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GIZA 11 AND GIZA 12; TWO NEW FLAX DUAL PURPOSE TYPE VARIETIES

[38]

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ABSTRACT

Sixteen flax genotypes {13 promising lines and 3 check varieties viz., Giza 8 (oil type), Sakha 1 (dual purpose type) and Sakha 3 (fiber type)} were evaluated for straw, seed, oil yields and their related traits under twelve different environments; four locations (Sakha, Etay El-Baroud, Ismailia and Giza Exp. Stations through three successive seasons (2011/12, 2012/13 and 2013/14). These materials were evaluated in a randomized complete blocks design with three replications at the twelve above-mentioned environments.

The analysis of variance revealed highly significant differences among genotypes (G), environments (E) and G x E interaction for all studied traits except straw weight per plant, 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 except both straw weight per plant and oil yield per fad 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. Interaction component of variance (σ^2ge) was less than the genotypic variance (σ^2g) for all characters, indicating that genotypes differ in their genetic potential for these traits. This was reflected in high heritability and low discrepancy between phenotypic (PCV) and genotypic (GCV) coefficients of variability values for these traits indicating the possibility of using each of long fiber percentage, plant height and technical stem length as selection indices for improving straw weight per plant, as well as, using 1000-seed weight and capsules number per plant as selection indices for improving seed weight per plant.

Yield stability (YSi) statistic indicated that S.541-C/3 and S.541-D/10 gave high mean performance and stability for straw, fiber, seed and oil yields per fad in addition to oil percentage, capsules number per plant and 1000-seed weight. Therefore, the two genotypes well be released under the name Giza 11 and Giza 12, respectively. These newly released varieties are of dual purpose type for straw, fiber, seed and oil yield. They may replace the low yielding cultivars Giza 8, Sakha 1 and Sakha 3.

INTRODUCTION

Flax (*Linum usitatissimum* L.) is one of man's oldest crops and today is widely grown for its fiber, seeds and both fiber and seeds

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(dual purpose). The dual purpose flax is most preferable type for the Egyptian farmers, and is also the most suitable for the Egyptian climate.

Stable performance of varieties under different environments with regard to the economic characters like straw yield and/or seed yield is of major significance in most breeding programs. In order to initiate the development of stable genotypes, information on various stability aspects and their mode of transmission would be very essential. The yield level, yield stability and genetic variance of the base populations would thus determine the success of any selection programs **(Kofoid et al 1978).** Efforts have been made to combine yield and performance stability into a single selection **criterion (Kang et al 1991 and Bachireddy et al 1992).** Benefits of emphasizing stability of performance during the selection process has been demonstrated **(Kang, 1993 and Kang & Magari, 1995).** Identification of yield–contributing traits, and a knowledge of genotype x environment (GE) interactions and yield stability are important for breeding new cultivars with improved adaptation to the environmental conditions prevailing in the target environments. With the availability of improved statistical tools to analyze and understand GE interactions, it is now possible to develop improved genotypes for target environments by exploiting GE interactions and marker – based selection integrated with traditional plant breeding (Kang, 1998). Many investigators studied GE interactions and stability of flax genotypes under different environments, and recorded different results for the stability across different environments **(Abo El-Zahab et al 1994 and Mahto, 1995).** The main goal of flax breeding programs in Egypt is to select genotypes, with high yielding potential and stability under different environments.

Therefore, the main objective of this study was **1)** to evaluate the yield potential of sixteen flax genotypes via a new yield-stability (YS_i) statistics using the data of flax trials conducted in Fiber Research Section, ARC, Egypt. and **2)** to estimate genetic and GE variance for deriving statistics, and to discuss the possibility of using these genotypes for developing stable lines to be released as new flax commercial cultivars.

MATERIALS AND METHODS

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

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

No.	Genotypes	Pedigree	Origin	Type
1	S.541-C/1	Giza 8 x S.2419/1	Local line	D
2	S.541-C/2	do	do	D
3	S.541-C/3	do	Local line(**Giza10**)	D
4	S.541-C/3/2	do	do	D
5	S.541-C/3/31	do	do	D
6	S.541-C/3/119	do	do	D
7	S.541-D/1	S.2419/1 x S.148/6/1	do	D
8	S.541-D/4	do	do	D
9	S.541-D/5	do	do	D
10	S.541-D/7	do	do	D
11	S.541-D/8	do	do	D
12	S.541-D/10	do	Local line(**Giza11**)	D
13	S.541-D/11	do	do	D
14	Giza 8	Giza 6 x I. Santa Catalina 6	Local variety	O
15	Sakha 1	I. Bombay x I.1485	do	D
16	Sakha 3	I. Belinka x I. 2569	do	F

In the early studies, out of 36 crosses, four crosses {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)} 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. Two cycles of selection for improving both straw and seed yields by using independent culling levels selection method (Poehlman, 1979), resulted in 48 promising families belongs to four crosses (541-A, 541-B, 541-C and 541-D) in F_4 generations (Abo-Kaied 2003). These breeding materials (48 families) were evaluated through three successive seasons; 2004/05 (F_5 generation), 2005/06 (F_6 generation) and 2006/07 (F_7 generation) at Etay El-Baroud Exp.Sta., El-Beheira Governorate. Out of 48 families, only 13 promising flax lines were superior than 3 check commercial varieties viz., Giza 8, Sakha 1 and Sakha 3 (Abo-Kaied *et al.*, 2008). The 13 promising flax lines and 3 check varieties viz., Giza 8, Sakha 1 and Sakha 3 were evaluated for straw, seed, oil yields and their related traits under nine different environments (three successive seasons; 2008/09, 2009/10 and 2010/11 over three locations) **(Abo-Kaied et al 2011).**

The materials used for the present investigation (16 genotypes were) evaluated in three successive seasons (2011/2012, 2012/2013 and 2013/2014) at four locations viz: Sakha Exp.Station, Kafr El-Sheikh Governorate (clay, organic matter of 1.77%, available nitrogen 32.03 ppm, E.C. 1.96 and pH = 8.11), Etay El-Baroud Exp. Sta., El-Beheira Governorate (clay, organic matter of 3.01%, available nitrogen 41.69 ppm, E.C. 1.58 and pH = 8.04), Ismailia Exp. Station, Ismailia Governorate (sandy soil, organic matter of 0.047 %, available nitrogen 6.65 ppm, E.C. 0.14 and pH value of 7.54) and Giza Exp.Station, Giza Governorate (clay, organic matter of 1.74%, available nitrogen 291.77 ppm, E.C. 1.84 and pH = 8.01). The experimental design was randomized complete block with three replications per each of the twelve environments (combination of locations x years). Flax seeds of each genotype were sown during the first week of November for all trials in all seasons. Plot consisted of 10 rows, 3 m long and 20 cm wide (1/700 fad). 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/fad 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., 1995).** The following characters were recorded:

1) **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.
2) **Seed yield, oil yield and their related characters**: (1) Seed yield (ton)/fad, (2) oil yield (ton)/fad, (3) seed weight (g)/plant, (4) capsules/plant, (5) seed index, as measured by 1000-seed weight in g and (6) oil percentage.

Statistical analysis

Plot means were used for statistical analysis. Data from each of twelve environments (combination of 3 years and 4 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 **Johnson et al (1959).** Analysis of variance was conducted, which revealed that genotype x environment interaction was significant for each trial.

A yield–stability statistic (YS_i) developed for simultaneous selection for yield and stability was calculated according to Kang and Magari (1995). The various steps involved in the calculation of the YS_i statistic are as follows:

1) Genotypes were ranked according to yield with the lowest-yielding genotype receiving a rank of 1; **2**) An adjustment to the yield rank was made; +1 if genotype mean yield was > overall mean yield (OMY) for a test, +2 and +3 if genotype mean yield was ≥ OMY by1 LSD, respectively; -1 if genotype mean yield < OMY, -2 and –3 if genotype mean yield was ≤1 LSD below OMY; **3**) The adjusted rank was labeled Y; **4**) A stability rating (S) was assigned as follows; 0, if σ^2 was not significant; and -2, -4, and -8 if σ^2 was significant at 10%, 5% and 1% probability level, respectively ; **5**) The adjusted rank, Y and the stability rating, S, for each genotype were summed; and **6**) The genotypes that had $YS_i > \sum YS_i$ / t(No. of genotypes) were selected.

RESULTS AND DISCUSSION

1- Variability

1-1- Straw yield, fiber yield and their related characters

The analysis of variance **(Table 2)** showed that genotypes (G) displayed highly significant differences for straw yield/fad, long fiber yield/fad, straw weight (g)/plant and its components viz.:, plant height (cm) and technical

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.

Characters	S.O.V.	Genotypes(G) (15)#	Environment (E) (11)#	Interaction (GxE) (165)#	Heterogeneity (15)#	Residual (150)#	Pooled Error (360)#
Straw yield and its components	Straw yield / fad (ton)	14.365**	11.108**	0.246**	0.905**	0.180**	0.029
	ong fiber yield / fad (ton)	0.648**	0.0184**	0.008**	0.031**	0.006**	0.002
	Straw weight / plant (g)	10.224**	7.874**	0.247 ns	0.830**	0.189 ns	1.611
	plant height (cm)	6227.850**	1997.830**	92.210**	304.467**	70.983**	2.898
	chnical stem length(cm)	2522.775**	3864.136**	99.632**	725.406**	37.054**	0.123
	ong fiber percentage (%)	70.038**	16.536**	0.971**	3.154**	0.753**	0.134
Seed yield and its components	Seed yield / fad (ton)	0.329**	1.383**	6.4486**	2.98**	4.836**	0.011
	Oil yield / fad (ton)	0.067**	0.234**	0.0013**	0.0057**	0.0008 ns	0.001
	Seed weight / plant (g)	0.325**	0.310**	0.010**	0.044**	0.006**	0.0002
	apsules number / plant	2345.462**	2252.301**	199.386**	184.310 ns	200.885**	0.279
	1000-seed weight (g)	72.374**	21.565**	0.971**	2.688**	0.799**	0.042
	Oil percentage (%)	54.713**	5.301**	2.585**	9.202**	1.922**	0.132

*,** = Indicate significant and highly significant, respectively.
=Values designated the corresponding degrees of freedom

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 twelve environments (3 yeas x 4 locations). The results indicated that genotypes (G) differed in their genetic potential for the previous characters. Environments (E) differed highly significantly for all traits, indicating a wide range of variation among the environments studied. 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, 2008 & 2011).** Also, GxE interaction was significant for all characters except straw weight/plant. This result indicated that genotypes had considerable different responses to environmental conditions.

The variances due to GxE (linear), i.e, heterogeneity were statistically significant for straw yield/fad, long fiber yield/fad, straw weight/plant, plant height, technical stem length and long fiber percentage suggesting that linear components of GxE were present. This means that heterogeneity in genotypes for the previous mentioned traits relative to the environmental index was significant. This environmental index represents all differences between environments which could include differences in soil fertility, cultural practices, insect or disease incidence, humidity, sunshine, etc. **(Haynes et al 1995).** The significant variance due to residual (pooled deviation) for all characters except straw weight/ plant 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).**

Estimates of variance components among sixteen flax genotypes grown at twelve 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 3.** Interaction components variances (σ^2ge) 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 and low discrepancy between phenotypic coefficient of variability (PCV) and genotypic coefficient of variability (GCV) values for long fiber percentage (H = 98.61%, PCV = 9.98%, GCV = 9.82%), plant height (H= 98.52%, PCV = 14.84%, GCV = 14.73%) and followed by technical stem length (Heritability (H)= 96.05, PCV = 11.58%, GCV = 11.35%). These results indicate the possibility of using each of long fiber percentage, plant height and technical stem length as selection indices for improving straw weight/plant. This result clearly indicates that variation among flax genotypes in the previous traits are mainly due to environmental variation plus the GE interaction ones. These results are in harmony with that reported by **Abo El-Zahab et al (1994) and Abo-Kaied et al (2006 and 2011).**

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 twelve environments of straw weight, seed weight/plant and other related traits.

Characters	σ^2_g	σ^2_{ge}	σ^2_e	H%	PCV%	GCV%
Straw weight/ plant (g)	0.370	-0.455	1.611	97.580	29.260	28.910
plant height (cm)	227.246	29.771	2.898	98.520	14.840	14.730
Technical stem length(cm)	89.746	33.170	0.123	96.050	11.580	11.350
Long fiber percentage (%)	2.558	0.279	0.134	98.610	9.890	9.820
Seed weight/plant (g)	0.012	0.003	0.0002	96.920	28.200	27.770
Capsules number / plant	79.484	66.369	0.279	91.500	22.710	21.720
1000-seed weight (g)	2.645	0.310	0.042	98.660	16.340	16.230
Oil percentage (%)	1.931	0.818	0.132	95.280	3.420	3.340

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

1-2- Seed yield, oil yield and their related traits

Mean squares due to genotypes for seed and oil yields/fad as well as oil percentage, seed weight/plant and its related characters are presented in **Table (2).** The results indicated that these genotypes showed reasonable degree of variability for these traits. Also, the results clearly indicated that environments (E) exhibited highly significant effects on all characters studied, indicating a wide range of variation among the environments studied. These findings are in line with those of **Abo El-Zahab et al (1994)** who found significant effects for locations and years on both seed yield and oil content in flax. Highly significant differences were also observed for seed and oil yields/fad as well as oil percentage, seed weight/plant and its related characters due to GxE interaction indicating that genotypes had considerable different responses to environmental influences. It appears, from these results, that the genotypes under study possess great genetic variability sufficient to provide basis of improvement through selecting superior genotypes.

The variances due to heterogeneity were significant for seed yield and its components except capsules number/plant suggesting that linear components of GxE was present. This means that heterogeneity in genotypes for the previously mentioned traits, relative to the environmental index, was significant. Whereas, variance due to residual for all characters was highly significant for seed yield/fad, oil percentage as well as seed weight/plant and its important components (capsules/plant and 1000-seed weight) indicated that genotypes differed with respect to their stability suggesting that prediction would be difficult. On the contrary, variance due to residual for oil yield/fad was non-significant.

Estimates of variance components among 16 flax genotypes for seed yield and its components as well as oil percentage are shown in **Table (3).** Genotype x environment interaction (σ^2ge) were less than the genotypic variance (σ^2g) for seed weight, capsules number/plant, 1000-seed weight and oil percentage indicating that genotypic differences overshadowed GE interaction effects. This means that genotypes differ in their genetic potential for these traits. The observed narrow range between phenotypic (PCV) and genotypic (GCV) coefficients of variability, which gave almost similar values of PCV (16.34%) and GCV (16.32%) in 1000-seed weight was mainly due to genetic effects as evidenced from the very high heritability estimate (98.66%). Also, seed weight/plant, oil percentage and capsules number/plant exhibited similar results, indicating possibility of using these components specially two traits (1000-seed weight and capsules number/plant) as in selection indices for improving seed weight/plant. These results are harmony with that reported by **Badwal et al (1971) and Abo-Kaied *et al* (2008 and 2011)** who reported that capsules number and 1000-seed weight are the major factors which directly contribute to seed weight/plant.

2- Genotypic mean performance and stability

2-1- Straw yield, fiber yield and their related characters

Mean performance, ranking of means and yield stability statistic (YS_i) according to **Kang and Magari (1995)** for straw, long fiber yields/fad and technical stem length as well as long fiber percentage for sixteen flax genotypes are presented in **Table 4.** S.541-D/10 (Giza 12) followed by S.541-C/3 (Giza 11) and S.541-C/3/2 showed high mean performance (high ranking) for each of straw yield/fad (5.304, 5.221 and 4.549 ton), fiber yield/fad (1.020, 0.879 and 0.737 ton) and technical stem length (101.74, 90.12 and 95.19 cm), respectively 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)}. Results indicated that Giza 12 had maximum mean performance for straw, long fiber yields/fad and technical stem length as well as long fiber percentage. Therefore, the previous mentioned genotypes specially S.541-D/10 deserve be released as commercial cultivars.

Out of sixteen flax genotypes, seven lines were stable according to **Kang and Magari, (1995)** (high yielding and stability) for both straw yield/fad and fiber percentage, eight lines for technical stem length and six lines for long fiber yield/fad. However, three lines, S.542-C/3/2, S.541-C/3 and S.541-D/10 exhibited superiority and stability for all/or most characters.

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

	Genotypes	Straw yield / fad (ton)			Long fiber yield / fad (ton)			Technical stem length (cm)			Long fiber percentage (%)		
		Means	Rank	Ys_i	Means	Rank	Ys_i	Means	Rank	Ys_i	Means	Rank	Ys_i
1	S.541-C/1	3.581	3	-8	0.593	5	-6	86.38	11	6 +	16.65	10	9 +
2	S.541-C/2	4.176	10	4 +	0.723	13	9+	87.48	12	7 +	17.73	14	9 +
3	S.541-C/3	5.221	15	14 +	0.879	15	10+	90.12	14	9 +	16.85	11	12 +
4	S.541-C/3/2	4.549	14	9 +	0.737	14	8+	95.19	15	10 +	15.73	5	-6
5	S.541-C/3/31	3.586	4	-7	0.583	3	-8	82.40	6	-5	16.26	9	0
6	S.541-C/3/119	3.664	6	-5	0.590	4	-7	83.86	9	12 +	16.16	8	-1
7	S.541-D/1	3.935	9	-1	0.617	6	-5	76.80	5	-6	15.81	6	-5
8	S.541-D/4	4.538	13	16 +	0.645	10	0	83.09	7	-4	14.23	2	-9
9	S.541-D/5	4.447	11	6 +	0.713	12	15+	84.32	10	5 +	16.03	7	-3
10	S.541-D/7	4.537	12	7 +	0.664	11	4 +	88.18	13	8 +	14.65	3	-8
11	S.541-D/8	3.671	7	-4	0.636	8	-2	75.02	3	-8	17.46	13	8 +
12	S.541-D/10	5.304	16	11 +	1.020	16	11+	101.74	16	11 +	19.23	16	11 +
13	S.541-D/11	3.637	5	-6	0.643	9	-1	83.50	8	1	17.74	15	10 +
14	Giza 8	3.112	1	-10	0.435	1	-10	75.24	4	-7	14.04	1	-10
15	Sakha 1	3.301	2	-9	0.497	2	-9	72.47	2	-9	15.05	4	-7
16	Sakha 3	3.737	8	-3	0.632	7	-3	69.96	1	-10	16.94	12	7 +
General mean		4.060		*0.875*	*0.662*		*0.375*	*83.48*		*1.25*	*16.29*		*1.06*
LSD $_{0.05}$		0.029			0.072			0.56			0.59		

+= Genotype selected on the basis of YS_i

In general, the two promising flax lines, S.541-D/10 and S.541-C/3 maintained mean performance advantage across nearly all the environments sampled by maintaining high level of almost all yield components and they are recommended to be released as commercial stable high yielding cultivars.

2-2- Seed yield, oil yield and their related traits

Mean performance for seed yield/fad, oil yield/fad, oil percentage, capsules number/plant and 1000-seed weight of sixteen flax genotypes averaged over twelve environments and yield stability statistic (Ysi) are presented in **Table (5).** 541-C/3 gave the highest values (first or second ranking) for all characters under study when compared with the other lines as well as the three check varieties (Giza 8, Sakha 1 and Sakha 3). Also, S.541-D/4 may follow the previous genotype S.541-C/3 for both seed and oil yields/fad as well as S.541-D/10 for 1000-seed weight.

The measure of stability (Ysi) was deemed appropriate (**Table 5).** Out of sixteen flax genotypes, nine lines were stable according to Kang and Magari, 1995 for seed yield/fad, eight lines for oil yield/fad, seven lines for oil percentage and ten lines for 1000-seed weight.

In general, S.541-C/3 followed by S.541-D/4 and S.541-D/10 gave high mean performance and stability for seed yield/fad, oil yield/fad and 1000-seed weight.

Table 5. Mean yield, rank (assigned before stability analysis was made), yield stability statistic (YS_i) and stable genotypes of seed yield/fad, oil yield/fad, oil percentage and 1000-seed weight for sixteen flax genotypes

Genotypes	Seed yield / fad (ton)			Oil yield / fad (ton)			Oil percentage (%)			1000-seed weight (g)		
	Means	Rank	Ys_i	Means	Rank	Ys_i	Means	Rank	Ys_i	Means	Rank	Ys_i
S.541-C/1	0.546	3	-8	0.226	3	-4	41.46	8	-2	10.71	12	7+
S.541-C/2	0.541	2	-3	0.220	2	-1	40.93	5	-6	10.73	13	8+
S.541-C/3	0.792	16	11+	0.344	16	19+	43.49	15	18 +	12.60	16	11+
S.541-C/3/2	0.617	8	9+	0.261	10	11+	42.26	13	11+	9.70	4	-3
S.541-C/3/31	0.583	6	-5	0.247	7	6	42.44	14	14+	9.97	5	-4
S.541-C/3/119	0.626	10	3+	0.275	12	6	43.74	16	11	10.10	6	-1
S.541-D/1	0.644	12	7+	0.256	8	7+	39.88	2	-5	10.29	8	11+
S.541-D/4	0.764	15	10 +	0.312	15	10+	40.92	4	-7	10.40	10	5+
S.541-D/5	0.557	4	-7	0.230	4	1	41.34	7	5+	10.67	11	14+
S.541-D/7	0.692	14	9 +	0.280	6	16+	40.62	3	-8	10.34	9	4+
S.541-D/8	0.619	9	8 +	0.257	13	10+	41.57	9	0	10.10	7	0
S.541-D/10	0.682	13	8 +	0.286	9	17 +	41.94	12	12+	11.19	15	10+
S.541-D/11	0.634	11	11+	0.274	14	13+	41.93	11	9+	10.85	14	9+
Giza 8	0.574	5	-6	0.240	11	1	41.91	10	11+	8.28	3	-8
Sakha 1	0.598	7	-3	0.245	6	5	41.09	6	3	7.92	2	-9+
Sakha 3	0.380	1	-10	0.148	-3	-10	39.17	1	-10	6.53	1	-10
General mean	0.616		2.125	0.256		6.69	41.62		3.5	10.02		2.75
$LSD_{0.05}$	0.169			0.051			0.58			0.33		

+= Genotype selected on the basis of YS_i

The previous collected data support the evidence that, the two lines S.541-C/3 and S.541-D/10 with high yield and stability may be released as new varieties (Giza 11 and Giza 12 respectively). They may be used to replace the low yielding cultivars, Giza 8, Sakha 1 and Sakha 3 in future as new dual purpose type Egyptian flax cultivars

REFERENCES

Abo El-Zahab, A.A. and Abo-Kaied H.M.H. 2000. Stability analysis and breeding potentialities of some stable selected flax genotype. I. Breeding potentialities of straw yield and its contributing variables. **Proc.9th Conf. Agron. Minufiya Univ., Egypt, 2-3 Sept., 2000: pp. 387-402.**

Abo El-Zahab, A.A.; N.K. Mourad and Abo-Kaied H.M.H. 1994. Genotype– environment interaction and evaluation of flax genotypes. 1 straw yield. **Proc. 6th Conf Agron., Al-Azhar Univ., Egypt, 1: 129-152.**

Abo-Kaied, H.M.H. 2003. Phenotypic, genotypic variances, heritability and expected genetic advance of yield and its components in F3 and F4 generations of some flax hybrids. **J. Agri. Sci. Mansoura Univ., 28(9): 6582–6582.**

Abo-Kaied H.M.H.; Amany, M.M. El-Refaie and El-Deeb E.I. 2011. Evaluation of performance for some promising flax lines under deferent environmental conditions. **Egypt. J. Appl. Sci., 26(9): 587-600.**

Abo-Kaied, H.M.H; M.A. Abd El-Dayem and Afaf E.A. Zahana. 2006. Variability and covariability of some agronomic and technological flax characters. **Egypt J. Agric Res. 84: 1117-1132.**

Abo-Kaied H.M.H.; Amany, M.M. El-Refaie and Afaf E.A. Zahana 2008. Comparative study for yield and yield components of some flax families with two commercial varieties, Sakha1 and Sakha 2. **J. Agri. Sci. Mansoura Univ., 33(7) : 4681-4693.**

A.O.A.C. 1995. **Official Methods of Analysis. 16th Ed.** Association of Official Analytical Chemist's. Washington, D.C., U.S.A.

Bachireddy, V.R.; Payne R.; Jr. K.L. Chin and M.S. Kang. 1992. Conventional selection versus methods that use genotype x environment interaction in sweet corn trials. **Hortscience 27: 436-438.**

Badwal, S.S., Gill K.S. and Singh H. (1971). Correlation and regression studies in linseed (*Linum usitatissimum* L.). **Indian J.. Agric. Sci. 41: 475-478.**

Haynes, K.G.; Wilson D.R. and Kang M.S. 1995. Genotype x environment interactions for specific gravity in diploid potatoes. **Crop. Sci. 35: 977-981.**

Kang, M.S. 1993. Simultaneous selection for yield and stability in crop performance trials: Consequences for growers**. Agron. J. 85: 754-757.**

Kang, M.S. 1998. Using Genotypes -by- environment interaction for crop cultivars development. **Adv. Agron. 35:199-200.**

Kang, M.S. and Magari R. 1995. Stable a BASICA program for calculating stability and yield - stability statistics. **Agron. J. 87: 276-277.**

Kang, M.S.; Gorman D.P. and Pham H.N. 1991. Application of a stability statistic to international maize yield trials. **Theor. Appl. Genet. 81: 162-165.**

Johnson, H.W.; Robinson H.F. and Comstock R.E. (1959). Estimates of genetic and environmental variability in soybeans. **Agron. J. 47: 314-318.**

Kofoid, K.D.; Ross W.M. and Mumm R.F. 1978. Yield stability of sorghum random mating populations. **Crop Sci. 18:677-679.**

Mahto, J.L. 1995. Genotype x environment interaction stability and genetic diversity study in linseed for yield and yield attributes under dry land situation. **Madras Agric. J. 82: 601-605.**

Poehlman, J.M. 1979. Breeding Field Crops. 2nd Ed. AVI Publishing Co. Inc. Connecticut, U.S.A. **483 pp.**