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ESTIMATION OF COMBINING ABILITY FOR EIGHT FLAX GENOTYPES UNDER SANDY SOIL CONDITIONS

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ABSTRACT

This study aimed to estimate the combining ability and gene action for eight flax genotypes under sandy soil conditions. This was achieved via evaluating the eight parents and their 16 F_1's progenies. The eight parents consisting of four females (P_1= S.541-C/6, P_2= S.402/1, P_3= S.813, and P_4= S.997) and four males (P_5= Sakha 3, P_6= S.541-C/7, P_7= Sozana and P_8= S.541-D/4). In 2013/14 season, each of the four male parents was crossed to the four female parents to obtain 16 F_1 crosses at the breeding nursery of Fiber Crops Res. Section, ARC at Giza. In 2014/15 season, the parents and their 16 F_1,s seeds were evaluated in Ismailia Exp. Station, Ismailia Governorate. The experiment was laid out in a randomized complete block design with four replications.

The collected data indicated that the values of additive and dominance as well as, the ratio of GCA/SCA indicated that additive played greater role than non-additive gene effects in the inheritance of straw yield per plant, plant height, technical stem length, no. of basal branches and 1000-seed weight. Therefore, selection should be possible within the F_2 and subsequent populations for these characters. On the other hand, the ratio of GCA/SCA revealed that non-additive played greater role than additive gene effects in the inheritance of seed weight per plant, no. of capsules per plant and no. of seeds per capsule. P_1 and P_5 among parents were outstanding as they showed significant desirable combining ability for straw yield per plant and in most important components as well as P_5 for technical stem length and P8 for both straw yield per plant and no. of basal branches per plant. On the other hand, P_1 and P_8 among parents are good general combiners for seed yield and most of its components, indicating that the use of these parents in flax breeding programs could be increase the above mentioned treats. Only one cross (P_4xP_5) exhibited significant positive SCA effects for straw yield and its components as well as this cross included high x low general combiner parents for straw yield per plant and two important components, plant height and technical stem length. Also, one cross (P_1xP_5) for both plant height and technical stem length, in addition one cross (P_1xP_6) for both straw yield/plant and plant height included high x high general combiner parents. For seed yield, three crosses (P_1xP_5, P_1xP_6 and P_4xP_8) exhibited significant positive SCA effects for seed yield per plant and no. of capsules per plant as well as high x low general combiner parents. Also, three crosses (P_1xP_5, P_1xP_7 and P_4xP_8) exhibited significant positive SCA effects for no. of seeds per capsule included high x low general combiner parents. While, out of the previous crosses, three crosses (P_1xP_5, P_1xP_6 and P_4xP_8) only included high x high general combiner parents for 1000-seed weight. These crosses were involved one good combiner parent, which indicated that such combinations are expected to throw desirable transgressive segregates. It could be concluded that the above mentioned crosses would be interesting and prospective for the future in flax breeding program for improving seed yield and straw yield and their components.

Keywords: Line x tester, Combining ability, Gene action, Flax.

INTRODUCTION

Flax (*Linum usitatissimum* L.) is a annual, self-pollinating plant species. It is the sole species of agricultural importance within the family Linaceae. This crop is grown for its fibers (fiber flax), or its seed oil (linseed), or both (dual purpose flax). In Egypt, flax is cultivated for two purposes i.e., seeds and fibers. It is considered as the second fiber crop after cotton, in Egypt. Flax has many industrial applications and its seed cake the remainder after seeds squeeze is used as animal feeding, while the fine flax fiber is used to produce high quality linen.

It is well known that combining ability estimation for parents by using diallel mating design became very difficult whenever more number of parents to be included in crosses, consequently great number of hybrids must be done. Moreover, that emasculation process in small flowering buds of flax plant represent difficulty in this case, in addition to prevent flax breeder to achieve great number of crosses during the blooming period. For this reason, it must be use the line x tester mating design in the state of great number of parents for combining ability determination, where this technique (line x tester) consider as more suitable in this case. As well as, this technique like diallel and partial diallel (Singh and Narayanan, 1993) also help in the identification of good general combiners and specific cross combinations as well as in the choice of breeding procedure for genetic improvement of various polygenic characters.

Several flax breeders have studied the nature and magnitude of combining ability and gene action for evaluating the potential of parents for producing desirable recombinations in flax. The additive genetic variance had more important role in the inheritance of straw yield, plant height, technical length and seed index as reported by Foster *et al* (1998), Abo-El-Zahab and Abo-Kaied (2000), Abo-Kaied and Amany, El-Refaie (2008), El-Kady and Abo-Kaied (2010) and Amany, El-Refaie *et al* (2011). ON the contrary, non-additive variance had an important role in the inheritance of no. of basal branches per plant, seed yield per plant and capsules per plant as reported by Roa and Singh (1987), Mishra and Rai (1996) and El-Kady and Abo-Kaied (2010).

Decreasing flax cultivating area annually in Egypt by reason of the great competition with the other winter crops in the ancient valley land like wheat, berseem, fababean …*etc*. Therefore, the biggest challenge in breeding new varieties has been to produce a variety that is adapted to the sandy soil conditions. For this reason, this study aimed to estimate the combining ability of eight flax genotypes and their crosses as well as to estimate the type of gene action for straw and seed yields in addition to their components under sandy soil conditions.

MATERIALS AND METHODS

The materials used for the present study comprised eight flax genotypes. These parents involved four flax genotypes, from P_1 to P_4 as female parents (called 'line' hereafter) and four flax genotypes, from P_5 to P_8 (called 'tester' hereafter) as male parents. Genotype characteristics of the material used according to their pedigree and origin are presented in Table (1). These parents (lines and tester) were selected on the basis of the presence of wide differences between them with respect to certain economic flax traits.

Table1. Identification of parental genotypes used, pedigree, classification (dual, oil, fiber types) and origin.

Genotype	Pedigree	Type	Origin
Line			
P_1= S.541-C/6	Giza 8 x S.2419/1	dual	Local strain
P_2= S.402/1	Giza 5 x I.C235 (USA)	oil	" " " " " "
P_3= S.813	S.420/140/5/10x Marlin	fiber	" " " " " "
P_4= S.997	S.119/7/8 x S.541-D/10	fiber	" " " " " "
Tester			
P_5= Sakha 3	Belinka x I.2569	fiber	Local variety
P_6= S.541-C/7	Giza 8 x S.2419/1	dual	Local strain
P_7= Sozana	Introduction Belgium	fiber	Belgica
P_8= S.541-D/4	S.2419/1 x S.148/6/1	dual	Local strain

In 2013/2014 season, each of the four male parents was crossed to the four female parents to obtain 16 F_1 crosses at Giza Res. Sta. of Agric. Res. Center. In 2014/2015 season, the parents and their 16 $F_1^{,s}$ seeds were evaluated in Ismailia Exp.Station, Ismailia Governorate (sandy soil, organic matter of 0.066 %, available nitrogen 7.11 ppm, E.C. 0.13 and pH value of 7.84).

The experiment was laid out in a randomized complete block design with four replications. Each entry (parent or cross) was grown in 2 rows, which were guarded by their two respective parents of the cross. Rows were 3 m long, spaced 20 cm apart. Single seeds were hand drilled in 5 cm spacing within rows. All cultural practices were followed through the growing season as usually done with ordinary flax culture. At harvest, individual guarded plants were taken at random from each entry; 10 plants for both of parent and F_1 per each replication. These plants were used for recording: straw yield/plant and its components (plant height, technical stem length and no. of basal branches) and seed yield/plant and its components (no. of capsules/plant, 1000-seed weight and no. of seeds/capsule).

Statistical analysis

Combining ability variances and effects were estimated according to line x tester analysis according to Kempthorne (1957). In this design, the genotypes to be evaluated are selected from the germplasm. Some of these selected genotypes are designated as males (testers) and other as females (lines). Each male parent is mated to each female parent, but either of male or female parents were not crossed made each of them. Moreover, each male is crossed to the same set of females.

The variation among $F_1^{,s}$ within generation is further divided into genetic variation components attributable to general (GCA) and specific combining ability (SCA) following the method suggested by Singh and Chaudhary (1985). Variances due to general (GCA) and specific (SCA) combining ability and due to additive and dominance type of gene action were estimated as follows:

$\sigma^2GCA=\{1/r(2mf-m-f)(((m-1)M_m+(f-1)M_f)/(m+f-2)-(M_{mf}))\}$, $\sigma^2SCA=(M_{mf}-M_e)/r$
$\sigma^2GCA=((1+F)/4)\ \sigma^2$Additive
$\sigma^2SCA=((1+F)/2)^2\ \sigma^2$ Dominance

Where:

m= males, f= females, F= inbreeding coefficient =1,
M_m ,M_f ,M_{mf} ,M_e= Mean squares due to , males, females, males x females interaction and error, respectively.

RESULTS AND DISCUSSION

Straw yield and its components:

Analysis of variance for straw yield/plant and its components viz., plant height, technical stem length and no. of basal branches/plant are shown in Table (2). Mean squares due to entries (parents and F_1's) were highly significant for all characters. This indicates that those parental genotypes as well as the F_1's crosses showed reasonable degrees of variability for these traits. Also, mean squares due to parents and crosses revealed significant differences among entries for all characters studied. These results indicated wide genetic variability for all variables study. Parents *vs*. crosses (P.*vs*.C.) mean squares as an indication of average heterosis over crosses are found to be highly significant for straw yield/plant and its components. Also, mean squares due to females and male parents as well as male x female (mxf) interactions are significant for straw yield/plant and its components.

The partitioning of genetic variance into general (GCA) and specific (SCA) combining ability variances are presented in Table (3). Both GCA and SCA variances were highly significant for all studied characters except for no. of basal branches/plant due to SCA variance, indicating the presence of both additive and dominance type of genetic variances. GCA variances were larger than the corresponding SCA variances for all studied characters indicating the predominant role of additive gene action involved in the expression of the these characters. Also, the values of additive and dominance as well as, the ratio of GCA/SCA variances for straw yield/plant and its components, indicate that the additive effects were more important than non-additive effects. Therefore, selection should be possible within these F_2 and subsequent populations for these characters. Similar results were reported by Foster *et al* (1998), and El-Zahab and Abo-Kaied (2000), Abo-Kaied and Amany, El-Refaie (2008), El-Kady and Abo-Kaied (2010) and Amany, El-Refaie *et al* (2011).

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Table3. Partitioning of the genetic variance into general and specific combining ability variances for each of straw and seed yields /plant and their components traits for eight flax parents and their 16 F_1's crosses

S.O.V.	Straw yield /plant and its components				Seed yield /plant and its components			
	Straw yield /plant (g)	Plant height (cm)	Technical stem length (cm)	No. of Basal branches per plant	Seed yield /plant (g)	No. of capsules /plant	1000-seed weight (g)	No. of seeds /capsule
GCA	0. 840 **	19.406**	8.270 **	0.016 **	0.084 **	2.667 ns	0.458 **	0.075 ns
SCA	0.146 **	18.436 **	7.387 *	0.003 ns	0.156 **	6.069 **	0.326 **	0.523 **
Additive	1.684	38.812	16.541	0.033	0.168	5.333	0.916	0.150
Dominance	0.146	18.436	7.387	0.003	0.156	6.069	0.326	0.523
Error	0.045	5.898	2.696	0.005	0.006	1.324	0.028	0.040
GCA/SCA	5.753	2.301	5.962	6.181	0.540	0.439	1.406	0.143

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

The general combining ability effects (ĝi) of eight parents (4 females and 4 males) for straw yield and its components are presented in Table (4). P_1 and P_4 among the lines (females) and P_6 and P_8 among the testers (males) showed significant desirable general combining ability effects for straw yield per plant. P_1 and P_2 in addition to P_1 and P_3 among the lines for both plant height and technical stem length respectively, as well as P_5, and P_6 among the testers exhibited significant positive GCA effects for both plant height and technical length. For no. of basal branches/plant, P_1 among lines and P_8 among the testers exhibited significant positive GCA effects.

In general, P_1(S.541-C/6) among lines for straw and its all components as well as P_6 (S.541-C/7) among testers were outstanding as they showed significant desirable combining ability for straw yield and in most important components and P_5 (Sakha 3) among testers for plant height and technical stem length and P_8 (S.541-D/4) among testes for both straw yield/plant and no. of basal branches/plant indicating that the use of these parents in flax breeding programs could be increase straw yield per plant. The other parents which showed desirable significant general combining ability effects for one or more characters will also be useful in component breeding program aiming at the improvement of individual component characters which in turn would be useful in the breeding program for improving straw yield per plant.

Table 4. Estimates of general combining ability effects ($\hat{g}_i$) for each of straw and seed yields/plant and their components traits for eight flax parents (four females and four males)

Parents	Straw yield /plant and its components				Seed yield /plant and its components			
	Straw yield /plant (g)	Plant height (cm)	Technical stem length (cm)	No. of Basal branches per plant	Seed yield /plant (g)	No. of capsules /plant	1000-seed weight (g)	No. of seeds /capsule
Females								
P_1= S.541-C/6	0.424 **	5.212 **	5.014 **	0.068 **	0.279 **	4.531**	-0.606 **	0.100 **
P_2= S.402/1	-0.809 **	1.914 **	0.226 ns	-0.023 ns	0.019 ns	-0.157 ns	-0.112 **	0.083 ns
P_3= S.813	0.019 ns	-1.090 ns	2.555 **	-0.065 **	-0.170 **	-3.228 **	0.572 **	0.409 **
P_4= S.997	0.366 **	-6.037 **	-7.795 **	0.020 ns	-0.128 **	-1.145 **	0.146 **	-0.592 **
Males								
P_5= Sakha 3	0.097 ns	2.877 **	2.308 **	0.030 ns	-0.286 **	-2.182 **	-1.561 **	-0.332 **
P_6= S.541-C/7	0.214 **	3.342 **	4.473 **	-0.018 ns	-0.066 **	-1.471 **	0.501 **	0.313 **
P_7= Sozana	-0.646 **	-5.579 **	-4.964 **	-0.092 **	-0.018 ns	-0.621 **	1.264 **	-0.723 **
P_8= S.541-D/4	0.335 **	-0.640 ns	-1.817 **	0.080 **	0.370 **	4.273 **	-0.204 **	0.742 **
S.E. $_{(gi-gi)}$	0.075	0.859	0.581	0.026	0.027	0.407	0.059	0.071

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

Specific combining ability effects (Ŝij) calculated for each cross are presented in Table (5). six crosses (P_1x P_6, P_1x P_8, P_2xP_7, P_3xP_7, P_4xP_5 and P_4xP_8) for straw yield/plant, six crosses (P_1xP_5, P_1xP_6, P_2xP_5, P_2xP_8, P_3xP_7 and P_4xP_5) for plant height, four crosses (P_1xP_5, P_2xP_8, P_3xP_7 and P_4xP_5) for technical stem length and four crosses(P_1xP_7, P_1xP_8, P_2xP_7 and P_4xP_5) for no. of basal branches/plant revealed significant positive specific combining ability.

In general, only one cross (P_4xP_5) exhibited significant positive SCA effects for straw yield and its components as well as this cross included high x low general combiner parents for straw yield/plant and two important components, plant height and technical stem length. Also, one cross (P_1xP_5) for both plant height and technical stem length, in addition one cross (P_1xP_6) for both straw yield/plant and plant height included high x high general combiner parents. For the breeding point of view as suggested by Thakur and Rana (1987) the SCA effects include dominance and epistatic effects and can be related with heterosis. In self-pollinated crops, however, the additive x additive type of interaction component is fixable in the latter generations.

The mean performance of lines, testers and F_1'^{s} crosses for straw yield and its components are presented in Table (6). The mean values of parents (lines and testers) showed wide differences with a range of 1.69-3.27 g; 65.93-88.67 cm; 51.91-70.59 cm and 1.26-1.64 for straw yield, plant height, technical stem length and no. of basal branches/plant, respectively. Also, the mean values of crosses indicated wide variability with a range of 2.86-5.73 g; 60.56-89.67 cm; 34.32-65.07 cm and 1.25-1.72 for the above mentioned characters in the same order. The two best parents P_1 (S.541-C/6) and P_6 (S.541-C/7); P_4 (S.997) and P_1 (S.541-C/6); P_7 (Sozana) and P_4

(S.997) and P_7 (Sozana) and P_5 (Sakha 3) recorded the highest values for the mentioned traits in the same order. On the other hand, the three best crosses (P_4xP_5, P_4 x P_8 and P_1 x P_6); (P_1 x P_6, P_1 x P_5 and P_2 x P_5); (P_1 x P_5, P_1 x P_6 and P_3xP_7) and (P_1xP_8, P_4xP_5 and P_1xP_7) for each of the mentioned characters in the same order recorded highest values. Out of these previous crosses, two crosses (P_1xP_6 and P_4xP_8) for straw yield/plant, two crosses (P_1xP_5 and P_1xP_6) for plant height and one cross (P_1xP_5) for technical length included high x high general combiner parents. It could be concluded that the above mentioned crosses as well as the best parents would be interesting and prospective for the future in flax breeding program for improving straw yield and its components.

Seed yield and its components:

The analysis of variance for seed yield per plant and its components (no. of capsules per plant, 1000-seed weight and no. of seeds/capsule) are presented in Table (2). Mean squares due to entries (parents and F_1,s crosses), crosses, lines and testers were significant for seed yield and its components. These results indicate that those parental genotypes (lines and testers) as well as in F_1,s crosses show reasonable degrees of variability in these material under study. Mean squares of parents vs. crosses as an indication to average heterosis over all hybrids was significant, revealing that heterotic effect was pronounced for seed yield/plant and its components. The variances due to females and males were for all traits. Additive gene effects, as indicated by male x female interactions were highly significant for seed yield and its all components.

The partitioning of genetic variance into GCA and SCA variances for seed yield and its components are presented in Table (3). Mean squares due to general (GCA) were highly significant for both seed yield and 1000-seed weight. While, specific (SCA) combining abilities were highly significant for seed yield and its components. In general, the magnitude of mean squares due to SCA were greater than that due to GCA except 1000-seed weight, which reflected on each of additive, dominance variances and GCA/SCA ratio. Low ratio of GCA/SCA was also detected. These results revealed that non-additive played greater role than additive gene effects in the inheritance of seed yield/plant, no. of capsules/plant and no. of seeds/capsule. On the other hand, high ratio of GCA/SCA for 1000-seed weight revealed that additive played greater role than non-additive gene effects in the inheritance for this treat. Similar results were reported by Patil and Chopde (1981), Abo El-Zahab and Abo-Kaied (2000) and El-Kady, Eman and Abo-Kaied (2010).

The estimates of general combining ability effects (ĝi) for females and male parents are shown in Table (4). One parent (P_1) among lines showed significant and positive GCA effects for seed yield per plant, no. of capsules/plant and no. of seeds/capsule as well as P_3 foe 1000 seed weight and no. of seeds/capsule and P_4 for 1000-seed weight and finally P_1 and P_3 for no. of seeds/capsule. While, P_8 among testers showed significant and positive GCA effects for both seed yield per plant, no. of capsules/plant and no. of seeds/capsule as well as P_6 and P_7 for 1000-seed weight.

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In general, P_1 (S.541-C/6) among lines and P_8 (S.541-D/4) among testers are good general combiners for seed yield and most of its components, indicating that the use of these parental genotypes in flax breeding programs could increase seed yield.

Specific combining ability effects (Ŝij) for seed yield/plant and its components are presented in Table (5). six crosses (P_1xP_5, P_1xP_6, P_2xP_7, P_3xP_7, P_4xP_6 and P_4xP_8), four crosses (P_1xP_5, P_1xP_6, P_2xP_7 and P_4xP_8), eight crosses (P_1xP_5, P_1xP_8, P_2xP_7, P_2xP_8, P_3xP_6, P_3xP_7, P_4xP_6 and P_4xP_7) and five crosses (P_1xP_5, P_1xP_7, P_2xP_6, P_3xP_5 and P_4xP_8) exhibited significant positive SCA effects for seed yield/plant, no. of capsules/plant, 1000-seed weight and no. of seeds/capsule, respectively.

In general, three crosses (P_1xP_5, P_1xP_6 and P_4xP_8) exhibited significant positive SCA effects for seed yield per plant and no. of capsules/plant as well as high x low general combiner parents. Also, three crosses (P_1xP_5, P_1xP_7 and P_4xP_8) exhibited significant positive SCA effects for no. of seeds/capsule included high x low general combiner parents. While, out of the previous crosses, two crosses (P_3xP_6 and P_3xP_7) only included high x high general combiner parents for 1000-seed weight in addition tow crosses (P_4xP_6 and P_7xP_7) were involved one good combiner parent, which indicated that such combinations are expected to throw desirable transgressive segregates. It is, therefore, suggested that SCA performance may be considered as a criterion for selecting the promising crosses in flax. It may also be worthwhile to attempt bi-parental mating in the segregating generation among selected crosses to permit greater recombinations.

The mean performance of parents (lines and testers) and their F_1's crosses for seed yield and its components are presented in Table (6). The means values of parents and crosses show wide differences. The two best parents P_2 (402/1) and P_6 (S.541-C/7); P_6 (S.541-C/7) and P_7 (Sozana); P_1 (S.541-C/6) and P_6 (541-C/7) and P_3 (S.813) and P_7 (Sozana) recorded the highest values for seed yield, no. of capsules/plant, 1000-seed weight and no. of basal branches/plant, respectively. While, the highest mean values of the best three crosses for each the mentioned characters in the same order were (P_1xP_8, P_2xP_7 and P_3xP_6); (P_1xP_6, P_1xP_8 and P_2xP_7); (P_2xP_7, P_3xP_7 and P_4xP_6) and (P_2xP_6, P_2xP_8 and P_4xP_8). It could be concluded that the above mentioned parents and crosses would be interesting and prospective for the future in flax breeding program for improving seed yield and its components.

Table 6. Mean performances of eight flax parents and 16 F_1' s crosses for studied straw and seed yields/plant and their components of flax.

Genotypes	Straw yield and its components				Seed yield and its components			
	Straw yield /plant (g)	Plant height (cm)	Technical stem length (cm)	No. of basal branches /plant	Seed yield /plant (g)	No. of capsules /plant	1000-seed weight (g)	No. of seeds /capsule
parents #								
P_1= S.541-C/6	3.27	65.93	51.91	1.56	0.53	7.57	11.11	6.37
P_2= S.402/1	2.99	69.64	54.16	1.41	0.81	9.65	10.18	8.25
P_3= S.813	2.23	80.33	63.33	1.26	0.38	5.99	6.85	9.31
P_4= S.997	2.40	88.67	67.67	1.29	0.28	5.42	7.07	7.40
P_5= Sakha 3	1.96	84.44	65.26	1.62	0.34	6.05	8.57	6.50
P_6= S.541-C/7	3.15	70.87	53.29	1.48	0.73	10.21	10.46	6.79
P_7= Sozana	2.24	87.67	70.59	1.64	0.58	10.56	6.26	8.83
P_8= S.541-D/4	2.85	79.56	59.11	1.34	0.66	9.75	10.28	6.57
crosses								
P1xP5	4.37	85.80	65.07	1.36	1.34	19.51	8.51	8.10
P1xP6	5.62	89.67	59.71	1.56	1.40	20.66	8.67	7.80
P1xP7	3.38	61.84	41.68	1.57	0.49	9.33	7.16	7.39
P1xP8	5.20	74.45	50.99	1.72	1.60	21.01	9.39	8.11
P2xP5	3.70	80.22	52.92	1.54	0.36	6.97	7.51	6.83
P2xP6	3.71	72.90	53.06	1.31	0.61	8.43	8.36	8.67
P2xP7	3.36	67.52	42.65	1.50	1.62	21.04	10.77	7.13
P2xP8	2.86	77.93	49.67	1.49	1.21	15.32	9.06	8.70
P3xP5	3.46	61.40	42.08	1.51	0.49	8.14	7.03	8.57
P3xP6	4.56	74.42	55.51	1.44	0.61	7.25	10.35	8.17
P3xP7	4.40	78.67	58.89	1.25	0.84	9.21	12.31	7.45
P3xP8	4.52	72.06	51.13	1.47	1.09	14.88	8.75	8.44
P4xP5	5.73	75.00	46.56	1.65	0.38	9.04	6.86	6.17
P4xP6	3.83	67.29	47.00	1.55	0.83	10.16	10.77	7.61
P4xP7	3.15	60.56	34.32	1.25	0.69	10.33	10.97	6.13
P4xP8	5.63	63.91	38.33	1.57	1.30	18.28	8.14	8.71
Mean	3.69	74.62	53.12	1.47	0.80	11.45	7.67	8.98
LSD0.05	0.20	3.83	2.39	0.06	0.06	1.56	0.19	0.15
LSD0.01	0.27	5.09	3.18	0.08	0.08	2.08	0.25	0.20

 # = Parents from 1 to 4 were used as female and from 5 to 8 as male parents

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تقدير القدرة علي الائتلاف لثمانية تراكيب وراثية من الكتان تحت ظروف الأراضـي الرملية

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أجريت هذه الدراسة بهدف تقدير القدرة علي الائتلاف والفعل الجيني لثمانية تراكيب وراثية من الكتان تحت ظروف الاراضي الرملية، وذلك من خلال تقييم ١٦ هجين ناتجة من التهجين بين اربعة تراكيب وراثية (١ = س ٥٤١-جـ/٦ ، ٢ = س ٤٠٢/١، ٣ = س ٨١٣، ٤ = س ٩٩٧) استخدمت كأمهات ، وأربعة تراكيب وراثية (٥ = سخا ٣ ،٦ =س ٥٤١-جـ/٧، ٧ = سوزانا،٨ = س٥٤١-د/٤) استخدمت كآباء كشافة. في موسم ٢٠١٣ /٢٠١٤ تم إجراء التهجينات بين الأربعة أباء الكشافة مع الأربعة أمهات في محطة البحوث الزراعية بالجيزة؛ وفي موسم ٢٠١٤ /٢٠١٥ تم تقييم الثمانية أباء (الاربعة اباء كشافة + الابعة أمهات) مع الـ ١٦ هجين في الجيل الأول في حقل تربية الكتان بمحطة البحوث الزراعية بالإسماعيلية محافظة الاسماعلية في تجربة قطاعات كاملة العشوائية ذات أربعة مكررات.

وتشير النتائج إلى أن تأثير العوامل الوراثية المضيفة كان أكبر من العوامل الغير مضيفة في توريث صفات محصول القش للنبات ومكوناته (الطوا الكلي والطول الفعال) بالاضافة لوزن الألف بذرة وهذا يشير إلى إمكانية الانتخاب المباشر لتلك الصفات في الجيل الثاني والأجيال التالية له٠ من ناحية اخري أن تأثير العوامل الوراثية الغيرمضيفة كان أكبر من العوامل المضيفة في توريث صفات محصول البذور للنبات وعدد الكبسولات للنبات ومتوسط عدد البذور بالكبسولة٠. كما تشير النتائج أن تباين القدرة العامة علي الائتلاف ان س ٥٤١-جـ/٦، وسخا ٣ اظهرا ا قدره عامة علي الائتلاف لصفة محصول القش ومعظم مكوناته، أيضا سخا ٣ اظهر قدره عامة علي الائتلاف لصفة الطول الفعال للساق، وكذلك السلالة ٥٤١-د/٤ لصفتي محصول القش وعدد الافرع القاعدية للنبات٠ كذلك السلالتين ٥٤١-جـ/٦، ٥٤١-د/١٠ اظهرا قدره عامة علي الائتلاف لصفة محصول البذور للنبات ومعظم مكوناته، وهذا يشير إلي إمكانية إدخال هذه الآباء في برنامج تربية الكتان لتحسين محصولي القش والبذور.

كما تشير نتائج القدرة الخاصة علي الائتلاف أن هجين واحد (٤×٥) أظهر قدرة خاصة علي الائتلاف لصفة محصول القش ومكوناتة، وأن أبويه اظهرا قدرة عامة على الائتلاف (عالي × منخفض) لتلك الصفة واهم مكونين لها (الطول الكلي والطول الفعال) ، كذلك اشارت نتائج القدرة الخاصة علي الائتلاف أن هجين واحد (١×٥) أظهر قدرة خاصة علي الائتلاف لصفتي الطول الكلي والطول الفعال وان كلا أبويه اظهرا قدرة عامة على الائتلاف (عالي × عالي) وهذا الهجين (١×٦) كان كلا أبويه اظهرا قدرة عامة على الائتلاف (عالي × عالي) لصفتي لمحصول القش والطول الكلي للنبات٠

بالنسبة لمصول البذور هناك ٣ هجن {(١×٥)، (١×٦)، (٤×٨)} أظهروا قدرة خاصة علي الائتلاف لصفتي محصول البذور للنبات وعدد الكبسولات للنبات وأن ابائها اظهرت قدرة عامة على الائتلاف (عالي × منخفض)، ايضا هناك ٣ هجن {(١×٥)، (١×٧)، (٤×٨)} أظهروا قدرة خاصة علي الائتلاف لصفة عدد البذور بالكبسولة وكذلك الاباء اظهرت قدرة عامة على الائتلاف (عالي × منخفض)٠ بينما تشير نتائج القدرة الخاصة علي الائتلاف أن هناك ٣ هجن {(١×٥)، (١×٦)، (٤×٨)} اظهرت الاباء قدرة عامة على الائتلاف (عالي × عالي) لصفة وزن الالف بذرة٠ويتوقع من الهجن التي ابائها لها قدرة عامة علي الائتلاف عالية ان نحصل منها علي تراكيب وراثية مرغوبة في الاجيال الانعزالية٠ بذلك يمكن أن نستخلص أن الهجن سالفة الذكر مناسبة في المستقبل لإدخالها في برنامج تربية الكتان لتحسين محصولي القش والبذور ومكوناتهما.

Table2. Mean squares for each of straw and seed yields/plant and their components traits for eight flax genotypes (four females and four males parents) and their 16 F1.s crosses.

S.O.V.	df	Straw yield /plant and its components				Seed yield /plant and its components			
		Straw yield/plant (g)	Plant height (cm)	Technical stem length (cm)	No. of Basal branches / plant	Seed yield/plant (g)	No. of capsules/ plant	1000-seed weight (g)	No. of seeds/capsule
Reps	3	0.022 ns	5.822 ns	4.111 ns	219.511 ns	0.001 ns	0.070 ns	0.050 ns	0.044 ns
Entries	23	7.045 **	1207.852 **	794.829 **	440.639 **	0.726 **	113.307**	24.648 **	13.262 **
Parents	7	0.953 **	298.176 **	200.921 **	1319.746 **	0.147 **	18.120 **	14.577 **	5.284 **
Crosses	15	3.502 **	297.851 **	275.481 **	0.071 **	0.757 **	117.077 **	10.321 **	2.888 **
P.vs.C.	1	179.224 **	50672.159 **	29677.521 **	902.782 **	11.530 **	2245.611	599.905 **	486.999 **
Females (f)	3	8.500 *	1065.110 **	731.120 **	0.170 *	8.500 *	272.206 *	24.547 *	6.853 **
Males (m)	3	7.123 *	471.893 *	589.000 **	0.139 *	7.123 *	236.377 *	23.065 *	6.842 **
m x f	9	0.630 **	39.640 **	19.095 **	0.016 *	0.630	25.601 **	1.331 **	0.249 **
Error	69	0.045	5.898	2.696	0.005	0.006	1.324	0.028	0.040

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

Table5. Specific combining ability effects ($\hat{s}_{ij}$) for straw and seed yields/plant and their components traits in 16 F_1's flax crosses.

Crosses	Straw yield and its components				Seed yield and its components			
	Straw yield/plant (g)	Plant height (cm)	Technical stem length (cm)	No. of basal branches Per plant	Seed yield/plant (g)	No. of capsules /plant	1000-seed weight (g)	No. of seeds /capsule
1x5 #	-0.369 *	4.983 **	8.398 **	-0.224 **	0.420 **	4.064 **	1.640 **	0.581 **
1x6	0.765 **	8.385 **	0.876 ns	0.030 ns	0.255 **	4.501 **	-0.261 *	-0.365 *
1x7	-0.618 **	-10.518 **	-7.720 **	0.108 *	-0.698 **	-7.674 **	-2.539 **	0.265 *
1x8	0.223 *	-2.850 *	-1.554 ns	0.087 *	0.022 ns	-0.891 ns	1.161 **	-0.481 **
2x5	0.196 ns	2.699 *	1.036 ns	0.047 ns	-0.305 **	-3.788 **	0.144 ns	-0.672 **
2x6	0.090 ns	-5.087 **	-0.984 ns	-0.132 *	-0.272 **	-3.036 **	-1.065 **	0.523 **
2x7	0.595 **	-1.540 ns	-1.962 *	0.132 *	0.687 **	8.722 **	0.582 **	0.025 ns
2x8	-0.882 **	3.928 *	1.911 *	-0.047 ns	-0.110 *	-1.898 *	0.339 **	0.124 ns
3x5	-0.874 **	-13.115 **	-12.131 **	0.063 ns	0.017 ns	0.451 ns	-1.018 **	0.742 **
3x6	0.113 ns	-0.558 ns	-0.866 ns	0.040 ns	-0.080 *	-1.147 ns	0.241 *	-0.298 *
3x7	0.810 **	12.608 **	11.951 **	-0.077 *	0.102 *	-0.042 ns	1.436 **	0.013 ns
3x8	-0.049 ns	1.064 ns	1.046 ns	-0.026 ns	-0.038 ns	0.738 ns	-0.659 **	-0.457 **
4x5	1.046 **	5.432 **	2.697 *	0.113 *	-0.133 *	-0.727 ns	-0.766 **	-0.652 **
4x6	-0.967 **	-2.741 *	0.975 ns	0.062 ns	0.097 *	-0.318 ns	1.085 **	0.140 ns
4x7	-0.787 **	-0.550 ns	-2.269 *	-0.162 **	-0.091 *	-1.005 ns	0.522 **	-0.303 *
4x8	0.708 **	-2.142 ns	-1.403 ns	-0.013 ns	0.127 *	2.050 *	-0.841 **	0.814 **
SE (sij-sii)	0.149	1.161	1.161	0.052	0.054	0.814	0.118	0.141

ns,*, Indicate non-significant, significant and highly significant, respectively.**
 # = For explanation see Table (4)