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DIALLEL ANALYSIS OF NINE WHITE MAIZE INBRED LINES FOR DIFFERENT CHARACTERS UNDER DIFFERENT LOCATIONS

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ABSTRACT

A Number of 36 single crosses obtained directly from crossing of nine inbred lines in a half diallel system and two checks were evaluated in a randomized complete block design, with four replications, in three locations; i.e., Sakha, Gemmeiza and Sids Res. Stations in 2005 summer season. The objectives of this study were to estimate heterosis and combining ability. The combined analysis of data across environments showed highly significant for locations (Loc), general combining ability (GCA), specific combining ability (SCA) and GCA x Loc. interaction for all studied characters except GCA x Loc interaction for ear height. Additive genetic effects exhibited to have played an important role than the non-additive genetic effects in the expression of all studied characters, except for grain yield under and over the three locations. Also, the additive genetic effects were much more influenced by change of location than the non-additive genetic effects for all studied characters. The highest desirable values of GCA effects were obtained from Sk5170 and Sk8170 inbreds for silking date, plant and ear height, Sk6017, Sk8014 and Sk9195 inbreds for grain yield and ear length and Gm152 inbred for number of rows/ear. The best crosses having desirable values for both SCA and heterotic effects relative to the best check were Sk8012 x Sk8170 for silking date; Sk63 x Sk8012, Sk5170 x Sk8170 and Sk8014 x Sk9195 for plant and ear height; Sd63 x Sk6017, Sk6017 x Sk8014 and Sk6018 x Sk9195 for grain yield, Sd63 x Sk6017 for ear length and Gm152 x Sk6017 and Gm152 x Sk9195 for number of rows/ear. It is worth noting that a cross having good SCA effects, may come from two parents when at least one of them possesses high GCA effects.

INTRODUCTION

Combining ability of inbred lines is the ultimate factor determining future usefulness of the lines for hybrids. Combining ability initially was a general concept considered collectively for classifying an inbred line relative to its cross performance. Sprague and Tatum (1942) refined the concept of combining ability; general combining ability (GCA) and specific combining ability (SCA) have a significant impact on inbred line evaluation and population improvement in maize breeding. Dhillon *et al.* (1978), Maggiore *et al.* (1979), Nevado and Cross (1990), Melchinger *et al.* (1990), Lima *et al.*(1995), Tulu and Ramachandrappa (1998), Choukan (1999), Rameeh *et al.* (2000), Zelleke (2000), Desai and Singh (2001), Mahto and Ganguly (2001), San Vicente *et al.* (2001) and Fan Xing Ming *et al.* (2001) found that both GCA and SCA were significant for silking date, plant and ear heights, grain yield, ear length and number of rows/ear. However Debnath *et al.* (1988), Nawar *et al.* ((1979), Crossa *et al.* (1990), Pal and Prodhan (1994), Lima *et al.* (1995), Dehghanpour *et al.* (1996) and Geetha and Jayaraman (2000) reported that the SCA (or non additive gene effects) was more important than GCA (or additive gene effects) in the inheritance of grain yield. While, Nawar *et al.* (1979), Cross *et al.* (1990), Tulu and Ramachandrappa (1998), Choukan (1999), and Nigussie and Zelleke (2001) found that the additive gene effects were the primary type of gene actions operative in the crosses for silking date, plant and ear heights, ear length and number of rows/ear. This study aimed to estimate of type and relative amount of genetic variance components and their interaction with locations and heterotic effects relative to check variety.

MATERIALS AND METHODS

The materials used in this study were nine white maize inbred lines obtained by the maize research program i.e., Sd63, Gm152, Sk5170, Sk6017, Sk6018,Sk8012, Sk8014, Sk8170, Sk9195. In 2004, summer growing season, the nine inbred lines were hand crossed in half diallel fashion to obtain hybrid seeds of 36 genotypes i.e., 36 F_{1S}. At the 2005 growing season, the obtained hybrid seeds of 36 genotypes plus the two commercial hybrids i.e., SC10 and SC129 were grown at three locations i.e., Sakha, Gemmeiza and Sids Experimental Stations. The maize genotypes were grown in four replications of a randomized complete block design. Each plot was a single row, 6m long, 80cm apart and 25cm hill spacing. After 21 days from planting date, plants were thinned to one plant per hill. The recommended cultural practices were applied at the proper time. Data were recorded on grain yield ard/fed (1 ardab =140 Kg and 1 feddan = 4200 m^2), adjusted on 15.5 basis grain moisture content and shelling percentage, ear length (cm), number of rows/ ear, plant height (cm), ear height (cm) and number of days from planting to 50% silking emergence. An ordinary analysis of variance for the data was performed for each location then combined over the three locations according to Steel and Torrei (1980). The effect of hybrids was considered fixed effect while that of locations was considered to be random effect. Variations among the 36 hybrids was partitioned into GCA and SCA and their interactions with locations according to Griffing (1956) for Method-4, Model-1.

RESULTS AND DISCUSSION

Mean squares of diallel analysis of 9x9-inbred lines combined over three locations for six characters are presented in Table (1). Locations mean squares were highly significant for all characters with mean values for Sakha Res. Station (North Egypt) being higher than those for Gemmeiza and Sids Res. Stations (Middle and South Egypt, respectively) for all characters. Frey and Maldonado (1967) defined the stress environment as the one in which mean performance for certain attribute is low. Therefore, Sakha Station seemed to be the non-stress environment. The mean squares of GCA and SCA were highly significant for all studied characters. Thus both additive and non-additive gene actions were found to be important in controlling all studied characters. These results are in agreement with those obtained by Nawar *et al.* (1979) for silking date, El-Hosary (1988) for plant height, El-Shamarka (1995) for ear height, Abdel-Sattar *et al.* (1999) for ear length and number of rows/ear, Mosa (2005) for grain yield. However, the additive genetic effects (K^2 GCA) exhibited to have played an important role than the non-additive genetic effects (K^2SCA) in the expression of all studied characters, except for grain yield under three locations and their combined Table (2). These results support the findings of Nawar *et al.* (1988) for plant and ear heights, Mosa (2005) for silking date, Mosa (2003) for grain yield, Motawei (2005) for ear length and El-Shenawy (2005) for number of rows/ear. Meanwhile the mean squares of interaction between GCA and locations were significant or highly significant for all studied characters, except for ear height, The magnitude of interactions for GCA x locations was generally higher than that for SCA ones for all characters (Table 2), revealing that additive genetic effects were much more influenced by change of locations than non-additive genetic effects in all studied characters. These results are in agreement with those previously attained by Matzinger *et al.* (1959) El-Rouby *et al* (1973), Debnath and Sarkar (1987), El-Hosary (1988), Mahmoud (1996) and Mosa (2003 and2005) suggested that the additive gene effects were more infinenced by interaction with environments than the non-additive gene effects.

Table (1): Mean squares of diallel analysis of 9 x 9 inbred lines combined over three locations for six characters.

S.O.V	d.f	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield ard/fed	Ear length (cm)	No.of rows/ear
Locations (L)	2	1004.22**	25069.02**	7856.81**	9422.70**	347.08**	21.79**
Rep/Loc	9	22.11	1876.47	1099.99	30.43	5.16	0.60
GCA	8	302.64**	12246.09**	9928.08**	438.69**	117.08**	31.56**
SCA	27	11.74**	1059.9**	548.28**	208.56**	17.56**	1.66**
GCA x L	16	2.85*	676.17**	115.97	75.07**	11.64**	3.66**
SCA x L	54	1.61	207.44	95.67	12.38	2.85	0.68
Error	+333	1.42	134.63	86.42	12.12	2.15	0.51

*,** significant at the 0.05 and 0.01 levels of probability, respectively
+ Including checks

Table (2): Estimates of genetic and genetic x environment parameters for six characters under three locations.

Loca	Silking date (days)		Plant height (cm)		Ear height (cm)		Grain yield (ard/fed)		Ear length (cm)		No.of rows/ear	
	K^2GCA/K^2SCA	$\sigma^2GCAxL/\sigma^2SCAxL$	K^2GCA/K^2SCA	$\sigma^2GCAxL/\sigma^2SCAxL$	K^2GCA/K^2SCA	$\sigma^2GCAxL/\sigma^2SCAxL$	K^2GCA/K^2SCA	$\sigma^2GCAxL/\sigma^2SCAxL$	K^2GCA/K^2SCA	$\sigma^2GCAxL/\sigma^2SCAxL$	K^2GCA/K^2SCA	$\sigma^2GCAxL/\sigma^2SCAxL$
Sakha	2.58	----	3.28	----	5.45	----	0.35	----	1.30	----	4.01	----
Gemm.	6.84	----	0.36	----	1.31	----	0.20	----	0.80	----	1.60	----
Sids	4.52	----	4.80	----	6.20	----	0.81	----	1.05	----	7.5	----
mb.	4.22	1.25	1.93	1.06	3.09	3.8	0.26	37.3	1.02	1.9	4.06	2.75

Estimates of GCA effects for the nine parental inbred lines in the combined analysis are presented in Table (3). The parental inbred lines Sk5170, Sk8012, Sk8170 and Sk9195 showed desirable values of GCA effects for silking date and plant and ear height, indicating that the four inbred lines could be considered as good combiners for developing early and short stalk genotypes. The inbred lines Sk6017, Sk8014 and Sk9195 had significant positive GCA effects for grain yield and ear length, while inbred line Gm 152 exhibited positive GCA effects for grain yield and number of rows/ear. Inbred lines Sd63 and Sk6018 for ear length and inbred line Sk9195 for number of rows/ear .These results suggested the importance of these lines to be involved for improving maize.

Table (3): Estimates of general combining ability effects of nine inbred lines for six characters over three locations.

Line	Silking date (days)	Plant height (cm)	Ear height (cm)	Grain yield ard/fed	Ear length (cm)	Number of rows/ear
Sd 63	2.46*	2.26	4.37*	-1.14*	0.35*	-0.41*
Gm 152	0.81*	-4.75*	3.93*	1.32*	-0.53*	1.45*
Sk5170	-2.78*	-15.96*	-17.54*	-1.91*	-1.20*	0.07
Sk6017	1.46*	24.17*	20.44*	3.23*	1.79*	-0.12
Sk6018	1.86*	10.71*	7.25*	-0.21	0.58*	-0.44*
Sk8012	-0.60*	-2.96*	-2.74*	-3.12*	-1.20*	-0.19*
Sk8014	0.42*	1.36	-0.49	0.90*	0.98*	-0.50*
Sk8170	-2.69*	-13.06*	-9.69*	-2.12*	-1.60*	-0.23*
Sk9195	-0.94*	-1.77	-5.54*	3.06*	0.84*	0.37*
LSD g_i 0.05	0.24	2.33	1.87	0.70	0.29	0.14

* significant from zero at 0.05 level of probability.

Mean performance (M), % heterosis relative to the best check (H) and specific combining ability effects for six characters over three locations are shown in Table (4).

Table (4): Mean performance(M); % heterosis relative to the best check (H) and specific combining ability effects (SCA) for six characters over three locations.

Cross	Silking date (days)			Plant height (cm)			Ear height (cm)		
	M	% H	SCA	M	%H	SCA	M	%H	SCA
Sd 63 x Gm152	65.58	3.55*	0.06	275.83	-4.33*	3.02	166.00	3.75	3.43
x Sk-5170	61.33	-3.15*	-0.59*	256.58	-7.89*	3.99	144.58	-9.63*	3.49
x Sk-6017	65.83	3.94*	-0.34	309.25	7.25*	7.51*	186.16	16.35*	7.09*
x Sk-6018	65.66	3.67*	-0.89*	284.66	-1.27	-3.61	162.25	1.40	-3.64
x Sk-8012	66.83	5.52*	2.73*	247.08	-14.30*	-27.51*	137.08	-14.32*	-18.80*
x Sk-8014	65.00	2.63*	-0.13	282.25	-2.10	3.32	158.00	-1.25	-0.14
x Sk-8170	61.00	-3.67*	-1.01*	267.50	-7.22*	3.00	147.83	-7.60*	-1.10
x Sk-9195	63.91	0.91	0.16	286.08	-0.78	10.29*	162.75	1.71	9.66*
Gm152x Sk-8170	60.25	-4.86*	-0.02	255.25	-11.47*	0.66	138.25	-13.59*	-2.40
x Sk-6017	64.66	2.10*	0.15	300.00	4.04*	5.27	179.33	12.08*	0.70
x Sk-6018	64.75	2.24*	-0.16	276.33	-4.16*	-4.93	160.33	0.20	-5.11*
x Sk-8012	61.41	-3.03*	-1.03*	264.91	-8.12*	-2.67	153.50	-4.06	-1.95
x Sk-8014	63.41	0.12	-0.05	271.58	-5.80*	-0.34	159.50	-0.31	1.8
x Sk-8170	60.50	-4.46*	0.15	262.91	-8.81*	5.43	153.16	-4.27	4.67*
x Sk-9195	63.00	-0.52	0.89*	262.33	-9.01*	-6.44*	151.50	-5.31*	-1.15
Sk-5170xSk-6017	60.42	-4.59*	-0.51	282.66	-1.96	-0.85	158.66	-0.83	1.51
x Sk-6018	61.08	-3.55*	-0.23	271.66	-5.78*	1.62	137.75	-13.9*	-6.22*
x Sk-8012	58.08	-8.28*	-0.76*	267.83	-7.10*	11.46*	141.50	-11.56*	7.53*
x Sk-8014	59.58	-5.92*	-0.29	262.41	-8.98*	1.71	141.58	-11.56*	5.36*
x Sk-8170	59.33	-6.31*	2.57*	226.50	-21.44*	-19.78*	116.83	-26.98*	-10.18*
x Sk-9195	58.33	-7.89*	-0.17	258.75	-10.25*	1.19	132.08	-17.45*	0.91
Sk-6017xSk-6018	65.08	2.76*	-0.48	295.66	2.54	-14.53*	182.66	14.16*	0.71
x Sk-8012	64.41	1.70*	1.32*	300.25	4.13*	3.74	171.58	7.23*	-0.38
x Sk-8014	64.16	1.31	0.04	303.66	5.31*	2.82	175.75	9.84*	1.54
x Sk-8170	60.75	-4.07*	-0.26	293.50	1.79	7.08*	167.33	4.58	2.33
x Sk-9195	62.83	-0.78	0.08	286.66	-0.57	-11.04*	155.66	-2.71	-13.49*
Sk-6018xSk-8012	63.25	-0.12	-0.24	287.25	-0.37	4.20	166.33	3.95	7.57*
x Sk-8014	66.08	4.34*	1.57*	294.33	2.08	6.95*	164.25	2.65	3.23
x Sk-8170	62.00	-2.10*	0.60*	273.91	-5.00*	0.96	150.5	-5.93*	-1.32
x Sk-9195	63.00	-0.52	-0.15	293.58	1.82	9.34*	160.75	0.46	4.78*
Sk-8012x x Sk-8014	61.50	-2.88*	-0.55	270.75	-6.09*	-2.96	146.41	-8.49*	-4.60*
x Sk-8170	57.83	-8.68*	-1.10*	269.00	-6.70*	9.72*	147.33	-7.91*	5.52*
x Sk-9195	60.33	-4.73*	-0.35	274.58	-4.76*	4.02	151.08	-5.57*	5.11*
Sk-8014 x Sk-8170	59.41	-6.18*	-0.54	258.33	-10.40*	-5.28	143.41	-10.36*	-0.65
x Sk-9195	61.66	-2.63*	-0.04	268.66	-6.82*	-6.23*	141.66	-11.46*	-6.55*
Sk-8170 x Sk-9195	58.16	-8.16*	-0.42	259.33	-10.05*	-1.13	139.75	-12.65*	0.73
Check SC10	65.33	—	—	301.50	—	—	172.0	—	—
Check SC129	63.33	—	—	288.33	—	—	160.0	—	—

* significant from zero at the 0.05 level of probability.

Cont. (4):

Cross	Grain yield (ard/fed)			Ear length (cm)			No.of rows/ear		
	M	% H	SCA	M	% H	SCA	M	% H	SCA
Sd 63 x Gm152	29.04	-14.83*	0.23	20.78	-7.84*	0.34	14.81	-0.13	-0.28
x Sk-5170	30.86	-9.50*	4.96*	19.80	-12.19*	0.18	14.4	-2.89	0.59*
x Sk-6017	35.42	3.87	4.56*	24.31	7.80*	1.59*	13.96	-5.86*	0.38*
x Sk-6018	25.65	-24.78*	-1.82*	21.4	-5.09	-0.10	13.03	-12.13*	-0.21
x Sk-8012	12.72	-62.69*	-11.99*	15.65	-30.59*	-4.06*	12.90	-13.01*	-0.62*
x Sk-8014	30.01	-11.99*	1.48	21.9	-2.88	-0.01	13.16	-11.26*	-0.06
x Sk-8170	27.90	-18.18*	2.26*	20.33	-9.84*	1.08*	14.0	-5.59*	0.57*
x Sk-9195	31.11	-8.76*	0.32	22.91	1.59	0.96*	13.66	-7.88*	-0.36*
Gm152x Sk-8170	27.32	-19.88*	-0.75	18.33	-18.71*	-0.51	15.83	6.74*	0.22
x Sk-6017	34.70	1.81	1.26	20.93	-7.18*	-0.92*	15.80	6.54*	0.35*
x Sk-6018	31.15	-8.65*	1.30	19.91	-11.70	-0.62	15.10	1.82	0.01
x Sk-8012	27.71	-18.73*	0.63	19.55	-13.30	0.65	15.53	4.72*	0.08
x Sk-8014	30.33	-11.05*	-0.74	21.48	-4.74	0.38	14.66	-1.14	-0.43*
x Sk-8170	28.47	-16.51*	0.38	19.3	-14.41*	0.89*	15.10	1.82	-0.29
x Sk-9195	30.91	-9.35*	-2.31*	20.56	-8.82*	-0.22	16.2	9.23*	0.35*
Sk-5170xSk-6017	31.95	-6.30	1.75*	22.60	0.22	1.32*	14.13	-4.72*	-0.02
x Sk-6018	26.97	-20.9*	0.20	20.10	-10.86*	0.12	13.66	-7.88*	-0.03
x Sk-8012	26.50	-22.28*	2.70*	18.71	-17.02*	0.49	14.23	-4.04*	0.05
x Sk-8014	27.67	-18.85*	-0.25	20.60	-8.64*	0.30	13.26	-10.58*	-0.30
x Sk-8170	13.85	-59.38*	-10.08*	15.48	-31.35*	-2.27*	13.03	-12.13*	-0.83*
x Sk-9195	32.39	-5.01	2.26*	20.53	-8.95*	0.36	14.86	0.20	0.31
Sk-6017xSk-6018	29.57	-13.28*	-2.37*	22.48	-0.31	-0.46	13.16	-11.26*	-0.33
x Sk-8012	28.01	-17.85*	-0.95	21.40	-5.09	0.15	13.73	-7.41*	-0.08
x Sk-8014	35.21	3.25	2.35*	22.88	1.46	-0.44	13.76	-7.21*	0.22
x Sk-8170	30.68	-10.02	0.63	21.13	-6.29*	0.39	13.63	-8.09*	0.03
x Sk-9195	27.85	-18.32*	-7.23*	21.61	-4.16	-1.64*	13.73	-7.41*	-0.56*
Sk-6018xSk-8012	25.74	-24.51*	0.33	20.80	-7.76*	0.87*	13.50	-8.96*	0.07
x Sk-8014	27.06	-20.64*	-2.45*	22.76	0.93	0.68	13.40	-9.64*	0.13
x Sk-8170	28.66	-15.95*	2.17*	18.91	-16.14*	-0.64	13.60	-8.29*	0.19
x Sk-9195	34.70	0.41	2.64*	22.18	1.64	0.15	14.16	-4.51*	0.16
Sk-8012x x Sk-8014	27.61	-19.03*	0.88	20.33	-9.84*	-0.11	13.66	-7.88*	0.13
x Sk-8170	27.15	-20.38*	3.50*	19.31	-14.36*	1.39*	13.86	-6.54*	0.11
x Sk-9195	33.69	-1.20	4.89*	20.78	-7.84*	0.61	14.53	-2.02	0.25
Sk-8014 x Sk-8170	28.32	-16.95*	0.63	19.35	-14.19*	-0.71*	13.66	-7.88*	0.33
x Sk-9195	30.86	-9.50*	-1.89*	22.33	-0.97	-0.08	13.86	-6.54*	-0.02
Sk-8170 x Sk-9195	31.11	-8.76	1.31	19.65	-12.86*	-0.15	14.16	-4.51*	-0.12
Check SC10	34.10	—	—	22.55	—	—	13.4	—	—
Check SC129	30.60	—	—	21.18	—	—	14.83	—	—

* significant from zero at 0.05 level of probability.

Six crosses showed significantly negative SCA effects for silking date, where five of them significantly had heterotic effects for earliness than the best check SC129 (63.3 days). The cross Sk8012 x Sk8170 had the best desirable values for both SCA and heterotic effects. Six crosses showed significantly negative SCA effects for plant height, where three of them significantly had shorter stalks than the best check SC129 (288.33 cm). Meanwhile seven crosses exhibited significantly negative SCA effects for ear height, five of them significantly were shorter than SC129 (160 cm).Concerning plant and ear height, the crosses Sd 63 x Sk8012 and Sk5170 xSk8170 and Sk8014 x Sk9195 had best values for both SCA and heterotic effects among tested genotypes and could be of value for breeding for lodging resistance. Eleven crosses showed significantly positive SCA effects for grain yield, where three of them; i.e. Sd63 x Sk6017, Sk6017 x Sk8014 and Sk6018 x Sk9195 outyielded the best check SC10 (34.1 ard/fed). Hence it could be concluded that these crosses offer good possibility for improving grain yield of maize.

Seven crosses showed significantly positive SCA effects for ear length; the cross Sd63 x Sk6017 had the highest values for both SCA and heterotic effects. Five crosses showed desirable values for SCA effects for number of rows/ ear, out of them i.e. Gm152 x Sk6017 and Gm152 x Sk9195 significantly had more rows/ear than the best check SC129. It is worth noting that a cross having good SCA effects may come from two parents possessing good GCA or from one with good GCA and the other with poor GCA effects , similar findings were obtained by Nawar *et al.,* (1979), El-Hosary (1988), Mahmoud (1996) and Mosa (2003).

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تحليل التهجينات الدائرية لتسع سلالات من الذرة الشامية الأبيض لصفات مختلفة تحت مواقع مختلفة

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تم تقييم ٣٦ هجيناً فردياً ناتجة من التهجين بين ٩ سلالات من الذرة الشامية البيضاء بنظام التزاوج الدائري مع استبعاد التزاوجات العكسية بالإضافة الي هجينين تجاريين في تصميم القطاعات الكاملة العشوائية في أربع تكرارات في ثلاث مواقع بحثية سخا و الجميزة و سدس في موسم صيف ٢٠٠٥.وذلك لدراسة القدرة علي الائتلاف وقوة الهجين. أظهر التحليل المشترك معنوية عالية بين المواقع والقدرة العامة والخاصة علي الائتلاف والتفاعل بين القدرة العامة علي الائتلاف والمواقع لكل الصفات تحت الدراسة ما عدا تفاعل القدرة العامة علي الائتلاف مع المواقع لصفة ارتفاع الكوز. أظهرت النتائج أن الفعل الوراثي المضيف للجين كان أكثر أهمية من الفعل الوراثي غير المضيف في وراثة جميع الصفات تحت الدراسة ما عدا صفة المحصول. كذلك كان الفعل الوراثي المضيف للجين أكثر تأثرا بالبيئة من الفعل الوراثي غير المضيف لكل الصفات تحت الدراسة.كانت أعلي قيم مرغوبة تحصل عليها لتأثيرات القدرة العامة علي الائتلاف في السلالات سخا ٥١٧٠ وسخا ٨١٧٠ لصفات تاريخ ظهور ٥٠% من الحرائر للنورات المؤنثة وارتفاع كل من النبات والكوز و كذلك السلالات سخا ٦٠١٧ وسخا ٨٠١٤ وسخا ٩١٩٥ لصفات محصول الحبوب وطول الكوز والسلالة جميزة ١٥٢ لصفة عدد الصفوف في الكوز .كذلك كانت أعلي قيم مرغوبة تم التحصل عليها لكلا من تأثيرات القدرة الخاصة علي الائتلاف وقوة الهجين نسبة لافضل هجن المقارنة في الهجن سخا ٨٠١٢ X سخا ٨١٧٠ لصفة تاريخ ظهور ٥٠% من حرائر النورات المؤنثة و الهجين سدس٦٣ X سخا ٨٠١٢ وسخا ٥١٧٠ X سخا٨١٧٠ وسخا ٨٠١٤ X سخا ٩١٩٥ لصفات ارتفاع النبات والكوز والهجن سدس٦٣ X سخا ٦٠١٧ وسخا ٨٠١٤ X سخا ٦٠١٨ وسخا ٩١٩٥ X سخا لصفات محصول الحبوب والهجين سدس ٦٣ X سخا٦٠١٧ لطول الكوز والهجين جميزة ١٥٢ X سخا ٦٠١٧ وجميزة١٥٢ X سخا ٩١٩٥ لصفة عدد الصفوف في الكوز.وتفيد نتائج الدراسة انة يمكن الحصول على هجين يتميز بقدرة خاصة مرتفعة على الائتلاف من أبوين يتميز أحدهما على الاقل بقدرة عامة عالية على الائتلاف