Estimation of Superiority Percentage and Combining Ability of Grain Yield and Some Other Traits in Yellow Maize

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ABSTRACT

Seventeen yellow inbred lines of maize were crossed with two yellow inbred testers Gm1002 and Gm 1021 to produce 38 hybrids during summer of 2016 at Gemmeiza research station. In summer seasons of 2017 the 38 hybrids and two checks were evaluated at two locations; Gemmeiza and sids research stations. The rustles of these studies might be summarized as follows, locations mean square were highly significant for all studied traits under combined data. The additive and additive x additive gene actions played more important role in the inheritance of for plant height and ear length from combined data, while, the non- additive gene action was more important for days to 50% silking, ear height, ear diameter and grain yield at Gemmeiza, Sids and the combined analysis. The results indicated that grain yield for inbred lines (Gm 23, 45, 46 and 53) had desirable positive and significant GCA (g^i). Two crosses namely (Gm 24x Gm 1021) (36.5 ard./fed.) and (Gm 46x Gm 1021) (35.4 ard./fed.) had desirable significant superiority percentage for grain yield compared with the best check hybrid, Sc 168 (32.1 ard./ fed.).

Key words*: (Zea mays* L.*),* Top cross, combining ability, Genotype x environment, Yellow Maize.

INTRODUCTION

Maize is one of the most important cereal crops and occupies a prominent position in global agriculture after wheat and rice. Among cereals, maize is rich in starch, proteins, oil and sucrose, due to which it has assumed significant industrial importance. The main goal of maize breeding is to obtain new hybrids with high genetic potential for yield and positive features that exceed the existing commercial hybrids. The commercial production of hybrids, however, depends upon two factors viz; the behavior of the line itself and the behavior of this line in hybrid combinations. The behavior of a line in hybrid combination is assessed through the estimation of general combining ability (gca) and specific combining ability (sca) effects. Combining ability analysis is an important method to evaluate the prepotency of cultures to be used in breeding programmer and to assess the gene action involved in various characters, so as, to design an appropriate and efficient breeding method. Combining ability analysis provides this information and is frequently used by plant breeders to choose parents with a high general combining ability and hybrids with high specific combining ability effects. Numerous investigators reported that the additive gene effects played an effective role in the inheritance of grain yield (Paul and Debanth, 1999; Irshad-El-Haq *et al.*, (2010) and El-Badawy (2013) and number of rows/ear (Mosa *et al*., 2009; Mosa, 2010 and Aly *et al.,* 2011). While, Kamara (2012), Aly (2013), El-Badawy (2013) and EL-Hosary and Elgammaal (2013) showed that, the non-additive gene effects represented the major role in the inheritance of grain yield and other agronomic traits. Line X tester analysis is an extension of the top cross method in which several testers are used (Kempthorne,1957). The main objectives of this study are; (a) estimate combining ability of inbred lines for grain yield and other agronomic traits (b) identify the type of gen action that play an effective role in the inheritance of studied traits and (c) identify the superior crosses with yielding ability in the maize breeding program.

MATERIAL AND METHODS

Seventeen yellow maize inbred lines; (Gm 23, 24, 25, 26, 28, 43, 45, 46, 48, 52, 53, 54, 55, 59, 62, 63 and 64) were crossed with two yellow inbred testers Gm1002 and Gm 1021 (name and origin of lines and testers was presented in Table 1) in line x tester fashion to produce 38 hybrids during summer of 2016 at Gemmeiza research station.

Table 1: Name and origin of seventeen yellow inbred lines and two yellow inbred testers.

Lines	Origin
Gm 23,24,25,26, 28 ,43 ,45 ,46, 48,52, 53, 54 and 55	Nubaria yellow Pop.
Gm 59,62,63 and 64	(Comp.♯ 21)
Testers	**Origin**
Gm1002	Sub-tropical yellow maize pop (DMR) imported from IITA Nigeria.
Gm 1021	Sd 121 x pop. (DMR – ESR) yellow.

The 34 F_1 hybrids with two standard check hybrids i.e; SC. 162 and SC.168 were evaluated in randomized block design with four replications during summer of 2017 in two experimental farms of Gemmeiza and Sids research stations. Each entry comprised of one rows having 25 plants per row in each replication in a plot size of 4.8 m^2. The data were recorded for six quantitative characters namely, days to 50 % silking, plant height, ear height, ear length, ear diameter and grain yield (ard. / fed.). Line x Tester analysis was carried out as described by Kempthorne (1957). The superiority percentage was estimated over the two checks as per standard procedure.

RESULTS AND DISCUSSION

1-Analysis of variance:

Mean squares results for six traits (days to 50% silking, plant height, ear height, ear length, ear diameter and grain yield) at the two locations and combined data were presented in Table 2. Locations mean square was highly significant for all studied traits, indicating, different environmental conditions at the two locations. These results were in agreement with those obtained by. Ibrahim *et al*. (2007) and Darwich *et al*. (2016). Mean squares of crosses and their partitions (lines, testers and lines x testers) were highly significant for all studied traits, except, crosses and line x tester mean squares for ear length and ear diameter at the two locations and combined data. Mean squares for ear length were insignificant for only lines and testers at Sids and also were insignificant for ear diameter at both locations. That was in harmony with combined analysis. These results were in line with those obtained by Sadek *et al*. (2001), Gamea *et al*. (2015) and Aboyousef *et al*. (2016). On the other hand, highly significant differences were detected for crosses x locations interaction for plant height, ear height and grain yield indicating variable response of crosses to environment. Line x location mean squares were highly significant for plant height, ear height and grain yield indicating that line varied in magnitude of character with different locations. while, tester x location exhibited significant effect for days to 50 % silking, ear height and grain yield, meaning that, testers were affected by change from one locations to another for these traits (Mosa, 2010 and Aly *et al.,* 2011).

2- Mean performance

Data in Table (3) showed the mean performance of thirty four crosses and two checks for days to 50%, plant height, ear height, ear length, ear diameter and grain yield traits over two locations and combined data. Number of days to 50% silking, showed that, three crosses at Gemmeiza location and all crosses at Sids location and over combined date, showed significantly for earliness, compared to the earliest check hybrid SC.166. As for, ear length, none of the evaluated crossed significantly surpassed the check hybrids with the tallest ear for SC.162. Regarding ear diameter, only (Gm. 23 x Gm. 1002) and (Gm. 45 x Gm. 1021) crosses significant gave lower ear diameter compared with the check SC.168, which, had the least ear diameter (5.1cm) at Gemmeiza location only. Grain yield at Gemmeiza location for crosses and checks ranged from 20.7 to 41.8 ard. / fed. Only the cross (Gm 24 x Gm 1021) produced the highest grain yield (41.8 ard./fed.) that significantly out-yielded the highest yielding check.

Only at Sids location (Gm46 x Gm 1021) cross (33.4 ard. /fed.) Significantly out- yielded the best check SC168 (29.8 ard. /fed.).

Values of combined data for grain yield ranged from (21.9 ard. / fed) for cross Gm46 x Gm1002 to 36.5 ard. / fed. for cross Gm24 x Gm1021. Two crosses i.e. (Gm24 x Gm1021) 36.5 ard. / fad. and Gm 46x Gm 1021 (35.4 ard./fed.) significantly out - yielded the best checks, SC 168.

Gene action

Estimation of genetic parameters for the six traits were shown as combined data in Table (4). Results in this Table cleared that, σ^2 GCA-L was more than σ^2 GCA xT for plant height and grain yield at Sids location and in combined data. Also, ear length and ear diameter at the two locations and combined date matched true. Days to 50 % silking and ear height at Sids location had such significant interactions, meaning that most of additive gene action was due to lines, while, in the other traits most of additive gene action was due to testers. These results in harmony with those reported by Aly *et al.* (2011), Mousa and Aly (2012) and Aly (2013). The additive and additive x additive gene actions played more importance in the inheritance of plant height and ear length from combined data, while, the non- additive gene actions was important in the inheritance of days to 50% silking, ear height, ear diameter and grain yield at Gemmeiza, Sids or from the combined data. These results was in harmony with those reported by Singh and Roy (2007) and Aboyousef *et al.*(2016). The ratio σ^2GCA x Loc / σ^2SCA x Loc was less than unity for plant and ear heights and grain yield, indicating that non- additive gene effects played an important role with change in environments. Aly (2013) found that, the interaction of σ^2SCA x location was higher than those σ^2GCA x location for plant and ear heights, and grain yield. On the other side, the same ratio was more than unity for; days to 50% silking, ear length and ear diameter traits, meaning that, additive genes were more important than non- additive with change in locations. Barakat *et al*. (2003) found that, the non additive gene effects were interacted with locations for grain yield.

Table 2: Analysis of variances for days to 50%, plant height, ear height, ear length , ear diameter and all grain yield traits over two locations and combined.

S.O.V.	Df		Days to 50% silking			Plant height			Ear height		
	Loc	com	Gm	Sid	Com	Gm	Sid	Com	Gm	Sid	Com
LOC		1			108.76**			4904.5**			437.59**
REP/LOC		6			21.811**			1106.8**			542.00**
CROSSES	33	33	4.096**	4.450**	7.387**	513.97**	385.30**	705.18**	665.17**	358.45**	741.15**
LINE	16	16	4.096**	3.655**	6.400**	506.93**	574.56**	887.94**	333.64**	521.14**	574.81**
TESTER	1	1	4.096**	9.007**	49.471**	2388.971**	1328.1**	3639.7**	10412**	1456.1**	9828.0**
L X T	16	16	4.096**	4.960**	5.744**	403.81**	137.11**	339.02**	387.50**	127.16**	339.56**
CR/LOC		33			1.719			194.08**			282.49**
L X LOC		16			1.351			193.57**			279.98**
T X LOC		1			7.779**			77.298			2040.5**
L X T XLOC		16			1.709			201.91**			175.10
ERORR	99	198	1.801	1.463	1.632	200.78	63.389	132.09	137.72	64.719	101.22
CV%			2.18	2.01	2.1	5.7	3.3	4.7	8.7	5.8	7.4
LOC		1			99.365**			28.730**			107.962**
REP/LOC		6			5.509			0.218			7.982
CROSSES	33	33	4.794	4.439	7.031	0.068	0.061	0.071	102.672**	35.662**	106.046**
LINE	16	16	6.436**	5.367	9.829**	0.107	0.085	0.122	46.275**	31.940**	58.681**
TESTER	1	1	18.236**	9.424	26.939**	0.036	0.003	0.029	1128.439**	19.166**	720.866**
L X T	16	16	2.311	3.201	2.988	0.031	0.040	0.023	94.959**	40.416**	114.984**
CR/LOC		33			2.202			0.057			32.289**
L X LOC		16			1.973			0.070			19.535**
T X LOC		1			0.721			0.009			426.739**
L X T XLOC		16			2.524			0.048			20.390**
ERORR	99	198	1.181	3.306	2.243	0.050	0.044	0.047	6.442	8.024	7.233
CV%			5.5	9.8	7.8	4.3	4.7	4.5	8.5	10	9.3

** Indicate Significant 0.01 probability level.

Table 3: Mean performance of thirty four crosses and two checks for days to 50%, plant height, ear height, ear length, ear diameter and grain yield traits in two locations and combined data.

Crosses	Days to 50%			Plant height			Ear height			Ear length			Ear diameter			Grain yield		
	Gm	sd	COM	Gm	sd	COM	Gm	sd	COM	Gm	sd	COM	Gm	sd	COM	Gm	sd	COM
Gm23×Gm1002	61.0	60.3	60.6	246.3	245.0	245.6	111.3	142.5	126.9	18.9	19.1	19.0	5.5	4.5	5.0	29.4	29.2	29.3
Gm23×Gm1021	62.3	60.0	61.1	265.0	255.0	260.0	143.8	151.3	147.5	20.1	19.6	19.8	5.2	4.8	5.0	35.4	29.0	32.2
Gm24×Gm1002	62.0	60.5	61.3	246.3	242.5	244.4	125.0	138.8	131.9	20.7	19.1	19.9	5.0	4.5	4.7	22.5	23.3	22.9
Gm24×Gm1021	61.5	59.3	60.4	276.3	257.5	266.9	150.0	152.5	151.3	20.0	19.7	19.8	5.1	4.5	4.8	41.8	31.2	36.5
Gm25×Gm1002	60.0	60.0	60.0	247.5	233.8	240.6	120.0	132.5	126.3	18.9	18.2	18.5	5.3	4.4	4.8	20.8	24.8	22.8
Gm25×Gm1021	62.3	59.8	61.0	236.3	250.0	243.1	131.3	146.3	138.8	21.2	18.8	20.0	5.2	4.2	4.7	28.1	25.8	27.0
Gm26×Gm1002	61.3	59.3	60.3	250.0	252.5	251.3	127.5	150.0	138.8	20.6	19.3	19.9	5.3	4.5	4.9	33.0	32.3	32.7
Gm26×Gm1021	61.5	60.0	60.8	252.5	255.0	253.8	143.8	152.5	148.1	21.3	18.8	20.0	5.4	4.6	5.0	28.7	28.2	28.5
Gm28×Gm1002	62.0	60.0	61.0	268.8	257.5	263.1	133.8	152.5	143.1	19.9	19.4	19.6	5.1	4.6	4.8	27.3	28.3	27.8
Gm28×Gm1021	63.8	63.0	63.4	247.5	260.0	253.8	156.3	157.5	156.9	20.8	19.1	19.9	5.1	4.5	4.8	35.9	28.9	32.4
Gm43×Gm1002	60.8	59.8	60.3	218.8	225.0	221.9	123.8	123.8	123.8	20.7	17.4	19.1	4.9	4.6	4.7	26.1	24.7	25.4
Gm43×Gm1021	61.0	60.0	60.5	235.0	232.5	233.8	136.3	130.0	133.1	19.5	20.1	19.8	5.0	4.6	4.8	32.5	27.2	29.8
Gm45×Gm1002	61.5	61.8	61.6	255.0	242.5	248.8	136.3	135.0	135.6	20.4	19.5	19.9	5.3	4.6	4.9	30.0	25.8	27.9
Gm45×Gm1021	62.3	60.3	61.3	260.0	242.5	251.3	145.0	147.5	146.3	22.5	21.3	21.9	5.5	4.6	5.0	35.8	31.4	33.6
Gm46×Gm1002	62.0	60.3	61.1	236.3	233.8	235.0	130.0	132.5	131.3	20.8	19.3	20.0	5.2	4.4	4.8	27.8	32.8	30.3
Gm46×Gm1021	64.0	61.5	62.8	258.8	242.5	250.6	156.3	142.5	149.4	21.6	19.3	20.4	5.0	4.4	4.7	37.5	33.4	35.4
Gm48×Gm1002	59.5	58.8	59.1	240.0	218.8	229.4	117.5	117.5	117.5	19.0	17.9	18.5	5.1	4.2	4.6	22.4	21.4	21.9
Gm48×Gm1021	62.0	60.0	61.0	253.8	237.5	245.6	151.3	137.5	144.4	20.8	17.9	19.3	5.0	4.4	4.7	35.7	28.4	32.1
Gm52×Gm1002	61.3	61.0	61.1	258.8	237.5	248.1	136.3	137.5	136.9	19.0	17.8	18.4	5.2	4.5	4.8	27.7	31.1	29.4
Gm52×Gm1021	60.8	60.5	60.6	252.5	236.3	244.4	141.3	135.0	138.1	20.6	19.0	19.8	5.3	4.5	4.9	27.3	27.9	27.6
Gm53×Gm1002	59.5	58.8	59.1	248.8	237.5	243.1	142.5	136.3	139.4	18.9	19.1	19.0	5.1	4.8	4.9	36.3	32.8	34.6
Gm53×Gm1021	62.5	58.8	60.6	238.8	232.5	235.6	125.0	130.0	127.5	19.8	20.2	20.0	5.1	4.6	4.8	28.0	29.1	28.6
Gm54×Gm1002	61.5	60.3	60.9	248.8	241.3	245.0	130.0	137.5	133.8	20.1	18.2	19.1	5.3	4.5	4.9	24.8	25.3	25.0
Gm54×Gm1021	62.0	59.5	60.8	258.8	233.8	246.3	146.3	132.5	139.4	21.2	18.3	19.7	5.2	4.6	4.9	33.1	31.1	32.1
Gm55×Gm1002	60.3	59.3	59.8	247.5	238.8	243.1	138.8	132.5	135.6	18.0	18.5	18.3	5.2	4.5	4.9	28.5	27.6	28.0
Gm55×Gm1021	61.5	61.0	61.3	250.0	251.3	250.6	143.8	145.0	144.4	19.1	17.2	18.1	5.2	4.5	4.8	31.5	28.9	30.2
Gm59×Gm1002	61.0	59.0	60.0	241.3	233.8	237.5	127.5	127.5	127.5	19.0	17.2	18.1	5.2	4.5	4.9	23.9	28.0	25.9
Gm59×Gm1021	63.0	62.8	62.9	251.3	241.3	246.3	160.0	140.0	150.0	20.2	19.2	19.7	5.2	4.5	4.8	32.6	27.3	29.9
Gm62×Gm1002	60.3	60.0	60.1	233.8	232.5	233.1	107.5	128.8	118.1	19.2	19.2	19.2	5.2	4.7	4.9	27.9	33.1	30.5
Gm62×Gm1021	61.0	60.5	60.8	260.0	236.3	248.1	147.5	128.8	138.1	18.5	17.2	17.8	5.1	4.5	4.8	26.7	23.1	24.9
Gm63×Gm1002	59.3	58.5	58.9	238.8	225.0	231.9	120.0	125.0	122.5	18.0	16.6	17.3	5.2	4.4	4.8	20.7	28.1	24.4
Gm63×Gm1021	62.0	61.0	61.5	256.3	243.8	250.0	131.3	137.5	134.4	18.8	19.0	18.9	5.0	4.5	4.8	34.7	30.4	32.5
Gm64×Gm1002	61.3	61.3	61.3	238.8	241.3	240.0	123.8	137.5	130.6	19.5	17.1	18.3	5.1	4.5	4.8	26.9	28.5	27.7
Gm64×Gm1021	61.3	59.5	60.4	255.0	237.5	246.3	140.0	132.5	136.3	18.3	17.2	17.7	5.1	4.4	4.7	28.4	28.5	28.5
SC162	66.5	67.0	66.8	263.8	255.0	259.4	142.5	152.5	147.5	24.5	17.9	21.2	4.9	4.3	4.6	32.5	19.1	25.8
SC168	65.5	65.8	65.6	223.8	231.3	227.5	136.3	131.3	133.8	21.5	19.3	20.4	5.1	4.5	4.8	35.1	29.2	32.1
LSD 0.05	1.9	1.7	1.8	19.9	11.2	11.4	16.5	11.3	10.0	1.52	2.5	1.4	0.31	0.29	0.21	3.5	3.9	2.6
LSD 0.01	2.4	2.2	2.3	25.8	14.5	14.8	21.4	14.6	12.9	1.9	3.3	1.9	0.40	0.38	0.28	4.6	5.1	3.4

Table 4: Estimates of the variance component due to general combining ability (GCA), specific combining ability (SCA) and their interaction with locations for six traits combined across two locations.

Parameter	Days to 50% silking			Plant height			Ear height			Ear length			Ear diameter			Grain yield		
	Gm	Sid	Com	Gm	Sid	Com	Gm	Sid	Com	Gm	Sid	Com	Gm	Sid	Com	Gm	Sid	Com
$\sigma^2 L$	0.20	-0.16	0.06	12.89	54.68	34.83	-6.73	49.25	8.15	0.52	0.27	0.46	0.010	0.006	0.005	-6.09	-1.06	-3.47
$\sigma^2 T$	0.67	0.06	0.28	29.19	17.51	25.19	147.42	19.54	56.05	0.23	0.09	0.19	0.000	-0.001	0.000	15.20	-0.31	1.47
$\sigma^2 GCA$	0.02	-0.01	0.06	1.09	2.46	19.34	2.75	2.29	18.34	0.02	0.01	0.13	0.000	0.000	0.000	0.08	-0.05	-0.64
$\sigma^2 SCa$	0.17	0.87	0.50	50.76	18.43	17.14	62.45	15.61	20.56	0.28	-0.03	0.06	-0.005	-0.001	-0.003	22.13	8.10	11.82
$\sigma^2 L$*loc			-0.04			-1.04			13.11			-0.07			0.003			-0.11
$\sigma^2 T$*loc			0.09			-1.83			27.43			-0.03			-0.001			5.98
$\sigma^2 GCA$*loc			-0.04			-1.04			13.11			-0.07			0.003			-0.11
$\sigma^2 SCa$*loc			0.02			17.46			18.47			0.07			0.000			3.29

All negative estimates of variance were considered zero

Table 5: General combining ability (GCA) effects of the seventeen inbred lines for grain yield and the other studied traits under two locations and combined date.

Lins		Days to 50%silking			Plant height			Ear height			Ear length			Ear diameter			Grain yield		
		Gm	Sid	Com	Gm	Sid	com	Gm	Sid	com	Gm	Sid	com	Gm	Sid	com	Gm	Sid	com
Gm23		0.191	-0.044	0.074	6.434	9.301**	7.868**	-7.794	9.044**	0.625	-0.376	0.682	0.153	0.157*	0.157*	0.157**	2.714**	0.657	1.685*
Gm24		0.316	-0.294	0.011	12.059**	9.301**	10.680**	2.206	7.794**	5.000	0.449	0.707	0.578	-0.143	-0.043	-0.093	2.431**	-1.155	0.638
Gm25		-0.309	-0.294	-0.301	-7.316	1.176	-3.070	-9.669*	1.544	-4.063	0.149	-0.168	-0.010	0.082	-0.193**	-0.055	-5.247**	-3.093**	-4.17**
Gm26		-0.059	-0.544	-0.301	2.059	13.051**	7.555**	0.331	13.419**	6.875**	1.074**	0.357	0.715	0.157*	0.032	0.095	1.148*	1.831	1.49*
Gm28		1.441**	1.331**	1.386**	8.934	18.051**	13.493**	9.706*	17.169**	13.438**	0.449	0.582	0.515	-0.043	0.007	-0.018	1.883	0.152	1.017
Gm43		-0.559	-0.294	-0.426	-22.316**	-11.949**	-17.132**	-5.294	-10.956**	-8.125**	0.249	0.107	0.178	-0.218**	0.057	-0.080	-0.393	-2.531*	-1.462*
Gm45		0.441	0.831	0.636*	8.309	1.801	5.055	5.331	3.419	4.375	1.574**	1.732**	1.653**	0.207**	0.107	0.157**	3.202**	0.147	1.674*
Gm46		1.566**	0.706	1.136**	-1.691	-2.574	-2.132	7.831	-0.331	3.750	1.324**	0.632	0.978**	-0.043	-0.093	-0.068	2.922**	4.648**	3.785**
Gm48		-0.684	-0.794	-0.739*	-2.316	-12.574**	-7.445**	-0.919	-10.331**	-5.625*	0.024	-0.743	-0.360	-0.143	-0.193**	-0.168**	-0.619	-3.500**	-2.06
Gm52		-0.434	0.581	0.074	6.434	-3.824	1.305	3.456	-1.581	0.938	-0.051	-0.293	-0.172	0.057	0.007	0.032	-2.183*	1.023	-0.58
Gm53		-0.434	-1.419**	-0.926**	-5.441	-5.699*	-5.570	-1.544	-4.706	-3.125	-0.551	0.957	0.203	-0.068	0.157*	0.045	2.479**	2.521*	2.5**
Gm54		0.316	-0.294	0.011	4.559	-3.199	0.680	2.831	-2.831	0.000	0.749	-0.418	0.165	0.057	0.032	0.045	-0.773	-0.282	-0.527
Gm55		-0.559	-0.044	-0.301	-0.441	4.301	1.930	5.956	0.919	3.438	-1.301**	-0.818	-1.060**	0.057	-0.018	0.020	0.308	-0.182	0.063
Gm59		0.566	0.706	0.636*	-2.941	-3.199	-3.070	8.456*	-4.081	2.188	-0.251	-0.493	-0.372	0.032	-0.018	0.007	-1.449	-0.795	-1.122
Gm62		-0.809	0.081	-0.364	-2.316	-6.324	7.868	-7.794	-9.081**	-8.438**	-1.051**	-0.443	-0.747	-0.043	0.107	0.032	-2.390**	-0.300	-1.345*
Gm63		-0.809	-0.419	-0.614	-1.691	-6.324	10.680	-9.669*	-6.581*	-8.125**	-1.476**	-0.893	-1.185**	-0.068	-0.043	-0.055	-1.981*	0.805	-0.588
Gm64		-0.184	0.206	0.011	-2.316	-1.324	-3.070	-3.419	-2.831	-3.125	-0.976**	-1.493**	-1.235**	-0.043	-0.068	-0.055	-2.052*	0.054	-0.999
LSD G_I	5%	0.944	0.851	0.636	9.969	5.602	5.718	8.257	5.660	5.005	0.764	1.279	0.745	0.157	0.148	0.108	1.786	1.993	1.338
	1%	1.224	1.103	0.824	12.925	7.262	7.413	10.705	7.338	6.489	0.991	1.659	0.966	0.203	0.192	0.140	2.315	2.584	1.735
LSD G_I-G_L	5%	1.335	1.204	0.899	14.099	7.922	8.086	11.677	8.005	7.079	1.081	1.809	1.054	0.222	0.210	0.153	2.525	2.819	1.892
	1%	1.731	1.561	1.165	18.279	10.271	10.483	15.139	10.378	9.177	1.402	2.346	1.366	0.288	0.272	0.198	3.274	3.654	2.453

*, ** Indicate significance at 0.05 and 0.01 levels of probability, respectively.

Table 6: General combining ability (GCA) effects of the two inbred testers for grain yield and the other studied traits under two locations and combined data.

Tester		Days to 50% silking			Plant height			Ear height			Ear length			Ear diameter			Grain yield		
		Gm	Sid	Com	Gm	Sid	Com	Gm	Sid	Com	Gm	Sid	Com	Gm	Sid	Com	Gm	Sid	Com
Gm1002		-0.596**	-0.257	-0.426**	-4.191*	-3.125**	-3.658**	-8.750**	-3.272**	-6.011**	-0.366**	-0.263	-0.315*	0.016	0.004	0.010	-2.881**	-0.375	-1.628
Gm1021		0.596**	0.257	0.426**	4.191*	3.125**	3.658**	8.750**	3.272**	6.011**	0.366**	0.263	0.315*	-0.016	-0.004	-0.010	2.881**	0.375	1.628
Lsd g_i	5%	0.324	0.292	0.218	3.419	1.921	1.961	2.832	1.941	1.717	0.262	0.439	0.256	0.054	0.051	0.037	0.612	0.684	0.459
	1%	0.420	0.378	0.283	4.433	2.491	2.543	3.672	2.517	2.226	0.340	0.569	0.331	0.070	0.066	0.048	0.794	0.886	0.595
Lsd	5%	0.458	0.413	0.308	4.836	2.717	2.773	4.005	2.746	2.428	0.371	0.621	0.361	0.076	0.072	0.052	0.866	0.967	0.649
g_i-g_j	1%	0.594	0.535	0.400	6.270	3.523	3.596	5.193	3.560	3.148	0.481	0.805	0.469	0.099	0.093	0.068	1.123	1.253	0.841

*, ** Indicate significance at 0.05 and 0.01 levels of probability, respectively.

Table 7: Specific combining ability effects of 34 top crosses for days to 50%silking, plant height, ear height, ear length, ear diameter and grain yield combined across two locations (2016 growing season).

Crosses	Days to 50%			Plant height			Ear height			Ear length			Ear diameter			Grain yield		
	Gm	sd	COM	Gm	sd	COM	Gm	sd	COM	Gm	sd	COM	Gm	sd	COM	Gm	sd	COM
Gm23×Gm1002	-0.03	0.38	0.18	-5.18	-1.88	-3.53	-7.50	-1.10	-4.30	-0.21	-0.01	-0.11	-0.15	-0.15	-0.01	-0.15	0.48	0.17
Gm23×Gm1021	0.03	-0.38	-0.18	5.18	1.88	3.53	7.50	1.10	4.30	0.21	0.01	0.11	0.15	0.15	0.01	0.15	-0.48	-0.17
Gm24×Gm1002	0.85	0.88	0.86	-10.81	-4.38	-7.59	-3.75	-3.60	-3.68	0.72	-0.04	0.34	0.00	0.00	-0.04	-6.76**	-3.58*	-5.17**
Gm24×Gm1021	-0.85	-0.88	-0.86	10.81	4.38	7.59	3.75	3.60	3.68	-0.72	0.04	-0.34	0.00	0.00	0.04	6.76**	3.58*	5.17**
Gm25×Gm1002	-0.53	0.38	-0.07	9.82	-5.00	2.41	3.12	-3.60	-0.24	-0.78	-0.01	-0.40	0.10	0.10	0.05	-0.79	-0.12	-0.46
Gm25×Gm1021	0.53	-0.38	0.07	-9.82	5.00	-2.41	-3.13	3.60	0.24	0.78	0.01	0.40	-0.10	-0.10	-0.05	0.79	0.12	0.46
Gm26×Gm1002	0.47	-0.12	0.18	2.94	1.88	2.41	0.62	2.02	1.32	0.04	0.51	0.28	-0.03	-0.03	-0.05	5.03	2.41	3.72**
Gm26×Gm1021	-0.47	0.12	-0.18	-2.94	-1.88	-2.41	-0.63	-2.02	-1.32	-0.04	-0.51	-0.28	0.03	0.03	0.05	-5.03	-2.41	-3.72**
Gm28×Gm1002	-0.28	-1.24*	-0.76	14.82*	1.88	8.35*	-2.50	0.77	-0.86	-0.08	0.44	0.18	0.05	0.05	0.01	-1.45	0.07	-0.69
Gm28×Gm1021	0.28	1.24*	0.76	-14.82*	-1.88	-8.35*	2.50	-0.77	0.86	0.08	-0.44	-0.18	-0.05	-0.05	-0.01	1.45	-0.07	0.69
Gm43×Gm1002	0.47	0.13	0.30	-3.93	-0.63	-2.28	2.50	0.15	1.32	0.97	-1.09	-0.06	0.00	0.00	-0.02	-0.31	-0.88	-0.59
Gm43×Gm1021	-0.47	-0.13	-0.30	3.93	0.63	2.28	-2.50	-0.15	-1.32	-0.97	1.09	0.06	0.00	0.00	0.02	0.31	0.88	0.59
Gm45×Gm1002	0.22	1.01	0.61	1.69	3.13	2.41	4.37	-2.98	0.70	-0.66	-0.66	-0.66	0.00	0.00	-0.06	0.00	-2.43	-1.22
Gm45×Gm1021	-0.22	-1.01	-0.61	-1.69	-3.13	-2.41	-4.38	2.98	-0.70	0.66	0.66	0.66	0.00	0.00	0.06	0.00	2.43	1.22
Gm46×Gm1002	-0.40	-0.37	-0.39	-7.06	-1.25	-4.15	-4.38	-1.73	-3.05	-0.06	0.29	0.11	0.00	0.00	0.04	-1.99	0.11	-0.94
Gm46×Gm1021	0.40	0.37	0.39	7.06	1.25	4.15	4.38	1.73	3.05	0.06	-0.29	-0.11	0.00	0.00	-0.04	1.99	-0.11	0.94
Gm48×Gm1002	-0.65	-0.37	-0.51	-2.68	-6.25	-4.47	-8.13	-6.73	-7.43*	-0.51	0.26	-0.12	-0.10	-0.10	-0.04	-3.78**	-3.12*	-3.45**
Gm48×Gm1021	0.65	0.37	0.51	2.68	6.25	4.47	8.13	6.73	7.43*	0.51	-0.26	0.12	0.10	0.10	0.04	3.78**	3.12*	3.45**
Gm52×Gm1002	0.85	0.51	0.68	7.32	3.75	5.53	6.25	4.52	5.39	-0.43	-0.34	-0.39	0.00	0.00	-0.04	3.08*	1.97	2.52**
Gm52×Gm1021	-0.85	-0.51	-0.68	-7.32	-3.75	-5.53	-6.25	-4.52	-5.39	0.43	0.34	0.39	0.00	0.00	0.04	-3.08*	-1.97	-2.52**
Gm53×Gm1002	-0.90	0.26	-0.32	9.19	5.63	7.41	17.50**	6.40	11.95**	-0.08	-0.29	-0.19	0.10	0.10	0.05	7.01**	2.26	4.64**
Gm53×Gm1021	0.90	-0.26	0.32	-9.19	-5.63	-7.41	-17.50**	-6.40	-11.95**	0.08	0.29	0.19	-0.10	-0.10	-0.05	-7.01**	-2.26	-4.64**
Gm54×Gm1002	0.35	0.63	0.49	-0.81	6.88	3.03	0.62	5.77	3.20	-0.18	0.19	0.00	-0.08	-0.08	-0.02	-1.30	-2.52	-1.91
Gm54×Gm1021	-0.35	-0.63	-0.49	0.81	-6.88	-3.03	-0.63	-5.77	-3.20	0.18	-0.19	0.00	0.08	0.08	0.02	1.30	2.52	1.91
Gm55×Gm1002	-0.03	-0.62	-0.32	2.94	-3.13	-0.09	6.25	-2.98	1.64	-0.18	0.94	0.38	0.02	0.02	0.00	1.36	-0.31	0.52
Gm55×Gm1021	0.03	0.62	0.32	-2.94	3.13	0.09	-6.25	2.98	-1.64	0.18	-0.94	-0.38	-0.02	-0.02	0.00	-1.36	0.31	-0.52
Gm59×Gm1002	-0.40	-1.62**	-1.01*	-0.81	-0.63	-0.72	-7.50	-2.98	-5.24	-0.23	-0.74	-0.49	0.02	0.02	0.01	-1.43	0.68	-0.37
Gm59×Gm1021	0.40	1.62**	1.01*	0.81	0.63	0.72	7.50	2.98	5.24	0.23	0.74	0.49	-0.02	-0.02	-0.01	1.43	-0.68	0.37
Gm62×Gm1002	0.22	0.01	0.11	-8.93	1.25	-3.84	-11.25	3.27	-3.99	0.72	1.26	0.99	0.10	0.10	0.06	3.50**	5.38**	4.44**
Gm62×Gm1021	-0.22	-0.01	-0.11	8.93	-1.25	3.84	11.25	-3.27	3.99	-0.72	-1.26	-0.99	-0.10	-0.10	-0.06	-3.50**	-5.38**	-4.44**
Gm63×Gm1002	-0.78	-0.99	-0.89	-4.56	-6.25	-5.40	3.12	-2.98	0.07	-0.01	-0.94	-0.47	-0.05	-0.05	0.00	-4.12**	-0.75	-2.44*
Gm63×Gm1021	0.78	0.99	0.89	4.56	6.25	5.40	-3.13	2.98	-0.07	0.01	0.94	0.47	0.05	0.05	0.00	4.12**	0.75	2.44*
Gm64×Gm1002	0.60	1.13	0.86	-3.93	5.00	0.53	0.62	5.77	3.20	0.99	0.21	0.60	0.07	0.07	0.03	2.09	0.35	1.22
Gm64×Gm1021	-0.60	-1.13	-0.86	3.93	-5.00	-0.53	-0.63	-5.77	-3.20	-0.99	-0.21	-0.60	-0.07	-0.07	-0.03	-2.09	-0.35	-1.22
LSD sij 0.05	1.34	1.20	0.90	14.10	7.92	8.09	11.68	8.00	7.08	1.08	1.81	1.05	0.22	0.21	0.15	2.53	2.82	1.89
LSD sij 0.01	1.73	1.56	1.17	18.28	10.27	10.48	15.14	10.38	9.18	1.40	2.35	1.37	0.29	0.27	0.20	3.27	3.65	2.45
LSD Sij-ski 0.05	1.89	1.70	1.27	19.94	11.20	11.44	16.51	11.32	10.01	1.53	2.56	1.49	0.31	0.30	0.22	3.57	3.99	2.68
LSD Sij-ski 0.01	2.46	2.21	1.65	25.93	14.57	14.87	21.48	14.72	13.02	1.99	3.33	1.94	0.41	0.39	0.28	4.64	5.18	3.48

*, ** Indicate significance at 0.05 and 0.01 levels of probability, respectively

Table 8: Superiority percentages of thirty four genotypes for days to 50%, plant height, ear height, ear length , ear diameter and Grain yield traits relative to SC 162 and SC 168 under combined data.

Crosses	Days to 50%		Plant height		Ear height		Ear length		Ear diameter		Grain yield	
	SC162	SC168	SC162	SC168	SC162	SC168	SC162	SC168	SC162	SC168	SC162	SC168
Gm23×Gm1002	-9.28**	-7.62**	-5.32*	7.96**	-13.97**	-5.16	-10.38**	-6.86*	8.70**	4.17	13.57**	-8.72*
Gm23×Gm1021	-8.53**	-6.86**	0.23	14.29**	0.00	10.24**	-6.60*	-2.94	8.70**	4.17	24.81**	0.31
Gm24×Gm1002	-8.23**	-6.55**	-5.78**	7.43**	-10.58**	-1.42	-6.13	-2.45	2.17	-2.08	-11.24*	-28.66**
Gm24×Gm1021	-9.58**	-7.93**	2.89	17.32**	2.58	13.08**	-6.60*	-2.94	4.35	0.00	41.47**	13.71**
Gm25×Gm1002	-10.18**	-8.54**	-7.25**	5.76*	-14.37**	-5.61	-12.74**	-9.31**	4.35	0.00	-11.63*	-28.97**
Gm25×Gm1021	-8.68**	-7.01**	-6.28**	6.86**	-5.90	3.74	-5.66	-1.96	2.17	-2.08	4.65	-15.89**
Gm26×Gm1002	-9.73**	-8.08**	-3.12	10.46**	-5.90	3.74	-6.13	-2.45	6.52**	2.08	26.74**	1.87
Gm26×Gm1021	-8.98**	-7.32**	-2.16	11.56**	0.41	10.69**	-5.66	-1.96	8.70**	4.17	10.47*	-11.21**
Gm28×Gm1002	-8.68**	-7.01**	1.43	15.65**	-2.98	6.95	-7.55*	-3.92	4.35	0.00	7.75	-13.40**
Gm28×Gm1021	-5.09**	-3.35**	-2.16	11.56**	6.37	17.26**	-6.13	-2.45	4.35	0.00	25.58**	0.93
Gm43×Gm1002	-9.73**	-8.08**	-14.46**	-2.46	-16.07**	-7.47*	-9.91**	-6.37	2.17	-2.08	-1.55	-20.87**
Gm43×Gm1021	-9.43**	-7.77**	-9.87**	2.77	-9.76**	-0.52	-6.60*	-2.94	4.35	0.00	15.50**	-7.17
Gm45×Gm1002	-7.78**	-6.10**	-4.09	9.36**	-8.07*	1.35	-6.13	-2.45	6.52**	2.08	8.14	-13.08**
Gm45×Gm1021	-8.23**	-6.55**	-3.12	10.46**	-0.81	9.34**	3.30	7.35*	8.70**	4.17	30.23**	4.67
Gm46×Gm1002	-8.53**	-6.86**	-9.41**	3.30	-10.98**	-1.87	-5.66	-1.96	4.35	0.00	17.44**	-5.61
Gm46×Gm1021	-5.99**	-4.27**	-3.39	10.15**	1.29	11.66**	-3.77	0.00	2.17	-2.08	37.21**	10.28*
Gm48×Gm1002	-11.53**	-9.91**	-11.57**	0.84	-20.34**	-12.18**	-12.74**	-9.31**	0.00	-4.17	-15.12**	-31.78**
Gm48×Gm1021	-8.68**	-7.01**	-5.32*	7.96**	-2.10	7.92*	-8.96**	-5.39	2.17	-2.08	24.42**	0.00
Gm52×Gm1002	-8.53**	-6.86**	-4.36*	9.05**	-7.19*	2.32	-13.21**	-9.80**	4.35	0.00	13.95**	-8.41
Gm52×Gm1021	-9.28**	-7.62**	-5.78**	7.43**	-6.37	3.21	-6.60*	-2.94	6.52**	2.08	6.98	-14.02**
Gm53×Gm1002	-11.53**	-9.91**	-6.28**	6.86**	-5.49	4.19	-10.38**	-6.86*	6.52**	2.08	34.11**	7.79
Gm53×Gm1021	-9.28**	-7.62**	-9.18**	3.56	-13.56**	-4.71	-5.66	-1.96	4.35	0.00	10.85*	-10.90**
Gm54×Gm1002	-8.83**	-7.16**	-5.55*	7.69**	-9.29**	0.00	-9.91**	-6.37	6.52**	2.08	-3.10	-22.12**
Gm54×Gm1021	-8.98**	-7.32**	-5.05*	8.26**	-5.49	4.19	-7.08*	-3.43	6.52**	2.08	24.42**	0.00
Gm55×Gm1002	-10.48**	-8.84**	-6.28**	6.86**	-8.07*	1.35	-13.68**	-10.29**	6.52**	2.08	8.53	-12.77**
Gm55×Gm1021	-8.23**	-6.55**	-3.39	10.15**	-2.10	7.92*	-14.62**	-11.27**	4.35	0.00	17.05**	-5.92
Gm59×Gm1002	-10.18**	-8.54**	-8.44**	4.40	-13.56**	-4.71	-14.62**	-11.27**	6.52**	2.08	0.39	-19.31**
Gm59×Gm1021	-5.84**	-4.12**	-5.05*	8.26**	1.69	12.11**	-7.08*	-3.43	4.35	0.00	15.89**	-6.85
Gm62×Gm1002	-10.03**	-8.38**	-10.14**	2.46	-19.93**	-11.73**	-9.43**	-5.88	6.52**	2.08	18.22**	-4.98
Gm62×Gm1021	-8.98**	-7.32**	-4.36*	9.05**	-6.37	3.21	-16.04**	-12.75**	4.35	0.00	-3.49	-22.43**
Gm63×Gm1002	-11.83**	-10.21**	-10.60**	1.93	-16.95**	-8.45*	-18.40**	-15.20**	4.35	0.00	-5.43	-23.99**
Gm63×Gm1021	-7.93**	-6.25**	-3.62	9.89**	-8.88**	0.45	-10.85**	-7.35*	4.35	0.00	25.97**	1.25
Gm64×Gm1002	-8.23**	-6.55**	-7.48**	5.49*	-11.46**	-2.39	-13.68**	-10.29**	4.35	0.00	7.36	-13.71**
Gm64×Gm1021	-9.58**	-7.93**	-5.05*	8.26**	-7.59*	1.87	-16.51**	-13.24**	2.17	-2.08	10.47*	-11.21**
LSD 0.05%	1.8		11.4		10		1.4		0.21		2.6	
LSD 0.01%	2.3		14.8		12.9		1.9		0.28		3.4	

*, ** Indicate significance at 0.05 and 0.01 levels of probability, respectively

General combining ability effects ($\hat{g}_i$):

Estimation of GCA effects for the seventeen yellow maize inbred lines were shown in Table (5). As for, days to 50% silking, the inbred line Gm53 had desirable negative and highly significant values for ($\hat{g}_i$) towards earliness. Gm43 at both locations and from combined data, Gm48 at Sids location and combined data and Gm53 at Sids location exhibited significant ($\hat{g}_i$) towards short plants.

Regarding ear height, at Gemmeiza two inbred lines (Gm25 and Gm63) and at Sids and from combined data, four inbred lines (Gm43, Gm48, Gm62 and Gm63), had negative (desirable) and significant ($\hat{g}_i$) effects towards lower ear placement. For ear length, Gm45 at the two locations and combined data, Gm46 at Gemmeiza and combined data and Gm26 at Gemmeiza showed positive desirable and highly significant (g^i) effects for this traits. Concerning ear diameter, Gm23 at the two locations and combined data, Gm45 at Gemmeiza and combined data, Gm26 at Gemmeiza and Gm53 at Sids showed significant (g^i) effects for this traits.

Grain yield data showed that, two inbred lines: (Gm46 and Gm53) under the two locations and combined data, two inbred lines: (Gm23 and Gm45) at Gemmeiza and combined data and one inbred line: (Gm24) at Gemmeiza had desirable significant positive (g^i) effects for grain yield.

Testers:

The inbred tester Gm1002 had desirable and significant values of ($\hat{g}_i$) effects for days to 50% silking, plant and ear heights, while, the tester Gm1021 showed positive and significant values of ($\hat{g}_i$) effects for ear length and grain yield at Gemmeiza and combined data (Table 6).

Specific combining ability effects ($\hat{s}_{ij}$):

Results in Table 7 showed that, days to 50 % silking showed one cross (Gm28 x Gm1002) at Sids and one cross at Sids and combined data (Gm59 x Gm 1002) had negative and significant ($\hat{s}_{ij}$) effects for earliness. As for plant height, cross (Gm28 x Gm 1002) had negative and significant ($\hat{s}_{ij}$) effects at Gemmeiza and in combined date. Regarding ear height, results revealed that, crosses (Gm48 x Gm 1002) and (Gm53 x Gm 1021) had negative and significant ($\hat{s}_{ij}$) at Gemmeiza and in combined data. Depending on grain yield, three crosses (Gm24 x Gm 1021), (Gm48 x Gm 1021) and (Gm62 x Gm 1002) had positive and significant ($\hat{s}_{ij}$) effects at both locations and their combined data, while, two crosses; (Gm53 x Gm 1002) and (Gm63 x Gm 1021) at Gemmeiza and from combined data and also the cross (Gm26 x Gm 1002) in combined data had significant ($\hat{s}_{ij}$) for this trait.

Superiority percentages:

Superiority percentages relative to the two checks; SC162 and SC168 for the 34 F_1 crosses from combined data were presented in (Table 8). It was noted that, negative values might be desired for no. of days to 50% silking, plant and ear heights, while the positive values would be favored for the other studied traits. Data showed that, all crosses had highly significant superiority for earliness over checks SC 162 and SC 168. 22 crosses had significant and negative superiority percentage in plant height over check SC 162. Out of the 34 crosses, 18 and 4 crosses had negative significant superiority percentages for low ear placement than check hybrids SC 162 and SC 168, respectively. Ear length results revealed that, one cross (Gm45 x Gm1021) had significant superiority percentage, over check SC 168. As for, ear diameter, 13 crosses had positive and significant superiority percentage, over check SC 162.

Concerning grain yield, data in Table 8 cleared that, relative to SC 162, 19 crosses had significant superiority percentage, while, relative to SC 168 only two crosses, i.e. Gm 24x Gm 1021 (13.71%) and Gm 46x Gm 1021 (10.28%).

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الملخص العربي

تقدير نسبة التفوق والقدرة على التآلف لصفة محصول الحبوب وبعض الصفات الأخرى في الذرة الشامية الصفراء

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نفذت هذه التجربة خلال موسمين زراعيين هما موسمى صيف ٢٠١٦ و٢٠١٧ فى كلا من محطتي البحوث الزراعية بالجميزة وسدس. فى موسم صيف ٢٠١٦ تم عمل التهجين القمى لعدد ١٧ سلالة صفراء مرباه داخليا مع عدد ٢ كشاف هما السلالة جميزة ١٠٠٢ والسلالة جميزة ١٠٢١. في موسم ٢٠١٧ تم تقييم الـ ٣٤ هجين قمي الناتجة من التهجين فى الموسم السابق بالإضافة الي هجينين للمقارنة هما هجين فردي١٦٢ وهجين فردي ١٦٨. تم تنفيذ التجربة في اربع قطاعات كاملة العشوائية وتم اجراء التحليل الوراثي طبقا لنموذج كمبثورن ١٩٥٦. وكانت الصفات محل الدراسة هي عدد الايام من الزراعة حتي ظهور ٥٠% من النورة المؤنثة وارتفاع النبات والكوز وطول وقطر الكوز ومحصول الحبوب(اردب /فدان).

ويمكن تلخيص النتائج علي النحو التالي:

١. تحليل التباين الراجع إلى المواقع عالي المعنوية لجميع الصفات محل الدراسة.
٢. كان الفعل الجيني المضيف له دور مهم في وراثة صفات ارتفاع النبات وقطر الكوز وذلك في التحليل التجميعي بينما كان الفعل الجيني الغير مضيف له دور مهم في وراثة صفات عدد الأيام من الزراعة حتى ٥٠% من النورة المؤنثة وارتفاع الكوز وقطر الكوز ومحصول الحبوب (اردب للفدان).
٣. اظهرت السلالات (جميزة ٢٣ و٤٥ و٤٦ و٥٣) قدرة عالية على التآلف لصفة محصول الحبوب وذلك من التحليل التجميعي.
٤. أعطت الهجن (Gm 24 x Gm 1021) و(Gm 46 x Gm 1021) قيما اعلى في محصول الحبوب والتبكير مقارنة بالهجن الاختبارية. كما اظهرت تفوقا معنويا عن أفضل هجن المقارنة وهو هجين فردي ١٦٨ لصفة محصول الحبوب والتبكير وكذلك قدرة خاصة علي التالف لصفة محصول الحبوب.