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EVALUATION OF YIELD AND STABILITY IN EARLY FLAX GENERATIONS. II. SEED YIELD AND ITS COMPONENTS

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Abstract

Combining ability and stability performance for seed yield/plant and its component traits viz., capsules/plant, seeds/capsule and 1000-seed weight were studied in the F_3 and F_4 generations of 36 diallel crosses involving nine flax parents over three diverse environments.

GCA/SCA mean squares indicated that both additive and non- additive gene effects governed the inheritance of seed yield/plant and its three component traits. However, additive was more important than non-additive genetic variance in the genetic expression of 1000-seed weight, seed yield/plant and capsules number/plant. On the other hand, non- additive was more important than additive genetic variance in the inheritance of seeds/capsule. Significant GCA x E interaction indicated that the additive effects were not stable over environments, hence more than one test environment is required to obtain reliable information for seed yield/plant and its components. On the contrary, SCA x E interaction was not significant for seed yield /plant and seeds/capsule indicating that the non-additive effects governing these two characters were less distorted by environmental fluctuations. Giza-8 and S.2419/1 were good combiners for seed yield/plant, capsules/plant and 1000-seed weight, whereas Ariane-R3 was good combiner for seeds/capsule. Nine out of the 36 studied crosses showed positive and significant SCA effects for seed yield/plant or its three components over environments in both F_3 and F_4 generations. Two out of these nine superior crosses, Giza 8 x Ariane-R3 and S.2419/1 x Ariane-R3 involved high x high general combining parents for seed yield /plant and one or more of its components. Moreover, the cross S.2419/1x S.148/6/1 showed positive and significant SCA effects for seed yield /plant plus two of its components 1000-seed weight and seeds /capsule. Stability analysis showed that the five crosses, (Giza 7 × Giza 8, Giza 7 × S.2419/1, Giza 8 × S.2419/1, Giza 8 × S.148/6/1 and S.2419/1 × S.148/6/1) were consistent for seed yield /plant and its two important components, 1000-seed weight and capsules/plant in F_3 and F_4 generations. Hence these five crosses were considered adapted and may be useful as potential breeding material for developing crosses with stable seed yield /plant in later generations. It concluded that early generation for yield and stability performance would provide reliable information for improving seed yield in flax.

INTRODUCTION

Gene effects are known to be influenced by environmental variation to a large extent. Several workers have reported significant interaction of GCA effects with seasons and locations in flax (Shehata and Comstock, 1971; Patil and Chopde, 1981 and Abo-El Zahab et al., 2000). Repeatability of GCA estimates over environments and the variability of better estimates from F2 generations indicated that it may be advisable

In crops such as flax (Linum usitatissimum L.) the small quantities of crossed seed produced by hand pollination prohibit adequate testing in the F_1 generation and combining ability studies would, therefore, be easier in the F_2 or F generations, in which there is usually ample seed (Shehata and Comstock, 1971; Bhullar *et al.*,1979 and Patile and Chopde,1981) .

Researchers need a statistic that provides a measure of stability or consistency of performance across a range of environments, particularly one that reflects the contribution of each genotype to the total GE interaction. Recently, Kang (1993) developed a yield - stability (Ys_i) statistic which is used as a selection criterion when GE interaction is significant. Keeping these points in view, the present investigation was conducted in the F_3 and F_4 generations over three environments to predict the breeding potentialities of 36 diallel crosses in flax.

MATERIALS AND METHODS

The materials used for the present investigation consisted of 36 possible diallel crosses among nine flax genotypes (the full details of these crosses in F_1 and F_2 generations were tested by Abo-Kaied, 1999). These nine parents included two standard cultivars (P_1=Giza 7 and P_2=Giza 8), five advanced experimental strains, (P_3=S.2419/1, P_4=S.2656/1, P_5=S.148/6/1, P_6=S.237/1 and P_7=S.110/3) and two introductions (P_8=Gawhar-552 and P_9=Ariane-R_3) .

In 1999/2000 season, a part of the F_2 seed bulks of the 36 diallel crosses was used to evaluate their F_3 progenies at Giza, Gemmiza and Zarzoora experiment stations of the Agricultural Research Center; located at Giza, Gharbia and El-Beheira Governorates, respectively. In 2000/2001 season,the other part of of the F_2 seed bulks of the 36 diallel crosses in addition to their F_3 of seed bulks resulting from 1999/2000 season were used to evaluate the F_3 and F_4 generations at the three previous experiment stations. The experiments were laid out in a randomized complete block design with 3 replications, and a restricted randomization where each plot consisted of two rows for each cross in F_3 and F_4 generations. Rows were 2m long, 20 cm apart, plants spaced 5 cm apart. Ten random guarded plants plot from each F_3 and F_4 p were used to measure seed yield per plant, number of capsules per plant, number of seeds per capsule and 1000- seed weight .

Plot means were used for statistical analysis. Data from each environment (years and locations) were analyzed and Barteltt's test for heterogeneity of error variances across environments indicated that error terms were homogeneous. In the combined analysis across environments effect was assumed to be fixed.

General (GCA) and specific (SCA) combining abilities were calculated according to Griffing's method 4, model 1. Forms of analysis for individual environments as given by Griffing (1956) and for combined analysis as suggested by Singh (1973) were used.

Data were subjected to yield - stability (Ysi) analysis as outlined by Kang (1993) according to the program developed by Kang and Magari (1995).

RESULTS AND DISCUSSION

Combining ability:

Mean squares due to GCA effects for seed yield/plant and its components viz., capsules / plant ,1000- seed weight and seeds/ capsule were significant in both F_3,F_4 generations for each environment and over environments (Table 1) except for No. of seeds/ capsule in E_1 in both F_3,F_4 generations in 2000/2001 and E_2 in F4 only. However, SCA mean squares were significant for seed yield and its components for individual environments and combined over environments except for E_2 in both seasons and E_1 in both F_3 and F_4 generations in 2000/2001 for seed yield/plant. Also, SCA mean square for capsules/plant (E_2) in F_4 generation was not significant.

The ratios of GCA/ SCA mean squares were significant in E_2 and E_3 in both F_3 and F_4 generations and over environments for seed yield/plant, except for the combined analysis in F_3 generation. Moreover, GCA/ SCA mean squares were significant for 1000-seed weight at all environments and combined over environments in both generations. These results indicated that both additive and non – additive effects were involved in the inheritance of seed yield/plant and 1000-seed weight. However, the additive effects were more important than non – additive for these traits. In spite of the significant GCA and SCA mean squares for capsules/plant at all environments ,except for E_2 in F_4 generation, and combined over environments ;the ratios of GCA/ SCA mean squares were not significant at most environments and combined analysis in both F_3 and F_4 generations. Seeds/capsule gave similar results to capsules/plant. A comparison of the magnitude of GCA mean squares for capsules /plant and seeds/capsule shows that both additive and non –additive genetic effects governed the inheritance of these two traits. Furthermore, non-additive genetic variance seemed to be more important than additive in the genetic expression of seeds /capsule. Murty and Anand 1966; Murty *et al.*, 1967; Mourad, 1977; El-Farouk *et al.*, 1998; and Abo-El-Zahab *et al.*, 2000 reported similar results.

Combining ability x environment interactions:

Mean squares of general combining ability by environments (GCA x E) interaction were significant for seed yield and its components in both F_3 and F_4 generations with the exception of seeds/capsule in F_4. Likewise, significant specific (SCA x E) was detected for 1000-seed weight in both generations and capsules / plant in F_3 generation

Table1. Mean square of individual and combined ANOVA across environments (E) for 36 flax crosses in F3 and F4 generations for seed yield and its components .

S.O.V.	F3 1999/2000 E1	F3 1999/2000 E2	F3 1999/2000 E3	F3 2000/2001 E1	F3 2000/2001 E2	F3 2000/2001 E3	F3 C	F4 2000/2001 E1	F4 2000/2001 E2	F4 2000/2001 E3	F4 C
Seed yield/plant (g)											
Rep./E	0.060	0.060	1.073	0.194.	0.122	0.864	0.395	0.030	0.075	0.085	0.060
Environments(E)							8.780 **				5.380 **
Crosses (C)	2.814 **	0.877 **	1.744 **	1.065 **	1.063 **	1.664 **	4.357 **	0.982 **	1.787 **	1.893 **	3.170 **
C * E							0.976 **				0.750 **
Heterogeneity							1.383 **				2.917 **
Residual							0.874 **				2.870 **
GCA	1.55 **	0.870 **	1.279 **	0.447 *	1.09 **	1.069 **	1.538 **	0.526 *	1.699 **	1.414 **	2.740 **
SCA	0.757 **	0.122	0.375 *	0.328	0.136	0.403 *	1.425 **	0.269	0.269 *	0.399	0.560 **
GCA*E							0.953 **				0.450 *
SCA*E							0.139				0.190
Pooled erorr	0.151	0.149	0.212	0.209	0.104	0.235	0.177	0.204	0.244	0.297	0.250
GCA/SCA	2.048	7.156 **	3.413 **	1.363	7.995 **	2.655 *	1.079	1.960	6.318 **	3.544 **	4.893 **
capsules/plant											
Rep./E	7.425	27.070	196.635	37.000	11.610	126.190	67.650	6.265	97.340	31.420	45.008
Environments(E)							2612.34 **				2898.15 **
Crosses (C)	351.191 **	245.198 **	520.483 **	223.473 **	306.671 **	425.93 **	849.190 **	172.952 **	156.849 **	430.253 **	418.552 **
C * E							243.130 **				170.756 **
Heterogeneity							357.136 **				234.956 **
Residual							214.621 **				106.536 **
GCA	129.833 **	192.543 **	319.44 **	67.53 *	259.823 **	216.775 **	437.350 **	51.028 *	87.781 *	291.485 **	245.541 **
SCA	113.317 **	48.9 *	130.622 **	76.591 **	55.528 *	115.903 **	237.350 **	59.628 **	41.765	99.546 *	108.053 **
GCA*E							149.720 **				92.376 **
SCA*E							60.700 **				46.443
Pooled erorr	49.663	27.500	44.882	32.576	26.901	43.002	37.420	24.271	40.375	46.683	37.110
GCA/SCA	1.146	3.937 **	2.446	0.882	4.679 **	1.870	1.843	0.856	2.102	2.928 *	2.272

Table1. Continued

S.O.V.	seeds/capsule										
	F3							F4			
	1999/2000			2000/2001			C	2000/2001			C
	E1	E2	E3	E1	E2	E3		E1	E2	E3	
Rep./E	0.050	0.123	0.043	0.060	0.122	0.059	0.076	0.095	0.140	0.225	0.153
Environments(E)							6.028 **				0.075
Crosses (C)	1.465 **	0.951 **	1.197 **	1.537 **	0.951 **	1.165 **	4.056 **	1.132 **	0.699 **	1.637 **	2.074 **
C*E							0.641 **				0.696 **
Heterogeneity							1.245 **				1.248 **
Residual							0.490 **				0.144
GCA	0.364 *	0.662 **	0.409 *	0.355	0.662 **	0.364 *	1.103 **	0.250	0.235	0.363 *	0.373 *
SCA	0.525 **	0.215 **	0.396 **	0.559 **	0.215 **	0.396 **	1.426 **	0.415 **	0.258 *	0.600 **	0.821 **
GCA*E							0.343 **				0.238
SCA*E							0.176				0.226
Pooled erorr	0.166	0.156	0.170	0.209	0.156	0.170	0.171	0.188	0.134	0.176	0.166
GCA/SCA	0.693	3.083 *	1.032	0.635	3.087 *	0.921	0.773	0.602	0.910	0.605	0.454
	1000- seed weight(g)										
Rep./E	0.252	0.030	0.281	0.003	0.351	0.481	0.233	1.162	0.330	0.770	2.260
Environments(E)							7.461 **				12.67 **
Crosses (C)	4.662 **	3.3 **	5.618 **	240.081 **	3.003 **	5.179 **	19.420 **	19.659 **	11.357 **	20.358 **	9.71 **
C * E							1.536 **				1.635 *
Heterogeneity							4.595 **				3.19 **
Residual							0.771 **				0.079
GCA	3.714 **	3.039 **	4.231 **	4.201 **	2.651 **	3.973 **	17.886 **	13.809 **	11.418 **	17.84 **	6.23 **
SCA	0.914 **	0.539 **	1.174 **	0.914 **	0.467 **	1.061 **	3.092 **	4.403 **	1.524	3.511 **	2.35 **
GCA*E							0.785 **				18.42 **
SCA*E							0.396 **				3.54 **
Pooled erorr	0.100	0.086	0.105	0.091	0.086	0.092	0.093	1.058	1.055	1.230	1.114
GCA/SCA	4.064 **	5.637 **	3.603 **	4.594 **	5.673 **	3.746 **	5.785 **	3.136 *	7.490 **	5.082 **	2.651 **

*,** indicating significant and highly significant ,respectively.
E1,E2 andE3=Giza,Gemmiza and Zarzoora,respectively
and C= combined over environments .

only. On the other hand, SCA x E interactions for seed yield /plant and seeds/capsule were non-significant in both generations and for capsules / plant in F_4 generation only. The consistency of GCA x environment interaction for seed yield/plant, capsules/plant and1000-seed weight suggests that the additive effects were no more stable over environments for these traits. On the contrary, non-additive genetic variance was less distorted by environmental fluctuation as the SCA x E interactions were not significant for seed yield/plant and seeds/capsule in both generations. Similar results were reported by Shehata and Comstock, 1971; Patil and Chopde,1981 and Abo- El Zahab *et al.*, 2000.

GCA effects:

Estimates of GCA effects are presented in Table 2. P_2 (Giza 8) and P_3 (S.2419/1) showed significant and positive GCA effects for seed yield/plant, capsules/plant and 1000-seed weight in F_3 and F_4 generations over individual environments and over environments.

The GCA estimates of these parents were consistent over generations, indicating that the F_3 data may give reliable indication of combining ability for seed yield and its components viz., capsules / plant, seeds/capsule and 1000-seed weight.

P_9 (Ariane-R3) gave significant and positive GCA effects in both generations for seeds/capsule in individual environments and combined over environments. Similar results were obtained by Abo – EL Zahab *et al.*, (2000).

SCA effects :

Out of the 36 crosses evaluated in F_3 and F_4 generations, two crosses viz., P3× P5 and P_4× P8 revealed positive and significant SCA effects for seed yield /plant in most individual environments and over environments in both generations (Table3) .

The five crosses P_5, $P_3 \times P_9$, $P_4 \times P_8$, $P_5 \times P_7$ and $P_6 \times P_9$, showed significant and positive SCA effects in F_3 and F_4 generations for 1000-seed weight over individual environments and over environments. The three crosses $P_2 \times P_7$, $P_2 \times P_8$ and $P_3 \times P_5$, gave positive and significant SCA effects for seeds/capsule. The two crosses P_1xP_3 and P_2xP_9 exhibited significant and positive SCA effects for capsules/plant in most individual environments and combined over environments in both generations. It could be noticed that two out of these nine crosses ,which showed positive and significant SCA effects for seed yield/plant and its three components across environments in both F_3 and F_4 generations, i.e. P_2 x P_9 and P_3 x P_9 resulted from crossing parents that have high GCA effects for yield or yield components. In addition, the three crosses P_2 x P_7, P_2 x P8 and P_3 x P_5 included at least one parent as high general combiner for seed yield. Bhatade and Bhale (1983) mentioned that hybrids which involved high × high

Table2.Estimates of GCA effects for seed yield /plant and its components in individual environments (E) and combined (C) over environments for 9- parents diallel cross in flax.

Parents	Seed yield/plant (g)										
	F3							F4			
	1999/2000			2000/2001			C	2000/2001			C
	E1	E2	E3	E1	E2	E3		E1	E2	E3	
P1 #	0.009	0.362 **	-0.328 **	-0.110	0.140	0.100	0.029	0.365 **	0.166 *	0.220 *	0.250
P2	0.242 **	0.102	0.595 **	0.763 **	0.570 **	0.580 **	0.475 **	0.123	0.868 **	0.800 **	0.597 **
P3	0.741 **	0.363 **	0.520 **	0.555 **	0.370 **	0.130	0.447 **	0.372 **	0.705 **	0.560 **	0.546 **
P4	-0.108	-0.048	-0.049	-0.028	-0.340 **	-0.010	-0.097 *	-0.039	-0.321 **	-0.300 *	-0.220
P5	0.026	-0.028	0.146 *	-0.154 *	0.520 **	0.500 **	0.168 *	0.032	-0.060	0.070	0.014
P6	-0.307 **	-0.143	-0.046	-0.145 *	-0.250 *	-0.260 *	-0.192 *	-0.217 *	-0.363 **	-0.170	-0.250
P7	-0.622 **	-0.379 **	-0.300 **	-0.415 **	0.020	0.010	-0.281 **	-0.385 **	-0.576 **	-0.300 *	-0.420 *
P8	0.588 **	0.034	-0.243 **	-0.326 **	-0.520 **	-0.530 **	-0.166 *	0.080	-0.250 **	-0.480 **	-0.217
P9	-0.569 **	-0.263 *	-0.296 **	-0.139 *	-0.510 **	-0.510 **	-0.381 **	-0.331 **	-0.171 *	-0.410 **	-0.304 *
LSD 5%	0.220	0.297	0.169	0.163	0.273	0.275	0.233	0.202	0.152	0.205	0.186
(Sij-Sik)1%	0.339	0.457	0.260	0.251	0.420	0.423	0.358	0.310	0.234	0.316	0.287
	capsules/plant										
P1	0.024	-0.725	-8.547 **	-8.268 **	4.800 **	4.890 **	-1.304	-0.667	-2.731 *	5.410 **	0.671
P2	6.390 **	3.709 **	7.455 **	8.883 **	9.070 **	5.500 **	6.835 **	2.958 *	3.189 *	9.410 **	5.186 *
P3	5.690 **	3.069 *	4.644 **	8.324 **	5.730 **	6.030 **	5.581 **	3.968 *	3.681 *	6.270 **	4.640 *
P4	-6.003 **	-5.155 **	0.073	-0.437	-9.880 **	-3.470 **	-4.145 **	-4.981 **	-6.127 **	-9.180 **	-6.763 **
P5	1.226	-2.856 *	5.717 **	3.698 **	0.430	0.520	1.456	-0.547	2.457	0.840	0.917
P6	-3.740 *	3.278 *	-0.845	-0.109	-1.350	-1.270	-0.673	0.974	2.759 *	0.470	1.401
P7	-4.570 **	-2.035	-2.755 *	-5.057 **	2.750 *	2.840 *	-1.471	-0.476	-3.174 *	-1.230	-1.627
P8	1.559	1.701	-5.359 **	-6.361 **	-10.93 **	-10.84 **	-5.038 **	1.166	1.956	-8.940 **	-1.939
P9	-0.576	-0.986	-0.383	-0.673	-0.640	-4.200 **	-1.243	-2.394	-2.010	-3.050 *	-2.485
LSD 5%	3.994	3.281	2.966	2.935	3.789	3.710	3.446	2.957	2.541	2.839	2.779
(Sij-Sik)1%	6.147	5.050	4.564	4.516	5.831	5.710	5.303	4.550	3.910	4.370	4.277

Table2. Continued

Parents	seeds /capsule										
	F3							F4			
	1999/2000			2000/2001			C	2000/2001			C
	E1	E2	E3	E1	E2	E3		E1	E2	E3	
P1 #	-0.168	-0.205 **	-0.109 **	-0.188 **	0.100	0.110	-0.077	-0.114	-0.020	0.090	-0.015
P2	0.037	0.069	-0.558 **	-0.479 **	-0.220 *	-0.250 *	-0.234 *	0.099	-0.044	-0.170	-0.038
P3	0.049	0.016	0.172 **	0.172 **	-0.220	-0.150	0.007	0.007	-0.020	-0.070	-0.028
P4	-0.208 *	-0.184 *	-0.199 **	-0.099 *	0.120	0.060	-0.085	-0.080	0.105	0.360 *	0.128 *
P5	-0.388 **	-0.387 **	-0.241 **	-0.341 **	-0.170	-0.160	-0.281 **	-0.418 **	-0.231 *	-0.130	-0.260 **
P6	0.380 **	0.368 **	0.167 **	0.166 **	-0.030	-0.020	0.172 *	0.143	0.024	-0.030	0.046
P7	0.156	0.150	0.011	0.111 *	0.140	0.140	0.118	0.032	-0.100	-0.220	-0.096
P8	0.000	0.057	0.228 **	0.127 *	-0.220 *	-0.210 *	-0.003	0.123	-0.017	-0.190	-0.028
P9	0.144	0.118	0.529 **	0.530 **	0.500 **	0.480 **	0.384 **	0.209	0.303 **	0.370 *	0.294 **
LSD 5%	0.293	0.260	0.134	0.134	0.293	0.293	0.235	0.251	0.202	0.273	0.242
(Sij-Sik)1%	0.451	0.401	0.206	0.206	0.451	0.451	0.361	0.386	0.310	0.420	0.372
	1000-seed weight (g)										
P1	1.029 **	0.971 **	0.612 **	0.502 **	-0.079	-0.080	0.493 **	1.047 **	0.474 **	-0.090 **	0.477 **
P2	0.685 **	0.820 **	0.739 **	0.849 **	0.720 **	0.750 **	0.761 **	0.666 **	0.803 **	0.780 **	0.750 **
P3	0.772 **	0.887 **	0.757 **	0.757 **	0.490 **	0.460 **	0.687 **	0.691 **	0.696 **	0.480 **	0.622 **
P4	0.003	-0.001	0.066	0.066	0.670 **	0.640 **	0.241 **	0.247 **	0.316 **	0.580 **	0.381 **
P5	0.085	0.055	0.139 *	0.139 *	0.440 **	0.450 **	0.218 **	0.104	0.198 *	0.430 **	0.244 **
P6	-0.925 **	-1.007 **	-0.354 **	-0.343 **	-0.440 **	-0.420 **	-0.582 **	-0.894 **	-0.646 **	-0.420 **	-0.653 **
P7	-0.925 **	-0.925 **	-0.643 **	-0.654 **	-0.570 **	-0.560 **	-0.713 **	-1.008 **	-0.792 **	-0.460 **	-0.753 **
P8	-0.097	-0.077	-0.149 *	-0.249 **	0.420 **	0.350 **	0.033	-0.149 *	0.074	0.330 **	0.085
P9	-0.626 **	-0.723 **	-1.167 **	-1.067 **	-1.650 **	-1.590 **	-1.137 **	-0.705 **	-1.124 **	-1.630 **	-1.153 **
LSD 5%	0.185	0.170	0.165	0.165	0.183	0.170	0.173	0.291	0.233	0.191	0.238
(Sij-Sik)1%	0.285	0.262	0.254	0.254	0.282	0.262	0.267	0.449	0.358	0.293	0.367

For expanation see Table (1) .

=(P1=Giza 7,P2=Giza 8,P3=S.2419/1,P4=S.2656/1,P5=S.148/6/1,P6=S237/1,P7=S.110/3,P8=Gawhar-552 and P9=Ariane-R3).

GCA combiners represented additive × additive type of interactions and these crosses may yield transgressive segregates in later generations.

Also data indicated that the cross P_3 x P_5 may yield transegressive segregates in later generations, because it exhibited significant SCA effects for seed yield/plant and its two components viz., 1000-seed weight and seeds/capsule. Similar results were reported by Abo-El-Zahab *et al.* (2000).

Stability measurement:

Mean squares from the individual environments (E) and combined variances over environments are given in Table 1. Highly significant variance due to crosses (C) revealed the presence of genetic variability in the material under investigation (36 crosses) for seed yield/plant and its components. Variances due to C x E interaction as well as environment were found to be significant and positive for these characters indicating differential expression of crosses over environments.T herefore, it is important to give ample consideration to C x E interaction effect while breeding flax to improve seed yield.

The variances due to heterogeneity (C x E- linear) were significant for seed yield/plant and its components viz., 1000-seed weight, capsules/plant and seeds/capsule in both generations, indicating that these crosses differed genetically in their response to different environments when tested with pooled deviation.

The variance due to the pooled deviation from regression (residual) was significant for all traits in both generations with the exception of 1000-seed weight, and capsules/plant in F_4 only. A portion of C x E interaction sum of squares was non linear, indicating that crosses differed with respect to their stability and that the prediction would be difficult, which means that selection of cross combinations on the basis of mean performance alone would not be appropriate. In such situations, methods that combine yield and stability of performance are useful (Bachireddy *et al.*, 1992).

Data presented in Table 4 show that, out of 36 crosses in this study 8 crosses for seed yield/plant, 14 crosses for capsules/plant and 15 crosses for 1000-seed weight were identified to be superior over generations by measuring yield and stability criterion(YS_i). Five out of these crosses, ($P_1 \times P_2$, $P_1 \times P_3$, $P_2 \times P_3$, $P_2 \times P_5$ and $P_3 \times P_5$) remained consistent for seed yield /plant and its two important components, 1000-seed weight, capsules/plant in F_3 and F_4 generations. Hence these crosses were considered adapted crosses in both generations and may be useful as potential breeding material for developing crosses with stable seed yield. Moreover, the cross P_3xP_5 exhibited significant positive SCA effects for seed yield /plant and its two components,1000-seed weight and seeds/capsule as well as stability measurement.

Table3. Estimates of SCA effects for seed yield /plant and its components in individual environments (E) and combined (C.) over environments for 36 flax crosses.

Crosses	Seed yield/plant (g)										
	F3							F4			
	1999/2000			2000/2001			C	2000/2001			C
	E1	E2	E3	E1	E2	E3		E1	E2	E3	
1x2	0.099	0.243	0.497 *	0.232	0.094	0.528 *	0.282	0.321	-0.045	0.099	0.125
1x3	0.497 **	0.225	0.443 *	-0.062	0.199	0.169	0.245	0.089	0.488 *	0.559 **	0.379
1x4	0.196	-0.056	-0.264	0.068	-0.119	-0.228	-0.067	0.070	0.240	-0.757 **	-0.149
1x5	-0.501 **	-0.305 *	-0.973 **	-0.535 **	-0.045	-0.929 **	-0.548 **	-0.325	-0.154	-0.845 **	-0.441 *
1x6	0.272	0.014	-0.430 *	0.030	0.072	-0.386	-0.071	-0.386	0.046	-0.243	-0.194
1x7	0.010	-0.139	0.794 **	0.043	-0.064	0.838 **	0.247	0.243	-0.348	0.864 **	0.253
1x8	-1.157 **	-0.336 *	0.251	-0.250	-0.293 *	0.295	-0.248	-0.219	-0.731 **	0.411	-0.180
1x9	0.584 **	0.354 *	-0.320	0.473 *	0.156	-0.289	0.160	0.208	0.504 **	-0.087	0.208
2x3	-0.599 **	0.382 **	0.497 *	0.212	0.356 **	-0.830 **	0.003	0.034	0.096	0.794 **	0.308
2x4	-0.223	-0.368 **	-0.344	0.189	-0.284 *	0.867 **	-0.027	0.185	-0.518 **	-0.172	-0.168
2x5	-0.228	-0.014	-0.073	0.176	-0.101	-0.071	-0.052	0.381	-0.506 **	-0.160	-0.095
2x6	0.082	-0.165	-1.023 **	-0.310	-0.057	-1.021 **	-0.416 *	-0.353	0.160	-0.722 **	-0.305
2x7	0.830 **	0.326 *	0.168	0.474 *	0.450 **	0.169	0.403 *	0.492 *	-0.040	0.039	0.164
2x8	-0.350 *	-0.528 **	-0.155	-1.340 **	-0.436 **	-0.154	-0.494 **	-1.130 **	0.024	-0.817 **	-0.641 **
2x9	0.388 *	0.125	0.433 *	0.370	-0.023	0.512 *	0.301	0.071	0.829 **	0.938 **	0.613 **
3x4	-0.839 *	0.183	-0.364	-0.122	-0.097	0.051	-0.198	-0.147	0.428 *	-0.205	0.025
3x5	1.284 **	0.154	0.923 **	0.975 **	0.140	1.163 **	0.773 **	0.738 **	0.730 **	1.043 **	0.837 **
3x6	0.627 **	-0.111	-0.167	-0.147	-0.579 **	0.073	-0.051	0.048	-0.310	-0.282	-0.181
3x7	-0.258	-0.403 **	-0.410 *	0.206	-0.146	-0.170	-0.197	-0.001	-0.123	-0.481 *	-0.202
3x8	0.339 *	-0.360 **	-0.366	-0.351	-0.135	-0.126	-0.167	-0.376	-0.330	-0.587 *	-0.431 **
3x9	-1.051 **	-0.071	-0.557 *	-0.711 **	0.261 *	-0.330	-0.410 *	-0.385	-0.978 **	-0.842 **	-0.735 **
4x5	-0.857 **	-0.273 *	-0.037	-0.628 *	0.183	-0.367	-0.330	-0.614 *	0.197	0.204	-0.071
4x6	-0.537 **	-0.448 **	0.553 *	-0.487 *	-0.263 *	0.223	-0.160	-0.435	-0.654 **	0.216	-0.291
4x7	-0.079	0.250 *	0.033	-0.133	-0.370 **	-0.297	-0.099	-0.150	-0.417 *	0.307	-0.087
4x8	2.678 **	0.516 **	-0.270	1.383	0.755 **	-0.599 **	0.744 **	1.315	0.360	-0.176	0.500 *
4x9	-0.339 *	0.196	0.692 **	-0.270	0.194	0.350	0.137	-0.224	0.365	0.582 *	0.241
5x6	-0.191	-0.060	1.000 **	0.237	0.517 **	1.015 **	0.420 *	0.237	0.042	0.761 **	0.347
5x7	-0.673 **	0.388 **	0.354	-0.620 *	-0.353 **	0.369	-0.089	-0.688 **	-0.418 *	-0.065	-0.390
5x8	0.003	0.420 **	-0.109	0.020	-0.352 **	-0.094	-0.019	-0.100	-0.128	-0.064	-0.097
5x9	1.164 **	-0.310 *	-1.087 **	0.377	0.011	-1.085 **	-0.155	0.371	0.237	-0.873 **	-0.088
6x7	0.260	0.323 *	-0.582 **	0.425	0.715 **	-0.568 *	0.096	0.492 *	0.721 **	-0.423	0.263
6x8	-1.057 **	0.516 **	0.518 *	-0.022	0.209	0.533 *	0.116	-0.007	0.282	0.721 **	0.332
6x9	0.544 **	-0.068	0.130	0.275	-0.615 **	0.132	0.066	0.404	-0.287	-0.028	0.030
7x8	0.371 *	-0.373 **	-0.468 *	0.341	0.002	-0.454 *	-0.097	0.288	0.908 **	-0.019	0.392
7x9	-0.461 *	-0.371 **	0.110	-0.735 **	-0.235	0.112	-0.263	-0.675 **	-0.283	-0.221	-0.393
8x9	-0.830 **	0.146	0.598 **	0.220	0.250 *	0.599 **	0.164	0.230	-0.386 *	0.530 *	0.125
LSD 5%	0.493	0.379	0.613	0.667	0.367	0.618	0.523	0.679	0.515	0.694	0.629
(Sij-Sik)1%	0.709	0.545	0.882	0.960	0.528	0.889	0.752	0.976	0.741	0.998	0.905

Table3. Continued

Crosses	capsules/plant										
	F3							F4			
	.1999/2000			.2000/2001			C	.2000/2001			C
	E1	E2	E3	E1	E2	E3		E1	E2	E3	
1x2	8.784 *	2.284	2.051	6.203 *	7.723 **	5.606 *	5.442 *	9.408 *	1.383	-1.252	3.180
1x3	14.840 **	7.732 **	8.260 **	13.306 **	3.843	7.947 **	9.321 **	10.168 **	10.46 **	4.472	8.367 *
1x4	-5.857 *	-3.764	-1.051	-5.660 *	-4.410 *	-7.468 **	-4.702	2.7	1.662	-6.495 *	-0.711
1x5	-5.192	-4.307	-11.526 **	0.788	-3.445	-11.623 **	-5.884 *	-2.137	-2.922	-13.096 **	-6.052
1x6	-5.276	3.042	-3.398	-10.546 **	1.150	-3.494	-3.087	-11.169 **	-1.808	0.189	-4.263
1x7	-5.961 *	-2.805	14.437 **	-6.080 *	-1.659	14.343 **	2.046	-2.095	-7.06 *	11.906 **	0.917
1x8	-15.722 **	-3.478	8.332 **	-13.235 **	-3.632	8.238 **	-3.250	-11.237 **	-4.418	14.267 **	-0.463
1x9	14.383 **	1.296	-17.104 **	15.225 **	0.430	-13.549 **	0.114	4.363	2.702	-9.99 **	-0.975
2x3	6.527 *	-0.430	-2.231	3.213	-0.872	-20.270 **	-2.344	0.263	7.193 *	0.139	2.532
2x4	-9.656 **	0.691	-8.001 *	6.063 *	2.345	10.615 **	0.343	0.162	-7.541 *	-3.758	-3.712
2x5	-8.465 **	-0.169	-4.553	-2.492	-0.456	-1.001	-2.856	-0.262	2.764	-0.632	0.623
2x6	2.632	1.106	-9.449 **	-2.726	-1.935	-5.892	-2.711	-1.817	5.665	-4.453	-0.202
2x7	9.557 **	3.213	1.343	1.034	3.210	4.898	3.876	1.967	-0.224	2.639	1.461
2x8	0.329	-12.767 **	-16.596 **	-5.469 *	-14.070 **	-13.043 **	-10.269 **	-4.948	-9.788 **	-19.053 **	-11.263 **
2x9	-9.709 **	6.071 *	37.436 **	-5.825 *	4.055	19.086 **	8.519 **	-4.772	0.548	26.37 **	7.382 *
3x4	1.163	1.369	3.027	7.049 **	-2.679	19.266 **	4.866	6.438	-4.76	1.168	0.949
3x5	6.634 *	1.142	2.249	-3.466	4.160	1.941	2.110	7.618 *	6.692 *	8.974 *	7.761 *
3x6	-5.536	-8.036 **	-1.527	4.250	2.411	-1.834	-1.712	-4.18	-9.937 **	-0.403	-4.840
3x7	-10.580 **	-3.489	-2.175	-9.047 **	-5.744 *	-2.481	-5.586 *	-6.657 *	-3.443	-9.034 *	-6.378 *
3x8	6.621 *	-2.066	3.133	0.367	-5.620 *	2.824	0.877	-3.222	-0.244	3.45	-0.005
3x9	-19.670 **	3.779	-10.736 **	-15.673 **	4.501 *	-7.393 **	-7.532 **	-10.428 **	-5.961 *	-8.766 *	-8.385 *
4x5	-5.903 *	11.093 **	4.102	-2.085	12.744 **	-2.311	2.940	-4.906	-1.44	5.417	-0.310
4x6	-5.363	-8.978 **	5.483	-12.136 **	-10.082 **	-0.936	-5.335 *	-10.261 **	-6.369 *	0.786	-5.281
4x7	7.727 *	3.035	-4.642	5.020 *	4.970 *	-11.062 **	0.841	3.032	3.335	-1.391	1.659
4x8	16.791 **	2.685	-1.844	3.055	3.320	-8.264 **	2.624	3.161	9.771 **	-1.95	3.661
4x9	1.097	-6.130 *	2.927	-1.305	-6.208 *	0.159	-1.577	-0.326	5.341	6.223	3.746
5x6	-1.182	-6.585 **	12.964 **	0.845	-9.750 **	12.866 **	1.526	0.585	2.24	6.005	2.943
5x7	-3.753	0.415	8.799 **	-1.895	-5.239 *	8.706 **	1.172	-6.018	3.804	11.675 **	3.154
5x8	-2.304	-4.062	2.711	-1.924	-1.918	2.611	-0.814	-3.953	-10.03 **	-4.504	-6.162
5x9	20.164 **	2.473	-14.745 **	10.229 **	3.904	-11.189 **	1.806	9.074 *	-1.11	-13.838 **	-1.958
6x7	10.588 **	12.467 **	-5.430	10.305 **	13.156 **	-5.529 *	5.926 *	10.794 **	3.532	-4.476	3.283
6x8	-4.181	12.980 **	1.012	3.405	12.370 **	0.920	4.418	5.989	3.625	0.655	3.423
6x9	8.318 *	-5.995 *	0.346	6.602 *	-7.319 **	3.899	0.975	10.059 **	3.051	1.698	4.936
7x8	2.735	-2.317	-5.477	11.858 **	0.111	-5.574 *	0.223	10.579 **	7.855 *	-1.242	5.731
7x9	-10.313 **	-10.518 **	-6.855 *	-11.195 **	-8.804 **	-3.301	-8.498 **	-11.601 **	-7.799 *	-10.076 **	-9.825 **
8x9	-4.269	9.025 **	8.730 **	1.943	9.440 **	12.288 **	6.193 *	3.631	3.228	8.378 *	5.079
LSD 5%	8.991	6.675	8.528	7.383	6.603	8.348	7.755	9.979	8.575	9.584	9.379
(Sij-Sik)1%	12.936	9.605	12.270	10.622	9.501	12.011	11.158	14.359	12.338	13.789	13.495

Table3. Continued

Crosses	seeds/capsule										
	F3							F4			
	1999/2000			2000/2001			C	2000/2001			C
	E1	E2	E3	E1	E2	E3		E1	E2	E3	
1x2	-0.772 **	0.510 **	0.379	-0.763 **	0.510 **	0.403	0.045	-0.747 *	-0.428	-0.083	-0.419
1x3	0.086	-0.220 *	-0.694 *	0.120	-0.220 *	-0.766 **	-0.282	-0.362	-0.585 *	-0.854 *	-0.600 *
1x4	0.293	0.224 *	-0.480 *	0.350	0.224 *	-0.425	0.031	0.415	-0.087	-0.615 *	-0.096
1x5	0.103	0.224 *	0.553 *	0.113	0.225 *	0.545 *	0.294	0.404	0.549 *	0.687 *	0.547 *
1x6	-0.336	-0.038	0.337	-0.295	-0.038	0.329	-0.007	-0.418	-0.003	0.425	0.001
1x7	0.378	-0.252 *	0.211	0.367	-0.253 *	0.203	0.109	0.167	0.285	0.437	0.296
1x8	0.781 **	-0.269 *	-0.431	0.822 **	-0.269 *	-0.439 *	0.033	0.775 *	0.101	-0.544	0.111
1x9	-0.533 *	-0.180	0.126	-0.715 **	-0.178	0.150	-0.222	-0.234	0.168	0.548	0.161
2x3	-0.130	-0.157	-0.564 *	-0.187	-0.156	-0.157	-0.225	-0.765 *	-0.415	-0.235	-0.472
2x4	-0.836 **	-1.286 **	-0.454 *	-0.834 **	-1.286 **	-0.813 **	-0.918 **	-0.321	-0.890 **	-1.023 **	-0.745 *
2x5	-0.322	-0.210 *	-0.614 *	-0.344	-0.211 *	-0.590 *	-0.382 *	-0.176	-0.121	-0.354	-0.217
2x6	1.319 **	-0.095	-1.053 **	1.334 **	-0.095	-1.029 **	0.064	0.582 *	-0.229	-0.943 **	-0.197
2x7	0.586 *	0.234 *	0.487 *	0.622 **	0.234 *	0.511 **	0.446 *	1.044 **	0.858 **	0.636 *	0.846 **
2x8	0.233	0.824 **	1.163	0.251	0.825 **	1.186 **	0.747 **	0.392	0.858 **	1.229 **	0.826 **
2x9	-0.078	0.180	0.656 **	-0.079	0.179	0.488 *	0.224	-0.010	0.365	0.774 *	0.376
3x4	-0.524 *	0.250 *	0.807 **	-0.544 *	0.250 *	0.799 **	0.173	-0.315	0.823 **	1.986 **	0.831 **
3x5	0.969 **	0.800 **	0.630 **	0.999 **	0.799 **	0.558 *	0.793 **	0.806 **	0.659	0.502	0.656 *
3x6	-0.313	-0.325 **	0.104	-0.292	-0.325 **	0.033	-0.186	0.124	0.011	-0.054	0.027
3x7	1.434 **	0.160	0.238	1.442 **	0.160	0.166	0.600 **	1.186 **	0.278	-0.608	0.285
3x8	-0.522 *	0.034	0.593 *	-0.572 **	0.034	0.521 *	0.015	0.037	0.115	0.378	0.177
3x9	-1.000	-0.544 **	-1.114 **	-0.966 **	-0.542 **	-1.154	-0.887 **	-0.712 *	-0.885 **	-1.114 **	-0.904 **
4x5	0.330	-0.620 **	-0.209	0.289	-0.621 **	-0.154	-0.164	0.153	-0.074	-0.310	-0.077
4x6	0.714 **	0.479 **	0.065	0.671 **	0.479 **	0.121	0.422 *	0.681 *	0.302	-0.189	0.265
4x7	-0.525 *	0.288 **	0.295	-0.558 **	0.291 **	0.351	0.024	-0.654 *	-0.035	0.510	-0.060
4x8	0.198	-0.059	-0.423	0.215	-0.059	-0.367	-0.083	-0.065	-0.298	-0.670	-0.344
4x9	0.350	0.723 **	0.400	0.411 *	0.722 **	0.488 *	0.516 **	0.105	0.259	0.311	0.225
5x6	-0.076	0.165	0.935 **	-0.120	0.164	0.927 **	0.333	0.026	0.265	0.590	0.294
5x7	-1.082	-0.140	-0.618 *	-1.135	-0.141	-0.626 *	-0.624 **	-1.095 **	-0.842 **	-0.451	-0.796 **
5x8	0.111	-0.156	-0.723 **	0.264	-0.154	-0.731 **	-0.232	0.119	-0.355	-0.915 **	-0.384
5x9	-0.033	-0.064	0.047	-0.066	-0.063	0.071	-0.018	-0.236	-0.081	0.250	-0.022
6x7	-0.937 **	-0.355 **	-0.368	-0.840 **	-0.355 **	-0.375	-0.538 **	-0.607 *	-0.213	0.034	-0.262
6x8	-0.437 *	0.029	0.031	-0.551 *	0.029	0.023	-0.146	-0.503	-0.143	0.253	-0.131
6x9	0.065	0.141	-0.052	0.092 **	0.140	-0.028	0.060	0.115	0.011	-0.115	0.004
7x8	-0.723 **	-0.042	-0.196	-0.826 **	-0.042	-0.204	-0.339	-0.884 **	-0.386	0.182	-0.363
7x9	0.869 **	0.107	-0.049	0.927 **	0.105	-0.025	0.322	0.844 **	0.055	-0.740 *	0.053
8x9	0.359	-0.363 **	-0.014	0.396 *	-0.364 **	0.010	0.004	0.128	0.108	0.086	0.107
LSD 5%	0.658	0.301	0.662	0.584	0.301	0.662	0.528	0.845	0.679	0.923	0.816
(Sij-Sik)1%	0.947	0.434	0.952	0.841	0.434	0.952	0.760	1.216	0.976	1.328	1.173

Table3. Continued

Crosses	1000-seed weight(g)										
	F3							F4			
	.1999/2000			.2000/2001			C	.2000/2001			C.
	E1	E2	E3	E1	E2	E3		E1	E2	E3	
1x2	0.230	-0.059	0.274 *	-0.059	0.259 *	1.157 **	0.300 **	-0.073	0.442	1.307 **	0.559 **
1x3	-0.560 **	-0.669 **	0.243	-0.669 **	0.229	1.492 **	0.011 **	-0.325	0.386	1.553 **	0.538 **
1x4	-0.122	0.032	-0.179	0.032	-0.199	-0.840 **	-0.213 **	-0.287	-0.202	-0.768 **	-0.419 *
1x5	-1.180 **	-1.187 **	-0.799 **	-1.187 **	-0.799 **	-1.143 **	-1.049 **	-1.167 **	-1.016	-1.129 **	-1.104 **
1x6	1.063 **	1.034 **	0.397 **	1.034 **	0.397 **	-0.885 **	0.507	0.834 **	-0.036	-0.962 **	-0.055
1x7	0.847 **	0.906 **	0.201	0.906 **	0.221	-0.213	0.478 *	0.784 **	0.277	-0.239	0.274
1x8	0.115	0.142	-0.311 *	0.142	-0.304 *	-0.301 *	-0.086	0.216	-0.170	-0.472 **	-0.142
1x9	-0.392 *	-0.199	0.155	-0.199	0.147	0.733 **	0.041	0.018	0.319	0.710 **	0.349
2x3	0.027	0.855 **	0.311 *	0.855 **	0.319 *	0.289 **	0.443 **	-0.183	0.431 *	0.502 **	0.250
2x4	0.156	0.229	0.795 **	0.229	0.793 **	0.374	0.429 **	1.008 **	0.184	0.275	0.489 *
2x5	0.414 **	0.227	0.015	0.227	0.010	0.517 **	0.235 *	0.377	0.326	0.613 **	0.439 *
2x6	-1.109 **	-1.212 **	-0.577 **	-1.212 **	-0.594 **	-0.472 **	-0.863 **	-0.945 **	-0.348	-0.286	-0.526 **
2x7	-0.172	-0.130	0.011	-0.130	0.111	-0.073	-0.064	-0.411	-0.301	-0.174	-0.295
2x8	-0.714 **	-0.788 **	-0.487 **	-0.788 **	-0.475 **	0.432 *	-0.470 *	-0.603 *	-0.208	0.347	-0.155
2x9	1.169 **	0.878 **	-0.311 *	0.878 **	-0.317 *	-2.223 **	0.012 **	0.830 **	-0.526 **	-2.585 **	-0.760 **
3x4	-0.601 **	-0.764 **	0.512 **	-0.764 **	0.501 **	0.610 **	-0.084	-0.482 *	-0.116	0.137	-0.154
3x5	0.914 **	0.770 **	0.428 **	0.770 **	0.439 **	0.852 **	0.696 **	0.542 **	0.549 **	0.869 **	0.653 **
3x6	-0.406 **	-0.492 **	-0.655 **	-0.492 **	-0.662 **	-0.526 **	-0.539 **	0.099	-0.288	-0.524 **	-0.238
3x7	-0.476 **	-0.634 **	-0.744 **	-0.634 **	-0.744 **	-1.968 **	-0.867 **	-0.357	-1.108 **	-1.595 **	-1.020 **
3x8	0.312	0.202	-1.263 **	0.202	-1.255 **	-2.095 **	-0.650 **	-0.139	-1.018 **	-2.224 **	-1.127 **
3x9	0.791 **	0.732 **	1.154 **	0.732 **	1.155 **	1.346 **	0.985 **	0.844 **	1.164 **	1.281 **	1.096 **
4x5	-0.634 **	-0.702 **	-1.111 **	-0.702 **	-1.133 **	-0.423 **	-0.784 **	-0.524 *	-0.428 *	-0.355	-0.436 *
4x6	-0.271	-0.264 *	-0.514 **	-0.264 *	-0.513 **	0.309 *	-0.253	-0.613	-0.075	0.445 **	-0.081
4x7	0.489 **	0.434 *	-0.111	0.434 *	-0.031	0.064	0.213	0.281	0.228	0.008	0.172
4x8	0.684 **	0.680 **	0.533 **	0.680 **	0.548 **	0.593 **	0.620 **	0.516 **	0.642 **	0.815 **	0.658 **
4x9	0.300 *	0.356 *	0.013	0.356 *	0.004	-0.686 **	0.057	0.102	-0.233	-0.556 **	-0.229
5x6	0.518 **	0.600	0.255 *	0.600	0.266 *	0.191	0.405 *	0.450 **	0.200	-0.053	0.199
5x7	1.238 **	1.225 **	0.731 **	1.225 **	0.734 **	0.790 **	0.991 **	1.271 **	1.067 **	0.743 **	1.027 **
5x8	0.716 **	0.927 **	1.502 **	0.927 **	1.511 **	-0.398 **	0.864 **	0.966 **	0.427 *	-0.393 *	0.333
5x9	-1.985 **	-1.860 **	-1.024 **	-1.860 **	-1.021 **	-0.387 *	-1.356	-1.915 **	-1.124 **	-0.295	-1.111 **
6x7	-0.616 **	-0.427 **	0.041	-0.427 **	0.044	0.105	-0.213	-0.442 *	-0.166	-0.006	-0.205
6x8	-1.091 **	-1.095 **	0.742 **	-1.095 **	0.743 **	1.114 **	-0.114	-1.120 **	-0.030	1.205 **	0.018
6x9	1.912 **	1.855 **	0.326 *	1.855 **	0.325 *	0.165	1.073 **	1.736 **	0.742 **	0.180	0.886 **
7x8	0.232	0.160	-0.337 *	0.160	-0.335 *	0.449 *	0.055	0.327	0.350 *	0.360 *	0.346
7x9	-1.541 **	-1.534 **	0.114	-1.534 **	0.113	0.847 **	-0.589	-1.453 **	-0.348 *	0.902 **	-0.300
8x9	-0.253	-0.228	-0.403 **	-0.228	-0.402 **	0.206	-0.218	-0.162	0.006	0.363 *	0.069
LSD 5%	0.416	0.384	0.372	0.384	0.372	0.386	0.386	0.653	0.525	0.428	0.536
(Sij-Sik)1%	0.598	0.552	0.535	0.552	0.535	0.555	0.555	0.940	0.756	0.615	0.771

For expanation see Table (1) .

Table 4. Mean yield and yield stability statistic (Ysi) for 36 flax crosses evaluated at 6 environmemts in F3 and 3 environments in F4 for seed yield and its component variables.

Crosses	Seed yield/plant(g)				No.of capsules/plant				No.of seeds/capsule				1000-seed weight(g)			
	F3		F4		F3		F4		F3		F4		F3		F4	
	Mean	Ysi	Mean	Ysi	Mean	Ysi	Mean	Ysi	Mean	Ysi	Mean	Ysi	Mean	Ysi	Mean	Ysi
1x2	4.37	35 #	4.60	18 #	72.87	33 #	73.62	32 #	7.04	-1	6.73	8	10.14	38 #	10.21	39 #
1x3	4.30	34 #	4.80	19 #	75.50	30 #	78.26	39 #	6.94	4	6.56	2	9.90	28 #	10.06	37 #
1x4	3.45	16 #	3.51	-2	51.75	0	57.78	3	7.17	12	7.22	18 #	8.71	19 #	8.86	25 #
1x5	3.23	8	3.45	0	56.17	7	60.12	11	7.21	5	7.48	27 #	8.01	3	8.04	11
1x6	3.35	14 #	3.43	3	56.84	8	62.40	11	7.38	23 #	7.24	17	8.44	16 #	8.19	13
1x7	3.58	14 #	3.71	2	61.17	9	64.55	10	7.46	22 #	7.39	25 #	8.41	14 #	8.42	20 #
1x8	3.20	0	3.48	-3	52.31	-7	62.86	8	7.23	6	7.27	17	8.68	18 #	8.84	24 #
1x9	3.39	8	3.78	8	59.47	5	61.80	14	7.37	14	7.65	29 #	7.91	1	8.10	13
2x3	4.51	30 #	5.07	18 #	71.98	28 #	76.94	37 #	6.86	3	6.67	4	10.22	31 #	10.04	36 #
2x4	3.93	21 #	3.83	13	64.94	18 #	59.30	9	6.09	-10	6.55	1	9.79	27 #	10.04	35 #
2x5	4.17	30 #	4.14	16 #	67.34	23 #	71.31	33 #	6.40	-1	6.69	5	9.66	26 #	9.85	33 #
2x6	3.45	11	3.67	5	65.35	29 #	70.97	32 #	7.31	12	7.02	4	7.83	-1	7.99	9
2x7	4.18	35 #	3.96	14 #	71.14	35 #	69.61	27 #	7.66	25 #	7.92	34 #	8.36	13 #	8.12	15
2x8	3.40	9	3.36	-6	53.43	-6	56.57	-7	7.81	34 #	7.96	37 #	8.88	21 #	9.10	29 #
2x9	3.98	31 #	4.53	9	76.01	31 #	74.67	27 #	7.69	29 #	7.84	34 #	6.93	-8	7.26	-6
3x4	3.73	24 #	3.98	13	68.21	24 #	63.41	15	7.41	17 #	8.14	30 #	9.42	25 #	9.27	31 #
3x5	4.97	31 #	5.02	21 #	71.05	26 #	77.91	38 #	7.80	33 #	7.57	29 #	9.97	29 #	9.94	34 #
3x6	3.79	23 #	3.74	11	65.10	19 #	65.79	20 #	7.29	15 #	7.25	20 #	7.92	10	8.15	16
3x7	3.55	20 #	3.55	6	60.43	6	61.22	13	8.04	29 #	7.36	16	7.24	-5	7.27	3
3x8	3.70	17 #	3.52	3	63.32	15 #	67.28	25 #	7.30	14	7.32	23 #	8.01	4	8.00	10
3x9	3.24	2	3.13	-2	58.71	4	58.36	5	6.80	-5	6.57	3	9.02	22 #	8.99	27 #
4x5	3.32	7	3.35	1	62.16	13 #	58.43	6	6.77	-2	7.00	11	8.07	7	8.61	23 #
4x6	3.13	1	2.86	-6	51.75	-1	53.94	0	7.82	33 #	7.65	31 #	7.86	0	8.07	12
4x7	3.10	2	2.90	-5	57.13	5	57.86	4	7.39	16 #	7.18	10	8.05	6	8.22	19 #
4x8	4.06	24 #	3.69	22 #	55.34	-3	59.55	2	7.13	11	6.96	10	9.30	24 #	9.55	32 #
4x9	3.24	7	3.34	27 #	54.94	3	59.08	8	8.13	34 #	7.85	35 #	7.36	-4	7.42	5
5x6	3.98	22 #	3.74	30 #	64.21	17 #	69.85	30 #	7.51	23 #	7.28	22 #	8.34	10	8.21	18 #
5x7	3.38	7	2.83	26 #	63.06	14 #	67.03	16	6.51	-8	6.05	-2	8.78	20 #	8.94	26 #
5x8	3.56	13	3.32	24 #	57.51	10	57.40	2	6.75	-7	6.53	-2	9.23	23 #	9.08	28 #
5x9	3.21	-1	3.25	33 #	63.92	16 #	61.06	4	7.37	19 #	7.22	15	6.36	-9	6.40	-1
6x7	3.20	2	3.22	39 #	65.68	22 #	67.65	23 #	7.07	9	6.89	9	6.94	-7	6.81	1
6x8	3.34	13	3.49	25 #	60.61	7	67.47	18 #	7.31	19 #	7.09	13	8.04	5	7.87	0
6x9	3.08	1	3.10	28 #	60.96	8	68.44	28 #	7.91	36 #	7.55	28 #	7.46	-3	7.50	6
7x8	3.04	-9	3.38	27 #	55.62	-2	66.75	15	7.08	8	6.72	7	7.76	-2	8.10	14
7x9	2.66	-10	2.50	28 #	50.69	-4	50.65	-2	8.14	39 #	7.45	18 #	6.34	-10	6.21	-2
8x9	3.20	5	3.23	21 #	61.81	18 #	65.24	21 #	7.67	30 #	7.58	30 #	7.11	-6	7.42	4
Mean	3.58	13.8	5.79	13.5	61.90	12.8	64.59	16.1	7.30	15.0	7.21	17.2	8.35	10.7	8.42	17.8
LSD 5%	0.255		0.386		3.354		5.704		0.238		0.500		0.073		0.819	

= Stable crosses on basis of Ysi

The aforementioned results show that evaluation of combining ability as well as stability measurement in early segregating generations is possible to obtain necessary information for improving seed yield in flax.

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تقييم المحصول وثبات السلوك الوراثي في الأجيال المبكرة في الكتان

٢- محصول البذرة ومكوناته

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تم دراسة ٣٦ هجيناً في كل من الجيلين الثالث والربع ناتجة من التهجين مابين٩ أباء من الكتان لتقدير القيمة التربوية وثبات السلوك الوراثي وذلك من خلال تقييمها عبر ثلاث بيئات مختلفة(الجيزة-الجميزة-زرزورة) في موسمي١٩٩٩/٢٠٠٠و٢٠٠١/٢٠٠٠ ,وكان التصميم التجريبي المستخدم هو قطاعات كاملة العشوائية ذات الاربعة مكررات ، وتشير نتائج نسبة التباين للقدرة العامة إلي الخاصة علي الائتلاف أن العوامل المضيفة وغير المضيفة تتحكم في توريث كلاً من صفات محصول البذرة/نبات و مكوناته ، ومع ذلك كانت العوامل الوراثية المضيفة اكثر أهمية في وراثة صفات محصول البذرة وعدد الكسولات /نبات ووزن الألف بذرة، بينما العوامل غير المضيفة كانت اكثر اهمية تتحكم في توريث صفة عدد البذور/كبسولة ، كما تشير معنوية التفاعل بين القدرة العامة علي الائتلاف و البيئة إلي أن التأثيرات المضيفة لم تكن ثابتة عبر البيئات ومن ثم فإن ذلك يتطلب التقييم في أكثر من بيئة واحدة للحصول علي نتائج يمكن الاعتماد عليها عند تقدير القدرة العامة علي الائتلاف لصفة محصول البذرة/ نبات. وعلي العكس من ذلك كان تباين تفاعل القدرة الخاصة علي الائتلاف مع البيئة غير معنوي لصفة محصول البذرة / نبات وعدد البذور/ بالكبسولة، أي أن العوامل غير المضيفة لهذه الصفات كانت اقل تأثرا بالتغيرات البيئية. كما أظهرت النتائج أن الآباء جـ٨ ، س ١/٢٤١٩ كانت ذات قدرة عالية علي الائتلاف لكل من صفات محصول البذرة/نبات وعدد الكسولات ووزن الألف بذرة بينما كان الأب اريانا ذي قدرة عالية علي الائتلاف لصفة عدد البذرة /كبسولة، كما تشير نتائج تأثير القدرة الخاصة علي الائتلاف أن تسعة هجن من بين الـ٣٦ هجين محل الدراسة أظهرت تفوقا معنويا لصفة محصول البذرة أو مكوناتها عبر البيئات والأجيال وأن هجينين منها فقط هما جـ٨×إريانا، س١/٢٤١٩× إريانا كانت آباؤها ذات قدرة عالية علي الائتلاف (مضيف × مضيف) لصفة محصول البذرة / نبات، كما تميز الهجين س١/٢٤١٩×س١٤٨/٦/ ١بالجمع بين القدرة الخاصة علي الائتلاف العالية لصفة محصول البذرة/نبات وأثنين من مكوناته هما وزن الألف بذرة و عدد البذور /كبسولة ، كما أوضحت النتائج الخاصة بتقديرات ثبات السلوك الوراثي أن خمسة هجن (جـ٧×جـ٨ ، جـ٧ ×س١/٢٤١٩، جـ٨× س١/٢٤١٩، جـ٨×س١٤٨/٦/١، س١/٢٤١٩ ×س١١/٦/١٤٨) ظلت مستمرة في الثبات عبر صفات محصول البذرة وأهم مكونين له هما وزن الألف بذرة و عدد الكبسولة/ نبات في كل من الجيلين الثالث والرابع ،لذلك تعتبر هذه الهجن ذات قيمة تربوية هامة لتحسين صفة محصول البذرة في الأجيال المتأخرة من برنامج التربية.ويستخلص من ذلك أن تقييم القدرة علي الائتلاف وثبات السلوك الوراثي في الاجيال الانعزالية المبكرة يوفر معلومات حقيقية لتحسين محصول البذرة في الكتان.