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HETEROSIS AND COMBINING ABILITY FOR SOME IMPORTANT TRAITS IN FLAX (*Linum uestitismum*, L.)

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ABSTRACT

A half diallel set of six parents was used in this study to estimate general and specific combining ability along with heterosis in some important traits of flax. The six parents and their 15 single crosses were evaluated in 2013/ 2014 winter season in a randomized complete block design with four replications. General and specific combining ability were evaluated according to Griffing (1956), method 2 and Model I. Results indicated that genotypes along with crosses mean squares were significant for all studied traits. Parent P1 was among the highest mean values for most studied traits. The single cross P1 x P2 gave the highest significant mean values for stem diameter, number of fruiting branches/ plant, number of seeds/ capsule, seeds yield/ plant, and oil %. The cross P1 x P3 expressed the most desirable mean values for days to flowering and straw yield/ plant. General and specific combining ability were significant for all studied traits and the GCA/ SCA ratio revealed the predominance of additive and additive x additive gene action in controlling most traits. Parent P1 seemed to be the best general combiner for flowering date, stem diameter, total length, number of fruiting branches, No. of capsules/ plant, number of seeds/ capsule, seed yield/ plant and straw yield/ plant. The most desirable SCA effects were detected for the crosses P1 x P2 for stem diameter, No. of seeds/ capsule, seed yield/ plant and oil %, the cross P1 x P5 for straw yield/ plant.

The cross P1 x P2 gave the most desirable heterotic effects for stem diameter, seed yield/ plant and oil% relative to mid parent and better parent heterosis. The best heterotic values for straw yield/ plant were obtained for the cross P1 x P5 (mid parent) and P1 x P3 (better parent).

Key words: Flax, Diallel analysis, combining ability, flax.

INTRODUCTION

Increasing yield potentiality of flax crop is the ultimate goal of plant breeder. To achieve this goal, many attempts have been made to develop new flax genotypes which characterized by higher yielding ability and better quality. This needs some important information about the inheritance of flax yield attributes. Such information about the nature of gene action of different traits help breeder to choose the most suitable breeding program toward the development of new promising flax varieties. One of the most important techniques to estimate nature of gene action is diallel analysis approach. In this technique general and specific combining abilities can be measured according to **Griffing (1956).** Combining ability is a powerful tool in identifying the best combiners which may be hybridized either to exploit heterosis or to accumulate fixable genes. Therefore, estimating general and specific combining ability is a must to determine the type of gene action controlling flax traits. In this concern, the additive genetic variance had more important role in the inheritance of straw yield, plant height, technical length, seed index as reported by **Thakur and Rana (1987), Singh (2000), Abo-Kaied (2002), Mohammadi *et al*. (2010)** and **Abdel-Moneam (2014).** On the contrary, non-additive variance had an important role in the inheritance of number of basal branches/plant, seed yield per plant and capsules/plant as reported by **Murty and Anand (1966),** and **Badwal and Gupta (1970).** The importance of both additive and non additive gene action in controlling linseed traits was previously reported by **Vikas and Mehta (2014).**

Also, estimating of heterosis is very important to determine the most desirable crosses to be used in commercial scale. Several researchers reported different magnitudes of heterosis relative to either mid parent or better parent in flax. Among those are **Rao *et al*. (2001), Singh *et al*. (2008), Reddy *et al*. (2013), and Vikas and Mehta (2014).**

Therefore, this work was undertaken to estimate general and specific combining ability along with heterosis effects relative to mid parent and better parent for some important traits of flax.

MATERIALS AND METHODS

The materials used for the present study consisted of six parents viz., P_1 (S 2465), P_2 (Giza 8), P_3 (Sakha1), P_4 (Sakha3), P_5 (Sakha4) and P_6 (Sozana). The names, pedigree and origin of parents are presented in Table (1). In 2013/2014 season, the six parents were crossed in a diallel mating design excluding reciprocals to obtain 15 F_1 crosses. In 2014/2015 season, the parents and their 15 F_1,s seeds were evaluated in Etay El-Baroud Exp. Sta., El-Beheira Governorate.

Table (1): Name, pedigree and origin of parents.

No	**Genotypes**	**Pedigree**	**Origin**	**Type**
P_1	*S2465/1	Selection from (Indian)	Indian	Oil
P_2	*Giza 8	Giza 6 x Santa Catalina	Egyptian	Oil
P_3	*Sakha	Bombay(USA)xI.2348	Egyption	DUAL
P_4	*Sakha 2	Hera x L. 2348	Egyptian	Dual
P_5	*Sakha 3	Belinka (2 E) x L. 209	Egyptian	Fiber
P_6	Sozana	Inrtoduction from Nethland	Nethland	Fiber

The experiment was carried out in a randomized complete block design with four replications. Rows were 3 m long, spaced 20 cm apart. Single seeds were hand drilled in 5 cm spacing within rows. At harvest, ten individual guarded plants were taken at random from each row (parent and F_1). These plants were used for recording: days to flowering, stem diameter, total length, technical length, number of fruiting branches/ plant, number of capsules/ plant, number of seeds/ capsules, seed yield/ plant, straw yield/plant, seed index, oil% and fiber %.

Combining abilities as general (GCA) and specific (SCA) were calculated according to **Griffing's (1956)** method 2 model 1 (fixed effects). Heterosis relative to mid-parent and better parent was estimated for each single crosses for all studied traits.

RESULTS AND DISCUSSION

A. Analysis of variances and mean performance:

Results in Table (2) indicated that, genotypes mean squares along with crosses mean squares were significant for all studied traits namely, flowering date, stem diameter, total length, technical length, No. of fruit branches/ plant, No. of capsules/ plant, No. of seeds/ capsules, seed yield/ plant, straw yield/ plant, seed index, oil % and fiber %. Such results indicated wide range of variability among flax genotypes for the studied traits. Moreover, significant mean squares due to parent were detected for all studied traits except flowering date, and technical length. Similar results were reported by **Mahammadi *et al.* (2010), El- Deeb (2012), Abd-Moneam (2014) and Vikas and Mehta (2014).**

The mean performances of parent and crosses for studied traits in F_1 generation are presented in Table (3). Results indicated that Parent P_1 was among the best parents for stem diameter, number of fruiting branches/ plant, and seed index. Also, parent P2 expressed the highest mean values for number of capsules/ plant, straw yield/ plant and seed index. Other parents had moderate mean values for the studied traits.

The single cross P_1 x P_2 was among the highest mean values for stem diameter (0.38), No. of fruiting branches/ plant (8.70), No. of seeds/ capsule (9.43), seeds yield/ plant (10.16), and oil % (42.50). The cross P_1 x P_3 expressed the most desirable mean values for flowering date (91.67) and straw yield/ plant (3.87). The single cross P_2 x P_4 was among the best significant mean value for seed index (9.55), while the cross P_3 x P_4 exhibited the highest significant values for No. of capsules/ plant (32.55). Also, the cross P_3 x P_5 expressed the highest desirable mean values for total length (116.87) and technical length (95.50). The F_1 combination P_5 x P_6 gave the highest significant mean values for fiber % being 23.19% (Table 3).

B. Combining ability analysis:

Analysis of variance for combining ability for all traits are presented in Table (2). Mean squares due to both general and specific combining ability were highly significant for all studied traits, indicating that, both additive and non additive are controlling the inheritance of these traits. However, the GCA/ SCA ratio which was largely exceeded the unity were detected for all studied traits except total length. Such results indicated that, additive and additive x additive gene actions were more important than non additive gene action in controlling these traits. Exceptionally, non additive gene action was more important for total length. The importance of additive gene action in the controlling of flax traits was previously reported by **Pavelek (1992), Yadav and Gupta (1999), Singh (2000), Abo-Kaied (2002), Swarnkar *et al*. (2005), Singh *et al*. (2008), El-Deeb (2012) and Abdel-Moneam (2014).**

General combining ability effects for all traits are presented in Table (4). Results indicated that P_1 seemed to be the best general combiner for days to flowering, stem diameter, total length, No. of fruiting branches, No. of capsules/ plant, No. of seeds/ capsule, seed yield/ plant and straw yield/ plant since, it expressed the most desirable and significant GCA effects. Meanwhile, parent P_5 appeared to be the best general combiner for technical length. Parent P_4 was the best general combiner for oil%, while parent P_5 was the best general combiner for technical length. Parent P_6 seemed to be the best general combiner for fiber % since it exhibited the highest significant and positive GCA for this trait (Table 4).

Specific combining ability effects of F_1 crosses for all studied traits are presented in Table (5). The most desirable SCA effects were detected for the crosses P_1 x P_2 for stem diameter, No. of seeds/ capsule, seed yield/ plant and oil %, the cross P_1 x P_4 for No. of fruiting branches/ plant, the cross P_1 x P_5 for straw yield/ plant, the cross P_2 x P_4 for days to flowering and seed index, the cross P_3 x P_4 for No. of capsules/ plant, the cross P_3 x P_5 for total length and technical length, and the cross P_4 x P_6 for fiber %.

From such results it could be concluded that the crosses P_1 x P_2, P_2 x P_4, P_1 x P_5, P_2 x P_4, P_3 x P_4, P_3 x P_5 and P_4 x P_6 are prospective in flax breeding and could be exploited in further breeding programs.

C. Heterosis:

Mean squares due to parent vs crosses which were indicative of average heterosis were detected only for technical length, and seed index (Table 1). Heterosis relative mid and better parent for all studied traits are presented in Table (6).

For days to flowering, two crosses namely P_1 x P_3 and P_2 x P_4 expressed negative and significant heterosis relative to better parent. With regard to stem diameter one cross only (P_1 x P_2) expressed significant positive desirable heterotic effect relative to mid parent and better parent. With respect to total length, two crosses (P_3 x P_5 and P_3 x P_6) gave positive and significant heterosis relative to better parent. However, parent P_3 x P_6 expressed the most desirable better parent heterosis for this trait recording 10.45% (Table 6).

For Technical length, the most desirable heterotic effects were detected for the P_3 x P_5 recording 21.47 and 20.68% for mid parent and better parent heterosis, respectively. With regard to No. of fruit branches/ plant one cross P_1 x P_2 expressed positive and significant heterosis relative to mid parent. For number of capsules/plant, the most desirable heterotic were recorded for the crosses P_1 x P_5 and P3 x P4 for the respective cases. Regarding number of seeds/ capsules, the most desirable values were obtained by the cross P_4 x P_6 recording 15.32 and 12.78% for the mid parent and better parent heterosis, respectively.

With regard to Seed yield/plant (g), the cross P_1 x P_2 gave the most desirable heterotic effects being 31.11 and 24.45% for mid parent and better parent heterosis, respectively (Table 5). As for straw yield/ plant (g), the best heterotic values were obtained for the cross P_1 x P_5 (mid parent) and P1 x P3 (better parent). For Seed index, the single cross P_2 x P_4 gave the most desirable heterosis relative to mid parent (27.73%) and better parent (25.82%). Regarding oil %, the single cross P_1 x P_2 gave the most desirable heterosis relative to mid parent (3.13%) and better parent (2.91%). With respect to fiber % five crosses expressed positive and significant heterosis relative to mid parent. However, the cross P2 x P6 exhibited the most desirable mid parent heterosis. None of the studied crosses exhibited significant desirable heterosis relative to better parent for this trait (Table 6).

Table (2): Mean squares for 21 genotypes, general (GCA) and specific (SCA) combining ability for straw and seed yields and their components in flax

S.O.V	d.f	Days to flowering (days)	Stem diameter (mm)	Total length (mm)	Technical length (mm)	No. of fruit branches / plant	No. of capsules/ plant
Rep.	2	62.73 **	0.0010	17.13	22.92	0.26	3.56
Genotypes	20	26.13 *	0.0070 **	141.06 **	92.31 **	8.17 **	113.31 **
Parent	5	5.30	0.0050 *	155.92 **	6.92	12.51 **	191.14 **
Crosses	14	35.32 **	0.0080 **	145.68 **	109.98 **	7.21 **	93.51 **
p vs c	1	1.525	0.0001	2.16	271.98 **	0.02	1.25
GCA	5	10.07 **	0.0050 **	46.34 **	34.80 **	9.29 **	104.40 **
SCA	15	8.257 **	0.0010 **	47.25 **	29.43 **	0.54 **	15.56 **
GCA/SCA		1.220	3.2250	0.98	1.18	17.46	6.71
Error	40	3.727	0.0001	10.47	8.25	0.14	1.46

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

Table (2): cont.

S.O.V	d.f	No. of seeds/ capsules	Seed yield/plant (g)	Straw yield/ plant (g)	Seed index	Oil %	Fiber %
Rep.	2	0.33	1.02	0.07	0.20	0.60	0.47
Genotypes	20	1.40 **	7.17 **	0.59 **	7.35 **	18.05 **	34.88 **
Parent	5	0.57 **	6.82 **	0.55 **	11.20 **	32.14 **	48.47 **
Crosses	14	1.77 **	7.77 **	0.64 **	5.97 **	14.30 **	32.46 **
p vs c	1	0.39	0.53	0.16	7.46 **	0.01	0.73
GCA	5	0.78 **	6.25 **	0.53 **	8.67 **	23.08 **	43.70 **
SCA	15	0.36 **	1.10 **	0.09 **	0.38 **	0.33 **	0.93 **
GCA/SCA		2.15	5.67	6.08	22.93	70.33	46.79

Error	**40**	**0.05**	**0.13**	**0.03**	**0.06**	**0.07**	**0.08**

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

Table (3): The genotypes mean performance of the studied traits in the F_1 generation.

Trait / Genotypes	Days to flowering (days)	Stem diameter mm)	Total length (mm)	Technical length (mm)	No. of fruit branches /plant	No. of capsules/ plant
P1	95.00	0.28	107.50	76.70	8.40	26.02
P2	99.00	0.25	100.13	76.07	7.00	24.40
P3	97.00	0.27	92.50	79.13	7.43	27.07
P4	97.00	0.23	107.17	75.77	6.90	26.65
P5	97.00	0.20	106.77	78.10	3.67	10.77
P6	96.00	0.18	92.43	75.13	3.57	10.58
Mean parents	**96.83**	**0.24**	**101.08**	**76.82**	**6.16**	**20.91**
P1 x P2	96.00	0.38	109.13	84.45	8.70	28.17
P1 x P3	91.67	0.23	108.93	80.21	8.67	26.83
P1 x P4	96.00	0.24	97.47	73.30	8.53	20.32
P1 x P5	92.33	0.23	108.93	87.01	5.47	26.32
P1 x P6	99.33	0.28	99.20	76.97	6.50	21.50
P2 x P3	94.67	0.19	95.80	74.60	7.60	24.10
P2 x P4	93.67	0.23	97.10	83.85	6.23	18.65
P2 x P5	98.33	0.18	96.03	86.44	4.83	23.02
P2 x P6	104.77	0.24	96.33	78.23	5.20	13.17
P3 x P4	100.66	0.26	97.33	74.03	5.13	32.55
P3 x P5	93.00	0.22	116.87	95.50	5.73	15.43
P3 x P6	96.00	0.21	102.13	81.27	4.87	19.43
P4 x P5	95.67	0.21	92.73	87.24	5.70	18.17
P4 x P6	98.33	0.20	107.17	78.85	4.37	16.80
P5 x P6	97.00	0.15	97.23	79.30	4.27	13.95
Mean crosses	**96.73**	**0.25**	**102.09**	**77.77**	**6.48**	**21.82**
LSD 1%	7.38	0.08	12.36	10.98	1.41	4.62

Table (3): Cont.

Trait / Genotypes	No. of seeds/ capsules	Seed yield/ plant (g)	Straw yield / plant (g)	Seed index	Oil %	Fiber %
P1	8.53	8.17	3.15	8.42	41.30	12.83
P2	7.97	7.34	3.28	7.59	41.12	13.03
P3	7.93	7.44	3.15	8.54	41.56	14.92
P4	7.23	7.67	3.23	7.36	42.21	15.60
P5	7.80	4.40	2.49	4.52	37.26	19.93
P6	7.57	5.27	2.29	4.18	33.92	22.84
Mean parents	**7.84**	**6.72**	**2.93**	**6.77**	**39.56**	**16.53**
P1 x P2	9.43	10.16	3.18	9.12	42.50	12.98
P1 x P3	9.17	9.45	3.87	8.68	41.20	12.00
P1 x P4	9.07	7.55	3.19	8.89	41.71	13.30
P1 x P5	7.53	5.19	3.69	6.47	38.03	15.65
P1 x P6	8.20	6.03	3.07	6.88	36.54	17.36
P2 x P3	6.97	6.21	3.31	9.25	41.34	13.99
P2 x P4	7.73	7.28	3.69	9.55	41.77	14.33
P2 x P5	7.60	5.08	2.65	6.82	39.18	17.91
P2 x P6	7.70	5.58	2.71	7.38	37.67	18.29
P3 x P4	8.23	6.84	3.10	8.09	41.83	14.93
P3 x P5	7.17	4.37	2.91	7.19	40.48	17.40
P3 x P6	7.20	5.11	2.70	7.05	37.79	18.22
P4 x P5	8.23	6.90	2.66	7.02	39.60	20.06
P4 x P6	8.53	6.28	2.72	6.33	37.99	21.82
P5 x P6	7.43	5.63	2.23	4.26	35.57	23.19
Mean crosses	**8.04**	**7.15**	**2.96**	**7.06**	**39.93**	**16.08**
LSD 1%	0.81	1.39	0.62	0.95	0.99	1.08

Table (4): Estimates of general combining ability effects for all studied traits in F_1 generation.

Parent	Days to flowering (days)	Stem diameter (mm)	Total length (mm)	Technical length (mm)	No. of fruit branches/ plant	No. of capsules/ plant
P1	-1.35 *	0.04 **	3.63 **	-0.67	1.47 **	3.40 **
P2	1.15	0.01	-1.87	-0.13	0.46 **	0.99 *
P3	-0.76	0.00	-0.45	0.40	0.49 **	3.07 **
P4	0.28	-0.00	-0.44	-1.49	0.11	1.48 **
P5	-0.72	-0.03 **	1.96	3.87 **	-1.20 **	-3.69 **
P6	1.40 *	-0.02 **	-2.84 **	-1.98 *	-1.32 **	-5.24 **
LSD(gi) 0.01	**1.66**	**0.02**	**2.82**	**2.51**	**0.32**	**1.05**
LSD (gi-gj) 0.01	**2.61**	**0.03**	**4.38**	**3.88**	**0.50**	**1.63**

Table (4): Cont.

Parent	No. of seeds/ capsules	Seed yield/plant (g)	Straw yield/ plant (g)	Seed index	Oil %	Fiber %
P1	0.59 **	1.09 **	0.28 **	0.71 **	0.72 **	-2.49 **
P2	-0.05	0.38 **	0.13 *	0.76 **	0.98 **	-1.66 **
P3	-0.14 *	0.11	0.14 **	0.77 **	1.25 **	-1.31 **
P4	0.07	0.53 **	0.09	0.43 **	1.31 **	-0.15
P5	-0.27 **	-1.25 **	-0.25 **	-1.30 **	-1.9 **	2.15 **
P6	-0.19 **	-0.85 **	-0.39 **	-1.37 **	-2.93 **	3.46 **
LSD (gi) 0.01	0.184	0.32	0.14	0.22	0.23	0.25
LSD (gi-gj) 0.01	0.29	0.49	0.22	0.33	0.35	0.38

Table (5): Estimation of specific combining ability effects for all studied traits in F1 generation.

Crosses	Days to flowering (days)	Stem diameter (mm)	Total length (mm)	Technical length (mm)	No. of fruit branches /plant	No. of capsules/ plant
P1 x P2	**-0.39**	**0.09 ****	**5.99 ***	**5.15 ***	**0.65**	**2.64 ***
P1 x {3	**-2.81**	**-0.04 ****	**4.37**	**0.38**	**0.57**	**-0.77**
P1 x P4	**0.48**	**-0.02**	**-7.10 ***	**-4.64**	**0.83 ***	**-5.70 ****
P1 x P5	**-2.19**	**-0.01**	**1.97**	**3.71**	**-0.94****	**5.47****
P1 x P6	**2.69**	**0.03**	**-2.97**	**-0.48**	**0.22**	**2.21***
P2 x P3	**-2.31**	**-0.06****	**-3.26**	**-5.77***	**0.52**	**-1.10**
P2 x P4	**-4.35***	**-0.01**	**-1.97**	**5.36***	**-0.46**	**-4.96****
P2 x P5	**1.32**	**-0.03**	**-5.44**	**2.59**	**-0.56**	**4.58****
P2 x P6	**5.52****	**0.02**	**-0.34**	**0.24**	**-0.06**	**-3.72****
P3 x P4	**4.57***	**0.02**	**-3.16**	**-4.97**	**-1.60****	**6.87****
P3 x P5	**-2.10**	**0.01**	**13.97****	**11.13***	**0.31**	**-5.08****
P3 x P6	**-1.23**	**0.00**	**4.04**	**2.75**	**-0.44**	**0.47**
P4 x P5	**-0.48**	**0.01**	**-10.17****	**4.76**	**0.66***	**-0.76**
P4 x P6	**0.07**	**-0.03**	**9.07****	**2.21**	**-0.55**	**-0.57**
P5 x P6	**-0.27**	**-0.03**	**-3.27**	**-2.70**	**0.66**	**1.75**
LSD(Sij)0.01	**4.63**	**0.05**	**7.76**	**6.88**	**0.89**	**2.89**
LSD(Sii)0.01	**3.82**	**0.04**	**6.41**	**5.69**	**0.73**	**2.39**
LSD(Sii-Sjj)0.01	**5.22**	**0.06**	**8.75**	**7.77**	**1.00**	**3.26**
LSD(Sij-Sik)0.01	**6.91**	**0.08**	**11.58**	**10.27**	**1.32**	**4.32**
LSD(Sij-Skl)0.01	**6.39**	**10.71**	**10.71**	**9.51**	**1.22**	**3.99**

Table (5): Cont.

Crosses	No. of seeds/ capsules	Seed yield/plant (g)	Straw yield/ plant (g)	Seed index	Oil %	Fiber %
P1 x P2	0.93 **	2.13**	-0.23	0.33	1.26**	0.44
P1 x {3	0.76**	1.68**	0.45**	-0.12	-0.18	-0.90**
P1 x P4	0.45*	-0.64	-0.19	0.44*	0.14	-0.75**
P1 x P5	-0.75**	-1.22**	0.65**	-0.25	-1.05**	-0.71**
P1 x P6	-0.16	-0.78	0.17	0.23	-0.80**	-0.31
P2 x P3	-0.80**	-0.84*	0.03	0.41	-0.31	0.27
P2 x P4	-0.25	-0.19	0.46**	1.05**	-0.07	-0.55*
P2 x P5	-0.04	-0.61	-0.24	0.04	-0.17	0.73**
P2 x P6	-0.02	-0.51	-0.05	0.67**	0.07	-0.20
P3 x P4	0.35	-0.36	-0.15	-0.41	-0.14	-0.31
P3 x P5	-0.38*	-1.06**	0.01	0.40	1.01**	-0.13
P3 x P6	-0.43*	-0.72*	-0.07	0.34	0.06	-0.63*
P4 x P5	0.48*	1.06*	-0.19	0.58*	-0.07	1.37**
P4 x P6	0.69**	0.04	0.00	-0.05	0.07	1.82**
P5 x P6	-0.07	1.17**	-0.15	-0.39	0.13	0.88**
LSD (Sij) 0.05	0.38	0.65	0.29	0.44	0.46	0.50
LSD (Sij) 0.01	0.51	0.87	0.39	0.59	0.62	0.68
LSD (Sii) 0.05	0.31	0.54	0.24	0.37	0.38	0.42
LSD (Sii) 0.01	0.41	0.72	0.32	0.49	0.51	0.56
LSD (Sii-Sjj) 0.01	0.57	0.98	0.44	0.69	0.69	0.77
LSD (Sij-Sik) 0.01	0.76	1.29	0.58	0.88	0.93	1.01
LSD (Sij-Skl) 0.01	0.699	1.200	0.534	0.818	0.856	0.939

Table (6): Percentage of heterosis in the F1 generation over both mid parent (MP) and better parent (BP) for the studied traits.

Crosses	Days to flowering (days)		Stem diameter (mm)		Total length (mm)		Technical length (mm)		No. of fruiting branches /plant		No. of capsules/plant	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
P1 x P2	-1.03	1.05	42.50**	35.71**	5.12	1.52	10.56 *	10.10	12.99*	3.57	11.74	8.26
P1 x {3	-4.51	-3.51	-15.85	-17.86	8.93*	1.33	2.94	1.36	9.47	3.17	1.10	-0.86
P1 x P4	0.00	-1.05	-5.19	-13.10	-9.19*	-9.33*	-3.85	-4.43	11.55	1.59	-22.85**	-21.39**
P1 x P5	-3.82	-2.81	-4.83	-17.86	1.68	1.33	12.42 **	11.41*	-9.39	-34.92**	43.10**	1.15
P1 x P6	4.01	4.56	21.17	-1.19	-0.77	-7.72	1.38	0.35	8.64	-22.62**	17.49*	-17.36*
P2 x P3	-3.40	-2.41	-25.64*	-27.50*	-0.54	-4.33	-3.87	-5.73	5.31	2.24	-6.35	-10.96
P2 x P4	-4.42	-3.44	-5.48	-9.21	-6.32	-9.39*	10.45 *	10.23	-10.31	-10.95	-26.93**	-30.02**
P2 x P5	0.34	1.37	-19.71	-27.63*	-7.17	-10.05*	12.14 *	10.68*	-9.38	-30.95**	30.89**	-5.67
P2 x P6	7.35**	9.03**	10.08	-6.58	0.05	-3.79	3.48	2.85	-1.58	-25.71**	-24.73**	-46.04**
P3 x P4	3.78	3.78	2.67	-3.75	-2.50	-9.18	-4.41	-6.44	-28.37**	-30.94**	21.19*	20.26*
P3 x P5	-4.12	-4.12	-6.38	-17.50	17.29**	9.46*	21.47 **	20.68**	3.30	-22.87**	-18.42*	-42.98**
P3 x P6	-0.52	0.00	-3.76	-20.00	10.45*	10.41*	5.36	2.70	-11.52	-34.53**	3.23	-28.20**
P4 x P5	-1.38	-1.37	-3.82	-10.00	-13.31**	-13.47**	13.39 **	11.70*	7.89	-17.39	-2.90	-31.83**
P4 x P6	1.90	2.43	-0.81	-12.86	7.38	0.00	4.50	4.07	-16.56	-36.71**	-9.76	-36.96**
P5 x P6	-1.03	1.05	-21.05	-26.23	-2.37	-8.93	3.49	1.53	17.97	16.36	30.66**	29.53

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

Table (6): cont.

Crosses	No. of seeds/ capsules		Seed yield/ plant (g)		Straw yield / plant (g)		Seed index		Oil %		Fiber %	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
P1 x P2	14.34**	10.55**	31.11**	24.45**	-1.04	-2.95	13.91**	8.27*	3.13**	2.91**	0.41	-0.33
P1 x {3	11.34**	7.42*	21.10**	15.71*	22.90**	22.83**	2.30	1.60	-0.55	-0.87	-13.53**	-19.59**
P1 x P4	15.01**	6.25	-4.71	-7.59	-0.10	1.13	12.63**	5.54	-0.10	0.98	-6.41*	3.01
P1 x P5	-7.76*	-11.72**	-17.48*	-36.49**	30.97**	17.12*	-0.03	-23.19**	-3.19**	-7.93**	-4.50*	-21.51**
P1 x P6	1.86	-3.91	-10.25	-26.16**	12.85	-2.54	9.23	-18.28**	-2.86**	-11.53**	-2.67	-23.99**
P2 x P3	-12.37**	-12.55**	-15.95*	-16.53*	2.96	0.91	14.70**	8.31*	-0.01	-0.55	0.16	-6.21*
P2 x P4	1.75	-2.93	-2.99	-5.13	13.41*	12.60	27.73**	25.82**	0.25	-1.05	0.13	-8.12**
P2 x P5	-3.59	-4.60	-13.46	-30.76**	-8.21	-19.31**	12.58*	-10.19*	-0.03	-4.72**	8.68**	-10.15**
P2 x P6	-0.86	-3.35	-11.42	-23.90**	-2.87	-17.48*	25.35**	-2.81	0.40	-8.38**	2.03	-19.89**
P3 x P4	8.57*	3.78	-9.44	-10.82	-2.98	-4.23	1.78	-5.23	-0.13	-0.89	-2.18	-4.30
P3 x P5	-8.90**	-9.66*	-26.15**	-41.22**	3.13	-7.72	10.06*	-15.85**	2.72**	-2.61**	-0.14	-12.69**
P3 x P6	-7.10*	-9.24*	-19.64**	-31.36**	-0.80	-14.29	10.90*	-17.41**	0.13	-9.07**	-3.52	-20.24**
P4 x P5	9.54**	5.56	14.33	-10.03	-6.99	-17.73*	18.09**	-4.71	-0.34	-6.18**	12.92**	0.64
P4 x P6	15.32**	12.78**	-2.91	-18.11*	-1.45	-15.77*	9.62	-14.08**	-0.19	-9.99**	13.54**	-4.47*
P5 x P6	-3.25	-4.70	16.47	6.89	-6.83	-10.46	-2.07	-5.75	-0.07	-4.54**	8.45**	1.55

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

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قوة الهجين والقدرة على التآلف لبعض الصفات الهامة فى الكتان

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الملخص العربي

أجرى التحليل الدائرى لعدد ستة أباء من الكتان متابينة فى صفاتها المختلفة وهى P1 (S 2465.), P2 (Giza 8), P3 (Sakha1), P4 (Sakha3), P5 (S.akha4) and P6 (Sozana) ، وذلك بهدف تقدير كلا من القدرة العامة والخاصة على الأئتلاف وكذلك قوة الهجين لبعض الصفات الهامة فى الكتان. وتم تقييم الأباء الستة وكذلك الهجن الفردية الناتجة منها (15 هجين) فى تصميم قطاعات كاملة العشوائية باستخدام أربعة مكررات. وتم تقدير تأثيرات القدرة العامة والخاصة على الآئتلاف طبقا لـ Griffing (1956) الطريقة الثانية ، الموديل الأول. وأظهرت النتائج أن تباين التراكيب الوراثية وكذلك الهجن كان معنويا لجميع الصفات تحت الدراسة. وأظهرت السلالة P1 اعلى متوسط لمعظم الصفات المدروسة. واعطى الهجين P1 x P2 اعلى القيم لصفات قطر الساق، عدد الفروع الثمرية، عدد البذور/ كبسولة، محصول البذور للنبات، نسبة الزيت فى البذور. وأظهر الهجين P1 x P3 افضل قيم لميعاد التزهير ومحصول القش للنبات. كان التباين الراجع الى كلا من القدرة العامة والخاصة على الآئتلاف معنويا لجميع الصفات تحت الدراسة، ولكن النسبة بين القدرة العامة والقدرة الخاصة على التآلف اظهرت ان التبان الوراثى المضيف، المضيف × المضيف هو الاكثر أهمية فى توارث معظم الصفات تحت الدراسة. وأعطت السلالة P1 أفضل تأثيرات للقدرة العامة على الآئتلاف لصفات ميعاد التزهير، قطر الساق، الطول الكلى، عدد الأفرع الثمرية، عدد الكبسولات/ نبات، عدد البذور / كبسولة، محصول البذور للنبات ومحصول القش للنبات. وأعطى الهجين P1 x P2 افضل قدرة خاصة على التألف لصفات قطر الساق، عدد البذور/ كبسولة، محصول البذور/ نبات ونسبة الزيت ، بينما اعطى الهجين P1 x P5 افضل قيمة للقدرة الخاصة على الأئتلاف لصفة محصول القش/ نبات. واعطى الهجين P1 x P2 افضل قيمة لقوة الهجين منسوبة الى متوسط الأبوين او أفضل الأبوين بالنسبة لصفة قطر الساق ومحصول البذور/ نبات ونسبة الزيت ، بينما اعطى الهجين P1 x P5 افضل قوة هجين لصفة محصول القش نسبة الى متوسط الأبوين والهجين P1 x P3 نسبة الى أفضل الأبوين.