Storing Unginned Cotton in Bales

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Due to intensive mechanization, cotton harvesting capacity frequently exceeds ginning capacity. When this occurs, large quantities of unginned cotton accumulates in trailers on the gin yard and the harvesting pace is slowed to that of ginning because of a lack of empty trailers. It is not uncommon in some areas for cotton strippers to be idled half time because of this. In order to free the producers' trainlers and permit continued harvesting, several gins have installed basket systems to temporarily store some of the unginned cotton.

Storage baskets represent a large investment. An alternative storage system which might be less costly is that of baling unginned cotton. The concept of storing unginned machine picked cotton in bales has been explored to some degree in Arkansas[2] and New Mexico.[3] Research reports from those states reflect optimism about the acceptability of several aspects of baled storage.

Research reported in this bulletin was made to determine the effects of baled storage of unginned cotton on the quality and value factors of resultant ginned lint and seed under the weather-variety-harvest regimes experienced in Oklahoma. This research was conducted at the Oklahoma Cotton Ginning Research Laboratory, Chickasha, in 1962, 1963, and 1964. No attempt was made to evaluate baling equipment or techniques in this series of experiments since these aspects of baling were believed secondary to quality preservation at this stage of investigation.

Test Variables and Procedures

Gin Press Bales

Twelve baling experiments were conducted during the three-year period. In eight of these experiments, the bales were made in a low density or "flat bale" lint press and were tied with conventional jute bagging and six steel ties.

Research reported herein was done under Oklahoma Station project number 753.

[1] Assistant Professor and Professor, respectively.
[2] Anderson, Fred B., and Waddle, B. A. "Effects of Storing Seedcotton in Bales on Quality and Value of Lint". Arkansas Agricultural Experiment Station Mimeograph Series 117; August, 1962.
[3] Abernathy, G. H., and Williams, J. M. "Baling Seedcotton for Storage and Handling". Transactions of ASAE, Vol. 4, No. 2, pp. 182-184, 1961.

One experiment (A) was designed to compare sheltered and unsheltered storage of both burrcotton and seedcotton bales[4] Seedcotton was obtained by processing portions of the burrcotton through the screen cleaners and burr machine prior to baling. In this test, bales of unginned cotton were stored under roof on a concrete floor, and also on well drained sod with no protection from moisture. The bales were stored on end (surface of least area) in direct contact with the concrete or sod, with a few inches clearance between adjacent bales. Burrcotton bales weighed 790 to 850 pounds and were compressed to a specific weight (or bulk density) of approximately 19 pounds per cubic foot. Seedcotton bales weighed 530 to 560 pounds, with a density of 13 pcf. These bales were placed in storage on December 14 for a 96-day period, during which 2.47 inches of precipitation were received. When placed in storage, the composite moisture content of the cotton ranged from 8.5 to 9.6 percent.

Two experiments were conducted to study the effects of bale density, bale storage position, and cleaning prior to baling. One of these experiments (B) was with hand snapped cotton, the other (C) was with machine picked cotton. Bale weights ranged from 490 to 855 pounds, resulting in densities of 16 to 26 pcf. One bale of the machine picked cotton was stored under shelter as a check. All other bales in these two tests were stored without shelter on wooden pallets on their end, sample, or flat side (photo-1.) Cotton was baled with and without prior cleaning in the gin overhead machinery to remove burrs and leaf trash. The hand snapped cotton was baled and placed in storage on April 24 for a five-day period during which 2.94 inches of rain were received. This cotton had been stored loose in a metal cotton house since harvest in December. Due to high humidity during the baling process, the composite moisture content of the hand snapped cotton averaged 12.5 percent when baled. The machine picked cotton was placed in baled storage on October 11 for a 41-day period, during which 2.20 inches of rain were received. This cotton was dried prior to baling, and ranged from 9.1 to 11.4 percent composite moisture when baled.

Another experiment (D) was designed to study the influence of initial moisture content in baled seedcotton. Seedcotton was baled at composite moisture contents ranging from 6.1 to 10.6 percent. Variations in moisture content were obtained by baling at widely varying relative humidities. The bales weighed 825 to 908 pounds and averaged 24 pcf in density. They were stored without shelter on their sample sides on wooden pallets. The bales were placed in storage on January 31 for a 74-day period during which 3.42 inches of precipitation were received.

[4] Burrcotton has not been extracted from the burrs; seedcotton has been extracted.

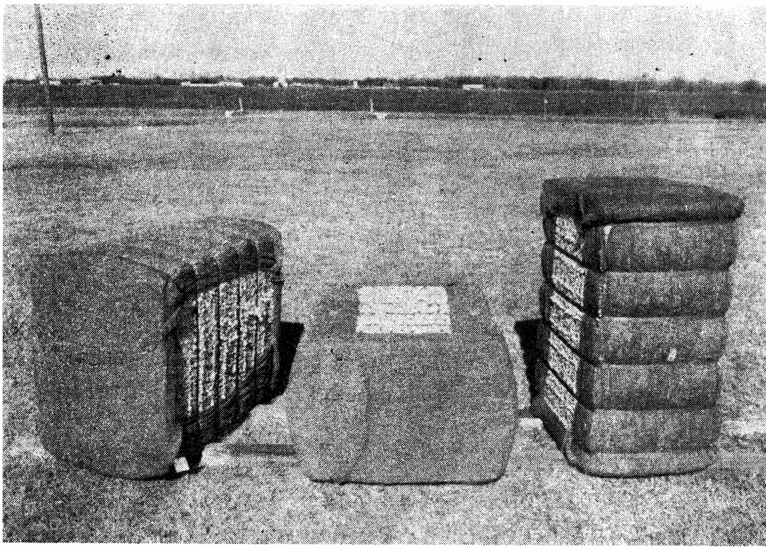

Photo 1. Burrcotton bales stored without shelter in various positions on wooden planks. (Left to right: sample, flat and end.)

A fifth experiment (E) was to determine the effects of stacking seedcotton bales while in unsheltered storage. Three bales were stacked one atop the other on their flat sides with no space between bales. The lower bale rested on a wooden pallet. These bales weighed 830 to 900 pounds and had densities of approximately 24.5 pcf. The bales were placed in storage on January 17 for an 88-day period, during which 4.49 inches of precipitation were received. The composite moisture content when baled ranged from 6.0 to 6.8 percent.

One experiment (F) was to determine the effect of protecting the upper surface of seedcotton bales against moisture penetration while in outdoor storage. A sheet of waterproof plastic was inserted between the seedcotton and jute bagging on one sample side before tying out the bale. The bale was stored on March 6 without other shelter on a wooden pallet for 39 days during which 1.68 inches of precipitation were received. The bale was at a density of approximately 24 pcf. Data from this bale were compared to those from unprotected counterpart bales from other experiments.

A similar experiment (G) was performed the following year to study the effects of protecting the upper surface of burrcotton bales against moisture penetration while in outdoor storage. In this experiment, one burrcotton bale was stored without shelter on its sample side; one was stored on its sample side with a plastic sheet under the jute bagging on the upper surface; and one was stored on end with a plastic sheet tied over the upper end. All three bales were stored on wooden pallets. A fourth bale was stored on end under roof. Bale weights ranged from 840 to 870 pounds, and density averaged 24 pcf. These bales were placed in storage on December 2 for a 57-day period during which 2.05 inches of precipitation were received. Composite moisture content of the material entering storage was 9.5 to 10.4 percent.

Cotton used in several of the foregoing experiments was stored in trailers or bins until the work load permitted baling. The eighth experiment (H) was to evaluate two methods of storing unginned cotton under conditions expected to occur during the peak harvesting and ginning season. These two methods had shown considerable promise of success in previous experiments. In this experiment, burrcotton was baled immediately after harvesting and the bales stored on end under shelter. Seedcotton was similarly baled and the bales stored without shelter on their sample sides on wooden pallets. Cotton was also ginned immediately after harvest in a conventional manner. Each of the three basic treatments was applied to cotton harvested at various moisture contents. Variations in moisture content were obtained by harvesting at different times during a day of progressively decreasing relative humidity. Harvesting started early on the morning of December 22 while dew was still on the bolls. Cotton was harvested at three other times during the day as field drying occurred. The bales were stored for 36 days, during which 1.41 inches of precipitation were received. These bales weighed 780 to 875 pounds, and averaged 27 pcf in density. Composite moisture contents of the material entering storage ranged from 9.4 to 13.9 percent.

To the extent permitted by the variables in the different experiments, the same basic procedure was followed throughout the foregoing test series. Green bolls were removed from all cotton to be baled. No drying was performed prior to baling except in the experiment with machine picked cotton (C). When burrcotton and seedcotton were compared in the same experiment, seedcotton was obtained by processing burrcotton through the gin overhead machinery prior to baling; and this seedcotton was not again processed through the same machines after storage. Insofar as possible, all cotton in a given experiment was processed through the same quantity and sequence of gin machinery. Thus for some treatments in some experiments, the majority of gin processing occurred prior to baling; while for others, the majority occurred after storage. Most of the experiments included a check or control treatment which was either ginned at the time the bales were placed in storage, or was stored loose under shelter until the bales were opened and ginned.

Cotton to be baled was deposited on the lint slide by a belt conveyor from the overflow discharge in two years, and one year by a separator mounted over the lint slide. Samples for foreign matter and moisture content determinations were taken from the unginned cotton at the lint slide as each bale was being formed.

In experiments D, E, F, G, and H, temperatures at various locations within the bales were recorded at 1 p.m. each day during storage. Thermocouples were inserted into the bales to a distance of 13½ inches; this was the maximum possible distance of any internal point from a flat side. For most bales, one thermocouple was located two inches below the upper surface, one was located midway between the upper and lower surfaces, and one to three other thermocouples were located at intermediate points. In one experiment, five thermocouples were equally spaced between the top and bottom surfaces.

When the bales were opened, they were placed on a sample side under the overflow suction telescope and the tie ends pried from the buckles. After opening, each bale was sampled for moisture content at five equally spaced points, the location of which depended on the bale storage position. For some experiments, seed, lint, and composite moisture determinations were made of the material entering and leaving storage. For other experiments, only composite moisture was measured. Material for lint and seed moisture determinations was obtained by immediately ginning a portion of the composite sample on an 8-saw gin. All moisture contents were calculated on a wet basis from drying oven data.

Following opening and sampling, each bale was processed through the appropriate gin machinery by operation of the suction telescope against a sample side of the bale. Earlier trials had shown that suction removal of cotton from any other surface was unsatisfactory because of the orientation of layers within the bale.

All cotton was processed (either before or after storage) through a green boll trap, 4-cylinder airline screen cleaner, burr machine, 7-cylinder inclined screen cleaner, 5-saw feeder, 18″x80-saw gin stand, and two saw-cylinder lint cleaners in series. Drying after storage was provided as needed by reel and tower dryers.

In most experiments, foreign matter and moisture content samples were taken from seedcotton entering the gin stand while each bale was being ginned. Also, lint samples were taken from the lint slide for determination of moisture and waste content, lint value, and fiber quality factors.

Laboratory Press Bales

In order to reduce the amount of cotton and time required for conducting investigations with baled storage, two small bench model presses or balers were constructed. It was believed that certain effects of baling could be as readily measured with small bales as with bales made in the gin press.

One press consisted simply of a hydraulically operated piston inside a 4⅜-inches-diameter cylinder. This press had no provision for tying or otherwise restraining the cotton bale after ejection. This apparatus was used for studying effects of bale density on seed damage. In the one experiment (I) with this press, various densities were obtained by compressing one-pound units of seedcotton to pre-determined lengths in the cylinder. Densities ranged from 15 to 38 pcf. Immediately after compression, each experimental unit of seedcotton was ejected from the press and stored loose in a paper sack for later ginning on an 8-saw laboratory gin. The ginned seed from each unit were inspected for visually evident damage. Damaged seed were so classified if they displayed any evidence of being cracked, chipped, crushed, or broken.

In the following year, a more versatile bench-model press was constructed. This press utilized a square, horizontal compression tube or chamber measuring 4⅞ inches on a side. After the compression chamber was hand charged with seedcotton, a hydraulic ram compressed the cotton into a pellet 4⅞ inches long. Thus a 4⅞-inch cube of seedcotton was formed at the end of the compression chamber. While the cube was held under pressure by the compression ram, a second horizontal ram positioned 90 degrees from the first ejected the cube of seedcotton through a 4⅞-inch square discharge nozzle on one side of the compression chamber.

Various methods of restraining the ejected cubes against decompression were considered and tried. The method used in the following experiment was to tie each cube with one strand of 14½-guage annealed steel wire at 1¼-inch intervals as it emerged from the discharge nozzle. This resulted in three ties per bale. A loop was twitsed in one end of each wire prior to use. The wires were also pre-formed to proper shape around a die. When placed on the cube, the male end of each wire was inserted through the loop and a sharp 180-degree bend was made to secure the tie. After tying and ejection, the bales expanded to approximately 6 inches in the compression dimension and 5 inches in the other two dimensions. This resulted in restraint at approximately 80 percent of the initially compressed density.

Two experiments with the cubical-bale press were to further study the effects of bale density on seed damage. One of these experiments (J) was with cotton harvested by once-over stripping. The other (K) was with elite cotton from the same field, selectively hand harvested on the same day so as to exclude all bolls displaying any evidence of immaturity or imperfection. This procedure was intended to provide a basis for comparing seed damage from cottons identical except for immature and damaged lock content; the degree of seed damage was suspected of being related to seed condition and maturity.

Since the press was constructed to produce bales of only one size, variations in bale density were obtained by pressing various amounts of seedcotton. Eleven densities, ranging from 15 to 38 pcf, were obtained by compressing experimental units of 1.02 to 2.56 pounds of seedcotton. One-pound units of seedcotton were also stored loose in paper sacks to serve as check treatments. All units were stored under shelter from January 6 to 28, at which time the bales were opened and all units ginned with an 8-saw laboratory gin. The ginned seed was later visually examined for damage and germination tests were made on the undamaged seed.

The third experiment (L) with the cubical-bale press was to determine the influence of seedcotton baling, length of storage period and shelter during storage on lint staple lengths. In this experiment, 1.67-pound experimental units were used. One-half of these were baled to a density of approximately 25 pcf; the others were stored loose in open-mesh onion sacks. One half the units were stored without shelter on wooden pallets; the others were stored under roof in an unheated shed. The storage periods were 1,4,7,19 and 33 days beginning on January 7. The units stored unsheltered for four and seven days received .05 inches of precipitation, those stored for 19 days received .97 inches and those stored 33 days received 1.69 inches. The units stored only one day received no precipitation. At the end of each storage period, appropriate units were ginned on an 8-saw laboratory gin and the lint from each was sacked for later value and quality factor determinations. The ginned seed were evaluated for damage and germination.

Cotton for experiments J, K, and L was harvested on Dec. 1 and processed through a laboratory extractor. The seedcotton thus obtained was stored under shelter in cotton pick sacks until the units were baled on January 6 or 7.

The cotton used for eight of the baling experiments was Lankart 57 grown under irrigation and stripped in a once-over operation after frost. For experiment A, the cotton was not irrigated. For experiment B, the cotton was hand snapped. For experiment C, the first machine picking of irrigated Acala 44 was used. For experiment K, only elite hand snapped bolls were used.

Appropriate statistical procedures were used in design of the experiments and analysis of data. Table I is a resume of the experiments, the experimental variables and other pertinent information.

Results and Discussion

Moisture Change During Storage

Moisture penetrated to a depth of 18-22 inches in baled burrcotton when it was unsheltered on its end or flat side. In some instances, evidence of decomposition and discoloration was visible in the wetted areas when these bales were opened; and localized moisture contents as high as 22 percent were measured. Average composite moisture contents in these bales increased as much as five percentage points during storage (figs. 1 and 2). Moisture increases in baled burrcotton were greatly reduced by storing the bales on their sample sides, possibly due to the horizontal orientation of layers within such bales. Moisture penetration was no more than two inches into the top surface and composite moisture content increased only 0.6 percentage points (fig. 2). Storage on the sample side was almost as effective as a waterproof cover over the upper bale surface in limiting moisture increases in unsheltered burrcotton bales (fig. 7). Moisture condensation underneath the waterproof cover was observed on some occasions, but no indication of deterioration or moisture accumulation at the surface was noted.

Extraction and cleaning of stripped and snapped cotton prior to baling also greatly reduced moisture changes in unsheltered bales (figs. 1, 2). Seedcotton bales were seldom damp more than an inch below the top surface when opened; usually, no evidence of penetration could be detected by touch unless the bales were opened shortly after a rain. Picked cotton was not penetrated by moisture more than one inch, regardless of pre-cleaning. From this it appears that burrs, rather than leaf trash, facilitate moisture penetration into and/or increased retention of moisture in baled burrcotton. The maximum increase in average moisture content during unsheltered storage for any seedcotton bale

TABLE I: Resume of Experiments with Baling of Unginned Cotton, 1962 - 1964

Exp.	Experimental Variables	Bale Weight (lbs.)	Bale Density (lbs./cu. ft.)	Baling Date	Storage Period (days)	Precip. During Storage (in.)	Initial Composite Moisture Content (pct.)	Bale Storage Conditions [1]	Cotton Form [2]	Bale Storage Position [3]
A	Shelter, Extraction	530-850	13-19	Dec. 14	96	2.47	8 5-9.6	S & US	BC & SC	End
B	Density, Storage Position, Extraction	585-855	19-26	Apr. 24	5	2.94	11.1-13.1	US	BC & SC	End, Sample, Flat
C	Density, Storage Position, Pre-cleaning	490-835	16-24	Oct. 11	41	2.20	9.1-11.4	US	SC	End, Sample, Flat
D	Initial Moisture Content	825-908	24	Jan. 30	74	3.42	6.1-10 6	US	SC	Sample
E	Bale Stacking	830-900	24.5	Jan. 17	88	4.49	6.0-6.8	US	SC	Flat
F	Waterproof Packaging	860	24	Mar. 6	39	1.68	5.8	US	SC	Sample
G	Waterproof Packaging	840-870	24	Dec. 2	57	2.05	9.5-10.4	US	BC	End, Sample
H	Bale Storage Regimes	780-875	27	Dec. 22	36	1.41	9.4-13.9	S & US	BC & SC	End, Sample
I	Bale Density	1.0	15-38	Mar. 30	NA[4]	NA	NA	S	SC	NA
J	Bale Density	1.02-2.56	15-38	Jan. 6	22	NA	NA	S	SC	NA
K	Bale Density	1.02-2.56	15-38	Jan. 6	22	NA	NA	S	SC	NA
L	Baling, Shelter, Storage Period	1.67	25	Jan. 7	1-33	0-1.69	NA	Loose & Baled S & US	SC	Flat

[1] S: Sheltered
US: Unsheltered
[2] BC: Burrcotton
SC: Seedcotton
[3] Surface on which bale rested during storage, see photo 1.
[4] NA: Not applicable or not available.

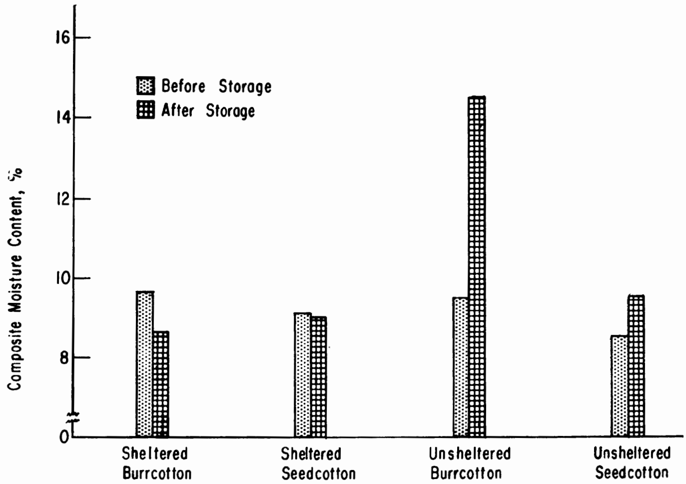

Figure 1. Influence of shelter and extraction on moisture changes in bales stored on end (Exp. A).

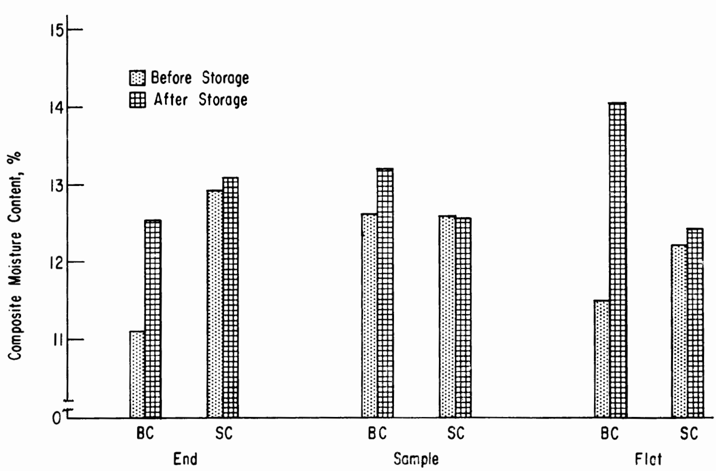

Figure 2. Influence of storage position and extraction (burrcotton or seedcotton) on moisture changes in bales stored without shelter (Exp. B).

was one percentage point. Several unsheltered seedcotton bales dried during storage, particularly those of picked cotton; this despite 2.2 inches of precipitation (fig. 4). Moisture changes in baled seedcotton were influenced only slightly, if at all, by bale storage position (figs. 2,3,4).

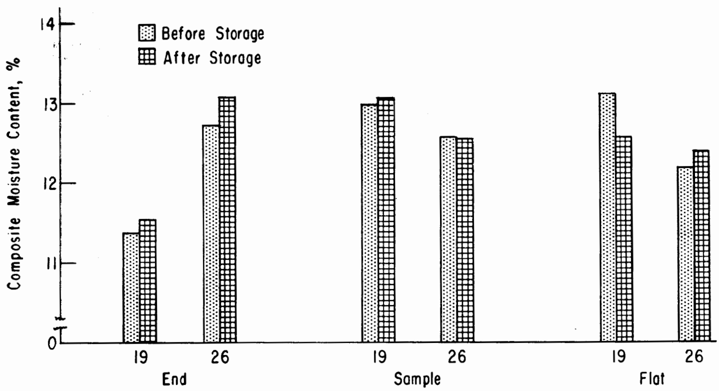

Figure 3. Influence of storage position and bale density (pcf) on moisture changes in seedcotton bales stored without shelter (Exp. B).

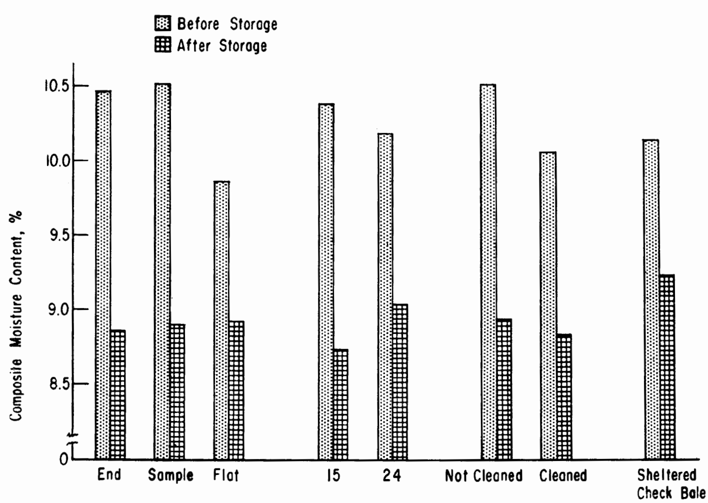

Figure 4. Influence of storage position, bale density (pcf) and prestorage cleaning on moisture changes in seedcotton bales stored without shelter (Exp. C).

Bale density had little influence on moisture changes in baled seedcotton (figs. 3 and 4). The effect of bale density was not investigated with burrcotton.

The influence of initial moisture content on moisture changes during storage was inconclusive. In one experiment with unsheltered seedcotton, bales initially high in moisture dried during storage, while initially dry bales increased in moisture (fig. 5). It appeared that the bales tended to approach an equilibrium moisture content near 7.3 percent. In another experiment, however, moisture content during seedcotton storage appeared to increase with increases in initial moisture content (fig. 8).

Stacking seedcotton bales during unsheltered storage had slight effect on moisture changes (fig. 6). The bottom bale increased 0.8 percentage points in moisture content, the middle bale 0.2, while the top bale dried slightly. However, the range of moisture content among bales following storage was only 0.14 percentage points, despite 4.49 inches of precipitation.

The influence of shelter during storage was inconsistent. In one experiment, burrcotton and seedcotton bales stored on end under shelter dried slightly during the storage period, while their unsheltered counterparts, particularly the burrcotton bale, increased in moisture content (fig. 1). But in the experiment with picked cotton, all except one of the unsheltered bales dried more during storage than did the sheltered bale (fig. 4), A burrcotton bale stored on its sample side without shelter increased in moisture content during storage only one-half percentage point more than one stored on end under shelter (fig. 7). Burrcotton bales stored under shelter increased more in moisture content in most instances than seedcotton bales stored without shelter (fig. 8).

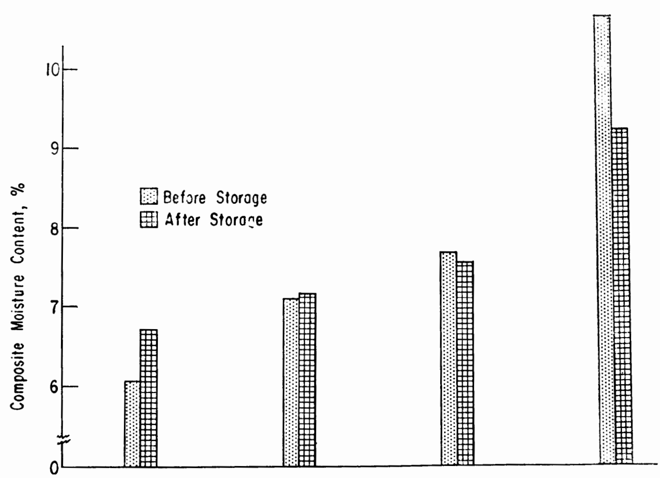

Figure 5. Influence of initial moisture content on moisture changes in seed cotton bales stored on sample side without shelter (Exp. D).

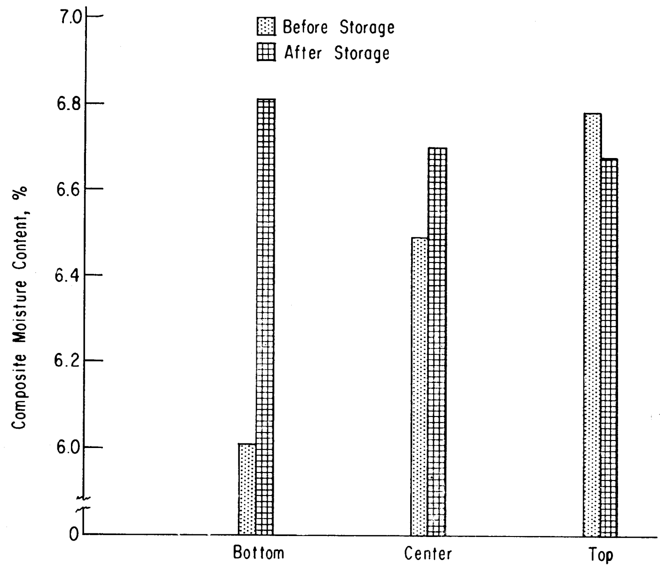

Figure 6. Influence of bale position in three-bale stack on moisture changes in seedcotton bales stored without shelter on flat side (Exp. E).

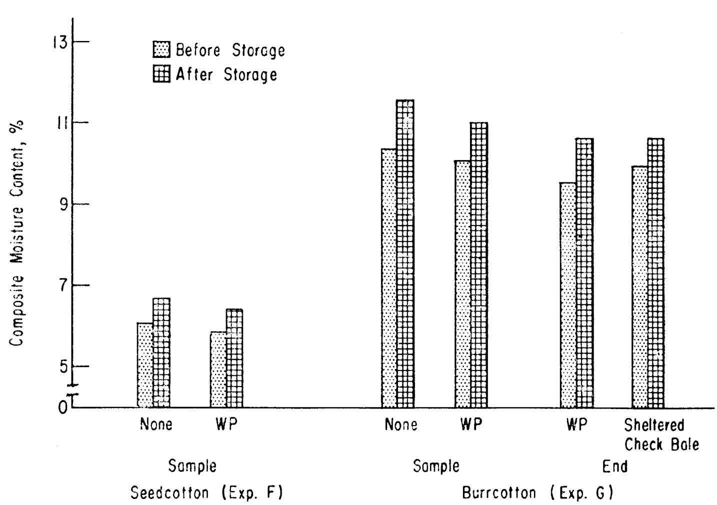

Figure 7. Influence of waterproof bale covering at two storage positions on moisture changes in bales stored without shelter (Exps. F & G).

Of the 32 seedcotton bales stored without shelter in this series of experiments, 17 dried during storage, while 15 gained in average composite moisture content. The average increase in moisture content for these 15 bales was 0.46 percentage points. The two seedcotton bales stored under shelter decreased an average of 0.52 points in moisture during storage. All of the seven burrcotton bales stored without shelter (including two with waterproof covers) increased in composite moisture content during storage. The average increase was 1.84 percentage points. Four of the six burrcotton bales stored under shelter increased in moisture content, the average increase for these four being 0.68 points.

In some instances, increases in moisture content within unsheltered burrcotton bales were probably due in part to general changes in ambient air conditions rather than to precipitation, since several bales stored under shelter also increased in moisture. These latter changes could not have been due to precipitation.

In 1962, all unsheltered bales were stored in direct contact with sod, and experienced severe moisture uptake into the lower four inches. This moisture absorption was essentially eliminated in following years by storing unsheltered bales on wooden pallets or planks. Except for those stored directly on the ground, moisture content within any unsheltered seedcotton bale was usually within a range of two percentage points. Little evidence of moisture penetration into the vertical sides of stored bales was noted, although they were sometimes damp to touch for a few hours after rainfall.

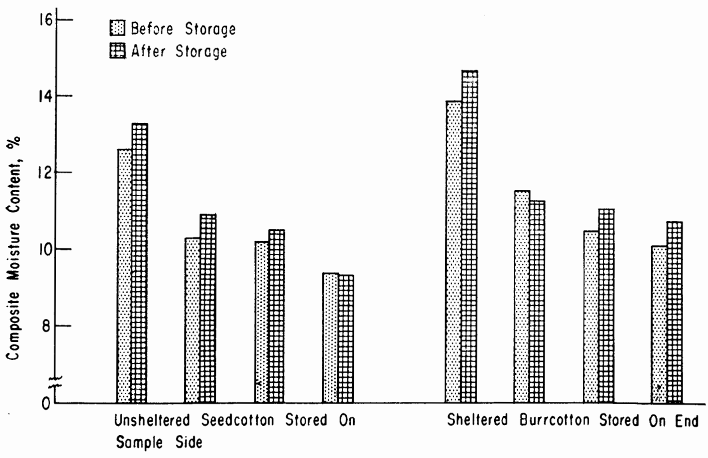

Figure 8. Influence of initial moisture content and storage regimes on moisture changes in cotton bales (Exp. H).

Seed moisture content, both before and after storage, was approximately equal to composite moisture content for unsheltered seedcotton bales (figs. 8,9). But for sheltered burrcotton, seed moisture was about one percentage point below composite moisture, both before and after storage. Changes in seed moisture content during storage were slight except in the burrcotton and seedcotton bales stored with initial composite moisture contents above 12 percent. In those bales, seed moisture content increased about one percentage point during storage (fig. 9). Waterproof bale coverings apparently caused greater increases in seed moisture content during storage than if the covers were omitted (fig. 10).

Spontaneous Heating

Spontaneous heating frequently results from storing organic materials with high moisture content. In one experiment (D), seedcotton bale temperatures during storage yielded little indication that low initial moisture content produced a low level of spontaneous heating. The two bales of eight to 11 percent initial moisture content were usually cooler at all locations than the bales of six to seven percent moisture. Temperatures near the upper surface of the drier bales responded to changes in ambient temperature more closely than in bales of high moisture content. This is believed due to the greater specific heat and consequent dampening effect on temperature fluctuations associated with the higher moisture bales. The maximum temperature recorded in any bale was 82°F about two inches below the top surface; this was in the driest bale, and with an ambient temperature of 75°. Ambient temperatures varied between 36.5° and 82° during the storage period in this experiment.

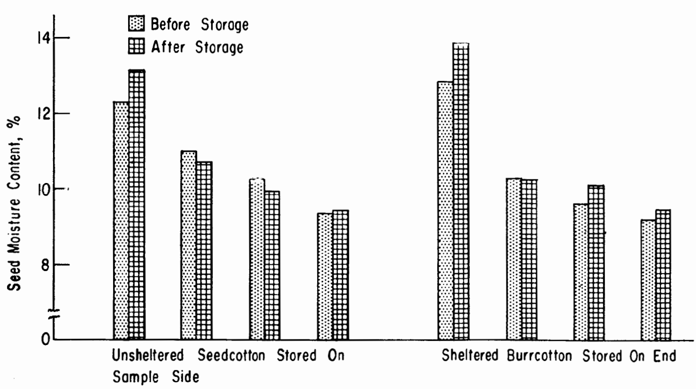

Figure 9. Influence of initial moisture content and storage regimes on seed moisture content in cotton bales (Exp. H).

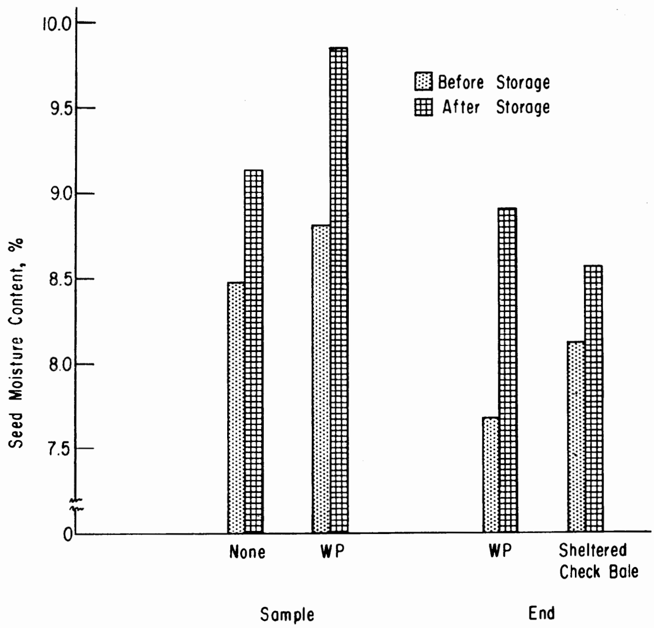

Figure 10. Influence of waterproof bale covering on seed moisture content in burrcotton bales stored without shelter in two positions (Exp. G).

In another experiment (H), bales with 12½ to 15 percent moisture usually maintained center temperatures one to four degrees warmer than those with less than 12 percent moisture. However, the maximum temperature in any bale was 67 degrees, recorded when ambient temperature was 63 degrees. Temperatures in seedcotton bales stored without shelter were frequently lower than those in sheltered burrcotton bales.

In the experiment with stacked seedcotton bales (E), temperatures throughout the stack were usually within the range of 35 to 65 degrees except at the top surface of the stack. At that location, bale temperature quickly reflected changes in ambient conditions. The highest bale temperature recorded was 96 degrees, near the upper surface of the top bale when ambient temperature was 71 degrees. The mid-day temperature at this location was usually above that of ambient, particularly on sunny days. However, this is not believed an indication of spontaneous heating since the maximum moisture content at any point in this bale was 7.5 percent, and since no noteworthy changes in temperature patterns due to precipitation were found.

In one experiment with waterproof bale covering (F), the temperature at the center of the protected bale was usually two to three degrees above that in the unprotected bale. No other indications of a temperature response to waterproof covering was found. The maximum bale temperature in this experiment was 83 degrees, when ambient temperature was 78 degrees.

In the other experiment with waterproof bale covering (G), the maximum temperature in any bale was 61 degrees, and no temperature response to protective covering was found.

Handling, Cleaning and Drying

All bales made in the gin press were readily handled with a fork lift truck between baling and ginning. No sloughing of cotton from any of these bales was noted; they appeared to be as stable as lint bales.

Except for occasional large clumps of cotton blocking the suction telescope entrance, no difficulty was encountered in removing cotton from the sample sides of the opened bales. These clumps were easily dislodged by the suction operator without appreciable loss of removal rate. Much higher removal rates appeared possible from baled cotton than from loose cotton because of the difference in bulk density. No difficulty with chokage of gin machines due to the dense clumps was experienced except in one instance when seedcotton was routed directly from the bale to the feeders above the gin stands. Due to the high density of this material each revolution of the feed rolls metered much more than the normal amount of material into the feeder and stand. This merely required reducing the feed roll speed to prevent overfeeding and chokages. No difficulty was encountered in processing any baled cotton which passed through the beaters of the master feed control or the overhead machinery prior to ginning, since this fluffed the cotton.

Waste content of the ginned lint is one indicator of the effectiveness of cleaning during the ginning process. The influence of the experimental variables on lint waste content was erratic and inconclusive. Bale density and pre-storage cleaning had no effect on the lint waste content of picked seedcotton stored without shelter (exp. C). However, extraction of stripped cotton prior to sheltered storage reduced lint waste content (exp. A). In the same experiment, sheltered storage of baled burrcotton resulted in higher lint waste than unsheltered storage. But with picked cotton, shelter during storage had no effect on lint waste content. Storage of picked seedcotton bales on their flat sides reduced waste content compared to end or sample-side storage.

In one experiment (D) initial moisture content of the baled seedcotton had no effect on lint waste; but in another experiment (H), lint waste increased with decreases in initial moisture content.

Lint waste content was not reduced by waterproof bale coverings, nor was lint waste appreciably influenced by the position of seedcotton bales in a three-bale stack.

In three experiments (D,E,F) baled storage of unginned cotton resulted in greater lint waste content than the check cotton stored loose under shelter or that ginned instead of being stored. In other experiments (A,C,G,H) baled storage frequently did not increase lint waste contents over that from loose stored or unstored cotton.

No difficulty arising from any of the experimental baling or storing variables was encountered in drying the stored cotton to proper lint moisture contents during the ginning process.

Lint Reflectance, Yellowness and Grade

In one experiment, reflectance of the ginned lint generally decreased when cotton was processed at composite moisture contents above 10½ percent, particularly if the cotton was baled prior to ginning (fig. 11). Reflectance was slightly higher from sheltered burrcotton bales than from unsheltered seedcotton bales. In another experiment (L), reflectance from cotton stored in cubical bales was higher than from cotton stored loose in open-mesh sacks. Reflectance was not significantly affected by the variables in any other experiment. In all experiments, the variation in reflectance was small, usually less than two percent, and probably of little importance.

Lint yellowness was increased by baling when the composite moisture content was above 10½ percent in one experiment (fig. 12). Also, yellowness was increased when unsheltered seedcotton bales were stored with a waterproof cover over the upper surface in one experiment (fig. 14) and when the bales were stored under shelter in a third experiment (fig. 16). The maximum increase in yellowness due to baling was 4½ percent with the high-moisture cotton. However, under other conditions, yellowness was reduced as much as seven percent by baled storage. Decreased yellowness occurred when burrcotton bales were stored without shelter on the sample side or with waterproof coverings on the upper surfaces (fig. 13) and when both burrcotton and seedcotton bales were stored without shelter (figs. 15, 16). With machine picked cotton, high density bales produced lint of greater yellowness than did low density bales and cotton cleaned prior to baling produced a higher lint

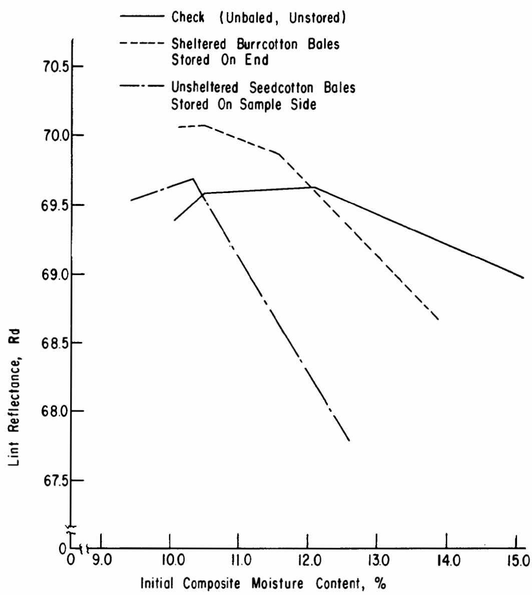

Figure 11. Influence of initial moisture content and storage regimes on reflectance of ginned lint (Exp. H).

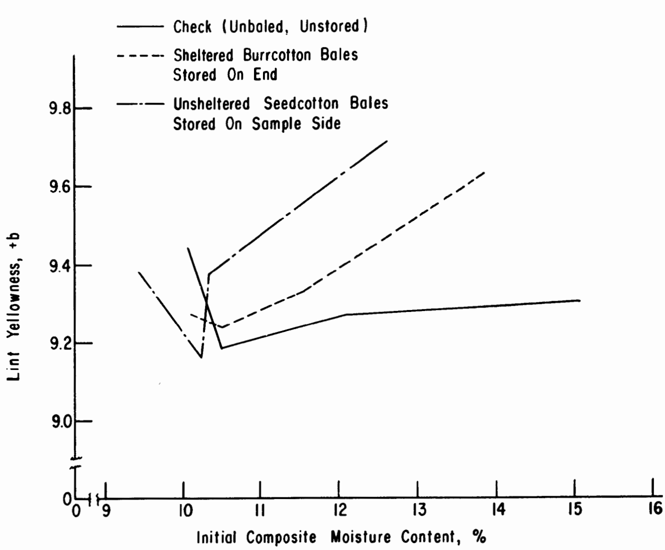

Figure 12. Influence of initial moisture content and storage regimes on yellowness of ginned lint (Exp. H).

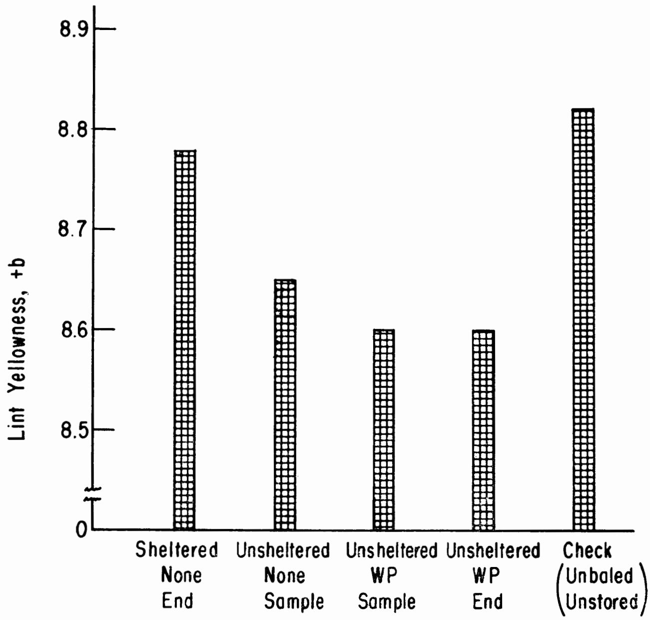

Figure 13. Influence of shelter and waterproof bale covering on yellowness of ginned lint from burrcotton bales stored in two positions (Exp. G).

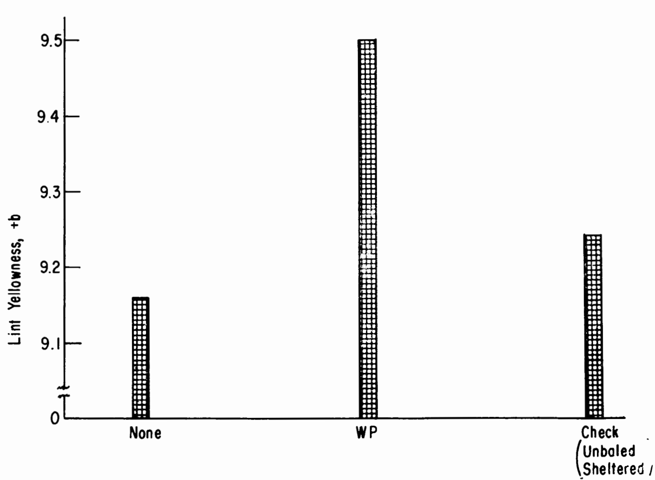

Figure 14. Influence of waterproof bale covering on lint yellowness from seedcotton bales stored on sample side without shelter (Exp. F).

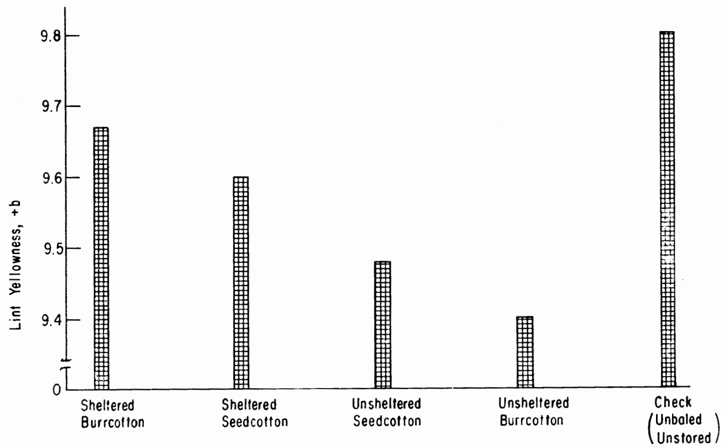

Figure 15. Influence of shelter and extraction on yellowness of ginned lint from bales stored on end (Exp. A).

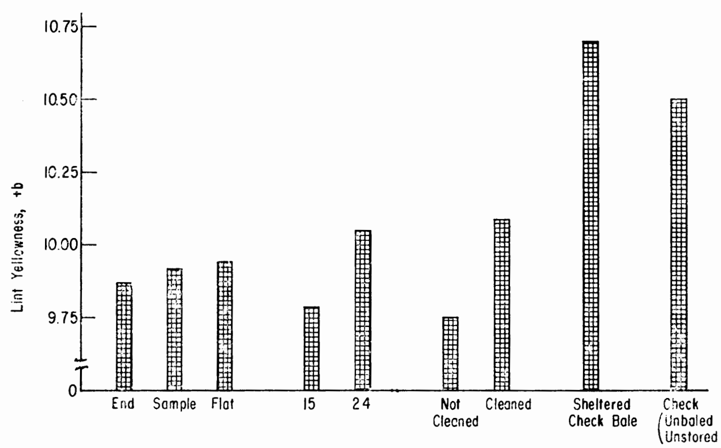

Figure 16. Influence of storage position, bale density (pcf) and pre-storage cleaning on lint yellowness from seedcotton bales stored without shelter (Exp. C).

yellowness than that not cleaned (fig. 16). Bale density had no effect on yellowness with hand snapped cotton. Bale stacking and length of storage period did not affect yellowness.

With respect to yellowness only, the foregoing results suggest that seedcotton bales should be stored without shelter and without waterproof covering, and that burrcotton bales should be stored without shelter on the sample side or with a waterproof covering over the upper surface. It would appear that sheltered storage may inhibit proper ventilation in some instances, which in some manner increased yellowness. The results also suggest that cotton should not be baled at composite moisture contents above 10½ percent.

Lint grades were not significantly affected by baling except in the experiment (L) comparing loose and baled storage with the cubicle bales. In that experiment grades from cotton stored in bales were slightly higher than from cotton stored loose in open-mesh sacks. These grades were Strict Good Ordinary to Strict Good Ordinary Plus. (Cotton for this experiment was ginned on a small laboratory gin with no lint cleaning.) The lowest grade for any sample from any other experiment was Strict Low Middling Spot and the highest grade was Middling.

Grades were not significantly affected by shelter during storage, extraction or pre-cleaning prior to baling, bale density, bale storage position, composite moisture content, bale stacking, length of storage or storage regime (sheltered burrcotton vs unsheltered seedcotton).

The use of a waterproof bale covering significantly lowered the grade of seedcotton bales stored without shelter in one experiment (fig. 17). In this experiment, all samples were classed Middling except those

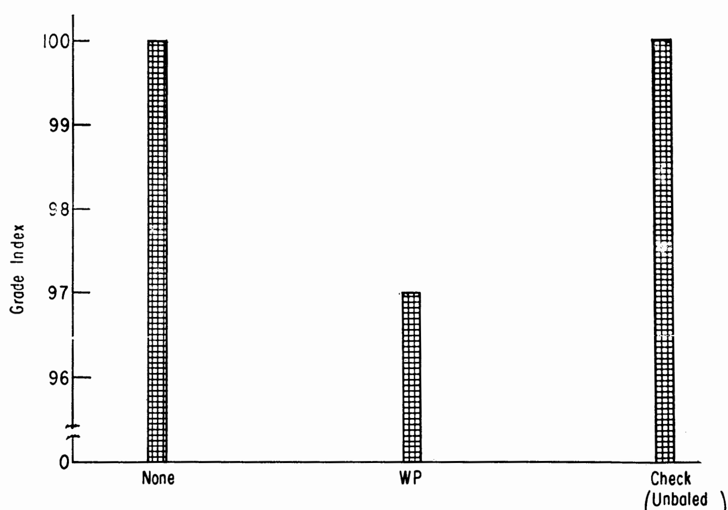

Figure 17. Influence of waterproof bale covering on lint grade index from seedcotton bales stored on sample side without shelter (Exp. F).

from the covered bales, 60 percent of which were assigned a light spot designation. In the other experiment (G) with waterproof coverings for burrcotton bales, all grades were identical, Strict Low Middling.

Although differences in grade due to initial composite moisture content were not statistically significant, it was noted that more samples from the bales of highest moisture content carried full spot designations than those from the drier bales. This, along with lint reflectance and yellowness data, suggests the possibility of grade reduction due to high initial moisture content beginning near the 10½ percent level.

Staple Length

Staple length was affected rather inconsistently by baling. Compared to conventional ginning, storage of unginned cotton in bales resulted in significantly shortened staple lengths in three experiments (figs. 19, 20, 22), but resulted in increased staple lengths under some conditions in other experiments (figs. 18, 21, 23).

Shelter during storage was of no significant value in staple length preservation in any experiment and resulted in shorter staple than did an unsheltered bale in one experiment (fig. 18). However, providing waterproof covers for unsheltered bales resulted in longer staple lengths than when no protection was used (fig. 21).

Staple lengths from high density machine picked seedcotton bales were shorter than from low density bales under some conditions.

Extraction or pre-cleaning and bale storage position had no effect on staple length, nor did stacking of the bales during storage.

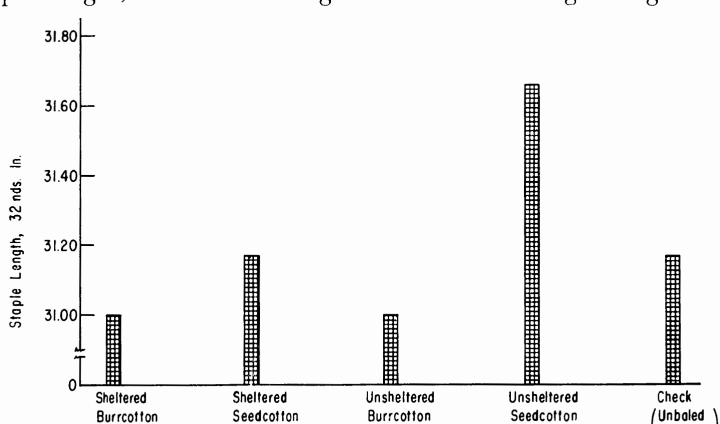

Figure 18. Influence of shelter and extraction on staple length from bales stored on end (Exp. A).

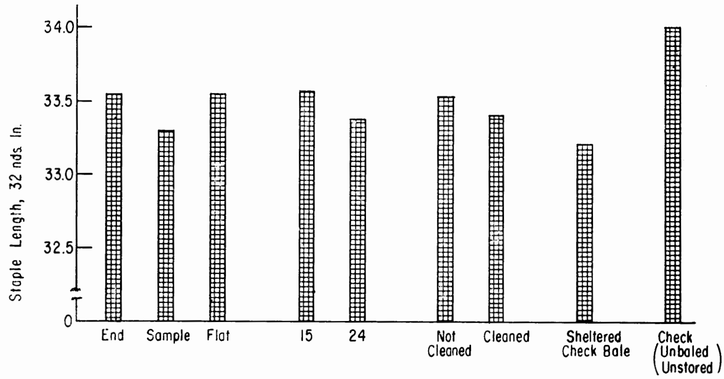

Figure 19. Influence of storage position, bale density (pcf) and pre-storage cleaning on staple length from seedcotton bales stored without shelter (Exp. C).

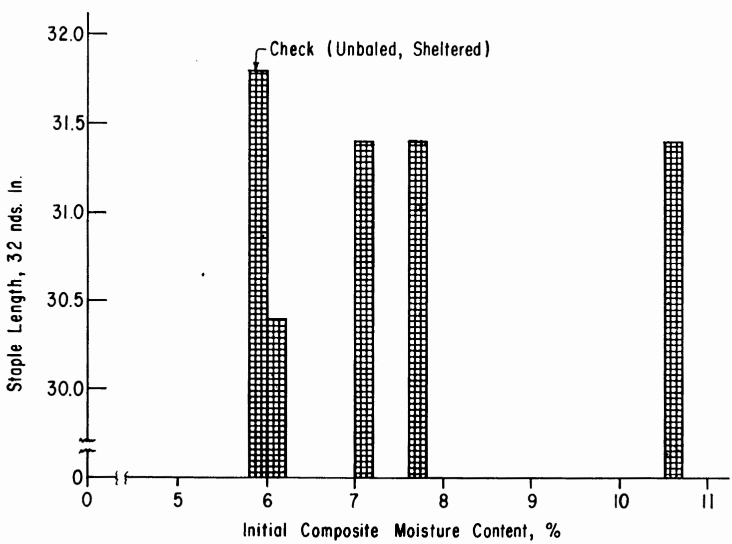

Figure 20. Influence of initial moisture content on staple length from seedcotton bales stored on sample side without shelter (Exp. D).

Low initial moisture content produced the shortest staple lengths in one experiment (fig. 20), but the results were quite inconclusive in another experiment (fig. 22).

In one experiment, a trend toward shortened staple lengths was associated with increases in storage time (fig. 23). This may have been

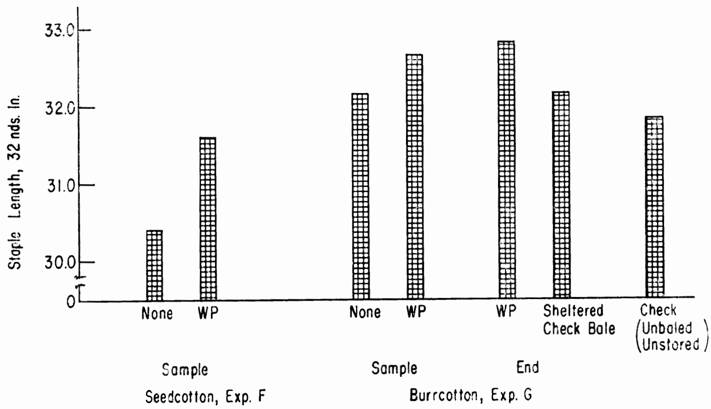

Figure 21. Influence of waterproof bale covering at two storage positions on staple length from bales stored without shelter (Exps. F & G).

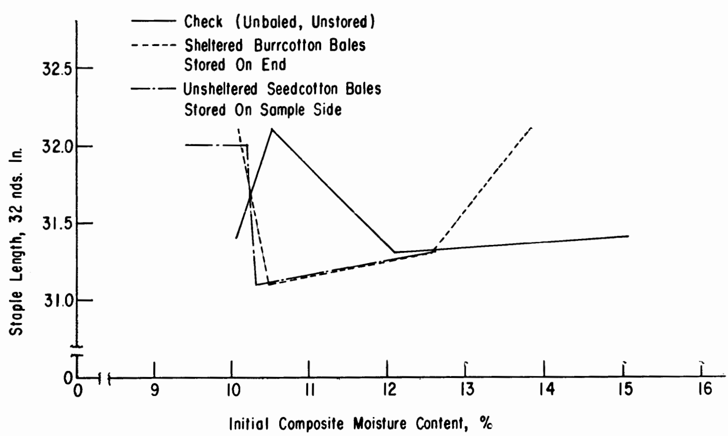

Figure 22. Influence of initial moisture content and storage regimes on staple length (Exp. H).

related to the increasing total of precipitation received with each extension of storage time. However, baled storage of unginned cotton did not result in shorter staples in two experiments in which the bales were stored 5 to 8 weeks.

With regard to staple length, the foregoing results suggest that detrimental effects from storing unginned cotton in bales are hardly more likely than are beneficial effects.

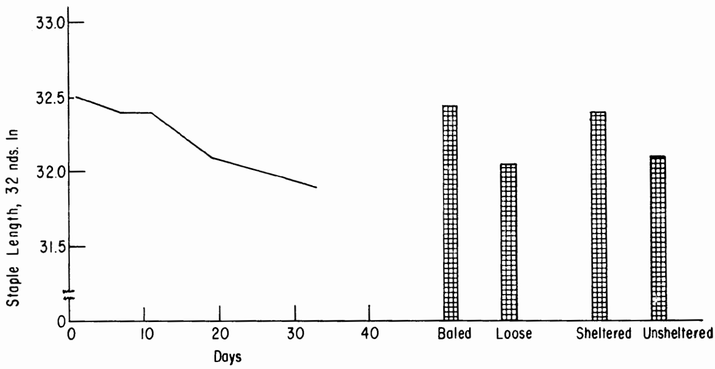

Figure 23. Influence of baling, shelter and length of storage on staple length from seedcotton bales (Exp. L).

Fiber Length, Strength and Coarseness

Two and one-half percent fiber span length was not affected by baling or by any of the variables in any baling experiment. Certain combinations of shelter, baling and storage time reacted differently from other combinations in experiment L. However, since no individual treatment was different from another treatment, this interaction was considered unimportant.

In one experiment, one-eighth-inch gage fiber strength was greater from all cotton stored in bales than from cotton ginned without storage (fig. 24). In only one instance was a reduction in fiber strength associated with baling. This was in the two bottom bales of the three-bale stack stored without shelter (fig. 25). This reduction was in 0-gage strength; one-eighth-inch gage strength was not affected. None of the other experimental variables produced noteworthy effects on fiber strength.

In no experiment was a reduction in micronaire reading associated with baling. In one experiment, fiber from a bale stored under shelter was significantly higher in micronaire than that from unsheltered bales. Waterproof coverings for unsheltered bales did not consistently produce this same effect on micronaire (fig. 6). In one experiment, micronaire increased slightly with increases in initial composite moisture content (fig. 27).

In general, it appears that fiber length, strength and coarseness will not be adversely affected by baled storage of unginned cotton if the bales are not stacked atop each other without shelter.

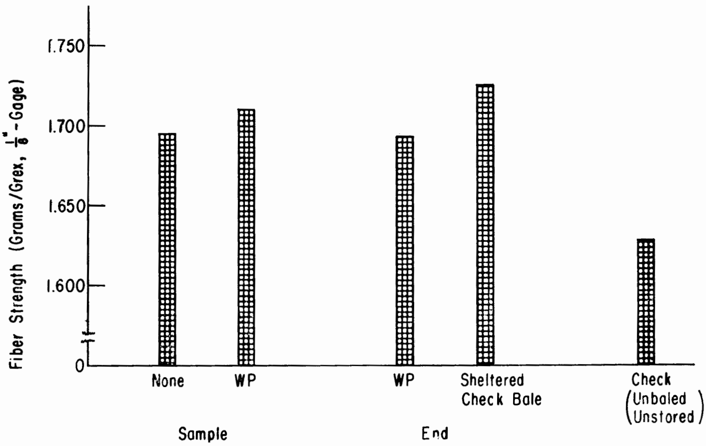

Figure 24. Influence of waterproof bale covering at two storage positions on fiber strength from burrcotton bales stored without shelter (Exp. G).

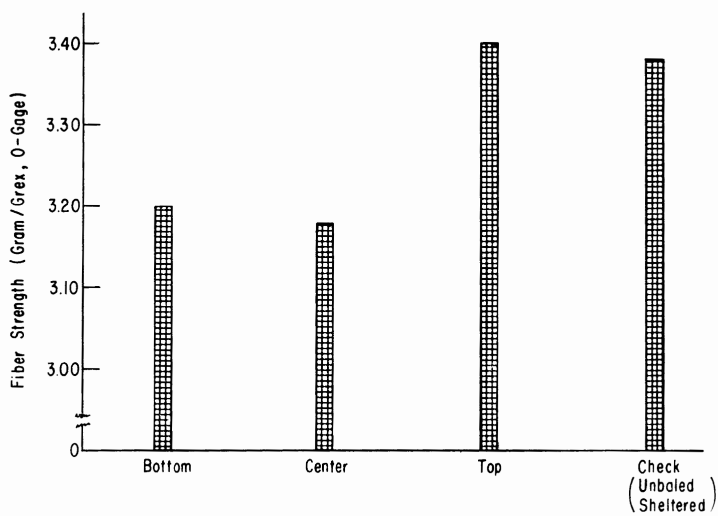

Figure 25. Influence of bale position in three-bale stack on fiber strength from seedcotton bales stored without shelter on flat sides (Exp. E).

Seed Damage and Germination

In three experiments, baling unginned cotton resulted in two to three times as much damaged seed as did loose storage or ginning without baling or storing (figs. 28, 29, 30). These three experiments were

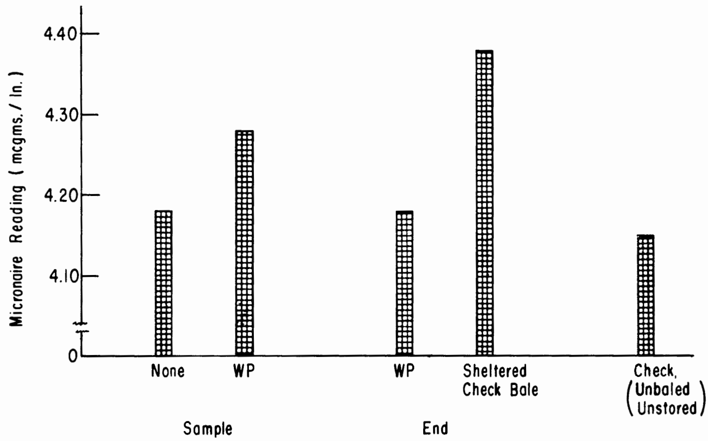

Figure 26. Influence of waterproof covering at two storage positions on fiber coarseness from burrcotton bales stored without shelter (Exp. G).

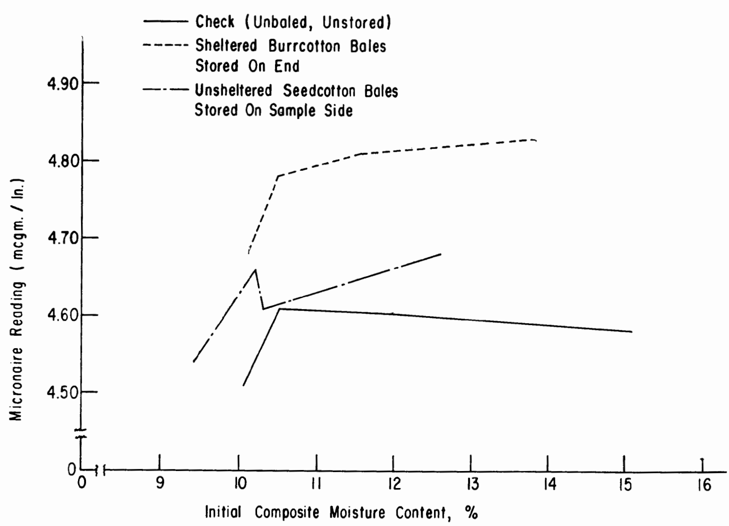

Figure 27. Influence of initial moisture content and storage regimes on fiber coarseness (Exp. H).

with gin press bales having a density of approximately 24 pounds per cubic foot. In another experiment (L), seed damage was reduced by baling. This was with cubical bales having a density of 25 pcf.

In the three experiments specifically designed to evaluate the effects of baling densities, significant increases in seed damage occurred at

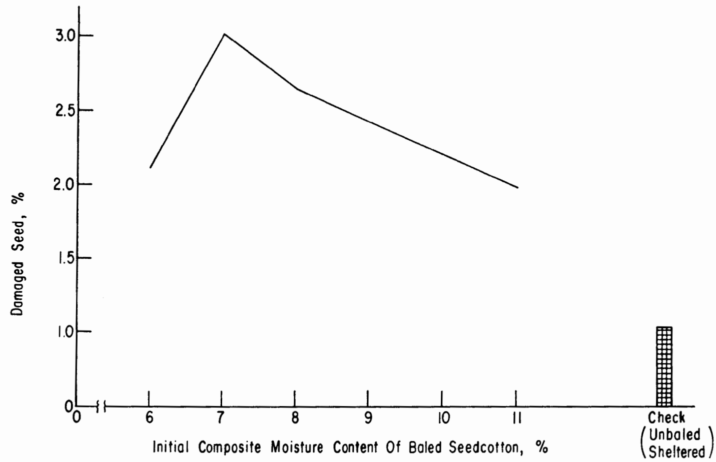

Figure 28. Influence of initial moisture content on seed damage in seedcotton bales stored on sample side without shelter (Exp. D).

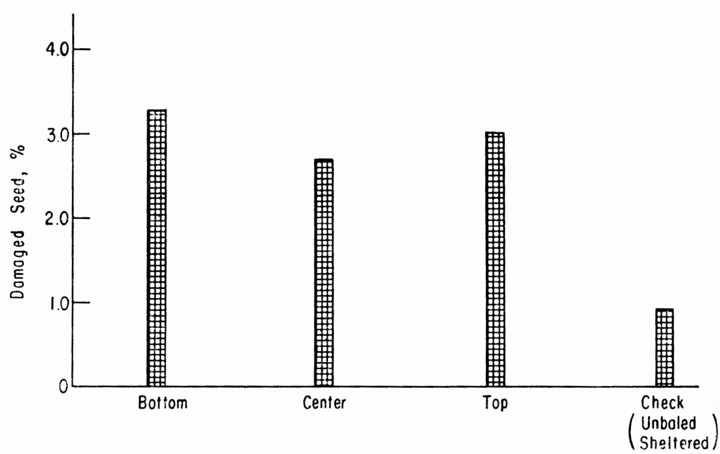

Figure 29. Influence of bale position in three-bale stack on seed damage in seedcotton bales stored without shelter on flat side (Exp. E).

densities between 27 and 30 pounds per cubic foot (figs. 31, 32). Seed from stripped cotton was damaged little if any more than from hand snapped elite cotton.

In one experiment, seed damage increased slightly with decreases in initial moisture content, perhaps due to a greater brittleness of the dryer seed (fig. 30). The effect of initial moisture content was not consistent in another experiment, however (fig. 28).

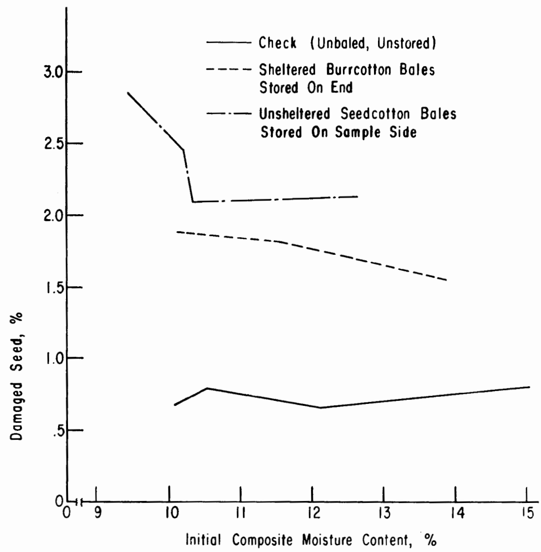

Figure 30. Influence of initial moisture content and storage regimes on seed damage (Exp. H).

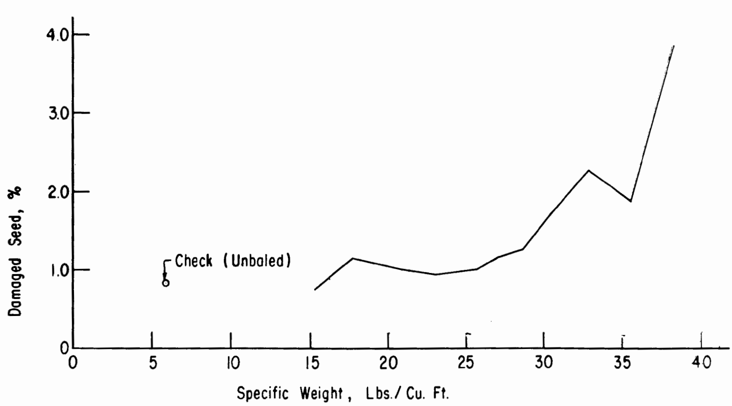

Figure 31. Influence of bale density on seed damage in seedcotton bales stored under shelter (Exp. I).

Seed damage was not affected by bale storage position, shelter during storage, length of storage period or location of the bales in a 3-bale stack. In one experiment seed damage from baled seedcotton was somewhat greater than from baled burrcotton (fig. 30).

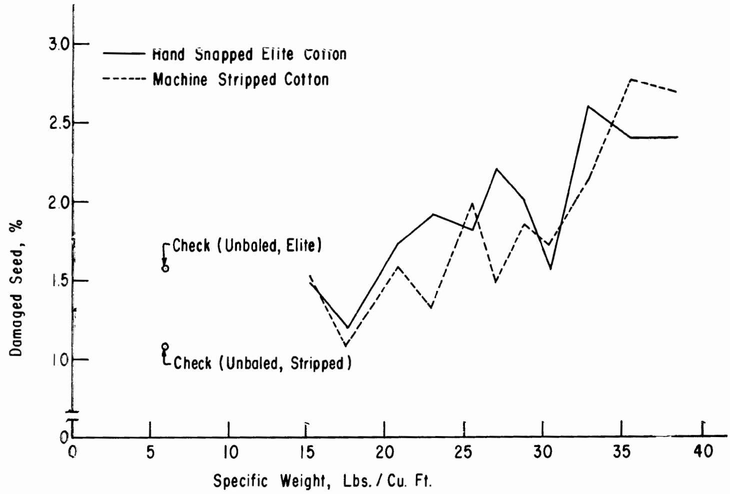

Figure 32. Influence of bale density and seedcotton quality on seed damage in seedcotton bales stored under shelter (Exps. J & K).

In the one experiment in which they were determined, free fatty acid content and peroxide number of the seed were not significantly affected by baling or by initial moisture content. Contamination of the lint by cottonseed oil was also unaffected by baling in this experiment.

In only one experiment was germination of the undamaged seed affected by baling or by any of the baling and storing variables. In this experiment, germination was reduced by baling, but only at high initial moisture contents (fig. 33).

In general, it appears that baling burrcotton or seedcotton will quite likely result in a one to two-fold increase in damaged seed, particularly as bale densities increase beyond about 25 pounds per cubic foot. Increases in moisture content at the time of baling may reduce seed breakage, but also may reduce germination.

Gin Turnout

In the one experiment in which turnout was determined, the amount of lint obtained from each unit of harvested material was slightly reduced by baling unginned burrcotton, compared to conventional ginning (fig. 34). Turnout was slightly increased by baling unginned seedcotton.

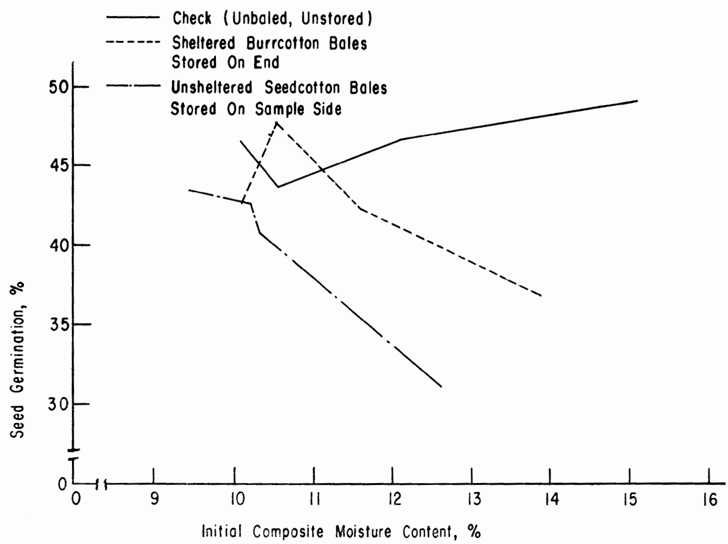

Figure 33. Influence of initial moisture content and storage regimes on germination of undamaged seed (Exp. H).

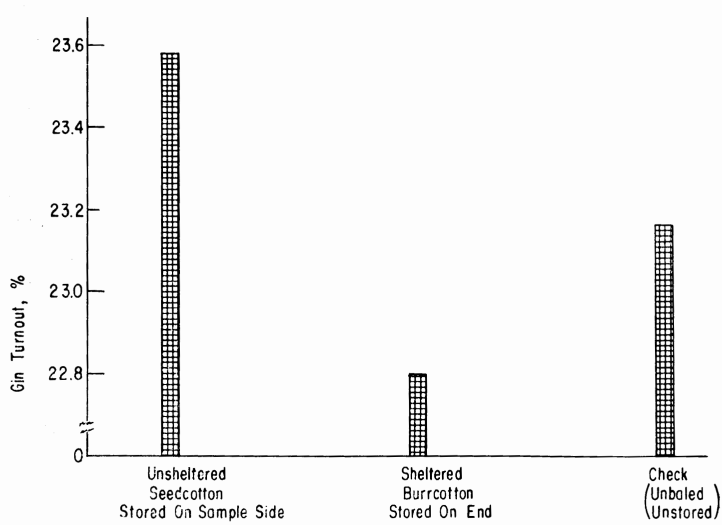

Figure 34. Influence of storage regimes on turnout (Exp. H).

Summary

Twelve experiments were conducted during a 3-year period to determine the effects of baled storage of unginned cotton on the quality and value factors of the resultant ginned lint and seed. In eight of the experiments, cotton was baled in a low density gin press to produce bales weighing approximately 500 to 900 pounds, and having densities of 13 to 27 pounds per cubic foot. These bales were packaged with ordinary jute bagging and ties. In four experiments, the bales were formed in laboratory presses. These bales weighed from 1.00 to 2.56 pounds and varied in density from 15 to 38 pounds per cubic foot. Packaging for these bales consisted simply of three steel wires.

The variables in these experiments included bale density, shelter during storage, extraction and cleaning prior to baling, bale position during storage, initial moisture content, stacking bales during storage, waterproof covering for unsheltered bales and length of storage period. The bales were stored for periods ranging from one to 96 days. Precipitation on the bales stored without shelter ranged from 0 to 4.49 inches. Initial composite moisture contents of the bales ranged from 5.8 to 13.9 percent.

The cotton used for these experiments was predominantly Lankart 57, grown under irrigation and stripped in a once-over operation after frost. Green bolls were removed from the cotton prior to baling; but in only one instance was the cotton dried before baling. When the bales were opened following storage, ginning was performed in a conventional manner, except that the cotton which had been cleaned and extracted prior to baling was not again subjected to the same processes.

Seedcotton bales stored without shelter experienced only slight increases in moisture, regardless of bale density or storage position. Unsheltered burrcotton bales were severely penetrated by moisture except when stored on their sample side, or when the upper surface was protected by a waterproof covering. The bottom surface of all unsheltered bales was severely penetrated by moisture unless the bales were placed on wooden pallets or planks to prevent intimate ground contact. When the limitations of ground contact and storage position or protective cover were observed, sheltered storage of seedcotton and burrcotton bales offered little advantage over unsheltered storage with respect to moisture increases. Unsheltered burrcotton bales stored subject to the foregoing limitations increased an average of 0.96 percentage points in composite moisture content during storage, unsheltered seedcotton bales decreased an average of 0.47 percentage points. Moisture penetration into the upper surface of the unsheltered bales was seldom more than one inch.

Sheltered burrcotton bales increased an average of 0.24 percentage points in moisture during storage, sheltered seedcotton bales decreased 0.52 percentage points.

Moisture changes in unsheltered bales were inconsistently affected by initial moisture content of the bales. Stacking unsheltered seedcotton bales on their flat sides one atop the other in a 3-bale stack had little if any influence on moisture changes. All three bales were of essentially equal moisture content following storage.

Changes in seed moisture were less than one percentage point in all bales except those with initial composite moisture contents above 12 percent, or those stored with waterproof coverings.

Bale temperature data indicated no spontaneous heating except when the bales were stored under conditions which permitted extensive moisture penetration, or when the bales were stored with composite moisture contents above 12 percent.

The influence of experimental variables on lint waste content was erratic and inconclusive. Lint reflectance was only slightly affected by the experimental variables.

Lint yellowness was increased by baling seedcotton at moisture contents above 10½ percent, by placing a waterproof cover over unsheltered seedcotton bales, and by storing seedcotton bales under shelter. Yellowness was decreased by baling when burrcotton bales were stored without shelter on the sample side or with waterproof coverings over their upper surface.

Lint grades were reduced by baling in one experiment when a waterproof covering was placed over a seedcotton bale stored without shelter. Grades were not adversely affected by baling or storage variables in any other experiment.

Acala cotton was reduced in staple length when baled; Lankart cotton increased in staple length when baled under some conditions, but decreased in staple under other conditions of baling. Shelter during baled storage was of no significant value in preserving or increasing staple lengths, although waterproof bale coverings during unsheltered storage were of some value. In one experiment, staple length tended to decrease with increases in storage time.

Two and one-half percent fiber span length was not affected by baling or by any of the baling and storing variables.

0-gage fiber strength was reduced about five percent by baling in the two bottom bales of a three-bale unsheltered stack. One-eighth-inch gage strength was not adversely affected by baling or by any of the variables in any experiment.

Micronaire readings were not adversely affected by baling. Micronaire readings were increased by baling in some instances, and appeared to increase slightly with increases in initial moisture content.

A one to two-fold increase in visibly damaged seed occurred as a result of baling in three experiments, but in one experiment, seed damage was reduced by baling. Seed damage became significant at densities of about 27 to 30 pounds per cubic foot in experiments with laboratory presses. Increases in initial moisture content slightly reduced seed damage in one experiment.

Baling at initial moisture contents above 10½ percent may have reduced germination of the undamaged seed in one experiment.

Conclusions

The results of these experiments indicate that unginned cotton could be baled in a low density lint press and stored during the peak periods of the harvest season with little risk of lint or fiber damage if certain precautions are followed. However, seed damage will quite likely be increased by baled storage.

The results suggest that:

1. Cotton should not be baled at composite moisture contents above 10½ percent in order to minimize possibilities of heating, increased lint yellowness, and lowered seed germination.
2. In order to minimize seed damage, cotton should not be compressed to densities above 25 pounds per cubic foot.
3. Baled cotton should be stored no longer than necessary in order to minimize the possibility of staple length reductions.
4. In order to minimize possibilities of fiber strength reduction, cotton bales should not be stacked one atop the other during unsheltered storage.
5. Cotton bales should be stored without shelter to minimize possibilities of grade reductions and increased lint yellowness.
6. Unsheltered seedcotton bales may be stored in any position, but burrcotton bales should be stored on their sample side or with a waterproof covering over the upper surface to minimize moisture penetration.
7. All bales stored without shelter should rest on wooden pallets, planks, or similar objects to prevent uptake of moisture.