Survey of Moisture Restoration At Midsouth Gins in 2002[1]

By W. STANLEY ANTHONY[2]

MOISTURE RESTORATION practices were surveyed in 18 gins in Mississippi and Arkansas in October and November 2002.

The types of moisture restoration systems surveyed were: 1) lint slide grid, 2) humidified air at/near the battery condenser, 3) direct water spray at the lint slide, and 4) combination of 2 and 3.

For this survey, one sample was taken from each bale before moisture restoration and another one after moisture restoration for 25 consecutive bales of cotton on three or more different days during the season. Initial moisture contents averaged for individual gins ranged from 3.7 to 6.2 percent, and final moisture contents averaged at individual gins ranged from 4.2 to 7.7 percent. The simple average across all samples and gins for initial and final moisture contents was 5.1 percent and 6.2 pecent, respectively, thus about 5.5 pounds of moisture was added per bale. Bales may be stored safely at moisture levels below 8 percent.

However, 8.6 percent of the bales were above the safe storage moisture of 8 percent. Ten of the 18 surveyed gins produced bales that exceeded the 8 percent, mostly with the direct spray or combination methods of moisture restoration. These bales may experience quality degradation during extended storage.

Introduction

After cotton bolls open, the fiber and cottonseed continually seek to reach equilibrium with the moisture in the air. Loose cotton fiber gives up moisture readily at low humidity but absorbs moisture much more slowly at high humidity.

The moisture of the seed cotton at harvesting differs dramatically across the Cotton Belt due to the variation from humid to arid climates in the United States.

In addition, the humidity before and during harvesting also influences the moisture of the lint, cottonseed and trash fractions of the seed cotton. After harvesting, the seed cotton is placed in modules or trailers and compacted. Published guidelines establish the upper limit for safe storage of seed cotton at 12 percent moisture content (Lalor, Willcutt and Curley, 1994). Seed cotton moisture is virtually impossible to determine accurately in the module; samples should be taken before modeling and oven-tested.

This technique is not done because of the time and expense involved. As an alternative, temperature measurements can be used to detect potential problems. Temperatures can be probed soon after the module is built and then again for several days. If temperatures rise over 15 (F, the moisture is too high and the module should be ginned immediately to avoid fiber quality degradation.

Nearly all moisture sensors used at the 970 gins in the United States measure the moisture of the lint and ignore the moisture of the cottonseed. Reference to safe module storage in terms of seed cotton moisture and safe ginning moisture in terms of lint confuses farmers and ginners. For example, lint represents about 35 percent of the seed cotton mass and cottonseed represent about 58 percent with the remainder being trash. About 1,400 pounds of seed cotton is required to produce a 480-pound bale of lint and about 810 pounds of cottonseed.

At the maximum safe storage level of 12 percent seed cotton moisture, the lint is about 9 percent moisture and the cottonseed about 13 percent moisture. This 12 percent upper limit for safe storage of seed cotton assumes that the cotton is not compressed excessively or enclosed in an impermeable material that restricts the ability of the cotton to "breathe".

In other words, the moisture must be able to escape to the drier air surrounding the module as the seed cotton equilibrates with the environment.

Most seed cotton is moduled at moisture contents significantly below 12 percent. At more typical moistures of 8 to 10 percent seed cotton moisture, the lint is 6 to 7 percent. It is not uncommon, however, for lint to enter the gin system at less than 5 percent moisture content.

After the seed cotton in the module equilibrates with the environment, ginning operations usually proceed more smoothly. Cotton is dried at gins in order to increase cleaning efficiency of machines and to improve the appearance of the cotton fiber. The Cotton Ginner's Handbook (1994) recommends maximum fiber moisture at ginning of 7 percent.

The Handbook does not give the safe storage moisture content for lint in universal density bales. After cotton fiber is baled, moisture transfer occurs very slowly especially at high densities. In fact, bales at densities of 12 lb/ft3 required over 60 days to equilibrate with the environment while bales at 28 lb/ft3 required over 110 days (Anthony, 1982), obviously, equilibration time is a function of the starting moisture as well as the humidity and temperature of the environment during storage.

The bales attempt to reach equilibrium with the environment and the rate of adsorption and desorption is influenced by bale density, ambient temperature and humidity, bale covering, surface area, air changes, fiber history, etc. (Anthony, 1997).

Ginners often add moisture at the lint slide to reduce bale-packaging forces and to recover some of the weight lost during field drying and gin processing (Anthony, Van Doorn and Herber, 1994). Two basic methods are used-humidified air and direct water spray. The humidified air approach rarely adds more than 2 percent moisture to a bale but the direct spray approach can add far more.

Most ginners believe that they add 5 to 15 pounds of water per bale with their moisture restoration systems. Anthony (2002a, 2002b and 2003) evaluated the impact of spraying moisture on cotton fiber quality at the lint slide in three studies.

In these studies, water was sprayed on cotton lint as it came down the lint slide, packaged the resulting bales at universal density in 1) polyethylene, 2) strip-laminated woven polypropylene, and 3) fully coated woven polypropylene bags, and then stored the bales for several months.

Across the three studies, color was reduced for the bales initially above 8 percent moisture content. As a result of these findings, ginners were cautioned against applying excessive moisture to cotton before long-term storage and noted that bales should be stored below 8 percent moisture content, wet basis, regardless of the permeability of the bale covering materials in order to avoid color degradation.

The purpose of this survey was to determine the amount of moisture added to cotton at the lint slide in gins in the Midsouth using commercially available moisture restoration systems.

Procedure

Eighteen gins in Mississippi and Arkansas cooperated in the survey during the ginning season in October and November 2002. The moisture restoration systems in this survey were: 1) lint slide grid, 2) humidified air at/near the condenser, 3) direct water spray at the lint slide, and 4) combination of 2 and 3.

For the first type system, most of the gins that used the lint slide grid by Samuel Jackson or a similar one.

For the second type, most gins used the Steamroller by Samuel Jackson although the Lummus Moisture Conditioner was also

[1] For publication in *The Cotton Gin and Oil Mill Press*

[2] Supervisory Agricultural Engineer, Agricultural Research Service, USDA, U.S. Cotton Ginning Laboratory, Stoneville, MS

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used. The Lewis Cotton Moisture System was used for the third type. Additional information can be obtained from the manufacturers.

For this survey, one sample was taken from each bale before moisture restoration and another one after moisture restoration for 25 consecutive bales of cotton on three or more different days during the season. The "before" sample was taken after the gin stand and before the battery condenser, and the "after" sample was taken from the same area as the class sample on the outside of the bale.

The moisture samples were placed in sealed metal cans for 4 to 6 days before analyses by the oven method (ASTM , 1971). The lint was allowed to remain in the cans longer than usual in order to allow the fiber to equilibrate in the can, especially in the case where the water was sprayed directly on the top of the batt.

Table 1. Initial and final moisture for multiple bales of cotton at 18 gins, averaged for about 25 bales monitored on three or more occasions.

Gin number	Type[1]	Moisture before restoration, %	Moisture after restoration, %		
			Average	Minimum	Maximum
6	Combo	6.0	6.8	4.9	10.2
2	Grid	5.4	6.2	4.8	10.0
4	Grid	3.7	4.2	3.2	7.3
5	Grid	4.4	5.2	4.2	6.2
7	Grid	5.2	6.0	4.6	9.6
8	Grid	5.6	6.0	4.8	8.2
17	Grid	4.9	5.5	4.4	6.8
11	Humid	6.0	6.9	5.3	8.5
13	Humid	4.4	5.2	4.4	6.8
15	Humid	3.8	4.7	3.3	6.2
18	Humid	4.0	4.6	3.4	7.6
1	Spray	4.4	6.6	4.8	10.0
3	Spray	5.4	6.3	5.0	8.2
9	Spray	5.1	6.6	4.9	10.4
10	Spray	5.2	6.3	4.8	9.6
12	Spray	4.8	6.0	5.2	7.1
14	Spray	5.3	7.3	5.0	13.3
16	Spray	6.2	7.7	5.6	15.6

[1] 1) Grid=slide grid, Humid=humidified air with Samuel Jackson Steamroller or Lummus MC at/near the battery condenser, Spray=direct water spray with the Lewis System at the lint slide, and Combo=combination of Humid and Spray.

Table 2. Average pounds added per bale and the percentage of bales exceeding 8% moisture content, averaged for about 25 bales monitored on three or more occasions.

Gin number	Type moisture restoration system[1]	Average weight added, pounds	Percent bales with moisture > 8%
6	Combo	5.8	13.1
2	Grid	1.9	0
4	Grid	2.5	0
5	Grid	4.2	0
7	Grid	4.1	0
8	Grid	1.9	1.4
17	Grid	3.1	0
11	Humid	4.8	9.7
13	Humid	3.9	0
15	Humid	4.5	0
18	Humid	3.2	0
1	Spray	10.9	11.0
3	Spray	4.1	1.0
9	Spray	7.3	7.5
10	Spray	5.5	7.5
12	Spray	5.9	0
14	Spray	9.7	23.1
16	Spray	7.9	31.6

[1] 1) Grid=slide grid, Humid=humidified air with Samuel Jackson Steamroller or Lummus MC at/near the battery condenser, Spray=direct water spray with the Lewis System at the lint slide, and Combo=combination of Humid and Spray.

Results

An unusually high amount of rain occurred during the October 2002 timeframe when the study was conducted, and many gins likely used moisture restoration systems less than normal. In fact, on some occasions the survey team postponed sampling because the moisture restoration system was turned off.

The average moisture before and after moisture restoration for all the samples taken at each gin is shown in Table 1 as well as the minimum and maximum values at each gin. The percentage of bales at various moisture levels before moisture restoration is shown in Figure 1 with the majority of the bales in the 4 to 6 percent moisture range (wet basis). Initial moisture contents averaged for individual gins ranged from 3.7 to 6.2 percent (Table 1).

The simple average across all samples and gins for initial content was 5.1 percent. After moisture restoration, the majority of the bales shifted to the 5 to 7 percent moisture range (Figure 2).

Final moisture contents averaged at individual gins ranged from 4.2 to 7.7 percent (Table 1). The simple average across all samples and gins for initial and final moisture contents was 5.1 percent and 6.2 percent, respectively.

Data in Table 1 is grouped together by the type of moisture restoration system. On average the final moisture contents were well within a safe range; however, the high maximum values suggest a possible problem at 10 of the surveyed gins since bale moistures exceeded 8 percent on one or more occasion. In a related study at one of the surveyed gins, all the lint was removed from a two-foot wide section across the entire lint slide, and moisture samples were removed from the upper, middle and lower portions of the batt.

Results clearly indicated that moisture was on the very top surface of the 6 to 12-inch batt for the spray system but was not on the fiber underneath the surface. Far less difference in moisture distribution throughout the batt was found for the lint slide grid and humid air systems.

The average pounds of moisture added to the lint at each gin was calculated by subtracting the initial moisture from the final moisture and multiplying times the bale weight (i.e. 0.07 - 0.06 times 500= 5) are shown in Table 2, and ranged from 1.9 to 10.9 pounds. The average across all bales was 5 pounds.

The percentage of bales that exceeded 8 percent moisture content at each gin is also shown in Table 2 and ranged from 0 to 31.6

Table 3. Water added for each type moisture restoration system, averaged for about 25 bales monitored on three or more occasions.

Water added, pounds		
Type moisture restoration system[1]	**Mean, pounds**	**Standard deviation**
Grid	2.7	2.2
Humid	4.0	4.1
Spray	7.6	6.2
Combo	5.8	6.1

[1]) Grid=slide grid, Humid=humidified air with Samuel Jackson Steamroller or Lummus MC at/near the battery condenser, Spray=direct water spray with the Lewis System at the lint slide, and Combo=combination of Humid and Spray.

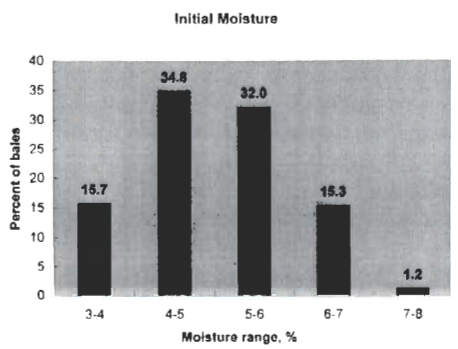

Figure 1. Frequency distribution for initial moisture for all gins in the survey.

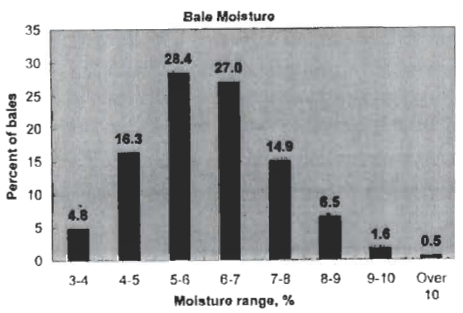

Figure 2. Frequency distribution for moisture content of bales after moisture restoration for all gins in the survey.

percent. Across the entire survey, 8.6 percent of the bales exceeded 8 percent moisture. The bales in the "exceed 8 percent category" will likely experience discoloration during storage.

Data averaged across each type of moisture restoration system are presented in Table 3 along with the standard deviation for each system and ranged from 3.9 pounds for the grid system to 7.3 pounds for the spray system suggesting the need for more uniform application of the moisture as well as better control of the restoration process. Note that the standard deviation is an indication of the variation in the amount of moisture added to each bale.

When the data for each measurement day was considered individually, the variation in moisture added was also much greater for the spray system than for the other types. Standard deviations were as low as 0.5 pounds for one grid system on one day to as high as 10 pounds for one spray system.

Conclusions

Gins with moisture restoration systems at the lint slide add about 5 pounds of water per bale. Some bales were packaged at 8 percent or higher moisture content and may experience color degradation during storage. Since substantial variations occurred in the moisture added within each consecutive 25-bale group, additional control and management oversight is needed in order to ensure uniform moisture restoration and avoid bales with excess moisture.

Disclaimer

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

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