to the 1970's indicate that nepping increases with increasing seed roll density, and can be affected by saw spacing, number of teeth per saw, and saw tooth condition. More recently, Mangialardi (1985) evaluated nep formation at the gin and determined that gin stands were a major contributor to nepping during gin processing. In another study, ginning rates from 1.4 to 6.4 bales per hour did not significantly affect nep count for a gin stand rated at 4.8 bales per hour (Mangialardi, et al., 1987).

Modern gin stands, often referred to as super-high-capacity gin stands, can process seed cotton at rates of 8 ½ to 15 bales per hour. The higher rates have been achieved by smaller saw spacing, improved seed roll agitators and seed tubes, and electronic feed controls. The very high rates have been achieved by also increasing the overall width of the gin stands. Limited information is available on how these modern gin stands affect nep formation and SFC.

The purpose of this study was to determine the extent of nepping and SFC caused by super-high-capacity gin stands.

Materials and Methods

The commercial-size ginning plant at the U.S. Cotton Ginning Laboratory (USCGL) in Stoneville Mississippi was used in this study. The recommended seed-cotton cleaning sequence for ginning Midsouth spindle-picked cotton was used in this study (Baker, et al., 1994). The standard sequence consists of a 24-shelf tower drier, 6-cylinder cleaner, stick machine, 24-shelf tower drier, 6-cylinder cleaner, and extractor-feeder. A temperature of 180 °F was maintained at the top of the first tower drier, while no heat was used in the second tower drier.

This experiment consisted of three replications involving one cotton variety and five gin stands (treatments), for a total of 15 test lots. Each test lot consisted of 350 pounds of seed cotton, requiring approximately four bales for the experiment. The cotton variety used in the experiment was Delta and Pine Land (DPL) 5409. The seed cotton was grown and spindle-harvested by the Delta Research and Extension Center, Mississippi Agricultural and Forestry Experiment Station (MAFES), and the Agricultural Research Service, USDA, Stoneville, MS. Harvesting was

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done during the week of September 20-25, 1997, and ginning was performed on June 3, 1998.

Five different gin stands were used in this study. A comparative list of the details of each gin stand, as supplied by the manufacturer, is shown in Table 1. Since this was a preliminary study to determine the impact of modern gin stands on short fiber content and neps, each gin stand was run at its normal operating capacity for the USCGL. Typical USCGL ginning rates are 85% to 95% of the manufactures recommended rates, these rates may vary with cotton variety.

Test lot numbers were assigned to the gin stand treatments in a randomized arrangement to limit the effects of processing order. To avert the effects of gin stand "cool down", 300 pounds of seed-cotton were ginned prior to each test lot. Further, sample collection was performed after the gin stands reached the desired capacity and before the capacity declined to reduce the ginning "starting and stopping effects".

During ginning, approximately 10 pounds of seed-cotton were collected from the feeder apron and three lint moisture and three Advanced Fiber Information System (AFIS) samples were collected behind the gin stand. The 10-pound seed-cotton samples were processed in the following manner: the entire sample was spread out on plastic approximately four inches deep, a sub-sample was collected by randomly taking 20 to 25 small handfuls, the sub-sample was ginned on a "bench-model" gin stand equipped with 6-inch diameter saws, the lint was collected for AFIS measurements, and the process was repeated 10 times.

The "bench-model" gin stand separates the lint from the seed and blends the fiber. This ginning method was used instead of hand ginning to produce representative samples for AFIS measurements. The alternative method, hand-ginning, would require mechanical blending for a similar representative sample. Both mechanical blending and saw ginning increase neps in the fiber and can alter other fiber properties. Further, the samples collected at feeder apron were collected to determine if there were significant differences in neps and short fiber content between gin stands prior to ginning. Based on this information, using the bench-model gin stand was the most efficient means of processing the seed cotton from the feeder apron samples.

The AFIS measurements of interest in this study included; neps, SFC, average length, seed coat neps, and upper quartile length. Neps were measured as total nep count normalized per gram, including both fiber and seed coat neps. Seed coat neps is an AFIS measurement that quantifies the number of neps with seed coat fragments. Seed coat nep counts were normalized per gram (SCN). Short fiber content by weight (SFC(w)) and short fiber content by number (SFC(n)) were both used for SFC analyses. Fiber length was evaluated as average length (L(w)) of all the fibers in a sample computed on a weight basis, and the length, which is exceeded by 25% of the fibers by weight, was evaluated as upper quartile length (UQL(w)).

Moisture contents on the samples collected behind the gin stand were performed at the USCGL, Stoneville, MS. The AFIS measurements on the samples collected from behind the gin stand and the AFIS measurements on the samples collected from the 6-inch gin stand were be performed at Cotton Incorporated, Raleigh, NC. The Statistical Analysis Software System (SAS) was used to investigate the results obtained from the moisture content and AFIS measurements at the 95% confidence level (SAS, 1987).

Results and Discussion

During this study, gin stands A, C, and E were unable to achieve the expected ginning rates. Estimated ginning rates for stands A, C, and E were 30-, 35-, and 40% below manufactures recommended rates, respectively. The lower than normal rates were attributed to insufficient horsepower. Mangialardi reported that ginning rate had little effect on neps in the range of 1.4 to 6.4 bales/hour (Mangialardi, et al., 1987). Therefore, this study was completed at these rates to attain preliminary data between gin stands.

Moisture contents collected behind the gin stands averaged 6.6% and were not significantly different between gin stand treatments, based on the Duncan statistical method. According to SAS analyses using the Duncan method there were no significant differences in AFIS measurements for feeder apron samples collected at each gin stand. However, several of the AFIS measurements taken from the samples directly behind the gin stand were significantly different between treatments. Table 2 shows the mean AFIS measurements and their corresponding significance.

Total nep count for gin stand A was significantly higher than gin stand D. The total nep count per gram, as shown in Table 2, demonstrates a possible trend of increasing neps with increased gin stand capacity. This trend follows anticipated results and could be attributed to one or a combination of variables that correspond to each individual gin stand, such as ginning rate, saw diameter, and saw spacing. Gin stand B produced significantly more SCN(n) than the other stands, while stand D produced significantly fewer SCN(n) than stands A, B, C, or E. The SFC(w) for gin stand E was significantly higher than gin stand D, while SFC(n) was significantly higher for stands A and E as compared to D. The L(w) measurements for gin stands B and D were significantly different stand E measurements. No significant differences in UQL(w) were found between gin stand treatments.

Summary

Based on the results of this study, there was a significant difference in SFC and neps between gin stands. Short fiber content was significantly higher for gin stands A and E as compared to gin stand D. These initial results show that high-capacity stands tend to have fewer neps and less short fiber content than the super-high-capacity stands; however, it should be noted that these results are preliminary and that three of the super-high-capacity stands were operating well below their recommended rates due to horsepower limitations. This study will be repeated with the gin stands operating within manufacturers specifications for more conclusive results.

Future Plans

Based on the results of this study and previous high capacity gin stand studies, additional research will focus on quantifying the effect of gin stand operating parameters on fiber quality. This study will cover a broad spectrum of parameters and cotton varieties, and causes of the impact on fiber quality will be isolated. A primary goal of future research will be to operate gin stands A, C, and E within manufacturers specifications. Additional gin stand studies will include ginning rate, saw diameter, saw spacing and saw loading. These studies will focus on the effect of neps, SFC, and seed damage associated with the different treatments of each study. These studies will be based on the parameters found in super-high-capacity gin stands and will be conducted similarly to previous studies on conventional and high-capacity gin stands.

Disclaimer

Mention of a trade name, propriety product or specific equipment does not constitute a guarantee or warranty by the U.S. Department of Agriculture and does not imply approval of a product to the exclusion of others that may be suitable.

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Table 1. Gin stand details as specified by the manufacturer (Columbus et al., 1994).

	Gin Stand				
Gin stand details	A	B	C	D	E
Saw spacing (in.)	0.5	0.625	0.625	0.75	0.5
Saw diameter (in.)	12	16	16	11.75, 12	12
Number of saws	112	93	93	178	116
Number of saw Cylinders	1	1	1	2	1
Recommended rate (bales/hour)	8.5	5	7.5	4-4.5	10
Agitator	Yes	No	Seed tube	No	Yes
Motor horsepower, Hp	75	50	75	50	100

Table 2. Mean AFIs measurements for the preliminary gin stand comparison study*. All means represent samples taken directly behind the gin stand. Bold numbers in each column are more desirable.

Gin Stand	Neps Count/gram	SCN Count/gram	SFC(w) %	SFC(n) %	L(w) in.	UQL(w) in.
A	178.8a	17.8b	7.6ab	21.0a	1.02ab	**1.24a**
B	170.1ab	22.9a	7.3ab	20.4ab	**1.03a**	**1.24a**
C	161.9ab	16.2b	7.6ab	20.8ab	1.02ab	**1.24a**
D	**152.7b**	**9.6c**	**6.8b**	**19.1b**	**1.03a**	**1.24a**
E	171.2ab	15.8b	8.0a	21.9a	1.01b	1.23a

* Numbers not followed by the same lower case letter in each column are significantly different based on the Duncan method at a 0.05 level