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Comparison of Physical Properties of Different Varieties of Cotton

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Abstract. Nineteen varieties of cotton of different countries of origin were subjected to tests for determination of physical properties of fibre viz., length (mm), length uniformity (%), short fibre index (SFI %), strength (g/tex), elongation (%), fineness (Micronaire value), reflectance (Rd value) and yellowness (+b value), using the Uster HVI system. Egypt (Giza 70), Egypt (Giza 88), India (MCU 5), USA (Elpaso), Egypt (Giza 86), Sudan (Barkat) and CIS (Sultop) had better overall fibre length, strength and length uniformity %, and low SFI %. Pearson correlation of these physical properties was also determined. A strong positive correlation was found among fibre length, strength and length uniformity while all three of these properties exhibited a strong negative correlation with SFI %.

Keywords: cotton fibre, physical properties, cotton varieties

Introduction

For the last six decades, despite competition from man-made fibres, cotton fibre has maintained its importance and utility to date. It plays an important role in the global economy. The total world production of cotton in the year 2005-2006 was reported at 24.85 million tons (www.fas.usda, 2005). The price of this production is estimated at more than US$ 35 billion with a very high potential of value addition.

The quality of cotton fibre is important in spinning and subsequent processes. It not only influences the lint price but also determines the use to which it is to be best put. Innovations in textile machinery demand increasingly better fibre quality to meet the processing needs and the quality of the end product. Fibre length, fineness, length distribution, strength, elongation and maturity are the most important quality factors of cotton for textile processing. In spinning, the importance of fibre quality varies with the spinning techniques e.g. ring, rotor and air-jet. Fibre qualities determine the yarn strength, yarn regularity, and handle and lustre of fabrics (Zeidman and Sawhney, 2002; Patel and Patil, 1975; Iyengar and Gupta, 1974a, 1974b; Weiss *et al.*, 1964).

A large number of cotton varieties are grown in more than seventy countries under different conditions of climate, soil and environment. The varied conditions and different varieties of cotton plant affect the ultimate cotton fibre characteristics. The present work was designed to study the physical properties of various cotton varieties and their correlation among one another.

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Materials and Methods

Samples of the following nineteen varieties of cotton fibres originating from ten different countries of origin were obtained:

American varieties:	SJV Pima; Elpaso; Memphis; Mote
Egyptian varieties:	Giza 70; Giza 88; Giza 86
CIS varieties:	Elisa; Sultop
Sudanese variety:	Barkat
Indian varieties:	MCU 5; Shanker 6
Mali variety:	Mali
Greek variety:	Greece
Brazilian variety:	Brazil Lot 1832, Lot 1017, Lot 992
Ivory Coast variety:	Ivory Coast
Pakistani variety:	Pak

Representative specimens from the cotton samples were prepared, using standard sampling procedure (ASTM-D, 2000). The specimens were conditioned in the laboratory as per prevalent practice (ASTM-D, 1998). The physical properties, viz., length (mm), length uniformity (%), short fibre index (%), strength (g/tex), elongation (%), fineness (Micronaire), reflectance (Rd value) and yellowness (+b value) were measured by using the Uster HVI system (ASTM-D, 1995). Then correlation of these physical properties was determined.

Results and Discussion

Table 1 shows the summary of the test results obtained.

Fibre length. A graphical representation of the comparison of average length of different varieties of cotton is given in Fig. 1. As can be seen, out of nineteen cotton varieties tested, nine had an average fibre length of 30 mm or above. USA (SJV Pima) cotton fibres were found to be the longest in the tested group of varieties, while Brazil (Lot, 992) cotton fibres were found to be the shortest in length.

Fibre length is critical to making yarn of a specific fineness and handle. Since longer fibres possess higher holding surface as compared to shorter fibres they require less twist to produce maximum yarn strength. In order to achieve the same strength of yarn spun from shorter fibres, higher twist level is required (Ramey *et al.,* 1977; Pan *et al.,* 2001). Increasing twist level beyond an optimum level reduces fibre strength resulting in loss in yarn strength. Thus stronger and softer yarns are produced at lower twist and higher production levels from longer fibres.

Table 1. Physical properties of different varieties of cotton fibres

Name of cotton variety	Length (mm)	Uniformity (%)	SFI (%)	Strength (g/tex)	Elongation (%)	Mic. value	Rd value	(+b) value
USA (SJV Pima)	35.2	83.4	6.8	28.8	6.7	4.35	75.1	10.2
Egypt (Giza 70)	35.1	86.9	3.5	39.8	5.2	3.80	75.4	10.9
Egypt (Giza 88)	34.8	86.4	3.5	39.4	4.6	3.75	68.0	13.6
USA (Elpaso)	34.3	85.9	3.5	38.9	6.2	4.60	78.1	9.5
CIS (Elisa)	33.7	83.5	4.7	32.3	5.6	3.80	70.0	13.9
CIS (Sultop)	33.1	85.3	3.5	36.8	7.6	3.85	76.5	11.8
Egypt (Giza 86)	32.4	85.8	3.5	36.7	6.9	4.00	74.9	12.2
Sudan (Barkat)	31.8	85.7	3.5	37.0	5.9	3.90	70.3	12.2
India (MCU 5)	30.1	86.4	3.5	39.1	5.9	3.85	73.2	11.5
Mali 29.0	82.3	7.5	27.9	5.7	4.30	63.7	14.6	
India (Shanker 6)	28.8	83.0	7.0	29.4	5.7	3.40	76.4	9.5
Greece	28.6	84.0	4.9	32.7	5.0	4.35	80.5	9.5
Brazil (Lot 1832)	28.4	83.7	5.9	31.6	5.5	4.80	80.6	9.1
Ivory Coast	28.3	82.7	7.3	30.2	5.3	3.35	80.7	11.3
USA (Memphis)	28.3	82.7	7.7	30.3	5.5	4.50	76.1	8.2
Brazil (Lot 1017)	28.3	82.8	7.1	29.8	5.4	4.20	75.8	9.1
Pak 27.7	83.6	6.3	29.6	6.0	3.45	75.1	10.1	
USA (Mote)	27.7	81.6	9.1	28.1	7.0	3.65	76.4	14.2
Brazil (Lot 992)	27.4	83.5	6.3	30.8	7.3	3.80	77.6	10.6

SFI = short fibre index; Mic. value = micronaire value; Rd value = reflectance value; (+b) value = yellowness

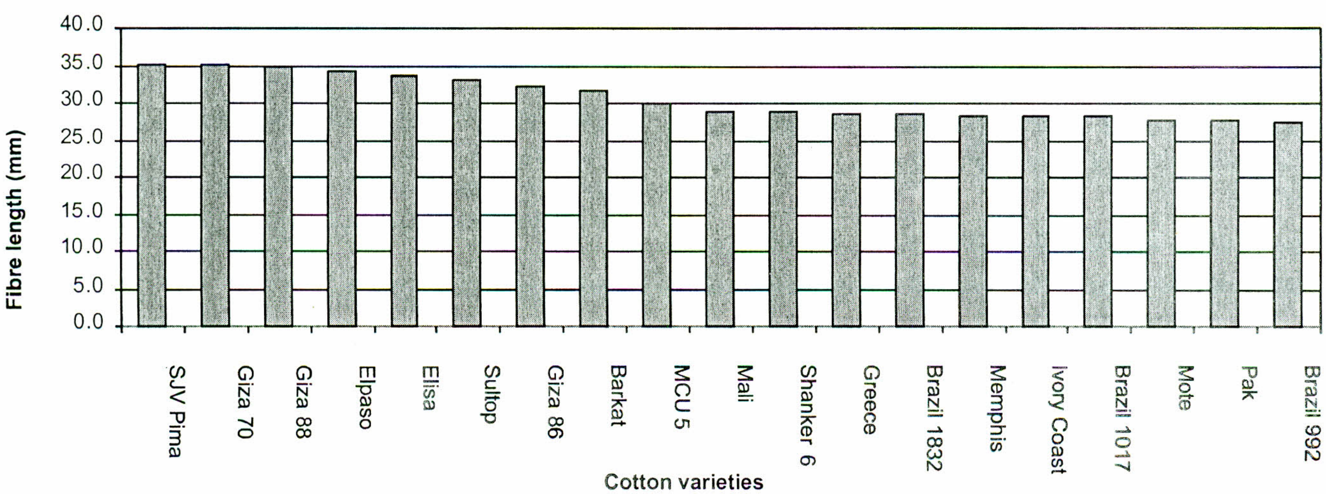

Fig. 1. Comparison of fibre length of different cotton varieties.

Length uniformity and short fibre index. A comparison of fibre length uniformity (%) of different varieties of cotton is given in Fig. 2. Seven cotton varieties, viz. Egypt (Giza 70), Egypt (Giza 88), India (MCU 5), USA (Elpaso), Egypt (Giza 86), Sudan (Barkat) and CIS (Sultop), have length uniformity (%) greater than 85%. USA (Mote) was found to have the lowest length uniformity (81.6%).

Fig. 3 shows the comparison of Short Fibre Index (%). USA (Mote) has the highest percentage of short fibres, while CIS (Sultop), Sudan (Barkat), Egypt (Giza 86), USA (Elpaso), India (MCU 5), Egypt (Giza 88) and Egypt (Giza 70) have very low SFI (%) of less than 4.

Fibres in the cotton boll do not show greater length variation (Klein, 1998). Shortening of fibres occurs due to mechanical working mainly during plucking and ginning. High length uniformity and low short fibre index are essential to improve the yarn appearance and strength along with reduced manufacturing waste and higher productivity during spinning.

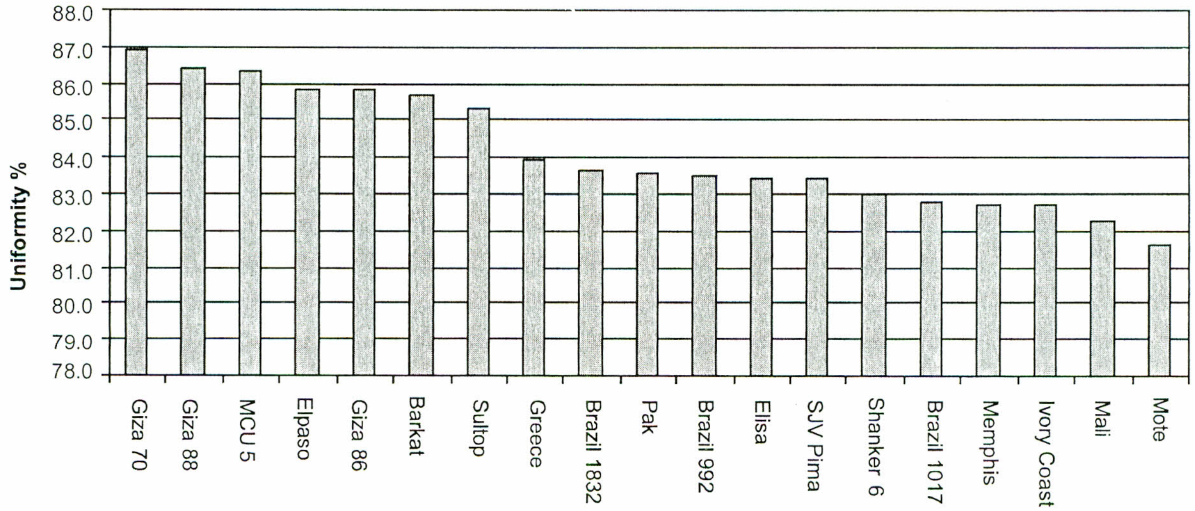

Fig. 2. Comparison of fibre length uniformity (%) of different cotton varieties.

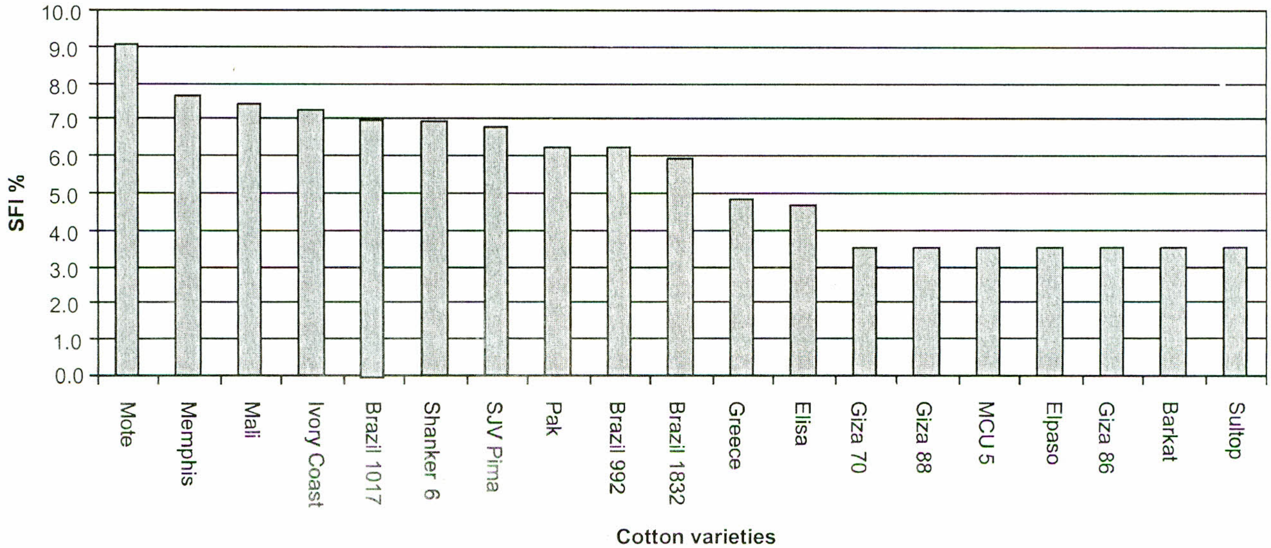

Fig. 3. Comparison of SFI (%) of different cotton varieties.

Fibre strength. Comparison of strength of different varieties of cotton fibres is given in Fig. 4. As can be seen that the same seven qualities, which have the lowest values of SFI (%), have very good fibre strength, which is greater than 35 g/tex. Mali cotton fibres have the lowest strength in the tested group. Fibre strength determines yarn strength, thus it is directly related to ends down in yarn manufacturing, weaving and knitting (Neelakantan and Subramaniam, 1976; Bogdan, 1967).

Fibre elongation. Fig. 5 indicates elongation (%) of different cotton varieties. As can be noticed, Egypt (Giza 88) has the lowest elongation (%), although it was found to have the very good fibre strength (Fig. 4). The influence of fibre elongation on yarn quality and weaving performance is well known. Fibre elongation is extremely important since textile products without elasticity would hardly be functional. But for normal textile goods higher fibre elongations make process difficulties in yarn manufacturing.

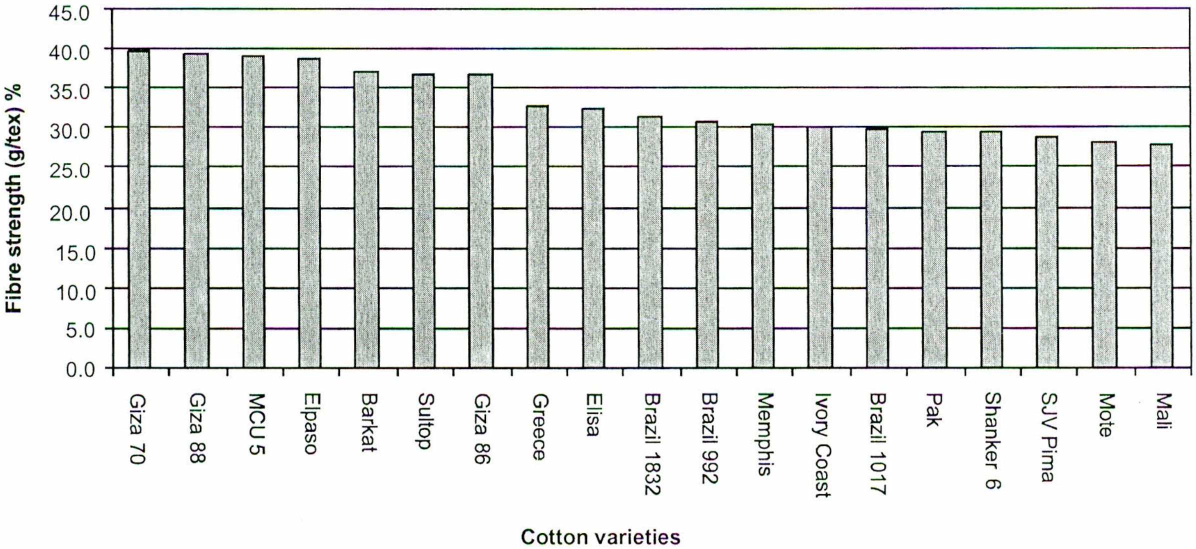

Fig. 4. Comparison of fibre strength of different cotton varieties.

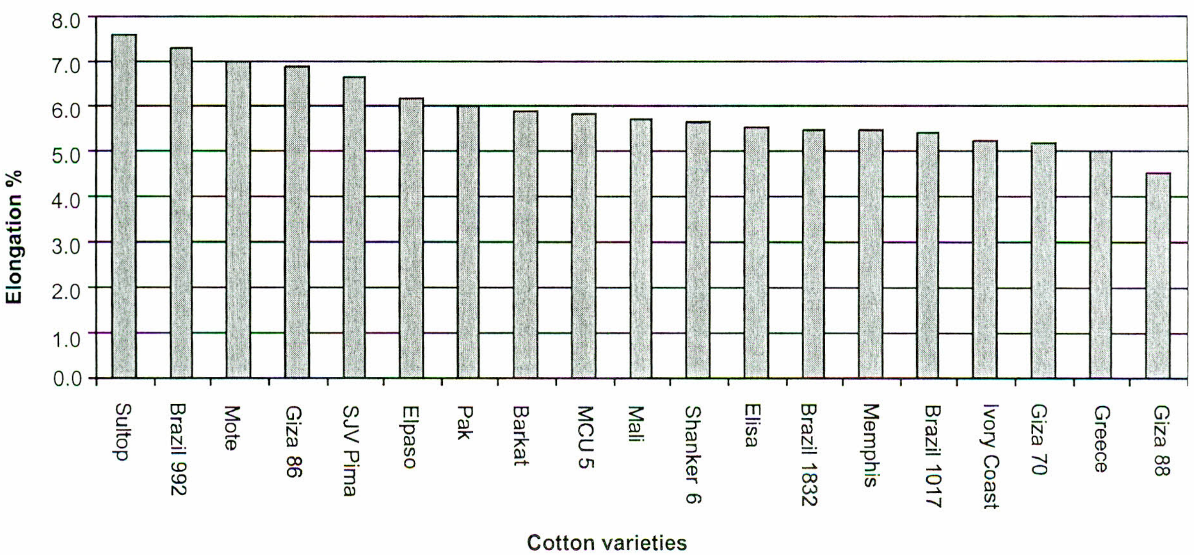

Fig. 5. Comparison of fibre elongation (%) of different cotton varieties.

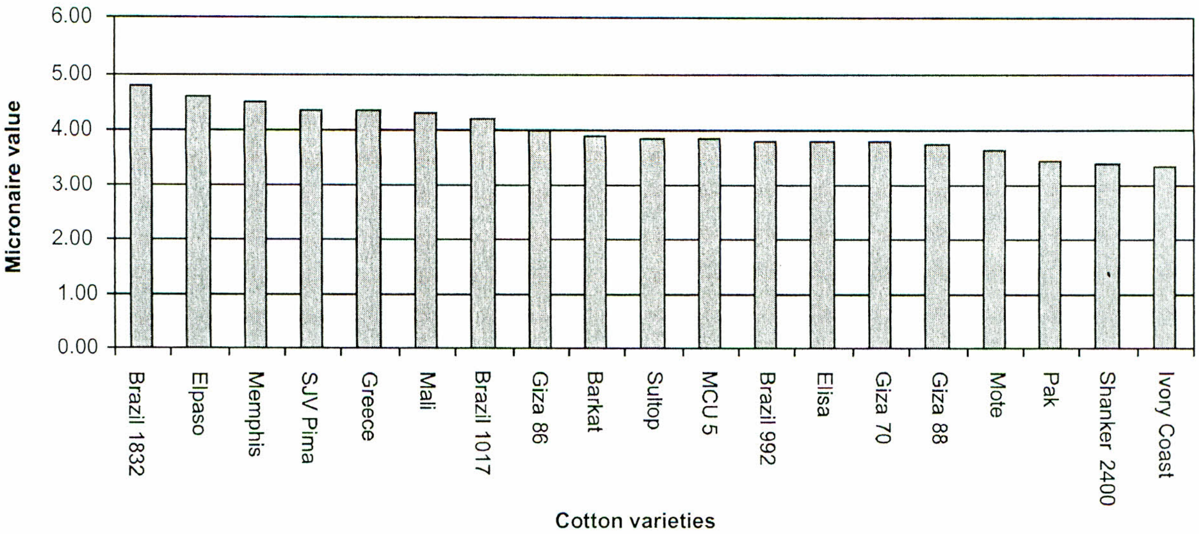

Fig. 6. Comparison of micronaire values of different cotton varieties.

Fibre fineness. Comparison of fibre fineness (micronaire values) of different cotton varieties is given in Fig. 6. Brazil (Lot 1832) has the highest micronaire value, followed by USA (Elpaso) while Ivory Coast cotton has the lowest micronaire value.

Fibre fineness directly determines yarn fineness. Finer yarns can only be produced from finer fibres. Fibre fineness not only influences spinning limit, yarn strength and evenness but also productivity of spinning, subsequent processes and fabric properties like lustre, drape, handle etc.

Reflectance and yellowness. Fig. 7 and 8 represent, respectively, the reflectance (Rd values) and yellowness (+b values) of different varieties of cotton. Mali cotton has the lowest Rd value and the highest +b value. Ivory Coast cotton has the highest Rd value, followed by Brazil (Lot 1832) and the Greek variety. Both Rd and

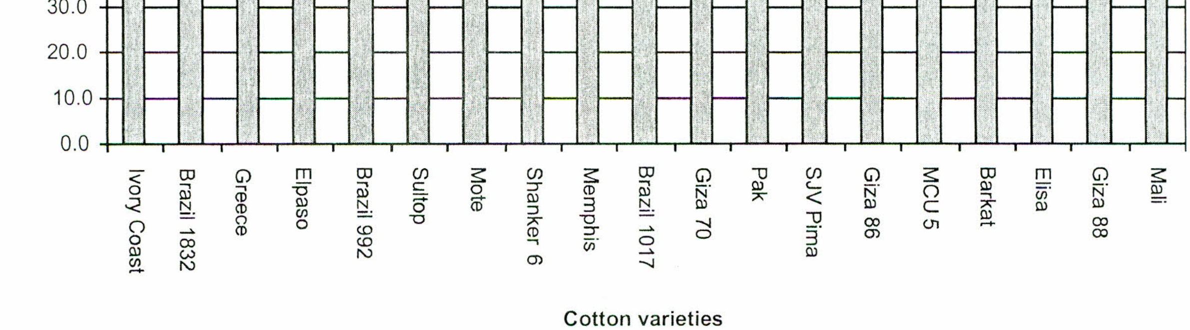

Fig. 7. Comparison of Rd values of different cotton varieties.

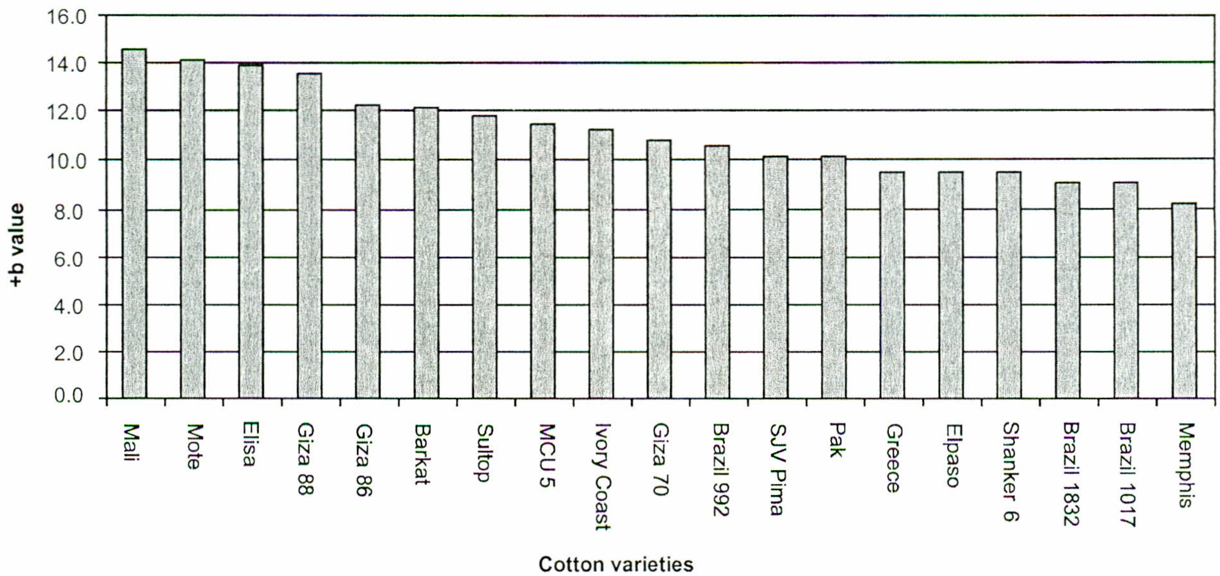

Fig. 8. Comparison of +b values of different cotton varieties.

Table 2. Correlation of different physical properties of cotton fibres

	Strength	Mic.	Elongation	Length	Uniformity	(+b)	Rd	SFI%
Strength	–	0.02	-0.1	0.988	0.94	0.1	-0.11	-0.932
Mic.	0.02	–	-0.08	0.002	-0.254	-0.374	0.099	-0.047
Elongation	-0.1	-0.08	–	-0.141	0.004	0.141	0.145	0.048
Length	0.988	0.002	-0.141	–	0.933	0.125	-0.131	-0.924
Uniformity	0.94	-0.254	0.004	0.933	–	0.238	-0.15	-0.851
(+b)	0.1	-0.374	0.141	0.125	0.238	–	-0.693	-0.097
Rd	-0.11	0.099	0.145	-0.131	-0.15	-0.693	–	0.149
SFI	-0.932	-0.047	0.048	-0.924	-0.851	-0.097	0.149	–

+b values are used in conjunction with one another to determine the colour grade of the cotton.

Correlation of physical properties. Table 2 represents the Pearson correlation values of different physical properties of cotton fibres based on the test data of the nineteen cotton varieties tested. The values nearest to +1 indicate good positive correlation i.e. when a cotton characteristic increases, the corresponding characteristic also increases. The values nearest to -1 indicate good negative correlation, i.e. when a cotton characteristic increases, the corresponding characteristic decreases. These correlations are also illustrated in Fig. 9. As can be seen, there is a strong positive correlation between fibre strength and length, strength and length uniformity, and length and length uniformity. There is a negative correlation between fibre strength and SFI, length and SFI, length uniformity and SFI, and Rd and +b values.

Conclusion

Physical properties of different global varieties of cotton were compared. Out of nineteen varieties tested, seven cotton varieties, viz. Egypt (Giza 70), Egypt (Giza 88), India (MCU 5), USA (Elpaso), Egypt (Giza 86), Sudan (Barkat) and CIS (Sultop) were found to have better overall fibre length, strength and length uniformity %, and low SFI %. Among these, CIS (Sultop) had the best elongation %, while USA (Elpaso) was found to have the highest micronaire and Rd values. A strong positive correlation was found among fibre length, strength and length

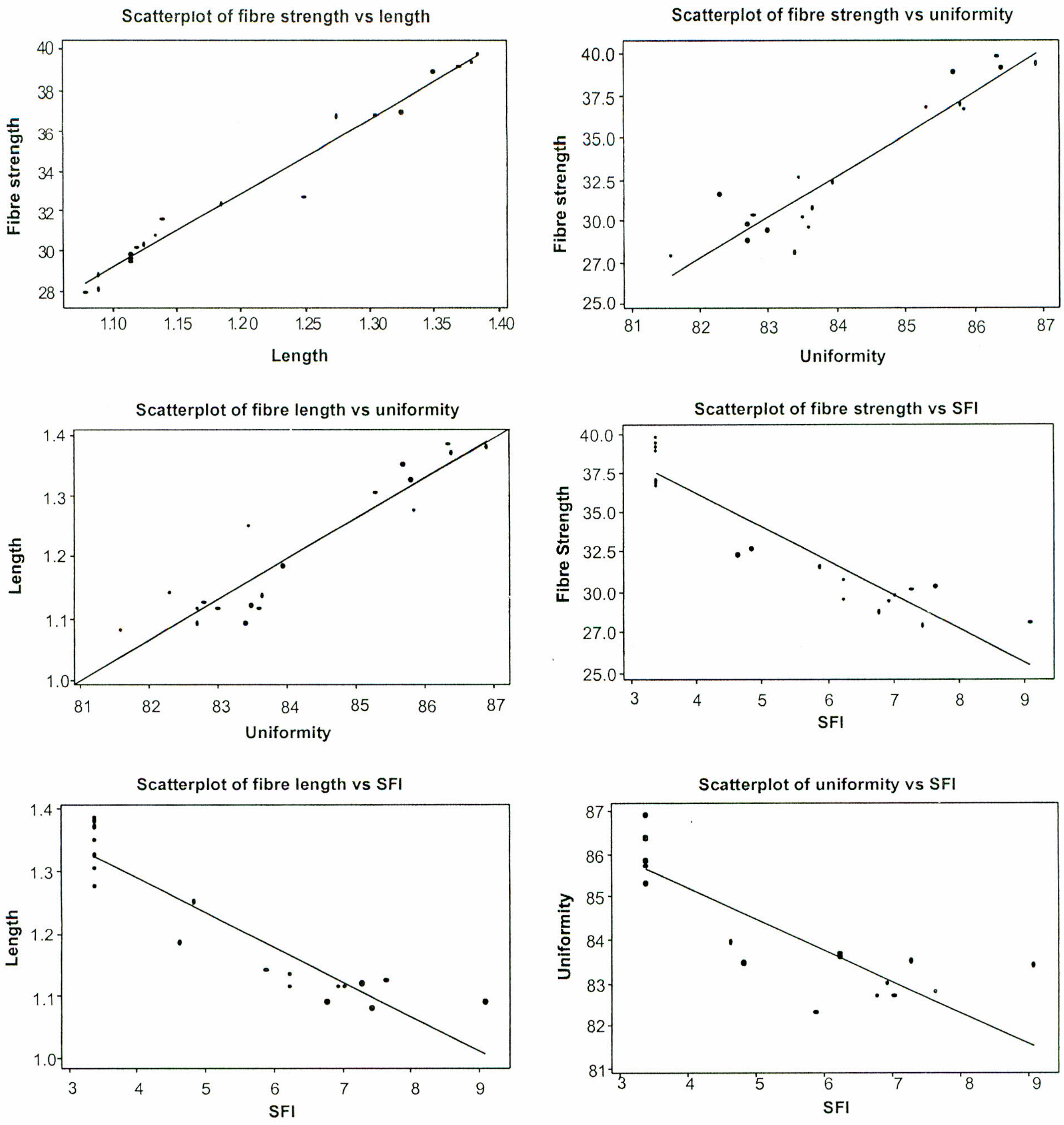

Fig. 9. Correlation of different physical properties of cotton fibres.

uniformity while all three of these properties exhibited a negative correlation with SFI%.

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