EVALUATION OF SOME FLAX GENOTYPES FOR YIELD AND YIELD COMPONENTS UNDER DIFFERENT ENVIRONMENTAL CONDITIONS

ABO-KAIED, H.M.H., T.A. ABUO-ZAID AND AFAF E.A. ZAHANA

Fiber Crops Res. Department, Field Crops Res .Inst., A.R.C., Giza

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Abstract

Ten flax genotypes (**G**) were evaluated over six environments "combination of three years (**Y**) [2003/04, 2004/05 and 2005/06] and two locations (**L**) [Gemmiza Exp. Sta., Gharbia Governorate and Ismaelia Exp. Sta., Ismaelia Governorate]" in Egypt. The objectives were to determine the genotype x environment interactions and estimates the potential of a genotype to stabilize its performance over various environments.

Genotypes mean squares were highly significant for all studied characters, indicating that the genotypes differ in their genetic potential. **GxY** interaction was insignificant for most characters, except straw weight per plant and plant height. On the other hand, **GxL** interaction was highly significant for all studied characters, indicating that location had the major effect on the relative genotypic potential for these traits. Therefore, it would certainly be necessary to test genotypes in more than two locations with few number from years. Estimates of variance components, phenotypic (PCV) and genotypic (GCV) coefficients of variability and broad sense heritability (H) indicated the possibility of using plant height as selection index for improving straw weight per plant and each of 1000-seed weight, No. of capsules per plant and No. of seeds per capsule in selection index for improving seed weight per plant.

Based on estimates of mean performance ($\bar{x}$), regression coefficient (b), deviation from regression (S^2d), coefficient of determination (r^2) and the ecovalence stability index (w), it could be concluded that the most stable genotype in straw yield, Sakha 3, in seed and oil yield, S.2419/1/3, in fiber yield, Sakha 1 followed by each of Escalina, Elona and Marleen, and in both fiber percentage and oil percentage, Sakha 4. Thus, they are recommended to be released as stable high-yielding cultivars and/or to be incorporated in the breeding stocks in any breeding program aiming to produce stable genotypes for the above-mentioned characters.

Phenotypic (r_p) and genotypic (r_g) correlation coefficients among straw weight and other components indicated the possibility of selecting genotypes characterized by high straw yielding ability and in the same time high seed yield potentialities. However, seed yield per plant was significant positively correlated with both No. of capsules per plant and 1000-seed weight. Also, No. of capsules per plant exhibited highly significant positive correlation with 1000-seed weight, indicated that both No. of capsules per plant and 1000-seed weight are the main components for seed weight per plant.

Key words*: *Flax, genotype x environment interactions, stability measurements.

INTRODUCTION

Flax (*Linum usitatissimum* L.) is grown commercially for two products, seed and fiber. Usually, separate cultivars are used to obtain these products and they are called seed flax or linseed, when grown for seed production, and fiber flax or flax, when grown for fiber production. Linseed oil has many industrial applications and the seed cake is used as animal feed, while flax fiber is used to produce high quality linen. In Egypt, flax is cultivated for two purposes, seeds and fibers.

The new released cultivars must be contained desired traits, such as high yield, tolerance or resistance to biotic and a biotic stresses, and stability to target environments. In consistent genotypic responses to environmental factors such as, soil moisture, soil type, or fertility level from location to location and year-to-year is a function of genotype x environment (GE) interaction. GE interaction encountered in yield traits are a challenge to plant breeders. The GE interaction has been shown to reduce progress from selection (Comstock and Moll,1963). In addition to high mean yield, information on a cultivar's stability performance across environments would enable breeders to select more consistent performing cultivars. Many investigators studied GE interactions and stability of flax genotypes under different environments (Abo El-Zahab *et al.*, 1994, Abo El-Zahab and Abo-Kaied, 2000 and El-Hariri *et al.*, 2004).

The objectives of this study was to evaluate 10 flax genotypes for their yield and yield components under several environments.

MATERIALS AND METHODS

Ten flax genotypes included four commercial flax cultivars, three local strains and three introductions from NetherLands were used in this study. The classification and pedigree of the genotypes are presented in Table (1).

Table 1. Pedigree of the ten flax genotypes and their classification (fiber type, F, dual type, D, oil type, O).

No.	Genotype	Pedigree	Type
1	Sakha 1	I. Bombay (U.S.A.) x I.1485 (U.S.A.)	D
2	Sakha 2	I. 2348 (Hungary) x I. Hira (India)	D
3	Sakha 3	I. Belinka x I. 2569	F
4	Sakha 4	I. Belinka x I. 2069	F
5	S.402/3/18/9	Giza 5 x I. 235 (U.S.A.)	D
6	S.2467/1/2	Selected from I. Hira 17/34-1 (India)	O
7	S.2419/1/3	Selected from I. Humpata (Hungarian)	O
8	Escalina	Introduction from NetherLands	F
9	Elona	Introduction from NetherLands	F
10	Marlin	Introduction from NetherLands	F

The genotypes were evaluated in three successive seasons (2003/04, 2004/05 and 2005/06) at two locations viz: Gemmiza Exp. Sta., Gharbia Governorate {old land (clay loamy with organic matter of 2.15%, available nitrogen 24.15 ppm and pH value of 7.92)} and Ismaelia Exp. Sta., Ismaelia Governorate {newly reclaimed land (Sandy clay loamy with organic matter of 0.61%, available nitrogen 7.20 ppm and pH value of 8.75)}. Six experiments (three seasons x two locations) were carried out. Sowing was done during the first week of November in all sites and seasons, the plot size was 2 x 3 m consisting of 10 rows, 20 cm apart and 3 m long. Plant density of 2000 seeds/m^2 was used, a randomized complete block design with three replications was applied at all experiments. Recommended cultural practices were maintained as recommended at optimum levels.

At harvest, data on ten randomly guarded plants in each plot were recorded to determine the averages of the individual plant traits. Straw, seed and fiber yields/fad (4200 m^2) was calculated on plot mean basis. Oil percentage was determined as an average of two random seed samples/plot using a Soxhlet apparatus (A.O.A.C. Society, 1995). The following characters were recorded:

I) Straw yield and its components: (1) Straw yield/fad (ton), (2) Straw weight/plant (g), (3) Plant height (cm) and (4) Technical stem length (cm).

II) Seed yield and its components: (1) Seed yield/fad (Kg), (2) Seed weight/plant (g), (3) No. of capsules/plant, (4) No. of seeds/capsule and (5) 1000-seed weight (g).

III) Fiber and oil yields / fad and some technological characters: (1) Fiber yield/fad (Kg), (2) Oil yield/fad (Kg), (3) Fiber percentage (%), (4) Fiber fineness (Nm) {were determined according to the technique described by Radwan and Momtaz (1966)} and (5) Oil percentage (%).

Statistical analysis:

Analysis of variance was made for each environment separately. Bartlett' test of homogeneity was used before combined analysis. The estimates of the variance components were calculated by using the expected mean squares (Johnson *et al.* 1959). Phenotypic (r_p) and genotypic (r_g) correlation coefficients were calculated according to the formula suggested by Al-Jibouri *et al.* (1958).

Stability measurements: Genotype stability was detected via determining four stability parameters. The first parameter is the linear regression coefficient (b value) and the second stability parameter was the mean square of deviation from regression for each entry (S^2d value) as described by Eberhart and Russel (1966). The third stability parameter was coefficient of determination (r^2) as outlined by Pinthus (1973), which was computed from the linear regression analysis. Finally, the fourth parameter was the ecovalence (W_i), the contribution of each variety to the genotype x environment interaction. It was calculated for each genotype according to method of Wricke (1962).

RESULTS AND DISCUSSION

Analysis of variance:

The combined analysis of variance for straw and seed yields and their components as well as some technological characters of ten flax genotypes based on data of the six environments are shown in Table (2). Genotype mean square was highly significant for all characters, indicating that the genotypes differ in their genetic performance for these traits. This result coupled with the large values of phenotypic coefficient of variability for all characters (Table 3) support the evident that great variability exists among the tested genotypes. Such variability among different flax genotypes in straw and seed yields and their related characters was also reported by Abo El-Zahab *et al.* (1994), Abo El-Zahab and Abo-Kaied (2000) and Abo-Kaied *et al.* (2006).

Genotype (G) x year (Y) interaction was non-significant for most characters except for both straw weight/plant and plant height. On the other hand, genotype (G) x location (L) interaction was highly significant for all characters, indicated that location had the major effect on variations for all traits. In such situation it may be rewarding to increase number of test locations and reduce number of years. It may be worthwhile to stratify the area into a number of sub–areas and to produce varieties for each sub-area. Thus the number of years could be reduced and the number of locations be increased. Similar observations have already been found by Abo El-Zahab *et al.* (1994). Increasing the number of locations may be an advantage if the period of testing can be reduced. Also, the variation from locations may be more easily controlled than that due to years because variation among locations is more predictable. The second order interaction (GLY), was highly significant for all characters studied indicating that some of the first-order interactions involving two of the variables were inconsistent over the third variable.

Variance components:

Partitioning of the phenotypic variance (σ^2ph) to its different components (σ^2g, σ^2gy, σ^2gl, σ^2gly, σ^2e) are made and shown in Table (3) for straw, seed weight and their related characters. The results revealed the genetic variances were higher than interaction variances. It supported the previously mentioned conclusion, that the bias introduced by the year was small. Therefore, it would certainly be necessary to test genotypes in more than two locations with few number of years. High heritability values and low discrepancy between PCV and GCV values were found for straw weight/plant (H = 90.65%, PCV = 8.80%, GCV = 8.38%), plant height (H = 86.34, PCV = 2.22%, GCV =2 .06%), seed weight (H = 96.82&, GCV = 15.59%, GCV =1 5.34%), No. of capsules / plant (H = 86.61%, PCV = 8.68%, GCV =8.12%) and No. of seeds/capsule (H = 92.38%, PCV = 4.70%, GCV = 4.52%). These results indicate the possibility of using plant height as a selection index for improving straw weight/plant and each of 1000-seed weight, No. of capsules/plant and No. of seeds/capsule as selection indices for improving seed weight per plant. These results are in harmony with those reported by Abo El-Zahab, (1994) and Mourad *et al.* (2003).

Genotypic mean performance:

The significant differences among genotypes in Table (4) show that genotype Sakha 1 followed by Sakha 2 exceeded significantly the other genotypes in straw weight/plant and its two components (plant height and technical stem length). S.2467/1/2 is ranked the third for both straw weight and technical stem length, while introduction Escalina had the third ranking for plant height. Concerning seed weight, S.2419/1/3 surpassed the other genotypes for seed weight, No. of capsules and 1000-seed weight, while S.2467/1/2 had the second ranking for seed weight and 1000-seed weight. For No. of seeds/capsule, the high mean values were recorded by Elona followed by Escalina and Sakha 3.

Two varieties (Sakha 1 and Sakha 2) proved to be superior in straw weight and its two important components, plant height and technical length. Similar trend was recorded for both S.2419/1/3 and S.2467/1/2 for seed weight and its most components. Therefore, these genotypes (Sakha 1 and Sakha 2 for straw weight as well as S.2419/1/3 and S.2467/1/2 for seed weight) may be incorporated as breeding stocks in flax breeding program aiming to improve these important mentioned characters.

Stability measurements:

The genotype x environment interaction plus environment linear effects were significant for all characters, *i.e.* straw, seed, fiber and oil yields per fad as well as some technological traits, *i.e.* fiber percentage, fiber fineness and oil percentage (Table 2). The significant mean squares due to environment (linear) indicated differences between environments. The variances due to GxE (linear) were statistically significant for all the above-mentioned characters suggesting that linear component of genotype x environment was present. There were also differences among the regression coefficients for the genotypes. The significant variances due to pooled deviation for all the above-mentioned characters, except for both fiber percentage and oil percentage, indicated that genotypes differed with respect to their stability and suggesting that the prediction of stability would be difficult.

Estimates of mean performance ($\bar{x}$), regression coefficient (b), deviation from regression (S^2d), coefficient of determination (r^2) and the ecovalence stability index (w) for straw, seed, fiber and oil yields per fad. as well as some technological characters (fiber percentage, fiber fineness and oil percentage) are presented in Table (5). The ideal genotype as proposed by Eberhart and Russell (1966) would have a high mean performance ($\bar{x}$) over a range of environments, a regression coefficient (b) not significantly different from one and deviation mean square from regression S^2d not significantly different from zero. According to Bresse (1969) genotypes with regression coefficient greater than 1.0 would be adopted to more favorable environments, while those with coefficients less than one would relatively better adopted to less favorable conditions. According to Pinthus (1973) the ideal genotype had the high values of the coefficient of determination (r^2), and the low contribution of genotypes to GE sum of squares (w) according to Wricke (1962).

Out of the ten studied genotypes only Sakha 3 exhibited good stability (general stability) for straw yield/fad. Moreover, S.2419/1/3 showed good stability for seed yield/fad. Concerning fiber yield / fad, Sakha 1 exhibited high degree of stability. A simultaneous consideration of the four stability parameters (b, S^2d, r^2 and w) evidenced that the most stable genotype was Escalina (fiber type) followed by Elona and Marleen for fiber yield/fad. S2419/1/3 could be considered as ideal genotypes for oil yield/fad and stability. With regard to fiber percentage, the first genotype in all stability parameters was Sakha 4, while Marleen is consider the second genotype for the four measurements of stability (b, S^2d, r^2 and w). For fiber fineness, Escalina (fiber type) exhibited good stability parameters. Finally, Sakha 4 followed by S.2467/1/2 and S.402/3/18/9 could be considered as ideal genotypes for oil percentage. While, according to Bresse (1969) some genotypes showed specific adaptation to high favorable environments, such as, Sakha 1 and Sakha 2 for both seed and oil yields/fad, Sakha 3 and Sakha 4 for both fiber yield/fad. and fiber fineness, and S.2419/1/3 for oil percentage. On the other hand, several genotypes exhibited specific adaptation to low favorable environments such as Elona and Marleen for straw yield/fad, 4023/18/9 and 2467/1/2 for seed yield/fad, Sakha 2 and Sakha 3 for fiber percentage, Sakha 1 for fiber fineness and Escalina for both oil percentage and oil yield / fad.

It could be concluded that the most stable genotype in straw yield/fad was Sakha 3, in seed and oil yields/fad (S.2419/1/3), whereas for fiber yield/fad is Sakha 1 followed by each Escalina, Elona and Marleen and in both fiber and oil percentage Sakha 4 ranked first in this respect. Thus, they are recommended to be released as stable high-yielding cultivars and/or to be incorporated as breeding stocks in any breeding program aiming to produce stable and high performing genotypes for the above-mentioned characters.

Characters association:

Phenotypic (r_p) and genotypic (r_g) correlation coefficients among straw, seed weight / plant and their components of ten flax genotypes based on data of the six environments are shown in Table (6). Straw weight, significant positive correlation with each of plant height (r_p=0.793, r_g=0.634), seed weight/plant (r_p=0.774, r_g=0.413) and 1000-seed weight (r_p=0.818, r_g=0.215) were observed, indicating possibility of selecting genotypes that are characterized by high straw yielding ability and in the same time high seed yield potentialities. Moreover, the significant association between the two components, plant height and technical stem length were observed (r_p=0.821, r_g=0.791). These results are in agreement with those obtained by Momtaz *et al.* (1977) and Abo-El-Zahab *et al.* (1994). However, seed weight / plant was significant positively correlated with both No. of capsules/plant (r_p=0.938, r_g=0.837) and 1000-seed weight (r_p=0.982, r_g=0.897). Also, No. of capsules/plant exhibited high and significant positive correlation with 1000-seed weight (r_p=0.898, r_g=0.567), indicating that both No. of capsules/plant and 1000-seed weight are the main components of seed weight/plant. These results are in a harmony with those reported by Momtaz *et al.* (1977), Abo-El-Zahab *et al.* (1994) and Abo-kaied *et al.* (2006). In contrast, No. of seeds/capsule exhibited significant negative correlation with each of straw weight, seed weight, No. of capsules/plant and 1000-seed weight. These results are in agreement with those obtained by Momtaz *et al.* (1977) and Abo-kaied *et al.* (2006).

Table 2 . Combined ANOVA for straw, seed yields and their components as well as some technological characters of ten flax genotypes based on data of six environments (2 locations x 3 years).

S.O.V.	df	Straw yield / fad (Ton)	Straw weight / plant (g)	Plant height (cm)	Technical stem length (cm)	Seed yield / fad (kg) $x(10)^{-2}$	Seed weight / plant (g)	No. of capsules / plant	No. of seeds / capsule	1000-seed weight (g)	Fiber yield / fad (Kg)	Oil yield / fad (kg) x $(10)^2$	Fiber percentage (%)	Fiber fineness (Nm)	Oil percentage (%)
Years (Y)	2	0.026	0.016	16.603	88.009	1.590	0.001	1.181	1.752	0.051	377.068	0.622	0.0604	30.700	0.616
Locations (L)	1	2.163**	2.037**	662.041**	642.449**	1335.666**	0.102**	12.104**	1.525	1.001**	19682.653**	15.875**	8.550**	231.752	2.431
L x Y	2	0.063	0.033	11.338	34.530	0.109	0.001	4.558	2.105	0.177	1265.168	0.155	0.007	87.120	0.563
Reps / L x Y	12	0.030	0.084	19.198	43.723	1.293	0.008	1.887	1.175	0.107	2110.719	0.255	0.524	240.737	0.650
Genotypes (G)	9	0.481**	0.418**	84.623**	33.649**	176.836**	0.081**	7.746**	2.499**	13.822**	15763.920**	43.332**	5.030**	5150.022**	20.407**
G x Y	18	0.001	0.012**	1.469	5.959**	0.272	0.001	0.044	0.045	0.003	69.084	0.055	0.052	0.196	0.001
G x L	9	0.060**	0.061**	20.753**	6.338**	4.634**	0.006**	1.741**	0.106**	0.015**	1535.759**	0.725**	0.642**	489.310**	0.061**
G x L x Y	18	0.019**	0.055**	17.039**	15.626**	2.845**	0.003**	1.484**	0.378**	0.035**	1172.347**	0.473**	0.431**	254.972**	0.094**
Environment (E)	5	1.404**	1.280**	430.755**	532.515**	83.438**	0.062**	14.149 *	5.543**	0.874**	1378.275**	10.458**	5.211**	280.436**	2.873**
(G x E)	45	0.014**	0.061**	18.935**	14.147**	3.399**	0.004**	1.173**	0.173**	0.018**	1238.127**	0.546**	0.516**	294.350**	0.038**
E + (G x E)	50	0.153				11.403					2492.342	1.538	0.985	292.959	0.321
E (linear)	1	7.021**				417.192**					68901.375**	52.289**	26.056**	1402.179**	14.365**
G x E (linear)	9	0.016**				13.358**					2873.960**	1.952**	1.879**	725.919**	0.106**
pooled deviation	40	0.012**				0.819**					746.252**	0.176**	0.158	167.812**	0.019
pooled error	108	0.004	0.005	1.946	1.276	0.322	0.0001	0.062	0.034	0.005	175.922	0.049	0.080	14.978	0.019

*, ** : Significant at 0.05 and 0.01 probability levels, respectively.

Table 3. Variance components estimates from combined ANOVA, phenotypic (PCV) and genotypic (GCV) coefficients of variability and broad sense heritability (H) for straw, seed weight per plant and their components of ten flax genotypes grown at six environments.

Variance components	Straw weight and its components			Seed weight and its components			
	Straw weight/plant (g)	Plant height (cm)	Technical stem length (cm)	Seed weight / plant (g)	No. of capsules / plant	No. of seeds / capsule	1000-seed weight (g)
σ^2_{ph}	0.0232 **	4.7013 **	1.8694 **	0.0045 **	0.4303 **	0.1388 **	0.7679 **
σ^2_{g}	0.0210 **	4.0594 **	1.3193 **	0.0044 **	0.3770 **	0.1283 **	0.7669 **
σ^2_{gy}	-0.0070 $	-2.5950	-1.6112 **	-0.0005	-0.2399	-0.0556	-0.0052
σ^2_{gl}	0.0008 **	0.4127 **	-1.0320 **	0.0003 **	0.0286 **	-0.0303 **	-0.0022 **
σ^2_{gly}	0.0166 **	5.0309 **	4.7832 **	0.0010 **	0.4738 **	0.1148 **	0.0100 **
σ^2_{e}	0.0049	1.9463	1.2760	0.0001	0.0621	0.0338	0.0046
PCV%	8.80	2.22	1.84	15.59	8.68	4.70	12.14
GCV%	8.38	2.06	1.55	15.34	8.12	4.52	12.13
H%	90.65	86.34	70.57	96.82	87.61	92.38	99.87

*, ** : Significant at 0.05 and 0.01 probability levels, respectively.
σ^2_{ph}, σ^2_{g}, σ^2_{gl}, σ^2_{gy}, σ^2_{gly} are the variance attributed to phenotype, genotypes, genotypes x locations, genotypes x years and genotypes x years x locations, respectively.
$: Negative estimate for which most reasonable value is zero.

Table 4. Mean values for straw and seed weight per plant and their components of ten flax genotypes grown at six environments.

Genotypes	Straw weight and its components			Seed weight and its components			
	Straw weight/plant (g)	Plant height (cm)	Technical stem length (cm)	Seed weight/plant (g)	No. of capsules / plant	No. of seeds /capsule	1000-seed weight (g)
Sakha1	2.53 a	109.50 a	81.20 a	0.51 e	8.20 e	6.81 f	9.10 e
Sakha2	2.31 b	103.97 b	77.21 b	0.58 d	9.48 c	6.62 f	9.38 d
Sakha3	1.58 e	99.78 cd	76.56 bc	0.32 f	7.02 g	8.30 c	5.52 f
Sakha4	1.52 f	97.56 d	74.84 cd	0.32 f	7.15 f	8.14 c	5.51 f
S.402/3/18/9	1.73 d	91.86 f	70.23 e	0.61 c	9.57 b	6.56 f	9.71 c
S.2467/1/1/2	1.96 c	99.52 cd	75.86 b-d	0.66 b	8.66 d	7.82 d	9.86 b
S.2419/1/3	1.95 c	94.55 e	67.00 f	0.69 a	9.74 a	7.13 e	10.24 a
Escalina	1.43 f	100.22 c	75.30 cd	0.26 g	6.85 h	9.16 b	4.23 h
Elona	1.17 g	91.16 f	74.34 d	0.15 i	3.98 h	9.48 a	4.11 i
Marleen	1.15 g	87.66 g	70.22 e	0.20 h	4.91 i	9.22 ab	4.52g
Means	1.73	97.58	74.28	0.43	7.56	7.92	7.22

Genotype means fallowed by the same letter (s) in a column are not significant by different at 0.05 levels of probability.

Table 5. Means ($\bar{x}$) and calculated stability parameters (b_i, S^2d_i, r^2 and w_i) for straw, seed, fiber and oil yields per fad. and some technological characters over six environments.

Genotype	$\bar{x}$	b_i	S^2d_i	r^2	w_i	$\bar{x}$	b_i	S^2d_i	r^2	w_i
	Straw yield / fad.(ton)					Seed yield / fad. (Kg)				
Sakha1	3.250 c	1.220	0.062*	0.67**	0.040	360.76 d	1.61**	32.67	0.98**	1705.44
Sakha2	3.029 d	1.035	0.064*	0.96**	0.031	419.17 c	2.05**	113.25**	0.97**	5127.42
Sakha3	3.305 c	1.075	0.034	0.98**	0.023	307.82 f	1.18	70.81*	0.95**	459.79
Sakha4	3.427 b	1.219	0.117**	0.95**	0.085	331.39 e	1.40	282.64**	0.87**	1838.13
S.402/3/18/9	3.674 a	1.040	0.314**	0.85**	0.132	411.72 c	0.46**	23.77	0.87**	1351.35
S.2467/1/2	3.640 a	1.084	0.191**	0.91**	0.086	441.92 b	0.49*	29.61	0.86**	1244.26
S.2419/1/3	3.688 a	0.995	0.188**	0.89**	0.080	473.00 a	0.48	64.12	0.77*	1413.32
Escalina	2.806 e	0.928	0.101**	0.93**	0.049	238.82 g	0.41*	47.68	0.75*	1702.18
Elona	2.487 f	0.768**	0.003	0.98**	0.043	220.21 h	0.82	15.49	0.96**	243.19
Marleen	2.327 f	0.734**	0.019	0.96**	0.062	221.75 h	1.10	31.39	0.97**	212.90
Mean	3.163					342.69				
Genotype	Fiber yield / fad (kg)					Oil yield / fad (kg)				
Sakha1	540.40 c	1.37	1.97.98	0.93**	1973.57	148.45 d	1.73*	9.11	0.97**	323.51
Sakha2	454.44 e	1.45	512.05**	0.86**	3699.58	174.98 c	2.22**	19.73**	0.97**	865.30
Sakha3	614.53 b	1.86*	1184.50**	0.83**	10108.95	117.95 f	1.10	13.05**	0.92**	64.06
Sakha4	636.06 a	1.73*	462.796**	0.91**	5772.09	124.71 e	1.31	50.80**	0.81**	260.11
S.402/3/18/9	497.04 d	0.46*	1064.85**	0.24	6516.71	174.20 c	0.61	8.39*	0.83**	120.16
S.2467/1/2	556.71 c	0.16*	1549.12**	0.03	11302.00	184.43 b	0.39	16.52**	0.53	265.84
S.2419/1/3	548.51 c	-0.04*	1642.17**	0.00	14287.34	198.80 a	0.47	24.94**	0.52	252.68
Escalina	465.49 e	1.09	201.69	0.89**	1098.47	86.58 g	0.40*	8.00	0.68*	227.05
Elona	405.67 f	1.08	36.33	0.96**	427.60	77.30 h	0.75	2.72	0.94**	50.51
Marleen	356.81 g	0.83	24.65	0.94**	528.76	74.88 h	1.02	5.80	0.95**	29.91
Mean	507.566					136.23				
Genotype	Fiber percentage (%)					Fiber fineness (Nm)				
Sakha1	16.67 b	0.81	-0.017	0.98**	0.132	198.791 e	0.69**	-4.422	0.97**	15.99
Sakha2	15.05 c	0.08**	0.087	0.03	2.681	185.399 f	1.43	11.405	0.81**	90.97
Sakha3	18.61 a	0.06**	0.311**	0.01	3.681	284.147 b	2.82*	91.543**	0.74*	850.65
Sakha4	18.61.a	0.77	-0.015	0.97**	0.180	292.024 a	3.09*	124.086**	0.72*	1129.92
S.402/3/18/9	13.61 d	1.51**	-0.008	0.99**	0.765	178.121 g	1.80	39.805**	0.72*	269.43
S.2467/1/1/2	15.42 c	2.37**	0.020	0.99**	5.102	176.946 g	1.04	-1.498	0.92**	14.18
S.2419/1/3	15.01 c	2.41**	0.143**	0.96**	5.850	232.228 d	-5.02**	1332.430**	0.40	10437.63
Escalina	16.60 b	0.95	0.824**	0.41	3.411	301.237 a	2.02	18.221	0.86**	239.14
Elona	16.34 b	0.35**	-0.017	0.90**	1.124	281.959 b	0.50	12.859	0.33	106.20
Marleen	15.39 c	0.69**	-0.019	0.98**	0.285	261.682 c	1.64	3.766	0.92**	91.65
Mean	16.31					239.254				
Genotype	Oil percentage (%)									
Sakha1	41.20 d	1.11	-0.005	0.98**	0.022					
Sakha2	41.77 c	1.32	0.016	0.96**	0.232					
Sakha3	38.38 e	1.20	0.009	0.97**	0.121					
Sakha4	37.72 f	1.02	-0.005	0.99**	0.004					
S.402/3/18/9	42.31 a	0.56	0.088**	0.55	0.653					
S.2467/1/2	41.74 c	1.36	0.023	0.95**	0.300					
S.2419/1/3	42.04 b	1.10**	-0.006	0.99**	0.016					
Escalina	36.26 g	0.88*	-0.005	0.99**	0.024					
Elona	35.13 h	0.81**	-0.004	0.98**	0.065					
Marleen	33.79 i	0.64	0.012	0.89**	0.259					
Mean	39.03									

Genotype means fallowed by the same letter (s) in a column are not significant by different at 0.05 level of probability.
*,**: indicates deviation from regression is significantly different at 0.05 and 0.01 levels of probability.

Table 6. Phenotypic (r_p) and genotypic (r_g) correlation coefficients among straw, seed weight / plant and their components of ten flax genotypes based on data of six environments.

Character		1	2	3	4	5	6
1- Straw weight / plant (g)							
2- Plant height (cm)	r_p	**0.793***					
	r_g	0.634					
3-Technical stem length (cm)	r_p	**0.446**	**0.821****				
	r_g	0.587	0.791				
4-Seed weight / plant (g)	r_p	**0.774***	**0.335**	**-0.107**			
	r_g	0.413	0.217	0.103			
5- No. of capsules / plant	r_p	**0.775***	**0.436**	**-0.053**	**0.938****		
	r_g	0.354	0.334	0.146	0.873		
6- No. of seeds / plant	r_p	**-0.856****	**-0.463**	**-0.079**	**-0.870****	**-0.907****	
	r_g	-0.583	0.501	-0.123	-0.654	0.112	
7-1000-seed weight (g)	r_p	**0.818****	**0.345**	**-0.059**	**0.982****	**0.898****	**-0.908****
	r_g	0.215	0.461	0.215	0.897	0.567	-0.774

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

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تقييم بعض التراكيب الوراثية في الكتان للمحصول ومكوناته تحت ظروف بيئية مختلفة

حسين مصطفي حسين أبوقايد ، طه عبد المنعم أبو زيد ، عفاف السيد عبد الواحد زهانه

قسم بحوث محاصيل الألياف – معهد بحوث المحاصيل الحقلية– مركز البحوث الزراعية– الجيزة

استخدم في هذه الدراسة ١٠ تراكيب وراثية من الكتان تم تقيمها في ٦ بيئات " ٢موقع (بالاسماعلية– محافظة الاسماعلية، والجميزة–محافظة الغربية) خلال ثلاثة مواسم (٢٠٠٣ / ٢٠٠٤، ٢٠٠٤ / ٢٠٠٥، ٢٠٠٥ / ٢٠٠٦)".

تشير النتائج إلى معنوية التباين الخاص بالتراكيب الوراثية مما يشير إلى أن هذه التراكيب يوجد بينها اختلافات كبيرة ، كان التفاعل بين التراكيب الوراثية x السنوات في معظم الصفات غير معنوي فيما عدا وزن القش للنبات والطول الكلي ، بينما كان تفاعل التراكيب الوراثية x المواقع عالي المعنوية لكل الصفات المدروسة مما يوضح مدى التأثير الكبير للمواقع على تلك الصفات ، لذلك فانه من الضروري أن يتم تقييم الأصناف في عدد أكبر من المواقع وعدد اقل من السنوات ، كما تشير تقديرات معاملي الاختلاف الظاهري والوراثي ودرجة التوريث في المعنى الواسع إلى إمكانية استخدام صفة الطول الكلي كمعامل انتخاب لتحسين وزن القش للنبات ، واستخدام كلا من وزن الألف بذرة وعدد الكبسولات للنبات وعدد البذور بالكبسولة كعوامل انتخابية لتحسين وزن البذور للنبات .

بناءًا على المقاييس المستخدمة لتقدير ثبات السلوك الوراثي ($\bar{x}$, b, S^2d, r^2, w) أشارت النتائج إلى أن التراكيب التي أظهرت ثباتا في سلوكها الوراثي هي س ٣/١/٢٤١٩ لمحصولي البذور والزيت / فدان ، سخا ١ يلي ذلك اسكالينا وايلونا ومارلين لمحصول الألياف / فدان ، وسخا ٤ لصفتي النسبة المئوية للزيت ومحصول الألياف / فدان لذلك يمكن استخدام هذه التراكيب كأصناف تجارية لتلك الصفات أو استخدامها في برامج التربية لإنتاج تراكيب وراثية عالية المحصول وثابتة في سلوكها الوراثي للصفات سالفة الذكر .

كما تشير نتائج الارتباط الظاهري والوراثي بين وزن كل من القش للنبات والبذور للنبات مع الصفات الأخرى (مكونات المحصولين) إلى إمكانية انتخاب تراكيب وراثية تمتاز بارتفاع محصولي القش والبذور في نفس الوقت . كذلك كان هناك ارتباط موجب ومعنوي بين وزن البذور للنبات وكلا من عدد الكبسولات ووزن الألف بذرة ، وكان هناك أيضا ارتباط موجب بين هاتين الصفتين مما يشير إلى أن هاتين الصفتين (عدد الكبسولات ووزن الألف بذرة) مكونيين رئيسيين لمحصول البذور بالنبات.