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Estimation of Genetic Parameters, Combining Ability and Heterotic Groups of New Yellow Maize Inbred Lines Using Line X Tester Model Across Two Locations

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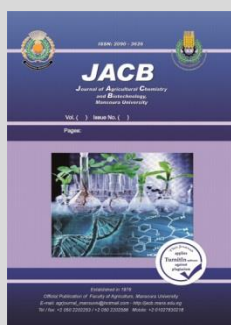
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ABSTRACT

The Line x Tester model stands as most potent method to estimate (GCA) and (SCA) effects, thereby aiding to select desirable parents and/or crosses. During the 2022 growing season, eleven inbred lines were crossed with three testers. The thirty-three crosses in addition to SC 168 as check hybrid were evaluated (in the 2023 growing season) at Two locations: Private Farms at Damietta and Dakahlia Governorates. Results showed that, the mean squares of genotypes and their partitioning were significant or highly significant for studied traits combined across two locations. Notably, lines L4, L6, and L9 exhibited significantly negative GCA effects, indicating desirable characteristics such as earliness, shorter plant height, and lower ear placement. Conversely, lines L2, L8, L10, and L11 demonstrated positive and significant GCA effects, contributing to increased grain yield. Five crosses showed positive and significant SCA effects for GYP-1 and GY and fed⁻¹; L3 x T2, L4 x T2, L6 x T1, L11 x T1 and L11 x T2. Heterotic groups using, Heterospecific Grouping Specific and Combining Ability (HSGCA) for grain yield divided the inbred lines into 3 groups according to the 3 testers. On the other side this method cannot categorize the four lines.; L1, L2, L8 and L10. These groups could be used in breeding programs to give breeders a chance to select the best parents to produce the new promising crosses that had high yielding potential.

Keywords: maize, genetic parameters, heterotic groups.



INTRODUCTION

Maize (*Zea mays L.*) holds a critical position as the world's second most important cereal crop after wheat and rice. It serves as a vital source of food for both humans and livestock, and additionally plays a key role as a raw material for diverse agro-allied industries worldwide (Undie *et al.*, 2012). Notably, maize boasts impressive yield potential and has become a leading cereal crop in terms of both production volume and productivity. Across diverse plant breeding programs in Egypt, scientists strive to develop innovative hybrid varieties surpassing the yield and other valuable traits of existing commercial options. Producing such hybrids hinges on two key aspects: individual plant characteristics and how they combine with other lines. This combining ability, broken down into general (GCA) and specific (SCA) effects, reveals a line's potential to create high-performing hybrids. In essence, selecting the right parents is the cornerstone of successful hybrid breeding programs. Identifying hybrids with high yield depends upon knowing parent's genetic structure and their combining ability (Ceyhan 2003). Kempthorne (1957) proposed the line × tester analysis method, which stands out as one of the most powerful approaches for estimating effects of both (GCA) and (SCA), facilitating the selection of good parents and crosses. The efficiency of this method mainly depends on the type of tester used in the evaluation. The suitable tester should be simple in use, provide information that correctly classifies the relative

merit of lines and maximizes the genetic gain (Hallauer, 1975; Menz *et al.*, 1999).

The use of an inbred as tester was suggested by Russell and Eberhart (1975). Determining of correlation coefficient provides knowledge of association among different attributes traits and grain yield. Studying correlation between different traits proves valuable for breeders in selecting genotypes possessing crop of desired traits (Ali *et al.*, 2008). Genetic variation which is heritable and hence important in any selection program (Singh *et al.*, 2009). Estimation of heterotic groups using general and specific combining ability (HSGCA) method is a practical and straightforward for categorizing maize inbred lines into known heterotic groups Fan *et al.*, (2009).

The objectives of this study were to, estimate general and specific combining abilities variances and effects of eleven inbred lines of yellow maize in testcross with three testers across two locations, identify the desirable superior inbred line(s) and the resulting single crosses for yielding potentiality to be recommended for future investigations in maize breeding programs, and classify the new eleven yellow maize inbred lines into heterotic groups using (HSGCA) in line x tester mating design.

MATERIALS AND METHODS

Plant materials and their sources.

The plant materials used in this investigation comprised eleven newly yellow maize inbred lines.; L1, L2, L3, L4, L5, L6, L7, L8, L9, L10 and L11 as lines and three testers;

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T₁, T₂ and T₃ derived from different local and exotic sources (Seeds Company and CIMMYT) and divergent in isolation from these sources.

Experimental sites and growing seasons

During the 2022 growing season, the eleven yellow maize inbred lines were crossed with three testers following a line x tester mating design. In the 2023 growing season, the 33 resulting crosses along with the yellow check hybrid (SC.168 commercial single cross) were assessed in a yield trial conducted at two locations: at a private farms in Kafr Saad City, Damietta Governorate and Shenisah, Aga, Dakahlia Governorate.

Experimental design and its management

The experiment followed a Randomized Complete Block Design with three replications to ensure unbiased data collection. Each plot consisted of a single row of maize plants, 6 m long and spaced 0.8 m apart, resulting in a total area of 4.8 m² per plot. Planting was made in hills evenly spaced at 0.25 m along the row at the rate of two kernels hill⁻¹. To achieve uniform plant density, seeds were initially planted in groups (hills) and then thinned to one plant per hill 21 days after planting. All recommended agricultural practices and timing were strictly adhered to throughout the experiment.

Data recorded.

Throughout the experiment, data were gathered on various agronomic traits, including days to 50% silking emergency (DS Day), plant height (PH cm), ear height (EH cm), percentage of plants resistant to late wilt disease (LWR %), grain yield per plant (GYP⁻¹ g), and grain yield per area (GY ard fed⁻¹), which was adjusted to 15.5% grain moisture content. To ensure the reliability of statistical analysis, we initially assessed the consistency in data variability between the two study locations using the Bartlett test. Subsequently, an analysis of variance (ANOVA) was conducted for the combined dataset across both locations, following the methodologies outlined by Snedecor and Cochran (1967).

Furthermore, a separate ANOVA was performed specifically to analyze the line x tester interaction, adhering to the method described by Kempthorne (1957).

Heterotic groups.

To classify the inbred lines into distinct heterotic groups for yield potential, we employed the Heterospecific Grouping Specific and Combining Ability (HSGCA) method of Fan *et al.* (2008, 2009). The HSGCA values were calculated following the approach described by both Fan *et al.* (2009) and Badu-Apraku *et al.* (2023).

$$\text{HSGCA} = \text{cross mean } X_{ij} - \text{tester mean } X_i$$

Where, X_{ij} is the mean yield of the cross between ith and jth and X_i is the mean of the ith inbred line over all cross combinations.

RESULTS AND DISCUSSION

Analysis of variance

Table 1 presents the results of ANOVA analysis conducted across two locations for all studied traits. The analysis revealed: Differences between the two locations were observed for all traits except (PH) and (EH), aligning with previous findings by Gamea (2019), Abu shosha *et al.*, (2020), Abdel Azeem *et al.*, (2022), Aly *et al.*, (2022) and Mousa *et al.*, (2023). Both Mean squares due to genotypes (G) and their interaction with location (G x Loc) were significant and highly significant for all traits except G x Loc for (DS). Mean squares due to crosses and their components (line, tester, line-by-tester interaction, and their interactions with location) were significant for most traits, except for C x Loc, L x Loc, T x Loc, and L x T x Loc in certain traits like DS and EH. Notably, LWR%, GYP⁻¹, and GY ard fed⁻¹ showed significant T x Loc interaction. Similar findings were reported by various researchers, including Rajesh *et al.* (2018), Ambikabathy *et al.* (2019), Gamea (2019) *et al.*, Abu Shosha *et al.* (2020), Alsebaey *et al.* (2020), and Mousa *et al.* (2023).

Table 1. Analysis of variances for six studied traits of 34 crosses combined over two locations.

S.O.V	Df	DS days	PH cm	EH cm	LWR %	GYP ⁻¹ g	GY ard fed ⁻¹
Locations (Loc.)	1	109.14**	23324.25*	16056.01*	271.84**	304691.56**	503.43**
Reps/Loc.	4	4.31	2070.44	962.11	10.75	305.84	6.53
Genotypes (G)	33	12.66**	1011.06**	595.04**	8.73*	10292.56**	132.25**
Crosses (C)	32	12.32**	1039.46**	613.26**	8.66**	10047.51**	133.45**
Lines (L)	10	18.11**	2308.59**	1140.03**	7.97	14004.23**	180.30**
Testers (T)	2	42.82**	1337.82**	1558.55**	3.47	8600.44**	83.05**
Lines x Testers	20	6.38**	375.06**	255.34**	9.52*	8213.86**	115.05**
G x Loc	33	1.27	273.22*	232.63**	8.32*	2054.16**	26.90**
C x Loc.	32	0.64	138.92	116.68	4.09	826.92*	10.91**
Lines x Loc.	10	1.61	392.38**	398.03	4.99	1184.93*	19.75**
Testers x Loc.	2	1.41	889.04**	255.82	4.93	509.55	2.07
L x T x Loc	20	1.09	159.44	148.78	10.08**	2002.73**	24.84**
Pooled error	134 ⁺	1.177	161.724	123.468	4.990	561.749	5.280

*, ** significant at 0.05 and 0.01 level of probability, respectively

Mean performance

Table 2 summarizes the average performance of 33 maize crosses and the yellow check hybrid SC.168 across two locations for the six studied traits. The results revealed promising findings for several crosses: 26 crosses matured significantly earlier than the check hybrid SC.168 (61.83 days), ranging from 56.50 days for L4 x T2 to 63.50 days for L1 x T3. Although 14 crosses did not differ significantly from the check (235.50 cm), L5 x T3 (122.50 cm), L6 x T3 (114.13 cm), and L11 x T3 (120.67 cm) achieved significantly shorter

plant height. Eleven crosses exhibited 100% resistance to late wilt disease. Four crosses (L2 x T2, L10 x T1, L11 x T1, and L11 x T2) yielded higher than the check hybrid (279.18 g) with significantly higher yields. Four crosses (L2 x T2, L10 x T3, L11 x T1, and L11 x T2) yielded significantly higher yields than the check (31.46 ard fed⁻¹). While 5 others showed comparable performance. Based on these findings, these promising crosses warrant further evaluation in advanced trials to confirm their potential contributions to breeding

programs aimed at developing superior maize hybrids with improved agronomic characteristics and stress tolerance

Table 2. Mean performances of 33 crosses and yellow check hybrids (SC.168) for six studied traits combined over two locations.

Cross	DS days	PH cm	EH cm	LWR %	GYP ⁻¹ G	GY ard fed ⁻¹
L ₁ x T ₁	59.83	240.83	134.17	97.33	256.74	28.21
L ₁ x T ₂	59.83	236.83	131.33	97.33	257.33	32.55
L ₁ x T ₃	63.50	243.33	136.50	100.00	259.08	31.23
L ₂ x T ₁	61.33	260.00	151.00	98.00	287.45	33.44
L ₂ x T ₂	60.00	256.17	151.83	100.00	312.67	34.99
L ₂ x T ₃	62.00	258.50	147.00	100.00	244.93	31.12
L ₃ x T ₁	59.33	231.67	127.83	98.67	182.26	19.68
L ₃ x T ₂	59.17	246.50	141.67	100.00	302.05	33.64
L ₃ x T ₃	61.33	244.67	134.17	98.67	258.49	27.48
L ₄ x T ₁	57.00	240.17	135.33	100.00	226.21	26.80
L ₄ x T ₂	56.50	221.50	126.00	98.67	254.76	29.29
L ₄ x T ₃	60.00	227.50	128.67	96.00	191.62	22.37
L ₅ x T ₁	58.83	243.67	140.00	99.33	238.11	27.83
L ₅ x T ₂	56.83	230.00	132.17	100.00	238.54	28.03
L ₅ x T ₃	60.17	222.33	122.50	97.33	199.54	22.50
L ₆ x T ₁	59.33	232.33	129.67	98.00	261.90	30.13
L ₆ x T ₂	58.17	226.83	128.67	97.33	195.89	21.44
L ₆ x T ₃	60.17	223.83	114.17	99.33	233.94	28.89
L ₇ x T ₁	59.67	242.83	145.50	96.67	236.51	25.75
L ₇ x T ₂	60.00	222.50	124.33	99.33	195.00	20.83
L ₇ x T ₃	61.50	224.17	129.50	98.67	230.18	23.52
L ₈ X T ₁	60.17	268.33	158.83	98.00	297.49	28.13
L ₈ X T ₂	60.33	246.33	146.50	100.00	274.54	30.70
L ₈ X T ₃	59.83	249.67	138.50	98.67	282.21	32.10
L ₉ X T ₁	59.67	223.33	125.83	98.00	197.81	22.72
L ₉ X T ₂	58.33	232.83	129.17	98.00	250.31	27.95
L ₉ X T ₃	59.83	242.67	130.17	96.67	246.35	27.75
L ₁₀ X T ₁	60.00	261.33	148.83	100.00	315.05	30.39
L ₁₀ X T ₂	60.33	250.50	139.00	98.00	270.88	31.62
L ₁₀ X T ₃	60.67	253.83	135.00	100.00	293.69	36.44
L ₁₁ X T ₁	60.00	248.67	146.33	100.00	331.42	34.74
L ₁₁ X T ₂	61.50	231.00	131.33	100.00	313.11	35.85
L ₁₁ X T ₃	59.00	225.17	120.67	99.33	192.52	20.37
SC 168	61.83	235.50	136.67	97.33	279.18	31.46
LSD 0.05	1.23	14.39	12.57	2.53	26.82	2.60
0.01	1.61	18.91	16.53	3.32	35.25	3.42
Grand X	59.82	239.69	135.22	98.71	252.38	28.44

General combining ability effects.

Table 3 summarizes (GCA) of 11 inbred lines and 3 testers for six maize traits studied across two locations. It's important to note that for (DS), (PH), and (EH), negative GCA values indicate desirable early maturity, shorter plants, and lower ear placement, respectively, while positive values are preferred for the other traits. Inbred lines L₄, L₅, L₆, and L₉ displayed favorable negative GCA effects for both DS and PH, making them promising candidates for breeding early maturing and compact maize varieties. Additionally, L₇ exhibited a desirable negative GCA effect for PH. Inbred lines L₄, L₆, and L₉ also possessed significant negative GCA effects for EH, suggesting their potential for breeding cultivars with lower ears. L₁₁ had a positive and significant GCA effect for percent plant resistance to late wilt disease, highlighting its value for incorporating resistance into new hybrids. Inbred lines L₂, L₈, L₁₀, and L₁₁ demonstrated favorable positive GCA effects for both GYP-1 and GY ard fed⁻¹, indicating their potential to contribute to high-yielding offspring. L₁ also contributed positively to GY ard fed⁻¹. Among the testers, T₂ emerged as a valuable candidate due to its desirable negative GCA effects for DS and PH, promoting

earliness and shorter plants. Remarkably, it also exhibited positive and significant GCA effects for both GYP-1 and GY ard fed⁻¹, promoting higher yield potential. Therefore, based on these findings, incorporating these identified lines and the T₂ tester into breeding programs offers promising opportunities for developing new maize hybrids with improved agronomic characteristics and enhanced yield potential.

Table 3. GCA effects of eleven inbred lines and three testers for six studied traits combined over two locations.

Lines	DS days	PH cm	EH cm	LWR %	GYP ⁻¹ G	GYard fed ⁻¹
L1	1.23**	0.64	-1.22	-0.48	5.34	2.23**
L2	1.29**	18.5**3	14.73**	0.63	29.30**	4.74**
L3	0.12	1.25	-0.66	0.40	-4.78	-1.50**
L4	-1.99**	-9.97**	-5.22*	-0.48	-28.19**	-2.29**
L5	-1.21**	-7.69**	-3.66	0.18	-26.98**	-2.32**
L6	-0.60*	-12.03**	-11.05**	-0.48	-21.81**	-1.62**
L7	0.57*	-9.86**	-2.11	-0.48	-31.81**	-5.07**
L8	0.29	15.09**	12.73**	0.18	32.36**	1.87**
L9	-0.55*	-6.75**	-6.83**	-1.15*	-20.89**	-2.30**
L10	0.51*	15.53**	5.73*	0.63	40.82**	4.38**
L11	0.34	-4.75	-2.44	1.07*	26.64**	1.88**
SE gi (L)	0.24	2.59	2.36	0.51	5.56	0.54
LSD 0.05	0.48	5.07	4.62	1.01	10.91	1.05
0.01	0.62	6.66	6.07	1.32	14.33	1.38
T1	-0.26*	5.14**	5.09**	-0.16	4.98	-0.45
T2	-0.64**	-3.24*	-0.49	0.26	8.08**	1.28**
T3	0.90**	-1.90	-4.60**	-0.10	-13.06**	-0.82**
S.E. gi (T)	0.13	1.35	1.23	0.27	2.91	0.28
LSD 0.05	0.25	2.65	2.41	0.53	5.70	0.55
0.01	0.33	3.48	3.17	0.69	7.48	0.72

*** significant at 0.05 and 0.01 level of probability, respectively

Specific combining ability

Table 4 presents estimates of (SCA) for six traits across two locations (Damietta and Dakahlia private farms) for 33 maize crosses. Four crosses (L₁ x T₁, L₅ x T₂, L₈ x T₃, and L₁₁ x T₃) displayed significantly negative SCA effects for days to 50% silking, indicating earlier maturity. Two crosses each (L₃ x T₁, L₉ x T₁ for plant height and L₃ x T₁, L₇ x T₂ for ear height) showed significantly negative SCA effects, suggesting shorter plants and lower ear placement, respectively. Two crosses (L₁ x T₃ and L₄ x T₁) had positive and significant SCA effects for percent plant resistance to late wilt disease, indicating improved tolerance. Notably, 9 and 10 crosses exhibited positive and significant SCA effects for (GYP⁻¹) and (GY ard fed⁻¹), respectively. Five crosses (L₃ x T₂, L₄ x T₂, L₆ x T₁, L₁₁ x T₁, and L₁₁ x T₂) stood out with positive and significant SCA effects for both GYP⁻¹ and GY ard fed⁻¹. These promising crosses hold potential for inclusion in maize breeding programs to enhance the targeted traits.

Table 5 presents estimates of genetic parameters and their interaction with the two studied locations (Damietta and Dakahlia Farms) for the six traits studied. Except for EH and LWR%, σ^2 SCA exhibited higher values than σ^2 GCA for all studied traits. These findings imply a prominent role of non-additive gene action in the inheritance of these traits. These findings are consistent with prior reports of Bayisa *et al.*, (2008), Mousa and Aly (2012), Aly (2013), El-Hosary and El-gammal (2013), Abo yousef (2016), Abu shosha *et al.*, (2020), Alsebaey *et al.*, (2020) and Aly *et al.*, (2023). The

lines exerted a greater influence compared to the testers across all studied traits, suggesting their pivotal role in enhancing these traits. These findings support those reported by Aly (2013), Gamea (2019), Aly *et al.*, (2023) and Mousa *et al.*, (2023).

Table 4. SCA effects of 33 crosses for six studied traits combined over two locations: Damietta and Dakahlia Farms.

Crosses	DS days	PH cm	EH cm	LWR %	GYP ⁻¹ g	GY ard fed ⁻¹
L ₁ x T ₁	-0.96*	-4.64	-4.92	-0.73	-5.95	-2.00*
L ₁ x T ₂	-0.58	-0.26	-2.18	-1.15	-8.47	0.61
L ₁ x T ₃	1.54**	4.90	7.10	1.88*	14.42	1.39
L ₂ x T ₁	0.48	-3.36	-4.03	-1.17	0.79	0.71
L ₂ x T ₂	-0.47	1.18	2.38	0.40	22.91**	0.53
L ₂ x T ₃	-0.02	2.18	1.65	0.77	-23.70**	-1.24
L ₃ x T ₁	-0.35	-14.42**	-11.81**	-0.28	-70.32**	-6.80**
L ₃ x T ₂	-0.14	8.79*	7.60	0.63	46.37**	5.43**
L ₃ x T ₃	0.48	5.63	4.21	-0.34	23.95*	1.37
L ₄ x T ₁	-0.57	5.30	0.25	1.94*	-2.97	1.10
L ₄ x T ₂	-0.69	-4.98	-3.51	0.18	22.49*	1.86*
L ₄ x T ₃	1.26**	-0.32	3.26	-2.12*	-19.52*	-2.96**
L ₅ x T ₁	0.48	6.53	3.36	0.61	7.73	2.17*
L ₅ x T ₂	-1.14**	1.24	1.10	0.85	5.06	0.63
L ₅ x T ₃	0.65	-7.76	-4.46	-1.45	-12.79	-2.80**
L ₆ x T ₁	0.37	-0.47	0.41	-0.06	26.35**	3.77**
L ₆ x T ₂	-0.41	2.40	4.99	-1.15	-42.77**	-6.66**
L ₆ x T ₃	0.04	-1.93	-5.40	1.21	16.42	2.89*
L ₇ x T ₁	-0.46	7.86	7.30	-1.39	10.97	2.84*
L ₇ x T ₂	0.25	-4.10	-8.29*	0.85	-33.64**	-3.82**
L ₇ x T ₃	0.21	-3.76	0.98	0.55	22.68*	0.98
L ₈ x T ₁	0.32	8.41	5.80	-0.73	7.76	-1.72
L ₈ x T ₂	0.86*	-5.21	-0.95	0.85	-18.29	-0.89
L ₈ x T ₃	-1.18**	-3.21	-4.85	-0.12	10.53	2.62**
L ₉ x T ₁	0.65	-14.75**	-7.64	0.61	-38.66**	-2.97**
L ₉ x T ₂	-0.30	3.13	1.27	0.18	10.74	0.54
L ₉ x T ₃	-0.35	11.63**	6.37	-0.79	27.92**	2.44
L ₁₀ x T ₁	-0.07	0.97	2.80	0.83	16.87	-1.97*
L ₁₀ x T ₂	0.64	-1.48	-1.45	-1.60	-30.41**	-2.47**
L ₁₀ x T ₃	-0.57	0.52	-1.35	0.77	13.54	4.45**
L ₁₁ x T ₁	0.10	8.58	8.47*	0.38	47.43**	4.87**
L ₁₁ x T ₂	1.97**	-0.71	-0.95	-0.04	26.01**	4.25**
L ₁₁ x T ₃	-2.07**	-7.87	-7.52	-0.34	-73.44**	-9.13**
SE Sij	0.42	4.48	4.08	0.89	9.64	0.93
LSD 0.05	0.82	8.78	8.01	1.74	18.89	1.82
0.01	1.08	11.54	10.52	2.29	24.82	2.39

*,** significant at 0.05 and 0.01 level of probability, respectively

Table 5. Genetic parameters and their interactions with locations combined for the studied traits.

Genetic parameters	DS days	PH cm	EH cm	LWR %	GYP ⁻¹ G	GY ard fed ⁻¹
σ ² GCA (aver.)	0.69	28.15	24.34	0.02	248.93	2.88
σ ² SCA (aver.)	0.88	35.94	17.76	-0.09	1035.19	15.04
σ ² GCA aver. x Loc	0.02	22.81	9.69	0.00	13.59	0.27
σ ² SCA average x Loc	-0.03	-0.76	8.44	1.70	480.33	6.52
Contribution of Lines	45.93	69.40	58.09	28.76	43.56	42.22
Contribution of Tester	21.72	8.04	15.88	2.51	5.35	3.89
Contribution of L x T	32.35	22.55	26.02	68.73	51.09	53.89

Table 6 presents the heterotic groups formed using the HSGCA method for grain yield ard fed⁻¹ across two locations (Damietta and Dakahlia private farms). The inbred lines were categorized based on Fan *et al.* (2009). The findings showed that the inbred lines were categorized into three heterotic groups based on the three testers: group 1 (T1) comprised L3 and L9; group 2 (T2) consisted of L5, L6, and L7; and group 3 (T3) included L4 and L11. However, the method failed to

classify the four inbred lines: L1, L2, L8, and L10. HSGCA was found to be more effective for breeding purposes than SCA (Fan *et al.*, 2009 and Mahato *et al.*, 2021). Breeders can leverage these results to carry out crosses for new hybrids. Notably, selecting lines from different heterotic groups is crucial for optimal performance, while crosses within the same group should be avoided. (Lee 1995, Alsebaey 2020, Kumar *et al.*, 2022 and Aly *et al.*, 2023).

Table 6. Heterotic groups using (HSGCA) for grain yield ard fed⁻¹ over two locations.

Lines	GY ard fed ⁻¹		
	Group1 (T1)	Group2 (T2)	Group3 (T3)
L1	0.23	2.83	3.62
L2	5.46	5.27	3.50
L3	-8.30#	3.92	-0.13
L4	-1.19	-0.43	-5.25#
L5	-0.15	-1.69#	-5.12
L6	2.15	-8.28#	1.27
L7	-2.23	-8.89#	-4.10
L8	0.15	0.98	4.49
L9	-5.27#	-1.76	0.14
L10	2.41	1.90	8.82
L11	6.76	6.13	-7.24#

means that this inbred line belongs to tester group.

Table 7 displays all feasible simple correlation coefficients among the studied traits across the two locations. A positive and statistically significant correlation was observed between GY and PH (0.618**), EH (0.529**), LWR% (0.425*), and GYP-1 (0.905**), this implies that indirectly selecting for correlated traits alongside yield could be beneficial and efficient in enhancing grain yield. These results are consistent with the findings of Abd El-Azeem *et al.* (2022) and Aly *et al.* (2022). PH was possessed the positive and highly correlation rank with each of EH (0.905**), GYP⁻¹ (0.679**) and GY (0.529**). Significant positive correlation values were observed between EH and both GYP-1 (0.679**) and GY (0.529**). The correlation coefficient between LWR% showed a positive and highly significant association with GYP⁻¹ (0.414*) and GY (0.425*). These results align with the findings of Abd El-Azeem *et al.* (2021) and Aly *et al.*, (2022).

Table 7. Correlation coefficient as combined over two locations.

	DS days	PH cm	EH cm	LWR %	GYP ⁻¹ g	GY ard fed ⁻¹
DS days	---	0.343	0.244	0.081	0.252	0.268
PH cm		---	0.905**	0.237	0.710**	0.618**
EH cm			---	0.215	0.679**	0.529**
LWR%				---	0.414*	0.425*
GYP ⁻¹ g					---	0.905**
GY ard fed ⁻¹						---

CONCLUSION

In this study, the combining abilities variances were estimated and the role of eleven yellow maize lines in testcross. Desirable superior lines were identified, hence resulting single crosses for yielding potentiality recommending future investigations in maize breeding programs. The new eleven yellow maize lines were categorized into three heterotic groups using (HSGCA) in line x tester mating design. These results enable the breeders carrying out crosses to produce new hybrids, then they must

take considerable selection lines from different heterotic groups to produce good hybrids and do not cross the lines from the same heterotic group.

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تقدير القياسات الوراثية، القدرة على التآلف والمجموعات الهجينية لسلاسل صفراء جديدة من الذرة الشامية باستخدام موديل السلالة في الكشف خلال موقعين

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الملخص

طريقة تحليل السلالة في الكشف واحدة من الأدوات الفعالة لتقدير تأثيرات القدرة العامة والخاصة على التآلف والتي تساعد في انتخاب الأباء والهجن المرغوبة. أجرى هذا البحث باستخدام إحدى عشرة سلالة صفراء من الذرة الشامية وتهجينهم مع ثلاثة كشافات مشتقين من مصادر محلية ومستوردات خلال الموسم الزراعي 2022. وفي الموسم 2023 تم تقييم الـ 33 هجيناً الناتجة بالإضافة إلى هجين فردي الأصفر 168 كهجين مقارنة محصولية، وذلك بموقعي مزارع خاصة بمدينة كفر سعد محافظة دمياط وقرية شنياسة بمركز أجا محافظة القهيلية. أظهرت النتائج أن مربعات القيم لكل من التراكيب الوراثية ومجزئتها (الهجن، السلالات، الكشافات والتفاعل بين السلالات والكشافات) معنوية أو عالية المعنوية لكافة الصفات تحت الدراسة من خلال نتائج تحليل التباين المشترك عبر الموقعين. امتلكت ثلاثة سلالات وهي سلالة 4، سلالة 6 وسلالة 9 أفضلية في قدرتها العامة على التآلف سالبة ومعنوية (مرغوبة) تجاه التبيكر وقصر النبات وأفضلية موقع الكوز على النبات. كما أظهرت أربعة سلالات وهي سلالة 2، سلالة 8، سلالة 10 وسلالة 11 أفضلية في قدرتها الانتلافية موجبة ومعنوية تجاه قدرتها على زيادة محصول الحبوب. امتلكت خمسة هجن وهي سلالة 3 x سلالة 2، سلالة 4 x سلالة 2، سلالة 6 x سلالة 1، سلالة 11 x سلالة 1 وسلالة 11 x سلالة 2 قدرة خاصة على التآلف موجبة ومعنوية لصفتي محصول الحبوب نبات¹ والمحصول أردب فدان¹. تم تصنيف السلالات تحت الدراسة إلى ثلاث مجموعات هجينية طبقاً للكشافات الثلاثة باستخدام (HSGCA) لصفة محصول الحبوب وكانت هذه الطريقة غير فعالة في تصنيف أربعة سلالات ووضعهم في أي من المجموعات الهجينية الثلاثة. لذا يمكن استخدام هذه السلالات داخل المجموعات الهجينية المختلفة في برامج التربية لإعطاء فرصة للمربي لانتخاب أفضل الأباء لإنتاج هجن جديدة مبشرة ذات قدرة محصولية عالية.