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Variations In Fiber Length And Color Parameters Of Four Varieties Of Cotton (Gossypium Hirsutum L.) In Two Climatic Zones Of Mali

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Abstract
Varietal selection involves developing varieties that best satisfy the requirements of growers (better productivity in the field), the ginning industry (high fiber yield), and the spinning industry (good technological fiber characteristics). The price of cotton fiber is essentially linked to the characteristics of the fiber. When selecting cotton varieties, it is essential to be very attentive to the characteristics and variations of the fiber in different environments. The aim of this study is to investigate variations in the fiber length and color parameters of four cotton varieties of Mali. Four cotton varieties were tested in two different environments, the southern and north-central zones of Mali, for variations in fiber length and color. The analysis showed a significant interaction between varieties and zones. The values of the parameters studied varied from one zone to another for the same variety. The best values for the Upper Half Mean Length(UHML) were obtained in the southern zone, while the uniformity index was better in the north-central zone. The colorimetry of all the varieties was good in the north-central zone, with a good percentage reflectance value and low levels of fiber yellowing. Variability in fiber properties at the crop production level can be used to determine potential and genotype choice.

Keywords:*length, colour, fibre, variation, cotton, Mali*

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I. Introduction

Cotton is the world's leading natural textile fiber. Its quality must constantly be improved to face competition from synthetic fibers and to adapt to the constant modernization of spinning systems (Nacoulima&Mergeai, 2014). Cotton fiber accounts for around 50% of the cost of yarn and there is a direct correlation between the quality of the fiber and that of the yarn. The price of cotton fiber is essentially linked to the characteristics of the fiber (Estur, 2008). Cotton spinning mills and fiber traders are becoming increasingly demanding with regard to the intrinsic quality of cotton fiber (IER, 2008).

On a physiological basis, the fiber quality of any cotton genotype is a composite property determined by complex interactions among the genetic potential of the genotype, the environmental fluctuations experienced by the maternal plant from planting through harvest, and the genetically controlled responses of the genotype to those environmental fluctuations (Bradow and Davidonis, 2010).

Cotton is an important export crop in sub-Saharan Africa, and the region currently accounts for 15% of world exports. Overall, cotton production in the region has been increasing for several years, mainly due to the expansion of the area under cotton (OCDE/FAO 2021). Cotton is produced in more than 40 Sub-Saharan African (SSA) countries, 30 of which export their production. Export volumes from SSA should continue to grow at a rate of around 2.7% per year over the next ten years, maintaining the region's market share at around 15% as in the reference period. The main destinations for these exports will be South Asia and Southeast Asia (OCDE/FAO 2021).

Mali is one of the key cotton-producing countries in sub-Saharan Africa, where cotton plays an important role in agriculture (Camara, 2015). Cotton growing in Mali is exclusively rainfed (CMDT & IER. 2005). With a production record of more than 760,000 tones for the 2020-2021 season, Mali has once again become the leading cotton-producing country in Africa (AFRICANEWS, 2022). Cotton cultivation provides income for 40% of the rural population, accounts for 15% of GDP, provides 22% of export receipts and 12% of

budget receipts (Panara, 2018). The amount of cotton processed by the Malian textile industry is less than 2% (Konaté, 2018), so all of Mali's cotton fiber production is exported. Because of the dependence of cotton fiber prices on fiber characteristics, such as: length, strength, color and maturity, essential elements of cotton fiber quality, it is important to be very watchful of fiber characteristics through the cotton breeding and selection program. The aim of this study is to investigate variations in the fiber length and color parameters of four cotton varieties.

II. Material and Methods

Study site

This study was carried out in 2019 in the south and north-central cotton-growing areas of Mali, including 12 and 19 villages in the south and north-central areas, respectively. A total of 31 villages. The southern zone is located in the Sudano-Guinean climatic area with mean annual rainfall > 1000 mm and the north-central zone in the Sudanian climatic area with mean annual rainfall between 600 mm and 1000 mm (Figure 1).

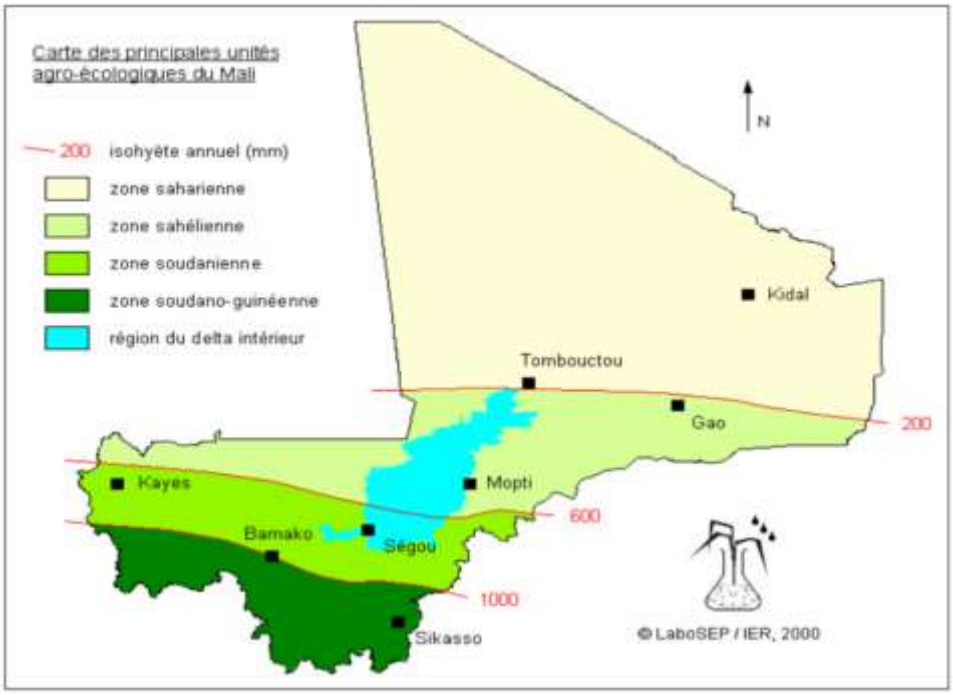

Figure 1: *Map of Mali's eco-climatic zones ((National Meteorological Direction, 2007)*

Plant material

The plant material consisted of four cotton varieties: BRS 293 of Brazilian origin (already released), NTA L65, NTA B149 and NTA E154, all of Malian origin (in the process of being released).

Experimental design

The trial was set up in a Fisher block design with two replications. The elementary plot was composed of 5 lines of 30 m each for one variety. The spacing, plant to plant and row to row distances were 0.30 and 0.80 m, respectively. Removal of 2 plants; 3 weeks after general emergence of the plants.

Mineral fertilizer supply

Mineral fertilizers are applied uniformly under the sowing rows at a rate of 200 kg/ha of 14 N-18 P2O5-18 K2O+6S+1B cotton complex and 50 kg/ha of 46% N urea 40 days after emergence.

Phytosanitary protection

The current (standard) calendar treatment was applied, with six insecticide treatments at 14-day intervals from the start of flowering. The first two treatments were made with Tihan and Callifan Extra for the other treatments.

Harvesting and Ginning

Harvesting is done in two stages. The first stage is between the 120th and 130th day of vegetation; the second stage, when the remaining bolls have fully opened. Only the bolls from the three central lines of each band are harvested and placed in separate bags marked with the name of each variety. They were then transported to the N'Tarla research station for ginning at the 20-saw factory. After ginning, 100g of fiber per variety and per site was taken for technological analysis using the High-Volume Instrument (HVI) at the Ségou metrology laboratory.

Data collection

The data collected after the HVI analysis involved two length parameters (UHML and UI) and two-color parameters (Rd and +b).

Upper Half Mean Length (UHML mm) or Fiber length

The HVI upper half mean length (UHML) is the average length of the longest 50% of fibers in a sample or bale (American Society for Testing and Materials, 1994b). This measurement is used to place cotton into the five upland staple classes which are short (<21.0 mm), medium (22.0 mm - 25.0 mm), medium-long (26.0 mm - 28.0 mm), long (29.0 mm. - 34.0 mm), and Extra-Long Staple (ELS) (>34.0 mm) (Bradow&Davidonis 2000).

The importance of fiber length to textile processing is significant. Longer fibers produce stronger yarns that allow for more valuable end products. Longer fibers also enable higher spinning speeds.

Uniformity Index (UI %) or fiber length uniformity

Basically, it is the ratio of mean length to UHML and is a measure of fiber uniformity in the sample expressed as a percentage. Thus, UI is expressed as

i.e. UI= M.L/UHML x 100

i.e. ratio of the average length of all fibers to the average length of the longest fibers. Altogether, lesser value makes processing more to lower the quality of the product (USDA, 2001).

Length uniformity affects yarn evenness and strength, and the efficiency of the spinning process This measurement is used to place cotton into the five upland staple classes which are very low (Less than 77 %), low (77~80 %), medium (81~84 %), high (85~87 %), and very high Above 88 %)(USDA, 2001).

Reflectance degree (Rd %) or whiteness and yellowness (+b unit)

The color grade is determined by the degree of reflectance (Rd) and yellowness (+b). Reflectance indicates how bright or dull a sample is and yellowness indicates the degree of color pigmentation (USDA, 2001). Cotton fiber color is one of the most important properties that determines the price of cotton.

Data analysis

Analysis of variance was performed at the 5% threshold using GenStat 12th Edition software. The effects of replicates and blocks were considered to be random, while those of genotypes were considered to be fixed. The results are presented in graph form using Excel 2013.

III. Results and Discussion

Upper Half Mean Length (UHML mm)

Length is an important quality criterion, but one that is highly variability in seed cotton harvests (Judais, 1997). The results of the analysis of variance (ANOVA), presented in Figure 2, show a significant interaction ($p<0.05$) between variety fiber length and zone. In the southern zone, the fiber length of all the varieties studied except NTA L65 is greater than in the central northern zone. And a significant difference between varieties for fiber length in the southern zone was also revealed by the analysis of variance. The variety NTA E154 has the best UHML length in both zones compared with the other varieties. NTA L65 had the lowest fiber length in the southern zone, but the best in the north-central zone after NTA E154. Judais (1997) distinguished between variability in fiber length between plants in the same environment and variability within a plant in different environments.

Uniformity Index (UI %)

The results in Figure 3 show that the uniformity index value of all varieties is higher in the north-central cotton zone than in the southern zone, except for the variety NTA E154.

The variety NTA B149 obtained the best uniformity index value in the north-central zone and the second-best value in the southern zone after NTA E154. These results are in agreement with those of Ünlü et al (2011) and Beslemes et al (2022) or the uniformity index, who obtained significant differences between genotypes in different environments.

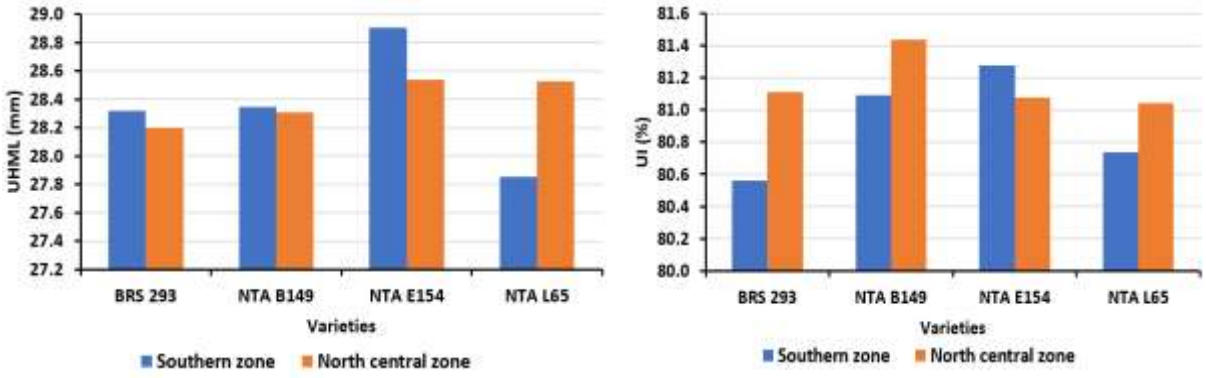

Figure 2. Upper Half Mean Length (UHML mm) of fiber in Southern and North central zone of Mali
Figure 3. Uniformity Index (UI %) of fiber in Southern and North central zone of Mali

Reflectance (Rd %) and Yellowness (+b)

The results showed that the reflectance and yellowness of the fiber for all varieties were better in the north-central zone. Beslemes et al (2022) observed significant environmental variations for the quality attributes of reflectance (Rd) and yellowness (+b).

We found that the colorimetry of the varieties was degraded in the southern zone where rainfall was more abundant. Wet conditions or rain can change the color of cotton from white to light-spotted or spotted (Beslemes et al. 2022). Wet conditions or rain increase microbial damage, which can reduce color quality (Luo, 2016). The color of cotton fibers can be affected by rainfall, freezes, insects, fungi, and staining through contact with soil, grass, or cottonplant leaves. Color can also be affected by excessive moisture and temperature levels during storage, both before and after ginning (www.cottoninc.com). The BRS 293 variety has the best percentage reflectance value and the lowest fiber yellowing rate. The varieties NTA B149 and NTA E154 obtained degrees of yellowing that were too high (higher than the norm) in the southern zone. The results are illustrated in Figures 4 and 5.

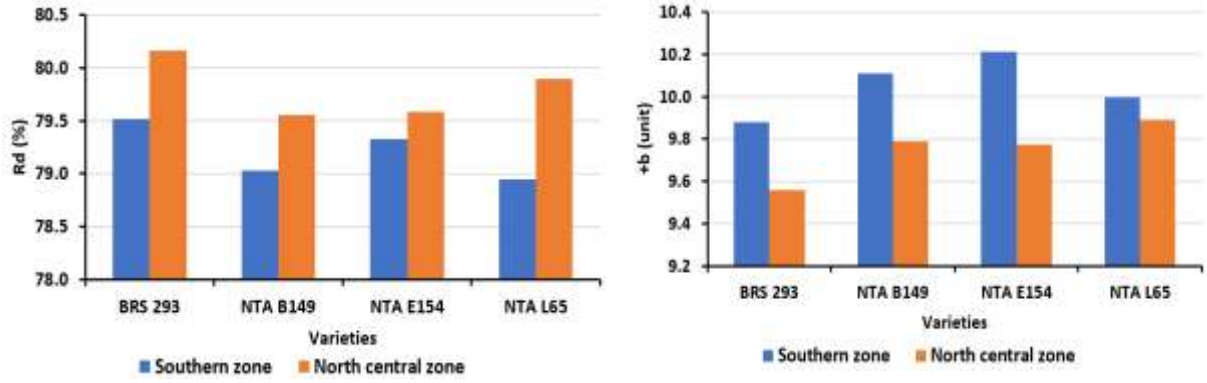

Figure 4. Reflectance (Rd %) of fiber in Southern and North central zone of Mali
Figure 4. Yellowness (+b) of fiber in Southern and North central zone of Mali

IV. Conclusion

Growth in cotton yields must be accompanied by an improvement in the technological characteristics of the fiber. The cost of manufacturing yarn depends on the quality of the fiber, which accounts for between 50 and 70% of the cost.

This study identified different behaviors of the same cotton variety for a given fiber parameter when the environment changes. For the choice of a variety for vulgarization, varieties that are stable in all production areas are recommended, otherwise the variety should be chosen for the area in which it best expresses its potential for the desired characteristic(s).

The variability of fiber properties at crop level can be used to determine the potential and the genotype choice.

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