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UTILIZATION OF LINE x TESTER ANALYSIS FOR ESTIMATING COMBINING ABILITY FOR SOME NEW YELLOW MAIZE INBRED LINES

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ABSTRACT

In 2018 summer season at Gemmeiza Research Station, eleven new yellow inbred lines were crossed with three testers: two inbred lines Gz.658 and Gm.6052) and one single cross SC 162 according to line x tester design. In 2019 summer season the resulting, 33 crosses and four check hybrids: two single crosses (SC 168 and SC 3084) and two three way crosses (TWC 360 and TWC 368) were evaluated at both of Gemmeiza and Sids experimental Research Stations. Significant and highly significant mean squares due to crosses and the partitions lines, testers and lines x testers were obtained for all studied traits across locations, except testers for grain yield. K^2 SCA (non- additive gene effects) were more important than K^2 GCA (additive gene effects) for all traits Gm.2, Gm.6, Gm.9 and Gm.35 had desirable values for GCA effects for grain yield. The best cross for SCA effects was Gm. 9 × SC. 162 for grain yield. Five single crosses, (Gm. 2 × Gz 658 (28.956 ard /fed), Gm. 35 × Gz 658 (27.777 ard /fed), Gm. 2 × Gm. 6052 (27.566 ard /fed), Gm. 6 x Gm. 6052 (28.157 ard /fed) and Gm. 35 × Gm. 6052 (28.123 ard /fed) did not significantly out-yielded the highest check SC 168 (27.190 ard/fed), while three- way cross Gm. 9 × SC. 162 (29.74 ard/fed) significantly out-yielded the best check TWC 360 (26.42 ard/fed).

Key words: ***Line x Tester, Combining ability, Inbred line, Maize (Zea mays L.).***

INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop after wheat and rice in Egypt. Area devoted to maize cultivation is about 2.64 million faddan. Maize productivity increased form (1.5 ton/fed) in 1980 to (3.2 ton /fed) in 2019 season. The ultimate goal of most breeding programs is developing high yielding hybrids of yellow maize, which depends on the identification of inbred lines with high general and specific combining ability. Line × tester mating design was developed by Kempthorne (1957), which provides reliable information on the general and specific combining ability effects of parents and their hybrid combinations in applied breeding programs. Nature and number of testers to be used in the line x tester model for evaluating inbred lines is still unsolved problem. Using broad and narrow base testers are the most common procedure for the evaluating process. In this regard, the choice of a suitable tester is an important decision. Matzinger (1953) and Menz *et al* (1999) concluded that the choice of suitable tester should be based on simplicity in use, ability to classify that relative merit of lines and maximizing genetic gain. Walejko and Russell (1977), Darrah *et al* (1972), Horner *et al* (1973) and Russell and Eberhart (1975) suggested the use of an inbred line as a tester. While the use of a single cross as a tester has been reported by El-Ghawas (1963) and Horner *et al* (1976), Mahgoub*et al* (1996) and Soliman *et al* (2001) who proved that narrow genetic base testers can by effectively used to identify lines having good GCA and the most efficient is the one that have a low frequency of favorable alleles. Abel and Pollak (1991) suggested at least two and perhaps more divergent testers that contain inherently high level of favorable alleles.

The main objectives of this study were to estimate the general (GCA) and specific (SCA) combining ability effects and type of gene action involved in the manifestation of grain yield and other agronomic traits and identify superior crosses from this study to be used in maize breeding programs.

MATERIALS AND METHODS

The materials of this study involved eleven new yellow maize inbred lines (Gm. 2, Gm.6, Gm.7, Gm.9, Gm.24, Gm.25, Gm.26, Gm.30, Gm.31, Gm.35 and Gm. 36) derived from different populations at Gemmeiza (Gm.) Agricultural Research Station. These eleven inbred lines were crossed with three testers: two inbred lines (Gz 658 and Gm 6052) and one single cross (SC 162) according to line x tester design proposed by Kempthorne (1957), in summer season 2018 at Gemmeiza Research Station. In 2019 summer season, the resulting33 crosses and four check hybrids: two single crosses (SC168 and SC 3084) and two three-way crosses (TWC 360 and TWC 368) were evaluated at both Gemmeiza and Sids experimental Stations. A randomized complete block design (RCBD) with four replications was used for each location. Each experimental unit consists of one row/ plot, 6-meter-long and 80 cm wide (4.8 m^2), plant to plant hill at 25 cm apart. All cultural practices were applied as recommended at proper time.

Data were taken for number of days to 50% silking, plant height (cm),ear height (cm), ear length (cm), ear diameter (cm) and grain yield, which was adjusted to 15.5 % grain moisture (estimated in kg/plot and converted to ard/fed). Bartlett test was used to test the homogeneity of error variances between the two locations. Analysis of variance was performed for the combined data across the locations according to Snedecor and Cochran (1967). The line x tester analysis of variance was performed when the differences between the 33 F_1 cross were significant according to Kempthorne (1957).

RESULTS AND DISCUSSION

The combined analysis of variance across locations for the six traits is presented in Table (1).

Table 1. Mean squares from line × tester analysis of 33 crosses for six traits across two locations.

SOV	df	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard./fed)
Locations(loc.)	1	518.561**	6061.458**	9540.034**	161.993**	8.691**	754.735**
Rep/loc.	6	7.934	829.812	809.564	11.166	1.309	67.530
Crosses (Cr.)	32	14.253**	1598.781**	701.961**	8.179**	0.285**	94.165**
Line (L)	10	26.559**	2031.083**	1264.276**	8.075**	0.569**	128.712**
Tester (T)	2	8.261**	7291.170**	795.163**	15.566**	0.387**	0.070
L x T	20	8.699**	813.391**	411.484**	7.492**	0.133*	86.301**
Cr. x loc.	32	4.451**	261.411**	156.362**	2.547*	0.074	17.276**
L x loc.	10	5.477**	235.500**	120.026**	2.798	0.096	14.824*
T x loc.	2	14.140**	699.277**	693.648**	4.321	0.030	20.846
L x T x loc.	20	2.969*	230.581**	120.802**	2.244	0.067	18.145**
Error	192	1.520	98.064	66.015	1.510	0.070	7.152
CV %		2.0	4.5	6.8	6.4	5.8	11.0

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

Mean squares due to locations were highly significant for all traits, indicating presence differences between the two locations. These results are in contrast with Ibrahim *et al* (2012), Aboyousef *et al* (2016), Darwich *et al*

(2016), Moshera *et al* (2016) and Gamea *et al* (2019). Significant and highly significant mean squares due to crosses and their partitions (lines, testers and lines x testers) were obtained for all traits, except testers for grain yield, revealing that a wide variability among crosses and parental lines, testers and that lines differed in their performance of crosses with the three testers for these traits. Mean squares due to crosses interaction with locations were significant for all traits, except ear diameter, indicating changes in ranking among genotypes across locations. Consequently, there is a calling for the need to conduct hybrids selection for specific adaptability as opposed to broad adaptability (Abdallah2014).Mean squares due to interactions between lines (L), testers (T) and lines x testers (L × T) with locations (Loc) were significant or highly significant for all traits, expect L × Loc and L × T × Loc for ear length and ear diameter and T × Loc for ear length, ear diameter and grain yield, indicating that the lines and testers performed differently under the two locations for these traits. In this concern, similar findings were detected by Mosa *et al* (2008), Gamea (2015) and Abu shosha and Habouh (2019).

Estimates of additive gene effects (K^2 GCA), non-additive gene effects (K^2 SCA) and the interaction with locations (K^2 GCA × Loc. and K^2 SCA × Loc) are presented in Table 2. The results showed that, K^2 SCA had more values than K^2 GCA for all traits. This result means the preponderance of non-additive gene effects for these traits. The role of non-additive gene effects for grain yield and other traits have been reported by Aly (2013), El-Hosary and Elgammaal (2013) and Aboyousef (2019). On the other side, K^2 SCA × loc was much greater than K^2 GCA × Loc for all traits except for ear diameter, indicating that the non-additive type of gene effects was more affected by the environment than the additive type of gene effects. These results are in agreement with the findings of Barakat *et al* (2003) and Attia *et al* (2015).

Table 2 Estimates of K^2 GCA, K^2 SCA effects and their interactions with locations.

Parameter	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard./fed)
K^2 GCA	0.28	0.81	17.2	0.18	0.007	1.08
K^2 SCA	0.98	0.89	43.18	0.74	0.008	9.89
K^2 GCA x loc.	0.29	7.59	12.17	0.07	0.0004	0.38
K^2 SCA x loc.	0.36	33.13	13.70	0.18	0.0001	2.75

Estimates of general combining ability effects (GCA) of testers for six traits across locations are presented in Table (3). High positive values of combining ability effects would be useful in all traits, except for days to 50% silking, plant height, ear height where high negative values. These values would be useful from plant breeder point of view.

Table 3. Estimates of general combining ability effects for three testers for six traits across at two locations.

Tester		Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard./fed)
Gz 658		-0.148	-10.352**	-3.428**	0.283**	0.074**	-0.008
Gm 6052		-0.205	3.602**	2.186*	-0.483**	-0.019	0.031
SC. 162		0.352**	6.750**	1.242	0.201	-0.055	-0.023
LSD gi	5%	0.262	2.101	1.724	0.261	0.056	0.567
	1%	0.339	2.724	2.235	0.338	0.073	0.736
LSD gi-gj	5%	0.370	2.971	2.438	0.369	0.080	0.802
	1%	0.480	3.852	3.160	0.478	0.103	1.040

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

The tester Gz.658 it had desirable and significant for GCA effects concerning plant height, ear height, ear length and ear diameter, while the results in table (4), showed that the desirable inbred lines for GCA effects were Gm. 7,Gm.30 and Gm.36 for days to 50 silking, plant and ear height, Gm. 35 for plant height, ear height and grain yield, Gm. 6 for ear length, ear diameter and grain yield, Gm. 9 for ear diameter and grain yield, Gm. 2 for grain yield and Gm. 24, Gm.26 and Gm.31 for ear length values and significant.

Table 4. Estimates of general combining ability effects for 11 inbred lines for six traits across at two locations.

Line		Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard./fed)
Gm. 2		-0.364	12.125**	12.322**	-0.719**	0.106	2.888**
Gm. 6		-0.239	13.500**	5.072**	0.631**	0.173**	2.905**
Gm. 7		-1.739**	-11.583**	-9.011**	-0.819**	-0.244	-1.473**
Gm. 9		0.053	3.375	2.114	-0.611*	0.273**	1.288**
Gm. 24		0.261	-0.750	0.280	0.631*	-0.060	0.918
Gm. 25		-0.030	5.750**	5.697**	-0.152	-0.002	0.520
Gm. 26		0.261	6.167**	4.322**	0.689**	0.073	-0.667
Gm. 30		-0.822**	-9.500**	-9.511**	-0.219	-0.002	-1.566**
Gm. 31		2.428**	1.292	2.739	0.656**	-0.006	-3.201**
Gm. 35		0.845**	-10.583**	-4.178*	-0.161	-0.110*	2.149**
Gm. 36		-0.655**	-9.792**	-9.845**	0.073	-0.202**	-3.761**
LSD g_i	5%	0.501	4.023	3.300	0.499	0.108	1.086
	1%	0.649	5.215	4.279	0.647	0.140	1.408
LSD g_i-g_j	5%	0.708	5.689	4.667	0.706	0.152	1.536
	1%	0.918	7.375	6.051	0.915	0.198	1.992

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

Estimates of specific combining ability effects (SCA) of the 33 top crosses for all traits are presented in Table (5).The desirable crosses for SCA effects were Gm. 31 × Gz 658 for days to 50% silking , ear length and grain yield, Gm. 24 × Gm. 6052 for plant height, ear height and ear length, Gm. 36 × Gm 6052 for days to 50% silking and ear height, Gm. 2 × SC. 162 for days to 50% silking and ear length, Gm. 9 x SC. 162 for ear length and grain yield, Gm. 9 × Gz 658, Gm. 36 × Gz 658, Gm 7 × SC 162 and Gm. 26 × SC.162 for plant height, Gm. 7 × Gz 658 and Gm. 31 × SC. 162 for ear height, Gm. 25 × Gm. 6052 and Gm. 6 × SC. 162 for ear length, Gm. 36 x SC.162 for ear diameter and Gm. 26 × Gz 658, Gm. 31 × Gm. 6052 and Gm. 30 × SC 162 for grain yield.

Table 5. Estimates of specific combining ability (SCA) effects of 33 crosses for six traits across at two locations.

Top crosses	Days to 50%	Plant height	Ear height	Ear length	Ear diameter	Grain yield (ard./fed)
Gm. 2 x Gz 658	0.648	-1.648	2.428	-1.024*	-0.066	-2.079*
Gm. 6 x Gz 658	1.273	-3.773	2.553	0.251	-0.082	1.863
Gm. 7 x Gz 658	-0.602	-0.439	-7.614**	-0.024	0.034	-0.211
Gm. 9 x Gz 658	0.731	-9.148**	-3.489	-1.108*	-0.082	-0.232
Gm. 24 x Gz 658	-0.227	14.227**	3.095	-0.549	0.026	-2.407*
Gm. 25 x Gz 658	0.689	-0.773	-4.197	-0.041	0.093	-3.124**
Gm. 26 x Gz 658	0.523	7.186*	4.178	0.192	0.043	2.180*
Gm. 30 x Gz 658	-0.269	-2.273	-2.489	0.476	0.043	1.085
Gm. 31 x Gz 658	-2.019**	12.061**	6.761*	1.551**	0.147	2.807**
Gm. 35 x Gz 658	-0.436	-6.064	-3.072	0.642	-0.024	1.431
Gm. 36 x Gz 658	-0.311	-9.356**	1.845	-0.366	-0.132	-1.310
Gm. 2 x Gm 6052	0.330	-1.352	-1.186	-0.333	0.078	0.441
Gm. 6 x Gm 6052	-0.920	3.273	-0.186	-1.433**	0.086	1.016
Gm. 7 x Gm 6052	-0.295	7.981*	11.773**	0.192	-0.172	0.465
Gm. 9 x Gm 6052	0.038	3.023	-1.477	0.208	0.186	-4.047**

Table 5. Cont.

Top crosses		Days to 50%	Plant height	Ear height	Ear length	Ear diameter	Grain yield (ard./fed)
Gm. 24 x Gm 6052		0.955*	-24.977**	-11.644**	1.017*	-0.156	1.804
Gm. 25 x Gm 6052		-0.129	0.523	-1.311	0.900*	-0.039	1.477
Gm. 26 x Gm 6052		-0.170	1.481	0.814	-0.517	-0.039	-2.113*
Gm. 30 x Gm 6052		0.788	0.898	0.648	-0.308	-0.039	-5.293**
Gm. 31 x Gm 6052		0.288	-6.394	0.398	0.117	0.015	3.642**
Gm. 35 x Gm 6052		0.371	13.981**	11.189**	-0.017	0.144	1.737
Gm. 36 x Gm 6052		-1.254**	1.564	-9.019**	0.175	-0.064	0.871
Gm. 2 x SC. 162		-0.977*	3.000	-1.242	1.358**	-0.012	1.638
Gm. 6 x SC.162		-0.352	0.500	-2.367	1.183**	-0.004	-2.878**
Gm. 7 x SC.162		0.898	-7.542*	-4.159	-0.167	0.138	-0.254
Gm. 9 x SC.162		-0.769	6.125	4.966	0.899*	-0.104	4.279**
Gm. 24 x SC.162		-0.727	10.750**	8.549*	-0.467	0.130	0.603
Gm. 25 x SC.162		-0.561	0.250	5.508	-0.859	-0.054	1.648
Gm. 26 x SC.162		-0.352	-8.667*	-4.992	0.324	-0.004	-0.066
Gm. 30 x SC.162		-0.519	1.375	1.841	-0.167	-0.004	4.208**
Gm. 31 x SC.162		1.731**	-5.667	-7.159*	-1.667**	-0.162	-6.449**
Gm. 35 x SC.162		0.064	-7.917*	-8.117**	-0.626	-0.120	-3.168**
Gm. 36 x SC.162		1.564**	7.792*	7.174*	0.191	0.196*	0.439
LSD S_{ij}	5%	0.868	6.967	5.716	0.865	0.187	1.882
	1%	1.125	9.033	7.411	1.121	0.242	2.440
LSD S_{ij}-S_{ki}	5%	1.23	9.85	8.08	1.22	0.26	2.66
	1%	1.60	12.81	10.51	1.59	0.34	3.46

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

Mean performance of the 33 crosses and the four check hybrids for six traits across two locations are presented in Table (6). For days to 50% silking, all crosses were significant for earliness compared with the early checks SC 168 and TWC 368 (65.1 days), except seven crosses (Gm. 6 × Gz. 658, Gm. 24 × Gm. 6052, Gm. 31 × Gm. 6052, Gm. 35 × Gm. 6052, Gm. 31 × SC 162, Gm. 35 × SC 162 and Gm. 36 × SC 162).

Table 6. Mean performance of 33 yellow crosses for six traits across at two locations.

Crosses	Days to 50% Silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard./fed)
Gm. 2 x Gz 658	63.3	218.25	131.50	17.8	4.7	25.006
Gm. 6 x Gz 658	64.0	217.50	124.38	20.4	4.8	28.965
Gm. 7 x Gz 658	60.6	195.75	100.13	18.7	4.5	22.513
Gm. 9 x Gz 658	63.8	202.00	115.38	17.8	4.9	25.253
Gm. 24 x Gz 658	63.0	221.25	120.13	19.6	4.6	22.708
Gm. 25 x Gz 658	63.6	212.75	118.25	19.4	4.8	21.593
Gm. 26 x Gz 658	63.8	221.13	125.25	20.4	4.8	25.710
Gm. 30 x Gz 658	61.9	196.00	104.75	19.8	4.7	23.716
Gm. 31 x Gz 658	63.4	221.13	126.25	21.8	4.8	23.803
Gm. 35 x Gz 658	63.4	191.13	109.50	20.0	4.5	27.777
Gm. 36 x Gz 658	62.0	188.63	108.75	19.3	4.3	19.126
Gm. 2 x Gm 6052	62.9	232.50	133.50	17.7	4.8	27.566
Gm. 6 x Gm 6052	61.8	238.50	127.25	18.0	4.8	28.157
Gm. 7 x Gm 6052	60.9	218.13	125.13	18.2	4.2	23.230
Gm. 9 x Gm 6052	63.0	228.13	123.00	18.4	5.0	21.478
Gm. 24 x Gm 6052	64.1	196.00	111.00	20.4	4.4	26.959
Gm. 25 x Gm 6052	62.8	228.00	126.75	19.5	4.5	26.234
Gm. 26 x Gm 6052	63.0	229.38	127.50	19.0	4.6	21.456
Gm. 30 x Gm 6052	62.9	213.13	113.50	18.3	4.5	17.378
Gm. 31 x Gm 6052	65.6	216.63	125.50	19.6	4.6	24.678
Gm. 35 x Gm 6052	64.1	225.13	129.38	18.6	4.6	28.123
Gm. 36 x Gm 6052	61.0	213.50	103.50	19.0	4.3	21.347

Table 6. Cont.

Crosses		Days to 50% Silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	Grain yield (ard./fed)
Gm. 2 x SC. 162		62.1	240.00	132.50	20.1	4.6	28.708
Gm. 6 x SC.162		62.9	238.88	124.13	21.3	4.7	24.209
Gm. 7 x SC.162		62.6	205.75	108.25	18.5	4.4	22.456
Gm. 9 x SC.162		62.8	234.38	128.50	19.8	4.7	29.749
Gm. 24 x SC.162		63.0	234.88	130.25	19.6	4.6	25.703
Gm. 25 x SC.162		62.9	230.86	132.63	18.5	4.5	26.350
Gm. 26 x SC.162		63.4	222.38	120.75	20.5	4.6	23.449
Gm. 30 x SC.162		62.1	216.75	113.75	19.1	4.5	26.824
Gm. 31 x SC.162		67.6	220.50	117.00	18.5	4.4	14.532
Gm. 35 x SC.162		64.4	206.38	109.13	18.7	4.3	23.164
Gm. 36 x SC.162		64.4	222.88	118.75	19.7	4.5	20.859
Checks	SC. 168	65.1	218.13	122.00	18.9	4.5	27.190
	SC. 3084	65.8	238.63	129.38	19.2	4.7	24.288
	TWC. 360	65.1	226.25	122.63	21.3	4.6	26.427
	TWC. 368	65.8	243.63	134.13	18.6	4.9	26.359
LSD. 0.05		1.2	9.85	8.08	1.2	0.3	2.661

For plant and ear height five crosses *i.e.* Gm7 × Gz 658, Gm 30 × Gz 658, Gm 35 × Gz 658, Gm 36 × Gz 658 and Gm 24 × Gm 6052 were shorter than the best check SC 168, while two three- way crosses *i.e.* Gm 7 × SC 162 and Gm 35 × SC 162 were shorter than the best check TWC 360. For ear length the four single crosses Gm 6 × Gz 658, Gm 26 × Gz 658, Gm 31 × Gz 658 and Gm 24 × Gm 6052 were longer than the best check SC 3084. For ear diameter, one single cross Gm 9 × Gm 6052 increased significantly than the best check SC 3084. For grain yield, the five single crosses Gm. 6 x Gz 658 (28.956 ard/fed), Gm. 35 × Gz 658 (27.777 ard /fed), Gm. 2 x Gm. 6052 (27.566 ard /fed), Gm. 6 x Gm. 6052 (28.157 ard /fed) and Gm. 35 x

Gm. 6052 (28.123ard /fed) were not significantly different from the highest check SC 168 (27.190 ard/fed). While, three-way cross Gm. 9 × SC 162 (29.749 ard/fed) had surpassed significantly the best check TWC 360 (26.427ard / fed). Meanwhile, two three-way crosses Gm 2 × SC 162 and Gm 30 × SC 162 did not significantly differ from TWC 360.

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إستخدام تحليل السلالة فى الكشاف لتقدير القدرة على التالف لبعض السلالات الجديدة للذرة الشامية الصفراء

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تم تنفيذ هذه التجربة في محطة البحوث الزراعية بالجميزة خلال الموسم الزراعي ٢٠١٨م . تم عمل التهجين لعدد ١١ سلالة صفراء جديدة مع عدد ٣ كشاف هم :(السلالة جيزة ٦٥٨ والسلالة جميزة ٦٠٥٢ والهجين الفردي ١٦٢). في الموسم الزراعي ٢٠١٩م تم تقيم الـ٣٣ هجين الناتجة بالإضافة الي أربع هجن للمقارنة هم: (هـ. ف ١٦٨، هـ. ف ٣٠٨٤)، (هـ.ث ٣٦٠، هـ.ث ٣٦٨) فى كلا من محطة البحوث الزراعية بالجميزة (غربية) وسدس (بنى سويف). أشارت نتائج تحليل التباين المشترك أن تباين الهجن مجزئاتها السلالة والكشاف والتفاعل بين السلالة والكشاف كان معنوياً وعالى المعنوية لكل الصفات محل الدراسة ما عدا محصول الحبوب فى الكشافات. تبين أن تأثيرات الفعل الوراثى غير المضيف أكثر أهمية من تأثيرات الفعل الوراثى المضيف فى وراثة كل الصفات ما عدا صفة قطر الكوز. أظهرت السلالات (جميزة ٢، ٦، ٩، ٣٥) قدرة عالية على التآلف لصفة محصول الحبوب كذلك أظهر الهجين (جميزة ٩ × هـ. ف ١٦٢) أعلى قدرة خاصة على الائتلاف. أظهرت خمسة هجن فردية وهم: (جميزة ٢ × جميزة ٦٠٥٢)، (جميزة ٦ × جيزة ٦٥٨)، (جميزة ٣٥ × جيزة ٦٥٨)، (جميزة ٦ × جميزة ٦٠٥٢)، (جميزة ٣٥ × جميزة ٦٠٥٢) زيادة غير معنوية فى المحصول مقارنة بالهجين التجارى هـ.ف ١٦٨. بينما أظهر الهجين الثلاثي (جميزة ٩ × هـ.ف ١٦٢) زيادة معنوية عن الهجين التجارى هـ.ث ٣٦٠.

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