WHERE NEPS IN PIMA COTTON ARE MADE

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Abstract

Complaints from foreign textile mills of high levels of neps in U.S. Pima cotton is of concern to the American Pima industry. Previous research has shown that the rotary-knife roller gin stand does not create very many neps during the ginning of Pima cotton. However, there may be other points during the harvesting and ginning process where a large number of neps are made. Using the AFIS nep test, research was done to determine the level of neps in Pima cotton from before machine-picking through to the bale press. The level of AFIS neps in the cotton lint on the plant was shown to be approximately 50% of the total number of neps at the bale press. Also, most of the increase in nep count occurred during the harvesting and seed-cotton cleaning part of the process. Roller ginning and lint cleaning did not significantly change the level of neps in the lint.

Introduction

A nep is defined as a tightly tangled knot-like mass of unorganized fibers(ASTM, 1997a). Complaints about neps in American cotton from foreign and domestic consumers are common and have been made over a long time period. In 1933, Dr. Norma Pearson (1933) wrote, "Recent complaints made to the Department of Agriculture and elsewhere, by foreign and domestic manufacturers, allege that neppiness and poor preparation occur in American cotton more often than is necessary." These same complaints continue even today. Some of the criticism of U. S. cotton seems to depend on its price relative to other world growths. As it becomes more expensive, buyers demand higher quality. Also, modern textile manufacturing processes and quality standards require continually higher-quality raw fiber. Consequently, high nep counts in raw cotton are a cause of complaint (Bargeron and Behery, 1979).

Because neps in raw cotton are a quality issue, USDA, ARS scientists and others have done considerable research on the causes of neps and how to measure nep levels. It has been documented that neps are formed during the cotton harvesting, ginning, and textile processing operations (Mangialardi, 1985). Some have said that neps are even created during boll development (Pearson, 1936). Nep tests have been developed to measure the levels of neps in raw cotton, card web, yarn and fabric. Some of the nep tests have been made industry standards (ASTM, 1976, ASTM, 1984 and ASTM, 1997b).

Hughs et al. (1988) investigated the relationship between neps made in raw cotton and yarn and the level of dyeing imperfections in finished cloth. Test treatments included hand- and machine-picked cotton, and roller- and saw-ginning with and without lint cleaning. Hughs et al. (1988) showed that there is a weak statistical relationship between "neps" in raw fiber and yarn and "neps" (or white specks) in dyed fabric. The term nep seems to be an ambiguous term whose meaning varies depending on the point(s) in processing where the measurements are made. Hughs et al.(1988) verified earlier work that showed, in general, the more severe the ginning treatment, the higher the nep levels in dyed fabrics. Also, method of picking (hand versus machine) and cotton variety have a significant affect on the observed level of neps in fabrics. None of the factors measured by Hughs et al. (1988) served as good predictors of nep levels in dyed fabrics.

Hughs and Lalor (1989) compared the fiber and yarn effects of roller- versus saw-ginning for Pima and upland cottons. Occasionally, there is commercial interest in roller ginning upland cottons, which are normally saw ginned. Hughs and Lalor (1989) showed that roller ginning upland cotton, when compared to saw ginning, improves the length, length uniformity, and nep count of the raw cotton. However, the short fiber content is not necessarily improved by roller ginning upland cotton, nor is yarn made from this cotton significantly improved. Roller-ginned Pima (the usual process) has fewer raw fiber neps and makes better yarn than saw-ginned Pima fiber.

By reputation and as verified by research, the roller ginning process makes fewer neps in ginning than saw ginning. Because of this lower nep production, all Pima cotton in the U. S. is roller ginned. However, there are still occasional complaints from foreign buyers concerning high nep counts of American Pima cotton when compared to foreign growths. This report describes research conducted by the Southwestern Cotton Ginning Research Laboratory, Mesilla Park, NM, to determine where neps are generated in the Pima cotton harvesting and ginning processes.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1593-1595 (2000)
National Cotton Council, Memphis TN

Materials and Methods

The objective of the experiment was to determine the nep content of Pima cotton in the field prior to harvesting, after machine picking, and then at several locations in ginning -- culminating at the bale press. If points of high nep generation during the processing sequence can be determined, then it might be possible to reduce nep levels at those points, resulting in lower average nep counts of baled Pima cotton. All cotton was grown in the Safford Valley of Arizona under normal irrigation production practices for that area. All ginning was done at Glenbar Gin Inc., Pima, AZ. Glenbar is what is known as a combo-gin with both saw- and roller-ginning under the same roof utilizing the same seed-cotton drying and pre-cleaning equipment.

A sampling and testing protocol was developed that limited uncontrolled variability as much as possible while obtaining the desired information. The Advanced Fiber Information System (AFIS) test for neps was used as the indicator of nep levels. This test requires only a few grams of fiber to give a reading, so many readings could be taken with small amounts of fiber. Multiple samples of either seed cotton or lint were taken at each point of interest in order to get a reliable estimate of the average nep levels at selected points in the processing sequence. All seed-cottons were hand ginned to obtain the lint samples. Samples of seed cotton were taken at the following locations:

1. In the cotton field prior to harvest
2. From cotton modules prior to ginning
3. In the gin plant, after the number 1 drying system
4. In the gin plant, after the number 2 drying system
5. In the gin plant, after the seed cotton feeder (prior to ginning).

Samples of ginned lint were taken at the following locations:

1. After the rotary-knife roller gin stand (prior to lint cleaning)
2. After lint cleaning (prior to baling).

Seed-Cotton Sampling

1. Cotton Field: Six uniform fields of Pima were selected in the Safford, Arizona growing area. The cotton included both Pima S-7 and White Pima varieties. Each field was divided into quarters with a seed-cotton sample taken from each quarter, as well as a sample taken in the middle of the field, for a total of five samples from each field. Each of the five seed-cotton samples was hand picked from a single plant that was "typical" of the surrounding plants in that section of the field. The samples were taken from the bottom, middle, and top sections of the plant. Three open bolls were selected in each section of the plant and all seed cotton was manually removed. The 9 total bolls from each plant yielded at least 20 grams of hand ginned fiber for testing. This sampling schedule resulted in a total of 30 samples (6 fields times 5 samples per field).
2. Cotton Modules: After each field was spindle-picker harvested, 2 modules from each of the 6 fields were selected at random for a total of 12 modules. Five separate seed-cotton samples were taken at different locations from each module for a total of 60 samples. Each of the 12 modules was to be sampled throughout the ginning process. However, due to a problem in scheduling, two of the modules were ginned without further samples being taken. Samples were collected from the remaining 10 modules.
3. Number One Drying System: As each of the remaining 10 modules was processed, 5 separate samples of seed cotton were taken after the first drying and cleaning stage(50 samples total). At this point, the seed cotton had been processed through a module feeder, a tower dryer, a hot-air 6-cylinder cleaner, and a stick machine.
4. Number Two Drying System: The cotton was processed through an additional tower dryer, a second hot-air 6-cylinder cleaner and a gravity 6-cylinder cleaner. The sampling procedure at this point was the same as for the number one drying system (50 samples total).
5. Gin Stand Feeder: This was the last seed-cotton cleaner and the last sampling point for seed cotton (another 50 samples collected). Prior to the feeder, the cotton was transported through a distributor.

Lint Cotton Sampling

1. Roller Gin Stand: Five samples of ginned lint were taken during processing after the rotary-knife roller gin stand and before the first lint cleaner for each of the ten modules (50 samples total).
2. Lint Cleaning: Again, 5 samples of lint were taken from the lint slide for each module for a total of 50 samples. These lint samples were processed through two 6-cylinder incline cleaners (operating at 1000 rpm) and a battery condenser.

A total of 340 samples of lint and seed cotton were collected as outlined above. The samples were taken over a period of several weeks during the normal progression of the harvest season. The season was open and dry with no unusual field, harvesting, or ginning conditions. About 8 or 9 grams of lint were hand ginned from each of the seed cotton samples. The seeds were well cleaned of fiber with no long fibers remaining on the seed after hand ginning. No further processing was done on the lint samples after hand ginning. The ginned cotton was randomly selected from the sample bag for counting of neps.

Test Analysis and Discussion

The ginned lint samples were sent to the USDA, ARS, Clemson Pilot Spinning Plant, Clemson, SC for testing. Nep measurements were made on an AFIS instrument. For each of the 340 lint samples, three sub-samples were tested and the results averaged for each sample. Table 1 summarizes the results of the nep tests and Figure 1 is a plot of the data showing the average, minimum and maximum values for the samples tested from each location.

As seen in Table 1, the average AFIS count for the field samples is 100.2 neps per gram. This cotton was hand-picked from mature, open bolls and hand-ginned with no mechanical handling. After the field, the average nep count increased with each successive stage up to and including the gin feeder which had an average nep count of 194 neps per gram. Each average nep level, from the field through the gin feeder, is significantly different. Processing the cotton through the roller gin stand does not change the average nep count as it remained at 194.4 after ginning. Subsequent lint cleaning increases the average to 209 neps per gram, but this is not significantly different from the levels after the gin feeder or after ginning.
From the bar graph shown in Figure 1, it can be seen that the minimum and maximum nep values for the feeder, gin stand and lint cleaning overlap each other, so it is expected that there are no significant differences between their averages. Pima cotton is ginned on a roller-gin stand because it has the reputation for not creating very many neps during the ginning process. This data substantiates this claim.

What is surprising about these test results is the relatively high level of neps in the field before machine processing, and that each subsequent step of harvesting, seed-cotton drying and cleaning, and gin stand feeding significantly added to the average nep level. It was originally thought that the cotton fibers contained in the open boll in the field are relatively nep free. Past research has also shown that the seed-cotton cleaning process adds relatively few neps (Annual Report, 1966). In some cases, the entire seed-cotton cleaning process added only 4 or 5 neps per 100 sq. inches as determined by the card web nep test (ASTM, 1984).

Measuring neps in the raw stock by ASTM Method D1446 and in card web by ASTM Method D3216 are different from the AFIS measurement (ASTM Method D5816). The AFIS measurement is done on processed sliver or on raw cotton that has been hand teased into a sliver-like state and is an electronic sensing method. The other tests involve manual/visual counts after the cotton has been processed into a web. The card web method requires a minimum of several pounds of lint to prepare the web from which specimens are selected and is very slow and time consuming. The AFIS instrument uses only a few grams of fiber and is very rapid. It is unclear how the two measurements compare because of the differences in method and fiber condition. However, the AFIS method is widely being used while the card web method has been largely abandoned.

Since the AFIS method of nep count is being so widely used, the initial average count of 100 neps per gram of cotton in the field samples is of concern. It is important to interpret this information in light of textile quality demands, particularly since the entire ginning process only doubled the number of neps that were initially counted in the field samples. In an attempt to evaluate what these nep counts might mean to the textile industry, a dyeing test was done on some of the ginned lint samples. A sample with the lowest nep count (64) and one with the highest nep count (280) were dyed a dark blue and visually evaluated for white or undyed spots. The 64 nep count came from a field sample and the 280 count came from a lint slide sample. Evaluations of these dyed samples showed no difference in either the dye levels or the white speck counts. Without being able to correlate some subsequent affect of the nep counts on textile quality, it is difficult to evaluate the AFIS nep counts any further.

One possible use of the data could be to assume that the average count of 100 neps per gram is a base number for Pima cotton that could be subtracted from any AFIS counts taken at the textile mill after ginning. For example, this data shows an average AFIS count of 246.2 neps per gram in the bale. Subtracting 100 would leave a net average measurement of 146.2 for these cottons. The same thing could be done for other Pima cottons and would then give a basis of comparison for AFIS nep measurements of Pima cottons. It is unclear what this might mean for later textile quality measurements.

Summary and Recommendations

A test was done to determine where and to what extent neps are formed during the Pima cotton harvesting and ginning processes. The AFIS nep measurement was the criterion used to evaluate nep levels. The nep levels for hand-picked and hand-ginned Pima cottons averaged approximately 50% of the nep levels of cotton that had been processed through the roller gin and baled. Further work needs to be done to determine how these AFIS nep counts relate to textile processing. Substantially different nep levels did not result in a discernable difference in dye defects. There was insufficient fiber available to make fabrics or do other textile quality tests.

Acknowledgment

Many thanks to Mrs. Mary Owen, Glenbar Gin, Inc. for her organization and execution of the field sampling and hand-ginning portions of the test.

References

American Society for Testing and Materials. 1976. Standard Method of Test for Number of Neps in Cotton Samples. ASTM Designation: D 1446. Part 33. The Society, Philadelphia.

American Society for Testing and Materials. 1984. Standard test method for grading cotton card webs for appearance. ASTM Designation: D 3216. Vol. 07.02. The Society, Philadelphia.

American Society for Testing and Materials. 1997a. Standard Terminology Relating to Textiles. ASTM Designation: D 123 - 96a. Vol. 07.01. The Society, Philadelphia.

American Society for Testing and Materials. 1997b. Standard Method for Neps in Cotton Fibers(AFIS-N Instrument). ASTM Designation: D 15866 - 95. Vol. 07.02. The Society, Philadelphia.

Annual Report. 1966. Fundamental mechanisms of nep formation in cotton. In-house report USDA, ARS, Southwestern Cotton Ginning Research Laboratory, Mesilla Park, NM. Pages 47-65.

Bargeron, J. D., and H. M. Behery. 1979. Neps in export cotton. Semiannual Progress Report, USDA Research Agreement 12-14-100-9712(51) and Clemson University Project Number 3-30-XXXX-1207-13-1102.

Hughs, S. E., and W. F. Lalor. 1989. Fiber and yarn effects of roller versus saw ginning. The Cotton Gin and Oil Mill Press. June 17, 1989.

Hughs, S. E., W. F. Lalor, and F. T. Wahba. 1988. Relationship of ginning and fiber properties to dyeing imperfections. Textile Research Journal 58(10):557-67. October.

Mangialardi, G. J., Jr. 1985. Neps in ginned lint: A review of research. Proceedings of the Beltwide Cotton Production Conferences. Pages 358-62.

Pearson, N. L. 1933. Neps and similar imperfections in cotton. USDA Technical Bulletin No. 396.

Pearson, N. L. 1936. Do neps occur in seed cotton. The Cotton Ginners' Journal.

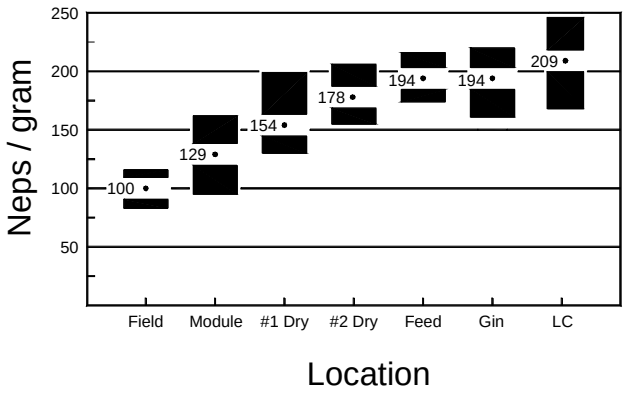

Figure 1. Graph of Average Nep Count.

Table 1. AFIS nep data.

Location	Average, neps/gram	Standard Deviation	Minimum	Maximum
Field	100.2	10.3	83.0	116.0
Module	129.6	23.3	95.0	162.4
#1 Drying	154.6	20.1	130.8	199.4
#2 Drying	178.8	16.9	155.0	205.8
Gin Feeder	194.0	14.5	174.6	216.8
Gin Stand	194.4	14.7	161.4	220.6
Lint Slide	209.9	27.0	168.0	246.2