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Impact of fiber maturity levels on fineness, maturity, strength and elongation measurements in Egyptian cotton

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Abstract
The present investigation was conducted in Cotton Res. Institute, Agric. Res. Center at Giza in 2018 season to study the impact of maturity levels on fiber fineness, maturity, strength and elongation measurements in Egyptian cotton. Lint cotton samples of five maturity levels from four Egyptian cotton varieties; Giza 92, Giza 93, Giza 94 and Giza 95 were tested by HVI, cutter & caustic soda and Stelometer methods. The results indicated that The Egyptian ElS cottons showed lower means of mike, HW, P, and elongation% but showed higher number of fibers in the Stelometer bundles, higher means of breaking load and strength than the LS cottons. Within a cotton variety, Micronaire value, MR, HW, and P decreased in the very immature and immature fibers while increased gradually to reach the maximum in the very mature fibers.
The number of fibers in Stelometer bundle increased in the very immature fibers and decreased as fiber maturity goes up. Breaking force, strength and elongation% decreased in the very immature and immature fibers although of the high number of fibers in the tested bundles due to the decrease of maturity, while, all of these mechanical properties increased as fibers become average mature or mature and slightly decreased in the very mature fibers. This can put more attention on producing cottons of average mature and mature fibers not to short cut the season very early and produce immature cotton and not to be very late to produce over mature cottons.
Keyword: *cotton – fiber maturity – bundle strength.*

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I. Introduction

Spinning performance and the quality of yarns, fabrics and end products obtained from cotton depend upon certain fiber properties such as length characteristics, tensile properties, fineness and maturity besides nep potential, color, luster and stickiness. Research work of [1,2,3,4,5] and experience have indicated that these cotton fiber qualities depend on a complex combination of factors associated with genotype and growth environment.

Cotton maturity refers to the degree of thickening of the fiber cell wall relative to the perimeter.[6,7] reported that cotton fiber maturity is one of the determinants in evaluating cotton quality that affects yield, physical and mechanical fiber properties. It is a trait highly affected by environment and agronomic practices which affect cotton plant growth, physiology and biochemical processes[6,8]**.** Cotton fiber maturity is desirable and important for cotton growers, breeders and processors to improve their cottons and quality control procedures[9,10]**.** Mature fibers usually possess greater strength and better resilience, while immature cottons result in large processing wastes of spinning and weaving besides breaks which may produce lower yarn strength and increase ends down in spinning. Immature fibers can cause neps that badly affect dye uniformity and show up as white specks in dyed fabrics[8,11]**.**

On the other hand, Fiber tensile properties are very important during processing, where the fibers are subjected to various degrees of mechanical effects. Fiber strength is the most contributor to yarn strength and its uniformity, while fiber elongation positively affects spindle speed (productivity) and yarn elongation, [12,13]reported that genotype**,** Growth environment and their interaction play a part in determining fiber strength and strength variability while**,** [14,15] reported that fiber strength was correlated with genotype only.

Tensile properties include mainly tensile strength (tenacity) which is a measure of the tensile force required to break the fiber or the bundle, Tenacity is usually measured in grams per tex (g/tex) and elongation which is the degree of stretching of a fiber or a bundle under a tensile force. It is commonly measured as "elongation-at-break"[16]**.** The effect of fiber maturity or immaturity on bundle strength tests is a point of contention. Despite a single mature fiber is inherently stronger than a single immature one due to its fine structure as crystallite orientation, fiber maturity, fibrillar orientation, crystalline cellulose structure, degree of polymerization and the spiral angle besides convolutions, reversals and other features of the fiber structure[17,18]**.** Research work of [19,20] have shown that high bundle strength can be obtained from a bundle of more numerous immature fibers, each of which could be weak on an individual fiber basis. Immature fibers have thin secondary walls, while mature and very mature fibers have secondary walls approaching maximum thickness**.** Moreover, a bundle of fibers consisting of a large amount of fine and mature fibers may have higher bundle strength than a bundle of coarse and very mature fibers. It is likely due to the number of fibers participating in the fiber bundle test. Indeed, a bundle of coarse and very mature fibers has fewer fibers participating in the bundle test specimen and between-fiber frictions and cohesion forces will be lower in the very mature fibers. Furthermore, [21]reported that the over-mature fibers result in the formation of virtually closed lumen by extra growth of cell wall and ultimately creates high resistance to bending and need more twist during the spinning process than the average mature and mature fibers. All these changes make it important to measure fiber maturity prior to spinning to avoid drop in yarn and fabric quality.

Linear density is a function of both fiber perimeter that determines the volume in which cellulose is laid and secondary cell wall thickness (maturity). Fibers of small perimeter (intrinsically fine) can give lower values for mass per unit length than fibers with large perimeter (intrinsically coarse). For a constant perimeter, mature fibers have higher degree of wall thickening[22]**.** Most of the variation in linear density within a cotton variety refers to the degree of wall thickening (maturity), while, fiber perimeter (fineness) usually shows little variation [23]. Linear density is one of the most important factors affecting the force-to-break of individual fibers within-a bundle sample. In other words the high number of those immature fibers can compensate the weakness of the individual fibers constitute those bundles, but, an important question should be considered which is: to what limit the number of immature and very immature fibers can result in and produce bundle strengths as high as in case of average mature and mature fibers within a given cotton variety? and what is the level of bundle strength of the very mature fibers in which the number of fibers in the bundle will be in the minimum?

Therefore, the objective of this research work is to study the impact of fiber maturity on, micronaire value, maturity ratio linear density, perimeter, number of fibers in Stelometer bundle test specimen, bundle strength and elongation % in long and extra-long staple Egyptian cotton varieties. Focusing on the effect of fibers number in the Stelometer test specimen on the breaking force, fiber strength and elongation under different maturity levels in Egyptian ELS and LS cotton varieties.

II. Material and Methods

The present investigation was carried out in Cotton Technology Res. Department, Cotton Res. Institute, Agric. Res. Center at Giza to study the impact of cotton fiber maturity levels on Fiber fineness, maturity, number of fibers in Stelometer test specimen, flat bundle strength and elongation measurements in Egyptian cotton. Four Egyptian cotton varieties namely Giza 92 and Giza 93 Extra Long Staple cottons (ELS), Giza 94 Delta Long Staple cotton variety (Delta LS), Giza 95 Upper Egypt Long Staple variety (Upper Egypt LS) were used in this study. The lint cotton samples of these cottons were selected from the yield trials included in the breeding and maintenance of varieties genetic purity programs of Cotton Research Institute delivered to High Volume Instrument (HVI) lab, Cotton Fiber Res. Section, Cotton Res. Institute in 2018 season. All the cotton samples were homogenized, conditioned and tested under standard temperature 20 ± 1ºC and relative humidity 65% ± 2 RH, as specified by [24]**.** HVI Spectrum II was employed to perform a rapid screening for micronaire values of these samples according to[25]. Based on HVI micronaire values the different samples of each variety were selected to represent a very wide range of micronaire (very wide range of maturity). Maturity ratio of the selected samples of each variety was determined using sodium hydroxide method according to British Standard Method, [26]. Maturity ratio' is directly proportional to the degree of wall thickening (Ɵ) and serves for everyday practical purposes. [27,28]. It is calculated as follows: Maturity ratio (MR) = [N% − D% /200] + 0.7, where N is the percentage of normal fibers (Ɵ ≥ 0.5); D is the percentage of dead fibers (Ɵ ≤ 0.25). Based on the determined MR, the selected samples of each variety were divided into five maturity levels according to the universal classification of cotton maturity (Uster manual 2001) which is:

maturity level	maturity ratio (MR)	degree of thickening (Ɵ)
very immature	< 0.68	< 0.39
immature	0.68 - 0.75	0.39 - 0.43
average mature	0.76 - 0.86	0.44 - 0.48
mature	0.87 - 0.96	0.50 - 0.55
very mature	> 0.96	> 0.55

each level of maturity was represented by four different repetitions. 20 samples of each variety (5 maturity levels x 4 repetitions) were used to measure fiber linear density (hair weight HW) using the cutter method according to British Standard Method [29]**,** each sample of the four repetitions tested three times to get their average. Measured values of HW and MR were used to calculate Hair weight standard (HS) according to[27] equation HS = HW/ MR. Fiber perimeter was calculated from the equations developed by[30]; P (perimeter µm) = 3.7853√ (HS) and the Degree of thickening Ɵ = MR* 0.577 was also calculated.

Stelometer apparatus was used to determine flat bundle strength and elongation % at 1/8-gauge length according to[31]. Stelometer is one of the conventional fiber strength testers used for measuring bundle strength and elongation %. It is still preferred by cotton researchers and breeders as a simple screening tool due to its significant low cost and portability[32,33]. In order to study the effect of the fibers number in the Stelometer bundle test on the breaking force (the force to break), the resulted fiber strength and elongation % under different maturity levels, 15 -20 Stelometer tests were done from each repetition of the five maturity levels within each cotton variety focusing to get and chose test specimen weights nearly similar (within acceptable range) to be 300 ± 5mg in all the studied varieties. The breaking force in Kgf of each of the accepted weights of test specimen were recorded and **t**he bundle strength (tenacity) were determined by applying the following equation: **T = f / m * 15.00 where:** f = breaking force in Kgf m = mass of the tested bundle in milligrams **T** = tenacity in gf/tex and 15.00 is the length of the specimen in millimeters**.** In order to calculate the fibers number in each tested bundle, the linear density (HW) determined for each repetition of the tested samples was used to apply the following equation: **m** = N * 15 * HW where**: m** = mass of the tested bundle in milligrams N = the number of fibers in the tested bundle and 15.00 is the length of the specimen in millimeters (the width of the Jews at 1/8inch gauge length)**. N (number of fibers) = m / HW * 15**

The experimental design used was complete randomized design with four repetitions. The obtained data was computed using SAS program. Analysis of variance and LSD 5 % test, outlined by[34] were employed to study the impact of maturity levels, cotton variety and their interaction on Micronaire value (mike), maturity ratio (MR), linear density (HW) in m/tex, fiber perimeter (P) in microns, number of fibers in the Stelometer test specimen, breaking force (breaking load) in kgf, bundle strength in g/tex and elongation % of the studied Egyptian cotton varieties.

III. Results and Discussion

Impact of maturity levels, cotton variety, and their interaction on fineness & maturity measurements

Data in Table `1 and Table 2 indicated that cotton variety, maturity levels and their interactions showed statistically significant differences between means of mike value, MR, ϴ, HW and P except the effect of cotton variety on MR and ϴ which was statistically insignificant. Furthermore, the effect of V x M interaction was significant in few cases in the long and extra - long staple studied varieties.

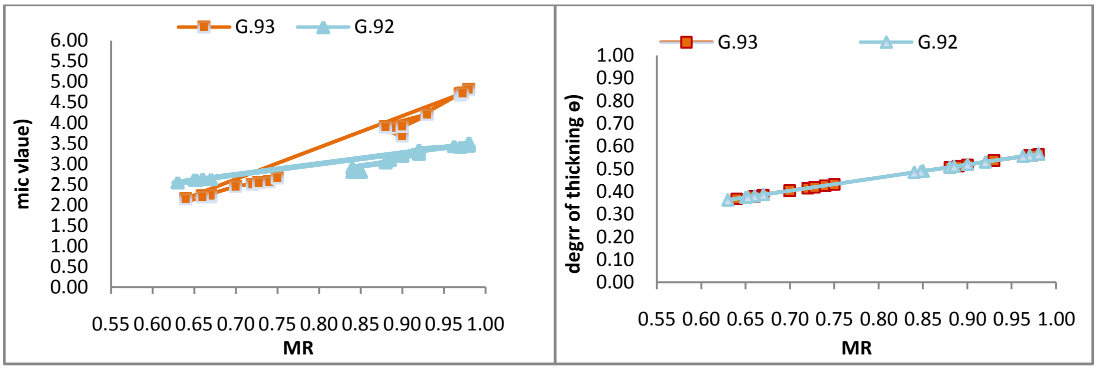
MR and ϴ are direct measures for fiber maturity. The results in Table1, and Table 2 illustrated in figure 1 and figure 2 showed that all the studied cottons exhibited nearly similar means of MR and ϴ being 0.82 and 0.47 for the two traits respectively. Furthermore, MR and ϴ of Giza 93 and Giza 92 ELS cotton varieties averaged 0.66 and 0.38 in the very immature fibers, 0.74 and 0.43 in immature fibers, 0.85 and 0.49 in the average mature fibers, 0.89 and 0.52 in the mature fibers, while averaged 0.97 and 0.56 in the very mature fibers. Giza 94 and Giza 95 LS Egyptian cotton varieties showed nearly the same MR and ϴ averages for the different maturity levels as in Giza 93 and Giza 92. The results indicated that fiber maturity can differ significantly within the cotton variety regardless of its genetic structure since it is a trait highly affected by environment and agronomic practices. These results agreed with[6,30,35] who reported that fiber maturity is a trait highly affected by environment and agronomic practices which affect cotton plant growth, physiology and biochemical processes.

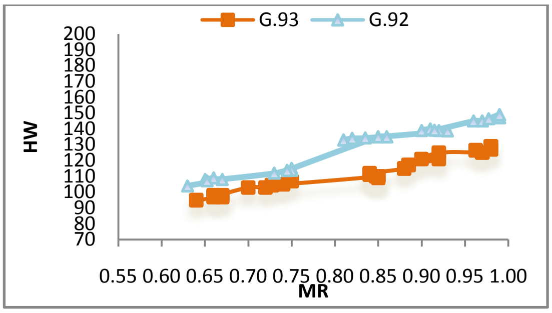
Mike value and linear density (HW) are measures for both of fineness and maturity in combination while perimeter (P) is a measure for fiber intrinsic fineness. The results in Table 1 and Table 2 assured that Within each of the studied varieties, most of variation in both mike value and HW refers to the variation in wall thickening (maturity) while, fiber perimeter (fineness) showed little variation. All of the studied varieties showed significantly different means for each of these traits, the recorded means of mike value were 2.82, 3.35, 3.70 and 4.00 for Giza 93, Giza 92, Giza 94 and Giza 95 respectively. The recorded means of HW were 111.11 mtex, 128.21 mtex, 142.31 mtex and 148.92 mtex for the aforementioned varieties respectively. Whilst the recorded means of fiber perimeter were 42.18 µ, 43.31 µ, 47.40 µ and 50.87 µ for the four varieties respectively.

Concerning the impact of maturity levels on Mike value, HW and fiber perimeter Mike value ranged in the ELS varieties Giza 93 and Giza 92 from 2.2 and 2.61 in the very immature level to 3.44 and 4.09 in the very mature level of the two varieties respectively. Mike value of Giza 94 and Giza 95 LS cottons showed the same trend to be ranged from 2.69 and 2.98 in the very immature level to 4.72 and 4.94 in the very mature level of the two varieties respectively. Moreover, fiber linear density or hair weight (HW) showed more variation between the different maturity levels being ranged from 97.00 mtex and 107.25 mtex in the very immature level of Giza 93 and Giza 92 to 126.5 mtex and 146.5 mtex in the very mature fibers of the two varieties respectively. The LS varieties Giza 94 and Giza 95 showed the same trend of the ELS varieties being ranged from 119.25 mtex and 122.75 mtex in the very immature level of Giza 94 and Giza 95 to 165.5 mtex and 174.5 mtex in the very mature level in the two varieties respectively. On the other hand, fiber perimeter P showed significant differences between the five maturity levels of the ELS and LS varieties under study, however, the variation in perimeter values due to the difference in fiber maturity was not as high as in micronaire value and linear density (HW). Fiber perimeter P ranged in Giza 93 and Giza 92 from 40.90 µ and 42.48 µ in the very immature level to 43.18 µ and 44.05 µ in the very mature fibers of the two varieties respectively. Giza 94 and Giza 95 exhibited the same trend of the ELS varieties to be ranged from 46.40 µ and 48.08 µ in the very immature level to 47.85 µ and 52.65 µ in the very mature fibers of the two varieties respectively. The noticed increase in fiber perimeter of the mature and very mature fibers could be due to the stress of the layers of the secondary wall on the stretchable primary wall resulting the perimeter increase. [23,36,37] came to similar conclusion.

Table (1): Impact of maturity levels, cotton variety and their interaction on Mike value, MR, ϴ, HW and P in Giza 93 and Giza 92 ELS Egyptian cotton varieties.

Variety	maturity level	Mike value	MR	Degree of thickening (ϴ)	HW m/tex	Perimeter (P) µ2
G93	very immature	2.20	0.66	0.38	97.00	40.90
	Immature	2.54	0.73	0.42	104.50	41.93
	Average mature	2.81	0.85	0.49	110.31	42.30
	Mature	3.10	0.88	0.51	117.25	42.60
	very mature	3.44	0.96	0.56	126.50	43.18
	Mean	2.82	0.82	0.47	111.11	42.18
G92	very immature	2.61	0.65	0.38	107.25	42.48
	Immature	3.03	0.75	0.43	113.75	43.00
	Average mature	3.35	0.84	0.48	134.30	43.40
	Mature	3.65	0.89	0.53	139.25	43.60
	very mature	4.09	0.98	0.56	146.50	44.05
	Mean	3.35	0.82	0.48	128.21	43.31
Maturity level	very immature	2.41	0.66	0.38	102.13	41.69
	Immature	2.79	0.74	0.43	109.13	42.47
	Average mature	3.08	0.85	0.49	122.31	42.85
	Mature	3.31	0.89	0.52	128.25	43.10
	very mature	3.76	0.97	0.56	136.50	43.62
	Grand means	3.07	0.82	0.47	119.66	42.74
LSD 5%						
Variety (V)		0.07	N.S	N.S	2.50	0.65
Maturity level (M) Maturity lev		0.09	0.03	0.02	3.41	o.74
V x M		0.12	N.S	N.S	4.55	0.85





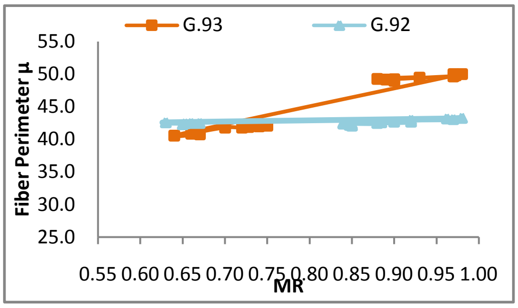
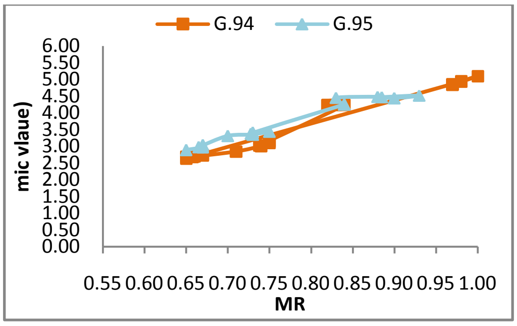
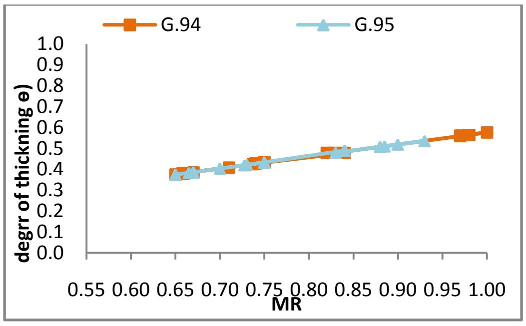


Fig. (1): Impact of maturity levels, cotton variety and their interaction on Mike value, MR, Ө, HW and P in Giza 93 and Giza 92 ELS Egyptian cotton varieties.

Table (2): Impact of maturity levels, cotton variety and their interaction on Mike value, MR, Ө, HW and P in Giza 94 and Giza 95 LS Egyptian cotton varieties.

Variety	maturity level	Mike Value	MR	Degree of thickening (Ө)	HW m/tex	Perimeter(P) µ2
G94	very immature	2.69	0.66	0.38	119.25	46.40
	Immature	3.03	0.74	0.43	137.25	47.45
	Average mature	3.83	0.83	0.48	141.30	47.60
	Mature	4.24	0.91	0.53	148.25	47.70
	very mature	4.72	0.97	0.56	165.50	47.85
	Mean	3.70	0.82	0.48	142.31	47.40
G95	very immature	2.98	0.67	0.38	122.75	48.08
	Immature	3.38	0.73	0.42	136.50	49.45
	Average mature	4.25	0.84	0.49	148.60	51.80
	Mature	4.47	0.89	0.51	162.25	52.35
	very mature	4.94	0.98	0.57	174.50	52.65
	Mean	4.00	0.82	0.47	148.92	50.87
Maturity level	very immature	2.83	0.66	0.38	121.00	47.86
	Immature	3.20	0.73	0.42	136.88	48.95
	Average mature	4.02	0.84	0.48	144.95	49.70
	Mature	4.19	0.88	0.51	154.25	50.03
	very mature	4.83	0.98	0.56	170.00	51.25
	Grad means	3.81	0.82	0.47	145.42	49.56
LSD 5%						
Variety (V)		0.079	N.S	N.S	2.48	0.46
Maturity level (M)		0.111	0.03	0.02	3.50	0.38
Maturity level (M) V x M		0.142	N.S	N.S	4.71	0.91





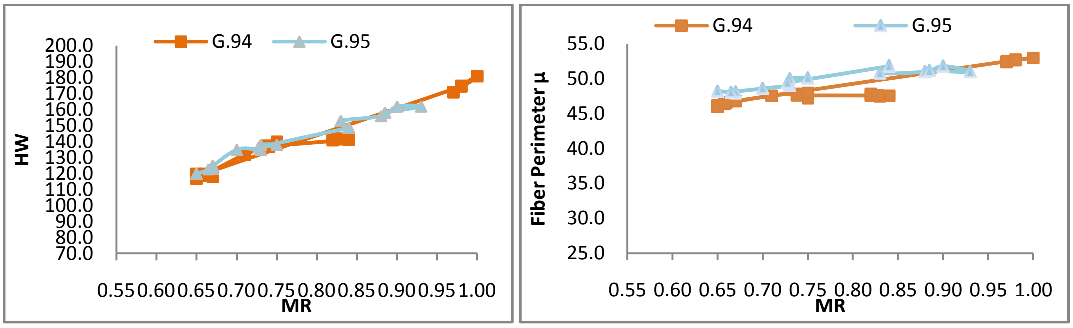


Fig. (2): Impact of maturity levels, cotton variety and their interaction on Mike value, MR, Θ, HW and P in Giza 94 and Giza 95 LS Egyptian cotton varieties**.**

Impact of maturity levels, cotton variety, and their interaction on fibers number in Stelometer test specimen, bundle strength and elongation % measurements:

Data in Table 3 and Table 4 showed statistically significant differences between means of cotton varieties, maturity levels and their interaction in number of fibers in the Stelometer tested bundles, breaking load, bundle tensile strength and elongation % of Giza 93 and Giza 92 ELS cotton varieties and Giza 94 and Giza 95 Egyptian LS cotton varieties. except the effect of cotton variety, maturity levels and their interaction on bundle weight of all the studied varieties which was not significant because the bundles weight is intended to be nearly similar being within a range of 300 ± 5 mg in all varieties and maturity levels to enable studying the effect of fibers number having different maturity levels on bundle strength and elongation %.

In Stelometer testing to measure bundle strength and elongation %, test specimen weight plays an important part in determining the breaking force and the resulted values of fiber strength and elongation, furthermore the bundle weight of the test specimen depends on the number of fibers and the amount of cellulose deposited in the secondary wall of these fibers (maturity). The results in Table 3 and Table 4 illustrated in figure 3 and figure 4 indicated that the number of fibers in the Stelometer test specimen having the same bundle weight differed significantly between varieties. The recorded means of the number of fibers in the constant bundle weight (300 ± 5 mg) were; 183.34, 159.61, 143.15 and 137.44 for Giza 93, Giza 92, Giza 94 and Giza 95 respectively. The number of fibers in the bundles of the same weight decreased gradually as the maturity level goes up in all the studied cotton varieties being averaged in the ELS cotton varieties 197.20 in the very immature level, 184.19 in the immature fibers level, 167.59 in the average mature fibers, 158.93 in the mature fibers and averaged 149.47 in the very mature fibers. The number of fibers in the tested bundles of the LS cotton varieties showed the same trend of the ELS varieties to be averaged 165.79 in the very immature level, 131.18 in the mature level and averaged 118.29 in the very mature level.

In the finest variety under study Giza 93, the number of fibers averaged 208.25, 192.67, 182.95, 172.13 and 160.72 in the five maturity levels; very immature, immature, average mature, mature and very mature respectively. and averaged in Giza 92 ELS variety; 186.15, 175.71, 152.23, 145.72 and 138.22 in the five maturity levels respectively, while averaged in the five maturity levels of Giza 94 Delta LS variety; 168.42, 149.73, 140.52, 136.05 and 121.05 respectively and averaged in the Upper Egypt LS cotton variety Giza 95; 163.15, 146.31. 135,89, 126.31 and 115.52 for the five maturity levels respectively. It is clear from these results that the number of fibers in a specific bundle weight differs within variety according to the amount of cellulose deposited in the fiber secondary wall (maturity) being decreased gradually as the fiber maturity increased, whilst differs between varieties of the same maturity according to the volume in which the cellulose is deposited expressed by intrinsic fineness of these varieties (Perimeter and/ or area of fiber cross section). This conclusion is in harmony with[22,23]**.**

In regard to the breaking force required to break bundles of similar weight. Bundle strength and elongation %, the results in Table 3 and Table 4 indicated that Giza 92 ELS cotton variety recorded the highest mean of breaking load and bundle strength while Giza 95 recorded the lowest ones and recorded the highest mean of elongation %. The recorded means of bundle breaking load were 6.79, 7.17, 6.20 and 5.78 kg for Giza 93, Giza 92, Giza 94 and Giza 95 respectively. The recorded means of bundle strength were 33.74, 35.58, 30.87 and 28.77 g/tex in the four varieties respectively. The recorded means of bundle elongation % were 5.82 %, 6.10 %, 6.52 %, and 7.73 % for the aforementioned four varieties respectively. [12,13]reported that genotype**,** Growth environment and their interaction play a part in determining fiber strength and strength variability.

Table (3): Impact of maturity levels, cotton variety and their interaction on Number of fibers, Breaking load, bundle strength, and elongation % in Giza 93 and Giza 92 ELS Egyptian cotton varieties.

Cotton variety	maturity level	Number of fibers	Breaking load (Kg)	Bundle Weight Mg	bundle strength g/tex	Elongation %
G93	very immature	208.25	6.05	300.00	29.99	4.85
	Immature	192.67	6.60	301.00	32.91	5.48
	Average mature	182.95	7.28	302.15	36.18	6.10
	Mature	172.13	7.18	302.00	35.70	6.35
	very mature	160.72	6.82	301.75	33.92	6.30
	Mean	183.34	6.79	301.38	33.74	5.82
G92	very immature	186.15	6.32	299.75	31.65	4.93
	immature	175.71	7.14	302.50	35.41	5.75
	Average mature	152.23	7.65	302.10	37.99	6.61
	mature	145.72	7.56	301.75	37.62	6.60
	very mature	138.22	7.15	303.00	35.24	6.63
	Mean	159.61	7.16	301.82	35.58	6.10
Maturity level	very immature	197.20	6.19	299.88	30.82	4.89
	immature	184.19	6.87	301.75	34.16	5.62
	Average mature	167.59	7.47	302.13	37.09	6.36
	mature	158.93	7.37	301.88	36.66	6.48
	very mature	149.47	6.99	302.38	34.58	6.47
	Grand means	171.48	6.98	301.60	34.66	5.96
LSD 5%						
Variety (V)		2.63	0.14	N.S	0.48	0.13
Maturity level (M)		3.72	0.18	N.S	0.59	0.19
V x M		4.25	0.31	N.S	078	0.28

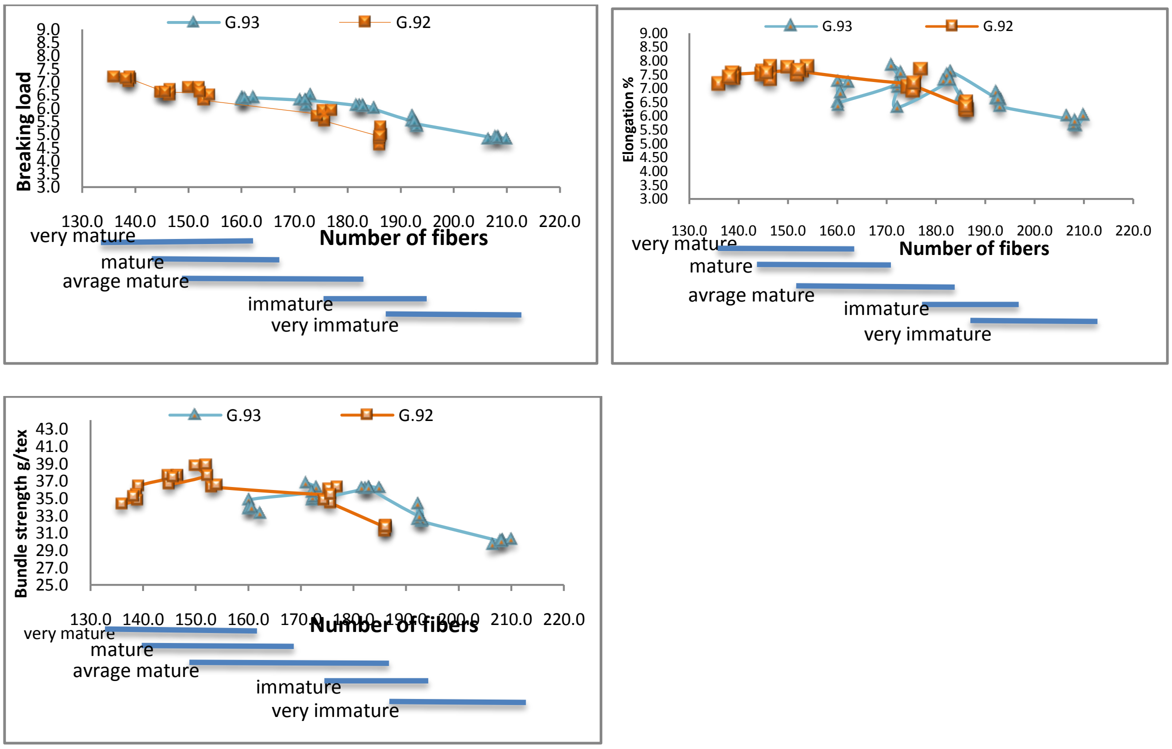
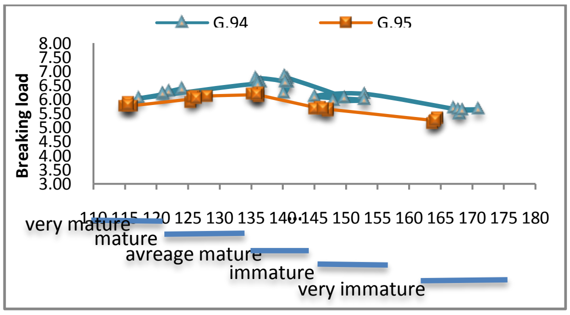
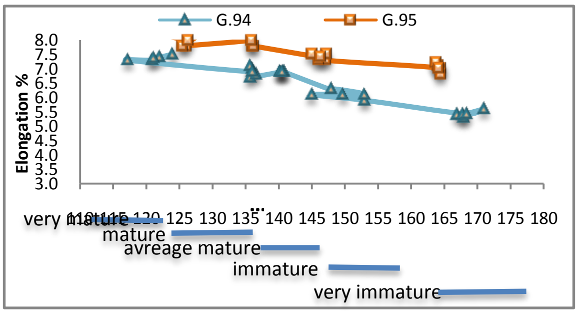


Fig (3): Impact of maturity levels, cotton variety on Number of fibers, Breaking load, bundle strength, and elongation % in Giza 93 and Giza 92 LS Egyptian cotton varieties.

Table (4): Impact of maturity levels, cotton variety and their interaction on Number of fibers, Breaking load, bundle strength, and elongation % in Giza 94 and Giza 95 LS Egyptian cotton varieties.

	maturity level	Number of fibers	breaking load (Kg)	Bundle Weight	bundle strength	Elongation
G94	very immature	168.42	5.64	301.25	28.09	5.43
	Immature	149.73	6.07	302.00	30.15	6.10
	Average mature	140.52	6.60	302.35	32.75	6.98
	Mature	136.05	6.54	301.75	32.55	7.10
	very mature	121.05	6.17	300.25	30.82	7.00
	Mean	143.15	6.20	301.52	30.87	6.52
G95	very immature	163.15	5.25	300.75	26.19	7.03
	Immature	146.31	5.65	299.75	28.32	7.40
	Average mature	135.89	6.16	301.95	30.58	8.20
	Mature	126.31	6.04	300.50	30.13	8.00
	very mature	115.52	5.78	301.75	28.65	8.00
	Mean	137.44	5.78	300.94	28.77	7.73
Maturity level	very immature	165.79	5.45	301.00	27.14	6.23
	Immature	148.02	5.86	300.88	29.24	6.75
	Average mature	138.21	6.38	302.15	31.67	7.59
	Mature	131.18	6.29	301.13	31.34	7.55
	very mature	118.29	5.98	301.00	29.74	7.50
	Grand means	140.30	5.99	301.23	29.82	7.12
LSD 5%						
Variety (V)		2.01	0.12	N.S	0.41	0.14
Maturity level (M)		2.84	0.15	N.S	0.52	0.21
V x M		3.34	0.25	N.S	0.73	0.31





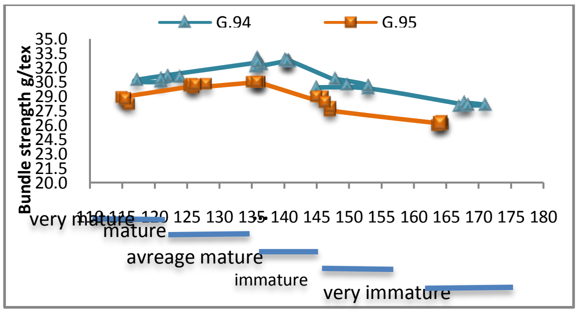


Fig. (4): Impact of maturity levels, cotton variety on Number of fibers, Breaking load, bundle strength, and elongation % in Giza 94 and Giza 95 LS Egyptian cotton varieties.

The breaking load, bundle strength and elongation % differed significantly between the different maturity levels. In the studied ELS, the recorded means of these three traits were 6.19 kg, 30.82 g/tex and 4.89 % in the very immature level, while being, 7.47 kg, 37.09 g/tex, and 6.36 % in the average mature level and being, 6.99 kg, 34.58 g/tex and 6.47 % in the very mature level of the ELS cottons. The LS cottons showed the same trend but in lower means of breaking load and bundle strength and higher means of bundle elongation %. The recorded means of the three traits respectively were 5.45 kg, 27.14 g/tex and 6.23 % in the very immature level and 6.38 kg, 31.67 g/tex and 7.59 % in the average mature level and being,5.98 kg, 29.74 g/tex and 7.50 % in the very mature fibers for the three traits respectively.

The results in Table 3 and Table 4 showed that within each of the studied varieties, bundles of similar weight (300 ± 5 mg) but differed in their maturity level, and linear density HW subsequently differed in the number of fibers existed in these bundles, the breaking load required to break these bundles and the resulted bundle strength decreased sharply in the very immature and immature levels and increased gradually as maturity level increased to be nearly of equal means in the average mature and mature levels then decreased slightly but significantly in the very mature level. Bundle elongation % decreased significantly in the very immature and immature levels but showed insignificant differences between the high levels of maturity; average mature, mature and very mature.

From these results it could be concluded that the high number of fibers in the two immature levels did not compensate the decrease in fiber maturity to the limit that the existed amount of cellulose in these immature fibers is too small and make the bundle to break easily with low amount of stretching under low breaking load resulting lower bundle strength and elongation, despite of the high number of fibers which can provide more friction and cohesion forces in these immature levels compared to the lower number of fibers in average mature, mature and very mature (over mature) levels which provide fibers of lower numbers but contain more cellulose enough to record higher breaking load and higher fiber strength and elongation. However, in the very mature fibers the number of fibers goes down to the limit that affect negatively the recorded breaking load and bundle strength. [7, 8, 9, 10] reported that cotton fiber maturity is one of the determinants affecting fiber mechanical properties. [21] reported that the over-maturity creates high resistance to bending and need more twist during the spinning process and added that it important to measure maturity prior cotton processing.

IV. Conclusion:

The Egyptian ElS cottons showed lower means of mike, HW, P, and elongation % but showed higher number of fibers in the Stelometer bundles, higher means of breaking load and strength compared to the LS cottons.

Within a given cotton variety, Micronaire value, maturity ratio MR, Linear density HW, and fiber permitter P decreased in the very immature and immature fibers while increased gradually to reach the maximum in the very mature fibers.

The number of fibers in Stelometer bundle having similar weights increased in the very immature fibers and decreased gradually as fiber maturity goes up to reach its minimum in the very mature fibers.

Fiber maturity of any cotton variety can affect significantly bundle breaking force, bundle strength and elongation %. All of these mechanical properties can decrease in the very immature and immature fibers although of the high number of fibers in the tested bundles due to the decrease of maturity. All of these mechanical properties increased as fibers become average mature or mature due to the enough amount of cellulose in the secondary wall but the breaking force and the resulted strength slightly decreased in the very mature fibers due to the relative decrease in the number of fibers in these bundles. This can put more attention on producing cottons of average mature and mature fibers through the agronomic practices, not to short cut the season very early and produce immature cotton and not to be very late to produce over mature cottons. Cotton marketing system in USA, puts premiums for any improvement in fiber quality measurements except micronaire value which should be within the acceptable range of the cotton variety to avoid producing immature or over mature cotton.

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الملخص العربي

تأثير مستويات نضج التيلة علي قياسات النعومة والنضج ومتانة واستطالة التيلة في القطن المصري

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يؤثر نضج التيلة في العديد من الصفات الطبيعية والميكانيكية للتيلة وينتج عن انخفاض النضج نقص في متانة واستطالة التيلة وظهور العقد بالقطن الخام وعدم انتظام الصباغة ونقص جودة الخيوط والنسيج والمنتج النهائي. إلا انه في بعض الحالات يؤدي انخفاض النضج نسبيا إلي قياسات متانة عاليه نظرا لارتفاع عدد الشعيرات في الخصلة أو في المقطع العرضي للخيوط المغزولة، والسؤال هنا إلي أي مدى يمكن ان تعوض زيادة عدد الشعيرات في الخصلة النقص في نضجها الراجع لنقص درجة ترسيب سلاسل السليلوز بالجدار الثانوي التي تقاوم الشد الواقع عليها. لذلك فقد أجري هذا البحث بقسم بحوث التيلة بمعهد بحوث القطن بمركز البحوث الزراعية علي أربعة من أصناف القطن المصري هي جيزة 93 وجيزة 92 (من الأصناف الطويلة الممتازة) وجيزة 94 وجيزة 95 (من الأصناف الطويلة) موسم 2018. حيث تم اختيار عينات تمثل خمسة مستويات من النضج (غير ناضج جدا- غير ناضج- متوسط النضج- ناضج- ناضج جدا) وتم تقدير صفات قراءة الميكرونير- نسبة النضج MR- - درجة ترسيب السليلوزθ- وزن وحدة الطولHW- عدد شعيرات الخصلة في ختبار المتانة والاستطالة بالاستيلوميتر لخصلات وزنها متساوي لدراسة تأثير مستويات النضج علي عدد الشعيرات بالخصلة وعلي متانة واستطالة الخصلة. تم تحليل النتائج المتحصل عليها باستخدام تصميم التام العشوائية في أربعة تكررات واستخدام اقل فرق معنوي (LSD5%) للمقارنة بين المتوسطات المختلفة وتتلخص النتائج المتحصل عليها فيما يلي:-

- لم تختلف الأصناف المدروسة معنويا في صفتي نسبة النضج MR- درجه ترسيب السليلوز θ حيث كانت مستوياتها حول 0.81 و 0.47 للصفتين علي التوالي بينما اختلفت معنويا في متوسطات قراءة الميكرونير حيث سجلت 2.82 ، 3.31 ، 3.59، 3.94 للصنف جيزة 93 ، جيزة 92، جيزة 94 وجيزة 95 علي التوالي وسجلت 111.31 ، 126.2 ، 143.1 و 148.0 ملليتكس لوزن الشعرة HW للأصناف الأربعة علي التوالي. متوسطات المحيط P هي 42.1 ، 43.3 ، 47.5 و 50.3 ميكرون ومتوسط الثقل القاطع 6.73 ، 7.38 ، 6.11 و 5.67 كجم ومتوسطات متانة الخصلة 33.13 ، 34.98 ، 30.40 و 28.32 جم/ تكس ومتوسط الاستطالة 5.84 ، 6.16 ، 6.45 و 7.73% للاصناف المذكورة علي التوالي.
- زاد ت قياسات نسبة النضج MR- درجه ترسيب السليلوز θ - قراءة الميكرونير- وزن وحدة الطول ومحيط الشعرة في الخصلة تدريجيا بزيادة مستوي النضج من المستوي غير الناضج جدا حتى بلغت أقصي قيم لها في المستوي الناضج جدا بينما نقص عدد الشعيرات في الخصلة بزيادة نضج الشعيرات ففي الصنف جيزة 93 كانت قراءة الميكرونير ومحيط الشعرة وعدد الشعيرات بالخصلة 2.2 ، 40.9 و 208.3 وفي الصنف جيزة 95 3.0 ، 48.1µ و 163.2 لهذة الصفات علي التوالي.
- نقصت قيم الثقل القاطع ومتانة واستطالة التيلة في المستوى غير الناضج جدا وغير الناضج في جميع الأصناف المدروسة وزاد حتى بلغ أقصى قيمة له في المستوي متوسط النضج والناضج في حين نقصت المتانة قليلا ولكن معنويا في المستوي الناضج جدا في حين لم تنقص الاستطالة في هذا المستوى وعلي سبيل المثال كانت قياسات الثقل القاطع ومتانة واستطالة التيلة في المستوي الغير ناضج جدا في الصنف جيزة 93 هي 6.1كجم، 30.0 جم/تكس و 4.9%. في الصنف جيزة 95 كانت هذه القياسات 5.3 كجم ، 26.2 جم/ تكس و 7.0% وكانت في مستويات النضج (متوسط النضج والناضج) في الصنف جيزة 93 هي 7.2 ، 36.5 جم/ تكس و 6.3% وفي الصنف جيزة 95 هي 6.1 ، 30.5 جم/تكس و 8.2% بينما في المستوي الناضج جدا في الصنف جيزة 93 هي 6.82 ، 33.9 جم/ تكس و 6.2% وفي الصنف جيزة 95 هي 5.78 ، 28.65 و 8.0% للصفات الثلاثة علي التوالي.
- بينت الدراسة انه في حالتي المستوي الغير ناضج جدا والغير ناضج لم تؤدي زيادة عدد الشعيرات في الخصلة إلي ثقل قاطع ومتانة واستطالة عاليتين كما في المستويات متوسطة النضج والناضجة الأقل في عدد الشعيرات ولكن الأعلى في محتواها من سلاسل السليلوز المترسب بجدر الشعيرات الذي يؤدي لتحمل ثقل قاطع اعلي ومتانة واستطالة عاليتين رغم نقص عدد الشعيرات بالخصلة كما انخفضت المتانة نسبيا في الشعيرات الناضجة جدا نظرا للنقص الحاد في عدد الشعيرات بالخصلة. ويستدعي ذلك أن نراعي أنتاج أقطاننا في المستوي المتوسط النضج والناضج ولا نلجأ لجني القطن أبكر من اللازم حتي لا تنتج أقطان منخفضة النضج أو نتأخر في الجني فتنتج أقطانا ناضجة جدا وفي كلتا الحالتين يكون ذلك علي حساب متانة القطن وكفاءة تشغيله وصفات جودة الخيوط والنسيج والمنتج النهائي.