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ASSESSMENT OF COMBINING ABILITY AND MEAN PERFORMANCE OF YIELD AND ITS CONTRIBUTING TRAITS IN MAIZE THROUGH LINE × TESTER ANALYSIS

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ABSTRACT

Assessing combing ability is crucial in maize breeding program in order to produce new highly productive hybrids and adapted to diverge environments. This investigation was carried out to identify the good combiners for maize grain yield and associated characteristics. Besides, picking up promising hybrids for studied traits. Ten promising inbreds were crossed to the two testers inbreds viz. GM-1002 and SD-3120 at Gemmiza Research Station, Agricultural Research Center (ARC), Egypt in 2022. Twenty generated hybrids were evaluated alongside with two checks viz. SC-168 and Corteva SC-3444 at three locations representing a wide range of climate and soil conditions. The trail was laid out in RCBD with three replications in each location. All the recommend agronomic package were adopted to maintain healthy plants till harvest. Data were collected on days to 50 % silking, plant and ear heights, ear length, ear diameter and grain yield (ardab/feddan). The results showed highly significant mean squares for locations and crosses. The non-addictive gene effect was the predominance for all measured characters excluding grain yield. The parental lines GM-53, GM-55 and GM-57 might be utilized as good combiners for earliness. Similarly, the lines GM-53 and GM-62 could be utilized for improving grain yield trait. Remarkably, the crosses GM-48 × SD-3120, GM-53 × SD-3120 and GM-61 × SD-3120 significantly out-performed the top check hybrid and could be considered as promising hybrids. These crosses would be advanced for multi-location trails in order to evaluate the stability before releasing as commercial hybrids by Maize Research Department, FCRI, Agricultural Research Center.

Key words: ***Nod-additive, Superiority, GCA, SCA, Gene action.***

INTRODUCTION

Maize (*Zea mays* L. ssp. *mays*) is a significant global staple crop after wheat and rice (Singh *et al* 2021). Maize is referred to as the “Queen of cereal crops” and it is employed as a model crop due to its high potential production (Singh *et al* 2023). Egypt relies on maize for food, feed and raw materials for some industrial goods. Yellow maize is a primary ingredient in animal feed formulations for Egypt's poultry, dairy and livestock industries. The cultivated area in Egypt reached one million hectares during 2022. The total production was 7.7 million metric tons with an average of 7.69 ton per hectare (Economic Sector 2022). Albeit, Egypt imports annually yellow corn to bridge the gap between domestic supply and demand. Egypt has adopted numerous measures to increase the total production and save the hard currency. Developing new high yielding maize hybrids is the key measures to address the disparity between production and consumption of maize, ensuring food security, economic growth, and sustainable development in the maize sector.

Line × Tester (L × T) method had been suggested by Kempthorne (1957) to evaluate combining ability of parental inbreds and select superior hybrids for further development. L × T analysis has been adopting by breeders to systematically assess combining ability of different parental combinations and identify hybrids with desirable characters such as high yielding, earliness, and stress tolerance (Ismail *et al* 2018; Abdul Hamed *et al* 2020; Patil *et al* 2020; Ismail *et al* 2022; Job and Igyuve, 2022; Subba *et al* 2022; Ismail *et al* 2023b). By partitioning the phenotypic variance into components attributed to general combining ability (GCA) and specific combining ability (SCA), breeders can gain insights into the kind of gene action controlling the inheritance of complex characters. The preponderance of SCA over GCA (non-additive gene action) for yield and various characters has been acknowledged by Adewale *et al* (2018); Italia *et al* (2022); Adewale *et al* (2023). While, the preponderance of GCA over SCA action (additive gene action) were observed by Dhasarathan *et al* (2015); Ertiro *et al* (2017); Ismail *et al* (2023b) and Tabu *et al* (2023). The disparity between researchers maybe referred to the source of inbred lines, environments (soil and climate). The investigation was conducted to assess combing ability effects for novel inbreds for yield and other traits and to identify promising crosses which may forward to further evaluation before releasing.

MATERIALS AND METHODS

Genetic materials: Ten of inbreds created by Maize Research Program at Gemmiza Research Station, Agricultural Research Center (ARC) Egypt, coded as GM-48, GM-53, GM-54, GM-55,GM-57, GM-58, GM-59, GM-60,GM-61 and GM-62 used as female parents: two narrow base testers served as male parents viz., inbred GM-1002 (T_1) and inbred SD-3120 (T_2) and two check hybrids *i.e.* Single cross (SC-168) developed by ARC and single cross (SC-3444) as a commercial hybrid from Corteva Agriscience.

Experimental design and field management

The two testers were crossed with ten female inbreds in 2022 season at Gemmiza Research Station based on the design of line × tester to generate 20 F_1 crosses according to Kempthorne (1957). In season 2023, the formed 20 F_1 crosses plus with two checks were assessed at diverge locations in climate and soil viz., Gemmiza, Ismailia and Sids Agricultural Research Stations. A randomized complete blocks design with three replications was adopted to lay out the experiment in each location. One row of 6 meters long considered as plot size for each entry. Plants were spaced 0.25 meters apart from one another and rows apart by 0.8 meters. Thinning was deployed to maintain one plant for each hill. All prescribed agronomic practices were adhered to in order to maintain a good crop standing.

Data collection

Number of days to 50% silking, plant height (cm), ear height (cm), ear length (cm), ear diameter (cm) and grain yield (kg) per plot adjusted at 15.5% grain moisture and finally converted to(ard/fed), (one ardab = 140 kg and one feddan= 4200 m^2).

Statistical analysis

In accordance with Snedecor and Cochran (1989), combined analysis of variance (ANOVA) was adopted to the collected data following a homogeneity of error variance test among locations for measured characters. Mean comparisons were performed using the least significant difference (LSD). General combining ability (GCA) and specific combining ability (SCA) estimates were calculated for measured characters according to Kempthorne (1957) using SAS software (SAS-Institute Inc. 2008).

RESULTS AND DISCUSSION

Analysis of variance:

Combined ANOVA of the crosses over three environments showed high significance mean squares for all measured traits (Table.1). High significance mean squares were recorded by Location for all measured characters, evincing the existence of diversity amongst the three locations in soil and climate condition.

Table 1 Mean squares for DS, PH, EH, EL, ED and GY traits over three locations.

SOV	df	Mean Squares					
		DS (day)	PH (cm)	EH (cm)	EL (cm)	ED (cm)	GY (ard/fed)
Location (Loc)	2	690.50**	35277.35**	7834.30**	66.77**	6.66**	628.45**
Rep/Loc	6	3.43	652.04	210.70	0.34	0.08	23.28
Crosses (C)	19	21.02**	2201.54**	1038.33**	4.22**	0.14**	156.74**
C × Loc	38	3.62**	462.14**	290.50**	3.51*	0.10	26.18**
Lines (L)	9	24.81**	3469.02**	1674.40**	4.63**	0.18*	71.34**
Testers (T)	1	18.05**	1742.22**	1355.75**	6.65**	0.05	1785.59**
L × T	9	17.56**	985.11**	366.99**	3.53*	0.11	61.16**
L × Loc	18	5.70**	557.22**	217.32**	4.12**	0.13*	17.66*
T × Loc	2	3.35	560.55**	1442.50**	3.11	0.42**	95.60**
L × T × Loc	18	1.57	356.13**	235.68**	2.95	0.03	26.99**
Pooled error	114	1.92	79.20	62.13	1.62	0.06	8.81

***, ** Denoting significance at probability levels of 0.05 and 0.01 correspondingly.**
DS= Days to 50% silking (day), PH= Plant height (cm), EH= Ear height (cm), EL= Ear length (cm), ED= Ear diameter (cm), GY= Grain yield (ard/fed).

These findings are in agreement with those acquired by Ismail *et al* (2018); Tesfaye *et al* (2019); Ismail *et al* (2022) and Ismail *et al* (2023b). Likewise, crosses mean squares for all examined characters were high significance, proving the existence of genetic diversity amongst the studied genotypes. Highly significant differences among the crosses for the majority of the studied attributes has been reported by (Akinwale *et al* 2014; Tulu *et al* 2018; Abebe *et al* 2020; Tulu *et al* 2021 and Nivethitha *et al* 2023). Crosses × locations interaction showed significance or high significance for all attributes excluding ear diameter, revealing that performance of crosses are contrasting from location to another and underscored the importance of identifying the high yielding and stable crosses over environments (Amegbor *et al* 2017). Contrastively, crosses interaction with locations were insignificant for ear diameter, revealing that these crosses are consistent across locations for this trait.

Analysis of variance for combing ability

Data in Table 1. showed that line mean squares were significance or high significance for all measured attributes, demonstrating the existence of significant variation between inbreds. The displayed results coincide with earlier outcomes published by Chandel *et al* (2019); Diviya *et al* (2022); Ismail *et al* (2022); Lal *et al* (2022) and Tabu *et al* (2023). Similarly, mean squares of testers and line x tester displayed high significance for all measured attributes excluding ear diameter.

The significant GCA (line), GCA (tester) and SCA (line x tester) obtained for most examined characters encouraged that additive and non-additive gene effects were played important role in the set of lines (Adewale *et al* 2023 and Ismail *et al* 2023b). Significant L × Loc mean squares were detected for all the traits under study. Similarly, T × Loc mean squares were high significance for measured characters except days to silking and ear length. The interaction of L × T × Loc was highly significant for plant height, ear height and grain yield. The existence significant of L × Loc, T × Loc and L × T × Loc for most of traits showing that these traits are impacted by location.

Mean Performance:

Table 2. displayed mean performance of twenty crosses plus two checks of all examined traits. Regarding to days to 50% silking, all the crosses were significant earlier compared to the earliest check SC-168 (61day), except the cross GM-54 × GM-1002. The lowest value for this trait (57 day) was obtained by seven crosses. Therefore, these crosses might be exploited to develop hybrids with early maturing that can withstand drought stress. Five crosses had significant lowest values compared to the superior check SC-3444 for plant height trait. Whereas,

the only cross GM-60 × GM-1002 showed significant value for ear height compared to the same check (SC-3444).

Table. 2. Mean performance of DS, PH, EH, EL, ED and GY attributes of 20 maize crosses throughout three locations.

Characters / Crosses	DS (day)	PH (cm)	EH (cm)	EL (cm)	ED (cm)	GY (ard/fed)
GM-48 × GM-1002	58	270.0	135.3	19.33	4.64	21.67
GM-48 × SD-3120	59	279.7	152.7	19.82	4.64	32.32
GM-53 × GM-1002	57	262.9	128.3	19.63	5.00	27.96
GM-53 × SD-3120	57	271.2	139.1	18.49	4.89	31.93
GM-54 × GM-1002	64	222.9	116.9	19.59	4.71	16.15
GM-54 × SD-3120	58	264.6	129.8	19.86	4.69	29.19
GM-55 × GM-1002	57	267.4	139.9	17.42	4.53	21.67
GM-55 × SD-3120	57	257.0	129.7	19.24	4.80	29.75
GM-57 × GM-1002	57	240.2	118.7	19.29	4.73	23.41
GM-57 × SD-3120	57	243.3	123.6	18.66	4.84	29.66
GM-58 × GM-1002	58	238.6	120.8	18.87	4.76	24.61
GM-58 × SD-3120	58	232.8	116.1	18.61	4.47	25.23
GM-59 × GM-1002	60	246.3	119.4	19.28	4.69	22.76
GM-59 × SD-3120	58	240.6	117.1	20.42	4.67	26.01
GM-60 × GM-1002	58	226.9	106.4	18.73	4.67	22.73
GM-60 × SD-3120	58	238.3	119.4	19.26	4.78	29.02
GM-61 × GM-1002	59	240.0	121.1	18.57	4.64	23.12
GM-61 × SD-3120	59	251.8	132.2	19.04	4.73	30.32
GM-62 × GM-1002	58	248.6	132.9	17.96	4.49	26.08
GM-62 × SD-3120	58	246.8	135.0	19.11	4.71	29.72
Check SC-168	61	247.6	133.6	18.96	4.73	24.01
Check SC-3444	63	246.9	123.1	19.93	4.80	26.04
LSD 0.05	1	8.3	7.4	1.20	0.25	2.78
LSD 0.01	2	10.8	9.6	1.55	0.32	3.61

DS= Days to 50% silking (day), PH= Plant height (cm), EH= Ear height (cm), EL= Ear length (cm), ED= Ear diameter (cm), GY= Grain yield (ard/fed).

The crosses with short plant height could be utilized in plant density tolerance program to increase the productivity indirectly through increasing the plant population in feddan. The cross GM-59 × SD-3120 significantly outperformed the check SC-168 (18.96 cm) for ear length trait. Nevertheless, all the crosses did not differ significantly from the check SC-3444 for same character except four crosses. For ear diameter, the cross GM-53 × GM-1002 surpassed significantly the check SC-168. While the three crosses viz. GM-53 × GM-1002, GM-53 × SD-3120 and GM-57 × SD-3120 insignificantly surpassed the best check for the same trait. Concerning grain yield trait, eight crosses significantly out-yielded the best check hybrid SC-3444. The superior three cross amongst them were GM-48 × SD-3120 (32.32 ard/fed), followed by GM-53 × SD-3120 (31.93 ard/fed) then GM-61 × SD-3120 (30.32 ard/fed). Intriguingly, these crosses were also early for days to 50% silking. Thereby, these crosses might be exploited for commercial cultivation of high-yielding hybrids after undergoing further multi-location trials to determine the yield stability in diverse environments.

Combining ability variance

δ^2 GCA lines and testers, δ^2 SCA for line x tester along with their interaction with locations are shown in Table 3. Displayed results stated that δ^2 GCA-L was greater than δ^2 GCA-T for DS, PH and EH traits, indicating that proportion of line in total variance for these traits was bigger than tester proportion. Contrastively, δ^2 GCA-T was greater than GCA-L for EL and GY, underscored the importance of tester in total variance for these traits. The variance resulting from SCA was greater than GCA variance for measured traits excluding GY, representing the predominance of non-additive gene action in the inheritance of these traits. Whereas, the additive gene action was main player in the inheritance of GY since GCA variance was greater than SCA variance. The prevailing of SCA over GCA action (non-additive gene action) for majority of assessed traits aligns with the studies of Adewale *et al* (2018); Italia *et al* (2022); Adewale *et al* (2023). While, The prevailing of GCA over SCA action (additive gene action) is in line with the outcomes of Dhasarathan *et al* (2015); Ismail *et al* (2023b); Tabu *et al* (2023).

Table 3. Variance of general combining ability (GCA) and specific combining ability (SCA)

Parameter	DS (day)	PH (cm)	EH (cm)	EL (cm)	ED (cm)	GY (ard/fed)
$\delta^2_{GCA\text{-}L}$	0.173	126.823	73.654	-0.004	-0.002	1.084
$\delta^2_{GCA\text{-}T}$	-0.014	6.141	-2.423	0.033	-0.005	18.398
$\delta^2_{GCA\ (average)}$	0.017	26.255	10.257	0.027	-0.005	15.512
δ^2_{SCA}	1.777	69.887	14.590	0.065	0.009	3.796
$\delta^2_{GCAL \times Loc}$	0.688	33.516	-3.060	0.196	0.017	-1.556
$\delta^2_{GCAT \times Loc}$	0.059	6.814	40.227	0.005	0.013	2.287
$\delta^2_{GCA \times Loc\ (average)}$	0.164	11.265	33.013	0.037	0.014	1.646
$\delta^2_{SCA \times Loc}$	-0.117	92.309	57.849	0.442	-0.012	6.062

 # All negative value referred to zero.
DS= Days to 50% silking (day), PH= Plant height (cm), EH= Ear height (cm), EL= Ear length (cm), ED= Ear diameter (cm), GY= Grain yield (ard/fed).

The interaction of δ^2 GCA-L × Loc was greater than the interaction of δ^2 GCA-T × Loc for DS, PH, EL and ED traits, showing that additive gene action for inbred lines was impacted greater by locations than tester additive gene action. Contrastively, the additive gene action for tester was more impacted by location than lines additive gene action for EH and GY. The interaction variance of δ^2 SCA × Loc was greater than δ^2 GCA × Loc for PH, EH, EL and GY traits, revealing that the non-additive gene action influenced greater by location than the additive gene action for these traits. Whereas, the additive gene action was impacted greater than the non-additive gene action for DS and ED traits.

General combining ability effects:

The general combining ability effects ($\hat{g}_i$) of ten inbreds plus two testers for studied attributes are displayed in Table 4. Inbreds with favorable GCA effects could be invested to generate heterotic populations for additional enhancement and for producing high productive and multiple stress-tolerant hybrids. The results showed that, the tester GM-1002 possessed the desirable significant GCA effects for plant height and ear height characters. While the tester SD-3120 indicated the favorable significant GCA effects for grain yield and earliness. Thus, the tester SD-3120 was the common parent in all the outperformed crosses for grain yield.

Table 4. General combining ability effects ($\hat{g}_i$) of 10 inbreds and two testers for examined traits over three locations.

Characters / Inbred lines	DS (day)	PH (cm)	EH (cm)	EL (cm)	ED (cm)	GY (ard/fed)
GM-48	0.02	25.34**	17.27**	0.51	-0.060	0.82
GM-53	-1.36**	17.56**	7.00**	0.002	0.240**	3.78**
GM-54	2.69	-5.76**	-3.38	0.663*	-0.004	-3.49**
GM-55	-0.97**	12.73**	8.05**	-0.726*	-0.038	-0.45
GM-57	-1.08**	-7.71**	-5.61**	-0.087	0.084	0.36
GM-58	-0.13	-13.82**	-8.27**	-0.320	-0.093	-1.24
GM-59	0.69*	-6.04**	-8.44**	0.791**	-0.027	-1.78*
GM-60	-0.41	-16.87**	-13.77**	-0.064	0.018	-0.28
GM-61	0.69*	-3.60	-0.05	-0.253	-0.016	0.55
GM-62	-0.13	-1.82	7.22**	-0.526	-0.104	1.73*
S.E. g_i	0.32	2.09	1.85	0.30	0.05	0.69
S.E. g_i-g_j	0.46	2.96	2.62	0.42	0.08	0.98
GM-1002	0.31*	-3.11**	-2.74**	-0.192	-0.018	-3.15**
SD-3120	-0.31*	3.11**	2.74**	0.192	0.018	3.15**
S.E. g_i	0.14	0.93	0.83	0.13	0.02	0.31
S.E. g_i-g_j	0.20	1.32	1.17	0.18	0.03	0.44

***, ** Denoting significance at probability levels of 0.05 and 0.01 correspondingly.**

DS= Days to 50% silking (day), PH= Plant height (cm), EH= Ear height (cm), EL= Ear length (cm), ED= Ear diameter (cm), GY= Grain yield (ard/fed).

High significance and negative GCA effects for earliness were detected by the inbreds GM-53, GM-55 and GM-57. These inbreds could be used to good advantage in maize programs for breeding early maturing hybrids. The inbred lines GM-57, GM-58, GM-59 and GM-60 were identified as good combiners for developing new short stature maize hybrids since they had obtained the significance favorable GCA effects for plant and ear heights traits. The inbreds GM-54 and GM-59 for ear length and the inbred GM-53 for ear diameter recorded significant favorable GCA effects for these characters and could be served as good combiners for enhancing these characters. The two inbred lines GM-53 and GM-62 could play crucial role for producing new high yielding hybrids of maize because they had significant favorable GCA effects for grain yield.

Specific combining ability effects

Specific combining ability (SCA) effects of the 20 crosses for examined characters are placed in Table 5.

The (SCA) effects could assist breeders to detect heterotic pattern among genotypes in order to pick up promising single crosses for targeting traits (Lahane *et al* 2014). The cross GM-54 × SD-3120 displayed highly significant and negative (SCA) effects for earliness. This cross was significantly earlier than the earliest check hybrid. According to Shavrukov *et al* (2017) selecting early hybrids could be beneficial in breeding programs for drought tolerance due to the drought escape mechanism. Moreover, adopting of early maturing maize could facilitate in growing more than one crop in a year.

For plant height, the four crosses GM-54 × GM-1002, GM-55 × SD-3120, GM-58 × SD-3120 and GM-59 × SD-3120 displayed significant and negative SCA effect. Similarly, the significant favorable SCA effects were obtained by the two crosses GM-48 × GM-1002 and GM-55 × SD-3120 for ear height. None of the assessed crosses displayed significant positive SCA effects for ear length and ear diameter characters, representing that the two tester used in this study were poor combiners for those traits. Three crosses viz. GM-48 × SD-3120, GM-54 × SD-3120 and GM-58 × GM-1002 out of twenty crosses displayed significant positive SCA effects for grain yield. Surprisingly, the two crosses GM-48 × SD-3120 and GM-54 × SD-3120 significantly outperformed the best check hybrids for same trait.

Table. 5. Estimates of (SCA) effects of 20 cross combination for the examined traits.

Characters / Crosses	DS (day)	PH (cm)	EH (cm)	EL (cm)	ED (cm)	GY (ard/fed)
GM-48 × GM-1002	-0.76	-1.72	-5.92*	-0.05	0.01	-2.17*
GM-48 × SD-3120	0.76	1.72	5.92*	0.05	-0.01	2.17*
GM-53 × GM-1002	-0.37	-1.05	-2.64	0.76	0.07	1.16
GM-53 × SD-3120	0.37	1.05	2.64	-0.76	-0.07	-1.16
GM-54 × GM-1002	2.68**	-17.72**	-3.70	0.05	0.02	-3.37**
GM-54 × SD-3120	-2.68**	17.72**	3.70	-0.05	-0.02	3.37**
GM-55 × GM-1002	-0.20	8.33**	7.85**	-0.71	-0.11	-0.89
GM-55 × SD-3120	0.20	-8.33**	-7.85**	0.71	0.11	0.89
GM-57 × GM-1002	-0.42	1.55	0.30	0.50	-0.03	0.02
GM-57 × SD-3120	0.42	-1.55	-0.30	-0.50	0.03	-0.02
GM-58 × GM-1002	-0.15	6.00*	5.07	0.32	0.16	2.83**
GM-58 × SD-3120	0.15	-6.00*	-5.07	-0.32	-0.16	-2.83**
GM-59 × GM-1002	0.35	6.00*	3.91	-0.38	0.02	1.52
GM-59 × SD-3120	-0.35	-6.00*	-3.91	0.38	-0.02	-1.52
GM-60 × GM-1002	-0.53	-2.61	-3.75	-0.06	-0.03	0.007
GM-60 × SD-3120	0.53	2.61	3.75	0.06	0.03	-0.007
GM-61 × GM-1002	-0.42	-2.77	-2.81	-0.04	-0.02	-0.45
GM-61 × SD-3120	0.42	2.77	2.81	0.04	0.02	0.45
GM-62 × GM-1002	-0.15	4.00	1.68	-0.38	-0.09	1.32
GM-62 × SD-3120	0.15	-4.00	-1.68	0.38	0.09	-1.32
S.E S_{ij}	0.46	2.96	2.62	0.42	0.08	0.98
S.E. S_{ij}-S_{ik}	0.65	4.19	3.71	0.60	0.11	1.39

***, ** Denoting significance at probability levels of 0.05 and 0.01 correspondingly.**

DS= Days to 50% silking (day), PH= Plant height (cm), EH= Ear height (cm), EL= Ear length (cm), ED= Ear diameter (cm), GY= Grain yield (ard/fed).

Superiority%

Grain yield superiority percentages related to the checks SC.168 and SC. 3444, for the 20 F_1's crosses are placed in Table 6.

Table 6. Superiority% for 20 yellow single crosses over the two checks for the grain yield (ard/fed) over three locations.

Crosses	GY (ard/fed)	Superiority%	
		SC-168	SC-3444
GM-48 × GM-1002	21.67	-9.74	-16.78**
GM-48 × SD-3120	32.32	34.61**	24.10**
GM-53 × GM-1002	27.96	16.47**	7.38
GM-53 × SD-3120	31.93	32.99**	22.61**
GM-54 × GM-1002	16.15	-32.73**	-37.98**
GM-54 × SD-3120	29.19	21.58**	12.08*
GM-55 × GM-1002	21.67	-9.71	-16.76**
GM-55 × SD-3120	29.75	23.94**	14.26**
GM-57 × GM-1002	23.41	-2.50	-10.11
GM-57 × SD-3120	29.66	23.55**	13.90**
GM-58 × GM-1002	24.61	2.51	-5.49
GM-58 × SD-3120	25.23	5.11	-3.09
GM-59 × GM-1002	22.76	-5.20	-12.60*
GM-59 × SD-3120	26.01	8.33	-0.13
GM-60 × GM-1002	22.73	-5.30	-12.69*
GM-60 × SD-3120	29.02	20.88**	11.44*
GM-61 × GM-1002	23.12	-3.70	-11.21*
GM-61 × SD-3120	30.32	26.29**	16.43**
GM-62 × GM-1002	26.08	8.62	0.14
GM-62 × SD-3120	29.72	23.80**	14.14**

***, ** Denoting significance at probability levels of 0.05 and 0.01 correspondingly.**

Nine crosses out of twenty have shown positive superiority to the check hybrid SC-168 for grain yield trait. The superiority % ranged from -32.73** to 34.61** for the same check hybrid. The superiority % ranged from -37.98** to 24.10** relative to the check hybrid SC-3444. Interestingly, eight crosses displayed positive superiority % relative to SC-3444. The highly significant favorable superiority relative to both checks were displayed by the six hybrids GM-48 × SD-3120, GM-53 × SD-3120, GM-54 × SD-3120, GM-55 × SD-3120, GM-57 × SD-3120 and GM-61 × SD-3120. Numerous investigators have reported useful superiority for grain yield in maize (Ismail *et al* 2018; Patel *et al* 2019; Aboyousef *et al* 2022; Karim *et al* 2022; Ismail *et al* 2023a).

CONCLUSION

This study has identified the tester SD-3120 as a good combiner for earliness and yield. While the tester GM-1002 displayed favorable GCA effects for plant and ear heights. The parental lines GM-53, GM-55 and GM-57 might be utilized as good combiners for earliness. Similarly, the inbreds GM-53 and GM-62 for improving grain yield trait. Remarkably, three crosses viz. GM-48 × SD-3120, GM-53 × SD-3120 and GM-61 × SD-3120 significantly out-performed the best check hybrid and could be considered as promising hybrids. Consequently, these hybrids could be exploited for commercial release after evaluating yield stability across varying environments.

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تقييم القدرة على الائتلاف ومتوسط الأداء لصفة المحصول والصفات المساهمة فيها في الذرة الشامية من خلال تحليل السلالة في المختبر

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يعد تقدير القدرة على الائتلاف أمرًا بالغ الأهمية في برنامج تربية الذرة من أجل تطوير هجن جديدة ذات إنتاجية عالية ومتأقلمة مع البيئات المتباينة. اجريت هذه الدراسة لتحديد السلالات ذات القدرة العامة على الائتلاف لصفة المحصول وبعض الصفات الأخرى، بالإضافة إلى تحديد الهجن المتفوقة للصفات المدروسة. تم إجراء التهجين بين عشر سلالات صفراء الحبوب مبشرة قمياً مع كشافين هما (سلالة جميزة ٢٠٠١وسلالة سدس ٣١٢٠) بمحطة البحوث الزراعية بالجميزة التابعة لمركز البحوث الزراعية فى موسم ٢٠٢٢. تم تقييم العشرين هجينا الناتجة مع هجينين فرديين هما (هجين فردى ١٦٨ و هجين فردى كورتيفا ٣٤٤٤) للمقارنة في ثلاث مواقع تمثل مدى التنوع الموجود في المناخ والتربة في موسم ٢٠٢٣باستخدام تصميم القطاعات كاملة العشوائية فى ثلاث مكرارت. تم اتباع التوصيات الموصى بها للحصول على عدد نباتات جيدة عند الحصاد. وكانت الصفات المدروسة هي عدد الأيام حتى ظهور ٥٠٪ من حرائر النورات المؤنثة، إرتفاع النبات، ارتفاع الكوز، طول وقطر الكوز ، ومحصول الحبوب بالأردب للفدان. أوضحت نتائج التحليل المجمع عبر المواقع أن هناك فروق عالية المعنوية بين المواقع و الهجن لجميع الصفات المدروسة. كما أظهرت النتائج ان الفعل الجينى غير المضيف يلعب دورا مهما في وراثة جميع الصفات المدروسة ما عدا صفة المحصول. أظهرت النتائج ان السلالات الابوية جميزة ٥٣، ٥٥، ٥٧ يمكن استخدامها في برامج التربية للتبكير حيث انهم أعطوا قدرة عالية المعنوية على الائتلاف لصفة التبكير، وكذلك السلالتان جميزة ٥٣، ٦٢ يمكن استخدامها في برامج التربية للمحصول العالى. كما أشارت النتائج إلى ان ثلاثة هجن فردية هما جميزة ٤٨ × سدس ٣١٢٠، جميزة ٥٣ × سدس ٣١٢٠، جميزة ٦١ × سدس ٣١٢٠ قد تفوقوا معنويا في المحصول على افضل هجينى المقارنة ويمكن اعتبارهم من الهجن المبشرة الواعدة. هذه الهجن يوصى بتقييمها في تجربة مواقع موسعة لاختبار الثبات المحصولى لها قبل تسجيلها كهجن تجارية بواسطة قسم بحوث الذرة الشامية، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية.

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