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ANALYSIS OF COMBINING ABILITY FOR SOME ECONOMICAL USEFUL CHARACTERS IN FLAX

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ABSTRACT: ***This study was conducted with the objective of estimating combining ability and gene action for straw and seed yields and their components in flax. This was achieved via evaluating six parents, P_1 (S.402/2/2/5), P_2 (S.2467/1/1), P_3 (Sakha1), P_4 (Leflora), P_5 (Giza 7), P_6 (S. 400/4/4/2) and their 15 F_1's progenies were evaluated in a randomized complete block design with three replications at Sakha Res. Station at Kafr El-Sheikh Governorate. The collected data indicated that the additive effects were more important than non-additive effects for each of plant height, technical length, seed yield per plant and 1000-seed weight, revealed that the inheritance of these traits were mainly controlled by additive effects of genes. On the other hand, the non- additive effects were more important than additive effects for each of straw yield, number of basal branches and number of capsules per plant. P_1 and P_5 for plant height, technical length, seed yield and number of capsules per plant exhibited significantly positive GCA effects. Also, P_6 for straw yield, technical length, number of basal branches, 1000-seed weight and number of seeds per capsule in addition P_2 for seed yield, number of capsules per plant and 1000-seed weight exhibited significantly positive GCA effects indicating that the possibility of using these parents for improving the previous traits. Three crosses ($P_2 \times P_5$, $P_3 \times P_4$ and $P_4 \times P_5$) showed high SCA effects in the desirable direction for straw yield and its all components. For the two important components, plant height and technical length out of the six crosses ($P_1 \times P_2$, $P_2 \times P_5$, $P_3 \times P_4$, $P_3 \times P_5$, $P_4 \times P_6$ and $P_5 \times P_6$), four crosses ($P_1 \times P_2$, $P_2 \times P_5$, $P_3 \times P_5$ and $P_5 \times P_6$) involved high x low general combiners for the above mentioned traits. For seed yield, the crosses exhibiting significant SCA effects which resulted from high $\times$ high good GCA combiners, such as the two crosses ($P_1 x P_2$ and $P_2 x P_6$) for 1000-seed weight and one cross ($P_2 x P_5$) for both seed yield and number of capsules per plant. Therefore, these crosses may be useful in breeding flax program to improvement seed yield per plant.***

Phenotypic correlation coefficients among eight traits indicated that, straw yield per plant was significantly positively correlated with each of plant height, number of basal branches, seed yield and number of capsules per plant. Also, a significant positive correlation between plant height and technical length was present, indicating that maximization of straw yield may be obtained by selection for these traits. Moreover, seed yield was significant positively correlated with number of basal branches, number of capsules per

plant, number of seeds per capsule and 1000-seed weight. Also, 1000-seed weight showed positive correlation with number of basal branches per plant and seed yield per plant.

Key words: ***Flax, Diallel analysis, Combining ability, Gene action, correlation.***

INTRODUCTION

Flax (*Linum usitatissimum* L.) is considered the second important fiber crop in Egypt after cotton and is grown as a dual purpose crop for both oil and fiber. The expression of most quantitative characters depend on many genes with minor effects. It has generally not been possible to study the individual genes, but economic significance of many quantitative characters has stimulated research workers to devise methods for the analysis of the genetic background of such characters

The diallel cross technique proposed by Griffing (1956) has been widely used for the evaluation of general combining ability (GCA) and specific combining ability (SCA). Recently, the use of diallel analysis for evaluating the potential of parents for producing desirable recombinations in self-polinated crops has been studied by several workers (Joshi and Dhawan, 1966 and Matzinger, 1963) inducing several investigations on flax. Information of the type of gene action involved in the expression of a character is helpful in deciding the breeding procedures to be used for improvement of the character and is necessary for efficient utilization of available germplasm in a plant breeding program. Combining ability analysis is the most widely used biometrical tool for classifying parental lines in terms of their ability to combine in hybrid combinations. With this method, the resulting total genetic variation is partitioned into the effects of general combining ability, a measure of additive gene action and specific combining ability, a measure of non-additive gene action. It is very essential that the breeder should evaluate the potentialities of the available germplasm for new recombinations and eventually combining ability have proved to be of considerable use in crop plants. In this regard, several studies have been reported in flax, *i.e.* Thakur *et al* (1987), Mishra and Rai (1996), Patil *et al* (1997), Foster *et al* (1998), Abo El-Zahab and Abo-Kaied (2000), Abo-Kaied (2002) and Abo-Kaied (2006).

The 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 correlation coefficients between seed, straw yields and their related characters.

MATERIALS AND METHODS

The materials used for the present study consisted of 6 parents viz., P_1 (S.402/2/2/5), P_2 (S.2467/1/1), P_3 (Sakha1), P_4 (Leflora), P_5 (Giza 7) and P_6 (S. 400/4/4/2). Genotype characteristics of these parents and their pedigree, type (dual, oil and fiber types) and origin are presented in Table (1).

Table 1: Identification of parental genotypes used, pedigree, classification (dual, oil, fiber types) and origin.

Genotypes	Pedigree	Type	Origin
P_1= S.402/2/2/5	Giza 5 (cv.) x I. 235 (USA)	oil	Local line
P_2= S.2467/1/1	Selected from I. Hira (Indian)	oil	Local line
P_3= Sakha 1	Bomby x I.1485	dual	Local *cv*.
P_4= Leflora	An Introduction	fiber	Holland
P_5= Giza 7	Giza 5 5 (cv.) x I. New river (USA)	dual	Local *cv*.
P_6=S. 400/4/4/2	S.2106/3 x Reina (Netherland)	dual	Local line

In 2007/08 season, the six parents were crossed in a diallel mating design excluding reciprocals to obtain 15 F_1 crosses. In 2008/09 season, the parents and their crosses were evaluated in the breeding nursery of the Sakha Res. Section, ARC at Kafr El-Sheikh Governorate.

The experiment was laid out in a randomized complete block design with three replications with restricted randomization where each plot consisted of single F_1 row guarded by one row of its parents. Rows were 3 m long, spaced 20 cm apart. Single seeds were hand drilled in 5 cm spacing within rows. At harvest, individual guarded plants were taken at random from each row; 10 plants from each parent and F_1 per replication. These plants were used for recording: straw yield (g) /plant, plant height (cm), technical stem length(cm), no. of basal branches, seed yield (g)/plant, 1000-seed weight (g), no. of capsules/plant, and no. of seeds/capsule.

STATISTICAL ANALYSIS

General (GCA) and specific (SCA) combining ability sum of squares were calculated according to Griffing's method 2 (parents and one set of F_1's are included but not reciprocal F_1's, i.e., (P (P-1)/2) combination, model 1 (fixed effects). Phenotypic correlation coefficients were calculated between the studied traits following Al-Jibouri *et al* (1958).

RESULTS AND DISCUSSION

1- Straw yield per plant and its components:

Mean squares due to genotypes (6 parents and 15 F_1's crosses) were significant for straw yield and its components viz., plant height, technical

length and number of basal branches per plant (Table 2). Also, general (GCA) and specific (SCA) combining ability variances for these traits were significant, indicating the presence of both additive and non-additive type of genetic variance.

The ratio of general to specific combining ability variances (GCA/SCA) for straw yield per plant and no. of basal branches per plant showed that the non-additive effects were more important than additive effects. Although SCA mean squares were significant for plant height and technical length, the magnitude of GCA mean squares were greater than SCA mean squares for the two important components (plant height and technical length) of straw yield. Therefore, the magnitude of additive genetic effects must be of considerable value for each character. Consequently, effective selection should be possible for these two traits within the F_2 and subsequent populations of the crosses. Similar results were reported by Singh *et al* (1987), Thakur *et al* (1987), Patil *et al* (1997), Foster *et al* (1998), Abo El-Zahab and Abo-Kaied (2000) and Abo-Kaied and El-Refaie (2008).

Table 2. Mean Squares for 21 flax genotypes (6 parents and 15 crosses) for straw and seed yields and their components.

S.O.V.	df	Straw yield and its components				Seed yield and its components			
		Straw yield / plant(g)	Plant height (cm)	Technical length (cm)	No. of basal branches	Seed yield/plant (g)	No. of capsules/plant	1000-seed weight	No. of seeds/capsule
REPS	2	0.670ns	0.200ns	3.980*	0.004ns	0.011ns	16.380*	0.520**	0.140**
GENOTYPES	20	8.670**	99.750**	29.950**	0.340**	1.740**	314.820**	1.590**	0.370**
crosses(C)	14	4.157**	96.918**	22.761**	0.123**	0.729**	241.065**	0.895**	0.272**
parents (P)	5	9.776**	90.805**	52.605**	0.662**	1.723**	95.338**	3.740**	0.340**
P.*vs*.C	1	66.342**	184.119**	17.407**	1.772**	15.898**	2444.888**	0.623**	1.960**
GCA	5	4.671**	150.43**	72.858**	0.318**	2.082**	181.98**	3.9**	0.291**
SCA	15	10.05**	82.857**	15.654**	0.348**	1.62**	359.106**	0.822**	0.402**
Error	40	0.351	0.987	0.996	0.015	0.012	3.816	0.024	0.012
GCA/SCA %		0.467	1.816	4.654	0.914	1.285	0.507	4.745	0.724

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

GCA effects:

The estimates of GCA effects are presented in Table (3). P_1 (S.402/2/2/5) showed high general combining ability for plant height and technical length,. The next high combiner was P_5 (Giza 7) for plant height, technical length and no. of basal branches per plant suggesting the importance of these two parents (P_1 and P_5) for increasing the two important components (plant height and technical length). Also, P_6(S.400/4/4/2) showed highly significant positive GCA effects for straw yield, technical length and no. of basal branches per plant, whereas, P_4 (Leflora) showed highly significant positive GCA effects for plant height only. The simple correlation between GCA values and parental means for plant height, technical length and no. of basal branches per plant were significantly positive. Similar findings were reported by Abo El-Zahab and Abo-Kaied 2000 and Abo-Kaied 2008 in flax. These results indicated that the parents showing higher mean performance (Table 5) proved to be the highest general combiners for these two important components. Therefore, high mean performance of the parents could be transferred to hybrids in such cases.

Table 3. Estimation of general combining ability effects ($\hat{g}_i$) for straw and seed yields and their components in 6 flax genotypes.

	Straw yield and its components				Seed yield and its components			
PARENTS	Straw yield / plant(g)	Plant height (cm)	Technical length (cm)	No. of basal branches	Seed yield/plant (g)	No. of capsules/plant	1000-seed weight	No. of seeds/capsule
P_1= S.402/2/2/5	0.091ns	1.842**	2.260**	-0.028ns	0.001 ns	-2.170 **	0.292 **	-0.168 **
P_2= S.2467/1/1	-0.489**	-1.112**	-2.218**	-0.017ns	0.434 **	4.369 **	0.192 **	-0.079 **
P_3= Sakha 1	-0.384**	-4.40**	-1.911**	-0.031ns	-0.088 **	-3.105 **	0.182 **	0.079 **
P_4= Leflora	-0.075ns	0.916**	0.165ns	-0.172**	-0.477 **	0.013 ns	-0.800 **	-0.028 ns
P_5= Giza 7	0.108ns	2.524**	0.962**	0.075**	0.093 **	1.873 **	0.004 ns	0.091 **
P_6= 400/4/4/2	0.749**	0.239ns	0.742**	0.171**	0.038 ns	-0.982 *	0.131 **	0.105 **
LSD $_{(gi-gi)}$								
0.0 5	0.346	0.580	0.582	0.068	0.066	1.140	0.090	0.063
0.01	0.463	0.776	0.779	0.091	0.089	1.525	0.120	0.084
r	0.69	0.84 **	0.96 **	0.90 **	0.88 **	0.59	0.99 **	0.87 **

*,** Significant at 0.05 and 0.01 levels of probability, respectively.
r : Simple correlation coefficients between GCA values and parental means.

SCA effects:

Specific combining ability effects for straw yield per plant and its components in flax crosses are presented in Table (4). Out of the 15 F_1 crosses, eight crosses (P_1×P_3, P_1×P_4, P_2×P_3, P_2×P_5, P_3×P_4, P_3×P_5, P_4×P_5 and P_4×P_6) showed highly significant positive SCA effects for straw yield per plant. Also, eight crosses (P_1×P_2, P_1×P_3, P_1×P_6, P_2×P_5, P_3×P_4, P_3×P_5, P_4×P_6 and P_5×P_6) for plant height, six crosses (P_1×P_2, P_2×P_5, P_3×P_4, P_3×P_5, P_4×P_6 and P_5×P_6) for technical length and seven crosses (P_1×P_4, P_1×P_6, P_2×P_4, P_2×P_5, P_2×P_6, P_3×P_4 and P_4×P_5) showed highly significant positive SCA effects for no. of basal branches/plant. In general, three crosses (P_2×P_5, P_3×P_4 and P_4×P_5) showed high SCA effects in the desirable direction for straw yield and its all components. For the two important components (plant height and technical length) out of the six crosses (P_1×P_2, P_2×P_5, P_3×P_4, P_3×P_5, P_4×P_6 and P_5×P_6), four crosses (P_1×P_2, P_2×P_5, P_3×P_5 and P_5×P_6) involved high x low general combiners for the above mentioned traits (plant height and technical length). Therefore, these crosses are likely to throw good segregates for these traits if the allelic genetic systems are present in good combination and epistatic effects present in the crosses act in the same direction to maximize the desirable characteristics. These results indicated that the importance of epistatic effects in the genetic control of these traits. The correlation between cross means (Table 5) and their SCA values (Table 4) was significant and positive indicating that high performing crosses were high specific combinations. Therefore, the choice of promising cross combinations would be based on SCA effects or mean performance of cross.

The mean performance of 6 parents and 15 F_1's crosses for straw yield and its components are presented in Table (5). P_1 (S.402/2/2/5) recorded the highest mean values for plant height and technical length. While P_6 (S. 400/4/4/2) for straw yield and no. of basal branches. On the other hand, the highest mean values of straw yield and its most component which obtained by flax crosses of P_3x P_4, followed by P_5x P_6. Also the two crosses (P_1x P_5 and P_1x P_6) recorded the highest mean values for technical length and the two crosses (P_2x P_6 and P_1x P_6) for no. of basal branches/plant. From these results, it could be noticed that the two strains (402/2/2/5 and 400/4/4/2) are consider good parents to improved straw yield/plant .

2- Seed yield per plant and its components:

Analysis of variance showed that mean squares due to genotypes, parents and crosses were highly significant for seed yield and its components viz., no. of capsules per plant, 1000-seed weight and no. of seeds per capsule (Table2). These results indicated that the parental genotypes and F_1 crosses showed reasonable degree of variability for these traits. Also, analysis of combining ability showed highly significant mean

squares for both general and specific combining ability for all characters, revealing the important role of both additive and non-additive genetic effects in the expression of seed yield and its components. The ratio of GCA/SCA for seed yield (1.285) and 1000-seed weight (4.745) showed that the inheritance of these traits were mainly controlled by additive effects of genes. Oppositely, the GCA/SCA ratio for no. of capsules/plant and no. of seeds/capsule indicates that these traits were mainly controlled by non-additive effects of genes. Thakur and Rana 1987, Abo El-Zahab and Abo-Kaied, 2000 and Abo-Kaied and El-Refaie,2008 reported similar results.

GCA effects:

Estimates of GCA effects for each parent are presented in Table (3). The data indicated that P_1 (S.402/2/2/5) showed significant and positive GCA effects for 1000-seed weight. P_2 (S.2467/1/1) exhibited significant positive GCA effects for seed yield and two important components (no. of capsules/plant and 1000-seed weight), whereas, P_3 (Sakha1) and P_6 (S. 400/4/4/2) were good combiners for 1000-seed weight and number of seeds per capsule. Also, P_5 (Giza 7) exhibited significant positive GCA effects for seed yield and no. of capsules/plant. In general, P_2 proved to be a good combiner for most characters under study. Using such parents in varietal improvement programs may be result in isolating desirable combinations of these traits. The simple correlation coefficient between GCA values and parental means for seed yield/plant, 1000-seed weight and no. of seeds/capsule were significantly positive. Similar findings were reported by Abo El-Zahab and Abo-Kaied (2000) and Abo-Kaied and El-Refaie (2008) in flax. These results indicated that the superiority of a parent in cross combinations could be directly predicted from its *per se* performance for the two traits:1000-seed weight and no. of seeds/capsule.

SCA effects:

Specific combining ability effects calculated for each cross are presented in Table (4). The data showed that twelve, seven, six and nine crosses exhibited significant positive SCA values for seed yield per plant, no. of capsules per plant, 1000-seed weight and no. of seeds per capsule exhibited significant positive SCA values, respectively. In general, four crosses ($P_1 \times P_3$, $P_1 \times P_4$, $P_2 \times P_5$ and $P_3 \times P_5$) exhibited significant and positive SCA effects for each of seed yield, no. of capsules/plant and no. of seeds/capsule. One cross ($P_2 \times P_5$) involved two parents of high x high GCA effects for no. of capsules/plant and high x low for no. of seeds per capsule. Also, three crosses (P_1xP_2, P_2xP_4 and P_2xP_6) exhibited significant and positive SCA effects for each of seed yield, 1000-seed weight and no. of seeds/capsule. These crosses (P_1xP_2, P_2xP_4 and P_2xP_6) among high x low general combiner parents for seed yield/plant, two crosses (P_2xP_4, P_2xP_6) for 1000-seed

weight. In contrast, two crosses (P_1xP_2 and P_2xP_6) involved two parents of high x high GCA effects for 1000-seed weight.

Table 4. Estimation of specific combining ability ($\hat{s}_{ij}$) effects for straw, seed yields and their components in 15 flax crosses.

CROSSES	Straw yield and its components				Seed yield and its components			
	Straw yield / plant(g)	Plant height (cm)	Technical length (cm)	No. of basal branches	Seed yield/plant (g)	No. of capsules/plant	1000-seed weight	No. of seeds/capsule
P_1xP_2 $	-1.021**	1.566**	1.658**	-0.014ns	0.392**	0.854ns	0.158*	0.125**
P_1xP_3	1.231**	0.994*	-1.349**	-0.003ns	0.251**	1.912*	0.118ns	0.190**
P_1xP_4	1.195**	-5.791**	-2.581**	0.408**	0.833**	15.007**	0.057ns	0.114*
P_1xP_5	-0.158ns	-0.649ns	0.701ns	0.021ns	0.180**	-0.360ns	0.387**	-0.165**
P_1xP_6	0.288ns	1.329**	0.598ns	0.138**	-0.156**	-2.132*	-0.244**	0.368**
P_2xP_3	1.004**	-0.419ns	0.762ns	-0.301**	0.439**	17.379**	-0.832**	-0.066ns
P_2xP_4	0.208ns	-0.824ns	-1.890**	0.140**	0.609**	-4.483**	0.840**	0.584**
P_2xP_5	1.321**	7.268**	2.399**	0.140**	0.225**	14.254**	-0.767**	0.159**
P_2xP_6	-1.049**	-1.840**	-0.671ns	0.211**	0.287**	-2.594**	0.403**	0.382**
P_3xP_4	2.223**	9.057**	4.163**	0.618**	0.321**	-3.452**	0.914**	0.043ns
P_3xP_5	1.940**	3.622**	1.739**	0.024ns	1.227**	9.582**	0.103ns	0.491**
P_3xP_6	-1.081**	-7.732**	-1.357**	-0.245**	-0.421**	-3.193**	-0.247**	-0.276**
P_4xP_5	0.991**	-1.580**	-3.327**	0.282**	0.107*	7.193**	-0.035ns	-0.492**
P_4xP_6	2.480**	3.696**	1.394**	0.182**	0.418**	12.068**	-0.142*	-0.043ns
P_5xP_6	0.164ns	7.521**	2.750**	-0.011ns	0.054ns	-2.935**	0.228**	0.259**
$LSD_{Sij-Skl}$								
5%	0.693	1.160	1.164	0.136	0.133	2.279	0.180	0.126
1%	0.927	1.552	1.558	0.183	0.177	3.050	0.241	0.169
r	0.898**	0.851**	0.664**	0.806**	0.705**	0.932**	0.570*	0.902**

$ = Number refer to parent codes, Table 3.

***,** Significant at 0.05 and 0.01 levels of probability, respectively.**
r : Simple correlation coefficients between SCA values and means of crosses

Table 5. Mean performances of 21 flax genotypes (6 parents and 15 F1's crosses) for straw, seed yield and their components.

Genotypes	STRAW YIELD AND ITS COMPONENTS				Seed yield and its components			
	Straw yield / plant(g)	Plant height (cm)	Technical length (cm)	No. of basal branches	Seed yield/plant (g)	No. of capsules/plant	1000-seed weight	No. of seeds/capsule
Parents								
P1 $	14.48	106.49	69.41	1.21	2.79	35.52	5.40	8.38
P2	13.86	96.43	58.84	1.42	3.43	43.53	5.53	8.29
P3	11.64	89.95	58.60	1.44	2.45	30.17	5.39	9.00
P4	11.37	101.08	65.85	0.39	1.44	34.36	2.63	8.88
P5	13.16	98.48	64.20	1.47	2.83	37.38	5.10	9.09
P6	16.17	100.52	64.53	1.75	3.52	44.93	5.31	8.90
Crosses								
P_1xP_2	13.65	103.82	66.10	1.49	4.36	50.55	5.69	8.91
P_1xP_3	16.01	99.95	63.40	1.48	3.70	44.13	5.64	9.14
P_1xP_4	16.28	98.49	64.25	1.75	3.89	60.35	4.60	8.95
P_1xP_5	15.11	105.24	68.33	1.61	3.81	46.84	5.73	8.79
P_1xP_6	16.20	104.94	68.00	1.83	3.42	42.21	5.23	9.34
P_2xP_3	15.20	95.59	61.04	1.20	4.32	66.14	4.59	8.97
P_2xP_4	14.71	100.51	60.46	1.50	4.10	47.40	5.28	9.51
P_2xP_5	16.01	110.21	65.55	1.74	4.29	67.99	4.48	9.21
P_2xP_6	14.28	98.81	62.26	1.91	4.30	48.29	5.78	9.44
P_3xP_4	16.83	107.09	66.82	1.96	3.29	40.95	5.35	9.13
P_3xP_5	16.73	103.26	65.19	1.61	4.77	55.85	5.34	9.70
P_3xP_6	14.35	89.62	61.88	1.44	3.07	40.22	5.12	8.94
P_4xP_5	16.09	103.39	62.20	1.73	3.26	56.58	4.22	8.61
P_4xP_6	18.22	106.38	66.70	1.73	3.52	58.60	4.24	9.07
P_5xP_6	16.09	111.81	68.86	1.78	3.72	45.45	5.41	9.49
G. MEANS	15.07	101.53	64.40	1.54	3.54	47.50	5.05	9.04
$LSD_{0.05}$	0.978	1.639	1.647	0.202	0.181	3.223	0.256	0.181

The values identified by the same letter are not significantly different at 5 % level of probability .
$ = Number refer to parent codes, Table 3.

Bhatade and Bhale (1983) suggested that for crosses exhibiting significant SCA effects which resulted from high × high good GCA combiners, such as the P_1xP_2 and P_2xP_6 crosses for 1000-seed weight and P_2xP_5 for both seed yield and capsules/plant, breeding procedure which may make use of both additive and non- additive genetic variance would be more useful for improvement of characters involved. The available additive genetic variance should first be exploited by adopting mass selection in early generations, then some form of *inter-se* mating may be followed among elite selections in later generations, which may help in fixing non- additive effects.

The simple correlation between cross means and their SCA values was significant and positive indicating that the crosses showing higher mean performance (Table 5) proved to be the highest specific combiners for the respective characters. Therefore, the choice of promising cross combinations would be based on SCA effects or mean performance of the crosses.

Data in Table (5) show the mean performance value of parents and their crosses for seed yield and its components. P_2 (S.2467/1/1) and P_6 (S. 400/4/4/2) recorded the highest mean values for seed yield and two important components (no. of capsules/plant and 1000-seed weight). Also, P_5 (Giza 7) recorded the highest mean value for no. of seeds/capsule. Whereas, the highest mean values of seed yield and number of seeds/capsule which obtained by flax cross P_1xP_3 followed by two crosses (P_1xP_2 and P_2xP_6) for both seed yield and 1000-seed weight and two crosses (P_2xP_3 and P_2xP_5) for both seed yield and no. of capsules/plant. 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 most components.

3- Correlation studies:

Phenotypic correlation coefficients among eight traits in flax are shown in Table (6). Straw yield/plant was significantly positively correlated with each of plant height, no. of basal branches, seed yield and no. of capsules/plant. Also, a significant positive correlation between plant height and technical length was present, indicating that maximization of straw yield may be obtained by selection for these traits. Moreover, seed yield was significant positively correlated with no. of basal branches, no. of capsules per plant, no. of seeds/capsule and 1000-seed weight. Also, 1000-seed weight showed positive correlation with no. of basal branches/plant and seed yield/plant. These results are in harmony with Momtaz *et al*.,1977; Sabh,1989; Abo El-Zahab *et al,*1994 and Abo-Kaied, 2006.

Table 6. Phenotypic correlation coefficients among eight traits in 21 flax genotypes.

CHARACTERS	Straw yield / plant(g)	Plant height (cm)	Technical length (cm)	No. of basal branches	Seed yield/plant (g)	No. of capsules/plant	1000-seed weight
Plant height (cm)	0.529 **						
Technical length (cm)	0.374	0.797 **					
No. of basal branches	0.677 **	0.295	0.112				
Seed yield/plant (g)	0.560 **	0.234	-0.012	0.586 **			
No. of capsules/plant	0.601 **	0.282	-0.007	0.328	0.724 **		
1000-seed weight	0.129	-0.045	-0.037	0.568 **	0.491 *	-0.171	
No. of seeds/capsule	0.282	0.199	0.106	0.349	0.443 *	0.191	0.134

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

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تحليل القدرة علي الائتلاف لبعض الصفات الاقتصادية الهامة في الكتان

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أجريت هذه الدراسة بهدف تقدير القدرة علي الائتلاف والفعل الجيني لمحصولي القش والبذور ومكوناتهما في الكتان من خلال تقييم ١٥ هجين ناتجة من التهجين بين ستة أباء (١= س ٤٠٢/٢/٢/٥، ٢= س ٢٤٦٧/١/١، ٣= س سخا١ ،٤= ليفلورا، ٥= جيزة ٧، ٦=س ٤٠٠/٤/٤/٢) باستعمال تحليل الهجن التبادلية . في موسم ٢٠٠٨ /٢٠٠٩ تم تقييم الـ٦ آباء مع ١٥ هجين في الجيل الأول في حقل تربية الكتان بمحطة البحوث الزراعية بسخا محافظة كفر الشيخ في تجربة قطاعات كاملة العشوائية ذات ثلاثة مكررات .

تشير النتائج إلى أن تأثير العوامل الوراثية المضيفة أكبر من الغير مضيفة في توريث صفات الطول الكلي والطول الفعال ومحصول البذرة ووزن الألف بذرة، مما يشير إلى أن العوامل الوراثية المضيفة كانت هي المتحكمة في توريث تلك الصافات. كما تشير النتائج إلى أن العوامل الوراثية الغير مضيفة كانت هي المتحكمة في توريث محصول القش وعدد الأفرع القاعدية وعدد الكبسولات/نبات. كما تشير تقديرات القدرة العامة علي الائتلاف أن الأبويين (س ٤٠٢/٢/٢/٥، جيزة ٧) لهما قدرة عالية علي الائتلاف لصفات الطول الكلي والطول الفعال ومحصول البذرة وعدد الكبسولات/نبات، أيضا الأب س ٤٠٠/٤/٤/٢ اظهر قدرة عالية علي الائتلاف لصفات محصول القش والطول الفعال وعدد الأفرع القاعدية ووزن الألف بذرة وعدد الكبسولات/نبات. بالإضافة إلى أن الأب = س ٢٤٦٧/١/١ اظهر قدرة عالية علي الائتلاف لصفات محصول البذرة وعدد الكبسولات/نبات ووزن الألف بذرة. مما يشير إلى إمكانية تحسين الصفات سالفة الذكر من خلال هذه الأباء.

أشارت نتائج القدرة الخاصة على الائتلاف تميز ثلاث هجن (١×٥، ٣×٤، ٤×٥) بالنسبة لمحصول القش وكل مكوناته . أما بالنسبة لصفتي الطول الكلي والطول الفعال فان من الستة هجن (١×٢، ٢×٥، ٣×٤، ٣×٥، ٤×٦، ٥×٦) المتميزة في القدرة الخاصة على الائتلاف ،

أربعة هجن منها فقط (١×٢، ٢×٥، ٣×٥، ٥×٦) كانت آبائها ذات قدرة عامة علي الائتلاف عالي × منخفض للصفات سالفة الذكر. أما بالنسبة لمحصول البذور فان الهجن التي أظهرت قدرة خاصة علي الائتلاف كما في الهجينين (١×٢، ٢×٦) لوزن الألف بذرة ، والهجين ٢×٥ لكل من محصول البذور وعدد الكبسولات للنبات والتي كانت آبائها عالي×عالي. لذلك هذه الهجن مهمة لبرنامج تربية الكتان لتحسين محصول البذور للنبات.

كما تشير نتائج الارتباط الظاهري بين صفات محصول القش والبذرة ومكوناتهما إلى أن هناك ارتباط موجب ومعنوي عالي بين محصول القش وكلا من الطول الكلى وعدد الأفرع القاعدية ومحصول البذور وعدد الكبسولات للنبات ، وأيضا بين كلا من الطول الكلى والطول الفعال ، مما يشير إلى إمكانية استفادة المربي من هذا للحصول علي محصول قش عالي من خلال الانتخاب لواحد أو اكثر من المكونات السابقة ، بينما محصول البذور للنبات أظهر ارتباط معنوي وموجب مع عدد الأفرع القاعدية وعدد الكبسولات للنبات وعدد البذور بالكبسولة ووزن الألف بذرة كذلك كان الارتباط موجب ومعنوي بين وزن الألف بذرة وكلا من عدد الكبسولات للنبات ومحصول البذور للنبات .