



Institut de Recherches du Coton et des Textiles exotiques

*Centre de Recherches
CIRAD de Montpellier*

***THE ACTUAL SITUATION OF
COTTON STICKINESS***

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E. HEQUET
R. FRYDRYCH

The actual situation of cotton stickiness.

E. HEQUET & R. FRYDRYCH
I.R.C.T./C.I.R.A.D. Montpellier FRANCE

PRESENTATION

The I.T.M.F. report "Cotton Contamination Survey 1991" involving the participation of 201 companies based in 22 different countries, alerted the industry to the fact that 27 % of cases presented problems of stickiness compared with 21 % in 1989.

These figures indicate a marked deterioration in the situation in only 2 years. There is a considerable increase in stickiness except in Europe. The Sudan remains the country most affected, but the North American zone with 31,7 % positive cases, is now at the same level as Africa (without the Sudan) ie. 32,7 % positive cases (see Figure 1). It should, however, be noted that this survey only determined the presence or absence of stickiness, rather than its intensity. Its conclusions should therefore be considered with care as cottons that are only slightly sticky do not systematically lead to problems during the spinning process.

Many research projects have been initiated to examine cotton stickiness in spinning in order to better understand the phenomenon, detect stickiness and eliminate its cause.

The problem is very complex because the stickiness of cottons from different geographical origins may be due to a variety of factors:

- various contaminants such as seed coat fragments, insecticide, oil, etc...,
- physiological sugars,
- entomological sugars.

The latter are excreted by two homopters : the aphid *Aphis gossypii* and the aleurode *Bemisia tabaci*. These excretions (usually called honeydew) can be found throughout the different stages involved in the transformation of cotton fibers, i.e. from the plant to the yarn.

HONEYDEW ON THE PLANT

Aphids and aleurodes on the plant are essentially found underneath leaves and on leaf stalks. They excrete honeydew onto the leaves and onto the fibers of open bolls. If climatic conditions are favorable, fungi start to develop on the honeydew to form fumagin which can also be found on non-sticky fibers, i.e. in the absence of honeydew. If the quantity of sugary deposit on the leaves is substantial, droplets form at the leaf tips before falling onto the fibers. These droplets, plus the honeydew directly excreted onto the fibres, combine to produce very high concentrations. The ginning process disperses the honey dew droplets along the fiber and by reducing their size renders them difficult to detect with the naked eye.

Why is this type of stickiness increasingly frequent ?

Before 1980 protection through insecticides was provided by organophosphate compounds which possessed good anti-aphid properties. At the end of the season, treatment with these products resulted in low numbers of homopters. From 1980 onwards, the synthetic pyrethroids (low toxicity for homeothermic animals) made their appearance. These chemicals were very effective in the control of carpophagous caterpillars, but their range of activity presented gaps as regards aphids and aleurodes. Since then, treatment associating pyrethroids and organophosphates has been used. However, the control of these insects remains difficult and resistance to organophosphates has appeared in different countries.

Nevertheless, the problem of stickiness should not be considered to be solely a consequence of the choice of insecticides. Several other factors are associated with the rapid multiplication of homopters at the end of the season and the deposit of honey dew on the open bolls:

- choice of the number of insecticide treatments carried out and the date of the last treatment
 - difficulty in reaching the insects as they are located on the underside of the leaves
 - the arrival of the dry season earlier than usual, known to favor the installation of aphid and aleurode populations
 - plant vegetation that is more or less abundant at the end of the season depending on the variety
 - influence of the sowing date
 - and above all, late harvesting that carries on for too long, a process that leaves the cotton exposed to contaminants.
- The above (non exhaustive) list gives some of the factors involved and illustrates the complexity of the phenomenon.

HONEYDEW DETECTION ON THE FIBER

The first step in our research was orientated toward chemical test. Physiological sugars are principally composed of reducing sugars (glucose and fructose), that can be measured using simple, well known chemical techniques such as methods by PERKINS, FEHLING-MASSAT, FOLIN etc. By contrast, as entomological sugars are composed of both reducing sugars and non-reducing sugars, their assay requires more complex methods such as thin layer chromatography or gas chromatography. Up to ten soluble glucides and polyphenols can be determined. Knowledge concerning these sugars is indispensable for research work, but the methods used for their determination are not applicable in an industrial context.

As we have just demonstrated, it is impractical to imagine that a simple chemical test will furnish reliable indications as regards the sticky potential of cottons. For this reason the IRCT has developed a physical test – that of the laboratory minicard already employed in the Sudan. The test is performed on 10 grams of cotton in a room conditioned at 55% relative humidity. Different grades of cotton have been defined from no stickiness to very heavy stickiness according to a scale from 1 to 7. The minicard test quickly proved to be of interest as it gave good indications concerning the sticky potential of cottons; this was confirmed in a study in collaboration with the industry. Subsequently, other studies were initiated to demonstrate the influence of hygrometric conditions on sticky potential and the possibility of using sticky cottons mixed with non-sticky cottons.

This material has, however, its limitations; its cost is relatively high, it is bulky and requires constant servicing. In addition, the test must be performed in a perfectly conditioned atmosphere, it only gives qualitative results and the influence of the operator is considerable. In laboratory work the test is therefore of limited use.

Because of this, the I.R.C.T. micro-spinning laboratory developed a new detection apparatus in 1987, that is simple and gives quantitative results that are easily evaluable. This apparatus uses the principle of thermodetection, and furnishes results that correlate well with those of the laboratory card (Figure 2). Based on a count of the number of sticky points, it allows a precise evaluation of the extent to which the cotton is contaminated. Its principle is simple: 2.5 g of cotton conditioned at $60\% \text{ RH} \pm 5\%$ in the form of a thin flat wad are sandwiched between 2 sheets of aluminium. The sheets are placed onto the machine and pressure applied while the metal sheets are heated to a determined temperature for a fixed time period. Pressure is applied a second time, without heating, for 2 minutes so that the sticky points become fixed to the aluminium sheets. The wad of cotton is removed and the number of points counted (Figure 3); only points where cotton fibers have remained attached are counted. This test is increasingly used by both the industry and laboratories as shown by the numerous machines

currently in use worldwide (more than 53 machines in 1992, Figure 4).

The study of cotton stickiness using the thermodetector has revealed the presence of different types of honeydew within the fiber that can be visualized after analysis by the thermodetector :

- very small size honeydew,
- honeydew group,
- large honeydew,
- small honeydew with fumagin,
- large honeydew with fumagin.

All these different forms of honeydew cause various degrees of disruption during spinning ; they induce increased irregularities in sliver and yarn, occasionally lead to yarn breakages, rotor clogging and machine shut downs.

Studies have been conducted in the technology laboratory to demonstrate the impact of cotton stickiness on yarn nepposity. Whereas USTER regularimeter determine the overall number of neps, a detailed analysis of the yarn has now been developed using the USTER GGP, IPI regulator to identify imperfections and classify them into various fragments (stem fragments), seed coat fragments, honeydew, fiber neps, (R. FRYDRYCH et J. GUTKNECHT, 1989, Cot. fib. trop.).

Results showed the influence of honeydew on the number of neps. Thirty cottons from 6 varieties grown in 5 regions of the same country were spun using ring spinning to produce 20 tex yarn. A detailed analysis of yarn imperfections (Figure 5) showed that, for 4 of the sites, the number of seed coat fragments was very close to the total number of Uster neps. In this case, the number of fiber neps remained relatively constant. The number of total Uster neps at the fifth site was elevated and related to a very high number of fiber neps. A thermodetector test showed that these cottons had a very high stickiness potential.

This example let us to perform detailed regulator and thermodetection analyses on 70 cottons spun to produce 20 tex yarn. The range of cottons studied was from 140 to 1074 Uster neps and from 3 to 116 sticky points on the thermodetector. Figure 6 illustrates the strong relationship between the number of sticky points and Uster neps. An examination of figure 6 shows that it is of no practical use to take account of stickiness potential in cottons that are only slightly sticky, as they do not lead to any measurable disruption of the spinning process. As regards very sticky cottons (more than 32 sticky points), the impact on the number of fiber neps is very clear.

A detailed analysis of the yarn showed that neps produced by stickiness are of different types, forms and sizes :

- neps formed by stickiness pulling up the fibers during the ring spinning process,
- neps with a small honeydew accumulation,
- neps with a large honeydew accumulation.

What can be done to limit stickiness ?

Studies of plant health continue in order to widen ecological knowledge of the insects, to choose methods to control them, and to determine the number of treatments that need to be applied at the end of the season.

As far as selection is concerned, investigations are under way to find cotton varieties more resistant to insect attack, such as increasing leaf hairiness (for hand picking only) or decreasing the foliar surface, which would reduce the number of insects and favor penetration of insecticides.

At present, the best method to obtain cotton that is only slightly contaminated with honeydew is to harvest it early: the open boll must be exposed to insect contamination for the minimum period of time. Early harvesting is often difficult in the absence of mechanization. In the French-speaking zone of Africa for example, growers have seen their production of seed cotton double or triple in the last fifteen years whereas local manpower has remained at the same level.

The Israelis have developed a system of field spraying (20 mm of artificial rain before harvesting) which washes away all or part of the honey dew.

Other directions of research are envisaged:

- the introduction of free nitrogen-fixing bacteria into the bales of cotton that would reduce the levels of sugar and thus reduce sticky potential. This technique has not, to our knowledge, been developed on an industrial scale,
- the systematic detection of sticky bales of cotton before they enter the manufacturing process would allow the batches to be judiciously mixed to reduce the risk of sticking during spinning. The number of thermodetectors used in the spinning industry shows that sorting batches is of interest,
- a decrease in the relative humidity of the room housing the cotton reduces the intensity of stickiness,
- additives employed either during ginning or spinning have given disparate results depending on the type of stickiness, and are not commonly used,
- the practice of washing highly contaminated bales is of interest to some in the spinning industry but the technique increases the price.
- IRCT is working about two different methods to eliminate stickiness

% of evaluations indicated occurrence of stickiness

Area	1989 (%)	1991 (%)
Africa	37	38
Af.-Sdn.*	25	33
North Am.	21	32
Europe	16	18
Asia	14	21
South Am.	4	11

Figure 2 : Thermodetector vs carde



Figure 3: Stickiness potential level

Level	Number of sticky points	Stickiness potential
A	0 - 2	no sticky
B	3 - 16	light
C	17 - 32	medium
D	33 - 53	heavy
E	> 54	very heavy

Figure 4: SCT worldwide installations

Country	Number of SCT
Italy	11
France	9
Switzerland	8
Germany	3
Portugal	1
United Kingdom	1
Netherland	2
Czechoslovakia	1
Turkey	1
China	1
U.S.A.	1
Madagascar	5
Ivory Coast	1
Chad	2
Mali	2
Togo	2
Cameroun	1
Sénégal	1
Total	53

Figure 5 : Effet of stickiness on yarn nep content (USTER)

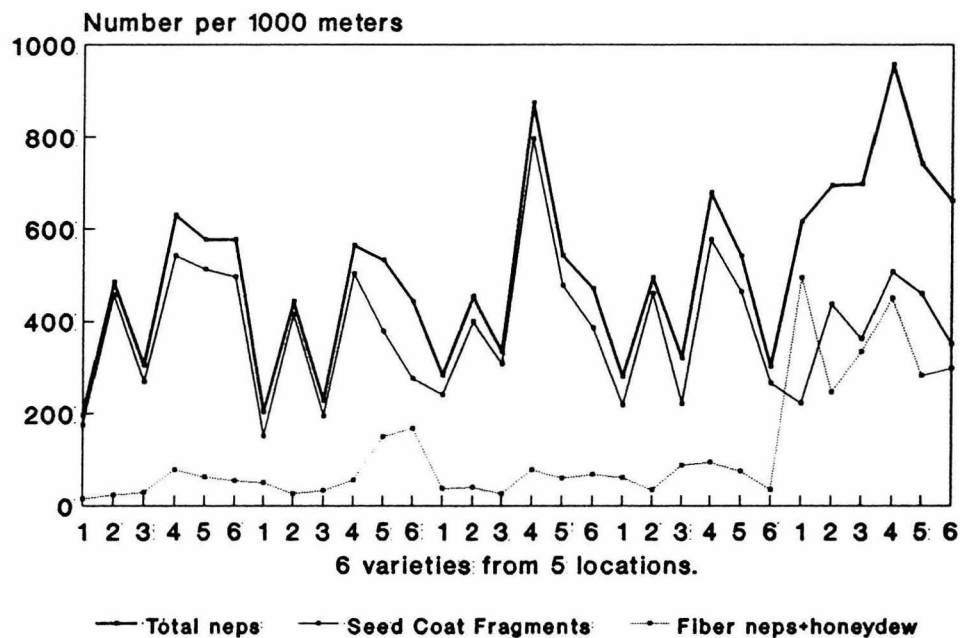


Figure 6 : Yarn nep content (USTER) VS thermodetector

Range of stickiness

Slight+moderate+high
1 to 116 sticky sports

$$\text{Neps} = 1.25 \cdot \text{SCF} + 22$$

$$R^2 = 80.6\%$$

$$\text{Neps} = 1.11 \cdot \text{SCF} + 2.64 \cdot \text{Stick}$$

$$R^2 = 92.5\%$$

Range of stickiness

Slight+moderate
1 to 29 sticky spots

$$\text{Neps} = 1.12 \cdot \text{SCF} + 28$$

$$R^2 = 91.9\%$$

$$\text{Neps} = 1.11 \cdot \text{SCF} + 2.19 \cdot \text{Stick}$$

$$R^2 = 92.9\%$$

$$\text{Fiber neps} = 2.79 \cdot \text{stickiness} + 32 \quad R^2 = 66.0\%$$