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COMPARATIVE STUDY FOR YIELD AND YIELD COMPONENTS OF SOME FLAX FAMILIES WITH THE TWO COMMERCIAL VARIETIES, SAKHA 1 AND SAKHA 2

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ABSTRACT

Three field experiments were conducted at the experimental Farm of Etay El-Baroud , El-Beheira Governorate, Egypt. These trials included forty eight families sown in F_5, F_6 and F_7 generations at the three successive seasons, 2004/05, 2005/06 and 2006/07, respectively. The objective of this investigation is to compare these families through three generations when with the two commercial varieties, Sakha 1 and Sakha 2 for yield and yield components as well as fiber and oil quality characters.

Mean squares due to families were significant for straw, seed weight and their components as well as for technological traits, fiber percentage, fiber fineness and oil percentage in all tested generations. For phenotypic (PCV) and genotypic (GCV) coefficient of variability and broad sense heritability (H%), the slight discrepancy between PCV and GCV for straw weight components (plant height and technical stem length) and also for seed weight components (No. of capsules and 1000-seed weight) with high heritability estimates in each of the three generations under study, indicated the presence of genetic variability among tested families for these characters and that selection in advanced generations would be effective for improving the above-mentioned traits.

Five families (No. 46 followed by 27. 43, 44 and No. 20) were superior for both seed and straw yields per fed, four of them (No. 46, 44, 43 and No. 20) were also superior for the two fiber technological characters, fiber percentage and fiber fineness. It is notable that the three families (No.43, 44 an No.46) are derived from the hybrid (S.2419/1 x S.148/6/1), whereas family No.20 and No.27 are belonged to the two hybrids (Giza 7 x S.2419/1) and (Giza 8 x S.2419/1), respectively. Therefore, these families (specially family No. 46) are recommended to be released and become as substitute for the commercial varieties Sakha 1 and Sakha 2 after evaluation in more locations before releasing as new commercial varieties for fiber and oil yields (as dual purpose type).

Phenotypic (r_p) and genotypic (r_g) correlation coefficients concluded that, straw weight per plant was significantly positively correlated with both of plant height and technical stem length. Seed weight per plant, exhibited positive association with each of capsules number per plant, 1000-seed weight, plant height and technical stem length, indicating that flax yield improvement could be achieved through selection for seed weight and high straw components (plant height and technical stem length). Fiber percentage showed positive association with both of straw weight per plant and fiber fineness, indicating that selection for a genotype characterized by high yielding ability for fiber yield and high fineness is possible.

Keywords: Flax, comparative study, yield and yield components, correlation

INTRODUCTION

Flax (*Linum usitatissimum* L.) is the source of products for existing, high-value markets in the textile, composites, paper pulp, and industrial/nutritional oil sectors. Long line fiber is used in manufacturing high value linen apparel, while short fiber has historically been the waste from long line fiber and used for lower value products. The flax breeding program at Fiber Crops Section, ARC, Egypt, strives to boost straw yield and seed yield as well as technological traits. Therefore, it is necessary to release new promising strains of flax that surpass quantitatively and qualitatively the commercial varieties.

As suggested by Burton (1952) and Johnson *et al* (1955), genetic variability together with heritability and genetic advance estimates would provide the best feature of the amount of the gain to be expected from selection. Miller et al (1958) reported that progress from selection depended on the extent that superior genotypes in a population may be readily phenotypically identified. So, information on the relative magnitude of the different sources of variation for several traits are needed. Also, Miller and Rawlings (1967) stated that realizing substantial genetic advance through selection for different yield component, needs sufficient genetic variability. Dudley and Moll (1969) reported that using estimates of heritability and genetic variances in breeding program may increase efficiency through optimization of available resources of the most fruitful parental combinations.

The relationships among yield and yield component are complex because the components are greatly influenced by heritable and non-heritable effects as well as their interaction. It is therefore important to estimate genotypic and phenotypic correlations among yield and its attributes. Kumar and Chauhan (1982) found that 1000-seed weight and seeds per capsule may be considered simultaneous characters for selection between flax varieties. Frank and Hollosi (1985) recorded that 1000-seed weight and No. of seeds per capsule have high heritability estimates and were suitable for use as selection principle for seed yield. They added that number of capsules, No. of seeds per capsule and 1000-seed weight were all inter-correlated. Mourad (1983) and Abo El-Zahab *et al,* (1994) found that the maximization of seed yield may be obtained via selection for its two main components, number of capsules per plant and seed size, while, Abo-Kaied (2003) and Zahana and Abo-Kaied (2007) found that the maximization of straw yield may be obtained by selection for plant height and technical stem length.

The purpose of the present investigation was to evaluate 48 families of flax derived from four crosses in F_5, F_6 and F_7 generations for phenotypic and genotypic coefficient of variability and heritability for straw, seed yields and their components and technological traits as well as to study the nature of association between key traits of seed and straw weight besides oil and fiber percentage. These parameters were used in order to compare the different allowed families of flax that surpass quantitatively and qualitatively the commercial varieties Sakha 1 and Sakha 2.

MATERIALS AND METHODS

The four {541/A=(Giza 7 x Giza 8), 541/B= (Giza 7 x S.2419/1), 541/C= (Giza 8 x S.2419/1) and 541/D= (S.2419/1 x S.148/6/1)} out of 36 crosses, which showed consistent superiority for integrating yield and stability in both F_1 and F_2 generations (Abo El-Zahab and Abo-Kaied 2000.) were used as a potential breeding material in F_3 and F_4 generations (Abo-Kaied 2003). Two cycles of selection for improving both straw and seed yields by using independent culling levels selection method, resultant forty eight promising families belongs to four crosses (541/A, 541/B, 541/C and 541/D) in F_4 generations.

The materials used for the present investigation consisted of 48 families (the full details of these families were tested by Abo-Kaied, 2003) as well as the two commercial varieties, Sakha 1 and Sakha 2 as check varieties.

In 2004/05 season, the 48 F_5 families in addition to the two commercial varieties (Sakha1 and Sakha2), were grown in Randomized Complete Block Design (RCBD) with three replicates at Etay El-Baroud Exp.Sta., El-Beheira Governorate. Each block contained 50 entries. A plot size was 3.0 x 2.0 m and contained 10 rows, 20 cm apart and 3 m long. Plant density of 2000 seeds/m^2 was used.

In 2005/06 season, 48 F_6 families along with the two commercial varieties, were grown in the same way as that followed in F_5.

In 2006/07 season, 48 F_7 families along with the two commercial varieties, were grown in the same way as that followed in F_5 and F_6 . Plot size, row length and distances between rows were the same as F_5 and F_6 generations. The normal recommended agronomic practices for flax cultivation were applied in all the three seasons.

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 (fed = 4200 m^2) were calculated on plot basis. Oil percentage was determined as an average of two random seed samples/plot using Soxhlet apparatus (A.O.A.C. Society, 1995). The following characters were recorded:

I) Straw yield and its components:

(1) Straw yield.(ton)/fed, (2) Straw weight (g)/plant., (3) Plant height (cm) and (4)Technical stem length (cm).

II) Seed yield and its components:

(1) Seed yield (ton)/fed, (2) Seed weight (g)/plant, (3) No. of capsules/plant and (4)1000-seed weight (g).

III) Technological characters as well as oil and long fiber yields per fed.:

(all the following characters were determined in F_7 generation only).

(1) Long fiber percentage (%),, (2) Fiber fineness (Nm) according to the technique described by Radwan and Momtaz (1966), and (3) Oil percentage (%). (4) Long fiber yield (ton)/fed and (5) Oil yield (Kg)/fed.

Biometrical analysis:

Data were subjected to regular analysis of variance of RCBD according to Snedecor and Cochran (1980). The phenotypic (PCV) and genotypic (GCV) coefficient of variation for families in each generation was computed as $(\sigma ph \times 100)/\bar{x}$ and $(\sigma g \times 100)/\bar{x}$, where σph is the square root of the phenotypic variance of families, σg is square root of genotypic variance of families and $\bar{x}$ is the general mean of families and H% is the heritability in broad sense, $(\sigma^2 g/\sigma^2 ph)x100$ for the character being evaluated. Phenotypic and genotypic correlation coefficients among all possible pairs of studied traits were computed by using the data of 48 families in F_7 generation.

RESULTS AND DISCUSSION

1- Variability

1-1- Straw weight and its components.

Mean square values, variance component estimates, phenotypic (PCV) and genotypic (GCV) coefficient of variability and broad sense heritability (H%) for straw weight/plant and its components of forty eight flax families based on data of three successive generations (F_5, F_6 and F_7) are presented in Table (1). Highly significant differences with a wide variation were detected among entries (48 families and 2 check varieties, Sakha 1 and Sakha 2) and families (48 families) in straw weight/plant and its two important components (plant height and technical stem length). This indicates that the genetic material used has sufficient variation, revealing the variability existed among these families, which in turn would increase the chance to select high-yielding potential genotypes for straw weight/plant. On the other hand, mean squares due to varieties (two check varieties) were non-significant for most traits under study, indicating that these two varieties may be considered at the same behavior for these characters. Whereas, the families *vs*. varieties was significant for most cases, indicating that these entries differ in their genetic potential for these characters. Such variability among different flax genotypes in straw weight, plant height and technical stem length was also reported by Momtaz *et al*, (1990) and Zahana and Abo-Kaied (2007).

Table 1 . Mean square values, variance component estimates, phenotypic (PCV) and genotypic (GCV) coefficients of variability and broad sense heritability (H%) for straw weight/plant and its components of forty eight flax families based on data of three successive generations (F_5, F_6 and F_7).

Characters		Entries(E) (4 9)#	Families (F) (47)#	Varieties (V) (1) #	F. vs. V.	Error (100) #	σ2ph	σ2g	σ2e	PCV%	GCV%	H%
		Straw weight / plant and its components										
Straw weight/plant (g)	F_5	1.628**	1.681**	0.052	0.719	0.304	0.56	0.46	0.304	21.45	19.41	81.92
	F_6	1.476**	1.462**	0.913	2.721**	0.381	0.487	0.36	0.381	18.58	15.97	73.94
	F_7	0.705**	0.680**	0.35	2.239*	0.116	0.227	0.19	0.116	12.77	11.63	82.97
Plant height (cm)	F_5	286.18**	279.31**	3.32	891.78**	15.29	93.103	88	15.29	9.609	9.343	94.53
	F_6	198.05**	202.89**	61.06 *	107.63**	27.39	67.629	58.5	27.39	7.308	6.797	86.5
	F_7	202.49**	202.93**	23.25	360.81**	6.817	67.645	65.4	6.817	7.691	7.56	96.64
Technical stem length (cm)	F_5	174.43**	178.15**	15.62	158.17**	13.9	59.384	54.8	13.9	9.979	9.582	92.2
	F_6	248.06**	256.39**	104.42**	0.623	15.93	85.462	80.2	15.93	10.72	10.39	93.79
	F_7	196.40**	203.53**	9.81	47.976	3.27	67.844	66.8	3.27	10.09	10.01	98.39

*,** = 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^2e : Phenotypic, genotypic, plot error variances, respectively.

Concerning estimates of the variance components and heritability, PCV and GCV reached maximum values for straw weight/plant, indicating the possibility to achieve further improvement by selection for this trait. The observed narrow range between PCV and GCV, which gave almost nearly similar values, specially for plant height and technical stem length in the three generations reflect the importance of selection for these traits which also, gave high heritability estimates. This conclusion may be supported by evidences that yield component traits are genetically controlled. These results indicated the possibility of using these yield component traits (plant height and technical length) in selection index technique with giving more weight for technical stem length which had high heritability ratios (F_5= 92.20, F_6= 93.79 and F_7= 98.39%) followed by plant height (F_5= 94.53, F_6 = 86.50 and F_7 = 96.64%). These results are in harmony with that reported by Abo-Kaied *et al*, (2008).

Mean performance for straw yield/fed, straw weight/plant and its components of forty eight flax families plus the two check varieties at three successive generations (F_5, F_6 and F_7) are presented in Table (4). The family No.46 gave highest values for straw yield (ton)/fed concerning the three generations (F_5= 4.853, F_6= 5.927 and F_7= 4.818) followed as descending order by families No. 43 (F_5= 4.773 , F_6= 4.770 and F_7= 4.605), No.44 (F_5=4.591 , F_6=4.695 and F_7=4.542), No. 27 (F_5= 4.457 , F_6= 4.683 and F_7= 4.355), No. 28 (F_5= 4.348, F_6= 4.372 and F_7= 4.415), No. 20 (F_5= 4.223, F_6= 4.277 and F_7= 4.599) and No. 11 (F_5= 4.019, F_6= 4.356 and F_7= 4.555). These families were superior than the other studied families as well as the two commercial varieties, Sakha 1 and Sakha 2 in straw yield/fed, straw weight/plant, plant height and technical stem length in most cases. These results indicated that the promising families No. 46, No. 43 and No. 44, which belongs to the cross 541/D (S.2419/1 x S.148/6/1) and families No. 27 and No. 28, which belongs to the cross 541/C (Giza 8 x S.2419/1) as well as family No. 20, which belongs to the cross 541/B (Giza 7 x S.2419/1) and finally family No. 11, which belongs to cross 541/A (Giza 7 x Giza 8) may be considered good substitutes for the low yielding ones, Sakha 1 and Sakha 2 in future after evaluation in more locations before releasing as a new Egyptian flax cultivar for straw yield production.

1-2- Seed weight and its components.

Mean square values, variance components estimates, phenotypic (PCV) and genotypic (GCV) coefficient of variability and broad sense heritability (H%) for seed weight/plant and its components of forty eight flax families based on data of the three successive generations (F_5, F_6 and F_7) are presented in Table (2). Mean square values showed that entries and families displayed highly significant differences for seed weight and its two important components, No. of capsules/plant and 1000-seed weight, indicating that the genetic material used has sufficient variation which might be useful to select for improving seed yield.

Regarding estimates of the variance components and heritability, phenotypic (PCV) and genotypic (GCV) coefficient of variability exhibited high values for both seed weight /plant and No. of capsules/plant in all generations studied. These results indicated that, the high range of variability might be useful in selecting lines characterized by high-yielding potential for both seed weight and capsules number/plant in this material. On the other hand, the low or moderate of PCV and GCV values in addition to the slight discrepancy between PCV and GCV values for 1000-seed weight was reflected in the high heritability estimates at the three generations (F_5= 91.42, F_6 = 96.81 and F_7 = 95.90%) for this trait. Such results support the view that the expected gain from selection would be valid and that a substantial improvement for this variable could be expected by selecting superior genotypes. Similar finding regarding high coefficient of variation of seed weight/plant and No. of capsules/plant with high heritability estimates have reported by Kumar and Chauhan (1982), Frank and Hollosi (1985), Abo El-Zahab *et al,* (1994), Zahana and Abo-Kaied (2007) and Abo-Kaied *et al*, (2008).

Table 2 . Mean square values, variance component estimates, phenotypic (PCV) and genotypic (GCV) coefficients of variability and broad sense heritability (H%) for seed weight/plant and its components of forty eight flax families based on data of three successive generations (F5, F6 and F7).

Characters	Entries(E) (4 9)#	Families (F) (47)#	Varieties (V) (1) #	F. vs. V.	Error (100) #	σ2ph	σ2g	σ2e	PCV%	GCV%	H%
			Seed weight / plant and its components								
Seed weight /plant (g) F_5	0.061**	0.063**	0.007	0.022	0.020	0.021	0.014	0.020	20.714	17.156	68.520
F_6	0.113**	0.118**	0.006	0.005	0.014	0.039	0.035	0.014	34.105	32.057	88.350
F_7	0.049**	0.051**	0.010	0.000	0.004	0.017	0.016	0.004	19.894	19.172	92.870
No. of capsules/plant F_5	13.627**	11.85**	59.693**	53.275**	4.343	3.950	2.502	4.343	19.070	15.178	63.350
F_6	15.686**	15.61**	9.652	25.324*	2.600	5.203	4.337	2.600	29.779	27.187	83.350
F_7	6.177**	6.344**	0.147	4.343	0.949	2.115	1.798	0.949	16.095	14.842	85.040
1000-seed weight (g) F_5	2.927**	2.885**	0.327	7.479**	0.248	0.962	0.879	0.248	9.442	9.028	91.420
F_6	6.144**	6.302**	0.047	4.789**	0.201	2.101	2.034	0.201	13.550	13.332	96.810
F_7	2.563**	2.553**	0.154	5.414**	0.105	0.851	0.816	0.105	8.798	8.615	95.900

For explanation see Table (1) .

Table 3 . Mean square values, variance component estimates, phenotypic (PCV) and genotypic (GCV) coefficients of variability and broad sense heritability (H%) for some technological characters of forty eight flax families based on data of F7 generation.

Characters	Entries(E) (4 9)#	Families (F) (47)#	Varieties (V) (1) #	F. vs. V.	Error (100) #	σ2ph	σ2g	σ2e	PCV%	GCV%	H%
			Technological characters								
Fiber percentage (%)	6.142**	6.358**	1.728**	0.402	0.297	2.119	2.020	0.297	9.478	9.254	68.520
Fiber fineness (Nm)	899.7**	882.1*	522.7*	2106.3**	17.541	294.015	288.168	17.541	8.305	8.222	88.350
Oil percentage (%)	18.667**	19.244**	0.286	9.906**	0.397	6.415	6.282	0.397	6.344	6.278	92.870

For explanation see Table (1) .

Table 4. Mean values for straw yield/fed, straw weight/plant and its components of forty eight flax families based on data of three successive generations (F5, F6 and F7).

Family	Straw yield (ton)/fed			Straw weight (kg)/plant			Plant height (cm)			Technical length (cm)		
No.	F5	F6	F7	F5	F6	F7	F5	F6	F7	F5	F6	F7
1	4.251	4.259	4.325	4.66	3.80	4.34	110.67	118.00	114.50	82.00	93.13	88.15
2	3.597	3.505	3.275	2.89	3.15	2.95	103.40	117.27	109.95	78.73	91.60	84.75
3	3.041	3.295	3.280	3.39	3.80	3.67	108.60	121.27	114.30	81.33	95.20	88.00
4	3.427	3.251	3.425	3.24	3.42	3.33	99.13	119.40	111.25	77.47	95.20	89.00
5	3.299	3.045	3.455	3.33	3.36	3.57	95.80	115.60	106.05	71.13	86.67	78.30
6	3.208	3.816	3.380	2.83	2.56	3.38	90.87	110.20	100.95	72.33	81.73	76.50
7	4.202	4.172	4.371	2.63	2.74	2.92	97.27	116.53	108.25	79.53	87.40	84.10
8	4.200	4.302	4.196	3.98	3.25	3.91	104.80	116.53	112.25	80.80	91.87	86.80
9	3.699	3.731	3.040	3.57	2.45	3.29	103.87	107.13	107.65	82.27	101.60	91.00
10	3.359	3.735	3.855	3.27	3.98	3.75	115.80	116.00	115.85	87.20	91.93	89.10
11	4.019	4.356	4.555	4.76	4.64	4.17	116.73	119.60	117.30	86.73	92.53	88.80
12	3.830	3.815	4.040	4.43	3.26	3.56	108.13	114.60	111.45	82.00	94.20	88.25
13	3.729	4.019	4.215	5.00	3.80	4.29	112.47	118.00	115.50	86.87	93.13	90.30
14	3.126	3.100	3.140	2.53	3.15	3.01	100.93	117.27	110.20	80.67	91.60	86.90
15	3.940	3.665	4.085	3.77	3.80	4.01	103.73	121.27	112.50	80.87	95.20	87.80
16	3.224	3.046	3.120	3.17	3.42	3.34	99.40	119.40	110.20	74.33	95.20	85.60
17	3.629	3.700	3.760	3.53	3.36	3.48	110.53	115.60	112.90	83.33	86.67	84.25
18	3.222	3.726	3.270	2.73	2.74	3.19	93.60	110.20	101.30	71.67	81.73	75.95
19	3.949	3.556	4.265	5.79	3.56	4.22	110.93	120.53	115.00	82.73	87.40	85.95
20	4.223	4.277	4.599	5.17	4.59	4.58	119.60	116.53	117.50	95.00	91.87	91.00
21	3.123	3.459	3.070	3.21	2.45	2.89	110.93	107.13	111.55	77.67	88.87	82.20
22	3.830	3.941	4.155	3.81	3.98	4.15	112.80	116.00	114.05	85.93	91.93	88.85
23	3.914	3.846	3.845	3.71	3.64	3.73	116.87	119.60	117.95	91.27	92.53	90.70
24	3.108	3.355	3.160	3.53	3.26	3.69	107.20	110.60	111.85	85.33	94.20	90.75
25	3.240	3.449	3.530	2.95	3.25	3.94	103.00	107.33	106.25	81.87	80.13	80.70
26	3.808	3.791	4.005	3.82	3.51	3.99	92.67	100.33	97.35	74.07	74.07	74.25
27	4.457	4.683	4.355	4.03	4.74	4.22	101.93	120.93	111.35	78.00	94.33	85.45
28	4.348	4.372	4.415	3.56	4.75	4.21	85.93	102.67	92.85	67.93	70.60	66.60
29	3.672	3.435	3.560	2.72	2.70	3.34	97.07	94.53	95.75	75.27	72.20	73.45
30	3.218	3.685	3.430	2.42	4.33	3.04	89.27	108.07	99.60	70.60	80.87	76.95
31	4.007	3.868	4.233	2.60	3.57	3.31	82.00	100.80	91.50	61.67	74.67	68.35
32	3.964	3.925	4.299	3.09	3.87	3.59	87.40	100.87	94.05	64.67	69.20	65.10
33	3.430	3.540	3.195	3.22	3.24	3.31	86.47	91.93	89.05	60.33	68.40	66.60
34	3.366	3.369	3.385	3.31	3.43	3.39	90.67	102.20	96.60	67.80	76.33	72.50
35	4.164	3.707	3.753	2.15	2.88	3.20	89.73	110.47	99.40	71.20	84.60	78.65
36	3.916	4.069	3.950	3.36	4.11	3.68	94.87	98.27	97.15	71.80	72.20	72.10
37	3.366	3.358	3.819	2.53	4.11	3.12	80.60	98.20	87.00	57.87	65.93	59.35
38	3.793	4.102	3.936	3.71	4.21	3.98	92.00	114.80	102.30	66.93	84.20	76.70
39	3.833	3.949	3.724	2.58	3.58	3.39	89.20	113.67	100.35	70.73	76.53	70.95
40	4.187	4.075	4.010	3.94	3.97	3.97	97.67	118.60	110.45	70.40	89.40	83.30
41	4.248	4.350	4.115	4.19	5.16	4.84	108.13	116.40	115.05	76.40	90.93	80.50
42	3.589	4.135	3.825	3.44	4.80	4.15	104.87	122.13	113.85	83.00	92.47	86.90
43	4.773	4.770	4.605	3.37	4.66	4.34	101.93	127.40	115.15	82.60	98.87	90.85
44	4.591	4.695	4.542	3.34	5.39	4.22	96.87	121.73	110.90	77.53	85.33	82.20
45	2.767	3.370	2.940	3.13	4.03	3.67	96.87	115.07	105.70	77.53	87.93	82.70
46	4.853	5.927	4.818	4.49	4.89	4.67	104.27	128.60	111.35	87.20	101.60	95.15
47	3.844	4.065	3.930	3.52	4.61	3.97	96.00	100.87	101.65	75.67	76.33	78.35
48	3.599	4.205	3.905	3.14	4.42	4.02	96.40	101.33	108.40	73.60	77.20	76.90
Mean	**3.754**	**3.872**	**3.837**	**3.49**	**3.76**	**3.73**	**100.41**	**112.53**	**106.94**	**77.12**	**86.20**	**81.62**
LSD 0.05	**0.188**	**0.456**	**0.266**	**0.68**	**0.77**	**0.42**	**4.85**	**6.50**	**3.24**	**4.63**	**4.95**	**2.24**
Sakha1	3.789	3.543	3.663	3.23	3.46	3.35	113.60	115.04	110.83	80.85	90.70	85.78
Sakha2	3.456	3.336	3.393	3.04	2.68	2.86	112.11	113.66	110.89	80.08	82.36	83.22

Families from 1:12 =cross 541/A (Giza 7 x Giza 8), families from13:24=cross 541/B (Giza 7 x S.2419/1) ,
families from25:36=cross 541/C (Giza 8 x S.2419/1) and families from37:48=cross 541/D (S.2419/1 x S.148/6/1).

Table (5) shows the mean performance of seed yield/fed, seed weight/plant, No. of capsules/plant and 1000-seed weight for 48 families and two check varieties at the three generations (F_5, F_6 and F_7).

Table 5. Mean values for seed yield/fed, seed weight/plant and its components of forty eight flax families based on data of three successive generations (F5, F6 and F7).

Family No.	Seed yield(ton)/fed			Seed weight(g)/plant			No. of capsules/plant			1000-seed weight(g)		
	F5	F6	F7	F5	F6	F7	F5	F6	F7	F5	F6	F7
1	0.744	0.724	0.729	0.75	0.44	0.64	13.27	7.13	11.20	8.71	9.24	8.93
2	0.599	0.587	0.537	0.48	0.43	0.46	6.75	6.08	6.41	10.19	11.21	10.64
3	0.569	0.564	0.534	0.55	0.46	0.53	8.77	5.78	7.42	10.46	11.67	11.07
4	0.661	0.619	0.549	0.57	0.43	0.52	10.56	6.42	8.17	9.42	9.81	9.56
5	0.592	0.539	0.560	0.77	0.56	0.68	11.94	7.38	9.93	9.50	10.51	10.04
6	0.510	0.465	0.469	0.69	0.45	0.60	11.69	7.65	9.28	9.98	8.55	9.47
7	0.768	0.715	0.692	0.61	0.37	0.49	10.05	5.32	7.79	10.08	9.75	10.00
8	0.796	0.738	0.738	0.76	0.37	0.64	11.90	5.12	9.10	9.54	10.59	10.01
9	0.697	0.668	0.599	0.66	0.27	0.49	11.44	5.02	8.46	9.66	9.19	9.40
10	0.635	0.582	0.576	0.62	0.48	0.57	8.46	8.42	8.84	8.19	9.65	9.01
11	0.601	0.546	0.540	0.76	0.53	0.63	12.53	7.72	9.74	8.99	10.11	9.66
12	0.639	0.633	0.619	0.92	0.25	0.65	12.46	4.12	9.61	9.92	9.31	9.51
13	0.734	0.579	0.644	0.75	0.44	0.58	10.86	7.13	9.10	9.83	9.24	9.42
14	0.590	0.471	0.588	0.45	0.43	0.45	5.69	6.08	6.12	10.93	11.21	10.71
15	0.635	0.644	0.679	0.69	0.46	0.66	9.59	5.78	8.74	10.85	11.67	11.12
16	0.565	0.582	0.511	0.71	0.43	0.53	10.73	6.42	8.08	10.53	9.81	10.18
17	0.663	0.579	0.624	0.67	0.56	0.63	8.38	7.38	8.13	10.58	10.51	10.44
18	0.544	0.511	0.540	0.64	0.45	0.55	9.19	7.65	8.32	9.57	8.55	9.13
19	0.690	0.666	0.672	0.92	0.37	0.65	11.43	5.32	8.73	10.55	9.75	10.06
20	0.787	0.771	0.816	0.73	0.48	0.59	10.31	8.75	7.93	10.35	10.59	10.58
21	0.465	0.469	0.509	0.54	0.27	0.42	7.87	5.02	6.41	12.08	9.19	10.71
22	0.604	0.589	0.594	0.60	0.48	0.58	9.62	8.42	9.29	11.78	9.65	10.45
23	0.471	0.461	0.461	0.39	0.53	0.48	6.47	7.72	7.55	9.74	10.11	9.91
24	0.428	0.446	0.456	0.61	0.25	0.44	10.36	4.12	7.08	11.81	9.31	10.61
25	0.516	0.572	0.582	0.45	0.64	0.70	8.06	9.92	9.87	9.29	12.15	10.63
26	0.829	0.706	0.775	0.68	0.53	0.66	10.32	6.45	9.08	10.07	10.95	10.55
27	0.901	0.852	0.867	0.80	1.04	0.93	11.87	12.85	11.94	13.15	14.15	13.52
28	0.821	0.805	0.801	0.61	0.65	0.63	10.77	9.50	9.00	12.24	11.47	11.40
29	0.807	0.801	0.826	0.98	0.88	0.83	14.71	7.70	11.11	10.65	14.69	12.05
30	0.690	0.643	0.653	0.54	0.70	0.65	9.33	9.55	9.82	10.35	11.30	10.65
31	0.875	0.826	0.853	0.72	0.83	0.76	12.19	10.35	10.42	10.62	11.31	10.89
32	0.848	0.811	0.791	0.78	0.98	0.91	10.35	12.23	11.42	10.00	9.59	9.87
33	0.878	0.777	0.827	0.96	0.79	0.91	14.12	11.20	12.61	10.06	9.81	10.04
34	0.775	0.690	0.726	0.79	0.73	0.75	11.90	9.43	10.12	9.40	9.00	9.60
35	0.848	0.812	0.809	0.66	0.55	0.61	10.92	7.70	8.79	9.35	9.25	9.60
36	0.819	0.812	0.846	0.59	0.73	0.64	9.03	11.50	10.64	12.28	13.72	12.92
37	0.772	0.755	0.775	0.74	0.99	0.81	10.58	12.28	10.88	11.82	11.30	11.56
38	0.584	0.610	0.559	0.62	0.68	0.57	14.04	10.68	8.99	10.95	13.12	12.01
39	0.494	0.570	0.669	0.72	0.78	0.84	9.39	9.18	10.25	9.76	10.37	10.15
40	0.773	0.710	0.756	0.82	0.48	0.68	11.47	5.95	8.48	10.21	10.95	10.81
41	0.555	0.602	0.581	0.60	0.61	0.67	8.03	6.10	7.39	10.88	10.93	10.71
42	0.566	0.588	0.589	0.66	0.65	0.65	8.60	8.28	8.08	11.00	10.51	10.81
43	0.797	0.788	0.842	0.78	0.65	0.75	9.78	7.53	8.60	10.95	11.26	10.86
44	0.797	0.676	0.792	0.96	0.68	0.77	8.25	6.62	6.57	10.46	11.17	10.66
45	0.649	0.689	0.685	0.84	0.78	0.84	12.22	8.73	10.40	10.52	11.21	10.79
46	0.804	0.790	0.771	0.88	0.74	0.78	12.77	6.28	8.89	10.10	11.47	10.61
47	0.793	0.723	0.778	0.82	0.91	0.79	9.68	9.93	9.27	11.28	10.70	10.74
48	0.768	0.775	0.736	0.77	0.74	0.82	11.60	7.77	9.70	9.94	12.89	11.24
Mean	**0.686**	**0.657**	**0.669**	**0.70**	**0.58**	**0.65**	**10.42**	**7.78**	**9.04**	**10.39**	**10.68**	**10.49**
LSD 0.05	**0.039**	**0.068**	**0.068**	**0.18**	**0.15**	**0.08**	**2.59**	**2.00**	**1.21**	**0.62**	**0.56**	**0.40**
Sakha1	0.414	0.394	0.404	0.60	0.58	0.61	8.23	8.49	9.75	9.01	9.70	9.36
Sakha2	0.504	0.445	0.476	0.67	0.64	0.65	10.54	11.03	10.06	9.48	9.87	9.68

For explanation see Table (4) .

Sixteen families (No. 27 which ranked first, followed by No.31, 36, 43, 33, 29, 20, 35, 44, 32, 47, 46, 37, 40, 8 and No.48) out of 48 families studied had high yielding potentiality for seed yield/fed of the three generations. Out of the above mentioned families which showed highest mean performance for seed yield/fed than the other studied families as well as the two check varieties, only eight families (No. 27 followed by 31, 36, 33, 29, 35, 37 and No. 48) showed superiority for seed weight/plant and its two important components, No. of capsules/plant and 1000-seed weight in most cases. Whereas, out of sixteen previous families, only five of them (No. 46 followed by 27. 43, 44 and No. 20) were superior for both seed and straw yields/fed. Therefore, these five families should be recommended as commercial varieties (as dual purpose type) and/or to be incorporated as breeding stocks in breeding program aiming at producing high yielding lines for seed and straw yields.

1-3- Fiber and oil yields/fed as well as some technological characters*:*

Mean square values, variance component estimates, phenotypic (PCV) and genotypic (GCV) coefficient of variability and broad sense heritability (H%) for some technological traits of forty eight flax families in F_7 generation are presented in Table (3). Mean squares due to entries, families, varieties and families vs. varieties were significant for all technological traits, fiber percentage, fiber fineness and oil percentage in most cases. This means that families differ in genetic potential for these traits and that selection would be effective for improving these traits.

Concerning PCV and GCV as well as broad sense heritability (H%), the discrepancy between PCV and GCV for the three technological traits were small. This was reflected in relatively high heritability estimates for fiber fineness (98.01%), oil percentage (97.93%) and fiber percentage (95.33%). Such high values of heritability with narrow range between PCV and GCV might be useful in selecting genotypes characterized by high quality for the above mentioned traits. These results are in harmony with that reported by Abo El-Zahab *et al,* (1994) and Abo-Kaied *et al*, (2008).

Mean performance for fiber and oil yields/fed as well as some technological traits of forty eight flax families in F_7 generation are presented in Table (6). The highest yielding fifteen families in descending order were number 46, 44, 43, 20, 32, 22, 31, 28, 41, 27, 12, 7, 36, 1 and number 48 when compared with the other families in addition to the two check commercial varieties for all characters studied. Out of fifteen previous families, five of them (No. 46, 44, 43, 20 and No.12) were also superior for the two fiber technological characters, fiber percentage and fiber fineness. Here, it must be mentioned that the family No. 46 recorded highest values for fiber yield/fed (0.866 ton), fiber percentage (17.97%) and fiber fineness (348.86 Nm) than the other families including the two check varieties. Therefore, these five families specially family No. 46 are recommended to be released and become as substitute for the commercial varieties Sakha 1 and Sakha 2 after evaluation in more locations before releasing as a new commercial varieties for fiber yield and technological characters.

Table 6. Mean values for fiber and oil yields/fed as well as some te traits of forty eight flax families based on data of F generation.

Family No.	Fiber percentage	Fiber fineness (Nm)	Fiber yield (ton)/fed	Oil percentage	Oil yield (Kg)/fed.
1	15.27	199.76	0.660	39.87	0.291
2	16.87	215.79	0.552	38.37	0.214
3	15.60	237.34	0.512	39.37	0.213
4	14.20	187.79	0.486	37.70	0.219
5	13.37	178.12	0.462	37.37	0.223
6	13.90	181.04	0.470	36.97	0.187
7	15.10	196.70	0.660	42.90	0.276
8	15.07	198.01	0.632	43.37	0.294
9	14.87	209.47	0.556	43.17	0.239
10	16.17	223.10	0.623	38.37	0.230
11	14.83	193.44	0.572	38.57	0.215
12	16.57	242.31	0.669	35.27	0.247
13	13.80	191.56	0.582	41.00	0.257
14	12.77	183.49	0.401	37.60	0.234
15	14.00	207.72	0.572	36.87	0.271
16	12.97	195.64	0.405	41.70	0.204
17	12.60	180.84	0.474	36.90	0.249
18	12.57	177.99	0.411	38.97	0.215
19	13.60	210.96	0.580	35.37	0.268
20	17.07	224.76	0.785	41.97	0.325
21	15.33	189.73	0.471	42.77	0.203
22	17.27	221.82	0.718	40.77	0.237
23	16.23	294.89	0.624	40.10	0.184
24	16.50	194.99	0.521	39.90	0.182
25	15.37	214.28	0.543	38.17	0.232
26	15.17	189.15	0.608	42.87	0.309
27	15.77	196.76	0.687	43.47	0.346
28	15.90	197.27	0.702	42.40	0.319
29	13.80	188.73	0.491	40.50	0.329
30	15.07	215.84	0.517	42.40	0.260
31	16.77	203.24	0.710	43.10	0.340
32	16.77	201.67	0.721	43.17	0.315
33	15.70	216.99	0.502	42.70	0.330
34	15.20	194.90	0.515	40.57	0.289
35	15.87	215.00	0.596	42.50	0.323
36	16.70	206.43	0.660	43.80	0.337
37	15.77	298.86	0.602	43.17	0.309
38	14.67	209.06	0.577	42.57	0.223
39	16.10	315.99	0.600	39.20	0.267
40	16.20	221.51	0.650	35.37	0.301
41	16.77	220.91	0.690	37.87	0.232
42	16.70	224.12	0.639	35.37	0.235
43	17.23	335.21	0.793	41.53	0.336
44	17.60	229.26	0.799	41.50	0.316
45	17.17	218.62	0.505	41.50	0.273
46	17.97	348.86	0.866	41.50	0.307
47	13.90	195.07	0.546	38.97	0.310
48	12.60	215.43	0.492	37.00	0.293
Mean	**15.36**	**216.88**	**0.592**	**40.13**	**0.268**
LSD 0.05	**0.68**	**5.20**	**0.056**	**0.78**	**0.056**
Sakha1	16.16	196.68	0.592	41.02	0.166
Sakha2	15.09	178.01	0.512	41.45	0.197

For explanation see Table (4) .

2- Correlation studies:

Phenotypic (r_p) and genotypic (r_g) correlation coefficients among straw, seed weight per plant and their components as well as some technological characters in 48 flax families based on data of F_7 generation are shown in Table (7). Straw weight / plant was significantly positively correlated with both of plant height, technical stem length, indicating that maximization of straw weight/plant may be obtained by selection for these two component variables. Also, plant height exhibited positive correlation with technical stem length. These results are in harmony with that reported by Abo El-Zahab *et al*., (1994) and Abo-kaied *et al*., (2006). Seed weight per plant, exhibited positive association with each of capsules number/plant, 1000-seed weight, plant height and technical stem length, indicating the possibility of selection for a genotype as dual purpose type which had high seed weight and high straw components (plant height and technical stem length). Fiber percentage showed positive association with both of straw weight/plant and fiber fineness, indicating that selection for a genotype characterized by high yielding ability of fiber yield and high fineness is possible. These results are in agreement with those obtained by Abo El-Zahab *et al*. (1994) and Abo-kaied *et al*., (2006).

Table 7: Phenotypic (rp) and genotypic (rg) correlation coefficients among straw, seed weight per plant and their components as well as some technological traits of forty eight flax families based on data of F7 generation.

Characters		1	2	3	4	5	6	7	8
1- Straw weight / plant (g)									
2- Plant height (cm)	rp	0.444**							
	rg	0.309							
3- Technical stem length (cm)	rp	0.345*	0.920**						
	rg	0.413	0.662						
4- Seed weight/ plant (cm)	rp	0.254	0.454**	0.499**					
	rg	0.325	0.103	0.271					
5- No.of capsules / plant	rp	0.046	-0.548**	-0.548**	0.756**				
	rg	0.201	0.267	-0.211	0.543				
6- 1000-seed weight (g)	rp	0.150	-0.210	-0.247	0.318*	0.161			
	rg	0.221	0.082	0.170	0.411	0.301			
7- Fiber percentage (%)	rp	0.304*	0.028	0.061	0.190	0.027	0.152		
	rg	0.205	0.363	0.377	-0.161	0.123	0.201		
8- Fiber fineness (Nm)	rp	0.243	0.085	0.111	0.257	0.018	0.079	0.544**	
	rg	0.332	0.313	0.402	0.081	0.121	-0.112	0.403	
9- Oil percentage (%)	rp	-0.129	-0.427**	-0.307*	0.145	0.267	0.263	0.309*	0.080
	rg	0.241	0.173	-0.143	0.421	0.317	0.412	0.112	0.072

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

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دراسة مقارنة للمحصول ومكوناته لبعض عائلات الكتان مع الصنفين التجاريين سخا١ وسخا٢

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استخدم في هذه الدراسة ٤٨ عائلة من الكتان زرعت في ثلاثة مواسم متتالية (٢٠٠٤ / ٢٠٠٥، ٢٠٠٥ / ٢٠٠٦، ٢٠٠٦ /٢٠٠٧)" جيل خامس وسادس وسابع مع الصنفين التجاريين سخا١ وسخا٢ بمحطة البحوث الزراعية بايتاي البارود– م البحيرة، وذلك لمقارنة المحصول ومكوناته لهذه العائلات مع الصنفين التجاريين سخا ١، سخا ٢.

تشير النتائج إلى معنوية التباين الخاص بالعائلات لكل من محصول القش والبذور ومكوناتهما وكذلك كل الصفات التكنولوجية المدروسة (النسبة المئوية للألياف والنعومة والنسبة المئوية للزيت). كما تشير النتائج إلى تقارب قيم تقديرات معاملي الاختلاف الظاهري والوراثي لمكوني محصول القش (الطول الكلي والطول الفعال) وكذلك مكوني محصول البذور (عدد الكبسولات/نبات ووزن الألف بذرة) مع درجة توريث عالية لتلك الصفات السابقة خلال الأجيال الثلاثة المدروسة. مما يدل على وجود تباين وراثي كاف لممارسة الانتخاب لتحسين الصفات سالفة الذكر.

أشارت النتائج أن خمس عائلات (عائلة رقم٤٦ ، ٢٧، ٤٣، ٤٤، ٢٠) تفوقت في محصولي القش والبذور للفدان ، وإن أربع عائلات منها (٤٦، ٤٣، ٤٤، ٢٠) تفوقت أيضا في الصفات التكنولوجية الخاصة بالألياف، ومن الجدير بالذكر ان العائلات الثلاثة رقم ٤٣، ٤٤، ٤٦ استنبطت من الهجين (س ١/٢٤١٩×س ١/٦/١٤٨) بينما العائلتين ٢٠، ٢٧ تنتمي للهجينين (جيزة ٧×س ١/٢٤١٩)، (جيزة ٨×س ١/٢٤١٩) علي الترتيب. لذلك هذه العائلات وخاصة العائلة رقم ٤٦ ممكن أن تصعد كأصناف ثنائية الغرض تحل محل الأصناف التجارية الثنائية سخا ١، وسخا ٢.

أشارت نتائج الارتباط الظاهري والوراثي أن وزن القش/نبات أظهر ارتباط موجب معنوي مع كل من الطول الكلي والطول الفعال . كذلك كان هناك ارتباط موجب ومعنوي بين وزن البذور للنبات وكل من عدد الكبسولات ووزن الألف بذرة والطول الكلي والطول الفعال. مما يدل علي إمكانية انتخاب تراكيب وراثية ثنائية الغرض تتميز بالمحصول العالي من البذور بالإضافة إلى تميزها في الطول الكلي والطول الفعال وهما أهم مكونين من مكونات محصول القش. كذلك كان هناك أيضا ارتباط موجب ومعنوي بين النسبة المئوية للألياف مع كل من محصول القش والنعومة مما يعطي إمكانية انتخاب تراكيب وراثية من بين هذه العائلات عالية في محصول الألياف والنعومة.