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Evaluation of F1s' , F2s' Hybrids , Heterosis , and Inbreeding Depression of Maize (*Zea mays* L.)

ABSTRACT

Six hybrids maize (*Zea mays* L.) line:(1) ZM4L,(2) ZM51L,(3) ZP-301,(4) ZM19L, (5) OH, and(6) Un440 were used in crossing program for obtaining first-generation hybrids during the spring 2016 season. Selfing F1s' of the previous hybrids on autumn season of the same year led to obtained the second-generation hybrids. The inbred lines Two generations hybrids were planted on 2017 spring season. The experiment was carried out by using Randomized Complete Block Design (RCBD), with three replicates. The goal of the experiment was to find out the performance of genotypes and estimation of heterosis based on the best parent, of the commercial hybrid (CADZ). of first-generation hybrids and inbreeding depression of the second-generation on the days to female flowering. Other characteristics including; plant height, leaf area, number of rows per ear , number of kernel in each row, weight of 300 grains, and yield of individual plant . The results of the statistical analysis revealed significant differences of all the studied characteristics of each parents, the first-generation, and second-generation except for the number of days of male flowering. Hybrid; Un440 x ZM4L showed a significant and desirable heterosis for the plant height, leaf area, and number of kernel in the rows compared to the best parents and commercial variety. The hybrids; ZM19L x ZM51L and Un440 x ZM51L, showed it did not happen to them inbreeding depression because of the negative and significant correlation with the desired the number of kernels in the row. While, the hybrid; OH x ZM4L , for the number of rows per ear and the hybrid; OH x ZM19L , for the weight of 300 grains.

INTRODUCTION

Maize (*Zea mays* L.) is an important grain crop in many world countries and it is the first crop in the world production. In Iraq. Corn followed wheat and rice crops in terms of importance. It occupies secondary importance (after wheat), in terms of cultivated area. It is widely used as cereals and other forms of food for human as bread and oil, and for feeding of farm animals, in addition to multiple industrial products. The New great important and economic utilization in production of biofuel industry. It could be a high-output hybrid heterosis especially for genetically non-related parents and vice versa. This potential encouraged the plant breeders to study the possibility and applied outcome results for improving the quantitative and qualitative characteristics, and Increasing production efficiency and produce excellent hybrid (Baktash and Abdul Hamid, 2015). Heterosis was studied based on a comparison with the best hybrid or expect best parent of maize (Hiremath et al., 2013), Khoury et al (2015), Wuhiab and Hadi (2016), Al-Jibouri (2016). While, inbreeding depression percentage varies according to the genetic rule; as the communities of a broad genetic base tend to

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exhibit high inbreeding depression and vice versa, (Pacheco et al., 2002). The internal breeding reduced the values of quantitative characteristics due to continuous self-inoculation cause the inbreeding depression, (Edward, and Lamkey, 2002, Arnhold et al., 2007). This is reached by Some researchers in their study of them Ahmad et al., (2010), Jain and Bharadwaj (2014), and Botelho et al., (2016) .

The study aim was to evaluate first and second generation's inbred line of hybrids. Estimate the heterosis of the first-generation compared to the best parent and commercial hybrid, and second-generation inbreeding depression to F1 generations why to the best parent. to approach the best hybrid, which can be adopted in the future after planting in more than one season and a location to test its stability extent and consider the quality characteristics.

MATERIALS AND METHODS

Six inbred lines were used: (1) ZM4L, (2) ZM51L,(3) ZP-301,(4) ZM19L,(5) OH, and (6) Un440, and the originator of the third and sixth lines Yugoslavia and the rest of the American breeds, their source was University of Tikrit, College of Agriculture. The half- diallel crosses breeding was carried out on spring of 2016, (fixed based on second Garfing's method) (Griffing b 1956) . The first-generation hybrids were planted to produce second-generation hybrids and at the same time, re-hybridization between the lines to produce the first-generation hybrids to substitute of the shortage occurred. In addition to that the self-pollination of the lines and the first-generation hybrids for increasing their seeds in the Autumn season of the same year. On Spring of 2017, The parents of lines, and hybrids of the first and second generations, and variety CADZ, were planted to compare in the farm at Zallaih region, located south of Tikrit Salahieldin Governorate . The experiment was carried out based on Randomized Complete Block Design, (RCBD) . The soil was ploughed, leveled and the lines for planting were formed. genotype two row's were grown for each the length of the row was 3 m, the distance between the row's was 0.75 m, the distance between the plants was 0.25 m. The super phosphate fertilizer was added on the rate of 200 Kg/ha. Nitrogen (Urea, 46% nitrogen) fertilizer was added at a rate of (200 kg / ha) two addation: the first time at the plowing time and the second was addition after one month, (Sibahy, 2011). The corn stalk borer insect (*Sesamia critica*) was treated with a 10% concentration of granular Diazinon . The following characteristics were studied: number of days until male and female flowering, plant height, leaf area, number of rows of per ear , number of kernel in each row, weight of 300 grains, and yield of individual plant. The statistical analysis of the studied traits was carried out by using RCBD design, and the genotypes of the studied traits were compared with the Duncan's Multi-Range Test at the 5% probability level (Al-Zubaidy and Al-Falahy, 2016).

The heterosis was estimated based on comparison of the best parents in the following equation $H\% = \frac{\bar{F}1 - B_P}{B_P} \times 100$

$\bar{F}1$ = average first generation. $\overline{H}P$ = average best parents

The t value of the heterosis values calculated for its significance t-test by

$$t(H) = \frac{H-O}{\sqrt{V(H)}} = \frac{H-O}{\sqrt{2\hat{E}_1}}$$

Heterosis variation V (H) was estimated as follows $V(H) = \sqrt{2\hat{E}_1}$, $\hat{E}_1 = \frac{MSe}{r}$

The heterosis was estimated based on the deviation of the first generation F1's relative to the CADZ comparison by $H\% = \frac{\bar{F}1 - \bar{V}_P}{\bar{V}_P} \times 100$

The t value of the heterosis values for each hybrid was calculated to test its significance

$$t(H) = \frac{H-0}{\sqrt{V(H)}} = \frac{H-0}{\sqrt{2\hat{E}_1}}$$

Heterosis variation V (H) was estimated as follows $V(H) = \sqrt{2\hat{E}_1}$, $\hat{E}_1 = \frac{MSe}{r}$

The inbreeding depression was also estimated as a percentage according to the following equation:

$\%ID = (\overline{F_1} - \overline{F_2})/\overline{F_1} * 100$

As:

ID= inbreeding dispersion.

$\bar{F}1$ = average first-generation hybrid.

$\bar{F}2$ = average second-generation hybrid.

The degree of inbreeding depression was calculated by comparing the following:

$$T = T_{tab} * \sqrt{(V\,F_2 + V\,F_1)\ /\ 2}$$

All the equations that were mentioned according to Al-Zubaidy and Al-Jiboury (2016).

RESULTS AND DISCUSSION

Appendix (1) , shows that the results of the analysis of variance for parents, the first and second generations, and commercial of studied characteristics were high significant differences for all studied characteristics except male and female flowering. The first and commercial generation hybrids resulted in significant differences at 1% probability level for plant height, leaf area, number rows of per ear, and plant kernel yield and significant number of day to male and number kernel of row and weight 300 grain. While it was not significant for the number of days to female flowering. The second-generation hybrid was significantly varied at the 1% probability level for all studied characteristics and significant at a 5% probability level for the number of days to female flowering, except the number of days to 50% of male flowering. This is due to different types of gene action and genetic differences between parents in the study. This reflected on the hybrids that require study of its genetic behavior and knowing the types of gene action that control these characteristics. Corresponding with by Rather et al., (2009), Wanos et al., (2011), Al-Jumaily and Al-Zubaidy (2014), and Al-Tikrity and Al-Karkhy, (2016).

1- Number of days to male flowering:

The flowering system, the subsequent period of light, the growth, maturity of the plant, and adaptation for a particular environment of a certain genotype are controlled by the light period and temperature. When the temperature reaches the optimal degree, the activity of increasing light-period genes. Since all genes are involved in this activity, an environmental genetic interference occurs, which is reflected in different genotypes, due to the large number of dominant gene pairs (Al-Sahouky, 2004). Table (1), shows the parents means, the first and second generations, the heterosis and the inbreeding depression of the number of days to male flowering. The parent (6), the earliest in flowering between parents with an average of 61.00 days. The first generation hybrid (ZM19LxZM4L) and the second-generation hybrids (ZP-301xZM4L) and (Un440xZM4L) earliest hybrids in flowering with average of 62.00 and 61.00 days respectively. This is due to the fact that parents (1) and (4) belonging to two genetically separated groups. For the heterosis, we noticed that the hybrid (ZM19LxZM4L) gave the highest negative heterosis and desirable rate of 4.61%, compared to the best parents and commercial hybrid, but without significant difference. The inbreeding depression coefficient was significant for the hybrid (ZM19LxZM51L) but not desirable and the two crosses (OHxZM4L) and (Un440xZM4L) significant but in the unwanted direction. This is due to the role of the dominant gene action that has reduced in each generation of selfing. This was accompanied by the loss of viability of the second generation. Corresponding with Abdul Jabbar and Taha (2014), and Al-Abdul Hady et al., (2014).

Table (1): Arithmetic means for parents, first and second generations, heterosis, and inbreeding depression for number of days to male flowering.

parents	Means	Hybrids	Means		Heterosis compare with the best parents	Heterosis compare with commercial hybrid	Inbreeding depression coefficient
			First generation	Second generation			
1	66.33 ab	1x2	67.33 abc	67.00 ab	1.50	3.59	0.49
		1x3	63.00 bc	61.00 b	3.57 -	3.07 -	3.17
		1x4	62.00 b	62.66 b	4.61 -	4.61 -	1.07-
		1x5	67.33 abc	63.33 b	2.02	3.59	5.94 *
		1x6	65.00 bc	61.00 b	6.55	0.00	6.15 *
2	69.33 a	2x3	62.66 c	63.33 b	4.08 -	3.59 -	1.06-
		2x4	68.66 ab	61.66 b	4.04	5.64	10.19 **
		2x5	64.33 bc	64.33b	2.52 -	1.02 -	0.00
		2x6	63.33 bc	63.66 b	3.82	2.56 -	0.52-
3	65.33 ab	3x4	63.00 bc	63.33 b	3.07 -	3.07 -	0.52-
		3x5	62.66 c	65.66 ab	4.08 -	3.59 -	4.78-
		3x6	65.66 abc	66.00 ab	7.65	1.02	0.50-
4	65.00 ab	4x5	65.66 abc	65.66 ab	1.02-	1.02	0.00
5	66.00 ab	4x6	66.00 abc	65.00 ab	8.19	1.53	1.51
6	61.00 b	5x6	70.66 a	71.33 a	15.84 **	8.71 *	0.95-
General mean	65.50	Commercial Hybrid	65.00bc				
		General mean	65.16	64.33			

2- Number of days to female flowering:

Parent, (6) was earlier female flowering with a lower mean of 66.33 days and a significantly differ from parent (2), which was the latest parent and reached 73.66 days. The first generation hybrids (ZM19LxZM4L and ZP-301xZM51L), were the earliest and significantly differ from the (ZM19LxZM51L) and (Un440xOH) hybrids. The second generation, hybrid (ZP-301xZM4L), was the lowest parent with a mean of 65.33 days, with a significant difference from the two hybrids, (ZM51LxZM4L) and (Un44oxOH). The heterosis hybrids (ZM19LxZM4L) and (ZP-301xZM51L) gave the highest negative heterosis of -4.26% for both of them compared with the best parents, which was -5.16% for both compared with commercial hybrid. This could be because of the super-dominance genes on characteristics. While the coefficient of genetic inbreeding depression; hybrid (OHxZP-301), gave the highest negative value, and it was not insignificant -2.42%. The rest of the hybrids did not reach the limits of the significant, Table (2). This results is along with Ibrahem and

Houmady, (2010), Al-Delemy and Al-Diraggy, (2011), with Al-Hamadany and Al-Naiemy (2013) and Abdul-Jabbar and Taha (2014).

Table (2): Arithmetic means for parents, first and second generations, Heterosis, and inbreeding depression for number of days to female flowering

parents	Means	Hybrids	Means		Heterosis compare with the best parents	Heterosis compare with commercial hybrid	Inbreeding depression coefficient
			First generation	Second generation			
1	71.66 ab	1x2	73.33 abc	72.00 ab	2.32	3.28	1.81
		1x3	68.00 c	65.33 c	3.31 -	4.25 -	3.92
		1x4	67.33 c	68.33 bc	4.26 -	5.16 -	1.48-
		1x5	73.33 abc	68.33 bc	3.28	3.28	6.81 **
		1x6	69.33 bc	66.33 bc	4.52	2.34 -	4.32
2	73.66 a	2x3	67.33 c	68.66 bc	4.26 -	5.16 -	1.98-
		2x4	74.66 ab	66.66 bc	6.16	5.16	10.71 **
		2x5	69.33 Bc	69.33 bc	2.34 -	2.34 -	0.00
		2x6	68.66 bc	68.00 bc	3.51	3.28 -	0.97
3	70.33 ab	3x4	68.33 bc	68.00 bc	2.84 -	3.75 -	0.48
		3x5	68.66 bc	70.33 bc	2.37 -	3.28 -	2.42-
		3x6	70.33 abc	70.33 bc	6.03	0.93 -	0.00
4	70.33 ab	4x5	70.66 abc	70.66 bc	0.47	0.46-	0.00
5	71.00 ab	4x6	71.33 abc	69.66 bc	7.53	0.46	2.33
6	66.33 b	5x6	76.33 a	76.33 a	15.07 **	7.51 *	0.00
General Means	70.55	Commercial Hybrid	71.00 abc				
		General Means	70.47	69.22 69.22			

3- Plant height (cm):

This characteristic is important one, that relationships to the yield, and plant breeders were concerned about the plant height through selection programs and breeding and the balance between the two trait where the highest yield is obtained with the lowest level height of the per ear, (Hee Chung et al., 2006). The parent (1) got the highest plant height, parent (1) which reached 186.60 cm with a significant difference from the other of the parents . The hybrid (Un440xZM4l) achieved the highest height of 214.60 cm and 210.40 cm for both the first and second generations and significantly different from the rest of the hybrids, including the commercial hybrid except for the hybrid (Un440xZM51L) in the first generation. This could be due to a desirable correlation between these characteristic and male and female flowering as they appeared in Appendix 2. This agrees with Al-

Qaisy (2016), and Al-Jaboury (2016). The heterosis; most of the hybrids obtained a strong heterosis. Hybrid (Un440xZM51L), gave the highest heterosis (28.14%). While, the hybrids of (OHxZM4L), (Un440xZM4L), and (Un440xZM5L) obtained a positive and high-strength heterosis compared to the commercial hybrid. The rest of the other hybrids were negative and significantly different. The inbreeding depression, hybrids (OHxZM4L), (Un440xZP-301), and (OHxZM19L), obtained positive and significant values at the level of probability at 1%. The hybrids (Un440xZM51L) and (OHxZP-301), obtained both positive and significant values at a 5% probability of inbreeding depression, as a result of selfing as shown in Table (3). This shows the control of the genetic dominance that is lacking in each generation, while the rest of the hybrids did not reach the significant limit.

Table (3): Arithmetic means for parents, first and second genera, heterosis, and inbreeding depression for plant height.

parents	Mean	Hybrids	Means		Heterosis compare with the best parents	Heterosis compare with commercial hybrid	Inbreeding depression coefficient
			First generation	Second generation			
1	186.60 a	1x2	182.86 e	184.33 b	2.00 -	4.90 - **	0.80-
		1x3	185.33 de	182.26 bc	0.67 -	3.62 - *	1.65
		1x4	182.60 e	165.60 ef	2.14 -	5.04 - **	9.31
		1x5	205.66 b	159.00 fg	10.21 **	6.95 **	22.69 **
		1x6	214.60 a	210.40 a	15.00 **	11.59 **	1.95
2	163.53 b	2x3	167.53 g	161.80 f	2.44	12.87 – **	3.42
		2x4	175.26 F	170.80 de	6.95 **	8.85 – **	2.54
		2x5	182.20 e	173.53 d	11.41 **	5.25 – **	4.75
		2x6	209.56 ab	185.66 b	28.14 **	8.97 **	11.40 *
3	155.80 c	3x4	175.20 f	176.53 cd	6.91 **	8.89 – **	0.76-
		3x5	195.40 c	174.80 d	25.36 **	1.61	10.54 *
		3x6	190.00 cd	152.73 g	21.95 **	1.19 -	19.61 **
4	163.86b	4x5	192.80 c	162.13 f	17.65 **	0.26	15.90 **
5	155.86c	4x6	175.60 f	164.06 ef	7.16 **	8.68- **	6.56
6	147.53d	5x6	180.20 ef	163.76 ef	15.61 **	6.292- **	9.11
General Mean	162.20	Commercial Hybrid	192.30 c				
		General Mean	187.66	172.50			

4- Leaf area:

The carbohydrate is accumulated in the leaf by photosynthesis. When the leaf area reaches the optimal limits the yield of any crop increased because there is a correlation between the yield and leaf area as the photosynthesis process efficiency increased. When the leaf area increased beyond the optimal limit , the photosynthesis is reduced because of shedding . This would lead to reduce the yield (Al-Alousy and Al-Sahouky, 2006). Table (4), shows that parents (1) and (2) obtained the largest leaf area (536.36 and 543.28 cm^2), sequentially and significantly different from the other of the parents. From Table (3), it is noticed that the same parent (1) exceeded the plant height and leaf area . This could be due to the existence of a desirable correlation between these two characteristics as shown in Appendix (2).

Table (4): Arithmetic means for parents, first and second genera, heterosis, and inbreeding depression for Area leaf.

parents	Means	Hybrids	Mean		Heterosis compare with the best parents	Heterosis compare with commercial hybrid	Inbreeding depression coefficient
			First generation	Second generation			
1	536.36 a	1x2	619.33 fg	680.63 bc	13.99 **	3.65 -	9.89-
		1x3	759.61 bc	665.06 cd	41.62 **	18.17 **	12.44 *
		1x4	668.89 e	646.52 d	24.70 **	4.05	3.34
		1x5	669.15 e	542.30 g	24.75 **	4.09	18.95 **
		1x6	771.21 b	626.29 e	43.78 **	19.97 **	18.79 **
2	543.28 a	2x3	821.27 a	662.88 cd	51.16 **	27.76 **	19.28 **
		2x4	605.01 g	594.34 f	11.36 **	5.87 - *	1.76
		2x5	651.56 ef	579.00 f	19.92 **	1.36	11.13 *
		2x6	625.02 fg	672.03 bc	15.04 **	2.76 -	7.52-
3	463.42 d	3x4	620.08 fg	720.69 a	28.43 **	3.53 -	16.22 *
		3x5	724.14 cd	687.05 b	42.10 **	12.65 **	5.12
		3x6	747.57 bcd	549.73 g	61.31 **	16.30 **	26.46 **
4	482.80c	4x5	564.74h	546.24g	10.82**	12.14-**	3.27
5	509.60b	4x6	553.36h	586.95f	14.61**	13.91-**	6.07-
6	451.85e	5x6	714.59d	648.37d	40.22**	11.16**	9.26
General Mean	497.88	Commercial Hybrid	642.80efg				
		General Mean	674.37	627.21			

The first generation hybrid (ZP-301xZM51L) achieved the largest area of 821.27 cm^2 and significantly different from all other hybrids. While the hybrid (ZM19LxZP-301) obtained the largest area in the second generation (720.69 cm^2), and significantly different from the other of the other hybrids and commercial hybrid. The heterosis of hybrid (Un440xZP-301), gave the highest heterosis based on comparison with the best parent and reached 61.31%, while the hybrid (ZP-301xZM51L) gave the highest positive heterosis and a high significant of 27.76% based on comparison with commercial hybrid. This is due to the control of the dominant genetic action in the behavior of this characteristic. This results are agre with Hussain and Ali (2011), and Muzal et al., (2013). The inbreeding depression of hybrids (OHxZM4L), (Un440xZM4L), (ZP-301xZM51L), and hybrids (ZP-301xZM4L), (OHxZM51L), and (ZM19LxZP-301), were also significant at 1% and 5%, respectively while the rest of the other hybrids was positive and negative but not significant. This shows inbreeding depression from generation to generation, and that the super genes are to govern in this characteristic.

5- Number row of per ear:

Parent (2), obtained the highest number row of per ear (16.06 row), and it differed significantly from the rest of the parents except parent (5).

Table (5): Arithmetic means for parents, first and second genera, heterosis, and inbreeding depression for Number row of per ear.

parents	Mean	Hybrids	Mean		Heterosis compare with the best parents	Heterosis compare with commercial hybrid	Inbreeding depression coefficient
			First generation	Second generation			
1	12.80 d	1x2	17.20 cd	17.00 abc	7.05 **	20.61 **	1.16
		1x3	18.13 ab	17.16 ab	31.40 **	27.16 **	5.33
		1x4	17.63 bc	16.60 bcd	18.87 **	23.65 **	5.86
		1x5	16.66 de	15.33 e	8.69 **	16.87 **	8.00 *
		1x6	15.50 g	16.23 d	21.09 **	8.69 **	4.73-
2	16.06 a	2x3	18.53 a	16.46 cd	15.35 **	29.96 **	11.15 **
		2x4	14.73 h	16.46 cd	8.29- **	3.31	11.76- **
		2x5	17.466 c	15.333 e	8.71 **	22.48 **	12.21 **
		2x6	16.16 ef	17.46 a	0.62	13.37 **	8.04- *
3	13.80 c	3x4	16.20 ef	16.40 cd	9.21 **	13.60 **	1.23-
		3x5	18.23 ab	14.33 f	18.91 **	27.86 **	21.38 **
		3x6	16.66 de	16.10 d	20.77 **	16.87 **	3.40
4	14.83 b	4x5	15.60 fg	14.43 f	1.73	9.39 **	7.47
5	15.33 ab	4x6	16.20 ef	16.33 cd	9.21 **	13.60 **	0.82-
6	12.13 d	5x6	17.20 cd	14.00 f	12.17 **	20.61 **	18.60 **
General Mean	14.16	Commercial Hybrid	14.26h				
		General Mean	16.81	15.98			

The first generation hybrid (ZP-301xZM51L) achieved the highest number of per row (18.53 kernels), with a significant difference for all hybrid except for hybrids (ZP-301xZM4L) and (OHxZP-301). The commercial hybrid has the lowest number of rows,(14.26 rows), compared to the general mean of the first generation hybrids.

The second generation and the hybrid (Un440xZM51L) produced of 17.46 rows, ear differed from all hybrids except for hybrids (ZM51L x ZM4L) and (ZP-301xZM4L). The number of rows in the per ear is one of the yield components as the increase in the rows number and increases the yield in addition to the presence of the correlation case with the yield as appeared in appendix (2). Most of the hybrids showed positive and significant heterosis at a level of 1% probability, except for hybrid (ZM19Lx ZM51L), which was negative and significant at 1%. The hybrids (Un440x2M51L) and (OHxZM19L) were not significant compared to the best parents. All hybrids showed positive and high heterosis except hybrid (ZM19LxZM51L), which did not differ significantly, compared with commercial hybrid. The highest one was hybrid (ZP-301xZM51L) with 29.96%. This is similar to the findings of Abdel Moneam et al., (2009), and the Al-Bank (2009). In the terms of inbreeding depression; hybrids (ZM19LxZM51L) and (Un440xZM51L), gave negative and significant values at the level of 1%. While, the first and second hybrids differed at 5%. This shows that these hybrids did not show inbreeding depression and that, may be due to the importance of the additional genetic action, which controls this characteristic, and as shown in Table 5.

6- Number of kernel per row:

Table (6) shows that parent (3) obtained the highest number kernels per rows (35.23 kernels), with a significant difference from all parents except parent (6). The first generation hybrids (ZM51LxZM4L) and (Un440xZP-301) , were distinguished from most of the hybrids with the highest mean, (43.4 and 43.23 respectively). They differed significantly from the rest of the other hybrids (ZM19LxZM4L), (OHxZM51L), and (OHxZP-301), and they did not overcome commercial hybrid, which got the most ranks of 47.13 kernel. In the second generation, hybrids (OHxZM4L) and (ZP-301xZM51L), showed a significant superiority over all other hybrids with an average of 42.26 and 41.16 kernels respectively. The heterosis was highly significant for all hybrids; hybrid (ZM19LxZM4L) gained the highest heterosis of 34.41% based on comparison with the best parents. All hybrids were negative and highly significant based on comparison with commercial hybrid. This is due to the dominance of genetic action, especially in inherited behavior of super dominant because of the superiority of the hybrid to the best parents. This is corresponding with Al- Zuhairy and Al-Zubaidy (2012), and Masoud et al., (2014). While, hybrid (OHxZM4L) was negative and significant at the 5% probability level. Hybrid (OHxZM4L) was desirable and showed no inbreeding depression due to the lower number of identical genes and the mixed genes locations increase. Hybrids (ZP301xZM4L), (Un440xZM4L), (Un440xZM51L), (OHxZP-301), (OHxZM19L) and (ZM51LxZM4L) were undesirable as they showed inbreeding depression due to the increase of genetically identical genes and the other hybrid did not had a statistical significance.

Table (6): Arithmetic means for parents, first and second genera, heterosis, and inbreeding depression for Number of kernel per row.

parents	Mean	Hybrids	Mean: First generation	Mean: Second generation	Heterosis compare with the best parents	Heterosis compare with commercial hybrid	Inbreeding depression coefficient
1	27.26 d	1x2	43.40 b	38.33 c	29.94 **	7.91- **	11.67 *
		1x3	39.43 def	33.43 de	11.92 **	16.33- **	15.21 **
		1x4	41.40 bcd	40.53 ab	34.41 **	12.15- **	2.09
		1x5	37.73 fg	42.26 a	22.24 **	19.93- **	12.01- *
		1x6	39.60 def	33.53 de	16.92 **	15.97- **	15.32 **
2	33.40 b	2x3	39.06 ef	41.1667 a	10.88 **	17.10- **	5.37-
		2x4	40.60 cde	37.33 c	21.55 **	13.85- **	8.04
		2x5	41.466 bcd	38.400 c	24.15 **	12.01- **	7.39
		2x6	40.73 cde	32.13 e	20.27 **	13.57- **	21.11 **
3	35.23 a	3x4	40.46 cde	37.93 c	14.85 **	14.13- **	6.26
		3x5	42.46 bc	34.46 d	20.53 **	9.89- **	18.83 **
		3x6	43.20 b	38.93 bc	27.55 **	8.33- **	9.87
4	30.80c	4x5	40.23de	35.30d	30.34**	14.63-**	12.26**
5	30.86c	4x6	36.20g	38.33c	6.89**	23.19-**	5.89-
6	33.86ab	5x6	38.66ef	38.00c	14.17**	17.95-**	1.72
General Mean	31.90	Commercial Hybrid	47.13a				
		General Mean	40.31	37.34			

7- Weight of 300 grains:

In table (7), parent (1), dominated and the highest weight of 300 grains (52.40 gm.). F1's (ZP-301xZM51L) achieved highest weight (77.93 gm.) it differed significantly from hybrid (OHxZM19L). The commercial hybrid got the highest weight (77.33 gm.), compared to the general average of the first and second generation. The hybrid (ZM19LxZM4L) achieved the highest weight of 70.36 gm. and a significant difference for all hybrid except hybrids (ZM51LxZM4L), (OHxZM51L), (Un440xZM51L) and (OHxZP-301) of the second generation. The domination of these two hybrids (ZM19LxZM4L) and (ZP301xZM51L), as well as the domination of the hybrid (ZP-301xZM51L) in leaf area characteristic, which was significantly correlated with this characteristic (Appendix 2). Most hybrids showed desirable heterosis (OHxZM19L) and the hybrids (OHxZM4L), (Un440xZM4L) and (Un440xZP-301) but other crosses were not shown significant. The hybrid (OHxZM19L) gave the highest negative heterosis and high significant of -45.98% compared to the commercial hybrid. These results are in agreement with Amiruzzaman et al., (2011) and Amanullah et al., (2011). Hybrid (OHxZM19L) showed a negative desirable and high significant value, this increases the weight of the grain thus increasing the yield causing no inbreeding depression, while hybrids (ZP-301xZM51L), (ZM19LxZP-301), and (Un440xOH) showed inbreeding depression that causing a decrease in grain weight.

Table (7): Arithmetic mean for parents, first and second genera, heterosis, and inbreeding depression for weight of 300 grains.

parents	Mean	Hybrids	Mean		Heterosis compare with the best parents	Heterosis compare with commercial hybrid	Inbreeding depression coefficient
			First generation	Second generation			
1	52.40 a	1x2	68.10 a	65.93 abc	29.96 *	11.93-	3.18
		1x3	73.70 a	65.76 bc	40.64 **	4.69-	10.76
		1x4	76.66 a	70.36 a	46.31 **	0.85-	8.21
		1x5	64.06 a	63.80 bc	22.26	17.15-	0.41
		1x6	63.46 a	55.96 fg	21.12	17.92- *	11.81
2	36.36 c	2x3	77.93 a	58.733 ef	49.29 **	0.78	24.63 **
		2x4	73.66 a	65.10 bc	71.45 **	4.73-	11.62
		2x5	65.433 a	66.733 abc	27.96 **	15.38-	1.98-
		2x6	72.50 a	66.53 abc	99.35 **	6.24-	8.23
3	52.20 a	3x4	74.46 a	53.83 g	42.65 **	3.70-	27.70 **
		3x5	75.30 a	67.66 ab	44.25 **	2.62-	10.13
		3x6	65.40 a	62.23 cde	25.28	15.42-	4.84
4	42.96 b	4x5	41.76 b	55.26 fg	18.31- **	45.98- **	32.32- **
5	51.13 a	4x6	62.66 a	59.23 def	45.84 **	18.96- *	5.47
6	30.96 d	5x6	77.06 a	63.40 bcd	50.71 **	0.34-	17.73 *
General Mean	44.33	Commercial Hybrid	77.33a				
		General Mean	68.81	62.70			

8- Grain yield / plant:

Table (8) shows that parents (3) and (5), dominated that gave 79.39 gm. and 75.22 gm. respectively than other parent. Hybrid (OHxZP-301) dominated and gave 192.3 gm. in the first generation and significantly different from all studied hybrids, but did not dominated the commercial hybrid. The commercial hybrid gave the highest yield of 193.86 gm. F2's, we can noticed hybrid (ZM19LxZM4L) domination with a significant difference than other parents, and produced highest yield (147.00) gm. This result could be attributed to a desirable correlation between this characteristic and the others (Appendix 2). All hybrids reflected a high significant heterosis compared to the best parents, On the other hand, when compared with commercial hybrid, all hybrids showed a negative heterosis and high significant except the hybrid (OHxZP--301), which did not differ significantly. These findings are in agreement with Bank (2009), and Hussain and Ali (2011). The hybrid (OHxZM4L) gave a negative and non-significant value. While all other hybrids showed undesirable values of inbreeding depression, which led to a yield decrease in second generation due to selfing .

Table (8): Arithmetic mean for parents, first and second generation, heterosis, and inbreeding depression for grain yield / plant.

parents	Mean	Hybrids	Mean		Heterosis compare with the best parents	Heterosis compare with commercial hybrid	Inbreeding depression coefficient
			First generation	Second generation			
1	65.86 c	1x2	157.45 d	134.84 b	123.70 **	18.78- **	14.36 *
		1x3	170.40 c	131.56 bc	114.63 **	12.10- **	22.79 **
		1x4	180.88 b	147.00 a	174.62 **	6.69- **	18.73 **
		1x5	121.80 h	133.05 bc	61.92 **	37.16- **	9.23-
		1x6	123.19 h	107.44 f	87.02 **	36.45- **	12.78
2	70.38 b	2x3	180.82 b	127.43 cd	127.77 **	6.72- **	29.52 **
		2x4	148.03 g	125.26 d	110.32 **	23.63- **	15.37 *
		2x5	151.077 efg	123.44 d	100.84 **	22.06- **	18.28 **
		2x6	148.96 fg	123.73 d	111.64 **	23.15- **	16.93 **
3	79.39 a	3x4	155.86 de	117.20 e	33.96 **	19.59- **	24.80 **
		3x5	192.30 a	106.51 f	142.22 **	0.80- n.s	44.61 **
		3x6	154.23 def	125.57 d	94.27 **	20.44- **	18.58 **
4	63.70 c	4x5	126.37 h	93.06 g	68.00 **	34.81- **	26.36 **
5	75.22 a	4x6	124.88 h	116.35 e	96.04 **	35.58- **	6.83
6	50.90 d	5x6	170.75 c	121.51 de	127.00 **	11.92- **	28.83 **
General Mean	67.57	Commercial Hybrid	193.86 a				
		General Mean	153.80	122.27			

From the results of this study**,** we conclude that the domination of the parent (1) in the characteristics of plant height, leaf area, the weight of 300 grains, and parent (6) in the number of days until the male and female flowering. parent (2) dominated in leaf area and the number rows of per ear, parent (3) in the number of rows of per ear and the plant grain yield. The hybrid (ZP-301xZM51L) dominated in most of characteristics in the first generation, while in the second generation, the hybrid (ZP-301xZM4L) in the days to male and female flowering. Hybrid (ZM19LxZM4L) also dominated in the weight of 300 grains and grain yield/ plant. For other hybrids; hybrids (Un440xZM51L) and (ZM19LxZM4L) led to increase heterosis in the characteristics of plant height, weight of 300 grains, number rows of per ear, and grain yield / plant respectively compared with the best parent . The hybrids (Un440xZM4L) and (ZP-301xZM51L), achieved heterosis in the characteristics of plant height, leaf area and number of rows of per ear respectively compared with commercial hybrid. Hybrids (OHxZM4L), (Un440xZM51L), and (OHxZM19L) showed no inbreeding depression in the number of rows of per ear, the number of kernels of per row, and weight of 300 grains, respectively. We noticed that hybrid (ZM19LxZM4L), dominated in giving highest heterosis and high significant number kernels of corn ear and the grain yield / plant . Therefore, it can be used in recurrent selection programs to be the beginning of a program to know its stability for more than one site and season to verify this excellence and promising genotypes.

Appendix (1): Analysis of variance of parents and hybrids of the first and second generations of eight characteristics.

S.O.V	parents			First generation and commercial hybrids			Second generation hybrids		
	Replication	Genotypes	Error	Replication	Genotypes	Error	Replication	Genotypes	Error
d.f / characters	2	5	10	2	15	30	2	14	28
number of days to male (day)	1.16	21.70	11.36	0.27	17.82 *	8.47	46.66	21.09	11.47
number of days to female (day)	3.38	17.42	9.85	0.43	21.77	10.88	50.95	20.98 *	9.71
plant height(cm)	5.64	537.65 **	15.68	52.15	528.15 **	12.43	15.48	612.99 **	17.69
Area Leafe	0.10	4327.56 **	2.25	564.86	17814.76 **	545.66	16.80	9750.41 **	113.23
Number rows of ear	0.05	6.92 **	0.21	0.04	4.58 *	0.13	0.44	3.37 **	0.12
Number kernels of per row	1.68	24.58 **	0.58	1.41	19.61 **	1.35	0.41	26.74 **	1.17
weight of 300 grain (gm)	10.01	250.31 **	4.71	31.71	252.01 *	108.26	0.12	74.76 **	5.88
plant grain yield (gm)	25.54	301.14 **	5.72	13.30	1728.92 **	10.44	9.40	515.36 **	10.46

Appendix (2): The simple correlation of parents and the first and second generations to eight characteristics.

Characteristics		grain yield / plant (gm)	number of days to male (day)	number of days to female (day)	Plant height (cm)	Area leaf	Number row of ear	Number kernels of row	weight of 300 grain (gm)
weight of 300 grain (gm)	parents	0.736**	0.318	0.383	0.468	0.226	-0.420	0.074	1
	first generation	0.732**	0.182−	0.119−	0.326−	0.451*	0.097	0.474**	1
	Second generation	0.621**	0.050	0.048	-0.076	0.092	0.037	0.115	1
Number kernels of row	parents	0.104	-0.194	-0.283	-0.817	-0.572	0.092	1	
	first generation	0.429*	-0.211	-0.178	0.061	0.088	0.149	1	
	Second generation	0.508**	0.167	0.236	-0.663**	-0.292	-0.113	1	
Number rows of ear	parents	0.572	0.764**	0.733**	-0.047	0.497	1		
	first generation	0.752**	-0.436*	-0.399*	-0.270	0.566**	1		
	Second generation	0.527**	-0.592**	-0.617**	0.359	0.314	1		
Area Leafe	parents	0.299	0.846**	0.862**	0.706*	1			
	first generation	0.476**	-0.256	-0.319	0.090	1			
	Second generation	0.153	-0.016	-0.024	0.458*	1			
plant height (cm)	parents	0.113	0.491	0.567	1				
	first generation	-0.416*	-0.048	-0.063	1				
	Second generation	-0.167	-0.396*	0.391*	1				
number of days to silk development (day)	parents	0.652*	0.994**	1					
	first generation	-0.311	0.983**	1					
	Second generation	-0.124	0.989**	1					
number of days to tessel development (day)	parents	0.654*	1						
	first generation	-0.375*	1						
	Second generation	-0.149	1						
plant grain yield (gm)	parents	1							
	first generation	1							
	Second generation	1							

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تقويم هجائن الجيل الأول والثاني وقوة الهجين والتدهور التربية الداخلية في الذرة الصفراء (*Zea mays* L.)

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المستخلص

أستخدمت ست سلالات من الذرة الصفراء هي :(ZM4L و ZM51L و ZP-301 و ZM19L و OH و Un440) في تهجين تبادلي نصفي للحصول على هجائن الجيل الأول خلال الموسم الربيعي 2016 واجري التلقيح الذاتي للهجائن السابقة للحصول على هجائن الجيل الثاني في الموسم الخريفي لنفس السنة , ومن ثم زرعت السلالات وهجائن الجيلين في الموسم الربيعي للعام 2017 بأستخدام تصميم القطاعات العشوائية الكاملة (R.C.B.D) وبثلاثة مكررات لتقويم اداء هذه التراكيب الوراثية وتقدير قوة الهجين على اساس افضل أب والصنف التجاري CADZ بالنسبة لهجائن الجيل الأول والتدهور الوراثي للجيل الثاني لصفات عدد الأيام لغاية التزهير الذكري الأنثوي وارتفاع النبات ومساحة الورقة وعدد صفوف العرنوص وعدد حبوب الصف ووزن 300 حبة وحاصل النبات الفردي . أوضحت نتائج التحليل الأحصائي وجود اختلافات معنوية لجميع الصفات المدروسة للأباء وهجائن الجيلين الأول والثاني عدا صفة عدد الأيام للتزهير الذكري فلم تصل إلى الحدود المعنوية الأحصائية في الجيل الثاني . وأن الهجين (6x1) أظهر قوة هجين معنوية ومرغوبة لصفات : ارتفاع النبات ومساحة الورقة وعدد حبوب الصف على أساس المقارنة مع أفضل الأباء والصنف التجاري , وأن الهجينين (4x2) و (6x2) لم يحدث لهما تدهوراً وراثياً نتيجة التربية الداخلية سالبة ومعنوية وبالأتجاه المرغوب لصفة عدد حبوب الصف و الهجين (5x1) لصفة عدد صفوف العرنوص والهجين (5x4) لصفة وزن 300 حبة .

الكلمات المفتاحية : الذرة الصفراء , قوة الهجين , التربية الداخلية .