THE EFFECTS OF THREE MODULE TYPES ON COTTON GINNING AND FIBER QUALITY

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Abstract

Traditionally seed cotton has been stored in modules from the time it was harvested until it was ginned. These modules have been formed using additional equipment and operators. In an effort to improve the efficiency of cotton production, by reducing the number of operators and equipment, two newer harvesters have been introduced which form modules on the harvester. These modules are smaller than the traditional modules, one being an approximately half-sized rectangular module and the other having a round cross section, holding approximately one fourth the seed cotton of a traditional module. Data and samples were obtained at seven gins located in four states to determine if significant problems in ginning were related to the newer modules. Cotton degradation was observed when loose seed cotton was placed at the ends of modules and when modules were stored closer together than recommended by the manufacturers. Small differences in seed cotton moisture content and ginning rate between the module types were observed at several of the gins. Bale classification data were obtained at one gin and small differences in color were related to the module type. The round modules produced seed cotton with better moisture levels, lint with better color, and they were processed somewhat more rapidly by the gin than with the other module types. However, because the variety, growth conditions, and harvest conditions of the seed cotton was uncontrolled between the modules the differences observed were too small to be able to conclude that the differences were related to the use of the different module types and not due to these other factors. Color deterioration was observed for the ends of modules which experienced significant rainfall during storage, especially when there was insufficient clearance between modules during storage, and this problem appeared to be less prevalent with the round modules. If ginning problems were related to the module types, they were relatively minor. The newer module types did not present any significant problems in ginning.

Introduction

Mechanical harvesting of cotton was adopted in the United States in the decades of 1950 and 1960. The early harvesters picked one row of cotton at a time, but eventually were expanded to picking multiple rows. These pickers carried the seed cotton in a basket then dumped the cotton into trailers which were emptied at the cotton gin for reuse during the ginning season. Adequate trailers were often not available during periods of good harvest conditions and the lack of storage of picked cotton was a limiting factor in the efficient harvest and ginning of cotton.

In the early 1970's, Lambert Wilkes, from Texas A&M University, led a team that developed the module builder, which formed the picked cotton into a loosely held mass, was covered with a tarp, and which could be left until ginning capacity was available. Thus the farmer could harvest quickly while the weather was good and the seed cotton could be stored in the modules at minimal expense until it was ginned.

The modules were formed by module builders and were about 2.3 m (7.5 ft) wide and 9.75 m (32 ft) long (ASAE Standards S392.1). Two heights were included in the standard, 2.74 m (9 ft) and 3.35 m (11 ft). The pickers could dump the picked cotton directly into the module builders but in some operations boll buggies were used to transport the cotton from the picker to the module builder allowing the harvester to pick a greater portion of the time. Each of these units required a tractor and an operator.

Several years ago Case IH (Racine, WI) released the Module Express 625 MI cotton harvester which included machinery to form an approximately half sized module, 2.4 m (8 ft) wide, 2.4 m (8 ft) high, and 4.6 m (15 ft) long on the harvester itself. Also, John Deere (Moline, IL) recently introduced the 7760 cotton harvester which can form a round module 2.4m (8 ft) in diameter. Both of these newer module forming cotton harvesters significantly reduce the amount of equipment and the number of operators required for harvesting.

Willcutt et al., 2009, found four harvesters operating in TN, MO, and MS that the round modules held an average of 3.7 bales, the half-sized modules held 6.5 bales, and the traditional modules held 16 bales. Several researchers have examined the field implications of the use of the new smaller modules vs. the traditional modules, but little information is available on the use of the modules at the gin. Cotton Incorporated has funded several projects to examine the impact of the newer module sizes on the cotton industry.

The purpose of this study was to examine the impact of the three module designs at the cotton gin. This project is in cooperation with other researchers examining other portions of the cotton production system.

Materials and Methods

Edcot Co-op Gin, located near Odem, TX, ginned cotton that was stored in all three types of modules during the 2008 ginning season. Data and samples used to examine the gin operation with each of the three module types were collected between Aug. 20 and Aug. 26, 2008. This site provided a good opportunity to evaluate the effectiveness of the different packages for preserving fiber quality during storage because it rained nearly every day during and immediately previous to the site visit. Personnel collected data and samples at five additional gins in West Tennessee, North Mississippi, and Missouri (Table 1). The Farmers Union Gin was considered to be two gins, one with Lummus equipment and the other with Continental equipment.

Table 1. Gins visited and dates of visit in 2008.

Gin name	Gin location	Dates visited
Edcot Co-op Gin	Odem, TX	Aug. 20-Aug. 26
Longtown Gin	Somerville, TN	Oct. 14, Oct. 15, Oct. 21
L+H Gin	Alamo, TN	Oct. 22
Farmers Union Gin	Senath, MO	Oct. 28
Peach Orchard Gin	Peach Orchard, MO	Oct. 29
Mill Creek Gin	Lyon, MS	Nov. 16

For the modules not from Edcot Gin, little or no rain occurred between the time these modules were harvested and ginned. Therefore significant loss in quality would not be expected at those gins.

Edcot Co-op Gin data evaluation

Upon arrival at the gin, a number of traditional, half-sized, and round modules were observed waiting to be ginned. Figure 1 shows two of the round modules spaced apart according to the manufacturers recommendations.

Figure 1. Two round modules stored at the gin ready for ginning, with sufficient clearance between modules.

At this gin the round modules were staged in groups of six with one front end loader, while another front end loader was used to remove the covers and place the modules on the module feeder.

Figure 2 shows several of the half-sized modules and Figure 3 shows a traditional module at the gin. These modules were handled with a traditional module hauler on the gin yard.

Figure 2. Two half-sized modules stored at the gin ready for ginning, with insufficient clearance between modules.

Figure 3. Traditional module stored at the gin ready for ginning.

Groups of modules of the same type were staged together for ginning, usually for approximately three hours of continuous ginning. After the modules were placed on the module feeder, the module numbers were recorded and samples were taken of the seed cotton. Each seed cotton sample was placed in a zip-closed plastic bag, the air removed from the bag, the bag sealed and placed in an additional zip-closed plastic bag and sealed (Byler, 2004). These samples were placed in plastic bags, boxed, and shipped to the Cotton Ginning Research Unit in Stoneville, MS (CGRU) where the moisture content, (mc), was determined by oven method (Shepherd, 1972). Fewer than five days elapsed from the time the samples were obtained until the moisture analysis was completed. All mc data was reported wet basis. For the Edcot Gin data, the mean of the module seed cotton mc was determined and that value was assigned as the seed cotton mc to each bale which came from that particular module. The mc statistics such as mean and standard deviation were then calculated on a per bale basis.

The bale numbers resulting from each module and the time for finishing each bale were recorded. Lint samples were obtained from many of the bales and were double bagged in zip-closed bags, and shipped to the CGRU. Later, the USDA Agricultural Marketing Service High Volume Instrument (HVI) classing data were retrieved for each bale and the mc and HVI data combined for analysis.

Moisture damage to cotton shows up first in a reduction in Rd and an increase of the +b in the HVI classing data. If the damage is severe enough, a change in the color grade will result. All of the module types were observed to have damage on the exterior, due to the rainfall. However the covers were good and a relatively small proportion of the cotton was damaged. The samples for HVI testing are very small relative to the bale so the chance of obtaining an HVI sample with damaged lint seems remote. In addition, the source of the cotton in the modules was not known and so the variety and growing conditions of the cotton varied. These factors could result in some difference in color of the cotton so small variations in color mean could not be attributed to the module type.

The HVI and moisture data were analyzed statistically, first to determine means and standard deviations for a general description of the data. Next the color distribution was examined to determine if there was an unusual pattern of low reflectance or high +b for one module type. The ginning rate data were also examined.

Other than Edcot Gin data

At the gins in TN, MO, and MS, little or no rainfall occurred from the time the modules were formed until the cotton was ginned. The cotton in the modules was dry, so no quality degradation was expected. Manual observations at the gins indicated no quality loss problems, so only seed cotton moisture data were examined. The mean seed cotton mc was determined for each module and the statistics calculated per module. Ginning rates were examined to see if there was any evidence that the newer modules caused any problems in the gin.

Results

Data and samples were obtained at seven gins in TN, TX, MO, and MS, during the 2008 harvest season, representing nearly 3100 bales. Observations were made and seed cotton and lint samples were taken for moisture determination. At Edcot gin, the HVI data was obtained for the bales studied and analyzed to determine if fiber damage could be related to the module type.

Module moisture data

Seed cotton samples were taken from modules on the module feeder and the module mc determined (Table 2). The mean and standard deviation give some idea about the range of observations while the ninetieth percentile gives an indication of any significant extreme in the data. Data were recorded so that the bales produced from those modules could be identified by number. Most of the gins grouped the non-traditional sized modules under one identification number called the "gin" module in this report, in contrast to the physical module. Two of the physical half-sized modules were usually grouped to form a gin module and four or six of the round modules were usually grouped to form a gin module.

The modules from Edcot Co-op Gin were compared because all three module types were processed at that gin and there had been significant rainfall on the modules. No significant problems were observed by the investigators during processing of any of these modules. Field personnel often placed loose seed cotton with the modules and for the half-sized modules this was often put between two modules placed close together. Due to the considerable amount of rain that occurred between the time the module was formed and ginned, this loose cotton often deteriorated. However, the personnel at the module feeder discarded some of the damaged seed cotton. In many cases the round and half-sized modules were stored with minimal spacing end-to-end, often with the loose seed cotton packed between modules. The rain ran off of the ends of the modules and very little seed cotton was damaged if some ventilation and drainage between modules was allowed. However, when the modules were stored too close to each other, the rain penetrated the loose cotton and modules thereby damaging more seed cotton. This problem was observed for all module types, but was less frequent for the traditional modules.

Table 2. Basic module data for gins visited in 2008.

Gin name	Module type	Number of physical modules per "gin" module	Number of physical modules	Mean seed cotton mc	Standard deviation, seed cotton mc	90th percentile seed cotton mc
Edcot Co-op Gin	Traditional	1	32	9.1	1.2	10.5
	Half-sized	2	112	10.3	1.6	12.4
	Round	6	252	8.8	1.4	10.9
Longtown Gin	Traditional	1	10	10.9	1.0	11.8
	Half-sized	2	29	11.4	1.5	13.6
L+H Gin	Traditional	1	5	9.6	0.9	11.2
	Half-sized	2	12	9.1	0.4	9.9
Farmers Union Gin – Lummus	Traditional	1	11	9.6	0.5	10.4
	Round	4	32	8.9	0.5	9.4
Farmers Union Gin - Continental	Traditional	1	8	9.6	0.4	10.0
	Half-sized	2	18	9.9	0.5	10.4
Peach Orchard Gin	Traditional	1	7	9.9	0.4	10.1
	Half-sized	1	14	10.4	0.6	10.9
Mill Creek Gin	Round	1	30	10.0	0.6	10.5

The recommended maximum mc for safe storage of modules is below 12% (Lalor et al., 1994). At 10.3% the mean seed cotton mc was slightly higher for the half-sized modules than at 8.8% for the round modules at the Edcot Gin, but the difference was not considered to be important. When the mc below which 90% of the modules were observed was compared, the half-sized modules at 12.4% were above the recommended upper limit for safe storage, while the traditional and round modules were nearly 2 percentage points lower, and well under the recommended maximum. At Longtown Gin, the seed cotton mc of some of the half-sized modules was observed to be higher than the recommended maximum mc. This could have been because an operator harvested under unfavorable conditions.

Edcot Gin HVI data

The number of bales from each module type received the grade indicated in Table 3. Relatively few bales received grades other than 31 and 41, although the bales from the half-sized modules had bales with lower grades and the bales from round modules had bales with higher grades. As stated above, the average mc of seed cotton from round modules was 8.8%. The average seed cotton mc for half-sized modules receiving a grade of 31 or 41 was 10.2%, while the average mc for bales receiving lower grades was only marginally higher at 10.7%. Because the source of the modules was unknown, differences in lint color may have occurred before the seed cotton was placed in the modules, some due to varietal differences and some due to weather conditions. Also, the seed cotton may have been placed into the half-sized modules at a higher mc than with the round modules. While the bales from round modules received better color grades than the bales from the traditional and half-sized modules, the reason for this difference is not clear from the data collected.

Table 3. Number of bales with indicated color grade from each module type for Edcot Gin.

Module type	Grade							
	11	21	31	32	41	42	52	53
Traditional	0	0	243	0	250	1	0	0
Half-size	0	0	373	4	275	75	2	1
Round	1	179	544	0	65	0	0	0

The HVI reflectance was analyzed by module type (Table 4). As with the color grades, the HVI reflectance was best for bales from the round modules, and lowest for bales from the half-sized module. The reason for this difference could not be determined. The higher standard deviation for the samples from the half-sized modules could be because some color degradation had occurred due to higher mc in those modules. However, the modules could have been formed at a higher mc or a wider range of color due to variety differences could have been placed in those modules.

Table 4. Results of statistical analysis of reflectance of lint samples for Edcot Gin from each module type.

	Number of bales	Mean	Standard deviation	Tenth percentile	Ninetieth percentile
Traditional	494	75.9	1.2	74.5	77.6
Half-sized	730	74.7	1.7	72.5	76.5
Round	789	78.7	1.1	77.1	80.0

Similarly, the HVI color component +b was examined (Table 5). In this case, lower numbers related to better color. The +b component of color was nearly the same for samples from the traditional and round modules, but the measurement was not as good for samples from the half-sized modules. As before, the difference was small and the reason for the difference could not be determined, based on the available information.

Table 5. Results of statistical analysis of +b of lint samples for Edcot Gin from each module type.

	Number of bales	Mean	Standard deviation	Tenth percentile	Ninetieth percentile
Traditional	494	8.1	0.25	8.4	7.8
Half-sized	730	8.6	0.43	9.0	8.3
Round	789	8.0	0.35	8.4	7.5

The means of several additional HVI measurements were calculated for each module type (Table 6). Unlike color, differences in these measurements were not considered to be related to module storage problems. The differences found strengthen the likelihood that there were significant differences in the cotton itself, unrelated to the module type, which could explain the observed differences in cotton lint color.

Table 6. Means of additional HVI data from Edcot Gin calculated by module type.

	Number of bales	Micronaire	Strength g/tex	Trash, percent area	Length in
Traditional	494	5.02	31.0	0.35	1.13
Half-sized	730	4.86	31.9	0.43	1.11
Round	789	5.07	30.9	0.28	1.10

The HVI color data were examined in more detail by plotting the HVI reflectance (Rd) portion of the bale color over time and the time at which the gin recorded a change in bale number plotted on an additional line (Figures 4, 5, and 6). At this gin, the module number changed with each change in traditional module, the half-sized modules were recorded in groups of two, and the round modules were recorded in groups of six. The data for the traditional and half-sized modules, particularly, showed occasional significant drops in Rd indicating lower color quality. These drops corresponded with the change of module. Two operational problems were observed at the gin which would explain this color drop. First, loose seed cotton was kept with the modules loaded in the field, stored in the module yard, and loaded onto the module feeder. During periods of significant rainfall, as occurred at this gin, this loose cotton was not covered and thus deteriorated much more than the cotton within the module. Very little loose cotton was observed with the round modules, except for the few which had come apart apparently due to module cover failure.

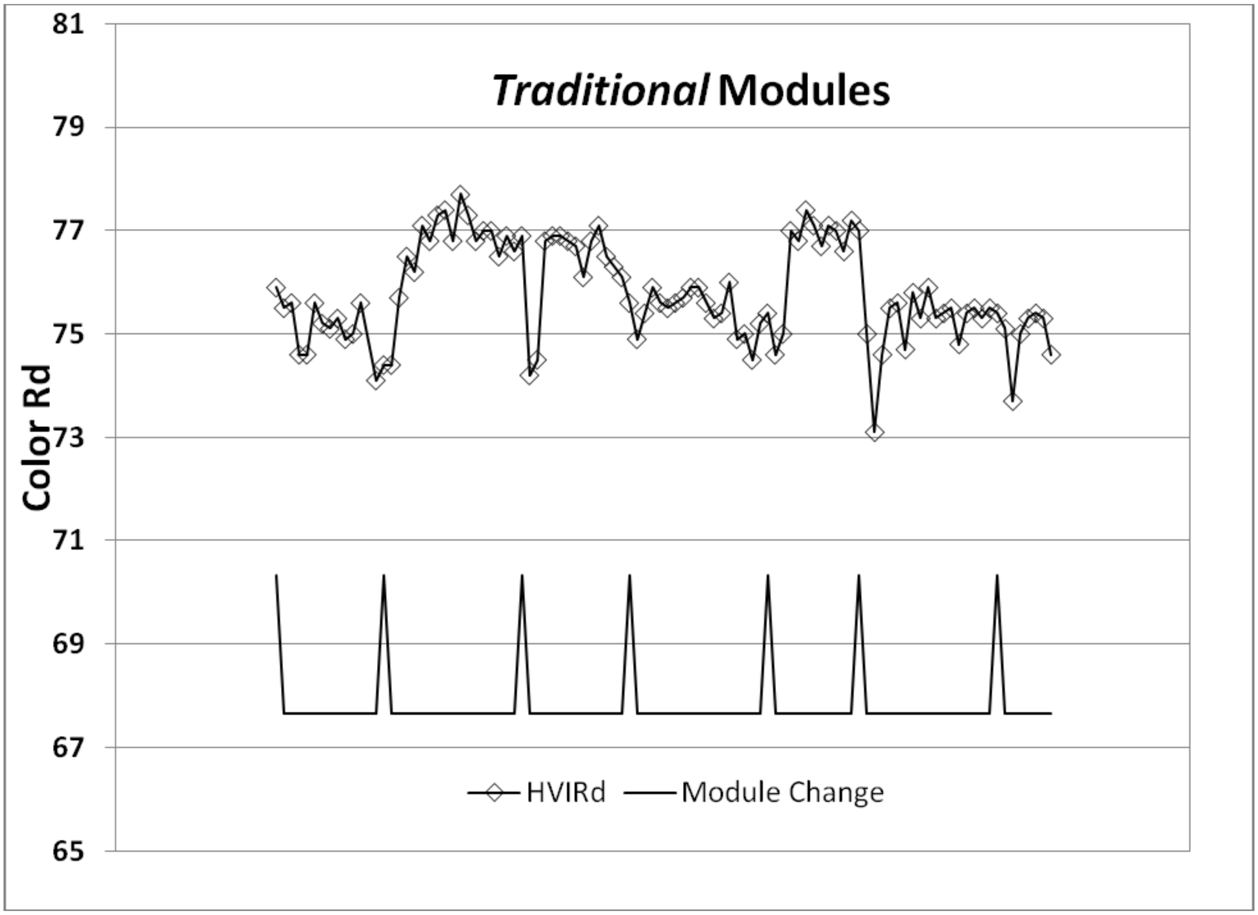

Figure 4. The reflectance portion of HVI color for bales, top line, and the time at which the change in modules occurred for traditional sized modules.

The second problem was that multiple modules of the half-size or round type were hauled together on the module hauler and were stored closely together in the module yard. When modules were stored with adequate room for ventilation very little moisture was absorbed into the ends of the modules, but when they were stored too closely together significant moisture was absorbed leading to quality degradation.

Management should consider how to handle loose seed cotton when significant rainfall occurs and whether the additional lint obtained is worth enough to make up for the lower color quality for the resulting bales, especially with traditional and half-sized modules. Issues regarding loose seed cotton occur with all three module types, but the issues are different for round and the other module types. All modules should be stored with room for ventilation at all sides of the module. This guideline should be emphasized for operators when modules are moved.

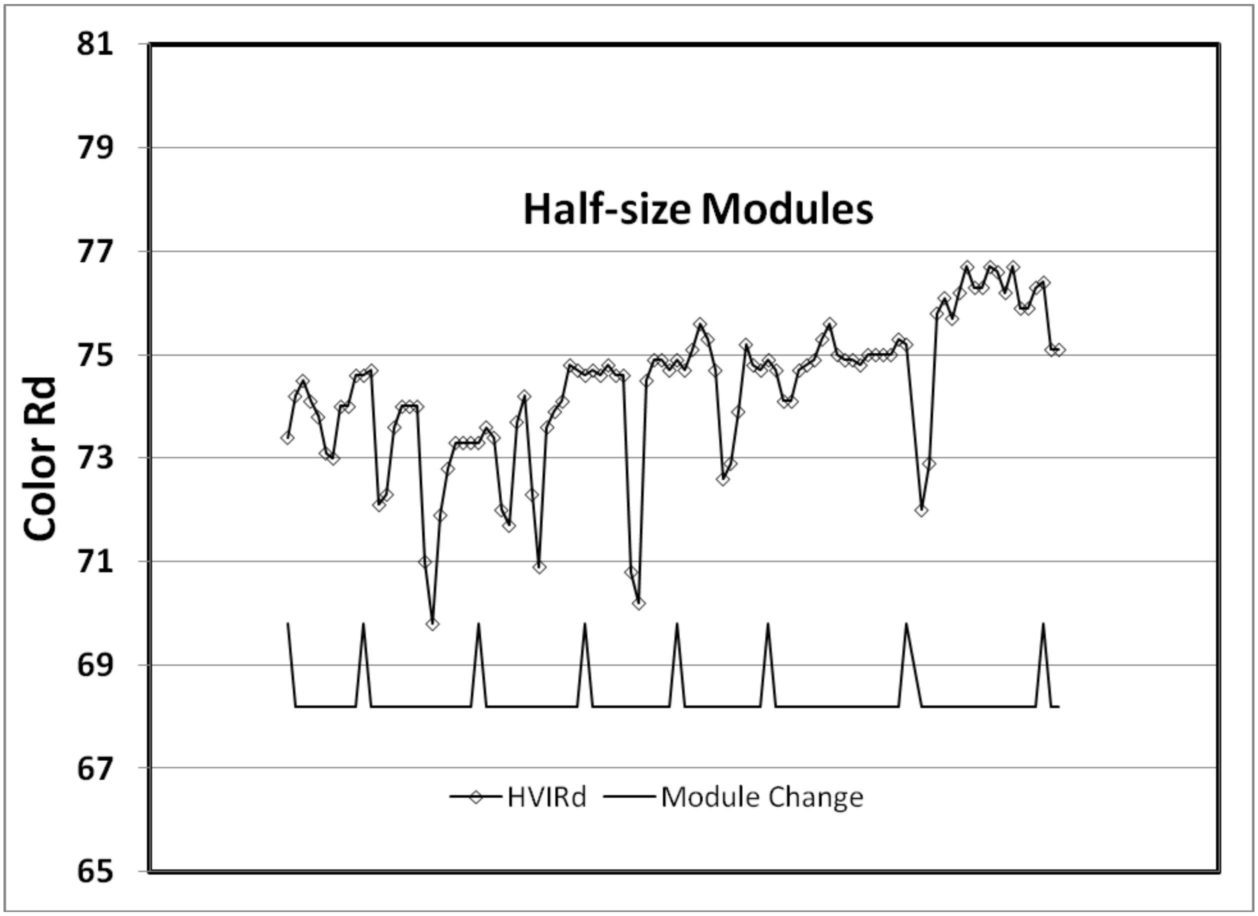

Figure 5. The reflectance portion of HVI color for bales, top line, and the time at which the change in 'gin' modules occurred for half-sized modules, with two half-sized modules per 'gin' module.

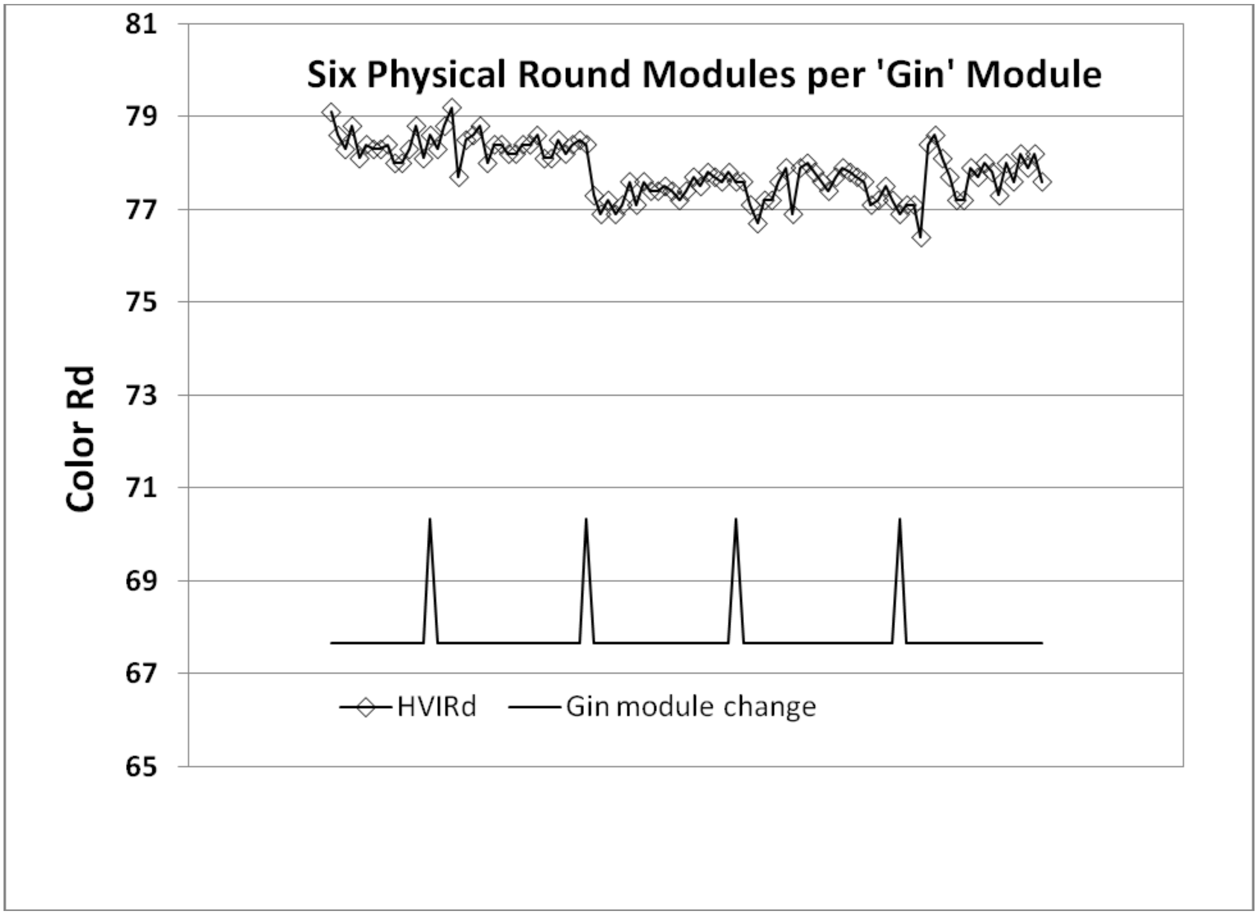

Figure 5. The reflectance portion of HVI color for bales, top line, and the time at which the change in 'gin' modules occurred for round modules, with six round modules per 'gin' module.

Ginning rate data

The ginning rate was calculated for periods with consecutive bales from the same module type (Table 7). Five gins processed both traditional and half-sized modules. For these gins, the half-sized modules ginned slightly more slowly in four of the five cases. Two of the gins processed both traditional and round modules and the gins processed the round modules somewhat faster than the traditional modules. At the only gin which processed all three module types, they processed the half-sized modules the slowest and the round modules the fastest. As with the color data, the reason for this difference was not apparent. There are many reasons a gin may process more slowly, including varietal and mc effects. No particular problems were observed with any of the module types which would contribute to a reduction of ginning rate. The gins were not observed to have to slow or stop ginning because seed cotton was not available.

Table 7. Ginning rate data for gins visited in 2008.

Gin name	Module type	Number of bales	Rate (bales/h)
Edcot Co-op Gin	Traditional	467	56.8
	Half-sized	677	54.6
	Round	757	57.3
Longtown Gin	Traditional	120	37.9
	Half-sized	138	31.8
L+H Gin	Traditional	83	34.5
	Half-sized	85	32.3
Farmers Union Gin – Lummus	Traditional	146	39.9
	Round	121	42.5
Farmers Union Gin - Continental	Traditional	112	36.6
	Half-sized	107	34.3
Peach Orchard Gin	Traditional	98	31.8
	Half-sized	72	32.6
Mill Creek Gin	Round	121	55.8

Conclusions

Data representing nearly 3100 cotton bales were collected at seven gins in TN, TX, MO, and MS, using traditional and at least one of the non-traditional module types, half-sized and/or round. These data showed that there were small differences in moisture content and lint color, which were statistically related to the module type. The round modules produced lint with better color and ginned somewhat faster than the other module types. However, because the modules were not matched with relation to growth conditions, harvest conditions, and variety these differences may have been caused by factors other than the module type. Because these differences were small, the only conclusion drawn was that using the harvesters producing the newer module sizes did not have a significant negative effect on the ginning system. For example, the gins were able to process cotton reliably from all module types including the small round modules at rates over 50 bales per hour. Seed cotton quality deterioration was observed when modules were stored without adequate ventilation or with loose seed cotton packed at the module end. Management should deal responsibly with loose seed cotton and spacing during storage of modules when rain may lead to reduced color quality.

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Disclaimer

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