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PERFORMANCE AND STABILITY ANALYSIS OF SOME EGYPTIAN COTTON GENOTYPES FOR YIELD, FIBER AND YARN TRAITS UNDER DIFFERENT ENVIRONMENTS

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ABSTRACT

The present research was conducted to evaluate performance and stability of six cotton genotypes included two long staple (variety G86 and promising strain 10229 × G86) and four extra-long staple (G88, G92, promising strains; G77× Pima S6 and G84(G70×51b)×P62. These materials were evaluated for seed cotton and lint yields (k/f), fiber length (mm), fiber strength(g/tex), fiber maturity (%) as well as single yarn strength (cN/tex) with two spinning systems (ring and compact). Experiments were planted in four locations of the middle and north Delta during the years of 2011 and 2012. Analysis of variance showed highly significant differences for each of year (Y), location (L) and genotype (G) for all traits suggesting the presence of wide range of differences among genotypes and locations. The first order and the second order (Y × L × G) interactions were significant for all studied traits except (Y× G) with seed cotton and lint yields. The overall mean performance for varieties and lines across the eight environments (4 locations x 2 years) demonstrated that Gharbia location was superior to other locations in seed cotton and lint yields and Kafr El-Sheikh came in second rank followed by Damietta, while Dakahlia produced the lowest value. Damietta location was superior to other locations in fiber strength, fiber maturity and yarn strength of both spinning system (ring and compact), while Dakahlia location surpassed the other locations in fiber length. Kafr el-Sheikh location ranked second in the superiority of fiber and yarn traits in all governorates. The long staple promising strain 10229 × G86 surpassed variety G86 in seed cotton and lint yields, fiber strength, degree of maturity and yarn strength of both ring and compact spinning. The extra- long staple G84 (G70×51b) × P62 recorded the highest seed cotton and lint yields followed by variety G92. Variety G92 surpassed all other genotypes in fiber maturity, fiber strength and yarn strength of ring and compact spinning, while variety G88 showed superiority in fiber length followed by strain G77 × Pima S6. The compact spinning system was superior to the traditional ring spinning in single yarn strength for all genotypes under varied environments. The results of phenotypic stability revealed that the promising extra - long staple strain G84 (G70×51b) ×P62 had the highest seed and lint cotton yields, regression coefficient equals to one and the deviation from the regression line did not significantly deviate from zero, so it is characterized by high crop, good stability and convenience for all environments. The strain 10229 × G86 (long staple category) had the highest seed and lint yield and adaptability to different environments. Therefore, these two promising stains are recommended to be developed as new elite cultivars.

Key words: ***Cotton Yield, Fiber, Yarn, Environment, Phenotypic Stability, Adaptability.***

INTRODUCTION

Cotton crop (*Gossypium* spp.) is the most important plant-based natural fibers; it has the potential to provide the world increasing demand for these types of fibers. Egyptian cotton "*Gossypium barbadense* L" is a

unique germplasm characterized by high lint quality, and gained tenths of years of world-wide reputation in this concern. For Egyptian people, cotton was a major contributor of gross domestic production (GDP) for many decades. In the last decade, however, Egyptian cotton has been suffering from many domestic and world market difficulties. The cultivated area decreased dramatically compared with the decades of 1970's and 1980's that directly bewildered the projected cotton area and production (Anonymous 2014).

On the other hand, decisions on cotton variety selection are typically based on experience with the potential varieties and production sites. Cotton Research Institute (CRI) introduces new cotton germplasm almost every year. It is important for cotton researcher to note the genotypic and phenotypic differences in varieties in their growing region in order to obtain maximum yield potential and good fiber quality. Moreover, using environmentally stable and high yielding genotypes is important for sustaining Egyptian cotton production (Abdalla *et al*, 2014). Since there is no single genotype adapted to all cotton locations, a potential way to eliminate the effects of genotype x environmental interaction is by selecting genotypes that are stable and limit interactions with the environment. Previous reports collectively indicated that a successful breeding program should focus efforts on genotype performance (average yield compared to standards), adaptation (the environment that the genotype best perform in), and stability (the consistent of the genotype performance compared to others). Many various techniques have devised to evaluate genotype stability over a range of environments in many crops. Eberhart and Russell (1966) found that measuring phenotypic stability could be accomplished by comparing a single variety yield with the average yield of all varieties over multiple environments. Each variety included in the experiments can be subjected to regression and parameters b_i and s^2d would provide estimates of stability. According to the model, a stable genotype is considered to have the highest yield over a broad range of environments, a regression coefficient value of one and deviation mean square of zero. The genotype x environment interaction was found to be significant for seed cotton and lint yield in many researches (Palomo *et al* 1998, Mert *et al* 1999 and Unay *et al* 2004). On the other hand, A high yielding genotype will be of low economic value if it is suffering from instability of fiber properties along season or/and growing conditions (Abdalla *et al* 2014). Therefore evaluating the G x E interaction for cotton plants have to take into consideration three major group-components that must be simultaneously stable. These three major components are lint yield, lint quality, and yarn quality.

The current study aimed to evaluate the genotypes performance and estimate the phenotypic stability in order to identify the best performance and environmentally stable cotton genotype for lint yield, fiber and yarn quality under the Delta Nile cotton zone.

MATERIALS AND METHODS

The present study was carried out to evaluate the performance and estimate stability of six cotton genotypes across eight divergent environments comprised from four locations and two years of experimentation. Genotype name, pedigree and lint category of the six genotypes are presented in Table (1).

Table1. Genotype name, pedigree, and lint category of the six cotton genotypes

No.	Genotype name	Pedigree and origin	Lint category
1	G86	G75x G81	Long staple
2	G86 x 10229	Promising strain	Long staple
3	G88	G77x G45b	Extra-long staple
4	G92	G84(G74xG68)	Extra-long staple
5	G77 x Pima S_6	Promising strain	Extra-long staple
6	G84(G70 x 51b) x P62	Promising strain	Extra-long staple

The growing locations were representing four governorate of Delta cotton zone namely; El- Gharbia (El-Mahala), El-Dakahlia (Dekernes), Kafr El-Sheikh (Sedi Salim) and Damietta (Kafr Saad). The growing years were 2011 and 2012. Soil characteristics of the four locations are presented in Table (2).

Table 2. Mechanical and chemical analysis of soil at four locations in 2011 and 2012 growing seasons

Mechanical analysis							Chemical analysis			Main element (ppm)		
Location	Year	Course sand %	Fine sand%	Silt %	Clay %	Class	PH	$CaCo_3$%	EC Ds/m	N	P	K
Gharbia	2011	0.53	25.09	24.69	49.38	Clay	7.8	2.8	0.97	25	0.22	97.77
	2012	4.4	6.6	28.8	60.2	Clay	7.5	3.1	1.01	35	0.29	65.42
Dakahlia	2011	1.05	22.36	20.58	55.84	Clay	8.1	1.6	0.54	37.3	7.52	368.56
	2012	6.1	18.7	32.8	42.4	Clay	7.9	1.8	0.59	45.27	8.36	389.15
Kafr El-Sheik	2011	1.05	18.55	37.03	43.21	Clay	7.6	2.4	0.53	94.4	0.01	154.84
	2012	7.2	17.2	32.3	43.3	Clay	7.5	3.1	1.77	91.56	2.12	37.28
Damietta	2011	2.63	22.36	24.69	41.15	Clay	7.93	1.26	1.13	89.5	8	493
	2012	5.4	17.3	37.2	40.1	Clay	8.06	0.87	2.6	91.05	7.13	380.12

Soil profile of the four locations were analyzed mechanically; prior to sowing according to Piper (1950) and chemically; according to Black *et al* (1965). Soil samples were analyzed by the facilities of soil, water and environment institute (SWEI) Cotton Research Institute at Giza, Egypt. Soil properties indicated various types of physical conditions. In general, soil physical and chemical properties were normal for cotton plant growth.

The chemical composition of soil extracts indicated that soil salinity of all locations was fall in normal range.

The experimental design at each location was a randomized complete block design with four replicates at each location. Some traits, however, were estimated in three replications (fiber and yarn quality traits). Each plot contained thirty ridges of four meters long and 65 cm wide to give rise to a plot size of 78 m^2. The distance between hills was 25 cm. The plants were thinned to two seedlings per hill after six weeks of planting. The sowing dates were from 10 to 15 April for the two years. While, the picking dates were from 1to 15 October for the two years. All agricultural practices were kept constant as possible for all locations and applied following the recommended package deal of Cotton Research Institute. Each plot was picked two times and used to estimate cotton yields, lint and yarn quality characters. The first and the last ridges were used to pick fifty random bolls, for estimating lint percentage. Yield and yield components variables included seed cotton yield (K/F): calculated for each plot and converted to kentar per feddan (kentar = 157.5 kg). Lint cotton yield (K/F): Weight of seed cotton yield per feddan × lint percentage. Fiber and yarn tests were performed at the laboratories of Cotton Fiber Research and Cotton Spinning Research Divisions. A sample of about 8 KG of each cotton genotype was used material for fiber and yarn tests.

Fiber and yarn tests were carried out under controlled atmospheric condition of 65%±2 relative humidity and 21ºC±2 temperature. Fiber length in mm (UHM) and fiber strength (g/tex) were measured by using High Volume Instrument (HVI) according to ASTM (D4605-86). Fiber maturity was measured by sodium hydroxide swelling method according to ASTM (D1442-86). The degree of Maturity (%): (Number of mature fibers / Number of total fibers) × 100.

Two spinning systems (ring and compact) were used in spinning mill, Cotton Spinning Research Division. Each cotton fiber material was spun into carded count 60·s using 4-twist multiplier. Yarn mechanical properties were yarn strength (cN/tex): measured by the Statimat ME Automatic tensile tester (ASTM D2256-91) with a testing speed of 5000 mm/min and test length of 50cm. Average of 120 tests for breaking load value was taken for the calculation of tenacity.

Statistical procedures

The regular analysis of variance of RCBD was computed for each location and year. Combined analysis of genotypes, locations and years were done according to Snedecor and Cochran (l982). The homogeneity of error variances was done prior to combine analysis. The cultivar effects were considered fixed, while the effects of year, replicate, and location were random (Annicchiarico, 2002).

Differences among treatment means were tested by least significant differences LSD. The stability model of Eberhart and Russell (1966) was employed for comparing a single variety yield with the average yield of all varieties over multiple environments. Each variety included in the experiments subjected to regression model: $Y_{ij} = \mu_i + \beta_i I_j + \delta_{ij}$. Where Y_{ij} is the variety mean of the i^{th} variety at the j^{th} environment, μ_i is the mean of the i^{th} variety over all environments, β_i is the regression coefficient that measures the response of the i^{th} variety to varying environments, δ_{ij} is the deviation from regression of the i^{th} variety at the j^{th} environment, and I_j is the environmental index obtained as the mean of all varieties at the j^{th} environment minus the grand mean. The three estimates; mean performance, linear regression coefficient (b_i) and mean squares of deviation from regression coefficient (S^2_d) were used as selection criteria for selecting stable genotype over the tested environments.

RESULTS AND DISCUSSION

Analysis of variance components

Mean squares of combined analysis of variance over years and locations for cotton yield, fiber and spinning properties of cotton genotypes are given in Table (3).

Table 3. Mean squares of combined analysis of variance over 4 locations (L), in 2 years (Y) 2011 and 2012 for cotton yield , fiber and yarn traits of 6 cotton genotypes (G).

Source of variation	df	Cotton yield (K/F)		df	Fiber traits			Yarn strength (cN/tex)	
		Seed cotton	Lint cotton		Length (mm)	Strength (g/tex)	Maturity (%)	Ring spinning	Comp. spinning
Year (Y)	1	167.50 **	279.3 **	1	24.502**	135.917**	11.90**	8.07**	8.87**
Location(L)	3	164.06**	268.5* *	3	1.245**	21.64**	6.53**	5.73**	6.87**
YL	3	43.93**	45.07**	3	2.774**	9.015**	18.22**	1.47**	1.67**
R(LY)	24	1.72*	2.24*	16	0.225	0.19	0.05	0.23	0.25
G	5	22.03**	83.81**	5	29.833**	123.21**	109.12**	55.39**	51.89**
YG	5	1.752	1.87	5	4.604**	34.995**	4.27**	4.51**	3.52**
LG	15	2.55**	5.09**	15	1.993**	7.48**	6.22**	1.89**	2.47**
YLG	15	3.41**	4.72**	15	1.449**	10.409**	3.03**	1.18**	1.35**
Error	120	0.85	1.33	80	0.149	0.18	0.7	0.16	0.21

***, ** denote significant differences at 5% and 1%levels, respectively.**

Mean squares of the main source of variation, i.e. genotypes (G) were highly significant, suggesting the presence of wide range of differences between genotypes for all the studied traits. Growing years (Y) and locations (L) were also highly significant for all traits indicating deep effects of seasonal and locational environmental changes. The first and second order interactions between the main factors were highly significant for all traits indicating environmental factors had prominent share in the

expression of the studied traits. These findings may suggest the importance of assessment of cotton genotypes either new strains or cultivated under varying environment in order to identify the best genotype for a particular environment or a range of environments. Several workers reported significant interactions between cotton genotypes and environmental factors such as locations and years for one or more of cotton traits of them Abdel-Hafez *et al* (2000) and Abdalla *et al* (2005). Since the growing years were significant for the studied traits, the mean performance will be discussed based on separate years and combined over years.

Performance of genotypes under different environments

Seed cotton yield

Mean performance of seed cotton yield (k/f) as affected by genotypes, locations, years and their interactions are presented in Table (4).

Location exerted marked effects on seed cotton yield. In the first year, Gharbia location gave the highest mean value for seed cotton yield (11.43 ken/fed) followed by Kafr El-Sheikh (9.64 ken/fed) and Damietta (9.40 ken/fed), while Dakahlia gave the lowest (7.34 K/F). In the second year, the highest mean values were obtained from Kafr El-Sheikh (10.17k/f) followed by Gharbia (9.11k/f), while Dakahlia and Damietta gave the lowest yield of 5.74 and 5.35 k/f, respectively.

The six genotypes showed differences in seed cotton yield in the two years. Results of the first year revealed that strain 10229 × G 86 produced the highest mean value of seed cotton yield followed by G 92 and G 86 with means 10.84, 9.77 and 9.67 k/f, respectively. In the second year, genotypes 10229 × G86 and {G84(G70xG51b)}x P62 produced the highest mean values of seed cotton yield followed by G 86 with averages of 9.10 ,7.60 and 7.52 ken/fed, respectively. Combined data showed that genotypes 10229 × G86, G86 and G92 gave the highest seed cotton yield with means of 9.97, 8.60 and 8.50 (ken/fed), respectively. Strain 10229 × G86 showed the same rank and superiority in Y1, Y2 and combined analysis with means 10.84, 9.10 and 9.97 ken/fed, respectively. The strain G77 × Pima S6 gave the lowest seed cotton yield at Y1, Y2 and combined analysis with values 8.00, 6.87 and 7.43 ken/fed, respectively. All ranks of interactions; Y×L, L×G and Y×L×G were significant except Y×G. In the first year, the highest seed cotton yield of 12.52ken/fed was shown in Gharbia location by the strain 10229 × G86.

The strain G77 × Pima S6 gave the lowest value (6.24 ken/fed) at Dakahlia location. In the second year, the highest seed cotton yield of 12.04 ken/fed was obtained at Kafr El-Sheikh location by the strain10229 × G86, while G 88 gave the lowest value (4.06 ken/fed) at Damietta location. 10229 × G86, while G 88 gave the lowest value (4.06 ken/fed) at Damietta location.

Table 4. Response of seed cotton yield (Ken/fed) of six cotton genotypes (G) to locations (L), years (Y) and their interactions.

Genotypes	1st year 2011(Y1)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	10.97	8.02	10.99	8.7	9.67
10229xG86	12.52	8.60	12.27	9.95	10.84
G88	12.05	6.73	8.16	9.46	9.10
G92	11.91	7.58	9.32	10.25	9.77
G77x S6	9.22	6.24	7.36	9.17	8.00
{G84(G70xG51b)}x P62	11.91	6.84	9.71	8.86	9.33
Mean	11.43	7.34	9.64	9.40	9.45
L.S.D 5%					
L					0.5368
G	1.12	1.251	1.552	ns	0.6575
LG					1.315
Genotypes	2nd year 2012 (Y2)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	8.91	4.97	9.95	6.26	7.52
10229xG86	10.74	5.67	12.04	7.95	9.10
G88	8.93	6.65	9.03	4.06	7.17
G92	9.06	5.25	10.27	4.38	7.24
G77x S6	8.18	5.54	9.26	4.48	6.87
{G84(G70xG51b)}x P62	8.83	6.37	10.47	4.72	7.60
Mean	9.11	5.74	10.17	5.31	7.58
L.S.D 5%					
L					0.585
G	ns	1.055	1.265	1.465	0.7165
LG					1.433
Genotypes	Combined				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Overall mean
G86	9.94	6.50	10.47	7.48	8.60
10229xG86	11.63	7.14	12.16	8.95	9.97
G88	10.49	6.69	8.60	6.76	8.13
G92	10.49	6.42	9.80	7.32	8.50
G77x S6	8.70	5.89	8.31	6.83	7.43
{G84(G70xG51b)}x P62	10.37	6.61	10.09	6.79	8.46
Mean	10.27	6.54	9.90	7.35	8.52
L.S.D 5%					
Y					0.2629
L					0.3717
YL					0.5257
R(LY)					1.051
G					0.4553
YG					ns
LG					0.9106
YLG					1.288

Lint cotton yield

Mean performance of lint cotton yield (Ken/fed) as affected by years (Y), locations (L) genotypes (G) and their interactions are recorded in Table (5).

Table 5. Response of lint cotton yield (Ken/fed) of six cotton genotypes (G) to locations (L), years (Y) and their interactions.

Genotypes	1st year 2011(Y1)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	13.87	10.19	13.85	10.61	12.13
10229xG86	16.50	11.39	16.35	12.26	14.13
G88	14.76	8.06	9.65	10.63	10.78
G92	13.82	8.85	10.45	11.19	11.08
G77x S6	10.48	7.07	8.11	9.75	8.85
{G84(G70xG51b)}x P62	15.25	8.67	12.03	10.21	11.54
Mean	14.11	9.04	11.74	10.78	11.42
L.S.D 5%					
L					0.6714
G	1.417	1.538	1.695	ns	0.8222
LG					1.644
Genotypes	2nd year 2012 (Y2)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	11.35	5.95	12.34	7.93	9.39
10229xG86	14.07	7.09	15.61	10.29	11.77
G88	10.35	7.31	10.43	4.73	8.21
G92	10.45	5.55	11.47	5.29	8.19
G77x S6	8.85	5.54	10.06	4.93	7.35
{G84(G70xG51b)}x P62	10.9	7.47	12.28	5.86	9.13
Mean	11.00	6.49	12.03	6.51	9.00
L.S.D 5%					
L					0.7128
G	2.041	1.22	1.486	1.864	0.873
LG					1.746
Genotypes	Combined				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Overall mean
G86	12.61	8.07	13.10	9.27	10.76
10229xG86	15.29	9.24	15.98	11.28	12.95
G88	12.56	7.69	10.04	7.68	9.49
G92	12.14	7.20	10.96	8.24	9.63
G77x S6	9.67	6.31	9.09	7.34	8.10
{G84(G70xG51b)}x P62	13.08	8.07	12.16	8.04	10.33
Mean	12.55	7.76	11.89	8.64	10.21
L.S.D 5%					
Y					0.3293
L					0.4657
YL					0.6587
R(LY)					1.317
G					0.5704
YG					ns
LG					1.141
YLG					1.613

Similar to SCY, locations had marked effects on lint cotton yield. In the first year, Gharbia location gave the highest mean value followed by Kafr El-Sheikh and Damietta with averages of 14.11, 11.74 and 10.78 ken/fed, respectively. In the second year, the highest mean values were obtained from Kafr El-Sheikh location followed by Gharbia and Damietta with means 12.03, 11.00 and 6.51 ken/fed, respectively. Dakahlia gave the lowest yield in both years. The six genotypes showed different lint yield performance in the two years. In the first year, the strain 10229 × G86 produced the highest mean value followed byG86 and {G84 (G70xG51b)} x P62 with means 14.13, 12.13 and 11.54 ken/fed, respectively. In the second year, the strains 10229 × G 86 and G 86 produced the highest mean values followed by{G84(G70xG51b)}x P62 with means11.77, 9.39 and 9.13 ken/fed, respectively. Combined analysis showed that genotypes10229 × G86, G86 and G84 (G70xG51b)} x P62 gave the highest lint cotton yield with means of 12.95, 10.76 and 10.33 ken/fed, respectively, while the promising strain G77 × Pima S6 gave the lowest lint cotton yield at Y1, Y2 and combined analysis.

All ranks of interactions Y × L, L × G and Y × L ×G were significant in combined analysis except Y × G interaction. In the first year, the highest lint cotton yield of 16.50 ken/fed was obtained at Gharbia by the strain 10229 × G86, while strain G77 × Pima S6 gave the lowest value of lint cotton yield (7.07 ken/fed) at Dakahlia. In the second year, the highest lint cotton yield of 15.61ken/fed was obtained at Kafr El- Sheikh by the strain 10229 × G86, while G 88 gave the lowest value (4.73 ken/fed) at those obtained by Patel *et al* (1994), Badr and Abd El-Aziz (2000), Badr (2003), Abdel-Hafez *et al* (2000),Abdalla *et al* (2014), who reported significant effect of G,Y,L and G ×Y× L interactions.

Fiber properties

Cotton Fiber quality is a composite property determined by complex interactions between genetic potential and environmental fluctuations from planting to harvest. Fiber length, strength and maturity are three important characters affected by growing conditions and affecting spinning limits of yarn strength (Abdalla *et al*, 2014).

Upper half mean length (UHML)

Data in Table (6) show the mean performance of the upper half mean length (UHML) as affected by years (Y), locations (L) , genotypes (G) and their interactions for 2011 and 2012 growing years. Significant differences existed between the main sources of variation, i.e. years, locations and genotypes and their first and second order interactions.

Table 6. Upper half mean length (UHM) of six cotton genotypes (G) as affected by locations (L), years (Y) and their interactions.

Genotypes	1st year 2011(Y1)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	33.80	34.30	34.10	34.00	34.05
10229xG86	34.00	34.30	34.20	34.80	34.33
G88	35.8	35.60	36.00	35.70	35.78
G92	34.20	34.80	35.10	35.40	34.88
G77x S6	36.50	36.50	37.10	37.80	36.98
{G84(G70xG51b)}x P62	36.03	35.60	36.30	34.10	35.51
Mean	35.06	35.18	35.47	35.30	35.25
L.S.D 5%					
L					0.3008
G	0.7846	1.042	0.8416	0.5979	0.3684
LG					0.7368
Genotypes	2nd year 2012 (Y2)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	33.80	33.00	33.40	33.20	33.35
10229xG86	33.60	33.00	33.20	33.00	33.20
G88	36.30	36.80	36.40	36.30	36.45
G92	31.50	34.90	33.90	33.40	33.43
G77x S6	36.00	36.70	33.80	34.10	35.15
{G84(G70xG51b)}x P62	36.03	35.50	34.60	33.80	34.98
Mean	34.54	34.98	34.22	33.97	34.43
L.S.D 5%					
L					0.2164
G	0.4108	0.5895	0.4813	0.6684	0.265
LG					0.53
Genotypes	Combined				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Overall mean
G86	33.80	33.65	33.75	33.60	33.70
10229xG86	33.80	33.65	33.70	33.90	33.76
G88	36.05	36.20	36.20	36.00	36.11
G92	32.85	34.85	34.50	34.40	34.15
G77x S6	36.25	36.60	35.45	35.95	36.06
{G84(G70xG51b)}x P62	36.03	35.55	35.45	33.95	35.25
Mean	34.8	35.08	34.84	34.63	34.84
L.S.D 5%					
Y					0.1282
L					0.1811
YL					0.2561
R(LY)					ns
G					0.2218
YG					0.3136
LG					0.4435
YLG					0.6272

The highest mean values of locations in the 1st year were at Kafr El-Sheikh followed by Damietta and Dakahlia, since they recorded 35.47, 35.30 and 35.18 mm, respectively ,while Gharbia gave the lowest (35.06mm). In the second year, Dakahlia location recorded the highest mean values followed by Gharbia and Kafr El-Sheikh locations with upper half mean of 34.98, 34.54 and 34.22 mm, respectively, while Damietta gave the lowest (33.97mm). The six genotypes showed wide differences in upper half mean length in the two years. Results of the first year showed that the strain G77 × Pima S6 produced the highest mean value followed by G 88 and G84(G70xG51b)}x P62 With means 36.98, 35.78 and 35.51 mm, respectively. G86 gave the lowest value of 34.05mm. The results totally indicated that genotypes G88 and G77 × Pima S6 were the longest fiber, while G86 was the shortest. All ranks of interactions Y × L, Y × G, L × G and Y × L ×G were significant in combined analysis. In the first year, the highest upper half mean of 37.80mm was shown in Damietta location by the promising strain G77 × Pima S6, while G 86 gave the lowest value of (33.80 mm) at Gharbia location. In the second year, the highest upper half mean of 36.80 mm was obtained at Dakahlia location by G88. Genotype G 92 gave the lowest value (31.50 mm) at Gharbia location. However, the overall mean of the combined analysis (Table 6) revealed that the used genotypes were located to each assigned fiber group where G86 and the promising strain 10229 ×G 86 fell in the" long –staple category "while the other four cultivars and strains fell in the "extra-long staple category".

Fiber strength

Response of fiber strength (g/tex) of six genotypes to four locations and their interactions over the two growing seasons are recorded in Table (7). Location exerted marked effects on fiber strength. In the first year, Damietta gave the highest mean values (47.37 g/tex) followed by Kafr El-Sheikh (45.23 g/tex). In the second year, Damietta showed the highest mean values (43.99 g/tex) followed by Kafr El-Sheikh (43.59 g/tex). Gharbia and Dakahlia gave the lowest values in both seasons .The six genotypes showed differences in fiber strength in the two years. Results of the first year showed that genotype G 92 produced the highest mean value fiber strength followed by G77 × Pima S6 and G 88 with means 48.73, 48.22 and 47.23 g/tex, respectively. The strain 10229 × G86 gave the lowest fiber strength with mean 40.15 g/tex. In the second year, the same genotype G92 produced the highest mean value of fiber strength followed by {G84 (G70xG51b)} x P62 and G86 with means 44.83, 44.60 and 44.40 g/tex, respectively. The overall mean of the combined analysis showed that the four extra-long staple genotypes, were stronger compared with the other two long genotypes.

Table 7. Response of fiber strength (g/tex) of six cotton genotypes (G) to locations (L), seasons (Y) and their interactions.

Genotypes	1st year 2011(Y1)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	41.7	44.1	42.3	46.0	**43.53**
10229xG86	40.0	37.8	38.8	44.0	**40.15**
G88	47.5	45.2	48.2	48.0	**47.23**
G92	48.4	47.1	49.9	49.5	**48.73**
G77x S6	47.5	47.9	47.6	49.9	**48.22**
{G84(G70xG51b)}x P62	44.2	45.4	44.6	46.8	**45.25**
Mean	**44.88**	**44.58**	**45.23**	**47.37**	**45.52**
L.S.D 5%					
L					**0.3588**
G	**1.085**	**1.298**	**0.9078**	**0.4149**	**0.4395**
LG					**0.8789**
Genotypes	2nd year 2012 (Y2)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	41.6	43.1	46.6	46.3	**44.4**
10229xG86	38.8	42.3	42.3	38.8	**40.55**
G88	41.4	44.1	42.3	45.3	**43.28**
G92	47.9	42.4	45.5	43.5	**44.83**
G77x S6	45.2	43.9	42.0	44.03	**43.78**
{G84(G70xG51b)}x P62	44.2	45.4	42.8	46.0	**44.6**
Mean	**43.18**	**43.53**	**43.59**	**43.99**	**43.57**
L.S.D 5%					
L					**0.1788**
G	**0.5979**	**0.5427**	**0.4068**	**0.4228**	**0.219**
LG					**0.4379**
Genotypes	Combined				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Overall mean
G86	41.65	43.60	44.45	46.15	**43.96**
10229xG86	39.40	40.05	40.55	41.40	**40.35**
G88	44.43	44.65	45.27	46.65	**45.25**
G92	48.15	44.75	47.70	46.50	**46.78**
G77x S6	46.35	45.90	44.78	46.97	**46.00**
{G84(G70xG51b)}x P62	44.20	45.4	43.70	46.40	**44.93**
Mean	**44.03**	**44.06**	**44.41**	**45.68**	**44.54**
L.S.D 5%					
Y					**0.1419**
L					**0.2007**
YL					**0.2838**
R(LY)					**ns**
G					**0.2458**
YG					**0.3475**
LG					**0.4915**
YLG					**0.6951**

All ranks of interactions Y × L, Y × G, L × G and Y × L ×G were significant in combined analysis. In the first year, the highest fiber strength Table 7. of 49.90 was shown in Kafr El-Sheikh and Damietta locations by G 92 and the promising extra- long strain G77 × Pima S6, while the promising long - staple strain 10229 × G 86 gave the lowest value of fiber strength (37.80 g/tex). In the second year, the highest fiber strength of (47.90 g/tex) was obtained at Gharbia location by the same genotype G92, also the promising strain 10229 × G 86 gave the lowest value of fiber strength at Damietta location.

Maturity ratio (%)

Fiber maturity is generally expressed by the degree (amount) of fiber cell-wall thickening relative to the diameter or fineness of the fiber. The fiber maturity index (ratio) is dependent upon the thickness of this cell wall. Cotton fibers are considered as mature when the cell wall of the moisture-swollen fiber represents 50-80% of the round cross-section, as immature when it represents 30-45%, and as dead when it represents less than 25% (Munro, 1987). Results presented in Table (8) revealed that Damietta location recorded the highest mean value of maturity percentage followed by Kafr El-Sheikh. Dakahlia and Gharbia gave the lowest maturity ratio. In the second year, Dakahlia ranked the first with mean 72.37% followed by Gharbia and Kafr El-Sheikh with means 72.00 and 71.87, respectively.

The six genotypes showed a range of differences in fiber maturity in both years. Results of the first year revealed that G 86 produced the highest mean value with mean(77.15%) followed by G 92 (72.88%) and G 88 (72.60%).In the second year, the same genotype G 86 recorded the highest mean value followed by G 92 and G 88 with means 75.55, 71.73 and 71.43%, respectively. In the combined analysis, the overall mean displayed superiority of G.86 (76.35%) followed byG.92 (72.30%) and G.88 (72.01%). The ranks of interactions Y × L, Y × G, L × G and Y × L ×G were significant in combined analysis. The highest fiber maturity ratio of 79.50% and 77.50% were shown by G 86 in Kafr El-Sheikh, in the first and second year, respectively Kumar *et al* (2003), El-Sharawy *et al* (2007) and El-Adly *et al* (2008) and others found significant G × E interactions for one or more fiber trait which agree with the present study.

Table 8. Response of maturity (%) of six cotton genotypes (G) to locations (L), seasons (Y) and their interactions.

Genotypes	1st year 2011(Y1)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	41.7	44.1	42.3	46.0	**43.53**
10229xG86	40.0	37.8	38.8	44.0	**40.15**
G88	47.5	45.2	48.2	48.0	**47.23**
G92	48.4	47.1	49.9	49.5	**48.73**
G77x S6	47.5	47.9	47.57	49.9	**48.22**
{G84(G70xG51b)}x P62	44.2	45.4	44.6	46.8	**45.25**
Mean	**44.88**	**44.58**	**45.23**	**47.37**	**45.52**
L.S.D 5%					
L					**0.3588**
G	**1.085**	**1.298**	**0.9078**	**0.4149**	**0.4395**
LG					**0.8789**
Genotypes	2nd year 2012 (Y2)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	41.6	43.1	46.6	46.3	**44.4**
10229xG86	38.8	42.3	42.3	38.8	**40.55**
G88	41.4	44.1	42.33	45.3	**43.28**
G92	47.9	42.4	45.5	43.5	**44.83**
G77x S6	45.2	43.9	42.0	44.03	**43.78**
{G84(G70xG51b)}x P62	44.2	45.4	42.8	46.0	**44.60**
Mean	**43.18**	**43.53**	**43.59**	**43.99**	**43.57**
L.S.D 5%					
L					**0.1788**
G	**0.5979**	**0.5427**	**0.4068**	**0.4228**	**0.219**
LG					**0.4379**
Genotypes	Combined				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Overall mean
G86	41.65	43.60	44.45	46.15	**43.96**
10229xG86	39.4	40.05	40.55	41.40	**40.35**
G88	44.43	44.65	45.27	46.65	**45.25**
G92	48.15	44.75	47.7	46.50	**46.78**
G77x S6	46.35	45.90	44.78	46.97	**46**
{G84(G70xG51b)}x P62	44.20	45.40	43.70	46.40	**44.93**
Mean	**44.03**	**44.06**	**44.41**	**45.68**	**44.54**
L.S.D 5%					
Y					**0.1053**
L					**0.2007**
YL					**0.2838**
R(LY)					**ns**
G					**0.2458**
YG					**0.3475**
LG					**0.4915**
YLG					**0.6951**

Yarn traits

Single yarn strength (cN/tex)

Ring spinning system:

Data in Table (9) showed that, in the 1st year, Damietta location recorded the highest mean value of ring yarn strength followed by Kafr El-

Sheikh and Gharbia with means 20.81, 20.21 and 20.08 cN/tex, respectively, and 19.87, 19.82 and19.48 cN/tex, respectively, in the second year with the same order. Dakahlia gave the lowest values in both years.

Table 9. Response of yarn strength (cN/tex) for six cotton genotypes (G) to locations (L), seasons (Y) and their Interactions for ring spinning system at the two growing seasons 2011/2012.

Genotypes	1st year 2011(Y1)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	17.80	16.56	17.76	18.75	**17.72**
10229xG86	19.11	17.85	17.85	19.77	**18.65**
G88	19.66	20.11	20.86	20.86	**20.37**
G92	21.11	22.13	23.11	22.81	**22.29**
G77x S6	22.12	20.84	21.13	22.24	**21.58**
{G84(G70xG51b)}x P62	20.67	18.78	20.53	20.43	**20.10**
Mean	**20.08**	**19.38**	**20.21**	**20.81**	**20.12**
L.S.D 5%					
L					**0.2717**
G	**0.8744**	**0.6276**	**0.5273**	**0.8668**	**0.3328**
LG					**0.6656**
Genotypes	**2nd year 2012 (Y2)**				
	Gharbia	**Dakahlia**	**Kafr El-Sheikh**	**Damietta**	**Mean**
G86	17.11	18.75	18.4	18.75	**18.25**
10229xG86	18.11	18.12	19.06	17.78	**18.27**
G88	19.67	20.15	20.00	20.63	**20.11**
G92	21.06	21.15	23.12	23.07	**22.1**
G77x S6	20.81	19.15	18.86	19.15	**19.49**
{G84(G70xG51b)}x P62	20.11	19.13	19.47	19.86	**19.64**
Mean	**19.48**	**19.41**	**19.82**	**19.87**	**19.64**
L.S.D 5%					
L					**0.2599**
G	**0.6559**	**0.5923**	**0.4848**	**0.9644**	**0.3183**
LG					**0.6365**
Genotypes	**Combined**				
	Gharbia	**Dakahlia**	**Kafr El-Sheikh**	**Damietta**	**Overall mean**
G86	59.43	37.98	18.08	37.38	**38.21**
10229xG86	57.50	36.38	18.46	34.98	**36.83**
G88	59.69	35.93	20.43	35.93	**37.99**
G92	59.35	36.33	23.12	36.30	**38.77**
G77x S6	57.46	36.08	20.00	35.35	**37.22**
{G84(G70xG51b)}x P62	57.40	35.48	20.00	35.13	**37.00**
Mean	**58.47**	**36.36**	20.01	**35.84**	**37.67**
L.S.D 5%					
Y					**0.1086**
L					**0.1853**
YL					**0.262**
R(LY)					**0.4538**
G					**0.2269**
YG					**0.3209**
LG					**0.4538**
YLG					**0.6418**

Results of the first year revealed that G 92 produced the highest mean value (22.29 cN/tex) followed by G77 × Pima S6 (21.58 cN/tex) and G 88 (20.37 cN/tex). In the second year, the same genotype G 92 gave the highest mean value of (22.10 cN/tex) followed by G 88 and the promising strain {G84 (G70xG51b)} xP62 with means 20.11 and 19.64 cN/tex, respectively. Conversely, G 86 recorded the lowest mean values in Y1, Y2 and combined analysis.

The ranks of interactions Y × L, Y × G, L × G and Y × L ×G were significant in combined analysis. In the first year, the highest yarn strength of 23.11cN/tex was shown in Kafr El-Sheikh location by G92. Genotype G 86 produced the lowest value (16.56cN/tex) at Dakahlia. In the second year, the highest yarn strength (23.12cN/tex) was obtained at Kafr El-Sheikh by G 92. The same genotype (G 86) produced the lowest value (17.11cN/tex) at Gharbia location. Badr and Abd El Aziz (2000) and Hassan and Sanad (2006) reported that the effects of genotypes, locations, years and their interactions were significant for single yarn strength.

Compact spinning system

Results presented in Table (10) showed the mean performance of compact single yarn strength as affected by years (Y), locations (L), genotypes (G) and their interactions. In the first season, location effects revealed that Damietta location recorded the highest mean value of yarn strength followed by Kafr El-Sheikh and Gharbia locations with means 21.66, 21.11 and 21.07 (cN/tex), respectively. In the second year, the same location (Damietta) recorded the highest mean value of yarn strength (20.85cN/tex) followed by Kafr El-Sheikh (20.67cN/tex).

The six genotypes showed a range of differences in compact yarn strength in both years. Results of the first year revealed that G 92 produced the highest mean value of yarn strength with mean (23.30 cN/tex) followed by G77 × Pima S6 (22.17 cN/tex) and G 88 (21.38 cN/tex). In the second year, the same genotype G 92 gave the highest mean value of yarn strength with mean (22.74 cN/tex) followed by G 88 and the promising strain {G84 (G70xG51b)} x P62 with means 21.06 and 20.49 cN/tex, respectively.

The ranks of interactions Y × L, Y × G, L × G and Y × L ×G were significant. In the 1st year, the highest yarn strength of 24.76 cN/tex was shown in Kafr El-Sheikh location by G 92, while G 86 produced the lowest value (17.44 cN/tex) at Dakahlia location. In the 2nd year, the highest yarn strength (24.05 cN/tex) was obtained at Kafr El-Sheikh location by the same genotype G 92, while G 86 produced the lowest value (17.86 cN/tex) at Gharbia location. Badr (2003) and Hassan and Sanad (2006) reported that the effects of genotypes, locations, years and their interactions were significant for single yarn strength.

Table 10. Response of yarn strength (cN/tex) of six cotton genotypes (G) to locations (L), years (Y) and their interactions for compact spinning system at the two seasons 2011/2012.

Genotypes	1st year 2011(Y1)				
	Gharbia	Dakahlia	Kafr El-Sheikh	Damietta	Mean
G86	18.80	17.44	18.35	20.35	**18.74**
10229xG86	19.94	18.32	18.50	20.94	**19.43**
G88	20.93	21.05	21.76	21.78	**21.38**
G92	22.25	23.05	24.76	23.12	**23.30**
G77x S6	22.78	21.21	22.07	22.62	**22.17**
{G84(G70xG51b)}x P62	21.73	19.92	21.22	21.15	**21.01**
Mean	**21.07**	**20.17**	**21.11**	**21.66**	**21.00**
L.S.D 5%					
L					**0.2894**
G	**0.9712**	**0.6807**	**0.8337**	**0.6534**	**0.3544**
LG					**0.7088**
Genotypes	2nd year 2012 (Y2)				
	Gharbia	**Dakahlia**	**Kafr El-Sheikh**	**Damietta**	**Mean**
G86	17.86	19.39	19.07	20.63	**19.24**
10229xG86	18.95	19.06	20.12	18.61	**19.19**
G88	20.42	21.00	21.00	21.81	**21.06**
G92	21.93	21.92	24.05	23.07	**22.74**
G77x S6	21.24	20.11	19.71	20.22	**20.32**
{G84(G70xG51b)}x P62	21.08	20.06	20.08	20.74	**20.49**
Mean	**20.25**	**20.26**	**20.67**	**20.85**	**20.51**
L.S.D 5%					
L					**0.3089**
G	**0.6088**	**0.8475**	**1.042**	**0.9365**	**0.3784**
LG					**0.7567**
Genotypes	**Combined**				
	Gharbia	**Dakahlia**	**Kafr El-Sheikh**	**Damietta**	**Overall mean**
G86	38.10	39.25	37.98	38.18	**38.38**
10229xG86	36.00	34.88	36.38	35.56	**35.70**
G88	35.88	36.30	35.93	36.01	**36.03**
G92	35.63	36.35	36.33	36.15	**36.11**
G77x S6	35.65	35.00	36.08	35.52	**35.56**
{G84(G70xG51b)}x P62	35.25	35.13	35.48	35.24	**35.27**
Mean	**36.08**	**36.15**	**36.36**	**36.11**	**36.18**
L.S.D 5%					
Y					**0.1261**
L					**0.2155**
YL					**0.3047**
R(LY)					**ns**
G					**0.2639**
YG					**0.3732**
LG					**0.5278**
YLG					**0.7464**

Inspecting the overall mean of the combined analysis in Tables (9 and 10), it is obvious that the compact spinning system consistently gave higher single yarn strength as compared with the conventional ring spinning system, confirming the results obtained by El-Banna *et al* , (2013). It is

worthy to note that the four extra - long staple genotypes exhibited higher values of yarn strength compared with the other two long – staple ones either measured by ring or compact spinning system.

Stability analysis

Stability model

The stability in genotype performance was analyzed for seed cotton and lint yield, fiber length, fiber strength, fiber maturity and yarn strength based on Eberhart and Russell (1966) model. According to the model, genotypes with high mean yield, regression coefficient equal to unity (b_i = 1) and deviation from regression as small as possible (S^2_{di}= 0) are considered generally stable (Perkins and Jinks, 1968).

Analysis of variance of Eberhart and Russell model was presented in Table (11). Results indicated significant differences among cotton genotypes, environments, and genotype and environment interaction GEI interaction for all characters.

Table 11. Mean squares of stability analysis of yield, fiber and yarn traits for the six cotton genotypes.

SOV	df	Yield traits		Fiber properties			Ring Spinning	Compact spinning
		Seed cotton	Lint cotton	UHM	Fiber strength	Maturity	Yarn strength	Yarn strength
Genotype (G)	5	83.815**	22.026**	29.833**	123.21**	109.12**	55.39**	51.88**
Environment+(G×E)	42	32.749**	21.185**	2.648**	15.981**	5.86**	2.34**	2.60**
Environment (linear)	1	1219.04**	791.48**	36.56**	227.88**	86.15**	29.68**	34.49**
G × E (linear)	5	4.389*	2.268*	5.465**	12.195**	4.48**	0.52**	0.47
Pooled deviation	36	3.736**	2.416**	1.315**	10.621**	3.82**	1.83**	2.01**
Giza 86	6	3.942*	2.904**	0.427*	14.724**	8.18**	1.91**	2.94**
10229xGiza86	6	7.208**	4.186**	0.63**	14.745**	6.88**	1.07**	1.81**
Giza88	6	5.605**	3.659**	0.425*	7.69**	1.41**	0.52**	0.46
Giza 92	6	1.31	0.764	3.153**	15.837**	2.55**	2.45**	2.98**
Giza77x PimaS6	6	2.443	1.966	0.95**	7.149**	2.21**	4.25**	2.98**
{G84(G70xG51b)}x P62	6	1.906	1.015	2.302**	3.579**	1.70**	0.78**	0.89**
Pooled error	120 (80)$^+$	1.4158	0.93129	0.1522	0.1799	0.07	0.16	0.21

***, **: denote significant differences at 5% and 1%levels, respectively, $^+$: Number between Parentheses is the df of the pooled error of fiber and yarn traits.**

The GE interaction was further partitioned into components of GE linear which reflecting the magnitude of regression coffecient (b_i) in the sums of squares and non-linear (pooled deviation) which reflects the magnitude of the deviation from regression(S^2_d). In other words, the linear component of GE interaction expresses the significance in the regression slope, which measures the differential response of the genotypes across the growing environments. Highly significant mean square due to environment + (GE) interaction for all traits pointed out that the genotypes interacted considerably with the changes in the environmental conditions.

The linear effect of environments that had a single *df* showed significant variation among environments and also was large enough for a proper estimation of b_i values. The pooled deviation from regression was highly significant for all studied traits.

Moreover the significance of the mean squares due to pooled deviation from regression indicated that the performance of some genotypes are not stable across environments, for instance, 3 genotypes with SCY and were not stable across environments. (Table 11). This highlighted the need to assess response of genotypes using both linear regression coefficient (bi) and deviation from regression ($s^2_{d_i}$). The GE interaction was significant for seed and lint yield as well as fiber traits in many studies (Palomo *et al* 1998, Mert *et al* 1999, Abdalla *et al* 2014 and 2015).

Evaluating genotypes stability

Seed cotton yield

The estimates of phenotypic parameters for seed cotton yield indicated that mean values of cotton genotypes ranged from 7.43 ken/fed for the promising extra - long strain G77 × Pima S6 to 9.97 ken/fed for the promising long - staple strain 10229 × G86 (Table 12).

Table 12. Mean performance and stability parameters of seed cotton yield (ken/f) and lint cotton yield (ken/f) for the six cotton genotypes.

Genotype	Seed cotton yield (ken/f)			Lint cotton yield (ken/f)		
	$\bar{x}$	b_i	S^2d_i	$\bar{x}$	b_i	S^2d_i
G 86	**8.6**	**0.92**	**2.90****	**10.76**	**0.97**	**3.94***
10229xG86	**9.97**	**1.03**	**4.18****	**12.94**	**1.14**	**7.21****
G88	**8.13**	**1.01**	**3.65****	**9.49**	**1.01**	**5.61****
G 92	**8.5**	**1.19***	**0.76**	**9.63**	**1.08**	**1.31**
G77x pima S6	**7.43**	**0.8**	**1.96**	**8.10**	**0.73***	**2.44**
G84(G70x G51b)}x P62	**8.46**	**1.07**	**1.01**	**10.33**	**1.08**	**1.91**
Mean	**8.52**			**10.21**		
LSD 5%	**0.48**			**0.59**		

The overall genotypes average was 8.52 ken/fed. The regression coefficient (b_i) as a stability parameter was not significant for all genotypes except G92; this indicated similar response of most genotypes to changes in environmental conditions. Genotype G86 exhibited insignificant regression coefficient smaller than one and mean performance greater than the genotypes average.

This genotype would be more adapted to grow and breed under environments of unfavorable growth conditions (negative environmental index) such as Dakahlia (E2 and E6) and Damietta (E8) (Table13).

Table 13. Environmental index of each trait for the studied eight environments.

Traits	Gh 1(E1)	Dak 1(E2)	Kfr 1(E3)	Dam1(E4)	Gh 2(E5)	Dak 2(E6)	Kfr 2(E7)	Dam 2(E8)
Seed cotton	2.91	-1.18	1.12	0.88	0.59	-2.77	1.65	-3.21
Lint cotton	3.90	-1.17	1.53	0.56	0.78	-3.73	1.82	-3.71
Fiber length	0.22	0.34	0.63	0.46	-0.30	0.14	-0.62	-0.87
Fiber strength	0.34	0.04	0.68	2.82	-1.37	-1.01	-0.96	-0.56
Maturity ratio	-0.85	-0.25	0.52	1.73	-0.22	0.15	-0.35	-0.73
Yarn strength (R)	0.20	-0.50	0.33	0.93	-0.40	-0.47	-0.06	-0.01
Yarn strength (C)	0.20	-0.50	0.33	0.93	-0.40	-0.47	-0.06	-0.01

The regression coefficient (b_i) as a stability parameter was not significant for all genotypes except G92; this indicated similar response of most genotypes to changes in environmental conditions. Genotype G86 exhibited insignificant regression coefficient of smaller than one and mean performance greater than the genotypes average. This genotype would be more adapted to grow and breed under environments of unfavorable growth conditions (negative environmental index) such as Dakahlia (E2 and E6) and Damietta (E8) (Table13).

In general, environments that had an environmental index greater than zero were considered of high input environments (favorable growth conditions), and those of lower than zero were low input environments or unfavorable growing conditions or restricted for response to environmental inputs. Genotype 10229xG86 was top mean performance over the environments; however, the significance of deviations from linear regression makes its behavior unpredictable over the environments.

Lint cotton yield

The mean values of lint cotton of genotypes ranged from 12.94 ken/fed for the strain 10229 × G86 to 8.10 ken/fed for promising strain G77 × Pima S6, the overall genotypes average was 10.21 ken/fed (Table 12). The regression coefficient (bi) was not significant for all genotypes except the strain G77 × Pima S6, indicating similar response of most genotypes to changes in environmental conditions and general adaptability lint cotton of most genotypes for the tested environments. Genotype G84(G70x G51b)}x P62 exhibited mean performance greater than the overall genotypes and insignificant b_i and S^2_d, thus, this genotype would be more adapted to grow and breed under most environments and can be used to improve, simultaneously, lint yield and stability.

Fiber and yarn properties

The mean performance, regression coefficient (b_i) and deviation from regression coefficient (b_i) and deviation from regression (S^2d_i) for fiber and yarn properties are presented in Tables (14 and 15).

Upper half mean length (UHML)

The genotypes UHML ranged from 33.70 mm for Giza 86 to 36.11mm for Giza88 with an overall mean of 34.84 mm (Table 14).

Table 14. Mean performance and stability parameters of upper half mean length, fiber strength and fiber maturity for the six cotton genotypes.

Genotype	UHM (mm.)			Fiber strength (g/tex)			Maturity (%)		
	$\bar{x}$	b_i	S^2d_i	$\bar{x}$	b_i	S^2d_i	$\bar{x}$	b_i	S^2d_i
Giza 86	**33.70**	**0.546**	**0.43***	**43.96**	**0.33**	**14.72****	**76.35**	**0.94**	**0.75****
10229xGiza86	**33.76**	**0.957**	**0.63****	**40.35**	**0.65**	**14.75****	**71.11**	**2.03**	**0.68****
Giza88	**36.11**	**-0.4***	**0.43***	**45.25**	**1.56**	**7.69****	**72.01**	**0.94**	**0.29****
Giza 92	**34.15**	**1.536**	**3.15****	**46.78**	**1.29**	**15.84****	**72.30**	**0.78**	**0.41****
Giza77x pimaS6	**36.06**	**2.426****	**0.95****	**46.00**	**1.64**	**7.15****	**71.04**	**0.99**	**0.38****
G84(G70x G51b)}x P62	**35.25**	**0.93**	**2.30****	**44.93**	**0.54**	**3.58****	**70.49**	**0.32**	**0.33****
Mean	**34.84**			**44.54**			**72.22**		
LSD 5%	**0.22**			**0.24**			**0.15**		

Linear portion (b_i) of G ×E interaction did not differ significantly from unity for all genotypes except Giza 88 and strain Giza 77 × Pima S6, indicating similar response of most genotypes to changes in environmental conditions and there adaptability to most environments. Across the eight environments, the extra - long genotypes {G84(G70xG51b)}x P62 and Giza 92 and the long - staple 10229×G86 are considered generally adapted to different environments, since their upper half mean was high performance and regression coefficient was approximately equals one. Genotype Giza 77 × Pima S6 had high mean performance and significant regression coefficient and deviation from regression, therefore the stability of its performance was unpredictable. However, it can be considered as specifically adapted to environments that had a positive environmental index (Table 13) such as Dakahlia.

Fiber strength

The fiber strength mean values ranged from 40.35g/tex for the promising strain 10229× G 86 to 46.78 g/tex for G 92 with an overall environments average of 44.54g/tex (Table 14). The estimates of stability parameters indicated that the genotypes G 88, Giza 92 and strain G 77 × Pima S6 had mean performance higher than the overall mean and b_i values were not significant indicated general adaptability of these genotypes across different environments. Genotype G 92 had the highest mean performance, insignificant (b_i>1) and S^2d_i significantly differed from zero, thus, it was specifically suitable for favorable environments.

Maturity

Table (14) presented the mean performance of fiber maturity and estimates of stability parameters. Mean values ranged from 70.49% for the strain {G84 (G70xG51b)} x P62 to 76.35 % for G86 with an overall average of 72.22%. All genotypes showed insignificant bi values indicating general adaptability across different environments. The extra - long G92 and G88 recorded mean performance of 72.30 and 32.01% higher than overall mean. Their regression coefficient was closer to unity indicating the higher response to different environments. The long - staple G86 recorded the highest mean performance (76.35), insignificant b_i (close to one) suggesting that this genotype appeared to be wide adapted to different environments for this trait. On the other hand, S^2d_i values deviate significantly from zero for all genotypes indicating that this trait was highly sensitive to environmental conditions and had lower phenotypic stability.

Yarn strength (ring spinning system)

The mean values of ring spinning yarn strength ranged from (17.99 cN/tex) for G86 to (22.20 cN/tex) for G92 with an overall environments average of 19.88 cN/tex (Table 15). All genotypes showed insignificant b_i values indicating similar response of all genotypes to changes in environmental conditions and its general adaptability for this trait. Across the eight environments studied, genotypes G92 and G 77 × Pima S6 had high mean values (22.20 cN/tex and 20.54 cN/tex), and insignificant positive regression coefficient close to unity indicating the higher response for favorable environments that exhibited a positive environmental index. On the other hand, S^2d_i values deviate significantly from zero for all genotypes indicating lower phenotypic stability.

Table 15. Mean performance and stability parameters of yarn strength for the six cotton genotypes.

Genotypes	Yarn strength (cN/tex)					
	Ring spinning			Compact spinning		
	$\bar{x}$	b_i	S^2d_i	$\bar{x}$	b_i	S^2d_i
G 86	17.99	0.77	1.91**	18.99	1.24	2.94**
10229xG86	18.46	1.04	1.07**	19.31	1.122	1.81**
G88	20.24	0.61	0.52**	21.22	0.676	0.46
G 92	22.2	0.95	2.44**	23.02	0.766	2.98**
G77x PimaS6	20.54	1.57	4.24**	21.25	1.381	2.98**
G84(G70x G51b)}x P62	19.87	1.04	0.77**	20.75	0.814	0.89**
Mean	19.88			20.75		
LSD 5%	0.23			0.26		

Yarn strength (compact spinning system)

The mean of yarn strength and estimates of stability parameters (b_i and S^2d_i) for all genotypes was in Table (15). Mean values ranged from 18.99 for G 86 to 23.02cN/tex for G 92 with an overall environments average of (20.75 cN/tex). All genotypes gave non-significant b_i values exhibiting general adaptability across different environments.

Across the eight environments, The extra - long staple G 92 and G 88 had high mean values (23.02 cN/tex and 21.22 cN/tex) for yarn strength, and regression coefficient b_i less than unity (0.766 and 0.676) and S^2d_i significantly differed from zero, indicating the higher response for poor environments. The strain G 77 × Pima S6 with high mean performance (21.25cN/tex), regression coefficient higher than unity (1.381), and the deviation from regression significantly differed from zero indicating the higher response for favorable environments. The high yielding long staple promising strain 10229×G86 had higher yarn strength relative to its corresponding cv. G86 and had bi close to one ,thus considered wide adapted to different environments. On the other hand, S^2d_i values deviate significantly from zero for all genotypes except G88 indicating lower phenotypic stability.

In conclusion, the study explored the presence of a wide range of fluctuated responses of the current set of genotypes to different environments. This fluctuation pointed out the difficulty to recommend a genotype for such environment or even interpret its performance based on the mean performance only. Justifying the stability in performance is also significant. Growing location exhibited marked effects on most traits. Gharbia, Kafr El-Sheikh, and Damietta locations gave the highest mean value for seed and lint cotton yield. Damietta and Kafr El-Sheikh were the highest maturity index. Damietta and Kafr El-Sheikh recorded the highest mean value of yarn strength. Compact spinning system produced higher single yarn strength than the ring spinning system did. The linear effect of environments showed significant variation among environments and also was large enough for a proper estimation of b_i values. On the overall genotypes and environments data sets, the genotypes 10229XPS6, {G84 (G70xG51b)} x P62 and G 92 were the most stable genotypes for most tested traits. These best performing genotypes along with the cultivated standard cultivars can be adopted to improve, simultaneously, both yield performance and stability. Moreover, whenever new varieties are released, information regarding its specific or general stability and adaptations need to be available to both breeder and grower.

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تحليل أداء وثبات بعض التراكيب الوراثية من القطن المصرى لصفات المحصول والتيلة والغزل تحت بيئات مختلفة

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أجرى هذا البحث لتقييم الكفاءة المحصولية والثبات المظهرى لستة تراكيب وراثية من القطن شملت اثنين من طبقة طويل التيلة هما : صنف G86 وسلالة مبشرة G86 ×10229 وأربعة من طبقة فائقة الطول: صنف G88 – صنف G92 وسلالتين مبشرتين: Pima S6 ×G77 و P62×(G70×51b)G84 تم تقييمها لصفات محصول القطن الزهر والشعر وصفات التيلة وهى : طول التيلة (مم) – متانة التيلة (جرام/تكس) – نضج التيلة (%) وكذلك متانة غزل الخيط المفرد (سم نيوتن/تكس) بنظامين للغزل هما : الغزل الحلقى (Ring) والغزل المدمج (Compact). زرعت التجارب بأربعة مواقع بمحافظات الوجه البحرى خلال موسمى ٢٠١١،٢٠١٢ . أظهر تحليل التباين وجود اختلافات عالية المعنوية لكل من مواسم الزراعة (Y) والمواقع (L) والتراكيب الوراثية (G) لجميع الصفات مما يدل على وجود مدى واسع من الاختلافات بين التراكيب الوراثية والبيئات . كانت تفاعلات الدرجة الأولى معنوية ما عدا (G ×Y) لصفتى محصول القطن الزهر والشعر. كما كانت تفاعلات الدرجة الثانية معنوية لكل الصفات. أظهر المتوسط العام لصفات الأصناف والسلالات عبر البيئات الثمانية تفوق منطقة الغربية على باقى المناطق فى صفتى القطن الزهر والشعر وجاءت كفر الشيخ فى المرتبة الثانية تليها دمياط أما الدقهلية فكانت أضعف المناطق انتاجا للزهر والشعر. وتفوقت منطقة دمياط فى متانة ونضج التيلة ومتانة الخيوط المغزولة على نظامى الغزل الحلقى والمدمج بينما تفوق موقع الدقهلية فى طول التيلة – وقد احتلت منطقة كفر الشيخ المرتبة الثانية من التفوق فى صفات التيلة والغزل فى جميع المحافظات. تفوقت السلالة المبشرة G86 ×10229 من فئة طويل التيلة على نظيرها صنف G86 فى محصولى الزهر والشعر وطول ومتانة ودرجة نضج التيلة ومتانة الغزل الحلقى والمدمج – أما فى طبقة الأقطان فائقة الطول فقد

سجلت السلالة P62×(G70×51b)G84 يليها الصنف G.92 أعلى محصول فى الزهر والشعر – وتفوق G92 فى صفات نضج الشعرات ومتانة التيلة ومتانة الغزل الحلقى والمدمج بينما تفوق G88 يليه السلالة G77 × Pima S6 فى صفة طول التيلة. أظهر نظام الغزل المدمج تفوقا على نظام الغزل الحلقى التقليدى فى متانة الخيط المفرد وذلك لجميع التراكيب الوراثية وكذلك جميع البيئات. أوضحت نتائج تحليل الثبات المظهرى لصفات الأصناف والسلالات تحت ظروف ٨ بيئات أن السلالة المبشرة P62×(G70×51b)G84 قد أعطت أعلى محصول زهر وشعر متفوقة على أصناف وسلالات طبقة الأقطان الأخرى " فائقة طول التيلة " وكان معامل الأنحدار لها (b_i) مساويا للواحد الصحيح والأنحراف عن خط الانحدار(S^2d_i) لا يختلف معنويا عن الصفر لذلك تتميز بالمحصول العالى والثبات الجيد والملاءمة لكل البيئات . كما أن السلالة G86 ×10229 (طبقة طويل التيلة) أعطت أعلى محصول زهر وشعر وملاءمة للبيئات المختلفة . لذلك تعتبر السلالتين من السلالات المبشرة المرغوبة والجديرة بالاكثاروالتوزيع كأصناف ممتازة.

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