VARIABILITY AND COVARIABILITY OF SOME AGRONOMIC AND TECHNOLOGICAL FLAX CHARACTERS

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Abstract

Two field experiments were conducted during 2003/04 and 2004/05 seasons at the experimental Station, Etay El-Baroud, El-Beheira Governorate, Egypt, to study the variability and covariability of ten flax genotypes concerning straw, seed yields and their related characters in addition to quality properties.

Mean square values show highly significant differences due to genotypes (G) for all characters under study. Also, due to genotypes x environments (E) interaction except seed index and oil percentage. Whereas, variances due to differences among genotypes (G) were higher than those due to the interaction (G x E). These results indicated that most of variability for these traits was mainly controlled by genetic factors with less influence by environmental factors. This mean that the improvement of these traits could be achieved by direct selection.

Heritability ($H_{b.s.}$) in broad sense estimates exhibited highest value for technical length followed by straw yield and plant height. For these also, were observed narrow range between phenotypic (PCV) and genotypic (GCV) coefficients of variability, indicating possibility of using these yield components (technical stem length and plant height) in selection index with giving more weight for technical stem length for improving straw weight per plant. Also, seed weight per plant and No. of capsules per plant exhibited similar results. indicating possibility of using these two components (seed index and No. of capsules per plant) in selection index for improving seed weight per plant.

The strain 15/1/2 was superior than commercial variety Sakha1 in both straw yield and long fiber yields per fed. Whereas S. 31/3/2 gave the highest vales, concerning seed yield per fed., seed weight per plant, No. of capsules per plant, seed index and oil yield per fed. Followed by Sakha2 for seed yield per fed., No. of capsules per plant and oil yield per fed.

Regarding quality traits, Ariane gave the highest long fiber percentage and highest fiber fineness. Also, S. 15/1/2 gave the highest value of long fiber percentage and fiber length. Regarding oil percentage (%), S.31/3/2 gave the highest value, followed by S.2465/1/3 and Sakha2. Therefore, Ariane, S.15/1/2, S.31/3/2, S.2465/1/3 and Sakha2 may be incorporated as breeding stocks in flax program aiming to improvement the mentioned traits.

Straw weight exhibited significant and positive correlations with each of its three components, plant height, technical stem length and No. of basal branches and also between the two components, plant height and technical stem length. These results indicated that plant height and technical stem length are main components for straw weight per plant. seed yield exhibited highly significant and positive correlations with each of its two components, No. of capsules and seed index indicated that No. of capsules followed by seed index, had the maximum direct effect on seed weight and direct selection for both traits should improve seed yield per plant. Moreover, the significant association between the two components, No. of capsules and seed index supports this view. Highly significant and positive correlation coefficients were obtained among fiber length and each of plant height, technical length and long fiber percentage. Also, fiber fineness was positive correlation with both of No. of seeds per capsule and fiber length. Also, the positive correlation between oil percentage with each of seed weight, capsules number, seed index and No. of basal branches, indicated that selection for high seed yield and seed oil content is possible.

INTRODUCTION

Flax (*Linum usitatissimum* L.) is a versatile crop which contributes now for many products manufactured from fibers, seeds and even shives extracted from the stem, which used of made compressed wood. The limitation of flax cultivated land challenges investigators to produce more fiber and seed yield per unit area through planting high yielding varieties and improvement of agricultural practices. One of the main objectives of breeding program is to develop to new recommended cultivars which surpass that commercial cultivar.

Plant breeding can be divided into three stages, assembly and creation of a pool of breeding population, selection of superior individual from the pool and utilization of the selected individuals to create a superior variety. Estimates of genetic variance and heritability can be of value in all three stages.

Yield (straw and seed) is complex character and as suggested by Grafius (1965) there may not be genes for yield *per se* and it is the joint interaction of the different components. The complex characters are likely to show high interaction with environment and thus unsuitable for direct selection. However, the components of yield are simpler in inheritance and exhibit less environmental interaction and in turn they can be used as selection criteria for improving yield. Thus it is necessary to know the variability for these components. The yield level and genetic variance of the base populations would thus determine the success of any selection programs (Kofoid *et al.,*1978).

Various workers found significant effect of years on straw yield, seed yield and their components. Varietal differences among flax genotypes has been studied by many investigators (e.g. Momtaz *et al.,*1990 and Zahana *et al.,*2003) they found that significant differences among genotypes of flax in straw yield per plant, plant height, technical stem length, seed yield per plant and per feddan and No. of capsules per plant. Badwal *et al.,*(1971) indicated that capsules number and 1000-seed weight were the most important yield components and the best criteria for selecting high yielding lines linseed. Kumar and Chauhan (1979) found that 1000-seed weight and seeds per capsule may be considered simultaneous component characters for selection between flax varieties.

The ultimate goal of flax breeding program in Egypt is to improve both straw and seed yields as well as fiber and oil quality traits. Phenotypic, genotypic variance and heritability estimates for yield (seed, straw) and its attributes and the associations between yield and other related agronomic traits are considered basic information for designing a successful breeding program to improve straw, seed yields and quality characters both of fiber and oil. Therefore, The main objectives for this study were to (1) quantitative assess the pattern of genotypes variation, the nature of association between key traits of seed, straw, oil and fiber yield, (2) estimate phenotypic and genotypic variance deriving statistics, unbiased by GE variance such as heritability and genetic coefficient of variation and used these parameters to provide information essential for population identification as well as to aid in planning more efficient improvement program by selection.

MATERIALS AND METHODS

In two successive seasons, 2003/04 and 2004/05, two field experiments were conducted at the experimental farm, Etay El-Baroud , El-Beheira Governorate, Egypt, to study the variability and covariability of ten flax genotypes concerning straw, seed yields and their related characters in addition to quality properties. These genotypes included the two commercial cultivars (Sakha1 and Sakha2), six promising strains (S.2465/1/3, S.402/12, S.16/3/12/4, S.119/7/8, S.31/3/2, and S.15/1/2) and two imported varieties (Bombay and Ariane). The classification and pedigree of the ten genotypes used are partially described in Table 1.

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

No.	Genotypes	Pedigree	type
1	Sakha1	Bombay (U.S.A.) x 1485 (U.S.A.)	D
2	Sakha2	2348 (Hungary) x Hira (India)	D
3	S.2465/1/3	Selection from Neelum (India)	O
4	S.402/12	Giza 5 x 235 (U.S.A.)	D
5	S.16/3/12/4	S.162/12 x S.2465/1	D
6	S.119/7/8	Giza 7 x Bombay	D
7	S.31/3/2	S.402/21/19/3 x S.400/5/6	D
8	S.15/1/2	S.162/12 x S.2465/1	D
9	Bombay	Introduction from U.S.A.	D
10	Ariane	Introduction from Belgium	F

Two experiments were carried out in randomized complete block design with four replications. Sowing data was the last week of October in both seasons, the plot size was 3.0 x 2.0 m and consisted of 10 rows, 20 cm apart and 3 m long. Plant density of 2000 seeds/m^2 was used. Recommended agronomic practices were followed.

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

I) Straw and fiber yield and their related characters:

(1) Straw yield t / fed*, (2) long fiber yield t / fed, (3) straw weight / plant (g), (4) plant height (cm), (5) technical stem length (cm) and (6) No. of basal branches / plant.

II) Seed yield and its components as well as oil yield:

(1) Seed yield kg /fed (2) seed weight /plant (g), (3) No. of capsules / plant, (4) seed index, as measured by 1000-seed weight in gram, (5) No. of seeds / capsule, and (6) oil yield kg/fed.

III) Fiber Technological characters:

(1) Long fiber percentage (2) fiber length (cm), (3) fiber fineness (Nm) were determined according to the technique described by Radwan and Momtaze (1966), and (4) oil percentage(%).

The data obtained for each season were subjected to analysis of variance (Gomez and Gomez,1984), therefore homogeneity test (Bartlett, test) was performed for error terms of each season. Error terms were homogeneous enabling combined analysis of variance over environments (years). Genotypic (V_g), environmental (V_e), their interaction (V_{ge}) and phenotypic (V_p) variances, as well as phenotypic (PCV) and genotypic (GCV) coefficients of variation, heritability in broad sense ($H_{b.s.}$) and phenotypic (r_p) and genetic (r_g) correlation coefficients were calculated according to Johnson *et al.,* (1955) as follows:

Sov	df	MS	Expected MS	E. Cov. Of cross product
Environments(years)	1			
Rep./Environments	6			
Genotypes (G)	9	M_1	$\sigma^2e + 4\sigma^2gy + 8\sigma^2g$	$\sigma_{e\,12} + 4\sigma_{gy\,12} + 8\,\sigma_{g\,12}$
G x Environments	9	M_2	$\sigma^2e + 4\sigma^2gy$	$\sigma_{e\,12} + 4\sigma_{gy\,12}$
Error	54	M_3	σ^2e	$\sigma_{e\,12}$

*** fed = 0.42 ha**

Where

(1) σ^2e, σ^2gy and σ^2g are environmental, genotypic x environmental and genotypic variances, respectively,

(2) $\sigma_{e\ 12}$, $\sigma_{gy\ 12}$ and $\sigma_{g\ 12}$ are the corresponding covariance components for the characters,1 and 2.

Form the above table the following estimates were calculated:

σ^2_p = phenotypic variance among the variety means = M1/(2 * 4)

r_{12p} = phenotypic correlation between characters 1 and 2

= $\sigma_{12p} / (\sigma_{1p} * \sigma_{2p})$

r_{12g} = genotypic correlation = $\sigma_{12g} / (\sigma_{1g} * \sigma_{2g})$

RESULTS AND DISCUSSION

1- Variability and genetic parameters:

1-1-Straw weight and its components:

Mean performance for straw weight and its components as well as fiber yield of ten flax genotypes averaged over two environments (years) are presented in Table (3). The strain 15/1/2 gave the highest values for each of straw yield / fed (4.50 ton), straw weight / plant (2.14 g), long fiber yield per fed. (0.75 ton), plant height (126.44 cm) and technical stem length (95.67 cm). Followed by Sakha1 for straw yield per fed. (4.25 ton) as well as per plant (2.13 g) and long fiber yield per fed. (0.68 ton). The promising strain 15/1/2 was superior than the commercial cultivar, Sakha1 in both straw yield and long fiber yields per fed. by 5.95% and 9.81%, respectively. These results indicated that the strain 15/1/2 should be subjected to further test in other locations before releasing as a new commercial cultivar for high straw and fiber yields and / or to be incorporated as breeding stocks in flax program aiming at producing high yielding lines.

Mean square values presented in Table (2) show highly significant differences due to genotypes for straw weight / plant and its components viz.: plant height, technical stem length and No. of basal branches / plant. This is expected because the materials under study consisted of different flax types which, as illustrated in Table (1), different in their origin, pedigree and consequently genetic background. Such variability among different flax genotypes in straw yield and its components and was also reported by Momtaz *et al.,* and Zahana *et al.*, 2003.

Highly significant differences were also observed for straw yield and its components due to Genotype x Year interaction indicating that genotypes had considerable different responses to environmental influences (Table 2). It appears, from these results, that the genotypes under study possess great genetic variability sufficient to provide substantial amounts of improvement through selecting superior genotypes. The ratio between the two variances (G and G x E interaction) was greater for technical stem length followed by seed weight /plant, plant height and No. of basal branches per plant. These results indicated that most of variability in the first three traits was mainly controlled by genetic factors with less influence by environmental factors. This mean that improvement of the first three traits could be achieved by selection. The effectiveness of selection depends on the variability present in a germplasm and the extent to which it is heritable (Miller and Rowling, 1967).

Estimates of the various variance components among ten flax genotypes for straw weight / plant and its components are shown in Table (2). The genotype x year variance (σ^2gy) as less than the genotypic variance (σ^2g) for all characters, specially technical length. These results supported the previously mentioned conclusion, that the biased introduced by year was small, concerning beneficial selection for most yield components, specially technical length. Heritability values ($H_{b.s.}$) in broad sense were high except for technical stem length (96.34) followed by straw weight (94.52) and plant height (93.83)%. Also, the observed narrow range between phenotypic (PCV) and genotypic (GCV) coefficients of variability, which gave almost similar values of PCV (10.10) and GCV (10.00) in technical stem length was mainly due to genetic differences as evidenced from the very high heritability. Also, straw weight and plant height showed similar results, indicating possibility of using these yield components (technical stem length and plant height) in selection index with giving more weight for technical stem length for improving straw weight / plant.

1-2- Seed weight and its components:

The highly significant genotypes components for oil, seed yield /fed, seed weight / plant and its components traits viz.: No. of capsules, seed index and No. of seeds / capsule indicated that genotypes differed in their genetic potential for seed weight and its mean components (Table 4). The promising strain 31/3/2 gave the highest vales concerning seed yield / fed (740.34 Kg), seed weight / plant (0.72 g), No. of capsules / plant (9.10), seed index (10.96) and oil yield / fed (322.66 Kg), followed by Sakha 2 for seed yield / fed (736.74 Kg), No. of capsules / plant (8.70) and oil yield / fed (311.75 Kg). These results indicated that, the promising strain 31/3/2 may be considered good substitutes in future after evaluation in more locations before releasing as a new Egyptian flax cultivar for seed and oil production. Also, the two introductions (Ariane and Bombay) gave the highest values for No. of seeds / capsule, with mean values of 8.89 and 8.49, respectively. On the other hand, these introductions were the latest one in most seed characters viz.: seed yield / fed., seed weight / plant and seed index as well as oil yield / fed. These results are in agreement with those obtained by Momtaz *et al.*, 1990, El – Hariri *et al.*,2002, and Zahana *et al.*, 2003.

Mean square values (Table2) revealed that genotypes displayed highly significant differences for seed weight / plant and its components, indicating the presence of genetic variability among the tested genotypes for these characters. Also, genotype x year interaction showed highly significant for seed and its components except seed index indicated that genotypes had considerable different responses to environmental influences. It is worth to note that variances due to differences among genotypes (G) were higher than those due to the interaction (G x E). the ratio between the two variances was greatest for seed weight / plant followed by No. of seeds /capsule and No. of capsules / plant. These results indicated that most of variability for these traits was mainly controlled by genetic factors. In respect to seed index, non significant G x E interaction, indicated that improvements could be done through direct selection.

Estimates of variance components among ten flax genotypes for seed yield and its components as well as oil yield / fed are shown in Table2. Genotype x year interaction (σ^2ge) were less than the genotypic variance (σ^2g) for the four traits (seed weight, No. of capsules, seed index and No. of seeds / capsule), indicating that genotypic differences over shadow GE interaction effects. This means that genotypes differ in their genetic potential for these traits. The observed narrow range between phenotypic (PCV) and genotypic (GCV) coefficients of variability, which gave almost similar values of PCV (29.58%) and GCV (29.56%) in seed index was mainly due to genetic differences as evidenced from the very high heritability estimate (99.86%). Also, seed weight/plant and No. of capsules/ plant similar results. indicating possibility of using these two components (seed index and No. of capsules / plant) in selection index for improving fiber yield / plant. These results are harmony with that reported by Badwal *et al.*, (1971) who reported that capsules number and 1000-seed weight are the major factors which directly contribute to seed yield.

1-3- Fiber Technological characters:

Data in Table 5 show that mean performances of technological fiber characters (long fiber percentage, fiber length and fiber fineness) as well as oil percentage. The introduction Ariane (fiber type) gave the highest long fiber percentage (16.978%) and highest fiber fineness (323.54 Nm). Also, the promising strain 15/1/2 gave the highest value of long fiber percentage (16.69%) and fiber length (96.73 cm). With respect to oil percentage (%), strain 31/3/2 gave the highest value (43.59%), followed by S.2465/1/3 (42.35%) and Sakha[2] (42.35%). Therefore, Ariane, S.15/1/2, S.31/3/2, S.2465/1/3 and Sakha 2 may be incorporated as breeding stocks in flax program aiming to improve the mentioned quality characters.

Mean square values presented in Table (2) show highly significant different due to genotypes for technological fiber treats as well as oil percentage (%). Also, highly significant differences were observed for the three fiber quality due to genotypes by environments (years) interaction, indicating that these genotypes had considerable different responses to environmental conditions. On the other hand, G x E interaction was non-significant for oil percentage. Meaning that the oil percentage was consistent across the two years. The ratio between two variances (G and G x E interaction) was greater for oil percentage followed by long fiber percentage and fiber fineness. These results indicated that most of variability in these traits was mainly controlled by genetic factors. This mean that the improvement for these traits could be achieved by direct selection.

Variance component estimates (Table2) showed that genetic variance (σ^2g) was higher than variance (σ^2gy) interaction for all technology characters except fiber fineness, mean that improvement of these traits could be achieved by selection. H values for all the technological characters (98.46, 95.59 and 99.63 %) with almost similar estimates of PCV and GCV (15.47, 15.36: 10.22, 9.99 and 7.29, 7.28%) were observed in for long fiber percentage, fiber length and oil percentage, respectively. while, moderate broad sense heritability (59.91%) was observed for fiber fineness. These results are in harmony with that reported by Abo-Kaied, 1992 and El-Hariri *et al.*,2002.

2- Covariability:

2.1- Association of straw weight/plant and its components:

Phenotypic (r_p) and genotypic (r_g) correlation coefficients among seed, straw weight / plant as well as some quality characters of ten flax genotypes based on data of two season (2003/04 and 2004/05) are shown in Table 6. Regarding straw weight exhibited significant and positive correlations with each of its three components, plant height (rp=0.657, rg=0.663), technical stem length (rp=0.687, rg=0.487) and No. of basal branches (rp=0.674, rg=0.474), indicated that maximization of straw weight may be obtained via selection for these three component variables. Moreover, the significant association between the two components, plant height and technical stem length (rp=0.843, rg=0.927). These results indicated that plant height and technical stem length are main components for straw weight / plant These results are agreement with those obtained by Abo-Kaied (1992). However, No. of basal branches exhibited significant correlation with No. of capsules per plant, this is logic and expected.

2.2- Association of seed weight / plant and its components:

In respect to seed weight exhibited highly significant and positive correlations with each of its two components, No. of capsules(rp=0.948, rg=0.937) and seed index (rp=0.929, rg=0.773) indicated that No. of capsules followed by seed index, had the maximum direct effect on seed yield and direct selection for both traits might improve seed weight / plant. Moreover, the significant association between the two components, No. of capsules and seed index (rp=0.802, rg=0.877) supports this view. These results are in harmony with that reported by Badwal *et al.,*(1971) and Abo-Kaied (1992). On the other hand, No. of seeds per capsule was significant and negatively correlated with each of seed weight / plant, No. of capsules and seed index. Also, seed index and number of seeds per capsule exhibited significant and negative correlation. These finding indicated that improving No. of seeds / capsule would not reflected on increased seed yield. These results are in harmony with that reported by Kumar and Chauhan (1979).

2.3- Association of fiber technological characters among themselves and with other treats:

The relationships among technological characters and with other treats are shown in Table 6. Highly significant correlation coefficients were obtained among fiber length and each of plant height, technical stem length and long fiber percentage, indicated that selection for higher fiber long percentage would increase fiber length. Also, fiber fineness was positively correlated with both of No. of seeds per capsule and fiber length, but it was negatively associated with each of seed weight / plant, No. of capsules, seed index and straw weight / plant. Therefore, in the present material there is no obstacle for screening for individual with high mean performance in both seed or straw yield with long fiber percentage. Also, oil percentage was negatively associated with both of No. of seeds per capsule and fiber fineness, and high significant positive association between oil percentage and each of the two seed characters, No. of capsules and seed index. This point of view may be partially supported by high heritability estimates obtained and low discrepancy between the phenotypic (PCV) and genotypic (GCV) coefficients of variability for the traits involved, seed index (H=99.86, PCV=29.58, GVC=29.56) and oil percentage (H=99.63, PCV=7.29, GCV=7.28) Table2. These data revealed that genetic variability among genotypes are already existed for seed index and oil percentage. This was reflected in high broad sense heritability and low discrepancy between PCV and GCV values. Also, the positive correlation between oil percentage with each of seed weight, capsules number, seed index and No. of basal branches, indicated that selection for high seed yield and seed oil content is possible.

Table 2 . Mean square values, variance components estimates, phenotypic (PCV) and genotypic (GCV) coefficients of variability and broad sense heritability (H%) for 12 characters of ten flax genotypes based on data of two seasons (2003/04 and 2004/05).

Characters	Combined ANOVA			Variance components and some genetic parameters						
	Genotypes(G) (9)#	G x Years (Y) (9)#	Pooled error (54)#	σ^2ph	σ^2g	σ^2gy	σ^2e	H%	PCV%	GCV%
Straw weight / plant and its components										
Straw weight/plant (g)	0.588 **	0.032 **	0.011	0.074	0.069	0.005	0.011	94.52	16.65	16.18
Plant height (cm)	746.321 **	46.070 **	16.545	93.290	87.531	7.381	16.545	93.83	8.60	8.33
Technical stem length (cm)	603.152 **	22.092 **	7.834	75.394	72.632	3.565	7.834	96.34	10.19	10.00
No. of basal branches	0.248 **	0.116 **	0.039	0.031	0.017	0.019	0.039	53.25	11.53	8.41
Seed weight / plant and its components										
Seed weight /plant (g)	0.290 **	0.023 **	0.008	0.036	0.033	0.004	0.008	91.96	44.35	42.35
No. of capsules/plant	27.243 **	4.867 **	1.422	3.405	2.797	0.861	1.422	83.13	24.74	24.74
Seed index (g)	48.193 **	0.067 ns	0.071	6.024	6.023	-0.001	0.071	99.86	29.56	29.56
No. of seeds/capsule	3.770 **	0.511 **	0.182	0.471	0.407	0.082	0.182	86.44	8.44	8.44
Technological characters										
Long fiber percentage (%)	37.458 **	0.575 **	0.192	4.682	4.610	0.099	0.192	98.46	15.47	15.47
Fiber length (cm)	623.728 **	27.536 **	9.463	77.966	74.524	4.518	9.463	95.59	10.22	10.22
Fiber fineness (Nm)	991.440 **	397.462 **	63.969	123.930	74.247	83.373	63.969	59.91	3.80	4.92
Oil percentage (%)	67.393 **	0.250 ns	0.342	8.424	8.393	-0.023	0.342	99.63	7.29	7.29

*,** = Indicate significance at the 0.05 and 0.01 levels of probability, respectively.
=Values designated the corresponding degrees of freedom .
σ^2ph, σ^2g, σ^2gy, σ^2e, phenotypic, genotypic, genotype x year plot error variances, respectively.

Table 3. Mean values for straw yield, yield components and fiber yield of flax genotypes (combined over two years, 2003/04 and2004/05).

Genotype	Straw yield (ton) / fed.*	Long fiber yield (ton)/ fed	Straw weight / plant (g)	Plant height (cm)	Technical stem length (cm)	No.of basal branches/plant
Sakha1	4.25 b	0.68 b	2.13 a	115.41 c	87.14 b	2.10 a
Sakha2	3.99 d	0.60 d	1.62 de	110.72 d	87.34 b	1.87 b
S.2465/1/3	4.08 c	0.45 f	1.56 e	99.82 e	81.59 c	1.24 cd
S.402/12	3.74 f	0.42 g	1.69 c	110.51 d	73.93 d	1.87 b
S.16/3/12/4	3.85 e	0.53 e	1.96 b	125.80 a	97.00 a	0.81 e
S.119/7/8	3.30 g	0.42 g	1.40 f	116.88 bc	87.94 b	1.34 c
S.31/3/2	3.15 h	0.38 h	1.67 cd	111.60 d	83.84 c	1.90 b
S.15/1/2	4.50 a	0.75 a	2.14 a	126.44 a	95.67 a	1.82 b
Bombay	3.05 I	0.43 g	1.13 g	96.25 f	69.13 e	1.36 c
Ariane	3.82 e	0.65 c	0.99 h	109.57 d	88.93 b	0.99 d
Mean	3.77	0.53	1.63	112.33	85.25	1.53

* fad = 0.42 ha

Means identified by the same letter are not significantly different at 0.05 level of probability according to FLSD.

Table 4. Mean values for seed yield, its components and oil yield of ten flax genotypes (combined over two years, 2003/04 and2004/05).

Genotype	Seed yield (kg) / fed	Seed weight / plant (g)	No.of capsules / plant	Seed index (g)	No.of seeds / capsule	Oil yield (kg) /Fed
Sakha1	686.56 b	0.50 c	7.32 b	9.25 e	7.25 c	284.00 d
Sakha2	736.38 a	0.59 c	8.70 a	9.63 d	7.11 c	311.75 b
S.2465/1/3	683.57 bc	0.56 b	8.07 ab	10.27 b	6.74 d	291.34 c
S.402/12	677.99 c	0.52 bc	7.28 b	9.98 c	7.15 c	279.82 e
S.16/3/12/4	638.34 d	0.42 e	6.27 c	8.75 f	7.75 b	237.46 f
S.119/7/8	593.38 e	0.27 e	4.50 d	8.19 g	7.90 b	225.67 g
S.31/3/2	740.34 a	0.72 a	9.10 a	10.96 a	7.24 c	322.66 a
S.15/1/2	526.30 f	0.41 f	7.25 b	7.98 h	7.10 cd	209.84 e
Bombay	329.38 h	0.22 fg	5.94 cd	4.37 I	8.49 a	119.81 f
Ariane	338.67 g	0.09 g	3.17 e	3.61 j	8.89 a	119.31 f
Mean	595.09	0.43	6.76	8.30	7.56	240.17

Means identified by the same letter are not significantly different at 0.05 level of probability according to FLSD .

Table 5. Mean values for technological characters of ten flax genotypes (combined over two years, 2003/04 and2004/05).

Genotypes	Long fiber percentage (%)	Fiber length (cm)	Fiber fineness (Nm)	Oil percentage (%)
Sakha1	16.08 b	88.13 c	197.78 e	41.37 c
Sakha2	14.93 c	88.32 c	177.31 g	42.35 b
S.2465/1/3	11.08 g	82.48 e	180.01 g	42.61 b
S.402/12	11.26 g	74.85 f	178.92 g	41.28 c
S.16/3/12/4	13.81 d	98.04 a	260.03 c	37.21 f
S.119/7/8	12.85 e	90.83 b	252.18 d	38.03 e
S.31/3/2	12.15 f	84.77 d	186.95 f	43.59 a
S.15/1/2	16.69 a	96.73 a	203.27 e	39.88 d
Bombay	14.02 d	69.99 g	301.11 b	36.36 g
Ariane	16.98 a	89.92 bc	323.54 a	35.25 h
Mean	13.98	86.40	226.11	39.79

The values identified by the same letter are not significantly different at 0.05 level of probability according to FLSD.

Table 6. Phenotypic (rp) and genotypic (rg) correlation coefficients among straw, seed weight / plant and their components as Well as some technological traits of ten flax genotypes based on data of two seasons (2003/04 and 2004/05).

Characters		1	2	3	4	5	6	7	8	9	10	11
1-Straw weight / plant (g)												
2- Plant height (cm)	rp	0.675 *										
	rg	0.663										
3- Technical stem length (cm)	rp	0.687 *	0.843 **									
	rg	0.487	0.927									
4- No. of basal branches / plant	rp	-0.674 *	0.050	-0.194								
	rg	0.474	0.347	0.112								
5-Seed weight/ plant (cm)	rp	0.586	0.076	0.001	0.589							
	rg	0.395	0.332	0.401	0.654							
6-No.of capsules / plant	rp	0.560	-0.042	-0.109	0.635 *	0.948 **						
	rg	0.574	0.198	0.244	0.781	0.937						
7-seed index (g)	rp	0.646 *	0.230	0.117	0.490	0.929 **	0.802 **					
	rg	0.569	0.337	-0.204	0.506	0.773	0.877					
8-No.of seeds/capsule	rp	-0.710 *	-0.169	-0.097	-0.572	-0.873**	-0.850 **	-0.907 **				
	rg	0.119	-0.423	-0.541	-0.074	0.045	-0.789	-0.895				
9-Long fiber percentage (%)	rp	0.086	0.367	0.494	0.035	-0.472	-0.371	-0.564	0.403			
	rg	0.369	0.687	0.557	0.417	-0.432	-0.325	-0.246	0.498			
10-Fiber length (cm)	rp	0.468	0.847 **	0.998 **	-0.201	-0.019	-0.138	0.114	-0.084	0.678 *		
	rg	0.568	0.706	0.874	-0.512	0.176	-0.232	0.318	0.345	0.774		
11-Fiber fineness (Nm)	rp	-0.642 *	-0.117	-0.004	-0.702*	-0.908**	-0.870 **	-0.915 **	0.970 **	0.703*	0.708 *	
	rg	0.567	0.562	0.542	0.219	-0.871	-0.713	-0.708	0.678	0.812	0.008	
12-Oil percentage (%)	rp	0.498	-0.051	-0.086	0.704 *	0.945**	0.904**	0.886 **	-0.900**	-0.434	-0.102	-0.954 **
	rg	0.327	0.244	0.087	0.874	0.872	0.827	0.792	-0.819	0.197	0.348	-0.543

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

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التباين والتغاير لبعض الصفات المحصولية والتكنولوجية في الكتان

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أجريت تجربتان حقليتان خلال موسمي ٢٠٠٣ / ٢٠٠٤ – ٢٠٠٤ / ٢٠٠٥ بمحطة البحوث الزراعية بإيتاي البارود– م البحيرة – مصر. وذلك لتقييم عشرة تراكيب وراثية من الكتان فيما يتعلق بمحصولي القش والبذرة ومكوناتهما وصفات الجودة إضافة إلى دراسة التباينات والتباينات المشتركة من خلال بعض التقديرات لبعض الثوابت الوراثية ؛ وكانت أهم النتائج ما يلي:

أظهرت جميع التراكيب الوراثية اختلافات عالية المعنوية لكل الصفات تحت الدراسة. كذلك التفاعل بين هذه التركيب والبيئات (G x E) كان معنوياً فيما عدي صفتي معامل البذرة والنسبة المئوية للزيت. بينما المساهمة النسبية في التباين الكلي للأصناف كان أعلي من مساهمة تباين التفاعل مما يدل علي أن معظم التباين لهذه الصفات يتحكم في معظمة عوامل وراثية مع تأثر قليل بالعوامل البيئية؛ وهذا يعني أن التحسين في هذه الصفات ممكن إنجازه بالانتخاب المباشر

كما تشير نتائج التقديرات لبعض الثوابت الوراثية إلى أن درجة التوريث في المعني الواسع أظهرت قيماً عالية لصفة الطول الفعال يلي ذلك محصول البذرة ثم الطول الكلي ؛ أيضاً تلك الصفات أظهرت تقارب لتقديرات معاملي التباين الظاهري (PCV) والوراثي (GCV). مما يشير إلى إمكانية استخدام هذين المكونين (الطول الكلي و الطول الفعال) كمعاملي انتخاب لتحسين محصول القش مع إعطاء أهمية أكبر للطول الفعال. كذلك أعطي محصول البذرة للنبات مع كل من عدد الكبسولات للنبات و معامل البذرة نتائج مماثلة مما يشير أيضاً إلى إمكانية استخدام مكوني معامل البذرة وعدد الكبسولات/ نبات في الانتخاب لتحسين صفة محصول البذور للنبات.

كما تشير النتائج إلى تفوق السلالة ١٥ / ١ / ٢ علي الصنف التجاري سخا ١ في محصول القش / فدان و محصول الألياف الطويلة / فدان . بينما السلالة ٣١ / ٣ / ٢ أظهرت أعلي قيم لمحصول البذور / فدان وللنبات ؛ وكذلك عدد الكبسولات / نبات ومعامل البذرة ومحصول الزيت / فدان يلي هذه السلالة الصنف التجاري سخا ٢ لصفات محصول البذور / فدان وعدد الكبسولات/ نبات ومحصول الزيت / فدان.

كما تشير النتائج الخاصة بصفات الجودة أن المستورد أريانا أعطي أعلي نسبة من الألياف الطويلة وكذلك النعومة؛ كذلك السلالة ١٥ / ١ / ٢ أعطت أعلي نسبة من الألياف الطويلة وطول الألياف؛ كما أن السلالة ٣١ / ٣ / ٢

أعطت اعلي قيمة من النسبة المئوية للزيت ؛ يلي ذلك السلالة ٢٤٦٥ /١ / ٣ ثم الصنف التجاري سخا ٢ .

وعلي ذلك ممكن استخدام المستورد أريانا ؛ س ١٥ /١ /٢ ؛ س ٣١ / ٣ /٢ ؛س ١٤٦٥ /١ /٣ ؛ سخا ٢ في برامج تربية الكتان لتحسين الصفات سالفة الذكر والتي أظهرت تفوق لها.

أشارت أهم نتائج الارتباط الظاهري والوراثي أن محصول القش / نبات أظهر ارتباطاً موجباً مع كل من الثلاث مكونات الخاصة به (الطول الكلي– الطول الفعال– عدد الأفرع القاعدية) . كما أن هناك ارتباط موجب ومعنوي بين الطول الكلي والطول الفعال؛ هذه النتائج تؤكد أن هاتين الـصفتان هما المكونين الرأسين لمحصول القش. كما أظهر محصول البذور للنبات ارتباطاً عـالي المعنويـة وموجب مع اثنين من مكوناته هما عدد الكبسولات للنبات ومعامل البذرة مما يؤكد أن عدد الكبسولات للنبات يلي ذلك معامل البذرة لهما التأثير الرئيسي المباشر علي محصول البذرة/ نبات كـذلك يمكـن استخدام هاتين الصفتين في الانتخاب المباشر لتحسين هذه الصفة؛ كذلك الارتباط بين الصفتين (عدد الكبسولات/نبات و معامل البذرة) يؤكد هذه الرؤية. كذلك وجد ارتباط موجب وعالي المعنوية لطول الألياف مع كل من الطول الكلي والطول الفعال والنسبة المئوية للألياف. كذلك وجد ارتباط موجـب بين كل من عدد البذور بالكبسولة وطول الألياف.أيضاً الارتباط الموجب بين النسبة المئوية للزيت مع كل من محصول البذور وعدد الكبسولات ومعامل البذرة وعدد الأفرع القاعدية يشير إلى أنه يمكـن الانتخاب للمحصول العالي من البذور ومحتوي عالي من الزيت معاً.