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IS COTTON DUST POTENTIAL CORRELATED WITH COTTON STICKINESS??

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Abstract

Sticky cotton became a greater problem in the early 1990's and researchers were concerned that possibly more dust would accumulate that would be released later during subsequent processing. This would be a potential problem in the processing of sticky cotton and might mean more frequent downtime for cleaning machinery and increased surveillance to remain in compliance with the Cotton Dust Standard. So a survey was conducted to determine if cotton dust potential is related to stickiness. A large number of samples with varying degrees of stickiness that was determined by the percent reducing sugar and the Thermodetector and Minicard rating method for stickiness, was collected and assayed for cotton dust potential. The stickiness levels and the associated cotton dust potential were compared. A small tendency for increased dust potential was observed when stickiness was measured by the reducing sugar and Thermodetector methods. But no difference was observed using the minicard stickiness rating method. Since the increased dust potential is small or practically no different from that of nonsticky cottons, additional adjustments to control cotton dust during processing is probably not necessary.

Introduction

The study of cotton dust and endotoxin as it relates to the respiratory disease byssinosis, has been and still is a major research charge at the Cotton Quality Research Station (CQRS), Clemson, SC. Likewise is the study of the problem of sticky cotton. So during the early 1990's when the last recent cycle of stickiness appeared as a serious industrial concern, the question was posed, "Is there any relationship between stickiness and cotton dust"? This concern arose because of the possibility that with the increased occurrence of stickiness perhaps increased levels of cotton dust might also accompany stickiness during processing. Unfortunately, the literature yielded little information and reasonable rationalizations could be made for both lower and higher cotton dust potential with sticky cottons. For instance, the sticky nature of the cotton could hold onto more dust or may act as a food source for phyllosphere Gram-negative bacteria and thus increase both dust material and endotoxin levels during processing. But on the other hand, this same stickiness might hold onto cotton dust more tenaciously and prevent its release during processing; and generally, stickiness is mostly observed as a western problem where cotton dust levels are generally lower so it would follow that less cotton dust would be expected with sticky cottons.

The practical problems of stickiness to the Industry have been described by Perkins (1971) and Hequet and Frydrych (1992). The nature of stickiness in cotton has been investigated in great detail (Brushwood and Perkins, 1994; Hendrix et al., 1993; Roberts et al., 1976) and possible remedies for stickiness have been suggested (Balasubramanya et al., 1985; Carter, 1990; Chun and Brushwood, 1998; Heuer and Plaut, 1985; Perkins, 1993). While a great deal of effort and information is available on stickiness and cotton dust, less has been done on cotton dust and stickiness together. One report by Chun et al. (1995) gave the first indication that sticky cotton may have greater cotton dust potential to suggest that sticky cottons may 'trap' and accumulate more airborne dust or soil or that the sticky material itself may be released as dust. In that study, the contrast between the nonsticky and the sticky cotton was extreme and involved a very localized source of cottons. That was a research study and may not have represented the larger domestic commercial situation so this study was initiated with a wider source of cotton and gradation of stickiness to re-examine the relationship between cotton stickiness and cotton dust potential.

Materials and Methods

Cotton Samples

A total of 400 cotton samples were assayed for this study. These samples consisted of cotton collected from ongoing studies at CQRS where thermodetector, sugar or minicard data were available for samples acquired during the current or previous years. Additional samples were taken from cotton samples sent to CQRS for service tests. The source of the cottons sent to CQRS for service tests were kept anonymous for this study. Where only partial data were available, the missing assay was performed so that for each sample, percent reducing sugar, thermodetector stickiness and minicard stickiness data were available.

Percent Reducing Sugar

The routine potassium ferricyanide test (Perkins, 1971, 1993a), also called the USDA potassium ferricyanide or Perkins test, was used to determine total reducing sugars, including glucose, fructose and trehalulose. The percent reducing sugar was based on dry weight of the sample. The percent reducing sugar test does not measure stickiness; but when levels of reducing sugars reach 0.35 % or higher, the potential for stickiness in processing exists. So in regard to stickiness, only two categories are considered when using reducing sugars, nonsticky or sticky cottons.

Thermodetector Stickiness

The GRAF/IRCT Thermodetector (TD) (Brushwood & Perkins, 1993 & 1993a; Perkins & Brushwood, 1994, 1995) was used to determine cotton stickiness potential. In this rating system, four categories of stickiness is used based on the number of Thermodetector spots from the assay: (a) Nonsticky, less than 5, (b) Light Stickiness, 5-14, (c) Moderate stickiness, 15-24, (d) Heavy Stickiness, above 24 spots.

Minicard Stickiness

While, the sticky cotton thermodetector was made a recommended testing method in 1994, this was done largely because there was no viable alternative since the minicard is not available on the open market to implement testing (Anonymous, 2000). The backbone reference for stickiness is the minicard since it most closely mimics the actual processing and had at one time been adopted as the reference method for assessing cotton stickiness by the International Committee on Cotton Testing Methods of the International Textile Manufacturers Federation (Anonymous, 1988). So the most important cotton stickiness potential measurement was based on using the standard minicard (Shirley Spinning System, Lancashire, England) and its rating system (Brushwood & Perkins, 1993 & 1993a). Three 10-g replicates per sample were used and the results averaged. The four rating levels are 0 (no stickiness), 1 (light stickiness), 2 (moderate stickiness) and 3 (heavy stickiness). The rating levels are based on five factors: (1) the number of times stickiness occurs on the delivery rolls; (2) the size of the sticky masses; (3) the tendency for the fiber web to wrap around the rolls; (4) the time for stickiness to develop on the rolls; and (5) the amount of residual sticky masses remaining on the delivery rolls after the test.

Cotton Dust Potential

Cotton dust potential was determined using a Microdust and Trash Monitor (MTM; Millner et al., 1988; Sasser et al., 1986) as described by Chun and Perkins (1996). The cotton dust potential assay was done by the Testing Laboratory at CQRS; and for each sample, 20-gm portions were assayed. The results are reported as the total cotton dust per 20-gm samples.

Statistical Analysis

Data were analyzed on a personnel computer using release 8.00, TS M0, of SAS (SAS, Statistical Analysis System; SAS system for Windows version 4.9.3; SAS Institute Inc., Cary, NC, USA) for making mean comparisons. Otherwise additional testing and data manipulation were done with Microsoft EXCEL 2000 Version 9.0.2720 for Windows ME (Microsoft Corporation, USA) and plotted using SigmaPlot for Windows Version 5.00 (SPSS, Inc., USA).

Results and Discussion

Depending on how stickiness was measured, a different relationship between stickiness and cotton dust potential were found. Using the percent reducing sugar rating which only has a potentially sticky and potentially nonsticky category, the mean for the non-sticky cottons is 1.944 mg/20-g (n=119) and for the sticky cottons 2.186 mg/20-g (n=281). While the difference between the sticky and non-sticky cottons is very small, 0.241mg/20-g, it is significantly different from zero ($t = 3.779$, d.f. = 245, $P < 0.001$, assuming unequal variances), which suggests that based on the percent reducing sugar stickiness, sticky cottons have a greater cotton dust potential.

This is in part supported by the use of the Thermodetector measurement of stickiness. The results suggest that sticky cottons tend to have greater cotton dust potential than nonsticky cottons (Table 1). However, the picture is less clear than it was for reducing sugar stickiness. The range for cotton dust potential is very narrow, just 1.957 for nonsticky cottons to 2.267 mg/20-g for moderately sticky cottons. Yet, nonsticky cottons are not significantly different from the heavy sticky cottons but are significantly different from the light and moderately sticky cottons.

Using the minicard stickiness measurement, nonsticky cottons do not appear to have a greater cotton dust potential than sticky cottons; although moderately and heavily sticky cottons tend to have greater cotton dust potential than lightly sticky cottons. Nevertheless, the range for stickiness is only 1.946 for slightly sticky cottons to 2.18 for heavily sticky cottons.

A practical interpretation is that stickiness is poorly correlated with cotton dust potential. The correlation coefficient for cotton dust potential and minicard, Thermodetector and percent reducing sugar stickiness, is between 0 and approximately 0.1. Even though differences are observed between nonsticky and sticky cottons for cotton dust potential for reducing sugar and Thermodetector stickiness, when the average dust potential is plotted against stickiness (Figures 1 to 3), just how small these differences are become clearer. While Thermodetector and reducing sugar stickiness tend to suggest greater dust potential with stickiness, no clear trend of stickiness and dust potential can be observed. However, the early work by Chun et al. (1995) showed that sticky cotton had a 2.4X greater cotton dust potential than its nonsticky counterpart. However, in that work, the cottons were grown in experimental plots in Brawly, CA, specifically for stickiness studies. Only nonsticky and heavily sticky cottons (1.17% reducing sugar and 38 Thermodetector spots) were used and represented the extremes of stickiness. Very possibly the cottons in that study were too localized and the stickiness contrast were too extreme to fully represent cottons from the larger commercial growing regions. While the overall results of this study seem to suggest a higher cotton dust potential to be associated with stickiness, this difference is very small. As suggested by Chun et al. (1995), sticky cottons may 'trap' and accumulate more airborne dust or soil or the sticky material itself, which may be released as dust and hence have a greater potential of releasing dust. But this effect of stickiness would probably only be effective in the sticky spotted areas of the lint and very likely these areas make up a very small portion of the total surface area and hence would have a very small effect which is probably why the differences seen in this study were so small. Concerning the additional complication of increased cotton dust during processing, the results do not approach the 2.4X increased level of that experimental cotton samples so this should probably not be a concern to the Cotton Industry in regard to the Cotton Dust Standard. Since minicard stickiness is a very reliable standard of stickiness, the results strongly suggest that on a practical interpretation, cotton stickiness is not correlated with increased or decreased cotton dust potential.

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Table 1. Thermodetector Stickiness and Cotton Dust Potential

Thermodetector Rating	**No. of Samples**	**Average[1] Dust, mg/20-g lint**
Nonsticky, less than 5	72	1.957[B]
Light Stickiness, 5-14	126	2.170[A]
Moderate Stickiness, 15-24	61	2.267[A]
Heavy Stickiness, above 24	141	2.077[AB]

[1]Mean separation within column by Duncan's multiple range test, 5% level. Means with the same letter are not significantly different.

Table 2. Minicard Stickiness and Cotton Dust Potential

Minicard Rating	**No. of Samples**	**Average[1] Dust, mg/20-g lint**
0	81	2.116[AB]
1	89	1.946[B]
2	59	2.171[A]
3	171	2.180[A]

[1]Mean separation within column by Duncan's multiple range test, 5% level. Means with the same letter are not significantly different.

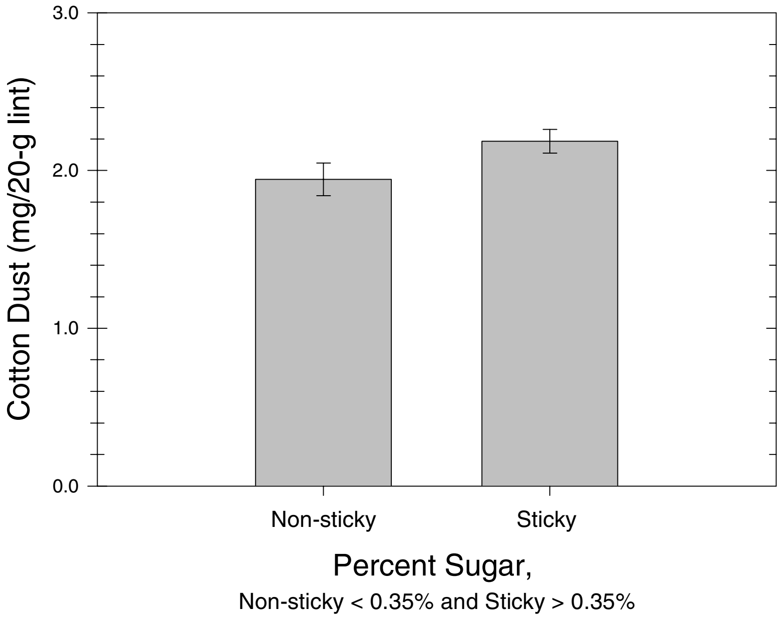

Figure 1. Percent reducing sugar stickiness and cotton dust potential.

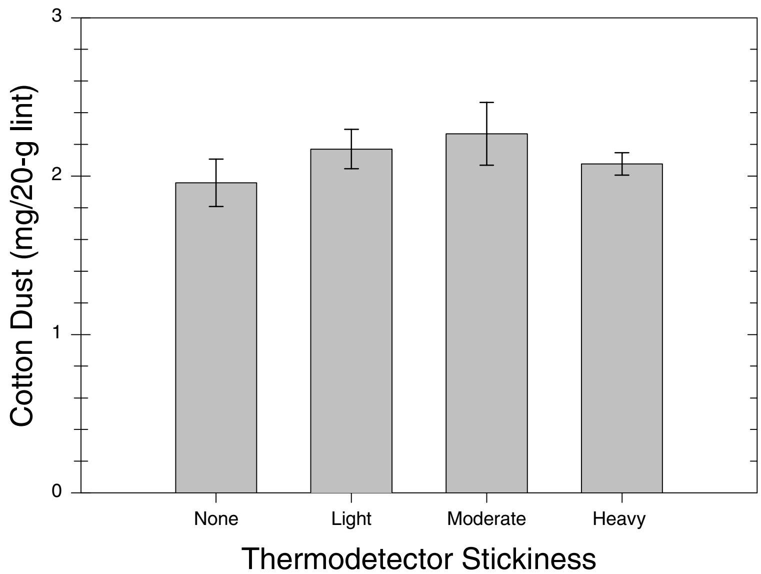

Figure 2. Thermodetector stickiness and cotton dust potential.

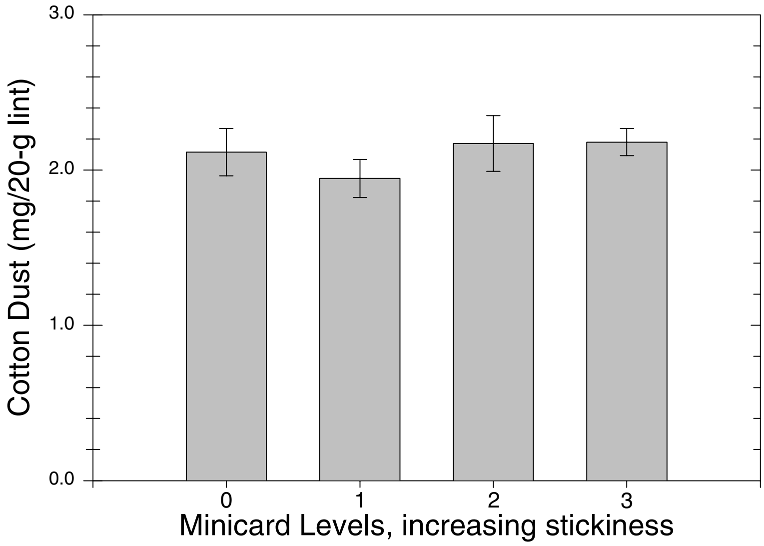

Figure 3. Minicard stickiness and cotton dust potential.