Egypt. J. Agric. Res., 84 (4), 2006

LINE X TESTER ANALYSIS FOR COMBINING ABILITY IN SOME FLAX GENOTYPES

ABO-KAIED, H. M.

Field Crops Res. Inst., ARC, Egypt

(Manuscript received 22 October 2005)

Abstract

This study was conducted to estimate combining ability and gene action in some flax genotypes. This was achieved via evaluating the twelve parents and their 32 F_1's progenies. The twelve parents consisting of eight females (P_1=Escalina, P_2=Leflora, P_3=Elona, P_4=Marlin, P_5=Alba, P_6=Verty, P_7=117/001 and P_8=117/002) and four males (P_9=Giza4, P_{10}=S.435/11/10/3, P_{11}= S.402/2/2/5 and P_{12}=S.2467/1). In 2003/04 season, each of the 4 male parents was crossed to the 8 female parents to obtain 32 F_1 crosses at the breeding nursery of Fiber Crops Res. Section, ARC at Giza. In 2004/05 season, the parents and their 32 $F_1{}^{'S}$ seeds were evaluated at the same location.

The collected data regarded herein indicated that for most traits studied, a large portion of gene action was due to non-additive, indicating that the most efficient system for breeding in this case is the bi-parental mating in to obtain new segregates in the segregating generations. GCA variances were not significant for most traits studied. This results may be occurred as a result for using all females in this study belong to one type (fiber type) only of flax.

For straw yield, four crosses ($p_1 \times p_{10}$, $p_2 \times p_{11}$, $p_4 \times p_{11}$ and $p_5 \times p_9$) exhibited significant and positive SCA effects for straw yield and most of its components. For seed yield, four crosses ($p_1 \times p_9$, $p_1 \times p_{10}$, $p_2 \times p_{12}$ and $p_7 \times p_{10}$) exhibited significant and positive SCA effects for seed yield per plant and in most of its components. It could be concluded that the above mentioned crosses would be interesting and prospective for the future in flax breeding for improving both of straw and seed yield and their components by using bi-parental mating system.

The pattern of phenotypic and genotypic correlation of straw, seed yield with other related traits supports the evidence for the possibility of selecting genotypes characterized with high straw yielding ability and in the same time high seed yield potentialities by using bi-parental mating system.

Key words: ***Line x tester, Combining ability, Gene action, correlation, Flax.***

INTRODUCTION

Choice of parents for hybridization is a crucial step in plant breeding programmers. Among many criteria used like *per se* performance of the parents and genetic diversity between the parents, the nature of combining ability of the elite parents to be used in hybridization program is very important. Combining ability analysis also provides the breeder an insight into the nature and relative magnitude of fixable and non-fixable genetic variance in the material he is dealing with which in turn will help him to take up sound decisions in the planning of a breeding program.

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 investigators studied the nature and magnitude of combining ability and gene action for evaluating the potential of parents for producing desirable recombination's in flax. The additive genetic variance had more important role in the inheritance of straw yield, plant height, technical length, seed index as reported by Thakur *et al* (1987), Sharma *et al* (1986), Patil *et al* (1997), Foster *et al* (1998) and Abo-El-Zahab and Abo-Kaied (2000). 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) and Mishra and Rai (1996). This present study is one such attempt to elicit information on combining ability and gene action with respect to straw, seed yields and their components in flax, with an ultimate goal of selecting suitable parents and the superior crosses which can be used in breeding program. As well as to estimate Phenotypic (r_p) and genotypic (r_g) correlation coefficients between seed, straw yields and related characters.

MATERIALS AND METHODS

The materials used for the present study comprised twelve genotypes selected on the basis of their geographical diversity and morphological variability. These parents involved eight introductions of flax viz:P_1=Escalina, P_2=Leflora, P_3=Elona, P_4=Marlin, P_5=Alba, P_6=Verty, P_7=117/001 and P_8=117/002 as female parents (called 'line' hereafter) and four adapted local genotypes viz: P_9=Giza4, P_{10}=S.435/11/10/3, P_{11}= S.402/2/2/5 and P_{12}=S.2467/1 (called 'tester' hereafter). These twelve parents represent a wide genetic variability for yield and yield component traits of flax.

In 2003/2004 season, each of the four male parents was crossed to the eight female parents to obtain 32 F_1 crosses at Giza Res. Sta. of Agric. Res. Center. In

2004/2005 season, the parents and their 32 $F_1{}^{'s}$ seeds were evaluated in the breeding nursery of Fiber Crops Res. Section, ARC at Giza.

The experiment was laid out in a randomized complete block design with three 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, 10 individual guarded plants were taken at random from each entry per replication. These plants were used for recording: straw yield (g) per plant and its components (plant height (cm), technical stem length (cm), No. of basal branches) and seed yield (g) per plant and its components (No. of capsules per plant, 1000-seed weight (g) and No. of seeds per capsule).

Statistical analysis

Analysis of variance of the data was performed on plot means bases. 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.

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:

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

$\sigma^2 GCA=((1+F)/4)\ \sigma^2 Additive$

$\sigma^2 SCA=((1+F)/2)^2\ \sigma^2\ Dominance$

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.

Phenotypic (r_p) and genotypic (r_g) correlation coefficients were calculated according to the formula suggested by Al-Jibouri et al., (1958).

RESULTS AND DISCUSSION

Straw yield and its components:

The analysis of variance for straw yield per plant and its components traits (plant height, technical stem length and No. of basal branches per plant) are presented in Table (1). Mean squares due to entries (parents and $F_1{}^{'s}$) are 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, crosses, females and male revealed significant differences among entries for all characters in most cases. These results indicated wide genetic variability for all variables study. On the other hand, female mean square was not significant for No. of basal branches per plant. Also, mean square due to male x female (m x f) interactions were not significant for all studied traits except for technical stem length.

Partitioning of genetic variance into general (GCA) and specific (SCA) combining ability variances is shown in Table (2). GCA variances were not significant for straw yield and its components. This results may be occurred as a result for using all females in this study belong to one type (fiber type) only of flax. In Egypt, flax is grown for both fiber and oil (dual purpose). For this reason, in future the Egyptian flax breeders must be use more than type (oil, fiber and dual purpose) for any hybridizations program of flax. So, in this case, the estimation of GCA effects for these parents for straw yield and its components is unnecessary. On the other hand, SCA variances were highly significant for these traits as well as SCA variances were larger than the corresponding GCA variances, indicating the predominant role of non-additive gene action involved in the expression of these characters. Since non-additive type of gene action was predominant for straw yield and its components, recurrent selection would prove most effective. However, flax being a strictly self-pollinated crop, recurrent selection in true sense is difficult to be exercised. Of course by the use of suitable male sterility (Comatock,1965) it is possible to exploit non-additive type of gene action for the production of hybrid seed, Dubey and Singth (1966) have also shown the feasibility of hybrid seed production in flax. But till the hybrid seed production on commercial scale becomes possible, non-additive type of gene action in flax could be exploited if we resort to multiple-crossing procedure. Also, the values of additive and dominance as well as, the ratio of GCA/SCA variances for all characters (Table2) showed that, the non-additive were more important than additive effects. These results are in agreement with those obtained by Roa and Singh (1987), Thakur and Rana (1987) and Mishra and Rai (1996) for No. of basal branches per plant. On the other hand, Thakur *et al* (1987) Abo-El-Zahab and Abo-Kaied (2000) reported that the largest part of the total genetic variability of these traits might be attributable to additive genetic effects.

Specific combining ability effects ($\hat{S}_{ij}$) calculated for each cross are presented in Table (3). Seven crosses ($p_1 \times p_{10}$, $p_2 \times p_{11}$,$p_2 \times p_{12}$, $p_4 \times p_{11}$, $p_5 \times p_9$, $p_6 \times p_{12}$, and $p_7 \times p_{10}$) exhibited significant positive specific combining ability effects for straw yield per plant. Six crosses ($p_1 \times p_{10}$, $p_2 \times p_{11}$, $p_4 \times p_{11}$, $p_5 \times p_9$, $p_5 \times p_{12}$ and $p_7 \times p_9$) indicated significant positive SCA effects for plant height. Six crosses ($p_1 \times p_{10}$, $p_2 \times p_{11}$, $p_3 \times p_{10}$,

$p_4 \times p_{11}$, $p_7 \times p_9$ and $p_7 \times p_{10}$) exhibited significant positive SCA effects for technical stem length. Five crosses ($p_1 \times p_{10}$, $p_2 \times p_{11}$, $p_2 \times p_{12}$, $p_5 \times p_9$ and $p_8 \times p_9$) showed significant positive SCA effects for No. of basal branches per plant. In general, four crosses ($p_1 \times p_{10}$, $p_2 \times p_{11}$, $p_4 \times p_{11}$ and $p_5 \times p_9$) exhibited significant positive SCA effects for straw yield and most of its components. 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 (4). The means values of lines showed wide differences with a rang of 1.49-4.37, 79.93-92.07 and 51.48-68.07 for straw yield, plant height, technical stem length and No. of basal branches per plant, respectively. Also, the mean values of testers indicated wide variability with a rang of 2.55-6.16, 83.81-92.45, 58.77-64.12 and 1.37-2.28 for the mentioned characters in the same order. The female parent p_5 (Alba), p_4 (Marlen), p_2 (Leflora) and p_4 (Marlen) recorded the highest values for the mentioned in the same order. On the other hand, male parents p_{11} (S.402/2/2/5) recorded the highest values for all straw yield components. However, the four best crosses ($p_4 \times p_{11}$, $p_5 \times p_9$, $p_4 \times p_{12}$, $p_1 \times p_{10}$), ($p_4 \times p_{11}$, $p_1 \times p_{10}$, $p_3 \times p_{11}$, $p_3 \times p_{12}$), ($p_1 \times p_9$, $p_3 \times p_9$, $p_5 \times p_9$, $p_7 \times p_9$) and ($p_3 \times p_9$, $p_5 \times p_9$, $p_8 \times p_9$, $p_2 \times p_{12}$) for each of the mentioned characters in the same order were recorded highest values. It could be concluded that the above mentioned crosses and their parents would be interesting and prospective for the future in flax breeding program for improving seed yield and its components.

Seed yield and its components:

Analysis of variance for seed yield per plant and its components viz., No. of capsules per plant, 1000-seed weight and No of seeds per capsule are shown in Table (1). Mean squares due to entries (parents and F_1'^{s} crosses), crosses, lines and testers were significant for all characters in most cases. These results indicated that those parental genotypes (lines and testers) as well as in F_1'^{s} crosses showed reasonable degrees of variability in these material under study. However, mean square due to lines x testers interaction was not significant for all traits. Also, mean square due to tester for No. of basal branches per plant were non- significant.

Partitioning of genetic variance into GCA and SCA variances for seed yield and its components is shown in Table (2). GCA variances were not significant for all traits except for 1000-seed weight. On the other hand, SCA variances were highly significant for all study traits. For all cases, SCA variances were larger than the corresponding GCA variances, which reflected on each of additive, dominance variances and

GCA/SCA ratio. These results, indicated the predominant role of non-additive and gene action involved in the expression of the these traits. Bhatnagar and Mehrotra (1980) also found non-additive type gene action of relatively greater importance for seeds per capsule, capsules per plant and seed yield per plant.

Table (3) shows specific combining ability effects ($\hat{S}_{ij}$) for seed yield per plant and its components. Six crosses ($p_1 \times p_9$, $p_2 \times p_{10}$, $p_2 \times p_{11}$, $p_2 \times p_{12}$, $p_6 \times p_{12}$ and $p_7 \times p_{12}$) indicated highly significant positive SCA effects for seed yield per plant. Eight crosses($p_1 \times p_9$, $p_1 \times p_{10}$, $p_2 \times p_{12}$, $p_3 \times p_{11}$, $p_4 \times p_{11}$, $p_5 \times p_9$, $p_6 \times p_{12}$, and $p_7 \times p_{10}$) exhibited highly significant positive SCA effects for No. of capsules per plant. Seven crosses ($p_1 \times p_{10}$, $p_1 \times p_{12}$, $p_2 \times p_{12}$, $p_4 \times p_9$, $p_5 \times p_{12}$, $p_7 \times p_{10}$, and $p_8 \times p_9$) showed significant positive specific for 1000-seed weight. Two crosses ($p_1 \times p_9$ and $p_5 \times p_9$) also, showed higher SCA effects for No. of seeds per capsule. In general, four crosses ($p_1 \times p_9$, $p_1 \times p_{10}$, $p_2 \times p_{12}$ and $p_7 \times p_{10}$) exhibited significant positive SCA effects for seed yield per plant and in most of its components. SCA performance may be considered as a criterion for selecting the promising crosses in flax. It may also be worth while to attempt bi-parental mating in the segregating generation among selected crosses to permit greater recombination's.

The mean performance of parents (lines and testers) and their $F_1{}^{'s}$ crosses for seed yield and its components are presented in Table (4). The means values of lines, testers and crosses showed wide differences. The female parents p_6 (Verty), p_5 (Alba), p_7 (177/001) and p_6 (Verty) recorded the highest values for seed yield, No. of capsules per plant, 1000-seed weight and No. of basal branches per plant, respectively. On the other hand, male parent p_{11} (S.402/2/2/5) recorded the highest values for seed yield and No. of capsules per plant. P_{12} (S.2467/1) recoded the highest values for 1000-seed weight and No. of basal branches per plant. While, the highest mean values of four crosses for each the mentioned characters in the same order were ($p_1 x p_{10}$, $p_1 x p_9$, $p_7 x p_{10}$ and $p_3 x p_9$), ($p_4 \times p_{11}$, $p_2 \times p_{12}$, $p_5 \times p_9$ and $p_4 \times p_9$), ($p_6 \times p_{10}$, $p_5 \times p_{12}$, $p_6 \times p_{11}$ and $p_6 \times p_{12}$), and ($p_1 \times p_9$, $p_4 \times p_{10}$, $p_7 \times p_{12}$ and $p_3 \times p_{12}$). It could be concluded that the above mentioned parents and crosses would be interesting and prospective for the future in flax breeding for improving seed yield and its components.

Phenotypic and genotypic correlation among straw, seed yields and other components:

The knowledge of genetic correlation coefficients between different yield attributes lead the flax breeder to find out the nature and magnitude of the association between these traits which are mostly used to attain better yield.

Phenotypic (rp) and genotypic (rg) correlation coefficient among eight traits in flax are shown in Table (5). The interrelationships between straw yield and each of plant height, technical stem length, basal branches, seed yield, capsules per plant and 1000-seed weight were significant positive. Also, the significant positive correlation among plant height and both of technical length and basal branches was present, indicating that the breeder can utilize such correlated response to obtain high straw yielding genotypes through selection for one or more of these characters in the segregating generations. Similar results were reported by Mourad (1983) and Abo-El-Zahab *et al* (1994). On the other hand, seed yield per plant was significant positively correlated with each of No. of capsules, 1000-seed weight, plant height, technical stem length and No. of basal branches. Also, No. of capsules per plant exhibited highly significant positive correlation with each of 1000-seed weight, plant height and technical stem length. These results are in harmony with those reported by Momtaz *et al.*,1977, and Abo-El-Zahab *et al* (1994)

In general, the pattern of association of straw, seed yield with other related traits supports the evidence for the possibility of selecting genotypes characterized with high straw yielding ability and in the same time high seed yield potentialities..

CONCLUSION

The collected data regarded herein indicated that for most traits studied, a large portion of gene action was due to non-additive, indicating that the most efficient system for breeding in this case is the bi-parental mating in to obtain new segregates in the segregating generations. However, the nature of nearly complete self-fertilization for flax, precluded the using of this system. However, further solution for this problem was discussed in the section titled results and discussion.

Table 1. Mean squares for each of straw and seed yield /plant and their components traits for twelve flax genotypes (eight females and four males) and their 32 $F_1^{'s}$ crosses.

		Straw yield /plant and its components				Seed yield /plant and its components			
S.O.V.	df	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	0.1033 ns	2.4968 ns	3.95162 ns	0.07854 ns	0.05803 ns	154.85 *	0.05832 ns	0.9396 ns
Entries	43	17.281 **	172.26 **	110.504 **	1.78794 **	2.5979 **	1344.59 **	12.1586 **	3.3330 **
Error	129	0.2942	6.2899	8.90548	0.07549	0.10706	39.577	0.13391	0.4362
Parents	11	5.2556 **	60.522 **	100.768 **	2.136 **	2.55244 **	271.375 **	22.7479 **	5.4099 **
Crosses	31	10.692 **	137.45 **	106.34 **	0.463 **	1.3055 **	958.618 **	4.4503 **	2.1536 **
Females (f)	7	21.286 *	351.14 **	147.839 *	0.5629 ns	1.42586 ns	444.520 **	14.9998 **	1.3889 **
Males (m)	3	4.2722 **	57.807 **	364.589 **	0.35401 **	2.23851 **	1816.27 *	1.75219 **	2.7659 ns
m x f	21	8.0779 ns	77.592 ns	55.6137 **	0.44526 ns	1.1321 ns	746.178 ns	1.31922 ns	2.0588 ns
Error	129	0.2942	6.2899	8.90548	0.07549	0.10706	39.577	0.13391	0.4362

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

Table 2. 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 12 flax parents and their 32 $F_1^{'s}$ 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	0.063 ns	1.450 ns	1.229 ns	0.0001 ns	0.004 ns	5.145 ns	0.076 *	0.002 ns
SCA	1.946 **	17.826 **	11.677 **	0.092 **	0.256 **	176.65 **	0.296 **	0.406 **
Additive	0.127	2.899	2.457	0.001	0.008	10.290	0.152	0.005
Dominance	1.946	17.826	11.677	0.092	0.256	176.650	0.296	0.406
Error	0.074	1.572	2.226	0.019	0.027	9.894	0.033	0.109
GCA/SCA	0.033	0.081	0.105	0.005	0.016	0.029	0.256	0.006

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

Table 3. Estimates of specific combining ability effects ($\hat{s}_{ij}$) for studied straw and seed yields/plant and their components traits in 32 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
1x9 #	0.462 ns	0.198 ns	2.789 ns	-0.693 **	0.477 **	11.733 **	-0.707 **	1.125 **
1x10	1.866 **	7.196 **	5.245 **	0.421 **	0.922 **	7.239 *	0.461 *	-0.722 *
1x11	-1.383 **	-5.218 **	-4.990 **	-0.019 ns	-0.531 **	-13.029 **	-0.188 ns	0.580 ns
1x12	-0.945 **	-2.176 ns	-3.044 ns	0.291 *	-0.868 **	-5.943 ns	0.434 *	-0.983 **
2x9	-3.108 **	-1.918 ns	-3.353 *	-0.560 **	-0.948 **	-27.154 **	-0.106 ns	0.054 ns
2x10	-0.247 ns	1.813 ns	0.071 ns	-0.163 ns	-0.196 ns	-2.854 ns	-0.485 *	-0.325 ns
2x11	1.666 **	3.631 **	3.068 *	0.281 *	0.508 **	3.200 ns	-0.157 ns	0.142 ns
2x12	1.689 **	-3.527 **	0.214 ns	0.442 **	0.636 **	26.808 **	0.748 **	0.129 ns
3x9	0.276 ns	-5.110 **	-0.445 ns	0.181 ns	0.250 ns	2.204 ns	-0.540 **	-0.063 ns
3x10	-0.717 *	0.688 ns	3.412 *	-0.105 ns	-0.248 ns	-7.547 *	0.106 ns	0.025 ns
3x11	0.825 **	2.074 ns	-3.723 *	0.140 ns	0.099 ns	11.310 **	0.274 ns	-0.440 ns
3x12	-0.384 ns	2.348 ns	0.755 ns	-0.217 ns	-0.101 ns	-5.967 ns	0.159 ns	0.479 ns
4x9	-0.638 *	0.615 ns	0.072 ns	0.085 ns	0.248 ns	-4.327 ns	0.810 **	-0.865 *
4x10	-0.969 **	-6.219 **	-1.571 ns	-0.050 ns	-0.252 ns	-9.615 **	-0.294 ns	1.223 **
4x11	1.364 **	9.431 **	6.526 **	0.127 ns	0.244 ns	19.969 **	0.054 ns	-0.060 ns
4x12	0.244 ns	-3.827 **	-5.028 **	-0.162 ns	-0.240 ns	-6.027 ns	-0.571 **	-0.298 ns
5x9	1.936 **	3.596 **	-0.890 ns	0.319 *	-0.111 ns	16.987 **	0.331 ns	0.842 *
5x10	0.065 ns	-3.264 *	-1.884 ns	0.000 ns	-0.216 ns	8.606 *	-1.023 **	0.448 ns
5x11	-0.645 *	-2.321 ns	-1.736 ns	-0.240 ns	0.198 ns	-8.807 **	0.110 ns	-0.817 *
5x12	-1.356 **	1.989 ns	4.510 **	-0.079 ns	0.129 ns	-16.786 **	0.582 **	-0.473 ns
6x9	0.263 ns	-0.803 ns	-2.927 ns	0.132 ns	-0.365 *	-5.279 ns	-0.115 ns	-0.963 **
6x10	-0.261 ns	-0.602 ns	0.762 ns	0.079 ns	-0.133 ns	1.736 ns	0.624 **	0.310 ns
6x11	-1.255 **	1.249 ns	2.360 ns	-0.227 ns	-0.149 ns	-4.890 ns	0.037 ns	0.092 ns
6x12	1.253 **	0.156 ns	-0.195 ns	0.016 ns	0.647 **	8.433 *	-0.546 **	0.561 ns
7x9	0.500 ns	3.232 *	4.023 *	0.164 ns	0.149 ns	1.073 ns	-0.270 ns	0.222 ns
7x10	1.494 **	-2.035 ns	-5.955 **	0.046 ns	0.641 **	12.849 **	0.501 *	-0.933 **
7x11	-1.148 **	-3.119 *	-1.090 ns	-0.327 *	-0.449 *	-7.639 *	-0.261 ns	0.065 ns
7x12	-0.845 **	1.922 ns	3.023 ns	0.116 ns	-0.341 *	-6.283 ns	0.029 ns	0.646 ns
8x9	0.310 ns	0.189 ns	0.731 ns	0.372 *	0.299 ns	4.762 ns	0.595 **	-0.350 ns
8x10	-1.231 **	2.422 ns	-0.080 ns	-0.228 ns	-0.519 **	-10.414 **	0.111 ns	-0.027 ns
8x11	0.577 *	-5.727 **	-0.415 ns	0.264 ns	0.081 ns	-0.112 ns	0.129 ns	0.438 ns
8x12	0.345 ns	3.115 *	-0.236 ns	-0.408 **	0.139 ns	5.764 ns	-0.836 **	-0.061 ns
SE $\hat{s}_{ij}$	0.271	1.254	1.492	0.137	0.164	3.146	0.183	0.330

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

Table 4. Mean performances of twelve flax parents and 32 F_1's crosses for studied straw and seed yields and their components of flax.

Genotypes	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
parents #								
1=I.Escalina	2.68	82.13	54.53	0.60	0.48	14.87	4.26	6.83
2=Leflora	1.49	88.13	68.07	0.49	0.48	10.77	4.54	6.00
3=Elona	2.58	84.87	61.53	0.17	0.39	16.48	4.12	5.43
4=Marlen	3.36	92.07	67.93	1.23	0.35	12.01	4.48	7.07
5=Alba	4.37	86.16	51.48	0.47	0.54	22.79	4.25	4.63
6=Verty	2.83	87.87	61.27	0.27	1.41	13.80	4.73	8.63
7=117/001	2.71	79.93	54.93	0.24	0.75	9.14	4.80	8.20
8=117/002	2.43	80.20	57.47	0.37	0.93	11.50	4.44	7.00
9=Giza 4	3.95	87.63	58.77	1.73	1.39	24.59	8.52	6.97
10=S.435/11/10/3	2.55	86.97	62.73	1.37	1.09	16.47	9.62	7.07
11=S.402/2/2/5	6.16	83.81	63.64	2.09	3.37	40.47	9.62	4.96
12=S.2467/1	3.44	92.45	64.12	2.28	1.31	19.69	10.03	7.10
crosses								
1x9	6.96	94.80	72.20	1.30	3.04	59.37	5.98	8.60
1x10	8.26	103.33	68.50	2.35	3.61	56.81	7.13	6.37
1x11	4.32	92.67	60.47	1.73	1.55	28.02	6.49	7.60
1x12	5.05	93.87	58.57	2.13	1.60	38.60	7.58	6.10
2x9	3.17	86.67	59.73	1.60	1.09	20.49	7.74	7.17
2x10	5.92	91.93	57.00	1.93	1.97	46.72	7.34	6.40
2x11	7.15	95.50	62.20	2.20	2.06	44.26	7.68	6.80
2x12	7.47	86.50	55.50	2.45	2.58	71.35	9.05	6.85
3x9	8.07	92.20	71.90	2.55	2.88	55.33	6.51	8.10
3x10	6.97	99.53	69.60	2.20	2.52	47.51	7.14	7.80
3x11	7.83	102.67	64.67	2.27	2.25	57.85	7.32	7.27
3x12	6.91	101.10	65.30	2.00	2.44	44.06	7.67	8.25
4x9	8.25	99.10	66.60	2.10	2.06	61.23	8.26	6.80
4x10	7.81	93.80	58.80	1.90	1.69	57.87	7.14	8.5
4x11	9.46	111.20	69.10	1.90	1.57	78.94	7.50	7.15
4x12	8.63	96.10	53.70	1.70	1.48	56.43	7.34	6.98
5x9	9.09	99.03	70.10	2.53	2.34	66.80	9.04	8.18
5x10	7.11	93.71	62.95	2.15	2.37	60.35	7.67	7.40
5x11	5.72	96.40	65.30	1.73	2.17	34.42	8.81	6.07
5x12	5.30	98.87	67.70	1.98	2.49	29.93	9.75	6.48
6x9	6.10	93.13	64.20	1.87	1.58	26.79	9.54	6.08
6x10	5.47	94.87	61.73	1.75	1.94	35.73	10.26	6.97
6x11	3.79	98.47	65.53	1.27	1.31	20.59	9.69	6.68
6x12	6.59	95.53	59.13	1.60	2.50	37.40	9.57	7.22
7x9	6.30	91.40	69.67	2.20	2.30	38.09	6.92	8.33
7x10	7.19	87.67	53.53	2.02	2.92	51.80	7.68	6.78
7x11	3.86	88.33	60.60	1.47	1.22	22.79	6.93	7.71
7x12	4.46	91.53	60.87	2.00	1.72	27.63	7.68	8.36
8x9	5.85	85.90	66.97	2.53	2.55	42.55	8.40	7.06
8x10	4.20	89.67	60.00	1.87	1.86	29.31	7.90	7.74
8x11	5.32	83.27	61.87	2.18	1.85	31.09	7.93	7.39
8x12	5.38	90.27	58.20	1.60	2.30	40.45	7.43	6.95
Mean	5.51	92.07	62.47	1.69	1.83	37.12	7.42	7.07
LSD0.05	0.76	3.51	4.18	0.38	0.46	10.171	0.51	1.068
LSD0.01	1.00	4.64	5.52	0.51	0.61	13.443	0.68	1.411

= Parents from 1 to 8 were used as female and from 9 to 12 as male parents.

Table 5. Phenotypic (r_p) and genotypic (r_g) correlation coefficients among eight traits for 44 flax genotypes (12 parents and 32 F_1 crosses).

Characters		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)
Plant height (cm)	r_p	0.668**						
	r_g	0.506						
Technical stem length (cm)	r_p	0.390*	0.533**					
	r_g	0.421	0.435					
No. of Basal branches/plant	r_p	0.716**	0.487**	0.360*				
	r_g	0.325	0.145	0.206				
Seed yield/plant(g)	r_p	0.722**	0.395**	0.366*	0.724**			
	r_g	0.324	0.221	0.105	0.518			
No. of capsules/plant	r_p	0.948**	0.612**	0.259	0.685**	0.698**		
	r_g	0.706	0.238	0.157	0.713	0.665		
1000-seed weight (g)	r_p	0.369*	0.353*	0.174	0.686**	0.500**	0.323*	
	r_g	0.208	0.211	0.224	0.279	0.467	0.428	
No. of seeds/capsule	r_p	0.173	0.147	0.257	0.163	0.156	0.179	-0.049
	r_g	0.106	0.011	0.111	0.165	-0.127	-0.18	-0.242

*,** Significant at 0.05 and 0.01 levels of probability, respectively.

REFERENCES

1. Abo El-Zahab, A. A. and H. M. H. Abo-Kaied. 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.2-3Sept. 387-402.
2. Abo El-Zahab, A. A., N. K. Mourad and H. M. H. Abo-Kaied. 1994. Genotype - Environment interaction and evaluation of flax Genotypes. I straw yield. Proc. 6 th Conf. Agron., Al-Azhar Univ., Cairo, Egypt, Vol. 1: 129-152.
3. Al-Jibouri, H. A., P. A. Miller and H. F. Robinson. 1958. Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin. Agron. J. 50: 633-636.
4. Bhatnagar, S. K. and H. N. Mehrotra. 1980. Combining ability and gene action for oil content in linseed. Indian J. of Genetics and plant breeding 40: 99-101.
5. Comostoc, V. E. 1965. Possibilities of hybrid seed production. Flax Institute 35: 24-5.
6. Dubey, D. K. and S. P. Singh. 1966. Use of cytoplasmic male sterility for production of hybrid seed in flax (*Linum usitatissimum* L.). Crop Science 6: 125-6.
7. Kempthorne, C. 1957. An Introduction to Genetical Statistics, PP. 468-71. John-Wiley & Sons, New York.
8. Mishra, V. K. and M. Rai. 1996. Combining ability analysis for seed yield and quality components of seed and oil in linseed (*Linum usitatissimum* L.). Indian J. Genet. 56: 155-161.
9. Momtaz, A., A. K. A. Selim and G. H. El- Shimy. 1977. Association studies between flax seed yield and some other characters. Agric. Res. Rev., 55: 45-55.
10. Mourad, N. K. M. 1983. Effect of different selection methods on improving yield in some flax crosses. Ph. D. thesis, Fac. Agric. Al- Azhar Univ.
11. Rao, S. K. and S. P. Singh. 1987. Additive, dominance and epistatic effects in linseed (*Linum usitatissimum* L.). Indian J. Agric. Sci. 57: 208-211.
12. Singh, P. and S. S. Narayanan. 1993. Biometrical techniques in plant breeding. Second edition, Kalyani Publishers, New Delhi, 1000 002.
13. Singh, R. K. and B. D. Chaudhary. 1985. Biometrical methods in quantitative genetic analysis. Third edition, Kalyani Publishers, 24, Daryaganj, New Delhi. India –110 002.
14. Thakur, H. L. and N. D. Rana. 1987. Combining ability in linseed. Indian J. Agric. Sci., 57: 303-308.
15. Thakur, H. L., N. D. Rana and O. P. Sood. 1987. Combining ability analysis for some quantitative characters in linseed. Indian J. Genet. 47: 6-10.

تحليل الأب الكشاف × سلالة لتقدير القدرة علي الائتلاف لبعض التراكيب الوراثية في الكتان

حسين مصطفي حسين أبوقايد

معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية– الجيزة

أجريت هذه الدراسة بهدف تقدير القدرة علي الائتلاف والفعل الجيني لبعض التراكيب الوراثية في الكتان باستخدام تحليل الأب الكشاف في السلالة من خلال تقييم ٣٢ هجين ناتجة من التهجين بين ثمانية مستوردات (١ = اسكالينا ، ٢ = ليفلورا ، ٣ = إيلونا ، ٤ = مارلين ، ٥ = ألبا ، ٦ = فرتي ، ٧ = ١١٧/ ٠٠١ ، ٨ = ١١٧/٠٠٢) استخدمت كأمهات ، وأربعة تراكيب وراثية (٩ = جيزة٤ ، ١٠ = س ٤٣٥/١١/١٠/٣ ، ١١ = س ٤٠٢/٢/٢/٥، ١٢ = س ٢٤٦٧/١) استخدمت كآباء كشافة.

في موسم ٢٠٠٣ /٢٠٠٤ تم إجراء التهجينات بين الأربعة أباء الكشافة مع الثمانية أمهات ؛ وفي موسم ٢٠٠٤ /٢٠٠٥ تم تقييم الـ١٢ أب مع الـ ٣٢ هجين في الجيل الأول مع هذه الآباء في حقل تربية الكتان بمركز البحوث الزراعية بالجيزة في تجربة قطاعات كاملة العشوائية ذات أربعة مكررات .

وتشير النتائج إلى أن تأثير العوامل الوراثية الغير مضيفة كان أكبر من العوامل المضيفة في توريث معظم الصفات المدروسة (محصولي القش والبذور ومكوناتهما) وهذا يشير إلى أن زيادة كفاءة برنامج التربية يتم عن طريق التزاوج بين الهجن المتميزة للحصول بعد ذلك علي هجن جديدة يتوقع منها أن تعطي بعد ذلك انعزالات متميزة في الأجيال الانعزالية المتقدمة. كما تشير النتائج أن تباين القدرة العامة علي الائتلاف كان غير معنوي لمعظم الصفات المدروسة وهذه النتيجة ربما ترجع إلى أن جميع الأمهات المستخدمة في الدراسة هي مستوردات تنتمي للطراز الليفي، والمعروف أن في مصر الطراز المنزرع هو الطراز الثنائي(للألياف والزيت) لذلك علي مربي الكتان في مصر في أي برنامج تهجينات في المستقبل أن تكون الأمهات تنتمي لأكثر من طراز من طرز الكتان خاصة عند استخدام تكنيك تحليل الأب الكشاف x سلالة.

كما تشير نتائج القدرة الخاصة علي الائتلاف أن هناك ٤ هجن {(١ x ١٠)، (٢x ١١)، (٤x ١١)، (٥x٩)} أظهروا قدرة عالية علي الائتلاف لصفة محصول القش و مكوناته، كذلك هناك ٤ هجن {(١ x٩)، (١x١٠)، (٢x١٢)، (٧x١٠)} أظهروا قدرة عالية علي الائتلاف لصفة محصول البذرة ومعظم مكوناته .

ومن هنا يمكن اختيار الهجن سالفة الذكر والتي تميزت بالقدرة العالية علي الائتلاف لإدخالها في المستقبل في برامج التربية بهدف تحسين محصولي القش والبذور ومكوناتهما.

كما تشير نتائج الارتباط الظاهري والوراثي لصفتي محصول القش والبذور ومكوناتهما إلى إمكانية انتخاب تراكيب وراثية تتميز بالمحصول المرتفع لكل من القش والبذرة .