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**Département
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CIRAD-CA**

Laboratoire
de technologie
cotonnière

New Developments in testing and treating of honeydew

<u>For presentation to:</u>

1993 ITMF Annual Conference
Joint Cotton Committee

Porto, September 26

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New developments in testing honeydew

Joint research project between CIRAD-CA and SCANERA supported by the National Agency for the Promotion of Research (ANVAR)

Introduction

Over the last few years it has been noted that cottons from various origins induce a stickiness phenomenon during spinning and thus lead to considerable production losses. It is becoming increasingly important to measure rapidly the sticky potential of cottons before they enter the spinning process as it is possible to reduce these sticky effects by appropriate means (mixing cottons that present different levels of contamination, reducing relative humidity in the premises, etc.) or by various treatments (lubricants, washing, etc.).

Stickiness is primarily due to insect excretions (Aphis gossypii and Bemisia tabacii), known as honeydew. These are composed of sugars which give the cotton its sticky potential.

In 1986 the CIRAD-CA developed a system for the detection of sticky cottons. The technique used combined the effects of heat and pressure. The test sample (2.5 g of fiber) was prepared in the form of a web (54 cm x 16 cm). This was sandwiched between two sheets of aluminium and the preparation subjected to pressure at 80°C for 12 seconds (the heating element being in contact with the upper aluminium sheet). The preparation was then subjected to 2 minutes ambient pressure. After removal of the web, the sticky potential of the cotton was determined by visually counting the number of fiber points stuck to the upper and lower aluminium sheets. The results obtained with the thermodetector in the evaluation of cotton sticky potential have been shown to be closely correlated to defects that occur during the spinning process.

This procedure requires an operator to prepare a cotton web of precise weight and surface area. He also needs to clean the aluminium sheets and count the sticky points on these sheets. The quality of the measurement is therefore not entirely independent of operator effect. Each test lasts about 5 minutes per repetition; 3 repetitions are recommended per sample in routine testing, the variability of intra-sample stickiness being fairly high.

The rapid detection of sticky cottons

The CIRAD-CA is currently developing a new measuring system where the human element in sample preparation, in the test itself and in counting the sticky points, has been reduced to a minimum. The duration of the test has also been reduced to render the determination of cotton stickiness compatible with the speed of HVI lines.

The new high speed sticky cotton detector prototype is made up of 5 work stations:

- sample preparation
- application of heat and pressure
- application of pressure at ambient temperature
- cleaning the aluminium surface
- enumeration of the sticky points

The sample and its mounting are transferred automatically between each of these stations. The processing time for each operation is between 20 and 30 seconds, and, as each is independant, it is therefore possible to process several samples simultaneously, wich means that a result is obtained at most every 30 seconds.

■ Sample preparation

The fiber sample weighs between 3 and 4 grams and has a surface area of about 250 cm^2. The sample is opened using a mechanical rotor-type opener to obtain a very homogeneous fiber-mounting interface and to allow all types of cotton to be processed (saw or roller ginning). As an example, cottons ginned by roller present a very irregular surface when raw. When opened using a roller opener the surface in contact with the mounting is comparable to that seen with saw ginned cottons.

■ Sample transfer from one station to the next

The sample is placed on a strip of aluminium originating from a roll at least 300 meters long. The aluminium is rolled along a conveyor belt which transfers the sample in front of each station. The aluminium strip is rolled up at the other end of the machine.

■ Application of heat and pressure

Pressure is applied to the sample for 20 to 30 seconds while the heating element is in contact with the cotton. The temperature differential between the heated cotton and the mounting creates a fine layer of steam on the aluminium mounting, which causes the sugar or honeydew drops to be deposited onto the aluminium mounting. The heating element exerts a pressure of about 600 g/cm^2.

■ Application of pressure at ambient temperature

Pressure is applied for 20 to 30 seconds at ambient temperature immediately after the hot pressure phase. This fixes the sticky points to the aluminium mounting. The same amount of pressure is applied as during the hot-pressure phase.

■ <u>Cleaning the aluminium sheets</u>

Our aim was to determine the optimum combination of heating temperature, heating time and pressure at ambient temperature to obtain both excellent sticky point fixation on the sheet and ease of cleaning (elimination of excess fiber and foreign matter). The fiber mass is aspirated and the aluminium sheet then cleaned automatically.

■ <u>Enumeration of the sticky points</u>

This is performed by video camera as it scans the sheet. The image is then analyzed by computer. The software used calculates the number of sticky points and produces a histogram of the surfaces.

Differences between the new procedure and the thermodetector

- The human element is reduced to a minimum.
- The sample, which can be between 3 and 4 g, does not require careful weighing, and this therefore gains precious time.
- The surface area of the sample is reduced.
- The method used to prepare the sample means that 4 times more sticky points are obtained per unit surface area on the aluminium sheet.
- A single side of the sample is in contact with the aluminium.
- The very rapid fixation of the sticky points allows for immediate cleaning whereas a wait of at least 30 minutes was required with the thermodetector.
- Sticky points are counted using an image analyzer.
- The determination of sticky potential is 8 to 10 times faster than with the thermodetector.

Preliminary results

■ <u>Quality of the image analysis</u>

114 cottons from various origins (saw and roller ginning) were compared using visual counting and image analysis of samples tested on the new system (figure 1). The correlation between the two techniques was very good ($100 * R^2 = 98.8\%$).

■ <u>Comparison of thermodetector results and the new system</u>

37 cottons from various origins were tested, 6 measurements were made on the thermodetector and 3 repetitions on the new H2SD (High Speed Stickiness Detector) system. Figure 2 shows the excellent correlation between the two measurement systems ($100 * R^2 = 97.8\%$).

Conclusion

The H2SD would seem to be very promising. We are currently optimizing this new technique and a validation phase using a large number of samples is scheduled for 1994.

New developments in treating honeydew

CIRAD-CA research project supported by the Ministry of Industry

Introduction

Although it is difficult to estimate with precision the economic impact of stickiness as precise information is not available, the discounts applied to sticky cottons are generally between 5 and 30% (no fixed rule has been established).

The detection of cotton stickiness by the thermodetection method developed by the CIRAD-CA is based on the deposit of sticky substances onto two aluminium sheets. The cotton is heated via a hotplate and releases its humidity. This humidity is absorbed by the honeydew which then sticks to the aluminium sheets during a second cold-press phase.

Figure 3 shows that the number of sticky points fluctuates depending on the relative humidity of the ambient air. Results in the 55% to 65% range seem to be stable, and this is confirmed by statistical analysis. Outside this relative humidity range, there is a marked fall in the number of sticky points. The maximum sticky potential is therefore expressed between 55 and 65% relative humidity, which means that there are therefore 2 ways of neutralizing the stickiness: drying or humidification.

The TNCC9 method of neutralizing stickiness developed by CIRAD uses the same combination of factors as the thermodetector, i.e. pressure, heat, humidity. The sheets that receive the sticky points are different in that they absorb and dissolve the honeydew.

The TNCC9 method of neutralization

The web of cotton to be treated is sandwiched between two pieces of damp cloth. Pressure is then applied (80 g/cm^2) and the preparation heated to a temperature of between 90 and 100°C for 12 seconds. The treated web is then dried for a few seconds to eliminate the excess humidity contained within.

Several things happen during this treatment. Under the effects of the temperature, humidity and pressure, the honeydew softens, is deposited onto the damp cloth and melts on contact. The hot water steam generated circulates within the fiber web and acts as a wetting agent. Similarly, it softens the honeydew deposits situated within the thickness of the web and partially dissolves them.

Mean values for sugar levels contained in samples of fiber from two raw and treated cottons are given in table 1. The figures show that sugar levels are reduced in the treated cottons, these sugars being found in the cloth (it should be noted that these two cottons were extremely sticky with about 180 thermodetector points).

Table 1: Chemical analysis of the sugars using Thin Layer Chromatography

Type of sugar	Raw Cotton 1	Treated Cotton 1	Raw Cotton 2	Treated Cotton 2
Glucose	0.20 %	0.13 %	0.20 %	0.15%
Fructose	0.20 %	0.15 %	0.30 %	0.18 %
Saccharose	0.12 %	0.05 %	0.12 %	0.08 %
Mélézitose	0.05 %	0.03 %	0.05 %	0.03 %
Raffinose	Traces	Traces	Traces	Traces
Total	0.57 %	0.36 %	0.67 %	0.44 %

Fiber webs of 125 g/m² were treated and the following tests performed on raw and treated cotton:

- a full technological analysis of the fiber (table 2)

- spinning trials (ring spinning, 20 tex yarn)

- a recording of all disturbances during the spinning process (table 3)

- a visual inspection of neps on the yarn to differentiate between seed coat fragments, fiber neps, neps due to stickiness and vegetal debris.

Results and discussion

The treatment applied considerably reduced the stickiness measured by the thermodetector and by the minicard (figures 4 and 5).

Treatment had no effect on micronaire index (figure 6).

Treatment seemed to slightly improve UHML length (figure 7), probably by decreasing the crimp factor.

There was a slight improvement in fiber strength (figure 8) due either to a partial modification in the crystalline structure of the cellulose (the spectra obtained from some analyses using nuclear magnetic resonance show a difference between treated and untreated cottons), or due to a decrease in the crimp factor, the latter hypothesis being the most likely.

There was no effect on fiber elongation (figure 9).

Contrary to what is observed with certain thermic treatments, yellow index (figure 10) was unaffected by the treatment.

Fiber reflectance (figure 11) decreased, which was as predicted. Generally, high humidification dulls the fiber.

To summarize, it would seem that, apart from effects on reflectance, the treatment did not induce any negative changes in the fiber's technological characteristics.

The treatment did not have any effect on the strength of the 20 tex yarn in ring spinning (figure 12).

The total number of fiber neps (figure 13) tended to be lower in treated cottons (particularly for very stick raw cottons).

The number of seed coat fragments (figure 14) tended to increase slightly in treated cottons. Certain debris was probably broken in two during web manufacture.

The number of real fiber neps (figure 15) increased slightly in certain cottons. We can explain this slight increase by a rise in the number of fiber neps induced by the method (numerous teams have shown that any mechanical treatment creates fiber neps, even though our treatment is not at all aggressive) or by honeydew so small that it is impossible to distinguish using our method, and which would therefore be counted as fiber neps.

The number of sticky neps (figure 16) decreased considerably.

We have previously demonstrated that there is a very strong correlation between seed coat fragments and total neps on non-sticky cotton. The sticky cotton used in the present study gave a coefficient of determination between seed coat fragments and total neps of 39.7% (raw cotton) and 87.8% (treated cotton). This shows that stickiness induces the formation of fiber neps (real or due to stickiness).

Similarly, we have previously shown that there is no strong relation between real fiber neps and total neps in non-sticky cotton. In the present study, the coefficient of determination between real fiber neps and total neps was 88.2% in raw cotton whereas it was only 1.0% in treated cotton. Stickiness therefore induces both sticky neps (i.e. neps containing honeydew) and real fiber neps (neps containing honeydew too small to be visible using our method or neps formed by disturbances during drawing).

Yarn from treated cottons was more regular than that from the raw cotton (less thick places, occasionally a very considerable fall in thin places, improved uniformity).

The number of sticky points on the back draught rollers of the spinning machine (figure 17) was considerably reduced, and most interestingly, these did not cause the fiber to wrap around the rollers (a phenomenon that leads to breakages), whereas the sticky points on the untreated cottons caused wrap-around. It is therefore unecessary to intervene during the spinning process to avoid breakages.

The excellent results obtained with the TNCC9 method on 125 g/m² webs led us to believe that it would be possible to treat even heavier webs.

We tested our method on 200 and 250 g/m² webs. Here it seemed that the efficacy of our procedure decreased as web weight increased. The sticky potential of a very sticky cotton (175 points on the thermodetector) fell to 44 sticky points after treatment of a 200 g/m² web and to 75 sticky points after treatment of a 250 g/m² web.

The procedure was therefore becoming saturated. Several hypotheses can be put forward to explain this saturation:

- our heating procedure penetrates insufficiently to heat the web in depth

- the heat-pressure application phase is too short

- the quantity of water in the damp cloth is insufficient to create an adequate amount of steam to treat heavy webs.

We decided to test the latter hypothesis. To do this we added a household steam generator (for cleaning floors) to our procedure and replaced the upper damp cloth by a strip of anti-mosquito netting. The lower cloth, which was not wetted, was left in place to absorb any condensation. To test whether the steam generator could replace the damp cloths were decided to start with low weight webs (table 4).

Table 4: Effect of TNCC9 treatment with a steam generator on the number of sticky points on the thermodetector

Web weight	29 g/m²	58 g/m²	87 g/m²	125 g/m²
Raw Cotton	157	157	157	157
Treated Cotton	2	31	62	68

The treated cotton was tested on the minicard and honeydew deposits were seen to form on the lower roller, and not on the upper roller as is the case for raw cottons. In addition, the deposits were very large.

In conclusion, steam treatment is effective but, like the damp cloth, the process becomes saturated, the quantity of steam used being insufficient.

Replacing the damp cloths by a steam generator would seem however to be promising as:

- this should allow webs of more than 250 g/m^2 to be treated

- web drying time should be reduced

- it should be possible to transfer this technique to cotton-producing countries

These points should be confirmed by building a laboratory prototype to test variations in:

- the temperature of the pressure plates and pressure duration

- the pressure and the quantity of steam injected.

Figure 1: Image Analysis vs Visual inspection 114 cotton samples

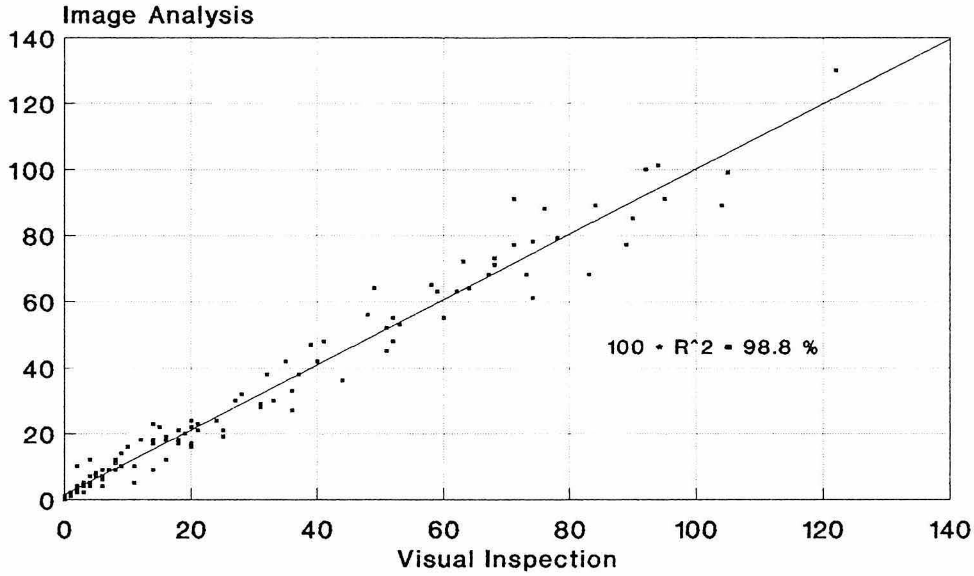

Figure 2: High Speed Stickiness Detector vs Thermodetector

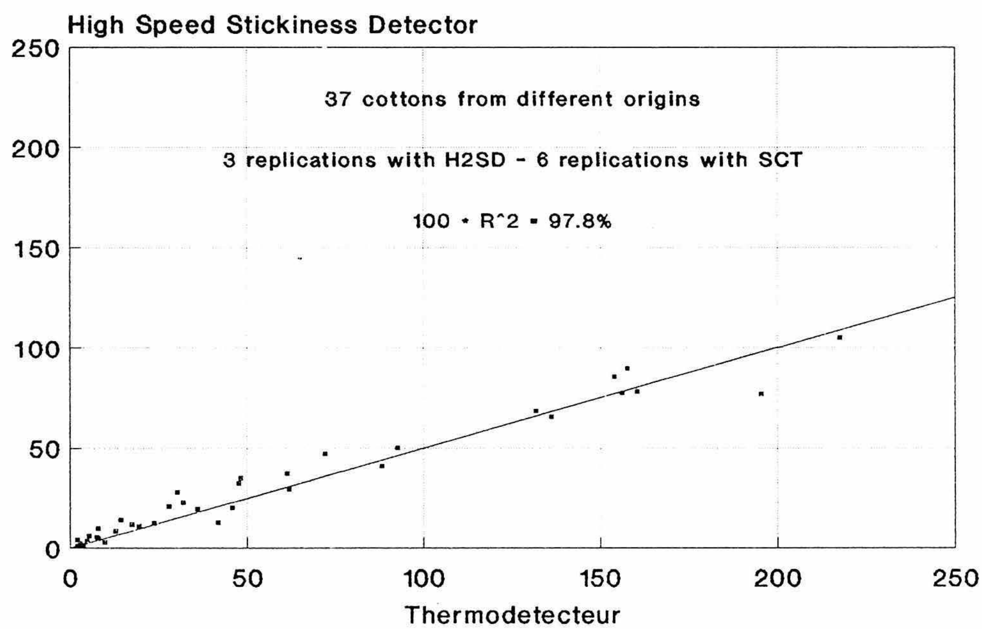

Figure 3: Number of sticky points vs relative humidity of the air

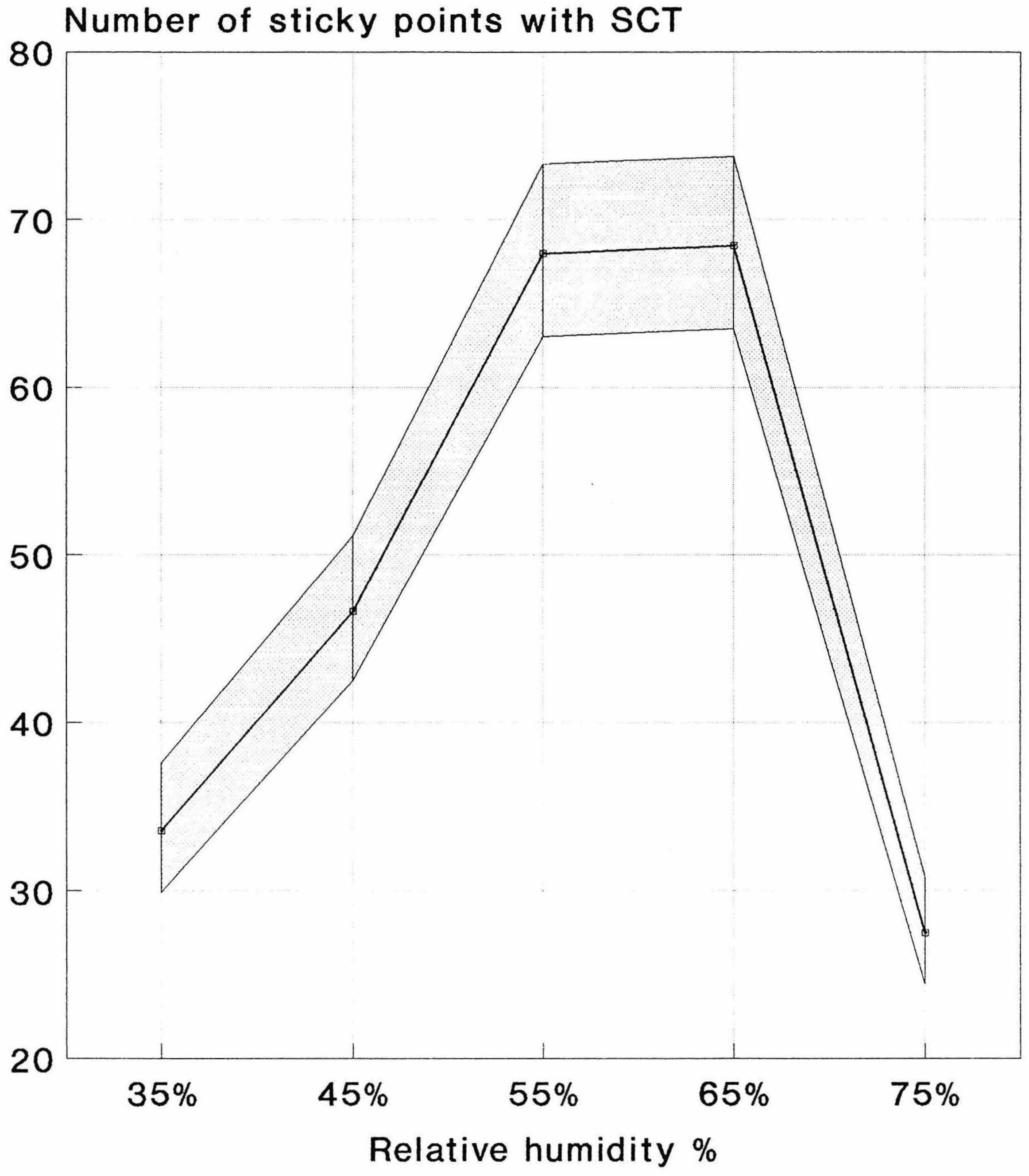

Table 2: Fiber characteristics (HVI MCI) and coefficients of correlation between raw cotton and treated cotton

	Raw Cotton	Treated Cotton	Coefficient of correlation
UHML mm	28.6	28.9	0.984 ***
ML mm	23.7	24.0	0.967 ***
Uniformity Index	82.9	83.0	0.448 NS
Strength g/tex	20.4	21.2	0.980 ***
Elongation %	7.3	7.2	0.974 ***
Micronaire	4.18	4.19	0.959 ***
Reflectance %	70.2	68.2	0.975 ***
Yellowness	12.2	12.2	0.979 ***

Table 3: Tests for stickiness, yarn quality and coefficients of correlation between raw cotton and treated cotton

	Raw Cotton	Treated Cotton	Coefficient of correlation
Thermodetecteur: number of sticky points	87	13	0.936 **
Card grade	5.2	2.0	0.816 *
Yarn strength (Uster) cN/tex	14.9	15.2	0.991 ***
Neps Uster	727	650	0.864 *
Seed coat fragments	365	421	0.997 ***
Real fiber neps	196	200	0.746 NS
Sticky neps	157	21	0.873 *
Other types of neps	10	8	0.420 NS
Thick places (Uster)	669	608	0.972 ***
Thin places (Uster)	180	110	0.785 *
Yarn elongation	6.7	7.0	0.888 **
Yarn Uniformity	16.7	15.9	0.912 **
Sticky points on the back draught rollers	33	7	0.617 NS
Number of wrappings around the back draught rollers	12	0	
Interventions to clear sticky points and wrappings	11	0	

Figure 4: Thermodetector values on raw and treated cottons

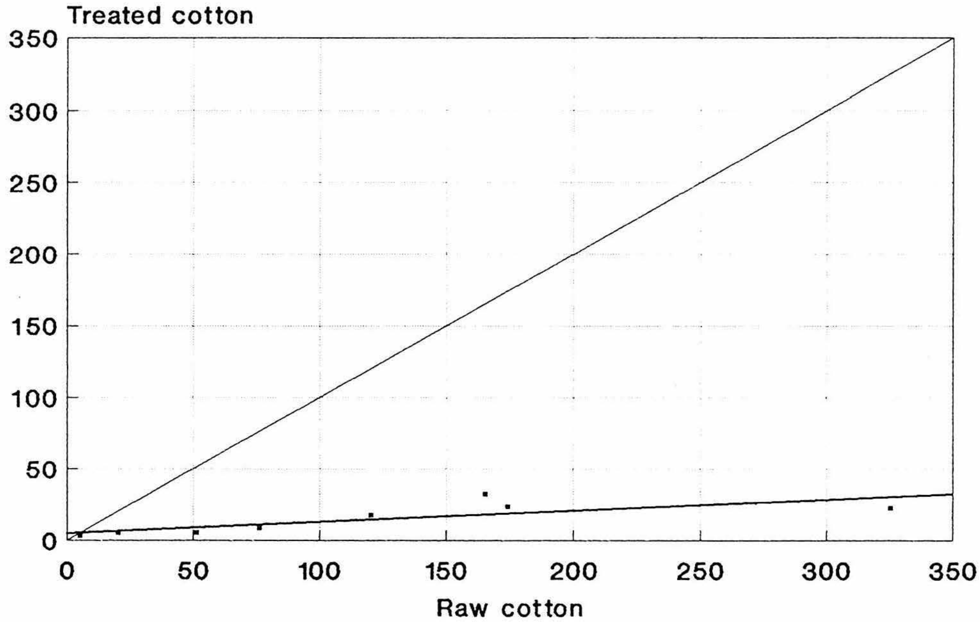

Figure 5: Card values on raw and treated cottons

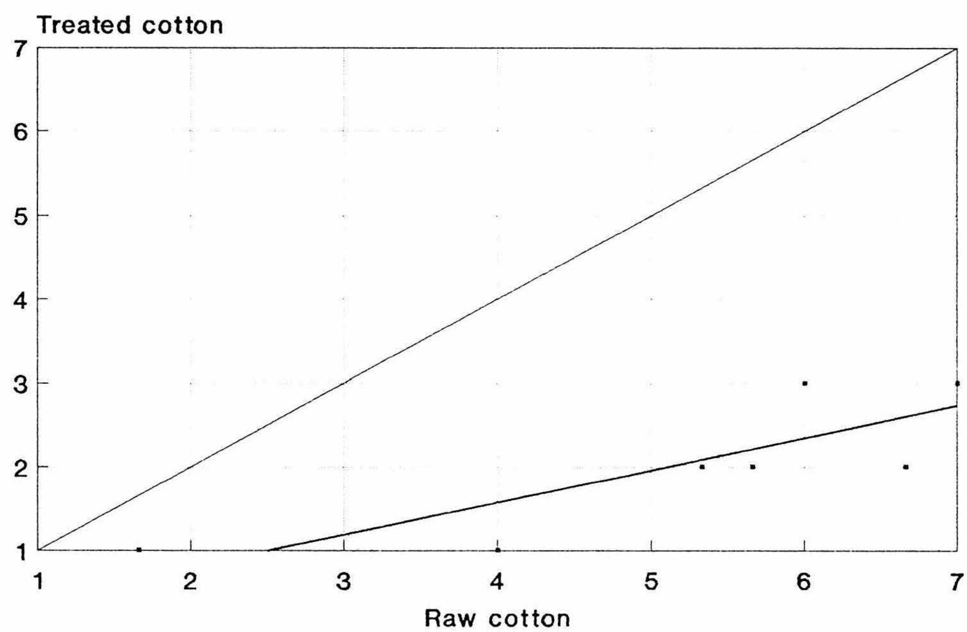

Figure 6: HVI Mike values
on raw and treated cottons

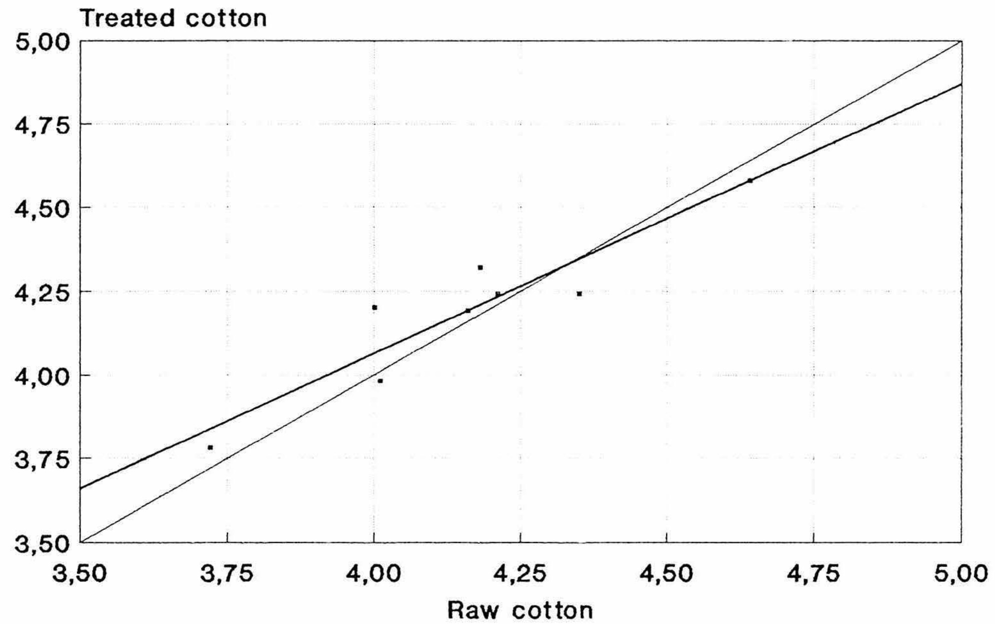

Figure 7: UHML values
on raw and treated cottons

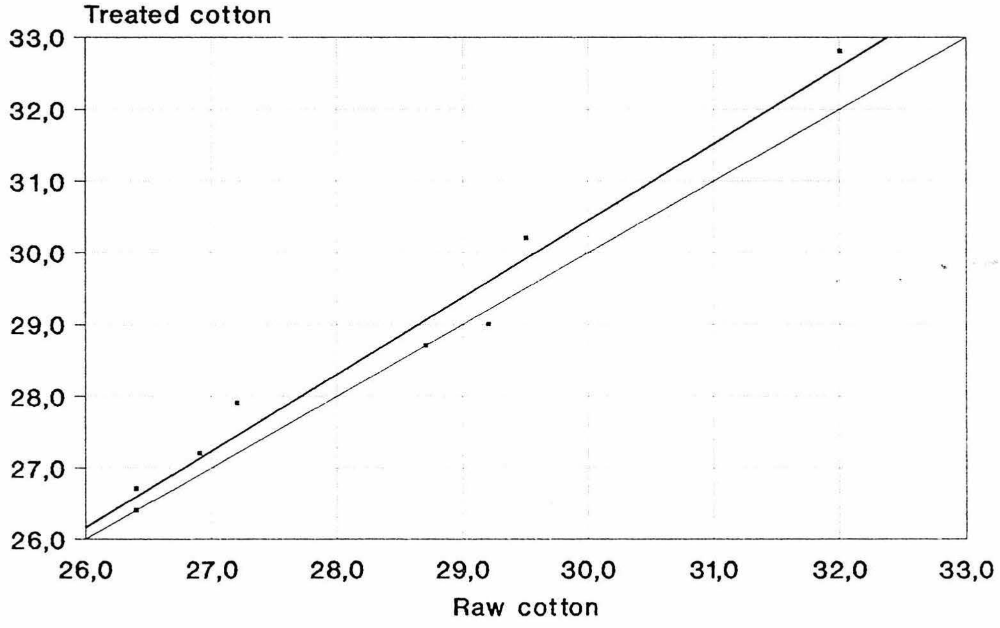

Figure 8: HVI strength values on raw and treated cottons

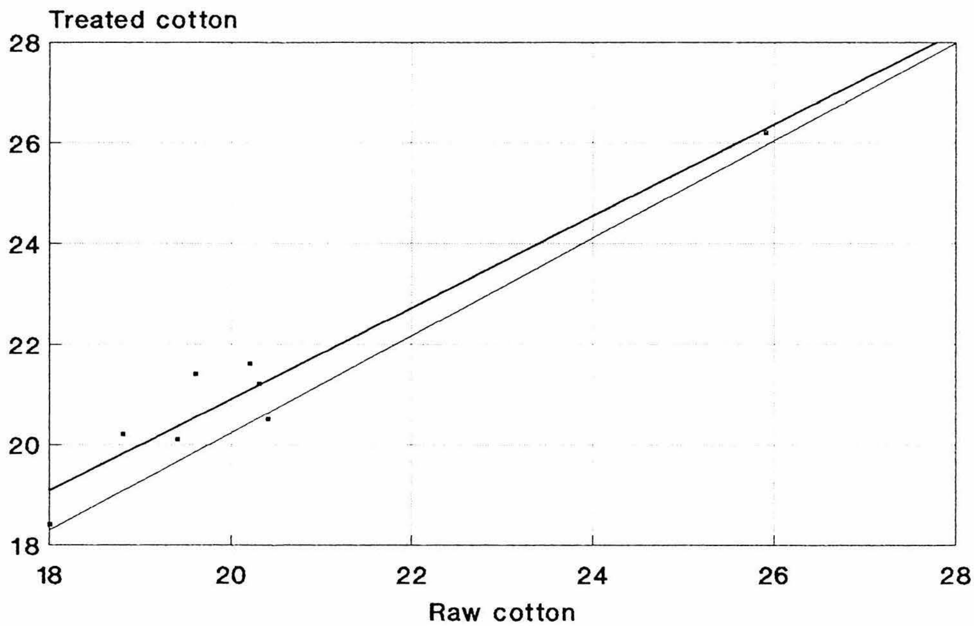

Figure 9: HVI elongation values on raw and treated cottons

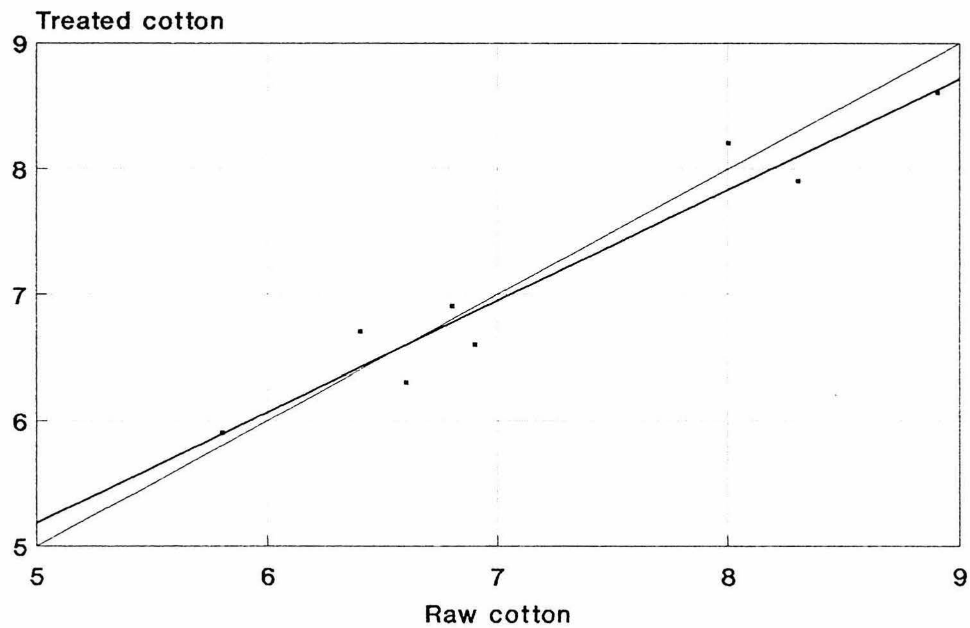

Figure 10: Yellowness
on raw and treated cottons

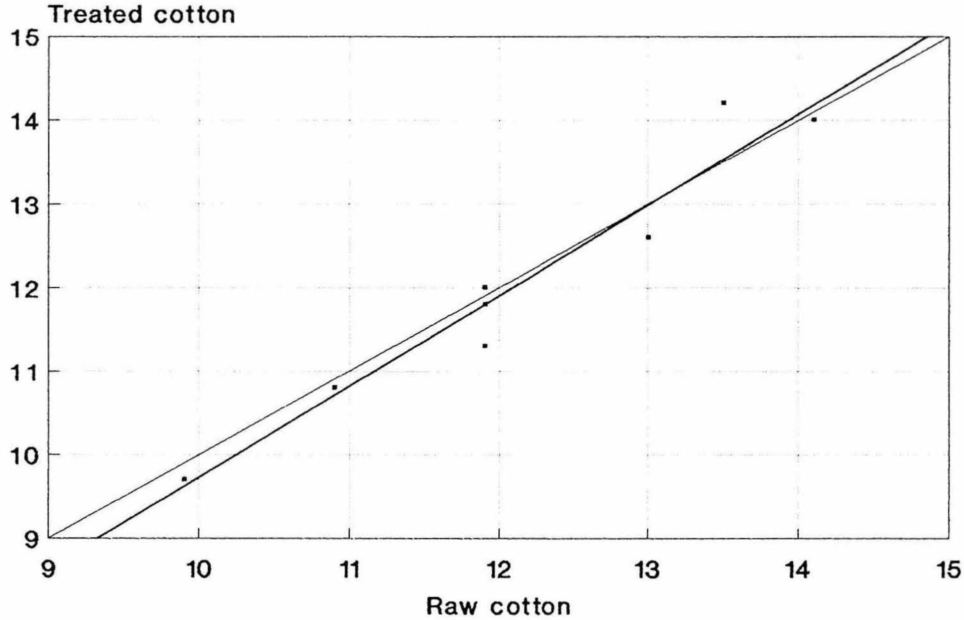

Figure 11: Reflectance
on raw and treated cottons

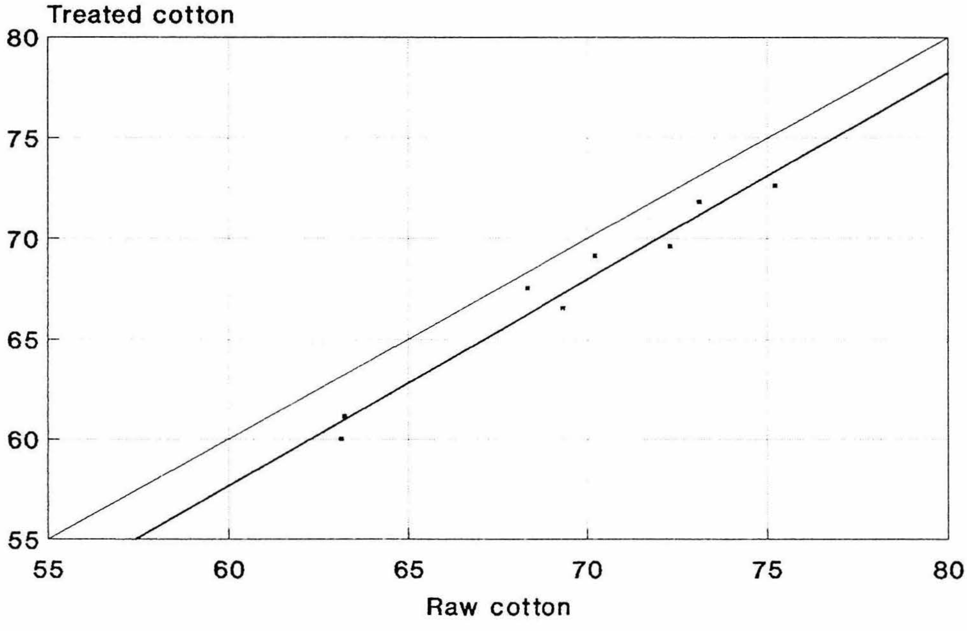

Figure 12: Yarn strength RS 20 tex on raw and treated cottons

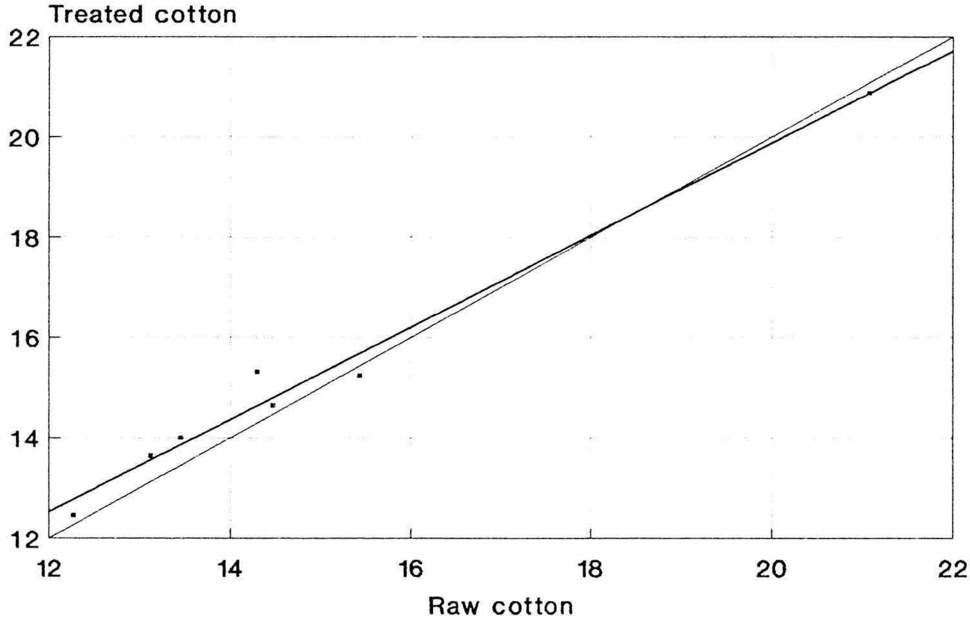

Figure 13: Total Uster neps RS 20 tex on raw and treated cottons

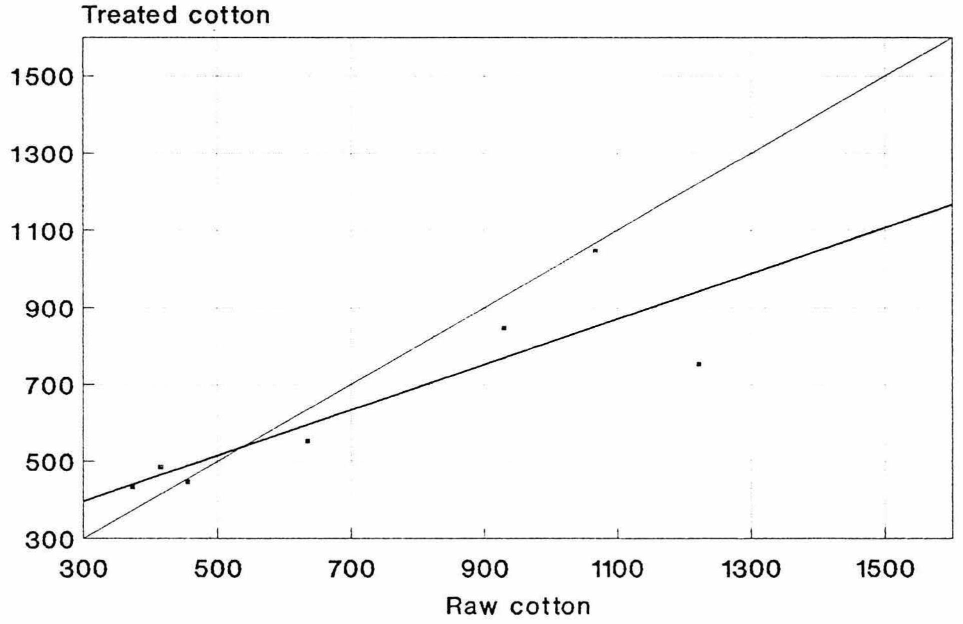

Figure 14: Seed coat fragments RS 20 tex on raw and treated cottons

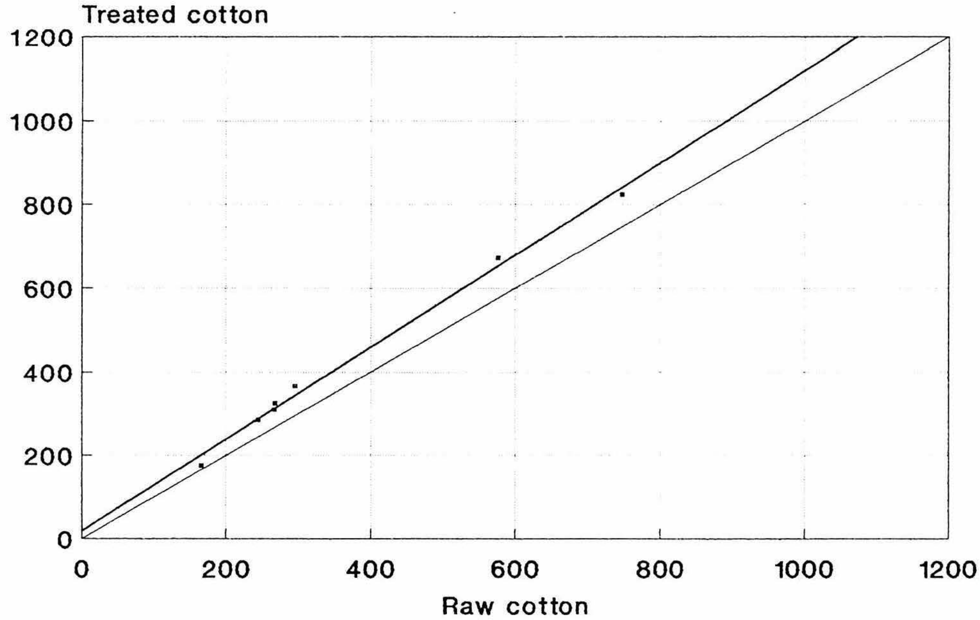

Figure 15: Real fiber neps RS 20 tex on raw and treated cottons

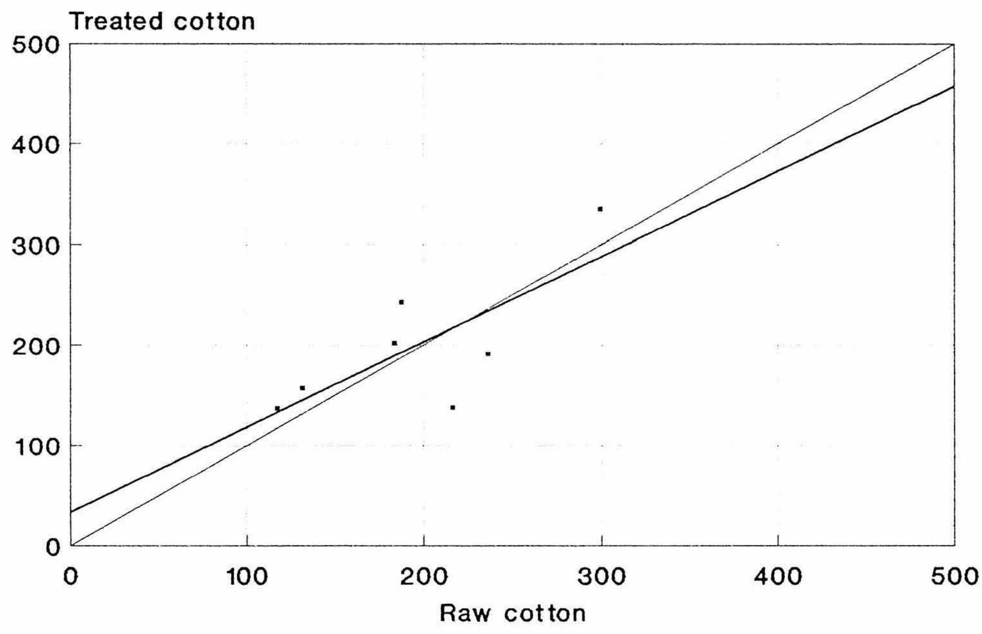

Figure 16: Sticky fiber neps RS 20 tex on raw and treated cottons

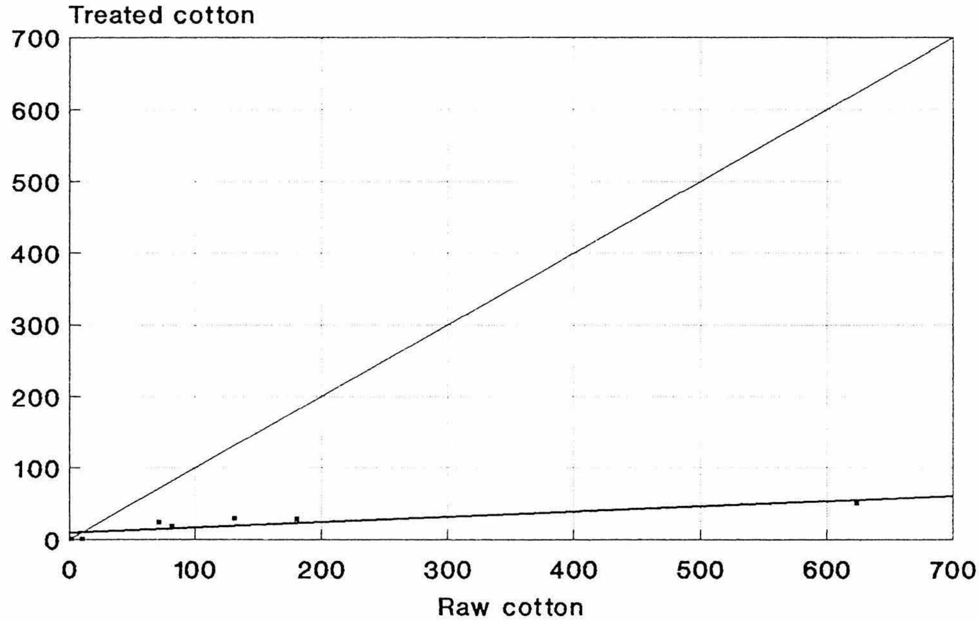

Figure 17: Number of sticky points on the back draught roller of the spinning machine