Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo, 11(2), 547-562, 2003

COMBINING ABILITY ANALYSIS FOR SEED AND STRAW YIELDS AND THEIR COMPONENTS IN A DIALLEL CROSS OF FLAX.

[41]

Abo El-Komsan, Sabah, M.[1]; A.M. El-Marakby[2]; Amna, H. El-Sweify[1] and Afaf, M.Tolba[2]

ABSTRACT

Twenty-one entries of flax *(Linum usitatissimum, L.)* involving 6 parental genotypes and their 15 F_1's hybrids were evaluated for seed and straw yields and their components at Itay El-Barood Agric. Res. Station during 2000/2001 season under two different plant distances. Diallel analysis according to **Griffing (1956)** was used. Mean squares due to entries, parents and crosses were highly significant indicating that parental genotypes as well as their F_1 crosses exhibited reasonable degrees of variability for all studied traits. Both GCA and SCA variances were highly significant, indicating the presence of both additive and dominance types of genetic variances. The additive effects were more important than non-additive effects for plant height, technical length, fiber percentage, seed index and days to maturity. On the other hand, the non-additive effects were more effective than additive for straw yield/ plant, No. of basal branches /plant, stem diameter, fiber fineness, seed yield / plant, No. of capsules/plant and oil and protein percentages. Some of crosses which exhibited significant and positive SCA effects included high x high and high x low general combiners, such as Sakha1 cv, imported fiber type Alba and the two new strains 402/12 and 282/98/16/2 suggesting that, the breeding procedure which utilize both additive and non-additive genetic variances would be more useful for improvement of both straw and seed yields of flax.

Key words: Flax, Diallel, Combining ability, Seed, Straw, Fiber quality, Oil and Protein percentage

INTRODUCTION

The important objective of flax breeding in Egypt is to improve simultaneously seed, straw yields, and high technical stem length in addition to high oil percentage in flax seed. The understanding of the nature of gene action involved in seed and fiber yields of flax is of great importance to plant breeders. The appropriate breeding methodology to be adopted for the improvement of a crop

1- Fiber Crops Res. Section, Field Crops Res. Inst., ARC,Giza, Egypt.
2- Agron. Dept., Fac. Of Agric., Ain Shams Univ. Shoubra El-Kheima, Cairo, Egypt.

(Received June 1, 2003)
(Accepted June 9, 2003)

depends primarily on the nature of combining ability of the parents to be used in the hybridization programs and also the nature of gene action involved in the expression of quantitative traits of economic importance. General combining ability (GCA) involves mostly additive and additive x additive gene effects. Specific combining ability (SCA), on the other hand, depends upon non-additive gene effects, which involves dominance and epistatic components of genetic variation. Knowledge of the relative magnitude of additive and non-additive effects would be very useful in designing an efficient breeding program.

Both GCA and SCA were studied in flax for yield and its components by several investigators. The additive genetic variance had more important role in the inheritance of plant height, technical length, fiber length, fiber percentage, seed index, maturity period as reported by **Rai (1976); Singh *et al* (1987); Thakur *et al* (1987); Rao & Singh (1985); Sharma *et al* (1986); Gaafar *et al* (1992); Foster *et al* (1998); Patil *et al* (1997); Singh (2000) and Abo-Kaied (2002).** On the contrary, non-additive variance had an important role in the inheritance of straw yield/plant No. of basal branches/plant, stem diameter, seed yield per plant, capsules/plant, oil and protein percentage as reported by **Shehata and Comstock (1971), Murty and Anand (1966), Patil and Chopde (1983), Singh *et al* (1983), Badwal and Gupta (1970), Badwal *et al* (1972), Roa and Singh (1987), Thakur and Rana (1987), Brahm and Sindhu (1986) and Mishra and Rai (1996).**

The present study aimed to estimate the combining ability for fourteen quantitative characters related to seed and straw yields in a 6x6 diallel cross of flax under two plant distances.

MATERIAL AND METHODS

This investigation was carried out during the two successive seasons 1999/00 and 2000/01, where in the first season all possible crosses were made, excluding reciprocals, in a diallel mating design involving six parental flax genotypes at Giza Agric. Res. Station. In the second season, the seeds of parental genotypes and their fifteen F_1 hybrids (21 entries) were planted at 22 nd November under two distances, i.e. 5 cm and 10 cm, between plants in a complete randomized block design with three replications per each distance at Itay El -Barood, Agric. Res. Station, Agric. Res Center (ARC).

The experimental plot consisted of single row, 2 meters long with 20 cm between rows. Genotypes characteristics of the material used according to their pedigree, origin and agronomic selected traits are presented in Table (1).

These genotypes were chosen on the basis of the presence of wide differences between them with respect to certain economic flax traits.

Observations and measurements were recorded for parents and F_1's on 10 guarded plants selected at random from each plot for the following characteristics: 1- straw yield / plant (gm), 2- Plant height: total length of main stem (cm), 3- Technical length: length of the main stem between the cotyledons and the apical branching point (cm), 4- Number of basal branches/plant, 5-Stem diameter at the middle region of the main stem (mm) using puclease apparatus, 6- Fiber length (cm), 7- Fiber percentage: calculated by

Table 1. Identification of genotypes used, pedigree, classification (dual, oil, fiber types), origin and important agronomic characteristics

Genotypes	Pedigree	Type	Origin
Sakha 1 (P_1)	I 1485 x Bombay	dual	Local cv.
S.402/12 (P_2)	I 235 x Giza 5 cv.	dual	Local promising strain
Sakha 2 (P_3)	I 2348 x Hera	oil	Local *cv.*
Alba (P_4)	An Introduction	fiber	Poland
Giza 4 (P_5)	Giza purple x Giza oil	dual	Local *cv.*
S.282/98/16/2 (P_6)	Giza 6 x I 897	dual	Local Promising strain

the following formula: *Fiber % = The total fiber yield/straw yield x100,* 8-Fiber fineness, which was estimated in metrical number (mg/mm) according to **Radwan and Momtaz (1966)**. 9- Seed yield / plant (gm), 10- Number of capsules/plant, 11-Seed index: weight of 1000-seeds (gm), 12-Oil percentage: determined by using diethyl ether according to soxhlet apparatus. **A.O.A.C. (1995),** 13- Protein percentage, determined by micro-Kjeldahl apparatus according to **A.O.A.C. (1995)** and 14-Days to maturity from sowing until all capsules turned yellow.

The analyses of variance for general and specific combining abilities were estimated according to **Griffing's** method 2 model 1 (**1956**).

RESULTS AND DISCUSSION

The diallel crossing technique is very important for the breeder to determine each line as either a good or a poor combiner to select the good line to be used in the improvement programs. Analysis of variance indicated that mean squares due to entries (parents and F_1's) were highly significant for all studied characters under two distances (5 and 10 cm) as well as the combined analysis between them (Table, 2). This means that those parental genotypes as well as the F_1's showed reasonable degrees of variability for these traits. Also, mean squares due to parents and crosses were highly significant for all traits under and over all the two investigated distances, indicating that sufficient genetic variability existed in the population for all traits.

The partitioning of genetic variance into general (GCA) and specific (SCA) combining ability variances are presented in Table (2). Both GCA and SCA variances were highly significant for all studied characters, under and over all the two investigated distances, indicating the presence of both additive and non-additive type of genetic variances. GCA variances were several time greater than the corresponding SCA variances for some studied characters under and over all the two tested distances, i.e. plant height, technical length, fiber length,

Table 2. Mean Squares for genotypes, general (GCA) and specific (SCA) combining ability at two plant distances (d) and combined data (C.) for 14 studied characters in flax

S.O.V.	5cm	10cm	C.	5cm	10cm	C.	5cm	10cm	C.	5cm	10cm	C.
	Straw yield			Plant height			Technical length			No. of basal branches		
Genotypes	3.95**	8.40**	10.41**	64.11**	90.04**	138.55**	21.58**	22.66**	41.60**	0.39**	0.35**	0.68**
Crosses	3.55**	7.17**	8.42**	61.67**	92.90**	134.61**	17.02**	17.25**	31.60**	0.21**	0.12**	0.25**
Parents	1.83**	3.30**	4.57**	66.13**	65.11**	126.14**	36.95**	39.10**	73.09**	0.70**	0.65**	1.32**
GCA	2.28**	1.30**	3.25**	54.48**	62.01**	112.45**	20.92**	21.60**	41.71**	0.09**	0.11**	0.16**
SCA	0.99**	3.30**	3.55**	10.34**	19.35**	24.09**	2.62**	2.87**	4.59**	0.15**	0.12**	0.25**
GCAxd			0.34**			4.03**			0.81			0.04**
SCAxd			0.75**			5.59**			0.90*			0.02*
Error	0.019	0.043	0.031	0.479	0.27	0.375	0.41	0.42	0.42	0.008	0.012	0.01
GCA/SCA	2.299	0.395	0.92	5.27	3.2	4.67	7.99	7.52	9.09	0.63	0.95	0.65
S.O.V.	Fiber fineness			Seed yield/plant			No. of capsules/plant			Seed index		
Genotypes	10196.9**	7557.1**	17635.4**	0.73**	3.14**	2.921**	295.2**	781.43**	908.44**	4.29**	5.32**	9.47**
Crosses	7977.9**	6220.0**	14134.8**	0.26**	2.02**	1.23**	237.0**	582.9**	643.6**	2.9**	3.94**	6.69**
Parents	18238.7**	12786.8**	30772.3**	1.17**	1.84**	2.9**	177.1**	343.8**	461.0**	9.03**	10.26**	19.13**
GCA	2219.9**	1602.1**	3795.1**	0.25**	0.55**	0.58**	40.6**	76.3**	86.9**	5.59**	6.96**	12.47**
SCA	3792**	2824.7**	6572.9**	0.24**	1.21**	1.11**	117.7**	321.9**	374.8**	0.05**	.05**	0.05**
GCAxd			26.8**			0.22**			29.9**			0.07**
SCAxd			43.8**			0.35**			64.78**			0.04**
Error	0.99	0.55	0.77	0.006	0.01	0.008	1.219	2.456	1.837	0.009	0.012	0.01
GCA/SCA	0.585	0.57	0.58	1.02	0.45	0.52	0.34	0.24	0.23	125.44	147.23	245.44

Table 2. Cont.

S.O.V.	5cm	10cm	C.	5cm	10cm	C.	5cm	10cm	C.
	Stem diameter			Fiber length			Fiber percentage		
Genotypes	0.13**	0.17**	0.29**	106.93**	121.0**	213.4**	18.12**	7.97**	23.52**
Crosses	0.09**	0.08**	0.15**	126.98**	143.6**	254.5**	7.95**	1.94**	7.79**
Parents	0.16**	0.20**	0.35**	65.96**	78.5**	140.8**	42.53**	18.87**	57.03**
GCA	0.036**	0.05**	0.09**	76.66**	111.6**	182.0**	17.70**	5.77**	21.22**
SCA	0.05**	0.06**	0.10**	21.97**	16.6**	34.2**	2.15**	1.62**	3.38**
GCAxd			0.01			6.3**			2.25**
SCAxd			0.01			4.4**			0.39**
Error	0.006	0.006	0.006	0.406	0.385	0.396	0.114	0.079	0.097
GCA/SCA	0.76	0.93	0.87	3.49	6.73	5.33	8.23	3.57	6.28
S.O.V.	Oil percentage			Protein percentage			Maturity		
Genotypes	20.09**	20.11**	40.15**	6.17**	6.03**	12.02**	10.79**	3.75**	10.76**
Crosses	6.21**	6.09**	12.23**	7.14**	7.14**	14.08**	12.53**	2.47**	10.09**
Parents	14.60**	14.63**	29.22**	0.72**	0.42**	1.02**	7.69**	8.00**	14.38**
GCA	3.80**	3.30**	7.07**	1.517**	1.52**	3.02**	5.60**	2.78**	8.04**
SCA	7.66**	7.84**	15.49**	2.24**	2.17**	4.34**	2.93**	0.74**	2.10**
GCAxd			0.02			0.02			0.344
SCAxd			0.02			0.07**			1.57**
Error	0.038	0.027	0.033	0.014	0.02	0.017	0.158	0.239	0.198
GCA/SCA	0.496	0.421	0.457	0.70	0.70	0.70	1.91	3.76	3.82

fiber percentage, seed index (1000-seed weight) and maturity traits. These results indicated that the additive effects were more important than non-additive effects for the previous mentioned traits. On the other hand, the non-additive effects were more effective than additive effect for the rest characters under study, viz.; straw yield, No. of basal branches, stem diameter, fiber fineness in addition to seed yield, No. of capsules/plant and oil and protein percentages. The ratios of GCA/SCA obtained herein are in agreement with those obtained by **Rao and Singh (1985)**, **Rao and Singh (1987)**, **Singh *et al* (1987)** and **Abo-Kaied (2002)**. Mean squares due to the interaction between GCA x plant distances (GCA x d) was highly significant for 9 out of the 14 studied traits as well as 12 traits showed significant SCA x d interaction, indicating that the magnitudes of GCA and SCA were influenced when estimated under different plant densities. However, the insignificant GCA x d and SCA x d for stem diameter and oil percentage indicate that both GCA and SCA seemed to be stable under different plant densities.

The estimates of general combining ability effects of the tested parents, evaluated in F_1 crosses are presented in Table (3). Data indicated that Sakha 1 *cv.* (P_1) was the best general combiner for straw yield /plant where it recorded highest significant and positive GCA effects among the other parents for this trait. It was also good general combiner for stem diameter at 5 cm distance and combined analysis and at the two investigated distances and combined for technical length and protein percentage. The line 402/12 (P2) recorded the highest significant positive effects of GCA for seed yield per plant at the 10 cm and combined distances and seed index at the two distances and their combined. Highly significant and positive GCA effects for oil percentage under the two investigated distances and their combined were obtained by Sakha 2 *cv.* (P_3). The imported fiber type named Alba (P_4), exhibited significant and positive GCA effects for straw yield/plant (especially at 5 cm distance), plant height, fiber length, fiber percentage and No. of capsules/plant at the two studied distances and their combined. The parent (P6), S.282/98/16/2, showed significant and positive GCA effects for seed yield/plant (only at 5 cm distance) and No. of basal branches at both distances and their combined. Since negative and significant GCA values are desirable in the case of fiber fineness and days to maturity, Sakha 2 (P_3) proved to be a good combiner for days to maturity followed by Alba (P_4) at 5 cm distance and combined analysis, while Giza 4 (P_5) proved to be the best general combiner for fiber fineness followed by Sakha 2 (P_3).

It could be concluded that Sakha 1 *cv.* and Alba (P4) are good general combiners for straw yield/plant and most of its components, indicating that the use of these parents in flax breeding programs could increase straw yield and improve its quality. However, using S.402/12, Sakha 2 cv. and Alba in flax breeding programs may be recommended for improving seed yield/plant by increasing the most important related characters viz: No. of capsules/plant, seed index and oil percentage.

Specific combining ability effects presented in Table (4) show that the four crosses ($P_1 x P_4$, $P_2 x P_4$, $P_3 x P_4$ and $P_3 x P_5$) have high significant positive SCA

Table 3. Estimation of general combining ability (GCA) effects for 14 studied characters under two plant distances and their combined (C) in flax

Parents	Straw yield 5cm	Straw yield 10cm	Straw yield C.	Plant height 5cm	Plant height 10cm	Plant height C.	Technical length 5cm	Technical length 10cm	Technical length C.	No. of basal branches 5cm	No. of basal branches 10cm	No. of basal branches C.
Sakha 1(P1)	0.66**	0.34**	0.50**	3.41**	2.44**	2.92**	2.40**	2.33**	2.36**	0.05	.-0.10**	-0.03
S.402/12 (P2)	-0.50**	-0.50**	.-0.50**	.-1.11**	.-0.74**	.-0.93**	.-1.88**	.-1.82**	.-1.85**	0.00	.-0.03	-0.02
Sakha 2(P3)	-0.74**	-0.41**	.-0.57	.-3.74**	.-3.61	.-3.68**	.-1.69	.-1.50**	.-1.59**	.-0.107**	0.05	-0.03
Alba (P4)	0.21**	0.53**	0.37**	2.30**	4.03**	3.16**	0.97**	1.32**	1.15**	.-0.115	.-0.16**	.-0.14**
Giza 4(P5)	0.39**	0.06	0.23**	0.47*	.-0.44*	0.02	0.10	0.42	0.26	0.00	0.08*	0.04
S.282/98/16/2(P6)	-0.02	-0.02	-0.02	.-1.32**	.-1.68**	.-1.50**	0.10	.-0.76**	.-0.33*	0.174**	0.16**	0.17**
L.S.D.(gi-gj) 5%	0.16	0.24	0.13	0.81	0.61	0.43	0.75	0.76	0.46	0.11	0.13	0.07
1%	0.22	0.33	0.17	1.08	0.81	0.57	1.00	1.01	0.60	0.14	0.17	0.09

Parents	Fiber fineness 5cm	Fiber fineness 10cm	Fiber fineness C.	Seed yield/plant 5cm	Seed yield/plant 10cm	Seed yield/plant C.	No. of capsules/plant 5cm	No. of capsules/plant 10cm	No. of capsules/plant C.	Seed index 5cm	Seed index 10cm	Seed index C.
Sakha 1(P1)	27.200**	2.54**	1.65**	0.087**	.-0.09**	0.00	.-1.407**	.-5.31**	.-3.36**	0.524**	0.60**	0.56**
S.402/12 (P2)	-22.62**	0.13	0.15	0.15**	0.42**	0.28**	.-1.90**	2.03**	0.06	0.628**	0.65**	0.64**
Sakha 2(P3)	-8.18**	.-2.25**	.-2.13**	.-0.15**	0.17**	0.01	.-2.28**	-0.88	.-1.58**	0.216**	0.33**	0.28**
Alba (P4)	6.19**	5.88**	5.79**	.-0.24**	.-0.35**	.-0.30**	3.48**	3.52**	3.5**	.-1.635**	.-1.85**	.-1.74**
Giza 4(P5)	-5.00**	.-4.54**	.-3.50**	-0.05	.-0.10**	.-0.07**	0.71	1.33*	1.02**	-0.05	0.06	0.01
S.282/98/16/2(P6)	2.41**	.-1.75**	.-1.96**	0.20**	-0.04	0.08**	1.41	-0.69	0.36	0.316**	0.20**	0.26**
L.S.D.(gi-gj) 5%	1.16	0.87	0.62	0.21	0.12	0.06	1.29	1.83	0.96	0.11	0.13	0.07
1%	1.55	1.16	0.82	0.28	0.15	0.08	1.72	2.45	1.27	0.15	0.17	0.10

Table 3. Cont.

Parents	Stem diameter			Fiber length			Fiber percentage		
	5cm	10cm	C.	5cm	10cm	C.	5cm	10cm	C.
Sakha 1(P1)	0.08**	0.04	0.06**	0.75**	2.54**	1.65**	-1.26**	-0.68**	-0.97**
S.402/12 (P2)	0.04	0.06*	0.05**	0.17	0.13	0.15	-0.41**	-0.25**	-0.33**
Sakha 2(P3)	-0.11**	-0.16**	-0.13**	-2.0**	-2.25**	-2.13**	0.96**	1.06**	1.01**
Alba (P4)	-0.01	0.03	0.01	5.71**	5.88**	5.79**	2.58**	1.09**	1.83**
Giza 4(P5)	0.03	0.05	0.04*	-2.46**	-4.54**	-3.50**	-0.88**	-0.49**	-0.68**
S.282/98/16/2(P6)	-0.04	-0.02	-0.03	-2.17**	-1.75**	-1.96**	-0.99**	-0.73**	-0.86**
L.S.D.(gi-gj) 5%	0.09	0.09	0.05	0.74	0.72	0.45	0.39	0.33	0.22
1%	0.12	0.12	0.07	1.00	0.97	0.59	0.53	0.44	0.29
Parents	**Oil percentage**			**Protien percentage**			**Maturity**		
Sakha 1(P1)	-0.82**	-0.77**	-0.80**	0.62**	0.63**	0.63**	0.31*	0.40*	0.35**
S.402/12 (P2)	0.45**	0.48**	0.47**	-0.50**	-0.46**	-0.48**	-0.32*	-0.10	-0.21**
Sakha 2(P3)	1.13**	1.02**	1.07**	0.43**	0.40**	0.41**	-1.03**	-0.81**	-0.92**
Alba (P4)	-0.41**	-0.31**	-0.36**	-0.16**	-0.18**	-0.17**	-0.44**	-0.31	-0.38**
Giza 4(P5)	-0.23**	-0.24**	-0.23**	-0.09*	0.01	-0.04	0.06	-0.10	-0.02
S.282/98/16/2(P6)	-0.12	-0.18**	-0.15**	-0.31**	-0.40**	-0.35**	1.43**	0.90**	1.17**
L.S.D.(gi-gj) 5%	0.23	0.19	0.13	0.14	0.16	0.09	0.46	0.57	0.32
1%	0.31	0.26	0.17	0.19	0.22	0.12	0.62	0.76	0.42

Table 4. Estimation of specific combining ability (SCA) effects for 14 studied characters under two plant distances and their combined (C) in flax

Crosses	Straw yield			Plant height			Technical length			No. of basal branches		
	5cm	10cm	C.	5cm	10cm	C.	5cm	10cm	C.	5cm	10cm	C.
P_1xP_2	0.21	0.83**	0.52**	-3.83**	3.66**	-0.08	0.06	1.74**	0.90*	-0.02	-0.01	-0.02
P_1xP_3	-0.36**	0.88**	0.26**	0.07	-1.19*	-0.56	0.12	-3.33**	-1.60**	-0.08	0.07	-0.01
P_1xP_4	1.64**	0.92**	1.28**	4.00**	0.97*	2.49**	-0.28	0.69	0.20	0.37**	0.43**	0.40**
P_1xP_5	0.52**	-0.09	0.22	0.52	-0.21	0.16	1.20*	0.09	0.64	0.14	-0.04	0.05
P_1xP_6	0.24	0.41**	0.33**	2.11**	0.73	1.42**	1.11	0.83	0.97*	0.17*	0.10	0.14*
P_2xP_3	-0.31**	-1.36**	-0.83**	0.44	-1.14*	-0.35	0.29	0.99	0.64	-0.46**	-0.15	-0.30**
P_2xP_4	0.54**	0.86**	0.70**	4.83**	5.16**	5.00**	2.03**	1.27*	1.65**	0.49**	0.22*	0.35**
P_2xP_5	-0.20	-0.36	-0.28**	0.37	-0.25	0.06	-1.94**	-1.46*	-1.70**	-0.02	-0.12	-0.07
P_2xP_6	0.36**	0.39**	0.37**	0.63	-0.30	0.17	0.81	-0.03	0.39	0.19*	0.24*	0.22**
P_3xP_4	0.63**	4.01**	2.32**	1.29*	9.01**	5.15**	2.37**	2.55**	2.46**	0.55**	0.62**	0.58**
P_3xP_5	1.89**	2.73**	2.31**	5.52**	4.70**	5.11**	1.69**	2.29**	1.99**	0.01	0.11	0.06
P_3xP_6	-0.71**	-1.25**	-0.98**	-3.82**	-5.67**	-4.75**	-0.83	0.46	-0.18	-0.20*	-0.28	-0.24**
P_4xP_5	-0.07	-0.28	-0.18	-0.06	1.79**	0.86*	0.66	0.36	0.51	0.31**	0.25*	0.28**
P_4xP_6	0.50**	-0.14	0.18	1.13	-1.35**	-0.11	-3.22**	-2.08	-2.65**	0.15	0.15	0.15*
P_5xP_6	0.50**	0.99**	0.74**	-1.98*	-0.12	-1.05	-0.58	0.46	-0.06	-0.16	0.16	0.00
L.S.D(Sij-Sik) 5%	0.37	0.56	0.31	1.85	1.39	1.06	1.72	1.73	1.12	0.24	0.29	0.17
1%	0.50	0 74	0.41	2.48	1.86	1.41	2.29	2.32	1.48	0.32	0.39	0.23

(P_1)=Sakha 1 (P_2)=S.402/12 (P_3)=Sakha 2 (P_4)=Alba (P_5)= Giza 4 (P_6)=S.282/98/16/2

Table 4. Cont.

Crosses		Stem diameter			Fiber length			Fiber percentage		
		5cm	10cm	C.	5cm	10cm	C.	5cm	10cm	C.
P_1xP_2		0.05	0.143*	0.10	-2.25*	-3.00**	-2.63**	-0.03	-0.08	-0.06
P_1xP_3		-0.02	0.04	0.01	6.25**	7.04**	6.65**	-1.53**	-1.21**	-1.37**
P_1xP_4		0.17*	0.22**	0.19**	-1.46*	-0.75	-1.10*	-2.83**	-1.46**	-2.15**
P_1xP_5		0.08	-0.05	0.01	-0.96	0.67	-0.15	0.58	0.15	0.37
P_1xP_6		0.08	-0.06	0.01	-2.58**	-1.13*	-1.85**	0.26	0.27	0.27
P_2xP_3		-0.06	-0.13	-0.09	-5.17**	-6.21**	-5.69**	-0.18	0.78**	0.30
P_2xP_4		0.13	0.15*	0.14**	8.13**	3.67**	5.90**	-1.56**	-1.30**	-1.43**
P_2xP_5		0.09	0.06	0.07	-1.38*	-2.58**	-1.98**	-0.33	-0.35	-0.34
P_2xP_6		-0.04	0.02	-0.01	4.67**	3.96**	4.31**	-0.48	0.04	-0.22
P_3xP_4		0.38**	0.41**	0.39**	6.96**	5.04**	6.00**	0.12	-1.42**	-0.65**
P_3xP_5		0.10	0.19**	0.14**	2.46**	-3.21**	-0.38	0.47	-0.14	0.17
P_3xP_6		-0.02	0.16*	0.07	-7.17**	-6.33**	-6.75**	0.44	-1.01**	-0.29
P_4xP_5		0.30*	0.28**	0.29**	-3.25	-1.33*	-2.29**	-0.68*	-1.01**	-0.85**
P_4xP_6		-0.05	-0.08	-0.06	-0.88	-0.46	-0.67	-1.45**	-0.79**	-1.12**
P_5xP_6		-0.26*	0.01	-0.12*	3.29**	-0.38	1.46 **	-0.20	0.15	-0.03
L.S.D.(Sij-Sik)	5%	0.20	0.21	0.13	1.70	1.66	1.09	0.90	0.75	0.54
	1%	0.27	0.28	0.18	2.28	2.22	1.44	1.21	1.01	0.71

(P_1)=Sakha 1 (P_2)=S.402/12 (P_3)=Sakha 2 (P_4)=Alba (P_5)= Giza 4 (P_6)=S.282/98/16/2

Table 4. Cont.

Crosses	Fiber fineness			Seed yield/plant			No. of capsules/plant			1000-seed weight		
	5cm	10cm	C.	5cm	10cm	C.	5cm	10cm	C.	5cm	10cm	C.
P_1xP_2	-14.26**	-11.74**	-13.00**	-0.13	1.08**	0.47**	-3.96**	5.82**	0.93	0.06	0.10	0.08
P_1xP_3	76.66**	69.99**	73.33**	0.303**	-0.02	0.14*	2.30*	4.56**	3.43**	-0.29**	0.32**	0.01
P_1xP_4	-46.08**	-36.86**	-41.47**	0.85**	0.40**	0.63**	12.50**	3.77**	8.14**	0.16	0.07	0.12
P_1xP_5	-36.37**	-33.80**	-35.08**	0.25**	-0.32**	-0.03	7.48**	-0.95	3.26**	0.08	-0.38**	-0.15*
P_1xP_6	39.01**	38.02**	38.51**	-0.22**	0.56**	0.17**	-2.09*	5.53**	1.72	-0.16	0.28**	0.06
P_2xP_3	51.99**	46.14**	49.06**	-0.15*	0.60**	0.23**	-1.41	-1.66	-1.54	0.00	-0.24*	-0.12
P_2xP_4	-32.79**	-28.12**	-30.46**	0.40**	1.08**	0.74**	2.29*	18.09**	10.19**	0.01	0.13	0.07
P_2xP_5	44.39**	42.43**	43.41**	-0.03	-0.84**	-0.44**	1.30	-14.97**	-6.83**	-0.26**	-0.01	-0.14
P_2xP_6	-56.74**	-52.51**	-54.63**	0.41**	0.25**	0.33**	5.24**	5.16**	5.20**	0.35**	0.19	0.27**
P_3xP_4	-85.11**	-70.51**	-77.81**	0.32**	1.64**	0.98**	15.61**	33.15**	24.38**	0.01	-0.09	-0.04
P_3xP_5	58.84**	51.94**	55.39**	0.67**	1.73**	1.20**	17.33**	28.41**	22.87**	0.30**	0.06	0.18*
P_3xP_6	48.42**	39.51**	43.96**	-0.23**	-0.81**	-0.52**	-10.36**	-11.38**	-10.87**	-0.25**	-0.37**	-0.31**
P_4xP_5	-29.65**	-20.86**	-25.26**	0.08	0.15	0.12	1.42	6.89**	4.15**	0.24**	0.08	0.16*
P_4xP_6	-46.99**	-38.30**	-42.65**	0.29**	0.11	0.20**	8.27**	1.14	4.71**	-0.17	-0.17	-0.17*
P_5xP_6	-10.01**	-8.89**	-9.49**	-0.07	0.40**	0.17**	-6.63**	7.09**	0.23	0.07	0.07	0.07
L.S.D(Si-Sik) 5%	2.66	1.98	1.52	0.21	0.27	0.15	2.95	4.19	2.35	0.25	0.29	0.18
1%	3.56	2.65	2.01	0.28	0.35	0.20	3.95	5.61	3.11	0.34	0.38	0.23

(P_1)=Sakha 1 (P_2)=S.402/12 (P_3)=Sakha 2 (P_4)=Alba (P_5)= Giza 4 (P_6)=S.282/98/16/2

Table 4. Cont.

Crosses	Oil percentage			Protien percentage			Maturity		
	5cm	10cm	C.	5cm	10cm	C.	5cm	10cm	C.
P_1xP_2	-0.06	0.03	-0.02	2.00**	1.60**	1.80**	0.51	1.16*	0.83**
P_1xP_3	0.61**	0.54**	0.58**	1.32**	1.83**	1.58**	1.55**	-0.14	0.71*
P_1xP_4	1.75**	1.92**	1.84**	1.66**	1.97**	1.82**	0.63	0.36	0.50
P_1xP_5	-0.14	-0.10	-0.12	0.54**	0.69**	0.61**	0.13	-0.85	-0.36
P_1xP_6	0.71**	0.74**	0.73**	-1.28**	-1.01**	-1.15**	-2.58**	-1.85**	-2.21**
P_2xP_3	1.25**	1.48**	1.36**	0.39**	0.18	0.29**	-2.16**	0.36	-0.90**
P_2xP_4	1.93**	1.72**	1.83**	0.08	-0.34**	-0.13	-3.74**	-0.14	-1.94**
P_2xP_5	1.80**	1.74**	1.77**	-0.69**	-0.76**	-0.73**	0.76*	-0.35	0.21
P_2xP_6	-0.55**	-0.52**	-0.54**	-0.72**	-0.33*	-0.52**	2.38**	-0.35	1.02**
P_3xP_4	2.06**	1.88**	1.97**	0.74**	0.31*	0.52**	0.69**	0.91*	0.94**
P_3xP_5	-0.18	-0.44**	-0.31	1.99**	2.10**	2.05**	-1.54**	-0.64	-1.09**
P_3xP_6	1.02**	0.86**	0.94**	-0.18	-0.70**	-0.44**	0.09	-0.64	-0.27
P_4xP_5	1.11**	1.34**	1.22**	-2.39**	-1.95**	-2.17**	1.88**	-0.14	0.87**
P_4xP_6	4.11**	4.33**	4.22**	1.22**	1.05**	1.14**	-0.49	0.86	0.19
P_5xP_6	3.17**	3.15**	3.16**	0.63**	0.51**	0.57**	0.01	0.66	0.33
L.S.D.(Si-Sik) 5%	0.52	0.44	0.31	0.32	0.37	0.23	1.06	1.31	0.77
1%	0.70	0.59	0.42	0.43	0.50	0.30	1.42	1.75	1.02

(P_1)=Sakha 1 (P_2)=S.402/12 (P_3)=Sakha 2 (P_4)=Alba (P_5)= Giza 4 (P_6)=S.282/98/16/2

effects for straw yield/plant and plant height at the two investigated distances and their combined. For technical stem length, three crosses (P_2xP_4, P_3xP_4 and P_3xP_5) showed significant and positive SCA effects for the two tested distances and their combined. Four crosses (P_1xP_4, P_2xP_4, P_3xP_4 and P_4xP_5) exhibited significant and positive SCA effects at the two tested distances and their combined for No. of basal branches. For stem diameter, only two crosses, i.e., P_3xP_4 and P_4xP_5 recorded highly significant and positive SCA effects for this trait. However, four crosses give highly significant and positive SCA effects with respect to fiber length, namely; P_1xP_3, P_2xP_4, P_2xP_6 and P_3xP_4. Regarding fiber fineness, nine crosses (P_1xP_2, P_1xP_4, P_1xP_5 P_2xP_4, P_2xP_6, P_3xP_4, P_4xP_5, P_4xP_6 and P_5xP_6), showed high significant negative SCA effects. For seed yield and No. of capsules/plant, results indicated that five crosses i.e., P_1xP_4, P_2xP_4, P_2xP_6, P_3xP_4 and P_3xP_5 exhibited significant and positive SCA effects at the two tested distances and their combined. While for seed index, two crosses (P_1xP_3 and P_1xP_6) at 10 cm distance and three crosses (P_2xP_6 , P_3xP_5 and P_4xP_5) at 5 cm distance had highly significant and positive SCA effects for this character. Seven crosses exhibited highly significant and positive SCA effects for protein percentage at the investigated distance, namely, P_1xP_2, P_1xP_3, P_1xP_4, P_1xP_5, P_3xP_5, P_4xP_6 and P5xP6. For days from sowing to maturity, four crosses (P_1xP_6, P_2xP_3, P_2xP_4 and P_3xP_5) recorded high significant and negative SCA effects for this trait.

Generally it could be mentioned that the crosses which exhibited significant and positive SCA for both straw and seed yield and most related traits, include one or both parents of high GCA effects viz, Sakha 1, S.402/12, Alba and S.282/98/16/2, meaning that some crosses included high x high or high x low general combiner parents. From the breeding point of view, crosses exhibiting significant and positive SCA effects resulted from high x high general combiner. The breeding procedure which utilize both additive and non-additive genetic variance would be more useful for improvement of both straw and seed yield. In this respect, **Thakur *et al* (1987), Mishra and Rai (1996)** and **Abo-Kaied (2002)** came to the same conclusion.

REFERENCES

Abo-Kaied, H.M.H. (2002). Combining ability and gene action for yield and yield components in flax. ***Egypt. J. Plant breed. 6(2): 51-63.***

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

Badwal, S.S. and V.P. Gupta (1970). General and specific combining ability in linseed. ***Indian J. Genet. Pl. Breed.30: 328-334.***

Badwal, S.S.; V.P. Gupta and K.S. Gill. (1972). Combining ability studies of selected world germplasm line of linseed.. ***J. Res. Punjab Agric. Univ. Ludhiana 9: 383-388.***

Brahm, S. and T.S. Sindhu. (1986). Combining ability and genetic architecture of oil content in linseed. ***J. Oil Seed Res. 3(1): 14-18***

Foster, R.; H.S. Pooni and I.J. Mackay. (1998). Quntitative analysis of *Linum usitatissimum* crosses for dual-purpose trait. ***J. Agric. Sci.131 (3): 285-292.***

Gaafar, S.M.; Alcia. A.El-Seodi; G. El Shimy; A.M. Omar and Naglaa Ashry. (1992). Combining ability studies on some flax hybrids (*Linum usitatissimum*). *Egypt. J. Agric. Res. 70(4): 1-12.*

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing systems. *Aust. J. Biol. Sci. 9: 436 - 93.*

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(2): 155-161.*

Murty, B.R. and I.J. Anand. (1966). Combining ability and genetic diversity in some varieties of *Linum usitatissimum*. *Indian J. Genet. and Pl. Breed., 26(1): 21-36.*

Patil, V.D. and P.R.Chopde (1983). Heterosis in relation to general and specific combining ability effects in linseed. *Indian. J. Genet. and Pl. Breed. , 43: 226-228.*

Patil, J.A; Y.K. Gupta; S.B. Patel and J.N. Patel. (1997). Combining ability analysis over environments in linseed. *Madras Agric. J. 84(4): 188-191.*

Radwan, S.R. and A. Momtaz. (1966). The technological properties of flax fiber and methods of estimating them.. *EL-Felaha. J. 46 (5): 466-476(in Arabic).*

Rai, M. (1976). Genetic analysis of flowering and maturity periods in linseed (*Linum usitatissimum* L.). *Indian J. of Heredity. 8(3/4): 39-47.*

Rao, S.K. and S.P. Singh (1985). Genetic architecture of yield and its components in linseed (*Linum usitatissinium* L.). *Indian J. Agric. Sci. 55: 512-516.*

Rao, S.K. and S.P. Singh. (1987). Additive, dominance and epistatic effects in linseed (*Linum usitatissimum* L.) .*Indian J. Agric. Sci. 57(3): 208-211.*

Sharma, H.K.; L. Singh and D. Sharma. (1986). Combining ability in diallel crosses in linseed. *Indian J. Agric. Sci. 56: 25-29.*

Shehata, A.H. and V.E. Comstock. (1971). Heterosis and combining ability estimates in F_2 flax populations as influenced by plant density. *Crop Sci., 11: 534-536.*

Singh, P.K. (2000). Gene action for seed yield and its components in linseed. *Indian J. Genet. 60(3): 407-410.*

Singh, R.R.; S.P. Singh and R.V. Singh. (1983). Study of genetic components variations in linseed. *Madras. Agric. J., 70(12): 786-788.*

Singh, P.; A.N. Srivastava and I.B. Singh. (1987). Estimation of genetic variances for yield components and oil content in linseed. *Farm Sci. J.2 (2): 138-143.*

Thakur, H.L. and N.D. Rana (1987). Combining ability in linseed. *Indian J. Agric. Sci., 57(5): 303-308.*

Thakur, H.L.; N.D. Rana and O.P. Sood. (1987). Combining ability analysis for some quantitative characters in linseed. *Indian J. Genet. 47(1): 6-10.*

مجلة اتحاد الجامعات العربية للدراسات والبحوث الزراعية ، جامعة عين شمس ، القاهرة ، ١١(٢) ، ٥٤٧ - ٥٦٢ ، ٢٠٠٣

تحليل القدرة على الائتلاف لمحصولي البذور والقش ومكوناتهما في أحد الهجن التبادلية في الكتان

[٤١]

صباح محمد أبو القمصان[١] - عبد المقصود محروس المراكبي[٢] - آمنة حافظ السويفى[١] - عفاف محمد طلبة[٢]

١- قسم بحوث محاصيل الألياف -معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية - الجيزة -مصر
٢- قسم المحاصيل - كلية الزراعة - جامعة عين شمس - شبرا الخيمة - القاهرة - مصر

أجرى هذا البحث في محطة البحوث بأيتاى البارود - محافظة البحيرة والتابعة لمركز البحوث الزراعية لتقييم ٢١ تركيب وراثي من الكتان شملت ٦ أباء و ١٥ هجين ناتجة من دائرة تهجينات مع استبعاد الهجن العكسية وذلك تحت مسافتين للزراعة بين النباتات (٥ سم ،١٠ سم) في تصميم قطاعات كاملة العشوائية وقد تم تقدير القدرة على الائتلاف بطريقة Griffing (1956) لمحصولي البذور والقش ومكوناتها .

وفيما يلي أهم النتائج :

١- كانت التباينات الراجعة إلى التراكيب الوراثية الأبوية وهجنها الفردية عالية المعنوية وهذا يعنى أن جميع التراكيب الوراثية أظهرت درجات من التباين الوراثي لكل الصفات .

٢- اظهر تحليل قدرتي التآلف العامة والخاصة معنوية عالية في كل الصفات تحت الدراسة مما يوضح الأهمية النسبية لكل من الجينات المضيفة وغير المضيفة في وراثة الصفات المدروسة.

٣- أشارت النتائج إلى أن تأثير الجينات المضيفة كان أكثر أهمية في وراثة صفات الطول الكلى ، الطول الفعال ، النسبة المنوية للألياف ،وزن ١٠٠٠ بذرة ؛ عدد الأيام حتى النضج . بينما كان للجينات غير المضيفة النصيب الأكبر في وراثة صفات محصول القش، عدد الأفرع القاعدية ، سمك الساق ، نعومة الألياف ، محصول البذرة /النبات، عدد الكبسولات / النبات ، النسبة المنوية لكلا من الزيت والبروتين .

٤- أظهر الصنف المحلي سخا١ والمستورد ألبا قدرة جيدة علي الائتلاف بالنسبة لمحصول القش للنبات ومعظم مكوناته، كما أظهرت الأصناف سخا٢ والسلالة المبشرة ٤٠٢/١٢ والصنف المستورد ألبا قدرة جيدة علي الائتلاف بالنسبة

لمحصول البذرة ، مما يشير إلى أهميـــة استخدام تلك الأصناف كآباء في برنـــامج تحسين محصول البذرة بزيـــادة معظـــم مكوناته الهامة ذات العلاقة وتشمل عـــدد الكبسولات بالنبات ودليل البذرة ونســـبة الزيت بالبذرة.

٥- الهجن التي أظهرت قدرة خاصة علـــى الائتـــلاف لصفتـــي محصـــول القـــش والبذرة/نبات كـــانت عبـــارة عـــن أب عالي × أب عالي القدرة على الائتـــلاف مثل الإبـــاء سخا ١ والمســـتورد ألبـــا والســـلالتين الجديدتيـــن ١٢/٤٠٢ ، ٢/١٦/٩٨/٢٨٢ .

٦- أوضحت الدراسة أن كلا من التـــأثيرات المضيفة وغير المضيفة للجينات ســـوف يكون لها أهميـــة كبـــيرة فـــي تحســـين محصولي البذور والقـــش فـــي الكتـــان باستخدام طريقة التربية المناسبة .

تحكيم: أ.د أحمد عبد الصادق محمد عبد الدايم
أ.د أحمد علي عبد الحليم