

Comparison between Three (3) New Cotton Varieties (A, B and C): Technological Characteristics of the Fibers and its Spinnability Index

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Abstract: In Mali, several studies and research have been undertaken in favor of varietal improvement of the cotton plant, which until then have focused on, among other things, the improvement of varietal species, the increase in productivity and the technological quality of fibers. The variety choice is now made at national organizational structure on the cotton sector from production up to commercialization level on the basis of variety trials conducted by national research. The choice of varieties is made according to the objectives of the moment and the requirements of the spinners. The general objective of this study is to evaluate the technological characteristics of the fibers of the cotton varieties G3 A, G3 B and G3 C with a view to their transformation through the spinning. The technological characteristics of the new varieties are generally good for the samples analyzed. In fiber technology, they are at the same level as the values sought or deemed appropriate by the textile industry. However "A" variety is the best in terms of fibers technological parameters (it is ranking in the first floor for four (4) parameters on six (6) parameters. Therefore its spinnability index is the best (SCI =139). Otherwise, concerning waste quantity it shows the least (ME% = 3.74) compared to two others. Finally, with regard to the varietal improvement objectives, the study showed that these must be clearly identified from economic and technical concerns, to lead to the development of specifications specifying the limits of the physico-technical parameters beforehand determined.

Keywords: cotton, varieties, fiber, technological characteristics, spinning.

1. Introduction

In cotton varietal improvement, the objectives sought are high productivity in the field with good adaptability to variable agro-climatic conditions, a good level of fiber yield at ginning and good technological characteristics. [1].

Thanks to the national cotton research and cotton production and sale structure efforts, we noticed the simultaneous improvement of cultivation practices and varieties has resulted in by increasing yields and improving the quality of cotton.

It is to estimate the importance of the varietal factor in this progress, both quantitative and qualitative, that a specific test was set up during the 2018/2019 campaign on three varieties A, B and C, from an experimentation point. The notion of experimentation point applies here to the national Agronomic Research Station where the cultivation of these varieties was carried out on plots. The plot is considered here as a unit of area on which the climate and cultivation techniques are considered homogeneous [2].

To achieve the objectives of this study, it will be necessary to identify the varieties which will prove to be particularly competitive and which will in fact combine several advantages including good production in the field, ease of harvesting and machining and a good yield. Ginning, large seeds and specifically for the purposes of this study, good technological characteristics: fiber length between 1¹/₁₆

(26.9 mm) and 1⁵/₃₂ (29.7 mm) and more, good tenacity, good micronaire index (fineness / maturity), colorimetry (Reflectance and yellow index) of the fiber etc.

The methodological approach put in place was structured in different phases. The seed cotton lots obtained from the experimental plots were ginned on the 20 saw gin of SRA N'Tarla. The lots of fiber obtained from this ginning were sampled by bale of each variety for the evaluation of the technological characteristics of the fibers.

For the three varieties in the multiplication phase (G3) whose seeds will be used to constitute the basic seeds of the national organizational structure on the cotton sector, fiber checks were carried out at the Laboratory of Instrumental Classification of Cotton Fiber (LCICF) of CERFITEX (Ségou) at the using fiber testing equipment.

Cotton fibers are hygroscopic, and their moisture content balances with ambient air conditions. To make the results of the various characterizations comparable with each other, over time, and in various places, it was necessary to condition the fibers in ambient air with standardized characteristics and strictly controlled in temperature and relative humidity. The tests were carried out under operating conditions respecting the required standards and practical recommendations on the use of fiber testing devices.

In general, to express the technological characteristics of the fibers of a variety, measurements were carried out on

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representative samples taken from each variety. A simple statistical analysis (mean, coefficient of variation, min and max values, standard deviation, distribution, etc.) and purely descriptive of the technological parameters was carried out to make the different characteristics comparable among themselves and between the three varieties and finally of assess the relative performance of each variety.

Overall, for the data used in this study which covers the six characteristics recommended and currently confirmed by the CSITC as sufficiently reliable for commercial purposes. The average results by variety and by characteristic show the same trend.

Also, these analyzes made it possible to have a more synthetic idea on the quality potential of each variety, the possible effects in spinning of the fiber on the quality of the yarn, to identify the varieties presenting technological characteristics corresponding to the values sought in the textile industry and whether trends related to variety are also visible.

2. Material and method

The seed cotton lots obtained from the plots were ginned on 20-saw gin. The lots of fiber obtained from this ginning were sampled by bale of each variety for the evaluation of the technological characteristics of the fibers.

For the three varieties that will be marketed and processed industrially, fiber checks were carried out at the Cotton Fiber Instrumental Classification laboratory (LCICF) of CERFITEX (Ségou) using fiber testing devices. At the end of a start-up carried out on the spinning equipment of the CERFITEX workshop. The characteristics of the semi-finished products and the yarns obtained from each variety were evaluated.

2.1. Control over fibers

For the tests on fibers, a standardized instrument for testing cotton (SITC), USTER HVI 1000 M700 type was used for the measurement of the characteristics of the fibers; a Shirley Analyzer MK2 to assess the percentage of foreign matter and good fibers and a "Sticky Cotton Thermodetector (SCT)" to assess the level of stickiness of cotton fibers.

2.2. Nature of the tests

The parameters measured on the fibers were as follows:

a) On the standardized instrument for testing cotton (SITC), USTER HVI 1000 M700, the six characteristics recommended and currently confirmed by the CSITC as sufficiently reliable for commercial purposes were measured, they are:

- Micronaire (Mic without unit),
- Tenacity (Str in g / tex),
- Upper Half Mean Length (UHML) (in mm),
- Length Uniformity Index (UI, in%),
- Color reflectance (Rd, in%),
- Yellow index (+ b without unit).

b) On the Shirley Analyzer MK2 were determined:

- The percentage of good fibers MF%
- The percentage of heavy waste MD%
- The percentage of fragments of fiber MFF%
- The percentage of dust MP%
- The percentage of foreign matter ME%
- Visible losses in%.

c) On the "Sticky Cotton Thermodetector (SCT)", the following measurements were taken:

- Number of sticky points
- Cotton stickiness level.

2.3. Operating conditions

Cotton fibers are hygroscopic, and their moisture content balances with ambient air conditions. To make the results of the various characterizations comparable with each other, over time, and in various places, it was necessary to condition the fibers in ambient air with standardized characteristics and strictly controlled in temperature and relative humidity. The tests were carried out under the following operating conditions:

• For the standardized instrument for testing cotton (SITC), USTER HVI 1000 M700:

All representative samples of cotton fiber taken by bale of each variety were collected, grouped, conditioned in the CERFITEX Cotton Fiber Instrumental Classification laboratory in a standard atmosphere (20 ° C +/- 2 ° C and 65% +/- 4% Relative Humidity (RH), according to ISO 139: 2005) for at least 24 hours and tested in accordance with the required standards and practical recommendations on the use of the standardized instrument for testing cotton (SITC) [3].

As the commercial methodologies common to fiber tests do not allow the required level of precision to be achieved [4], they have been adapted to the specific practical recommendations put in place by the breeders as follows: obtaining a homogeneous mixture of fibers, compliance of the operating mode making it possible to limit the variability of the results and to increase the representativeness of the sample and finally for the SITC device, each time carry out six (06) measurements per sample of each variety. The operating condition and the calibration of the various modules of the SITC device were checked or even calibrated at the start of the tests according to the manufacturer's instructions using universal reference materials called Universal High Volume Instrument Calibration Cottons (UHVICC).

• For the Shirley Analyzer MK2:

After conditioning for 24 hours in a standard atmosphere at 20 ° C. ± 2 and 65% ± 4 RH, 100 g of fibers were weighed per sample taken from each bale and per variety. This specimen of 100 g of fiber after passing through the Shirley Analyzer gives MF1 = weight of fiber and MD1 = weight of foreign matter. MD1 is passed through the machine again giving MF2 = weight of fiber and MD2 = weight of foreign material. The good fibers have been separated from the foreign matter, the final fiber weight is obtained by adding

MF1 and MF2 and then the respective percentages of good fibers and waste have been deduced.

• **For the SCT thermodetector:**

For the measurement of stickiness, three (3) specimens of 2.5 g were weighed per sample taken from each bale and per variety after conditioning for 24 hours in a standard atmosphere at 20 ° C ± 2 and 65% ± 4 RH. Each specimen was opened on a mechanical opener, then sandwiched between the non-shiny sides of two sheets of aluminum on which, thanks to a thermal and mechanical action (pressure) of two plates.

After cooling the plates, the deposits of the sticky points on the two aluminum sheets were counted and their number determining the extent of stickiness or the level of stickiness of the cotton was evaluated.

The calibration and verification of the calibration of all these test devices was carried out in order to relate the measurement results obtained in the series of analyzes carried out in the laboratory to international references and also to verify their stability over time. Thanks to these provisions, sufficient details can be achieved in order to allow good efficiency in the choice of variety.

3. Results and discussions

In general, to express the technological characteristics of the fibers of a variety, measurements were carried out on representative samples taken from each variety. A simple statistical analysis (mean, coefficient of variation, min and max values, standard deviation, distribution, etc.) and purely descriptive of the technological parameters was carried out to make the different characteristics comparable among themselves and between the three varieties and finally to evaluate the performance relative of each variety.

3.1. On the standardized instrument for testing cotton (SITC), USTER HVI 1000 M700

To express the quality characteristics of the fibers by variety, from measurements taken on the samples, an average value was calculated (Table 1). In this table 1, we have compared by variety and by characteristic, the average values of the results obtained on the quality of the fibers. This exercise allows us to have a synthetic idea of the quality potential of each variety and also to know whether trends related to the variety are also visible.

Table 1: Statistical representation of the results of measurement of the characteristics of fibers by variety on the USTER HVI 1000 M700

(a)

Cotton Varieties	Characteristics								
	SCI	Mst	Mic	Mat	UHML	UI	SF	Str	
A	Moyenne	139	7,8	3,55	0,85	28,86	81,6	8,3	31,0
	Std.Dev.	5	0,2	0,02	0,00	0,46	0,5	0,3	1,1
	CV%	3,5	2,4	0,6	0,1	1,6	0,6	4,2	3,4
	Min	133	7,6	3,52	0,85	28,34	81,0	7,7	29,2
	Max	146	8,0	3,58	0,85	29,60	82,4	8,6	32,2

B	Moyenne	136	7,6	3,69	0,85	28,35	81,6	8,4	30,4
	Std.Dev.	5	0,2	0,02	0,00	0,28	0,8	0,5	0,6
	CV%	3,5	2,2	0,6	0,1	1,0	1,0	5,9	1,9
	Min	128	7,4	3,67	0,85	28,01	80,4	7,7	29,9
	Max	141	7,8	3,72	0,85	28,77	82,8	9,1	31,4
C	Moyenne	127	7,5	3,98	0,86	28,86	80,9	9,2	29,4
	Std.Dev.	6	0,2	0,11	0,00	0,50	0,7	0,7	0,7
	CV%	4,5	2,7	2,8	0,3	1,7	0,9	7,8	2,5
	Min	119	7,3	3,88	0,86	28,23	80,1	8,3	28,4
	Max	134	7,7	4,14	0,86	29,47	82,1	10,1	30,5

(b)

Cotton Varieties	Characteristics								
	Elg	Rd	+b	CGrd	TrCnt	TrAr	TrID	Elg	
A	Moyenne	5,5	77,4	10,2	22-1	19	0,19	2	5,5
	Std.Dev.	0,1	0,3	0,5		3	0,07		0,1
	CV%	1,4	0,3	4,9		17,5	34,6		1,4
	Min	5,4	76,9	9,6		14	0,14		5,4
	Max	5,6	77,7	10,8		23	0,29		5,6
B	Moyenne	5,4	78,2	11,0	12-1	17	0,32	3	5,4
	Std.Dev.	0,1	0,3	0,1		3	0,14		0,1
	CV%	2,2	0,3	0,9		20,0	42,4		2,2
	Min	5,2	77,7	10,9		11	0,11		5,2
	Max	5,5	78,4	11,2		21	0,47		5,5
C	Moyenne	5,4	75,8	11,4	13-2	19	0,22	2	5,4
	Std.Dev.	0,1	0,2	0,3		6	0,04		0,1
	CV%	1,2	0,3	2,8		33,0	17,7		1,2
	Min	5,3	75,5	11,0		12	0,18		5,3
	Max	5,5	76,1	11,8		26	0,28		5,5

The average results of the characteristics of the fibers obtained by variety are as follows:

• **Upper Half Mean Length (UHML) (mm)**

All three varieties exhibit a good silk length of between 1”1/8 and 1”5/32 (28 mm and 29.7 mm). The “A” variety exhibits a potential silk length of approximately 28.86 mm which is equal to that of “C” (28.86mm) followed by “B” (28.35mm). These lengths are comparable to those of long bristle cottons, ideally suited for making medium gauge yarn up to Ne (60-70) and Nm (101.6 - 118.5). It can also be used as a base to improve the titration of short bristles by spinning mixing.

• **Length Uniformity Index (%)**

The uniformity of length is average for all three new varieties with a value between 80.9 and 81.6% against a recommendation of 80 to 85% and above.

“A” and “B” have the best length uniformities (81.6%) followed by “C” (80.9%).

• **Micronaire (without unit)**

For all three varieties, the value of the micronaire is between 3.55 and 3.98 against a recommendation of 3.7 to 4.90. Micronaire is average overall for “C” (3.98) and “B” varieties; it is low for “A” (3.55).

It is generally believed that cottons with too low or too high a micronaire should be avoided, with the commercially desirable values or ideal range lying between 3.7 and 4.2. Values below 3.7 are nevertheless preferable as long as the

cotton is mature, especially for rotor spinning.

• Resistance / Tenacity (g / tex)

The fibers of these three varieties are very resistant for all the samples analyzed with values between 29.4 and 31 g / tex against a recommendation of 26 to 32 g / tex and more. However, compared to the other two varieties, “C” shows relatively low resistance on the samples analyzed.

The color of a cotton is determined by its yellow index (+ b) and its reflectance (Rd). The yellow index gives an indication of the pigmentation of cotton and the reflectance on its shine.

• Yellow index (+ b without unit)

The fiber of the new varieties analyzed is lightly creamed overall “A” (+ b: 10.2), “B” (+ b: 11, 0) to cream “C” (+ b: 11.4).

• Color reflectance (Rd, in %)

The fiber of the new varieties analyzed is particularly bright for “B”: Rd (78.2%) to bright “A” (Rd: 77.4%), “C” (Rd: 75.8%).

Generally, for these characteristics, the following values are nevertheless preferable: + b <10 and Rd > 75%. In our case the reflectance is from good to very good.

Table 2: Summary of the above analyzes and discussions

Characteristics / Technological parameters	Performance rank ranking			Observations
	1	2	3	
Length UHML (mm)	“A” and “C” (28,86 mm)	“B” (28,35 mm)		Very well These lengths are comparable to those of long silk cottons.
Length Uniformity Index (%)	“A” and “B” (81,6%)	“C” (80,9 %)		Good Recommendation respected (80 to 85% or more)
Micronaire (without unit)	“C” (3,98)	“B” (3,69)	“C” (3,55)	Medium for C and B Low for A Recommendation (3.7 to 4.9)
Strength / tenacity (g / tex)	“A” (31 g/tex)	“B” (30,4 g/tex)	“C” (29,4 g/tex)	Good Recommendation respected (26 to 32 g / tex)
Yellow index + b (without unit)	“A”+b = 10,2	“B” +b = 11	“C” +b = 11,4	Insufficient Recommendation (+ b less than 10)
Color Reflectance Rd (%)	“B” Rd = 78,2 %	“A” Rd = 77,4 %	“C” Rd = 75,8 %	Sufficient to Good Recommendation (Rd greater than 75%)

We have relatively similar values on the three varieties and we can note that at equal potential, the “C” is of lower quality compared to “B” and “A” respectively. The latter, in view of the results obtained is distinguished better on all measured characteristics.

For the three varieties, the average results by variety and by characteristic show in the end that it is “A” which presents a better fiber for the criteria, uniformity of length, percentage of short fibers, tenacity, elongation, yellow index and also better or equal for the other characteristics (length, maturity, reflectance). Its micronaire index is relatively low than those of “C” and “B” respectively, but with the same level of maturity as that of “B”. Therefore, “A” exhibits the better level of spinability index (SCI: 139) than the other two varieties “B” (SCI: 136) and “C” (SCI: 127) which also showed better results.

Overall, for the data used in this study which relate to the six characteristics recommended and currently confirmed by the CSITC as sufficiently reliable for commercial purposes (see above), the average results by variety and by characteristic, however, show the same trend (Figure 1).

Comparison of the commercial characteristics of fibers

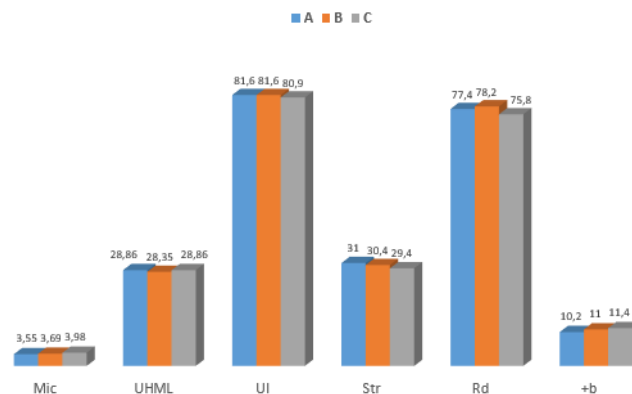


Figure 1: Average results by variety and by characteristic

These analyzes made it possible to have a more synthetic idea of the quality potential of each variety, of the possible effects in spinning of the fiber on the quality of the yarn, to identify the varieties with technological characteristics corresponding to the values sought in the textile industry and also whether trends related to variety are also visible.

Finally, the technological characteristics of the new varieties are generally good for the samples analyzed. In fiber technology, they are at the same level as the values sought or deemed appropriate by the textile industry.

3.2. On the Shirley Analyzer Mk2

The waste control was carried out in the laboratory on the Shirley Analyzer Mk2. It made it possible to optimize the cleaning of the cotton, since it was possible to recover the good fibers put in waste by a second pass, and to determine the percentage of good fibers (% BF) and that of real waste. The results of measuring the percentage of good fiber, foreign material (waste) and determining the USDA grade by variety are shown in Table 3:

Table 3: Statistical results of the measurement of the percentage of good fibers, the percentage of foreign matter (waste) and the USDA grade on Shirley Analyzer Mk2

	MF%	MD%	MFF%	MP%	ME%	LOSSES %	Analogy with the USDA grade
C	96	1,78	0,12	2,1	3,88	8,51	SM
A	96	1,77	0,26	1,97	3,74	8,38	SM
B	96	1,14	0,11	2,75	3,89	8,52	GM

For the three varieties, the percentage of good fibers is identical (96%). The percentage of foreign matter (ME) varies slightly from 3.74 to 3.89%. The estimate of manufacturing losses according to the variety shows a greater loss for the industrial spinner in waste / ME, since it cannot be optimized, which ranges from 8.38% to 8.52%. The varietal impact on the rate of spinning waste therefore has its technical importance (wear of the linings, quality, etc.) and economic (cost price). Here again it is the variety "A" which presents the least waste (ME%) compared to the two other varieties.

3.3. Stickiness detection on Sticky Cotton Thermodetector

The cotton sticking control was carried out in the laboratory on the SCT Thermodetector. It was used to assess the level of stickiness of the cottons, since it was possible to determine the number of sticky dots by counting. The results of the measurement of the stickiness level by variety (mean, standard deviation, CV% and max and min values) by variety are shown in Table 4.

Table 4: Statistical results of measuring stickiness by variety on SCT Thermodetector

	G3 "C"	G3 "A"	G3 "B"
Average	25	32	37
SD	1	1	2
CV%	4	4	5,4
Max. value	26	33	39
Min. value	24	31	35
Stickiness level	Medium	Medium	Strong

For the three varieties, the stickiness level varies slightly from 25 to 37. The sticky point count shows that "B" has a high stickiness level (37) compared to "C" and "A" which have levels of stickiness bonding means, respectively (25) and (32). The impact of the level of stickiness on "B" in spinning is therefore of technical importance (disruption of the manufacturing process, quality etc.) and economic (cost price).

4. Conclusion

The technological characteristics of the new varieties are generally good for the samples analyzed. In fiber technology, they are at the same level as the values sought or deemed appropriate by the textile industry.

However for the six fibers technical parameters (determined on USTER HVI 1000 M700), "A" has the first floor on four (4) parameters; "B" on two (2) parameters and after "C". It is interesting to notice that "C" has the third floor on four (4) parameters. Consequently these varieties perform in the following order: "A", "B" and "C".

We observed that this ranking is in correlation with the level of spinnability index: "A"=SCI : 139, "B"=SCI : 136 and "C"=SCI : 127.

Concerning Shirley Analyser MK2. The variety "A" exhibits the least waste (ME = 3.74 %) compared the two others.

For the stickiness measurement (realized on thermodetector SCT), "B" indicates strong stickiness. This is not desirable for spinning industry.

In view of above information, we can say without being wrong that "A" variety is the best in term of fibers characteristics for spinning industry in comparison to the fibers of the two other cotton varieties.

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