Simultaneous selection for high yielding and stability of some economic kenaf characters

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ABSTRACT

The materials used for the present study consisted of fourteen kenaf genotypes (G) which were evaluated over six environments (three at Ismailia Governorate, two at Giza Governorate and one at El-Beheira Governorate) through three successive seasons (2009 to 2011). in Egypt.

The analysis of variance revealed highly significant differences among genotypes, environments and G x E interaction for all studied traits, indicating a wide range of variation among genotypes, environments and these genotypes exhibited differential response to environmental conditions. The significant variance due to residual for all characters indicated that genotypes differed with respect to their stability suggesting that prediction would be difficult, which means that mean performance alone would not be appropriate. Interaction component of variance (σ^2ge) was less than the genotypic variance (σ^2g) for all characters. This means that genotypes differ in their genetic potential for these traits. The observed narrow range between phenotypic and genotypic coefficients of variability with high heritability in broad since for fiber percentage . Also, fiber weight per plant, technical stem length and plant height showed similar results, indicating possibility of using these three yield traits in selection criteria with giving more weight for fiber weight per plant and technical stem length for improving green stalk yield per plant in turn fiber yield.

The criterion, yield stability (YS_i) statistic indicated that S.105/2 and S.113 were proved to be superior in yield and stability for all characters studied as well as three genotypes, S.96/20, Giza3 and S.8 were stable for most characters studied. Therefore, the two genotypes (S.105/2 and S.113) maintained mean performance advantage across nearly all the environments sampled by maintaining high level for the above-mentioned traits and they are recommended to be released as commercial stable high yielding cultivars and/or to be incorporated in kenaf breeding program for producing stable high yielding lines.

Phenotypic correlation coefficients among green stalk weight with other related characters of kenaf, indicated that, plant height, technical stem length, and fiber percentage are the major components contributing to green stalk weight per plant. Therefore, selection for these traits will improve green stalk weight per plant and in turn fiber yield in kenaf.

INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) is often touted as being a new crop but in fact it is an ancient crop. kenaf is one of the most important fiber crops in the world. It has been cultivated and used as cordage crop to produce twine, rope, gunny-bag and sackcloth for over six millennia (Charles, 2002). New applications of kenaf have been developed, such as pulping and papermaking, oil absorption and potting media, board making, filtration media and animal feed (Sellers and Reichert, 1999; Cheng, 2001). Kenaf is commercially cultivated in more than 20 countries, particularly in India, China, Thailand and Vietnam (FAO, 2003). Kenaf will grow well and produce high fiber yield when grown on an extremely wide range of soils. The principal requirement is that the soils possess good drainage, although it will tolerate flooding in the last stages of growth (Dempsey, 1975). It can be planted on marginal land. Therefore, it suitable to Egyptian agriculture for marginal and sub marginal soils. Many investigators studied the differences between kenaf genotypes i.e.,Osman and Momtaz,1982 and Abd El-Dayem, 2001. On the other hand, the estimation of some genetic parameters and stability in kenaf is limited. Subramanyam *et al.*, (1995) studying the heritability in eight kenaf hybrids. They found that, fiber weight per plant and green plant weight showed high heritability, indicating that selection in early generations would be effective. Abd El-Dayem (2001) found that heritability ratios in broad sense were high in all traits studied.

Plant breeding aims to improve crop production either within a given macro-environment or in a wide range of growing conditions. The yield level, yield stability and genetic variance of the base populations would thus determine the success of any selection programs (Kofoid *et al.*, 1978). Efforts have been made to combine yield and performance stability into a single selection criterion (Kang *et al.*, 1991 and Bachireddy *et al.*, 1992). Benefit to farmers of emphasizing stability of performance during the selection process has been demonstrated (Kang, 1993 and Kang and Magari, 1995). With the availability of improved statistical tools to analyze and understand GE interactions, it is now possible to develop improved cultivars for target environments by exploiting GE interactions and marker – based selection integrated with traditional plant breeding (Boema and Kang, 1998 and Kang, 1998).

The main objective of this study was to study the genetic variability for agronomic characteristics of fourteen kenaf genotypes via a new yield-stability (YS_i) statistics. Another objective was to estimate genetic and GE variance for deriving statistics, unbiased by GE variance such as heritability and genetic coefficient of variation, and to discuss the possibility of implications of these genotypes for obtaining stable lines to be released as cultivars or to be used as stable experimental lines to be incorporated in breeding program for selecting stable high yielding potential cultivars.

MATERIALS AND METHODS

The materials used for the present study consisted of fourteen kenaf genotypes (one local variety, twelve advanced lines and one introduction). The classification and pedigree of the fourteen genotypes used are partially described in Table1.

These fourteen genotypes were evaluated in three successive seasons (2009 to 2011). In 2009 season, these materials were evaluated at two locations viz: Giza Exp. Sta., Giza Governorate (clay loom, pH=7.85); and Ismailia, Ismailia Governorate (Sandy soil, pH=7.55). In 2010 season, these materials were evaluated at one location (Ismailia) only. In 2011 season, the previous materials were evaluated at the three locations, Giza Exp. Sta., Giza Governorate; Ismailia, Ismailia Governorate and Etay El-Baroud Exp. Sta., El-Beheira Governorate (clay loom, pH=8.04). The

experimental design was randomized complete block with three replications per each of the six environments (locations). Sowing date was the first week of May in each seasons, the plot size was 3 meters long and 2 meters wide (1/700 fed) and consisted of 4 rows, 50 cm apart and the distance between hills was 20 cm. Thinning to two plants per hill was performed four weeks after sowing. The recommended cultural practices for kenaf production were applied. At maturity stage, ten random guarded plants from each plot were taken to score the following traits:
(1) Green stalk yield (ton)/fed, (2) Fiber yield (Kg)/fed (the two characters previously mentioned were calculated from yield per plot), (3) Fiber percentage = (fiber weight/plant x 100 ÷ green weight/plant), (4) Green weight (g)/plant, as weight in grams of kenaf stalk plant after 48 hours from harvesting, (5) Fiber weight (g)/plant, as the weight in grams of the air-dried fibers extracted from retted green stalk of kenaf plant, (6) Plant height (m), measured as the distance from the two cotyledonary nodes up to uppermost capsule, (7) Technical stem length (m), measured as the distance from the two cotyledonary nodes to the first apical branch, (8) Seed yield (Kg)/fed (calculated from yield per plot), (9) Seed weight (g)/plant and (10) Fruiting zone length (m), measured as the distance from the first apical branch to uppermost capsule.

Table 1. Pedigree of the fourteen kenaf genotypes under study, origin and Year release

Genotypes	Pedigree	Origin	Year released#
1- Giza 3	Selected from farmer fields	Local cultivar	1961
2- S. 8	Selected from H.106 (G.5 x 77/68-1)	Advanced line	1993
3- S.105/2	Giza 5 x S.87/68-1	" " " "	1994
4- S.96/20	Giza 3 x 17/64-2	" " " "	2002
5- S.108/9	Giza 3 x S.127/130	" " " "	1996
6- S.98/205	S.77/68/1 x S.87/68/1	" " " "	1992
7- S.112	H.27/127 x H.27/130	" " " "	1994
8- S.119	Selected from H.119 (G.4 x 16/63-2)	" " " "	2000
9- S. 114	S.16/63/2 x S.29/145	" " " "	1993
10-New Indian	Selected from I. New Indian	India	1996
11- S.38	Giza 3 x 4/59-27	Advanced line	1976
12- S.113	S.16/63 x S.4/59/3	" " " "	1990
13- S.116	S.4/59 x S.29/1451	" " " "	1998
14- S.45/29	S.80/68/1 x S.4/59/26	" " " "	1977

#Year released, selected or introduced

Statistical analysis:

Plot means were used for statistical analysis. Data from each of six environments (locations) were analyzed. Barteltt' test of homogeneity was used before combined analysis .The estimates of the variance components were calculated by using the expected mean squares as outlined by the procedures described by Johnson *et al*., (1959). Analysis of variance was conducted, which revealed that genotype x environment interaction was significant for each trial. Phenotypic correlation coefficients were calculated according to the formula suggested by Al-Jibouri *et al*., (1958).

A yield – stability statistic (YSi) developed for simultaneous selection for yield and stability was calculated according to Kang (1993). The various steps involved in the calculation of the YSi statistic are as follows:

1) Genotypes were ranked according to yield with the lowest-yielding genotype receiving a rank of 1; 2) An adjustment to the yield rank was made; +1 if genotype mean yield was > overall mean yield (OMY) for a test, +2 and +3 if genotype mean yield was ≥ OMY by1 LSD, respectively; -1 if genotype mean yield < OMY, -2 and –3 if genotype mean yield was ≤1 LSD below OMY; 3) The adjusted rank was labeled Y; 4) A stability rating (S) was assigned as follows; 0, if $\sigma 2$ was not significant; and -2, -4, and -8 if $\sigma 2$ was significant at 10%, 5% and 1% probability level, respectively ; 5) The adjusted rank, Y and the stability rating, S, for each genotype were summed; and 6) The genotypes that had YSi > ∑YSi / t(No. of genotypes) were selected.

RESULTS AND DISCUSSION

Variability:

The analysis of variance for green stalk yield, seed yield and other related traits over six environments of kenaf are presented in Table (2). Mean squares due to genotypes (G) showed highly significant for all characters, indicating the presence of genetic variability among the tested genotypes for these characters. Environments (E) differed highly significantly for all traits, indicating a wide range of variation among the environments under study. Moreover, environments ratio of variation explaining 81.52, 92.38, and 84.21% of the variances in green yield (g)/plant, green stalk yield (ton/fed.) and seed yield (kg/fed), respectively. Also, GxE interaction was significant for all characters.

Table 2. Genotype x environment interaction mean squares and its partitioning into heterogeneity due to environmental index and residual from the combined analysis of variance over six environments for ten characters of kenaf.

S.O.V. / Characters	Genotypes (G) (13)#	Environment (E) (5)#	Interaction (GxE)(65)#	Heterogeneity (13)#	Residual (52)#	Pooled Error (156)#
Green stalk yield (ton)/fed	58.969 **	729.236**	1.222 **	1.650 *	1.115 *	0.728
Fiber yield (kg)/ fed	5552.34**	10348.95**	60.104 **	227.761 **	18.190 **	6.447
Fiber percentage (%)	4.469**	86.789**	0.765 **	2.308 **	0.371 **	0.030
Green weight (g) / plant	98606.54**	442965.6**	1774.66**	5323.965 **	887.331*	493.80
Fiber weight (g) / plant	815.468**	631.242**	5.574 **	23.651 **	1.055 ns	4.004
plant height (m)	2.873**	27.926**	0.047 **	0.190 **	0.012*	0.006
Technical stem length (m)	1.277**	17.276**	0.022 **	0.086 **	0.005 *	0.003
Seed yield (kg)/fed	6043.14**	32788.02**	103.31 **	170.456 **	86.519*	57.007
Seed weight (g) / plant	23.018**	56.480**	0.606 **	2.123 *	0.227 *	0.137
Fruiting zone length (m)	0.767**	1.274**	0.126 **	0.062 **	0.0001 ns	0.016

ns,*, = Indicate nob-significant, significant and highly significant, respectively.**
 # =Values designated the corresponding degrees of freedom .

This result indicated that genotypes had considerable different responses to environmental conditions. The ratio between the two variances, G and GxE was greater for all characters studied indicating that improvement of these characters could be achieved by direct selection. When GxE interaction was partitioned into heterogeneity due to the environmental index and residual, the variances due to heterogeneity (GxE linear) were highly significant for all traits, suggesting that linear components of genotype – environment was present. This means that heterogeneity among genotypes for these traits relative to the environmental index was significant. Whereas, variance due to residual (pooled deviation) for all characters was significant except both fiber weight/plant and fruiting zone length, indicated that genotypes differed with respect to their stability suggesting that prediction would be difficult, which means that mean performance alone (mean yield) would not be appropriate. In such situation, methods that combine yield and stability of performance are useful (Bachireddy *et al.*, 1992).

Variance components:

Estimates of variance components among fourteen kenaf genotypes for seven characters (green stalk yield/plant and its related characters) grown at six environments are shown in Table(3).

Table 3. Variance component estimates from combined ANOVA, phenotypic (PCV) and genotypic (GCV) coefficients of variability and broad sense heritability (H) for the combined analysis of variance over six environments for green weight, seed weight/plant and their components of kenaf.

Characters	σ^2_{ph}	σ^2_g	σ^2_{ge}	σ^2_e	H%	PCV%	GCV%
Green weight (g) / plant	5478.14**	5379.55**	426.95 **	493.80	98.20	22.81	22.60
Fiber percentage (%)	0.248 **	0.206 **	0.245 **	0.030	82.88	6.715	6.114
Fiber weight (g) / plant	45.304 **	44.994 **	0.523 **	4.004	99.32	29.11	29.01
plant height (m)	0.160 **	0.157 **	0.014 **	0.006	98.35	15.67	15.54
Technical stem length (m)	0.071 **	0.070 **	0.006 **	0.003	98.32	13.30	13.19
Seed weight (g) / plant	1.279 **	1.245 **	0.156 **	0.137	97.37	32.15	31.72
Fruiting zone length (m)	0.043 **	0.036 **	0.037 **	0.016	83.64	37.745	34.518

ns,*, = Indicate nob-significant, significant and highly significant, respectively.**
σ^2_g, σ^2_{ge}, σ^2_e are the variance attributed to , genotypes , genotype x environment interaction and plot error, respectively.

Interaction components variances (σ^2ge) were less than the genotypic variance (σ^2g) for all characters, indicating that genotypic differences over shadow GE interaction effects. This means that genotypes differ in their genetic potential for these traits. phenotypic (PCV) and genotypic (GCV) coefficients of variability reached maximum values for fruiting zone length whereas, recorded minimum values for fiber percentage. The observed narrow range between phenotypic (PCV) and genotypic (GCV) coefficients of variability, which gave almost similar values of PCV (6.72%) and GCV (6.11%) in fiber percentage was mainly due to genetic differences as evidenced from the high heritability estimate (98.29%). Also, fiber weight/plant, technical stem length and plant height showed similar results, indicating possibility of using these three yield traits in selection criteria with giving more weight for fiber weight/plant and technical stem length for improving green stalk yield/plant. These results are in harmony with that reported by Osman and Momtaz,1982; El-Kady and El-Sweify,1995, Abd El-Dayem, 2001, Abo-Kaied, 2007 and Abo-Kaied and Abuo Zaid, 2008.

Genotypic mean performance and stability:

Mean performance, ranking of means and yield stability statistic (YSi) for green stalk yield, fiber yield and other related characters for fourteen kenaf genotypes averaged over six environments are presented in Table (4). S.105/2 followed S.113 and commercial variety Giza 3 showed high mean performance (high ranking) for green stalk yield / fed (16.903, 15.021 and 14.861 ton). Also, S.105/2 and S.96/20 mean performance exhibited high ranking for each of fiber yield/fed (134.855 and 110.031kg), fiber percentage (8.38 and 8.49 %), fiber weight/plant (43.59 and 26.76 g), technical stem length (2.034 and 2.276 m) and seed weight/pant (5.990 and 5.044 g). Whereas, S.105/2 and Giza 3 for Green stalk yield / plant (546.50 and 376.34 g), S.105/2 and S.8 for plant height (3.374 and 3.034 m), S.96/20 and New Indian for seed yield/fed which recorded 113.151 and 112.855 kg/fed and S.105/2 and S.8 for fruiting zone length (0.999 and 0.959 m) exhibited high mean performance for above-mentioned characters, respectively. Results indicated that S.105/2 and S.96/20 proved maximum (first or second ranking for mean performance) for most characters studied. Therefore, the previous mentioned genotypes specially S.105/2 may be released as commercial cultivars and/or to be incorporated as breeding stocks in kenaf breeding program aiming for producing high yielding lines.

The presence of GE interaction (Table 2) indicated that conclusions based solely on genotypes means were not reliable. Genotypes responded differently to changes in environments; therefore, measure of stability (Ysi) was deemed appropriate (Table 4). Yield stability according to Kang (1993), revealed that S.105/2 and S.113 exhibited high degree of stability for all characters studied. Whereas, S.96/20 was stable for all characters except fruiting zone length but, commercial variety Giza 3 was unstable only for fiber percentage in addition S.8 was stable for all characters except both seed yield/fed and seed weight/plant and New Indian (introduction) was also stable for all characters except each of fiber yield/fed, fiber weight/plant and fruiting zone length and finally S.112 exhibited high degree of stability for all characters with the exception of green yield/fed and fiber yield/fed. These results indicated that, the above mentioned genotypes are considered as ideal stable genotypes (according Ys_i measurement) to most characters studied. It is worth to mention here that the two lines, S.105/2 and S.113 were proved to be superior in yield and stability for all characters studied as well as three genotypes,S.96/20, Giza3 and S.8 were stable for most characters studied. Therefore, the two genotypes (S.105/2 and S.113) maintained mean performance advantage across nearly all the environments sampled by maintaining high level for the above-mentioned traits and they are recommended to be released as commercial stable high yielding cultivars and/or to be incorporated in kenaf breeding program for producing stable high yielding lines.

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Correlation study:

Phenotypic correlation coefficients among green stalk weight, fiber weight/ plant and their related characters of fourteen kenaf genotypes averaged over six environments are shown in Table (5). Green stalk weight exhibited significant positive correlation with each of fiber weight/plant, plant height and fruiting zone length. Also, fiber weight/plant exhibited significant positive correlation with each of plant height, technical stem length, seed weight/plant and fruiting zone length. These results, indicated that maximization of fiber weight/plant may be obtained via selection for previous traits, specially plant height and fiber percentage, where there was an association with significant positive between fiber percentage and fiber weight/plant. Moreover, significant association was obtained between plant height with each of technical stem length, seed weight/plant and fruiting zone length. Seed weight/plant was significantly positively correlated with fruiting zone length. These results indicated that plant height and fiber percentage are the main components for fiber weight/plant. These results are in agreement with those obtained by Mourad *et al*.,1987; El-Shimy *et al*.,1990; Bunpromma,1992; Abo-Kaied, 2007 and Abo-Kaied and Abuo Zaid, 2008.

In general, it can be concluded that plant height, technical stem length, and fiber percentage are the major components contributing to green stalk weight/plant. Therefore, selection for these traits will improve fiber yield (weight) in kenaf.

Table 5. Phenotypic correlation coefficients among seven characters of fourteen kenaf genotypes averaged over six environments.

Characters	1	2	3	4	5	6
1-Green weight (g) / plant						
2-Fiber percentage (%)	0.631					
3-Fiber weight (g) / plant	0.981 **	0.763 *				
4-plant height (m)	0.822 **	0.637	0.827 **			
5-Technical stem length (m)	0.648	0.642	0.683 *	0.883 **		
6-Seed weight (g) / plant	0.643	0.750 *	0.722 *	0.725 *	0.868 **	
7-Fruiting zone length (m)	0.736 *	0.422	0.706 *	0.824 **	0.533	0.803**

***,** = Indicate significance at the 0.05 and 0.01 levels of probability, respectively.**

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الانتخاب للقدرة المحصولية العالية وثبات السلوك لبعض الصفات الاقتصادية في التيل

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استخدمت في هذه الدراسة ١٤ تركيبا وراثيا من التيل تم تقيمها في ٦ بيئات (٣بيئات بمحافظة الإسماعيلية و بيئتان بمحافظة الجيزة وبيئة بمحافظة البحيرة) خلال ثلاثة موسم (٢٠٠٩الي٢٠١١) متوالية. تشير نتائج تحليل التباين أن كل من التراكيب الوراثية(G) والبيئات(**E**) والتفاعل بينهم(**G x E**) جميعها كانت معنوية لكل الصفات تحت الدراسة ، مما يدل علي مدي الاختلاف الواسع بين التراكيب الوراثية والبيئات وكذلك اختلاف استجابة هذه التركيب للظروف البيئية ، كذلك المعنوية العالية للتباين الراجع للجزء المتبقي من التفاعل يشير إلى اختلاف هذه التراكيب فيما بينها علاوة علي صعوبة التنبؤ بثبات سلوكها الوراثي عند الاعتماد علي القيمة المحصوليه فقط .

كانت تقديرات مكونات تباين التفاعل بين الأصناف والبيئات (σ^2ge) أقل من تباين الأصناف (σ^2g) لكل الصفات المدروسة. هذا يعني أن هذه الأصناف تختلف فيما بينها في القدرة المحصولية لهذه الصفات وهذا انعكس في تقديرات درجة التوريث العالية والفارق المنخفض بين معاملي التباين الظاهري والوراثي لصفة النسبة المئوية للألياف وكذلك لصفات وزن الألياف للنبات والطول الكلي والطول الفعال. لذلك يمكن استخدام هذه الصفات كدلائل انتخابية لتحسين صفة الوزن الأخضر للساق وبالتالي تحسين محصول الأليا

كما أشار مقياس الثبات (YS_i) والذي يقيس ثبات السلوك مع المحصول العالي إلى أن السلالتين (٢/١٠٥، ١/١١٣) كانتا متفوقتين في كل الصفات تحت الدراسة كذلك تفوقت الثلاثة تركيب وراثية (٢٠/٩٦، جيزة ٣ ، س ٨) لمعظم الصفات تحت الدراسة، ولذلك يمكن أن يوصي باستخدام هاتين السلالتين (٢/١٠٥ و١/١١٣) كأصناف تجارية لإنتاج محصول عالي وثابت كما يمكن استخدامها في برنامج التربية لإنتاج سلالات ثابتة وعالية في المحصول.

كما تشير نتائج الارتباط الظاهري إلي أن هناك ارتباط موجب ومعنوي بين صفة الوزن الأخضر للساق وكل من الطول الكلي والطول الفعال والنسبة المئوية للألياف والتي تعتبر المكونات الرئيسية لهذه الصفة (الوزن الأخضر للساق) كذلك كان هناك ارتباط موجب ومعنوي بين الطول الكلي والطول الفعال ، لذلك يمكن استخدامهما كدلائل انتخابية لتحسين صفة الوزن الأخضر للساق والذي يترتب علية تحسين محصول الألياف في التيل.

قام بتحكيم البحث

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Table 4. Mean yield, rank (assigned before stability analysis was made), yield stability statistic (YS_i) and stable genotypes for ten characters of fourteen kenaf genotypes .

+= Genotype selected on the basis of YS_i

Genotypes	plant height (m)			Technical stem length (m)			Seed yield (kg)/fed			Seed weight (g) / plant			Fruiting zone length (m)		
	Means	Rank	YS_i	Means	Rank	YS_i	Means	Rank	YS_i	Means	Rank	YS_i	Means	Rank	YS_i
1- Giza 3	2.663	9	12 +	2.145	10	13 +	97.690	10	13 +	3.615	7	8 +	0.518	10	9 +
2- S. 8	3.034	13	8 +	2.034	8	10 +	80.351	6	4	3.177	6	4	0.999	14	9 +
3- S.105/2	3.374	14	9 +	2.415	14	9 +	99.726	11	14 +	5.990	14	9 +	0.959	13	8 +
4- S.96/20	2.733	10	13 +	2.276	13	8 +	113.151	14	9 +	5.044	13	8 +	0.457	4	2
5- S.108/9	2.318	4	-3	1.835	4	-3	70.728	5	2	2.775	5	2	0.483	7	5 +
6- S.98/205	1.704	1	-10	1.391	1	-10	63.662	2	-9	2.098	2	-9	0.313	2	-5
7- S.112	2.776	12	11 +	2.217	11	6 +	90.226	7	8 +	4.045	12	15 +	0.543	11	10 +
8- S.119	2.224	3	-8	1.746	2	-9	69.788	4	1	2.214	3	-8	0.304	6	4
9- S. 114	2.219	2	-9	1.915	6	3	94.759	8	10 +	3.743	8	10 +	0.471	1	-6
10-New Indian	2.611	8	10 +	2.140	9	10 +	112.855	13	8 +	4.013	11	6 +	0.485	5	3
11- S.38	2.399	5	2	1.914	5	2	66.397	3	-4	2.612	4	-3	0.483	9	7 +
12- S.113	2.736	11	14	2.251	12	7 +	103.325	12	15 +	4.001	10	13 +	0.708	8	6 +
13- S.116	2.514	7	6	1.805	3	-8	60.056	1	-10	2.082	1	-10	0.709	12	15 +
14- S.45/29	2.403	6	3	1.950	7	5 +	96.917	9	12 +	3.839	9	11	0.453	3	1
General mean	*2.550*		4.14	*2.003*		4.14	*87.116*		5.21	*3.518*		4	*0.547*		4.86
LSD $_{0.05}$	0.121			0.086			11.836			0.58			0.086		

Table 4 Cont. += Genotype selected on the basis of YS_i

Genotypes	Green stalk yield (ton)/fed			Fiber yield (kg)/ fed			Fiber percentage (%)			Green weight (g) / plant			Fiber weight (g) / plant		
	Means	Rank	YS_i	Means	Rank	YS_i	Means	Rank	YS_i	Means	Rank	YS_i	Means	Rank	YS_i
1- Giza 3	14.861	12	15 +	100.360	10	12 +	7.18	6	5	376.34	13	14 +	25.43	12	15 +
2- S. 8	14.626	11	14 +	104.158	11	14 +	7.46	10	11 +	346.21	11	13 +	24.61	10	12 +
3- S.105/2	16.903	14	9 +	134.855	14	13 +	8.38	13	16 +	546.50	14	9 +	43.59	14	9 +
4- S.96/20	13.519	9	10 +	110.031	13	8 +	8.49	14	17 +	327.99	9	10 +	26.76	13	8 +
5- S.108/9	11.075	2	-9	73.465	2	-1	6.96	3	1	269.77	3	-8	17.89	2	-1
6- S.98/205	10.154	1	-10	69.694	1	-4	7.27	7	6	244.12	1	-10	16.72	1	-6
7- S.112	12.586	6	4	92.864	8	7	7.73	12	14 +	305.19	8	6 +	22.53	8	7 +
8- S.119	12.703	7	6 +	86.539	6	4	7.13	4	3	291.91	6	1	19.91	6	3
9- S. 114	11.218	3	0	76.537	3	0	7.16	5	4	269.14	2	-1	18.34	4	1
10-New Indian	12.892	8	7 +	91.198	7	6	7.45	9	10 +	300.62	7	5 +	21.29	7	5
11- S.38	12.223	4	1	79.332	4	1	6.84	1	-1	281.13	4	1	18.25	3	0
12- S.113	15.021	13	16 +	107.738	12	15 +	7.52	11	12 +	335.35	10	11 +	24.03	9	10 +
13- S.116	14.082	10	12 +	98.968	9	11 +	7.39	8	7	358.11	12	15 +	25.14	11	13 +
14- S.45/29	12.489	5	3	82.429	5	2	6.92	2	0	291.23	5	2	19.24	5	2
General mean	*13.168*		5.57	*93.440*		6.286	*7.42*		7.5	*324.54*		4.85	*23.12*		5.57
LSD $_{0.05}$	1.338			12.587			0.86			38.84			3.14		

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