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Study of Some Flax Characters, Genetic Stability and their Relation to Yield

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ABSTRACT

The present study consisted of twelve genotypes of flax which were evaluated over twelve environments (2 seasons (2013/14 and 2014/15), 2 locations (Etay El-Baroud Exp. Sta., El-Beheira Governorate and Ismailia Exp.Station, Ismailia Governorate) and 3 plant density (1000,1250 and 1500 seeds/m^2)) These materials were evaluated in a split plot design with three replications at the twelve environments which-mentioned before. The mean square of environments (E) genotypes (G), and E x G interaction for all studied traits revealed highly significant differences, indicating a wide range of variation among genotypes, environments and these genotypes exhibited differential response to environmental conditions. The significant variance due to residual for all characters indicated that genotypes differed with respect to their stability suggesting that prediction would be difficult, which means that mean performance alone (mean yield) would not be appropriate. Interaction component of variance (σ^2ge) was less than the genotypic variance (σ^2g) for all characters except each of straw weight per plant, plant height and capsules number per plant. This was reflected in high value of heritability and low gap between GCV and PCV values for 1000 – seed weight, fiber percentage, oil percentage, seeds number per capsule, and technical length. These results indicating the possibility of using technical length as selection index for improving straw weight/plant and both of number of seeds per capsule and 1000- seed weight as selection indices for improving seed weight/plant. The criterion, yield stability (YSi) statistic indicated that only one genotype (S.541- D/4) exhibited superiority and stability for all straw characters, in addition to S.435-11/10/3 for each of straw yield/fad, technical length and plant height. Also, S.541- /6 gave high mean performance and stability (YSi) for seed yield/fad, oil yield/fad, 1000- seed weight and oil percentage. Therefore, the two strains (S.541-D/4 and S.435/11/10/3) may be recommended to be included in any breeding program for improving straw yield and its related traits and also, S.541-C/6 for improving seed yield and its related characters. Straw weight/plant was positive and significant correlated with each of technical length, plant height, and seed weight/plant. And also, plant height exhibited positive correlation with technical length. Whereas, seed weight per plant, exhibited positive correlation with both of capsules number/plant and 1000 - seed weight. Whereas, the correlation between oil percentage with both of 1000- seed weight and capsules number per plant was positive. These mean that the possibility of using both of technical length and plant height as selection indices for improving straw weight/plant and both of1000-seed weight and capsules number/plant and as selection indices for improving seeds weight/plant.

Keywords: Flax, variance and variance components, stability, correlation.

INTRODUCTION

Flax (*Linum usitatissimum* L.) is one of the old age and important bast fiber crop, which grown in Egypt for fiber (extracted from straw) and oil (extracted from seeds) as a main two products. This crop plays an important role in Egyptian national economy by its exportation from the excess quantity of fibers as well as the local fabrication from fiber and oil in different industries. The limitation of flax cultivated land area challenges investigators to produce more fiber and seed yield per unit area through improvement for both of high yielding ability of varieties and agricultural practices. Most of work in the plant breeding program is to developed to create new recommended stable varieties which surpass that old commercial cultivar.

In plant breeding, selection for qualitative traits can be successfully conducted in limited nursery test. Selection for complex traits, such as yield, which are strongly influenced by environment, should be based on tests conducted in several environments. Yield stability is of particular importance in developing countries, for which Egypt is a member, where control over diseases and insects are limited. This, together with differences in climate and soil type, result in considerable variation among environments. Cultivars need to be widely adapted to perform consistently over environments. many methods have been developed to analyze GE interaction. Merits and demerits of several methods were discussed by Kang and Miller (1984). These types of measures are useful to agronomists and breeders because they provide contribution of each genotype in a test to total GE interaction. They also can be used to evaluate testing locations by identifying those locations with similar GE interaction pattern (Glaz *et al*., 1985). Dashiell *et al*. (1994) evaluated the usefulness of several methods of stability statistics for simultaneously selecting for high yield and stability of performance in soybean. Fernandez (1991) also evaluated stability statistics for similar purposes. Kang and Magari (1995) developed method of stability "Stable a BASICA program for calculating stability and yield - stability statistics".

Successful linseed cultivars must perform reliably in yield and other agronomic characters over a wide range of environments. Genotypic differences in yield stability can be explained by the wide occurrence of genotype x environment interaction. Linseed cultivars differ in yielding ability (Gubbels and Kenaschuk, 1989), but results reporting yield stability of cultivars have not been available. many investigators found significant effect of seasons on straw yield, seed yield and their related traits. Cultivars differences among flax genotypes has been studied by many workers (Momtaz *et al*.,1990 and Zahana *et al*., 2003) they found that significant differences among flax genotypes in straw yield per plant, plant height, technical length, seed yield per plant and per faddan and capsules number. Badwal *et al*.,(1971) indicated that 1000- seed weight and capsules number were the most important components of seed yield and the best criteria for selecting high yielding flax lines. Kumar and Chauhan (1979) found that 1000-seed weight and seeds number per capsule may be considered simultaneous component characters for selection between flax varieties.

The mean goal of flax breeder in Egypt is to improve each of straw yield and seed yield in addition oil and fiber quality characters. Phenotypic, genotypic variance and heritability estimates for yield (seed, straw) and its components as well as the correlation between yield and other related characters are considered mean information for designing a successful breeding program to improve straw yield, seed yield and quality characters for 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 variance components 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 and (3) evaluate the yield potential of twelve flax genotypes via a new yield-stability (YSi) statistics using the data of flax trials conducted in Fiber Research Section, ARC, Egypt.

MATERIALS AND METHODS

Data utilized for this investigation pertain to the evaluation of twelve flax genotypes, chosen on the basis of their genetic diversity. The pedigree, origin and the classification of these genotypes are partially described in Table1.

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

No.	Genotypes	Pedigree	Origin	Type
1	Sakha 1	I. Bombay (USA) x I. 148/6/1(USA)	Local variety	D
2	Sakha 3	I.Belinka x I. 2569	Do	F
3	S. 541-C/8	Giza 8 x S.2419/1	Local line	D
4	S. 541-C/6	Do	Do	D
5	S. 5	I.20351 x I. 2681/1	Do	D
6	S. 8/2	I.1145 x I. 1150	Do	D
7	S. 541-C/3/2	Giza 8 x S.2419/1	Do	D
8	S. 541-D/4	S.2419/1 x I. 148/6/1(USA)	Do	D
9	S. 541-D/11	Do	Do	D
10	S. 402/3/3/7	Giza 5 x I 235	Do	D
11	S.435/11/10/3	I. 467/2 x S.162/12	Do	D
12	S.402/1	Giza 5 x I. 235	Do	O

These twelve genotypes were evaluated in two successive seasons (2013/14, 2014/2015) at two locations viz: Etay El-Baroud Exp. Sta., El-Beheira Governorate(clay, organic matter of 3.4 %, available nitrogen 40.16 ppm, E.C. 1.53 and pH = 7.940) and Ismailia Exp. Station, Ismailia Governorate(sandy soil, organic matter of 0.044 %, available nitrogen 6.51 ppm, E.C. 0.12 and pH value of 7.48). These genotypes were sowing under three plant density (1000, 1250 and 1500 seeds/m^2). The experimental design was split plot design with three replications per each of the twelve environments (combination of locations x years x seeding rate). Seeding rate was allocated to main plots and genotypes were allocated to sub-plot. Flax seeds of each genotype were sown during the first week of November for all trials in all seasons and locations. Each plot consisted of 10 rows, 3m long and 20cm wide (1/700 fad). Recommended agronomic practices were followed.

At harvest, ten randomly guarded plants from each plot were recorded to determine the averages of the individual plant traits. Straw yield, seed yield and fiber yield/fad was calculated on plot area basis. Oil percentage was determined as an average of three random seed samples per plot using Soxhlet apparatus (A.O.A.C. Society, 1995). The following traits were recorded:

I) Straw, fiber yields and their related traits: (1) Straw yield (ton) / fad (fad=0.42 ha), (2) long fiber yield (ton) / fad, (3) straw weight (g) / plant, (4) plant height (cm), (5) technical length (cm) and (6) fiber percentage .

II) Seed, oil yields and their related traits: (1) Seed yield (ton) / fed, (2) oil yield (ton) / fad, (3) seed weight (g) / plant , (4) capsules number/plant, (5) 1000-seed weight (g) and (6) oil percentage.

Statistical analysis:

Plot means were used for this statistical analysis. Data from each of twelve environments were analyzed. Bartlett' test of homogeneity was used before analysis of combined. The estimates of the variance components were calculated by using the expected mean squares as outlined by the procedures described by Johnson *et al*., (1959). Analysis of variance was conducted.

A yield–stability statistic (YS_i) developed for simultaneous selection for yield and stability was calculated according to Kang and Magari (1995).

RESULTS AND DISCUSSION

1- Variance and variance components:

Genotype, genotype x environment interaction mean squares and its partitioning into heterogeneity due to environmental index and residual from the combined analysis of variance over twelve environments (2 years, 2 locations, 3 plant density) for straw, seed yields and their related traits are shown in Table (2). Highly significant differences due to genotypes for all characters under study. This is expected because these materials consisted of different flax types which, as illustrated in Table (1), different in their origin, pedigree and consequently genetic background. this variability among genotypes in straw yield, seed yield and their components and was also reported by Abo-Kaied *et al*., (2015). Environments (E) differed highly significantly for all traits, indicating a wide range of variation among the environments studied. Highly significant differences were also observed for straw yield and seed yield as well as there components due to Genotype x environment interaction indicating that genotypes had considerable different responses to environmental influences. Whereas, heterogeneity (GxE linear) due to all characters studied was significant except for capsules number/plant, suggesting that linear components of GxE was present. This means that heterogeneity among genotypes for these traits relative to the environmental index was significant. Also, mean square due to residual for all characters was highly significant except for fiber yield/fad. The significant variance due to residual (pooled deviation) for all characters indicated that genotypes differed with respect to their stability suggesting that prediction would be difficult, which means that mean performance alone would not be appropriate. In such situation, methods that combine yield and stability of performance are useful (Bachireddy *et al*., 1992).

Table 2. Genotype x environment interaction mean squares and its partitioning into heterogeneity due to environmental index and residual from the combined analysis of variance over twelve environments for straw, seed yields and their related characters.

S.O.V. Characters	Genotypes(G) (11)#	Environment (E) (11)#	Interaction (GxE) (121)#	Heterogeneity (11)#	Residual (110)#	Pooled Error (264)#
Straw yield / fed (ton)	1.054 **	47.491 **	0.189 **	0.798 **	0.128 **	0.021
Fiber yield / fed (kg)	0.044**	1.728 **	0.007 **	0.038 **	0.004 ns	0.007
Straw weight / plant (g)	3.410 **	73.965 **	0.524 **	3.998 **	0.176 **	0.078
plant height (cm)	400.159 **	10979.640 **	33.000 **	92.416 **	27.058 **	0.002
Technical length(cm)	356.506 **	8829.699 **	31.540 **	162.093 **	18.485 **	9.612
Seed yield / fed (kg)	0.043 **	1.041 **	0.009 **	0.020 **	0.008 **	0.001
Oil yield / fed (kg)	0.0126 **	0.1586 **	0.0016 **	0.0034 **	0.0014 **	0.0002
Seed weight / plant (g)	0.602 **	5.686 **	0.076 **	0.355 **	0.048 **	0.011
Capsules number / plant	77.966 **	1633.175 **	16.578 **	71.084 ns	11.128 **	2.828
1000-seed weight (g)	51.578 **	1.788 **	0.187 **	0.581 **	0.147 **	0.041
No of seeds/capsule	4.688 **	21.357 **	0.371 **	0.560 **	0.352 **	0.060
Fiber percentage (%)	59.960 **	33.113 **	0.347 **	1.147 **	0.267 **	0.037
Oil percentage (%)	142.385 **	16.266 **	0.788 **	1.820 **	0.685 **	0.085

***,** = Indicate significant and highly significant, respectively.**

Estimates of mean squre among twelve flax genotypes grown at twelve environments for straw yield, seed weight / plant and their components as well as some technological characters (fiber percentage and oil percentage) are shown in Table 3. mean square of interaction between genotypes and environments (σ^2ge) were less than mean square of genotypic (σ^2g) for all traits except each of straw weight per plant, plant height and capsules number/plant, indicated that this genotypes differ in their genetic potential for these characters. Moreover, there was reflected in high heritability and low gap between PCV and GCV values for 1000 – seed weight (H 99.64%, PCV = 12.87%, GCV = 12.85%), fiber percentage (H = 99.42, PCV = 7.49%, GCV = 7.47%), oil percentage (H = 99.45, PCV = 4.94%, GCV =4.92%), no. of seeds/capsule (H = 92.08%, PCV = 4.79%, GCV =4.59%), and technical stem length (H = 91.15%, PCV = 4.93%, GCV = 4.71%). These results indicating the possibility of using technical length as selection index for improving straw weight / plant and both of seeds member/ capsule and 1000 - seed weight as selection indices for improving seed weight/plant. In contrast, Interaction component of variance (σ^2ge) was more than the genotypic variance (σ^2g) for each of straw weight/plant, plant height and capsules number/plant. This result clearly indicates that variation among flax genotypes in the three previous traits are mainly due to environmental variation plus the GE interaction ones. These results are in agreement with that reported by Abo El-Zahab *et al*., (1994), Mourad *et al*., (2003) and Abo-Kaied *et al*.,(2006).

Table 3. Variance component estimates from combined ANOVA, phenotypic (PCV) and genotypic (GCV) coefficients of variability and broad sense heritability (H) for the combined analysis of variance over six environments of straw weight, seed weight / plant and other related traits as well as some technological characters.

Characters	σ^2_g	σ^2_{ge}	σ^2_e	H%	PCV%	GCV%
Straw weight / plant (g)	0.08 **	0.15 **	0.08	84.64	11.13	10.24
plant height (cm)	10.20 **	11.00 **	0.00	91.75	3.93	3.77
Technical length(cm)	9.03 **	7.31 **	9.61	91.15	4.93	4.71
Seed weight / plant (g)	9.03 **	7.31 **	9.61	91.15	4.93	4.71
Capsules number / plant	1.7052 **	4.5836 **	2.8276	78.74	10.02	8.89
1000-seed weight (g)	1.43 **	0.05 **	0.04	99.64	12.87	12.85
No. of seeds/capsule	0.12 **	0.10 **	0.06	92.08	4.79	4.59
Fiber percentage (%)	1.66 **	0.10 **	0.04	99.42	7.49	7.47
Oil percentage (%)	3.93 **	0.23 **	0.08	99.45	4.94	4.92

**** = Indicate significant and highly significant, respectively.**

σ^2_g, σ^2_{ge}, σ^2_e are the variance attributed to , genotypes , genotype x environment interaction and plot error, respectively.

2- Mean performance and stability:

Straw yield and its related traits:

Mean yield, rank (assigned before stability analysis was made), yield stability statistic (YSi) and stable genotypes of straw, fiber yields as well as some related characters for twelve flax genotypes are shown in Table 4. The strain 541-D/4 gave the highest values (highest ranking) for straw yield/fad (2.204 ton) followed by S.402/3/3/7 (2.102 ton) and S.435/11/10/3 (2.088 ton). Also, the strain 541-D/4 gave the highest values for fiber yield/fad (0.420 ton) followed by S.541-C/6 (0.368 ton) and S.402/3/3/7 (0.363 ton). Concerning plant height and technical stem length, S.541-D/4 gave the first ranking fallowed by S.435/11/10/3 and Sakha1. On the other hand, S.541-D/11 gave the highest value for fiber percentage (18.70%) followed by S.541-C/6 (18.66 %) and S.541-D/4 (18.62 %). In general, S.541-D/4 exhibited the first ranking for each of straw yield per fad, fiber yield per fad, plant height and technical length. Also, S.435/11/10/3 gave the second or ranked third for each of straw yield/fad, plant height and technical stem length. Whereas, S.541-D/11 gave highest values for fiber percentage and while, S.541-D/4 gave the third rank.

Table 4. Mean yield, rank (assigned before stability analysis was made), yield stability statistic (YS_i) and stable genotypes of straw and fiber yields as well as some related characters for twelve flax genotypes.

Genotypes	Straw yield / fed (ton)			Fiber yield / fed (ton)			Plant height (cm)			Technical length (cm)			Fiber percentage (%)		
	Means	Rank	Ys_i	Means	Rank	Ys_i	Means	Rank	Ys_i	Means	Rank	Ys_i	Means	Rank	Ys_i
1-Sakha 1	1.929	6	-1	0.331	6	5+	87.91	10	5+	68.96	11	14+	16.67	5	-6
2-Sakha 3	1.710	2	-9	0.323	4	3+	82.37	4	-7	65.13	9	3+	18.48	9	4+
3-S. 541-C/8	1.611	1	-10	0.294	1	-1	78.27	1	-10	58.65	1	-10	18.09	8	3+
4-S. 541-C/6	1.937	7	0+	0.368	11	12+	82.23	3	-8	62.33	4	-6	18.65	11	6+
5-S. 5	2.003	9	3+	0.325	5	4+	84.51	6	-5	63.19	6	-3	15.82	3	-8
6-S. 8/2	1.884	4	-5	0.304	3	1+	85.39	7	2+	62.74	5	-4	15.72	2	-5
7-S. 541-C/3/2	1.940	8	9+	0.353	9	10+	82.77	5	-6	60.93	3	0	17.8	7	2+
8-S. 541-D/4	2.204	12	7+	0.420	12	7+	89.37	12	7+	68.97	12	7+	18.62	10	5+
9-S. 541-D/11	1.748	3	-8	0.334	7	6+	82.19	2	-9	60.48	2	-9	18.69	12	7+
10-S. 402/3/3/7	2.102	11	6+	0.363	10	11+	87.75	9	4+	64.65	7	0	16.73	6	-5
11-S.435/11/10/3	2.088	10	5+	0.345	8	9+	88.67	11	6+	65.54	10	8+	15.87	4	-7
12-S.402/1	1.887	5	-4	0.301	2	0	86.11	8	3+	64.65	7	0	15.53	1	-10
General mean	1.920		-0.58	0.338		5.58	84.79		-1.5	63.85		0	17.23		-1.17
$LSD_{0.05}$	0.236			0.136			0.068			5.012		1.20	0.311		

#= Genotype selected on the basis of YS_i

Concerning yield stability statistic (YSi) according to Kang and Magari, 1995 (high yielding and stability), out of twelve flax genotypes, six genotypes were stable according to each of straw yield/fad, fiber yield/fad plant height and fiber percentage. Whereas, only four genotypes exhibited high yielding and stability for technical stem length. However, only one genotype (S.541-D/4) exhibited superiority and stability for all characters of straw in addition S.435/11/10/3 for each of straw yield per fad, plant height and technical length. In general, the two flax lines (S.541-D/4 and S.435/11/10/3) maintained mean performance advantage across nearly all the environments sampled by maintaining high level of almost all yield components.

Seed yield and its related traits:

Mean yield, rank (assigned before stability analysis was made), yield stability statistic (YSi) and stable genotypes of seed, oil yields as well as some related characters for twelve flax genotypes are shown in Table 5. S.435/11/10/3 followed by S.541-C/6 and S.402/3/3/7 showed high mean performance (high ranking) for each of seed yield/fad (0.429, 0.422 and 0.415 ton), for oil yield/fad, S.541-C/6 followed by S.435/11/10/3 and S.451-C/3/2 gave high values (0.177, 0.172 and 0.171 ton), for capsules number/plant, S.8/2 followed by S.541-D/11 and S.402/3/3/7 (16.69, 16.04 and 15.98 ton), respectively. Also, S.541-C/3/2 followed by S.541-C/6 mean performance exhibited high ranking for both of 1000-seed weight (10.85 and 10.53 g) and oil percentage (42.50 and 42.02%). Therefore, the previous mentioned genotypes specially S.541-C/6 may be released as commercial varieties and/or to be incorporated as breeding stocks in any flax breeding program aiming to producing high yielding lines for seed yield and its related characters.

The measure of stability (Ysi) was deemed appropriate (Table 5). Out of twelve flax genotypes, seven lines were stable according to Kang and Magari, 1995 for each of oil yield/fad, oil percentage and five lines for capsules number/plant. Whereas, for both seed yield/fad and 1000 seed weight six genotypes exhibited high yielding and stability over various environments. In general, S.541-C/6 gave high mean performance and stability (YSi) for seed yield per fad, oil yield per fad, 1000- seed weight and oil percentage.

The previous collected data support the evidence that these two strains (S.541-D/4 and S.435/11/10/3) may be recommended to be included in any breeding program for improving straw yield and its related characters and also, improving seed yield and its related treats by using S.541/C/6.

Table 5. Mean yield, rank (assigned before stability analysis was made), yield stability statistic (YS_i) and stable genotypes of seed and oil yields / fed as well as some related characters for twelve flax genotypes ..

Genotypes	Seed yield / fed (ton)			Oil yield / fed (ton)			Capsules number/plant			1000-seed weight (g)			Oil percentage (%)		
	Means	Rank	Ys_i	Means	Rank	Ys_i	Means	Rank	Ys_i	Means	Rank	Ys_i	Means	Rank	Ys_i
1-Sakha 1	0.360	2	-9	0.146	4	-6	11.86	1	-10	10.14	10	5+	40.58	6	1+
2-Sakha 3	0.298	1	-10	0.110	1	-10	12.88	2	-9	6.44	1	-10	37.06	2	-9
3-S.541-C/8	0.382	4	-5	0.158	5	-2	13.64	4	-6	10.02	8	3+	41.69	9	4+
4-S. 541-C/6	0.422	11	6+	0.177	12	7+	14.53	5	-4	10.53	11	6+	42.02	11	6+
5-S.5	0.386	5	-4	0.145	3	1+	15.75	9	3+	8.99	5	-6	37.76	3	-8
6-S.8/2	0.374	3	-6	0.137	2	-9	16.69	12	7+	9.03	6	-5	36.77	1	-10
7-S.541-C/3/2	0.405	9	3+	0.171	10	5+	15.5	8	2+	10.85	12	15+	42.5	12	7+
8-S.541-D/4	0.389	7	0+	0.162	7	1+	13.33	3	-8	9.77	7	6+	41.76	10	9+
9-S. 541-D/11	0.387	6	-3	0.160	6	-1	16.04	11	6+	10.07	9	4+	41.59	8	3+
10-S.402/3/3/7	0.415	10	5+	0.167	9	4+	15.98	10	4+	8.6	3	-8	40.34	5	-2
11-S.435/11/10/3	0.429	12	7+	0.172	11	6+	14.94	6	-1	8.57	2	-1	40.31	4	-3
12-S. 402/1	0.402	8	2+	0.164	8	2+	15.13	7	0	8.64	4	-7	40.98	7	6+
General mean	0.387		-1.17	0.156		-1.67	14.69		-1.33	9.30		0.17	40.28		0.33
LSD $_{0.05}$	0.056			0.014			2.72			0.33			0.47		

#= Genotype selected on the basis of YS_i

3- Association studies:

Phenotypic correlation coefficients among straw, seeds weight/plant and their related characters in twelve flax genotypes on based data of twelve environments are presented in Table 6. Straw weight per plant was significant and positive correlated with each of plant height , technical length and seed weight per plant. Also, plant height exhibited positive correlation with technical length indicating that maximization of straw weight/plant may be obtained by selection for these two component variables. These results are in harmony with both of Abo El-Zahab *et al*., (1994) and Abo-kaied *et al*., (2006). On the other hand, straw weight/plant showed significant negative correlation with fiber percentage. Whereas, seed weight per plant, exhibited positive correlation with both of capsules number per plant and 1000 - seed weight. While, the correlation between oil percentage with both of 1000 - seed weight and seeds number/capsule was positive and highly significant. These result indicating that selection for a genotype which had high straw weight/plant and high seed weight/plant is possible (dual purpose type). These results are in harmony with those repotted by Kumar and Chauhan (1979), Abo El-Zahab *et al*. (1994) and Abo-kaied *et al*., (2006). Generally, indicate that using both of plant height and technical length as selection indices for improving straw weight per plant and both of capsules number per plant and 1000 - seed weight as selection indices for improving seeds weight/plant.

Table 6. Phenotypic correlation coefficients among straw, seed weight / plant and their components as well as some technological traits of twelve flax genotypes data of combined analisis.

characters	1	2	3	4	5	6	7	8
1- Straw weight / plant (g)								
2- plant height (cm)	0.887**							
3-Technical length(cm)	0.705*	0.850**						
4- Seed weight / plant (g)	0.595*	-0.166	-0.572					
5- Capsules number / plant	0.364	-0.043	-0.512	0.762**				
6- 1000-seed weight (g)	0.469	-0.043	-0.278	0.673*	0.065			
7- Seeds number / capsule	-0.384	-0.162	0.299	-0.674*	-0.266	-0.877**		
8- Fiber percentage (%)	-0.584*	0.075	-0.197	-0.167	-0.360	0.253	-0.336	
9- Oil percentage (%)	0.101	-0.467	-0.140	0.317	-0.141	0.725**	0.725**	0.437

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

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دراسة بعض صفات الكتان وثبات السلوك الوراثي وعلاقتهم بالمحصول

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أستخدم في هذه الدراسة 12 تركيباً وراثياً من الكتان تم تقييمها كذلك في 12 بيئة (موسمين (2013/ 2014، 2015/2014) , وموقعين (إيتاي البارود بمحافظة البحيرة والإسماعيلية بمحافظة الإسماعيلية) وثلاث كثافات (1000، 1250، 1500 بذرة/م2) . تم تقييم مواد البحث السابقة في الـ12 بيئة السابقة تحت تصميم القطع المنشقة مرة واحدة ذات الثلاث مكررات . تشير نتائج تحليل التباين أن كل من التراكيب الوراثية (G) والبيئات (E) والتفاعل بينهم (GxE) جميعها كانت معنوية في كل الصفات تحت الدراسة مما يدل علي مدي الاختلاف الواسع بين التراكيب الوراثية والبيئات ، كذلك المعنوية العالية للتباين الراجع للجزء المتبقي من التفاعل يشير الى صعوبة التنبؤ بثبات سلوكها الوراثي عند الاعتماد علي القيمة المحصوليه (متوسط المحصول) فقط . أشارت مكونات تقديرات التباين أن تباين التفاعل بين الأصناف والبيئات (σ^2ge) أقل من تباين الأصناف (σ^2g) لكل الصفات المدروسة فيما عدا وزن القش للنبات والطول الكلى ، وعدد الكبسولة للنبات. وهذا انعكس في تقديرات درجة التوريث العالية في المعنى الواسع والفارق المنخفض بين معاملي الاختلاف الظاهري والوراثي لصفات وزن الألف بذرة والنسبة المئوية للألياف والنسبة المئوية للزيت وعدد البذور بالكبسولة والطول الفعال. لذلك يمكن استخدام الطول الفعال كدليل إنتخابى لتحسين صفة محصول القش للنبات وكما يمكن استخدام كلا من عدد البذور بالكبسولة ووزن الألف بذرة كدلائل إنتخابية لتحسين محصول وزن البذور للنبات. كما أشار مقياس الثبات (YS_i) والذي يقيس ثبات السلوك الوراثي مع المحصول العالي إلى أن السلالة 541-د/4 ظلت محتفظة بتفوقها في المحصول وثبات السلوك لكل صفات محصول القش وكذلك ألسلاله 3/10/11/435 لمحصول القش للفدان والطول الكلى والطول الفعال . كذلك ألسلاله 541-جـ/6 كانت ثابتة لمحصول البذرة للفدان , محصول الزيت للفدان , وزن الألف بذرة , النسبة المئوية للزيت . لذلك هذان التركيبان (541- د/4, 3/10/11/435) يمكن إدخالهم في برنامج تربية يهدف لتحسين صفة محصول القش ومكوناته. وكذلك ألسلاله 541- جـ /6 لتحسين صفة محصول البذرة ومكوناتها. كما تشير نتائج الارتباط الظاهري إلي أن هناك ارتباط موجب ومعنوي بين وزن القش للنبات وكل من الطول الكلي والطول الفعال ووزن البذرة للنبات, و كان هناك ارتباط موجب ومعنوي بين الطول الكلي والطول الفعال. وأيضاً هناك ارتباط موجب ومعنوي بين وزن البذور للنبات وكل من عدد الكبسولات للنبات ، ووزن الألف بذرة ، كذلك كان هناك ارتباط موجب ومعنوي بين كل من النسبة المئوية للزيت وكلا من وزن الألف بذرة وعدد الكبسولات بالنبات وبالتالي يمكن استخدام كلاً من الطول الكلى والطول الفعال في الانتخاب لتحسين صفه وزن القش للنبات , كذلك كلاً من عدد الكبسولات للنبات ووزن الألف بذرة لتحسين صفة محصول البذرة للنبات .