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20EVALUATION OF YIELD AND ITS COMPONENTS FOR SIXTEEN FLAX GENOTYPES UNDER NORMAL AND SANDY SOIL CONDITIONS

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ABSTRACT

The present investigation was conducted using sixteen flax genotypes, thirteen local lines and three commercial varieties (Giza 8, Sakha 1 and Sakha 3) as check. These sixteen genotypes were evaluated in two successive seasons (2012/2013 and 2013/14) at two locations viz: Giza Exp. Station, Giza Governorate (normal soil) and Ismailia Exp. Station, Ismailia Governorate (sandy soil). The experimental design was randomized complete block with three replications per each of the four environments (combination of locations x years).

Mean squares due to genotypes (G) showed highly significant for all characters, indicating the presence of genetic variability among the tested genotypes for all traits under study. Mean squares due to locations (L) differed highly significantly for all traits except no. of seeds per capsule, indicating a wide range of variation between the two locations under study. Mean squares due to GL interaction were comparable in magnitude to those of GY for straw, long fiber yields per fad, plant height, technical stem length, seed yield per fad, oil yield per fad, 1000-seed weight and no. of capsules per plant, indicating that location had the major effect on the relative genotypic potential of these treats. This means that for reliable evaluation of the previous traits it would certainly be necessary to test genotypes in more than multi-location testing. Interaction components variances (σ^2gl, σ^2gy and σ^2gly) were less than the genotypic variance (σ^2g) for all characters. This means that genotypes differ in their genetic potential for these traits. This was reflected in high heritability in broad sense and low discrepancy between phenotypic and genotypic coefficients of variability specially for long fiber percentage, plant height, technical stem length, 1000-seed weight, no. of capsules per plant and oil percentage. These results indicating the possibility of using both of plant height and technical stem length as selection indices for improving straw weight per plant and using both of 1000-seed weight and no. of capsules per plant for improving seed weight per plant.

S.541-D/10 and S.541-C/3 proved maximum mean performance for straw, long fiber yields per fed, plant height and technical stem length as well as long fiber percentage when compared with the three check varieties, Giza 8, Sakha 1 and Sakha 3. Also, S.541-C/3 and S.541-D/10 exhibited high tolerance to sandy soil conditions for both straw yield per fed and fiber yield per fad. Therefore the two promising lines, S.541-C/3 and S.541-D/10 may be consider good substitutes for the low yielding ones, Giza 8, Sakha 1 and Sakha 3 in future as a new Egyptian flax cultivars for both straw and fiber yields. Also, S.541-C/3, S.541-D/10 and Sakha1 exhibited highest values for seed yield per fad, oil yield per fad, seed weight per plant and 1000-seed weight than other genotypes. It can be concluded that, S.541-D/10 gave high yielding ability for seed yield/fad, oil yield per fad, seed weight per plant and oil percentage with moderate tolerant to drought. Although, the promising flax line S.541-C/3 gave high mean performance for seed yield per fad, oil yield per fad, seed weight per plant and oil percentage but exhibited low tolerant to sandy soil conditions.

Key words: Flax, variability, Drought tolerance and susceptibility index.

INTRODUCTION

Flax (*Linum usitatissimum* L.) is use for many purposes, such as linen, and traditionally used for bed sheets, underclothes, table linen and its main use now is for finer fabric yarns (including blending with wool and synthetic materials).. The oil is known as linseed oil. Flax is grown for its oil, used as a nutritional supplement, and as an ingredient in many wood-finishing products. Flax is also grown as an ornamental plant in gardens. Flax fibers are taken from the stem of the plant and are two to three times as strong as those of cotton.

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 objective 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 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 environments 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, Zahana *et al.,*2003 and Abo-Kaied *et al*., 2006 and 2008) 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 faddan 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.

The ultimate goal of flax breeding program in Egypt is to improve straw and seed yields as well as fiber and oil quality traits. Phenotypic, genotypic variance and heritability estimates for yield and its attributes are considered basic information for designing a successful breeding program to improve straw, seed yields and quality characters both of fiber and oil. A stress susceptibility index (S) proposed by Fisher and Maurer (1978) can be used as indicator for measuring drought tolerance under stress conditions and could help for isolating improved tolerant genotypes (Winter *et al.*, 1988). Therefore, the present study aimed to 1) evaluation of 16 flax genotypes under both normal and sandy soil conditions (drought), 2) evaluate the influence of drought stress on yield and yield components of these genotypes and 3) identify the best flax genotypes which could be recommended for breeding drought tolerant or suitable to sandy soil conditions.

MATERIALS AND METHODS

The materials used for the present study consisted of sixteen flax genotypes, thirteen local lines and three commercial varieties (Giza 8, Sakha 1 and Sakha 3) as check. The pedigree and origin of the sixteen genotypes used are partially described in Table1.

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

No.	Genotypes	Pedigree	Origin	Type
1	Giza 8	Giza 5 x I. Santa Catalina 6	Local variety	O
2	Sakha 1	Bombay x I.1485	≈ ≈ ≈ ≈ ≈	D
3	Sakha 3	I. Belinka x I. 2569	≈ ≈ ≈ ≈ ≈	D
4	S.22	I. 370 x I. 2561	Local line	O
5	S.809/8/8	Giza 7 x Marleen	≈ ≈ ≈ ≈ ≈	F
6	S.620/3/5	Giza 7 x S.422	≈ ≈ ≈ ≈ ≈	F
7	S.541-C/3	S.2419/1 x Giza 8	≈ ≈ ≈ ≈ ≈	D
8	S.541-D/10	S.2419/1 x S.148/6/1	≈ ≈ ≈ ≈ ≈	D
9	S.808/67/1	I. Belinka x S.2467	≈ ≈ ≈ ≈ ≈	F
10	S.808/8/5	I. Belinka x S.2467	≈ ≈ ≈ ≈ ≈	F
11	S.806/23/3	S.485/93/10/6 x S.533	≈ ≈ ≈ ≈ ≈	F
12	S.806/5/8	S.485/93/10/6 x S.533	≈ ≈ ≈ ≈ ≈	F
13	S.887/18	Romania 14 x I.Istru	≈ ≈ ≈ ≈ ≈	F
14	S.888/22	Romania 20 x I.Daniel	≈ ≈ ≈ ≈ ≈	F
15	S.888/14	Romania 20 x I.Daniel	≈ ≈ ≈ ≈ ≈	F
16	S.777/10/5	Bombay x S.2465	≈ ≈ ≈ ≈ ≈	F

These sixteen genotypes were evaluated in two successive seasons (2012/2013 and 2013/14) at two locations viz: Giza Exp.Station, Giza Governorate (clay, organic matter of 1.87%, available nitrogen 29.87 ppm, E.C. 1.87 and pH = 7.87) and Ismailia Exp. Station, Ismailia Governorate (sandy soil, organic matter of 0.055 %, available nitrogen 6.77 ppm, E.C. 0.14 and pH value of 7.62). The experimental design was randomized complete block with three replications per each of the four environments (combination of locations x years). Flax seeds of each genotype were sown during the second week of November for all trials in all seasons. Plot consisted of 10 rows, 3 m long and 2 m wide (1/700 fed). Plant density of 2000 seeds/m^2 was used. Recommended agronomic practices were followed.

At harvest, data on ten randomly guarded plants from each plot 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.A.C. Society, 1995). The following characters were recorded:
I) Straw yield, fiber yield and their related characters: (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 stem length (cm) and (6) long fiber percentage.

II) Seed yield, oil yield and their related characters: (1) Seed yield (ton)/fad, (2) oil yield (ton)/fad, (3) seed weight (g)/plant, (4) 1000-seed weight in gram, (5) No. of capsules/plant, (6) No. of seeds/capsule and (7) oil percentage.

Statistical analysis:

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

Susceptibility analysis:

A stress - susceptibility analysis index (S) was used to characterize each genotype in the stress environments and the index was calculated using genotype means and a generalized formula (Fisher and Maurer 1978) in which

S = (1-YS / YN) / D, where YS = mean yield with stress environment, YN = mean yield with normal environment, and D = environment stress intensity = 1- (mean YS of all genotypes / mean YN of all genotypes).

The "S" was used to characterize the relative drought stress tolerance of the various genotypes, where S<0.50 is indicated highly stress tolerant genotypes, S>0.50<1.00 designated moderately stress tolerant and S>1.00 referred to susceptible genotypes.

RESULTS AND DISCUSSION

1- Variability:-

Straw yield and its related characters:

The combined ANOVA for straw, fiber yields and their related characters of 16 flax genotypes evaluated at 4 environments (2 years and 2 locations) is presented in Table 2. The analysis of variance showed that genotypes (G) displayed highly significant differences for straw yield/fed, fiber yield/fed, straw weight (g)/plant and its components viz.:, plant height (cm) and technical stem length (cm) as well as long fiber percentage due to 13 promising flax lines as well as the three check varieties (Giza 8, Sakha 1 and Sakha 3) for combined analysis over 4 environments, this result indicated that genotypes (G) differed in their genetic potential for the previous characters. Such variability among different flax genotypes in straw yield and its components was also reported by Abo El-Zahab *et al*., (1994) and Abo-Kaied *et al*., (2006 and 2008). Splitting the environmental effects into the main sources, years (Y) and locations (L) revealed that years, locations and their first order interaction (GL,GY) had highly significant effect for all traits except long fiber percentage was non-significant, indicating a wide range of variation among the environments studied. This result indicated that genotypes had considerable different responses to environmental conditions. Mean squares due to GL interaction were comparable in magnitude to those of GY for long fiber percentage and straw weight/plant and of higher magnitude for straw yield/fad, fiber yield/fad, plant height and technical stem length, indicating that location had the major effect on the relative genotypic potential of each straw yield/fad, fiber yield, plant height and technical stem length. This means that for reliable evaluation of straw yield and fiber yield it would certainly be necessary to test genotypes in more than multi-location testing. The second order interaction (GLY) was highly significant only for straw weight/plant and its two important components, plant height and technical stem length.

Estimates of variance components among sixteen flax genotypes grown at four environments for straw weight/plant and its important components (plant height and technical stem length) as well as long fiber percentage are shown in Table 4. Interaction components variances (σ^2gl, σ^2gy and σ^2gly) were less than the genotypic variance (σ^2g) for all characters. This means that genotypes differ in their genetic potential for these traits. This was reflected in high heritability in broad sense and low discrepancy between phenotypic (PCV) and genotypic (GCV) coefficients of variability specially for long fiber percentage (h^2 = 98.28%, PCV = 6.37%, GCV = 6.31%), plant height (h^2=90.99%, PCV = 11.74%, GCV = 11.19%) and followed by technical stem length (h^2 = 81.47, PCV = 10.72%, GCV = 9.68%). These results indicating the possibility of using both of plant height and technical stem length as selection indices for improving straw weight/plant. These results are in harmony with that reported by Abo El-Zahab *et al*., (1994) and Abo-Kaied *et al.,(*2006).

Table 2. Combined ANOVA for straw yield and its components of 16 flax genotypes based on data of four environments (two years and two locations).

S.O.V.	Straw yield/fad. (ton)	Fiber yield/fad. (ton)	Long fiber percentage (%)	Straw weight /plant (g)	Plant height (cm)	Technical stem length (cm)
Location (L)	42.299 **	0.831 **	27.946 **	95.358 **	27957.5 **	20858.13 **
Year (Y)	4.403 **	0.265 **	37.887 **	112.47 **	6280.788 **	3650.105 **
Y*L	0.13 ns	0.008 *	0.169 ns	14.78 **	39.567 ns	17.904 ns
Rep/Y*L.	0.062	0.001	0.445	0.262	57.89075	117.099
Genotype (G)	6.354 **	0.16 **	13.158 **	6.203 **	1209.574 **	646.845 **
G*L	0.385 **	0.012 **	0.081 **	0.809 **	138.311 **	142.542 **
G*Y	0.057 **	0.003 **	0.548 ns	0.936 **	54.29213 **	93.79 **
G*L*Y	0.002	0.0001ns	0.05 ns	0.429 *	134.4133 **	123.235 **
Error	0.015	0.001	0.073	0.116	18.615	13.882

ns,*, Indicate non-significant, significant and highly significant, respectively**

Seed yield and its related traits:-

The analysis of variance for seed yield/fad, oil yield/fad, oil percentage, seed yield/plant and other related traits over four environments of 16 flax genotypes are presented in Table 3. Mean squares due to genotypes (G) showed highly significant for all characters, indicating the presence of genetic variability among the tested genotypes for these characters. Mean squares due to locations (L) differed highly significantly for all traits except no. of seeds/capsule, indicating a wide range of variation between the two locations under study. Mean squares of years (Y) exhibited highly significant for each of seed yield/fad, oil yield/fad, oil percentage and seed weight/plant. Also, GL interaction was significant for all characters with exception no. of seeds/capsule. This result indicated that genotypes had considerable different responses to differential locations. On the other hand, GY interaction was non-significant for all characters except seed weight/plant which showed highly significant. This reveals the necessity of increasing the test locations but not the seasons in conducting flax traits in Egypt. These findings are in line with those of Shehata and Comstock (1971) and Abo El-Zahab *et al*., (1994) who found significant effects for locations and years on both seed yield and oil content in flax. The second order interaction (GLY) had highly significant fore each of oil percentage, seed weight/plant, no. of capsules/plant and no. of seeds/capsule.

Table 3. Combined ANOVA for seed yield and its components of 16 flax genotypes based on data of four environments (two years and two locations).

S.O.V.	Seed yield /fad (ton)	Oil yield /fad (ton)	Oil percentage (%)	Seed weight /plant (g)	1000-seed weight (g)	No. of capsules /plant	No. of seeds /capsule
Location (L)	0.565 **	0.0770 **	11.016 **	3.347 **	11.628 **	794.098 **	0.334 ns
Year (Y)	0.126 **	0.0330 **	70.458 **	0.064 **	0.294 ns	5.940 ns	0.008 ns
Y*L	0.007 ns	0.0010 **	4.622 **	0.163 **	0.695 **	23.681 **	0.657 **
Rep/Y*L.	0.001	0.0004	4.764	0.005	0.093	1.117	0.263
Genotype (G)	0.321 **	0.0680 **	49.685 **	0.199 **	20.053 **	209.646 **	1.096 **
G*L	0.008 *	0.0012 **	0.635**	0.028 **	0.408 *	18.994 **	0.656 ns
G*Y	0.001 ns	0.0001 ns	0.288 ns	0.119 **	0.175 ns	2.029 ns	0.632 ns
G*L*Y	0.0001 ns	0.0001 ns	0.309 **	0.014 **	0.066 ns	7.962 **	1.187 **
Error	0.002	0.0004	0.194	0.005	0.094	1.686	0.235

ns,*, Indicate non-significant, significant and highly significant, respectively.**

Table (5) shows estimates of variance components among 16 flax genotypes for seed weight/plant and its components as well as oil percentage. Genotype x environment interaction (σ^2gl, σ^2gy and σ^2gly) was less than the genotypic variance (σ^2g) for, 1000-seed weight, no. of capsules/plant and oil percentage indicating that genotypic differences over shadow GE interaction effects. Also, this reflected in the values of observed narrow range between phenotypic (PCV) and genotypic (GCV) coefficients of variability, which gave almost similar values of PCV (16.69%) and GCV (16.60%) in 1000-seed weight was mainly due to genetic differences as evidenced from the high heritability estimate (98.92%). Also, no. of capsules/plant and oil percentage showed similar results, indicating possibility of using these three yield traits in selection criteria with giving more weight for 1000-seed weight and no. of capsules/plant for improving seed weight/plant. On the other hand, the values of variance components of no. of seeds/capsule, especially low values of PCV (4.02%) and GCV (2.00%) as well as narrow range between them and low degree of heritability (24.73%)

indicated that this trait has no significant role in improving seed weight/plant and selection for this trait well be misleading. These results are harmony with that reported by Badwal *et al.*, (1971) and Abo-Kaied *et al*., (2008) who reported that capsules number and 1000-seed weight are the major factors which directly contribute to seed weight/plant.

Table 4. Variance component estimates, phenotypic (PCV) and genotypic (GCV) coefficients of variability and broad sense heritability (h^2) for straw yield and its components of 16 flax genotypes based on data of four environments (two years and two locations).

S.O.V.	Straw weight /plant (g)	Plant height (cm)	Technical stem length (cm)	Long fiber percentage (%)
σ^2_g	0.457 **	91.714 **	43.916 **	1.078 **
σ^2_{gL}	0.063 **	0.650 **	3.218 **	0.005 **
σ^2_{gY}	0.085 *	–13.354 **	–4.908 **	0.083 ns
σ^2_{gLy}	0.104	38.599 **	36.451 **	–0.008 ns
σ^2_e	0.116	18.615	13.882	0.073
$h^2_{(broadS)}$=	88.22	90.99	81.47	98.28
PCV=	27.20	11.74	10.72	6.37
GCV=	25.56	11.19	9.68	6.31

ns,*, Indicate non-significant, significant and highly significant, respectively.**
Negative estimate for which most reasonable value is zero.

Table 5. Variance component estimates, phenotypic (PCV) and genotypic (GCV) coefficients of variability and broad sense heritability (h^2) for seed yield and its components of 16 flax genotypes based on data of 4 environments (two years and two locations).

S.O.V.	Seed weight/plant (g)	1000-seed weight (g)	No. of capsules /plant	No. of seeds /capsule	Oil percentage (%)
σ^2_g	0.012 **	1.653 **	16.665 **	0.023 **	4.106 **
σ^2_{gL}	0.018 **	0.018 *	1.839 **	–0.089 ns	0.054 **
σ^2_{gY}	0.002 **	0.057 ns	–0.989 ns	–0.093 ns	–0.004 ns
σ^2_{gLy}	0.003 **	–0.009 ns	2.092 **	0.317 **	0.0383 **
σ^2_e	0.005	0.094	1.686	0.235	0.194
$h^2_{(broadS)}$=	73.03	98.92	95.39	24.73	99.17
PCV=	22.43	16.69	10.66	4.02	5.19
GCV=	19.17	16.60	10.41	2.00	5.17

For explanation see Table 4.

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2- Genotypic mean performance and stress-susceptibility index (S).
Straw yield and its related characters.

Mean performance and susceptibility index (S) for straw, long fiber yields/fed and their related traits as well as long fiber percentage for sixteen flax genotypes is shown in Table 6. S.541-D/10 followed by S.541-C/3 and Sakha 1 show high mean performance for both of straw yield/fed and plant height for almost individual environments and combined. Also, S.541-D/10, S.541-C/3 and S.806/23/3 exhibited high mean performance for both of fiber yield/fad and straw weight/plant in addition S.541-D/10, S.541-C/3 and S.808/8/5 for technical stem length. And finally S.541-D/10, Sakha 3 and S.808/8/5 gave high mean performance for fiber percentage for almost individual environments and combined.

In general, results indicated that, S.541-D/10 and S.541-C/3 proved maximum mean performance for straw, long fiber yields/fed, plant height and technical stem length as well as long fiber percentage when compared with the other lines as well as the three check varieties, Giza 8 (oil type), Sakha 1 (dual purpose type) and Sakha 3 (fiber type). Therefore, the previous mentioned two lines may be released as commercial cultivars and/or to be incorporated as breeding stocks in flax breeding program aiming at producing high straw and fiber yields lines.

A stress susceptibility index (S) proposed by Fisher and Maurer (1978) can be used as indicator for measuring drought tolerance under stress conditions could help for isolating improved tolerant genotypes (Winter *et al.*, 1988). Drought reduces the ability of plants to take up elements, and this quickly causes reductions in growth rate, along with a number of metabolic changes identical to those caused by water stress. (Munns, 2002).

Table (6) shows mean performance of sixteen flax genotypes for straw yield/fad, oil yield/fad, straw weight/plant and its components as well as fiber percentage under normal (E_1) and drought (E_2) environments as well as their combined data and the susceptibility index (S). For both of straw yield/fad and fiber yield/fad, out of sixteen flax genotypes, two promising flax lines (S.541-D/10 and S.541-C/3) were identified as high yield potential with high tolerance to drought (sandy soil conditions). Moreover, the other flax lines exhibited moderate tolerance or high susceptibility to sandy soil conditions for other characters. S.620/3/5 showed moderate tolerant for straw weight and its components (plant height and technical stem length) as well as fiber percentage. S.541-C/3 was moderate tolerance for both plant height and technical stem length. S.806/23/3 exhibited moderate tolerance for all traits under study except straw weight/plant. Also, S.888/22 showed moderate tolerant for all characters except plant height. S.777/10/5 exhibited moderate tolerance for all traits except fiber percentage. Also, noted that mean performance of normal environment (E_1) always greater than in E_2 in all traits except with fiber percentage, may be due to the xylem weight was lower under sandy soil conditions.

In general, S.541-C/3 and S.541-D/10 gave high mean performance for most characters under study as well as exhibited high tolerance to sandy soil conditions for both straw yield/fed and fiber yield/fad.

The previous collected data support the evidence that, the two promising lines, S.541-C/3 and S.541-D/10 may be consider good (high yielding and tolerant) substitutes for the low yielding ones, Giza 8, Sakha 1 and Sakha 3 in future as a new Egyptian flax cultivars for both straw and fiber yields.

Seed yield and its related traits:-

Mean performance for seed yield/fed, oil yield/fed, oil percentage, seed weight/plant and its two important components (no. of capsules/plant and 1000-seed weight) of sixteen flax genotypes under normal (E_1) and drought (E_2) environments as well as their combined (C) data and the susceptibility index (S) are presented in Table 7. Out of 16 genotypes, S.541-C/3, S.541-D/10 and Sakha1 exhibited highest values for seed yield/fad, oil yield/fad, seed weight/plant and 1000-seed weight than other genotypes. For no. of capsules/plant, three lines, S.22, S3809/88 and S.620/3/5 gave high mean performance than other genotypes. Also, S541-C/3, S.22 and S541-D/10 exhibited high mean performance for oil percentage.

Table (7) shows mean performance of sixteen genotypes for seed yield, oil yield, seed weight and its components as well as oil percentage under normal (E_1) and drought (E_2) environments in addition combined data and the susceptibility index (S). Out of 16 genotypes, one genotype (Giza 8) for seed yield/fad, two genotypes (Giza 8 and S.888/14) for oil yield/fad, four genotypes (Giza 8, Sakha 1, Sakha 3 and S.22) for oil percentage, five genotypes (Sakha 3, S.620/3/5, S.541-D/10, S.888/22 and S.888/14) for 1000-seed weight and two genotypes (Sakha 1 and S.808/67/1) for no. of capsules/plant exhibited high tolerance to drought (sandy soil conditions) than other genotypes. Moreover, the other flax genotypes exhibited moderate tolerance or high susceptibility to sandy soil conditions for these characters.

It can be concluded that, S.541-C/3 gave high yielding ability for seed yield/fad, oil yield/fad, seed weight/plant and oil percentage with moderate tolerant to sandy soil conditions (drought). Although, the promising flax line S.541-D/10 gave high mean performance for the previous traits but exhibited high susceptibility to sandy soil conditions.

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تقييم المحصول ومكوناته لستة عشر تركيباً وراثياً من الكتان تحت ظروف الأراضي العادية والرملية

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أجريت هذه الدراسة لتقييم ستة عشر تركيبًا وراثيًا من الكتان (13 سلالة مبشرة بالإضافة إلي ثلاثة أصناف تجارية هي جيزة 8، سخا 1، سخا 3 كأصناف قياسية)، تم تقييم تلك التراكيب خلال موسمين متتاليين (2012 / 2013 – 2013 / 2014) بموقعين الأول بمحطة البحوث الزراعية بالجيزة تمثل الأراضي العادية والموقع الثاني بمحطة البحوث الزراعية بالإسماعيلية تمثل الأراضي الرملية، وكان التصميم المستخدم قطاعات كاملة العشوائية ذات الثلاث مكررات وذلك للأربع بيئات (سنتين x موقعين)، وكانت أهم النتائج للتحليل التجميعي ما يلي:

أظهرت جميع التراكيب الوراثية اختلافات عالية المعنوية لكل الصفات تحت الدراسة. مما يدل علي وجود تباين واسع بين هذه التراكيب لكل الصفات تحت الدراسة. كذلك كان تأثير المواقع معنوي لكل الصفات ما عدي صفة عدد البذور بالكبسولة مما يدل علي التباين الواسع بين الموقعين تحت الدراسة، كذلك تباين التفاعل بين هذه التركيب والمواقع (G×L) كان أعلي من تباين تفاعل هذه التركيب والسنوات(G×Y) لصفات محصول القش للفدان و محصول الألياف الطويلة للفدان والطول الكلي و الطول الفعال ومحصول البذور للفدان ومحصول الزيت للفدان ووزن الألف بذرة وعدد الكبسولات للنبات، مما يدل علي أن التأثير الأكبر علي تلك الصفات كان للمواقع وهذا يعني انه يجب زيادة عدد المواقع عن مواسم التقييم لتلك الصفات.

كما تشير نتائج مكونات التباين إلي أن التباين الوراثي كان أكبر من تباينات التفاعل للتراكيب الوراثية مع كل من المواقع والسنوات لكل الصفات تحت الدراسة، وهذا أنعكس علي درجة التوريث في المعني الواسع والتي أظهرت قيماً عالية مع تقارب لتقديرات معاملي التباين الظاهري (PCV) والوراثي (GCV) لصفات النسبة المئوية للألياف الطويلة والطول الكلي والطول الفعال ووزن الألف بذرة وعدد الكبسولات للنبات والنسبة المئوية للزيت مما يشير إلى إمكانية استخدام هذين المكونين (الطول الكلي و الطول الفعال) كمعاملي انتخاب لتحسين محصول القش، وأيضاً إلى إمكانية استخدام مكوني عدد الكبسولات للنبات ووزن الألف بذرة في الانتخاب لتحسين صفة محصول البذور للنبات.

أشارت النتائج إلي تفوق السلالتين 541-جـ/3، 541-د/10 في محصولي القش والألياف الطويلة للفدان والطول الكلي والطول الفعال والنسبة المئوية للألياف الطويلة مقارنةً بالأصناف التجارية القياسية جيزة 8، وسخا1، وسخا 3، كذلك أظهرتا هاتين السلالتين تحمل عالي لظروف الأراضي الرملية لصفتي محصولي القش والألياف الطويلة للفدان لذلك هاتين السلالتين (541-جـ/3، 541-د/10) يجب تصعيدهما كأصناف تجارية تحل في المستقبل محل الأصناف التجارية المصرية جيزة 8، وسخا1، وسخا 3، كذلك هاتين السلالتين مع الصنف التجاري سخا1 أعطت أعلي محصول من البذور والزيت للفدان ووزن الألف بذرة ووزن البذور للنبات، كذلك السلالة 541-د/10 أعطت أعلي محصول من البذور والزيت للفدان ووزن البذور للنبات وكذلك أعلي نسبة مئوية للزيت وأظهرت تحمل متوسط لظروف الأراضي الرملية. بالرغم أن السلالة 541-جـ/3 أظهرت تفوق في صفات محصول البذور والزيت للفدان ووزن البذور للنبات والنسبة المئوية للزيت إلا إنها أظهرت حساسية عالية لظروف الأراضي الرملية.

Table 6: Mean performance for straw yield and its related characters recorded under normal (E_1) and sandy (E_2) soil conditions as well as their combined (C) data and the susceptibility index (S)

Genotype	E_1	E_2	C	S	E_1	E_2	C	S	E_1	E_2	C	S
	Straw yield/fad (ton)				Fiber yield/fad (ton)				Fiber percentage (%)			
1-Giza 8	3.134	1.932	2.533	1.35	0.442	0.293	0.368	1.37	14.10	15.13	14.61	1.54
2-Sakha 1	3.819	2.419	3.119	1.29	0.596	0.392	0.494	1.39	15.61	16.19	15.90	0.79
3-Sakha 3	3.112	2.002	2.557	1.26	0.530	0.362	0.446	1.29	17.02	18.06	17.54	1.28
4-S.22	3.444	2.174	2.809	1.30	0.567	0.370	0.469	1.41	16.47	17.04	16.75	0.73
5-S.809/8/8	3.446	2.224	2.835	1.25	0.560	0.378	0.469	1.32	16.20	16.96	16.58	0.99
6-S.620/3/5	3.721	2.423	3.072	1.23	0.592	0.402	0.497	1.31	15.92	16.58	16.25	0.87
7-S.541-C/3	4.365	3.783	4.074	0.47	0.700	0.643	0.672	0.33	16.03	16.99	16.51	1.26
8-S.541-D/10	4.787	4.738	4.763	0.04	0.884	0.920	0.902	-0.17	18.46	19.41	18.93	1.09
9-S.808/67/1	2.493	1.316	1.905	1.66	0.398	0.220	0.309	1.82	15.95	16.74	16.34	1.04
10-S.808/8/5	3.183	2.187	2.685	1.10	0.547	0.388	0.468	1.18	17.13	17.67	17.40	0.67
11-S.806/23/3	3.285	2.487	2.886	0.86	0.561	0.442	0.502	0.86	17.01	17.70	17.35	0.85
12-S.806/5/8	3.184	2.285	2.735	0.99	0.488	0.364	0.426	1.03	15.24	15.89	15.57	0.91
13-S.887/18	2.507	1.734	2.121	1.09	0.388	0.281	0.335	1.12	15.42	16.14	15.78	0.97
14-S.888/22	2.880	2.173	2.527	0.86	0.449	0.354	0.402	0.86	15.56	16.24	15.90	0.91
15-S.888/14	3.392	2.344	2.868	1.09	0.553	0.398	0.476	1.14	16.25	16.92	16.58	0.87
16-S.777/10/5	2.142	1.654	1.898	0.80	0.314	0.257	0.286	0.74	14.59	15.50	15.04	1.31
Mean	3.31	2.367	2.837		0.536	0.404	0.470		16.06	16.82	16.44	
$LSD_{0.05}$	0.247	0.135	0.189		0.033	0.023	0.031		0.12	0.11	0.12	

Table 6. Continued.

Genotype	E_1	E_2	C	S	E_1	E_2	C	S	E_1	E_2	C	S
	Straw weight/plant (g)				Plant height/plant (cm)				Technical stem length/plant (cm)			
1-Giza 8	2.87	1.88	2.38	0.82	96.33	69.92	83.13	1.11	77.80	58.39	68.10	0.93
2-Sakha 1	3.31	2.02	2.66	0.93	100.67	79.92	90.29	0.83	80.21	56.71	68.46	1.09
3-Sakha 3	3.30	2.04	2.67	0.91	98.27	76.68	87.48	0.89	77.40	55.88	66.64	1.04
4-S.22	2.85	1.75	2.30	0.92	87.18	62.38	74.78	1.15	74.95	45.46	60.21	1.47
5-S.809/8/8	3.08	1.54	2.31	1.19	80.24	66.98	73.61	0.67	61.06	52.05	56.56	0.55
6-S.620/3/5	2.87	1.87	2.37	0.83	94.18	74.18	84.18	0.86	73.80	58.88	66.34	0.76
7-S.541-C/3	5.27	2.90	4.09	1.07	117.35	88.92	103.13	0.98	90.00	68.64	79.32	0.89
8-S.541-D/10	5.61	3.14	4.38	1.05	127.66	94.17	110.91	1.06	97.12	72.59	84.86	0.94
9-S.808/67/1	2.34	1.49	1.92	0.86	83.02	65.45	74.23	0.86	66.64	49.26	57.95	0.98
10-S.808/8/5	3.68	2.26	2.97	0.92	106.37	72.07	89.22	1.30	87.81	55.84	71.82	1.36
11-S.806/23/3	4.35	2.23	3.29	1.16	88.03	70.42	79.22	0.81	66.47	56.43	61.45	0.56
12-S.806/5/8	2.56	1.29	1.93	1.18	93.73	60.13	76.93	1.45	76.25	47.66	61.95	1.40
13-S.887/18	2.43	1.56	2.00	0.85	100.07	74.22	87.14	1.05	81.11	59.81	70.46	0.98
14-S.888/22	2.80	1.63	2.22	0.99	94.41	71.18	82.80	1.00	79.09	59.12	69.10	0.94
15-S.888/14	3.47	1.66	2.57	1.24	102.15	71.17	86.66	1.23	83.28	55.09	69.19	1.27
16-S.777/10/5	2.78	1.76	2.27	0.88	92.44	78.17	85.30	0.62	73.68	61.30	67.49	0.63
Mean	3.35	1.94	2.64		97.63	73.50	85.56		77.92	57.07	67.49	
$LSD_{0.05}$	0.36	0.20	0.28		4.55	2.49	3.49		3.93	2.15	3.01	

Table 7: Mean performance for seed yield and its related characters recorded under normal (E_1) and sandy (E_2) soil conditions as well as their combined (C) data and the susceptibility index (S).

Genotype	E_1	E_2	C	S	E_1	E_2	C	S	E_1	E_2	C	S
	Seed yield/fad (ton)				Oil yield/fad (ton)				Oil percentage (%)			
1-Giza 8	0.552	0.509	0.531	0.42	0.227	0.209	0.218	0.45	41.03	41.01	41.02	-0.04
2-Sakha 1	0.678	0.595	0.637	0.66	0.281	0.247	0.264	0.69	41.38	41.45	41.42	0.14
3-Sakha 3	0.515	0.458	0.487	0.60	0.202	0.180	0.191	0.62	39.30	39.27	39.28	-0.06
4-S.22	0.538	0.461	0.500	0.77	0.225	0.194	0.210	0.79	41.85	41.93	41.89	0.15
5-S.809/8/8	0.670	0.584	0.627	0.69	0.260	0.231	0.246	0.64	38.85	39.63	39.24	1.63
6-S.620/3/5	0.430	0.371	0.401	0.74	0.170	0.149	0.160	0.71	39.46	40.25	39.86	1.63
7-S.541-C/3	1.080	0.849	0.965	1.15	0.461	0.369	0.415	1.14	42.71	43.46	43.08	1.42
8-S.541-D/10	0.904	0.750	0.827	0.92	0.370	0.314	0.342	0.87	40.92	41.84	41.38	1.84
9-S.808/67/1	0.486	0.365	0.426	1.34	0.187	0.141	0.164	1.41	38.33	38.70	38.51	0.79
10-S.808/8/5	0.538	0.404	0.471	1.34	0.199	0.151	0.175	1.38	36.92	37.37	37.14	0.99
11-S.806/23/3	0.560	0.439	0.500	1.16	0.203	0.160	0.182	1.21	36.19	36.54	36.36	0.79
12-S.806/5/8	0.513	0.364	0.439	1.56	0.194	0.140	0.167	1.59	37.82	38.48	38.15	1.42
13-S.887/18	0.566	0.396	0.481	1.61	0.210	0.149	0.180	1.66	37.02	37.66	37.34	1.42
14-S.888/22	0.407	0.367	0.387	0.53	0.154	0.141	0.148	0.48	37.72	38.37	38.05	1.42
15-S.888/14	0.431	0.338	0.385	1.16	0.157	0.125	0.141	1.17	36.25	36.89	36.57	1.42
16-S.777/10/5	0.465	0.347	0.406	1.36	0.177	0.134	0.156	1.39	38.02	38.58	38.30	1.21
Mean	0.583	0.475	0.529		0.23	0.19	0.210		38.98	39.46	39.22	
$LSD_{0.05}$	0.759	0.028	0.389		0.020	0.011	0.015		0.57	0.31	0.44	

Table 7. Continued

Genotype	E_1	E_2	C	S	E_1	E_2	C	S	E_1	E_2	C	S
	Seed weight/plant (g)				1000 seed weight (g)				No. of capsules/plant			
1-Giza 8	0.64	0.50	0.57	0.59	9.23	8.32	8.77	1.60	9.67	7.51	8.59	0.65
2-Sakha 1	0.76	0.58	0.67	0.65	9.21	8.63	8.92	1.03	10.72	9.52	10.12	0.33
3-Sakha 3	0.71	0.38	0.54	1.25	6.19	6.14	6.17	0.13	13.67	8.48	11.07	1.11
4-S.22	0.72	0.39	0.55	1.23	6.40	6.11	6.26	0.74	15.92	8.51	12.21	1.36
5-S.809/8/8	0.85	0.48	0.67	1.17	8.21	7.59	7.90	1.21	14.34	8.26	11.30	1.24
6-S.620/3/5	0.57	0.42	0.50	0.70	6.10	6.19	6.14	-0.24	12.34	8.94	10.64	0.81
7-S.541-C/3	1.14	0.71	0.93	1.00	11.08	10.23	10.65	1.25	12.64	9.24	10.94	0.79
8-S.541-D/10	0.85	0.65	0.75	0.62	10.15	9.94	10.04	0.33	11.17	8.91	10.04	0.59
9-S.808/67/1	0.54	0.38	0.46	0.78	8.17	7.20	7.68	1.92	9.36	7.76	8.56	0.50
10-S.808/8/5	0.72	0.48	0.60	0.90	7.30	6.68	6.99	1.37	12.56	9.32	10.94	0.76
11-S.806/23/3	0.74	0.41	0.58	1.18	7.24	6.97	7.10	0.62	14.44	8.12	11.28	1.28
12-S.806/5/8	0.66	0.31	0.48	1.43	7.63	7.12	7.38	1.10	11.51	5.73	8.62	1.47
13-S.887/18	0.74	0.33	0.53	1.47	7.68	6.65	7.16	2.18	13.24	6.77	10.00	1.43
14-S.888/22	0.53	0.31	0.42	1.11	7.41	7.28	7.35	0.27	9.11	5.55	7.33	1.14
15-S.888/14	0.55	0.39	0.47	0.78	7.77	7.72	7.75	0.12	8.89	6.14	7.51	0.91
16-S.777/10/5	0.59	0.36	0.47	1.05	8.13	7.25	7.69	1.76	10.91	6.68	8.79	1.14
Mean	0.71	0.44	0.57		7.99	7.50	7.75		11.91	7.84	9.87	
$LSD_{0.05}$	0.08	0.04	0.06		0.32	0.18	0.25		1.37	0.75	1.05	