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ESTIMATION OF COMBINING ABILITY FOR NEW WHITE INBRED LINES OF MAIZE *via* LINE × TESTER ANALYSIS

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ABSTRACT

The main purpose of this research was to estimate combining ability for fifteen white inbred lines of maize via line × tester mating design. 15 inbred lines were crossed with two testers. The resulting 30 crosses with three commercial checks were evaluated in a randomized complete block design with 4 replications at two locations: Sakha and Sids Res. Station in 2018 season. Analysis of variance showed existence of variability among genotypes. Additive gene effects had the important role in the inheritance of most studied traits. The cross Sk5008/75 × Sk-13 (38.1 ard/fad.) did not significantly outyield the three commercial checks. The tester Sk-13 was favorable combiner than Sk-8 for most of studied traits. The best inbred line for general combining ability effects was Sk5008/76 for earliness, Sk5007/74 for plant and ear heights, Sk5008/75 for grain yield, Sk5008/79 for ear length and Sk5008/81 for ear diameter.

Key words: ***Maize, Combining ability, Line x tester, Additive gene effects.***

INTRODUCTION

Maize breeding depends essentially on crossing between extracted inbred lines to form high-yielding crosses. Making all possible combinations among a large number of inbred lines is impractical. So it is of great importance to study the performance of inbred lines to characterize them. Knowing information about combining ability of lines saves the breeders effort and time to specify which lines could unite for high-yield potential. Line × tester analysis introduced by Kempthorne (1957) provides this information for the newly extracted lines to screen out and focus on the good ones. The concepts of general combining ability (GCA) and specific combining ability (SCA) became useful for characterization of inbred lines in crosses and often have been included in the description of an inbred line (Hallauer and Miranda 1988). Breeders and geneticists therefore have been looking for predictive approaches to either preselect inbred lines or identify the most promising hybrid combinations to be evaluated (Schrag *et al* 2006). Top crossing have been fairly widely used for the preliminary evaluation of the combining ability of new inbred (Jenkins (1978). Ideal tester should allow great expression of genetic variability in their progeny (Russell 1961). The use of inbred line as a tester was suggested by Russell and Eberhart (1975) and it has been widely used by maize breeder (Walejke and Russell 1977, Darrah 1985 and Horner *et al* 1989). The main aim for this research was to study the combining ability of 15 new white maize inbred lines; beside identifying their high-yielding crosses to be evaluated precisely in further steps of our national maize program.

MATERIALS AND METHODS

Fifteen new white maize (*Zea mays* L.) inbred lines isolated from five different sources at Sakha (Sk) agricultural research station were top crossed with the two testers inbred lines Sk-8 and Sk-13 in 2017 season. The resulting 30 crosses along with three commercial checks (SC 10, SC 128 and SC 2031) were evaluated at two locations, *i.e*. Sakha and Sids Agric. Res. Stations in 2018 season. Entries were grown in single-ridge plot, 6 m long, 0.8 m width between ridges and 0.25 m between hills within the ridge. A randomized complete block design with 4 replications was used at each location. Cultural practices were done during the growing season as recommended. Data were recorded for six traits: number of days to 50% silking, plant height (cm), ear height (cm), ear length (cm), ear diameter (cm), and grain yield (ard/fad) adjusted at 15.5% grain moisture content. Analysis of variance was carried out for each location and when homogeneity of error mean squares for the two locations was proven hence combined analysis was done according to Snedecor and Cochran (1967). Line x tester analysis was done according to (Kempthorne, 1957).

RESULTS AND DISCUSSION

Analysis of variance in Table 1, showed that the mean squares due to locations (Loc) and genotypes (G) were highly significant, meaning the existence of differences among genotypes and between the two locations for all traits, while the mean squares due to the interaction between genotypes × locations (G×Loc) was significant or highly significant for ear height, grain yield and ear length, meaning that genotypes performance differed from location to the other for these traits.

Table 1. Combined analysis of variance for six studied traits of maize across the two locations.

SOV	df	Days to 50% silking	Plant height	Ear height	Grain yield	Ear length	Ear diameter
Locations (Loc)	1	750.09**	70103.0**	25783.64**	3162.44**	439.94**	22.81**
Rep/Loc	6	8.74	1958.4	1086.97	73.78	8.20	0.135
Genotypes (G)	32	14.01**	1366.2**	801.36**	137.09**	10.57**	0.184**
G x Loc.	32	3.54	144.9	226.52**	41.68**	2.13*	0.040
Error	192	2.83	108.40	108.10	15.15	1.32	0.045

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

Line × Tester (L×T) analysis in Table 2, showed that the mean squares due to Lines (L), Testers (T) and their interaction (L×T) were significant or highly significant for all the studied traits, except for T of ear length and diameter and L×T of days to 50% silking and ear diameter, meaning the existence of differences among lines performance for all traits and between testers performance for all traits except for ear length and ear diameter also. Lines performance differed from tester to the other for plant height, ear height, grain yield and ear length. The mean squares due to L×Loc interaction was significant or highly significant for ear height, grain yield and ear length, indicating that lines performance differed from location to other for these traits, while mean squares due to T×Loc interaction was significant for days to 50% silking and grain yield, meaning that testers performance changed from location to the other for these traits. Meanwhile the interaction between L×T×Loc was not significant for all traits.

Table 2. Line × tester analysis for six studied traits of maize across the two locations.

SOV	df	Days to 50% silking	Plant height	Ear height	Grain yield	Ear length	Ear diameter
Lines (L)	14	18.35**	1602.4**	1072.78**	107.59**	16.07**	0.292**
Testers (T)	1	21.60**	2076.8**	738.50**	1867.74**	4.99	0.067
L x T	14	3.98	217.3*	152.72*	46.44**	7.41**	0.071
L x Loc	14	2.36	147.61	182.58*	50.40**	2.83**	0.059
T x Loc	1	16.0*	390.15	203.5	83.07*	0.28	0.08
L x T x Loc.	14	4.05	119.63	82.99	25.68	1.85	0.023
Error	174	2.96	102.1	86.08	15.99	1.28	0.046

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

Mean performance of the 30 crosses and three checks for six traits across two locations are presented in Table (3). For days to 50% silking, the crosses ranged from 61 days for Sk5007/74 × Sk-13 to 65.8 days for Sk5009/82 × Sk-13 and Sk5009/83 × Sk-8. Three crosses Sk5007/74 × Sk-13, Sk5008/76 × Sk-13 and Sk5004/69 × Sk-13 were not significant by differ for earliness from the best check SC 128. All crosses had significantly by shorter plant than the two checks SC10 and SC 2031.

Table 3. Mean performance of 30 crosses of maize and three checks for six studied traits across the two locations.

Cross	Days to 50% silking	Plant height (cm)	Ear height (cm)	Grain yield (ard/fad)	Ear length (cm)	Ear diameter (cm)
Sk5004/69×Sk-8	63.3	244.1	132.6	28.5	21.9	4.7
Sk5004/69×Sk-13	61.3	233.6	122.0	30.4	23.4	4.8
Sk5005/70×Sk-8	64.6	233.8	124.1	27.6	22.7	4.8
Sk5005/70×Sk-13	63.3	237.0	125.8	30.8	24.5	4.9
Sk5006/71×Sk-8	65.3	252.1	140.6	28.2	22.1	5.0
Sk5006/71×Sk-13	64.6	263.6	151.6	29.9	24.5	5.0
Sk5007/72×Sk-8	64.4	261.4	142.0	31.1	22.9	4.8
Sk5007/72×Sk-13	64.3	256.0	145.9	36.6	24.3	4.9
Sk5007/73×Sk-8	63.5	249.9	142.5	31.0	23.3	4.8
Sk5007/73×Sk-13	63.0	245.4	137.5	34.9	22.5	4.7
Sk5007/74×Sk-8	63.6	231.8	126.8	25.4	23.6	4.8
Sk5007/74×Sk-13	61.0	221.5	122.0	30.4	22.3	4.7
Sk5008/75×Sk-8	63.5	261.8	152.4	31.3	20.4	5.0
Sk5008/75×Sk-13	63.8	253.9	146.1	38.1	22.9	5.2
Sk5008/76×Sk-8	62.9	248.8	142.5	25.3	22.9	5.1
Sk5008/76 Sk-13	61.1	244.0	142.3	34.9	23.1	4.8
Sk5008/77×Sk-8	62.8	256.9	142.9	23.9	23.5	5.2
Sk5008/77×Sk-13	63.4	251.8	140.1	34.9	21.6	5.0
Sk5008/78×Sk-8	63.1	264.6	153.9	31.6	22.6	5.2
Sk5008/78×Sk-13	62.8	244.5	140.3	33.8	21.4	5.0
Sk5008/79×Sk-8	63.5	266.8	152.3	30.4	25.3	4.9
Sk5008/79×Sk-13	62.9	260.3	148.5	35.4	24.6	4.9
Sk5008/81×Sk-8	63.1	244.8	140.8	26.0	22.6	5.2
Sk5008/81×Sk-13	63.6	241.8	136.5	34.9	22.3	5.1
Sk5009/82×Sk-8	64.9	253.0	142.6	26.4	22.0	4.9
Sk5009/82×Sk-13	65.8	245.4	137.1	28.0	21.9	4.9
Sk5009/83×Sk-8	65.8	250.0	139.5	19.6	23.2	4.9
Sk5009/83×Sk-13	65.3	248.3	138.3	31.5	23.4	5.0
Sk5009/84×Sk-8	64.0	249.1	143.9	28.1	20.4	4.9
Sk5009/84×Sk-13	63.3	233.5	132.8	33.7	20.9	4.8
Check SC10	64.9	282.9	168.1	34.5	22.3	4.7
Check SC128	61.4	249.1	135.5	34.3	23.1	4.9
Check SC2031	66.4	279.3	152.9	34.7	23.3	5.1
LSD 0.05	1.7	10.2	10.2	3.8	1.1	0.2

While the six crosses Sk5007/74 × Sk-13, Sk5007/74 x Sk-8, Sk5009/84 × Sk-13, Sk5004/69 × Sk-13, Sk5005/70 × Sk-8 and Sk5005/70 × Sk-13 showed significant shorter plant than the shortest check SC 128. For ear height Sk5004/69 × Sk-13, Sk5005/70 × Sk-8 and Sk5007/74 × Sk-13 had significant lower ear height than SC 10, SC 2031and SC 128. From above results, Sk5007/74 × Sk-13 showed the earliest and the shortest plant and ear height. For grain yield, crosses ranged from 19.6 to 38.1 ard/fad for Sk5009/83 × Sk-8 and Sk5008/75 × Sk-13, respectively. Seven crosses; Sk5007/72 × Sk-13, Sk5007/73 × Sk-13, Sk5008/75 × Sk-13, Sk5008/76 × Sk-13, Sk5008/77 × Sk-13, Sk5008/79 × Sk-13 and Sk5008/81 × Sk-13 did not significantly out yield from all checks; SC10 34.5ard/fad, SC128 34.3 ard/fad, SC2031 34.7 ard/fad. For ear length, four crosses Sk5005/70 × Sk-13, Sk5006/71 × Sk-13, Sk5008/79 × Sk-8 and Sk5008/79 × Sk-13 were increased significantly than the best check 2031. For ear diameter, four crosses Sk5008/75 × Sk-13, Sk5008/77 × Sk-8 and Sk5008/78 × Sk-8 and Sk5008/81 × Sk-8 did not differ significantly for big ear diameter from the best check SC 2031. From above result the cross Sk5008/75 × Sk-13 was the best for grain yield and ear diameter, therefor it will be evaluated in the advanced level of testing in the maize program.

Estimate of general combining ability effects (GCA) of 15 inbred lines and two testers are presented in Table (4). The desirable inbred lines for GCA effects were Sk5004/69, Sk5007/74 and Sk5008/76 for earliness, Sk5004/69, Sk5005/70 and Sk5007/74 for both plant and ear heights plus Sk5008/81 and Sk5009/84 for plant height, Sk5007/72, Sk5007/73, Sk5008/75, Sk5008/78 and Sk5008/79 for grain yield, Sk5005/70, Sk5007/72 and Sk5008/79 for ear length and Sk5008/75, Sk5008/77, Sk5008/78 and Sk5008/81 for ear diameter. From the above results the best inbred lines for GCA effects were Sk5004/69 and Sk5007/74 for earliness, short plant and ear height, Sk5005/70 for short plant and ear height and ear length, Sk5007/72 and Sk5008/79 for grain yield and ear length, Sk5008/75 and Sk5008/78 for grain yield and ear diameter, suggesting the possibility of utilizing these inbred lines in the breeding program. The best tester for desirable general combining ability effects was Sk-13 for earliness, plant and ear height and grain yield.

Table 4. General combining ability effects of 15 inbred lines of maize and 2 testers for six studied traits across the two locations.

Inbred line	Days to 50% silking	Plant height (cm)	Ear height (cm)	Grain yield (ard/fad)	Ear length (cm)	Ear diameter (cm)
Sk5004/69	-1.325**	-9.425**	-12.217**	-0.980	-0.120	-0.162**
Sk5005/70	0.363	-12.925**	-14.592**	-1.182	0.830**	-0.087
Sk5006/71	1.363**	9.575**	6.596**	-1.343	0.530	0.088
Sk5007/72	0.738	10.388**	4.408	3.466**	0.868**	-0.062
Sk5007/73	-0.325	-0.675	0.471	2.553*	0.105	-0.212**
Sk5007/74	-1.263**	-21.675**	-15.154**	-2.545*	0.168	-0.137*
Sk5008/75	0.050	9.513**	9.721**	4.265**	-1.120**	0.188**
Sk5008/76	-1.575**	-1.925	2.846	-0.335	0.218	0.013
Sk5008/77	-0.513	6.013*	1.971	-1.032	-0.220	0.188**
Sk5008/78	-0.638	6.263*	7.533**	2.277*	-0.770*	0.151**
Sk5008/79	-0.388	15.200**	10.846**	2.443*	2.218**	-0.037
Sk5008/81	-0.200	-5.050*	-0.904	0.046	-0.345	0.201**
Sk5009/82	1.738**	0.888	0.346	-3.205**	-0.795**	-0.062
Sk5009/83	1.925**	0.825	-0.654	-4.896**	0.530	0.013
Sk5009/84	0.050	-6.988**	-1.217	0.469	-2.095**	-0.087
Tester Sk-8	0.300*	2.942**	1.754*	-2.790**	-0.144	0.017
Tester Sk-13	-0.300*	-2.942**	-1.754*	2.790**	0.144	-0.017
LSD g_i (L) 0.05	0.843	4.951	4.546	1.959	0.554	0.105
LSD g_i-g_j (L) 0.05	1.192	7.002	6.429	2.771	0.784	0.149
LSD g_i (T) 0.05	0.308	1.808	1.660	0.715	0.202	0.038
LSD g_i-g_j (T) 0.05	0.435	2.557	2.348	1.012	0.286	0.054

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

Estimates of specific combining ability effects (SCA) for 30 crosses are presented in Table (5). The desired crosses for SCA effects were Sk5006/71 × Sk-8 for plant height and ear height. Sk5008/78 × Sk-13 for plant height, Sk5008/77 × Sk-13, Sk5009/83 × Sk-13 for grain yield and Sk5005/70 × Sk-13, Sk5006/71 × Sk-13, Sk5007/74× Sk-8, Sk5008/75 × Sk-13 and Sk5008/77 × Sk-8 for ear length.

Table 5. Specific combining ability effects of 30 top crosses of maize for six traits across two locations.

Cross	Days to 50% silking	Plant height (cm)	Ear height (cm)	Grain yield (ard/fad)	Ear length (cm)	Ear diameter (cm)
Sk5004/69×Sk-8	0.700	2.308	3.558	1.820	-0.618	-0.092
Sk5004/69×Sk-13	-0.700	-2.308	-3.558	-1.820	0.618	0.092
Sk5005/70×Sk-8	0.388	-4.567	-2.567	1.198	-0.793*	-0.092
Sk5005/70×Sk-13	-0.388	4.567	2.567	-1.198	0.793*	0.092
Sk5006/71×Sk-8	0.013	-8.692*	-7.254*	1.948	-1.043**	-0.017
Sk5006/71×Sk-13	-0.013	8.692*	7.254*	-1.948	1.043**	0.017
Sk5007/72×Sk-8	-0.238	-0.254	-3.692	0.038	-0.556	-0.042
Sk5007/72×Sk-13	0.238	0.254	3.692	-0.038	0.556	0.042
Sk5007/73×Sk-8	-0.050	-0.692	0.746	0.819	0.532	0.033
Sk5007/73×Sk-13	0.050	0.692	-0.746	-0.819	-0.532	-0.033
Sk5007/74×Sk-8	1.013	2.183	0.621	0.304	0.794*	0.033
Sk5007/74×Sk-13	-1.013	-2.183	-0.621	-0.304	-0.794*	-0.033
Sk5008/75×Sk-8	-0.425	0.996	1.371	-0.585	-1.068**	-0.117
Sk5008/75×Sk-13	0.425	-0.996	-1.371	0.585	1.068**	0.117
Sk5008/76×Sk-8	0.575	-0.567	-1.629	-2.025	0.044	0.108
Sk5008/76 Sk-13	-0.575	0.567	1.629	2.025	-0.044	-0.108
Sk5008/77×Sk-8	-0.613	-0.379	-0.379	-2.692*	1.057**	0.058
Sk5008/77×Sk-13	0.613	0.379	0.379	2.692*	-1.057**	-0.058
Sk5008/78×Sk-8	-0.113	7.121*	5.058	1.664	0.732	0.071
Sk5008/78×Sk-13	0.113	-7.121*	-5.058	-1.664	-0.732	-0.071
Sk5008/79×Sk-8	0.013	0.308	0.121	0.292	0.494	0.008
Sk5008/79×Sk-13	-0.013	-0.308	-0.121	-0.292	-0.494	-0.008
Sk5008/81×Sk-8	-0.550	-1.442	0.371	-1.685	0.282	0.046
Sk5008/81×Sk-13	0.550	1.442	-0.371	1.685	-0.282	-0.046
Sk5009/82×Sk-8	-0.738	0.871	0.996	2.020	0.182	-0.017
Sk5009/82×Sk-13	0.738	-0.871	-0.996	-2.020	-0.182	0.017
Sk5009/83×Sk-8	-0.050	-2.067	-1.129	-3.140*	0.057	-0.042
Sk5009/83×Sk-13	0.050	2.067	1.129	3.140*	-0.057	0.042
Sk5009/84×Sk-8	0.075	4.871	3.808	0.025	-0.093	0.058
Sk5009/84×Sk-13	-0.075	-4.871	-3.808	-0.025	0.093	-0.058
LSD S_{ij} 0.05	1.192	7.002	6.429	2.771	0.784	0.149
LSD S_{ij}-S_{ik} 0.05	1.686	9.902	9.092	3.919	1.109	0.210

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

Data in Table (6) showed that the general combining ability effects K^2GCA or additive gene effects were higher than the specific combining ability effects K^2SCA or non-additive gene effects for all traits except for ear length, meaning, the important role of additive gene effects in the inheritance of most studied traits. Several researchers are in agreement with this result with regard to grain yield such as Zehuic *et al* (2000), Vacaroe *et al* (2002), Sharma *et al* (2004), Bayisa *et al* (2008), Aly (2013) and Abdallah (2014). On the other hand, several researchers such as Sadek *et al* (2002), El-Hifny *et al* (2010), Izhar and Chakraborty (2013) and El-Hossary (2014) found that non-additive gene effects was more important than additive gene effects for inheritance of grain yield.

Table 6. Estimates of general (K^2GCA) and specific (K^2SCA) combining ability effects for studied traits of maize across two locations.

Genetic component	Days to 50% silking	Plant height	Ear height	Grain yield	Ear length	Ear diameter
K^2GCA	**0.25**	**25.55**	**12.05**	**14.28**	**0.14**	**0.003**
K^2SCA	**0.13**	**14.40**	**8.33**	**3.81**	**0.77**	**0.002**

REFERENCES

Abdallah, T.A.E. (2014). Combining ability estimates using line × tester analysis to develop high yielding maize hybrids. Egypt. J. Plant Breed. 18(1):45 – 55.

Aly, R. S. H. (2013). Relationship between combining ability of grain yield and yield components for some newly yellow maize inbred lines via line × tester analysis. Alex. J. Agric. Res. 58 (2):115-124.

Bayisa A., M. Hussen and Z. Habtamu (2008). Combining ability of transition highland maize inbred lines. East African Crop Sci. J. 2:19-24.

Darrah, L. L. (1985). Evaluation of population improvement in the Kenya maize breeding methods study. P 160-175. In To Feed Ourselves. Proc. First eastern, Central and southern Africa regional Workshop-Lusaka, Zambia. Cymmyt, Mexico, D.F.

El-Hifny, M.Z., E. A. Hassaballa, M.A. Abd El-Moula and Kh.A.M. Ibrahim (2010). Combining ability and types of gene action in yellow maize (*Zea mays* L.). Assiut J. Agric. Sci. 41(1):1-27.

El-Hosary, A.A.A. (2014). Relative values of three different testers in evaluating combining ability of new maize inbred lines. International Jurnal of Plant Breeding and Genetics. 8 (2): 57-65.

Hallauer, A.R. and J. B. Miranda (1988). Quantitative Genetics In Maize Breeding. Ames: Iowa State University Press USA.

Horner, E. S.; E. Magloire and J.A. Morera (1989). Comparison of selection for S_2 progeny vs. test cross performance for population improvement in maize. Crop Sci. 29: 868-874.

Izhar, T. and M. Chakraborty (2013). Combining ability and heterosis for grain yield and its components in maize (*Zea mays* L.) inbreds over environments. Afr. J. Agric. Res. 8 (25): 3276-3280.

Jenkins, M. T. (1978). Maize breeding during the development early years of hybrid maize. In walden, D. B. (ed.) Maize Breeding and Genetics. John Wiley, New York. 13-28

Kempthorne, O. (1957). An Introduction to Genetic Statistics, John Wiley & Sons, New York, NY, USA.

Russel, W. A. (1961). A comparison of five types of testers in evaluating the relationship of stalk rots in corn inbred lines and stalk strength of the lines in hybrids combination. Crop Sci. 1:393-397.

Russel, W. A. and S.A. Eberhart (1975). Hybrid performance of selected maize lines from reciprocal recurrent selection and test cross selection programs. Crop Sci. 15:1-4.

Sadek, S.E., M.S.M Soliman, A.A. Barakat and K.I Khalifa (2002). Top-crosses analysis for selecting maize lines in the early self-generations. Minufiya J. Agric. Res. 27:197-213.

Schrag, T.A., A.E. Melchinger, A.P. Sørensen and M. Frisch (2006). Prediction of single-cross hybrid performance for grain yield and grain dry matter content in maize using AFLP markers associated with QTL. Theor. Appl. Genet. 113:1037–1047.

Snedecor, G.W. and W. G. Cochran (1967). Statistical Methods. 6^{th} ed. Iowa State Univ. Press. Ames., Iowa, USA.

Sharma, S, R. Narwal, M. S. Kumar and S. Dass (2004). Line x tester analysis in maize (*Zea mays*, L.), Forage Res. 30: 28-30.

Vacaroe, J.F., D.G. Barbosa-Neto, C.N. Pegoraro and N.L.D.H. Conceicao (2002). Combining ability of twelve maize populations. Pesquisa-Agropecuaria-Brasileir. 37:67-72.

Walejko, R. N. and W. A. Russell (1977). Evaluation of recurrent selection for specific combining ability in two open pollinated maize cultivars.Crop Sci. 17:647-651.

Zehuic. M. Xiang, G. Zu and G. Xa (2000). Study in the combining ability and heterosis of Suman germplasm lines. Scientia Agricultura- Sinica 33: 113-118.

تقدير القدرة على الإئتلاف لسلالات جديدة من الذرة الشامية من خلال تحليل السلاله × الكشاف

رفيق حليم عبد العزيز السباعي, هاني عبد العاطى درويش و عماد اسماعيل محمود محمد
قسم بحوث الذرة الشامية– معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية

تهدف هذه الدراسة لتقدير القدرة على الائتلاف لـ ١٥ سلالة بيضاء جديدة من الذرة الشامية من خلال نظام التزواج السلاله × الكشاف. تم تهجين ١٥ سلالة مع اثنين من الكشافات . قيمت الـ٣٠ هجن الناتجة مع ثلاثة من الهجن التجارية في محطتى بحوث سخا وسدس فى تصميم القطاعات الكاملة العشوائية فى اربع مكررات. اوضح تحليل التباين وجود اختلافات وراثيه بين الهجن المقيمة. كان الفعل الوراثى المضيف هو الاكثر تحكما فى وراثة معظم الصفات المدروسة. اعطى الهجين سخا ٥٠٠٨/٧٥× سخا ١٣ محصولا ٣٨,١أردب للفدان ولا يختلف معنويا عن هجن المقارنة. أفضل السلالات فى القدرة العامة على الائتلاف كانت السلاله سخا ٥٠٠٨/٧٦ للتبكير والسلاله سخا ٥٠٠٧/٧٤ لارتفاع النبات والكوز والسلالة سخا ٥٠٠٨/٧٥ لمحصول الحبوب والسلالة سخا ٥٠٠٨/٧٩ لطول الكوز والسلالة سخا ٥٠٠٨/٨١ لقطر الكوز.

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