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Combining Ability and Gene Action Using 10 X 10 Diallel Crosses of Ten Maize Inbred Lines *(Zea mays* L.*)*

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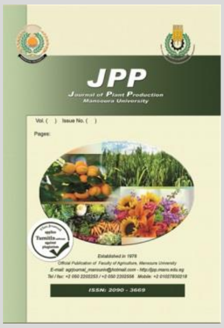

ABSTRACT

Ten yellow maize inbred lines were derived from different sources were evaluated in this study to estimate combining ability, type of gene action and superiority % of the F_1's over commercial check hybrids. In 2019 grown season, all possible combinations between these lines were done in a half diallel (Griffing's 1956, method 4, model 1) to give 45 crosses at Sids Agricultural Research Station. In 2020 season, 45 crosses along two commercial hybrids; SC. 168 and SC. 3444 were evaluated in replicated trails conducted at three locations; Sakha, Sids and Nubaria Agricultural Research Stations. Data were recorded for days to 50% silking, plant height, ear height, ear position%, late wilt resistant % and grain yield. The results showed significant differences between the three locations for all the studied traits except LWR % and GY traits, indicating that the three locations differed in the environmental conditions. Mean squares of genotypes and their interactions with locations were significant or highly significant for all the studied traits. The results showed that the general combining ability and specific combining ability variances were significant or highly significant for all the studied traits, indicating that both additive and non-additive gene action were important in the inheritance of these traits. The parental lines Sd. 3180 and Sd. 21 had a good GCA effects for all the studied traits. The crosses Sk. 1 x Sd. 15 and Gm. 6052 x Gz. 658 showed desirable values of SCA effects and superiority% over check for yield.

Keywords: Diallel, GCA, SCA, superiority%, Correlations.

INTRODUCTION

Maize is the third most important cereals crop of Egypt and is valued as food, feed, fodder and industrial raw materials. Hybrids of maize crop have been the most extensively studied including conventional and molecular based varietal development. Combining abilities studies are more reliable as they provide useful information for the selection of parent in terms of performance of hybrid. One of the most informative methodologies in the concern is diallel analysis system. The two genetic parameters of diallel analysis which are essential in developing breeding strategies; are GCA and SCA. The concept of general and specific combining abilities was indicated by Sprague and Tatum (1942). The nature and magnitude of gene action is an important factor in developing an effective breeding program, which can be understood through combining ability analysis. Maize breeders have been developing various quantative estimation of general (GCA) and specific (SCA) combining abilities for determine the most suitable crossing. Application of GCA and SCA will enhance the opportunity of getting best combination among maize populations (Vassal *et al*. 1992).

The main objectives of this study were identifying superior crosses over the best check for all the studied traits, estimating the combining ability and nature of gene action of grain yield and its attributes and studying the correlation coefficient between all the studied traits.

MATERIALS AND METHODS

Ten yellow maize inbred lines, derived from different sources at different research stations (Sakha (Sk), Sids (Sd), Mallawy (Mall), Gemmeiza (Gm) and Giza (Gz)) namely; Sd.3118, Sd.3180, Sk.1, Mall.5035, Gm.6052, Gz.658, Sd.3/2013, Sd.15/2013, Sd.21/2015 and Sd.25/2013 were used in this study. All possible combinations without reciprocal crosses among them were made in half diallel mating design to obtained 45 single crosses at Sids Agric. Res. Station during 2019 growing season. In the growing summer season 2020, the 45 crosses along with two checks; commercial yellow single cross SC.168 and SC pioneer 3444 were evaluated at three locations; Sakha, Sids and Nubaria Agric. Res. Stations. The experimental design was a randomized complete blocks design (RCBD) with three replicates. The experimental plot size was one row, 6 m long and 0.8 m apart (= 4.8 m^2). Planting was made in hills spaced at 0.25 m along the row at the rate of two kernels $hill^{-1}$, which thinned to one plant $hill^{-1}$ after 21 days of planting date. All agricultural practices were applied as recommended at the proper time. Data were recorded for days to 50% silking (DTS), plant height (PHT) cm, ear height (EHT) cm, ear position (Epos%), late wilt resistant (LWR%) and grain yield (GY) Ard. Fed^{-1}. Grain yield was adjusted to 15.5 % grain moisture, one ardab = 140 kg and one feddan = 4200 m^2.

Analysis of variance was performed for the combined data across three locations according Snedecor and Cochran (1980). The GLM procedures Statistical

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Analysis System (SAS, version 9.1, SAS Institute, 2005) were used. Combining ability analysis was performed for traits that showed statistical differences among crosses. Griffing's Method-4, Model-1 (Griffing's 1956) was employed to determine general combining ability (GCA), specific combining ability (SCA) and their interaction effects with locations. Superiority % of 45 crosses expressed as the % deviation of the mean performance of F_1 than the best check.

RESULTS AND DISCUSSION

Analysis of variances for six traits across three locations are presented in Table 1. The results showed significant differences between the three locations for all the studied traits except LWR % and GY traits, indicating that the three locations differed in the environmental conditions. These findings agree with those reported by Zare *et al.* (2011), Haddadi *et al.* (2012), Aly and Mousa (2012) and Aly (2013). The mean squares of genotypes and their interactions with locations were highly significant for all the studied traits, meaning that the genotypes were differ among them and influenced by change location. Numerous researchers affirmed similar results among them; Abdel-Azeem *et al.* (2009) for DTS, PHT, EHT. and GY, Aly and Mousa (2011) for DTS, PHT., EHT., Epos% and GY, Bartaula *et al.* (2019) for PHT, EHT. and GY, Bisen *et al.* (2020) for DTS and PHT., El-Hosary (2020) for DTS, PHT., EHT. and GY and Onejeme *et al.* (2020) for DTS, PHT., EHT and GY traits.

Table 1. Analysis of variances for six traits across three locations for all the studied traits.

sov	df	DTS (days)	PHT (cm)	EHT (cm)	Epos %	LWR %	GY ard.fed^{-1}
Location (Loc)	2	1549.31**	121285.16**	55528.58**	3930.07**	84.66	124.48
Rep/Loc	6	12.20	154.76	281.52	38.50	28.20	91.86
Genotypes (G)	46	13.79**	1432.12**	1064.71**	47.25**	13.27*	126.84**
G x Loc	92	4.40**	380.81**	304.87**	27.00**	14.16**	34.06**
Pooled error	276	1.03	113.31	78.90	13.17	6.64	12.08

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

General (GCA) and specific (SCA) combining abilities variances and their interaction with locations for all the studied traits across three locations are shown in Table 2. The results showed that the general combining ability (GCA) and specific combining ability (SCA) variances were significant or highly significant for all the studied traits, indicating that both additive and non-additive gene action were important in the inheritance of these traits. The present results were inconsistence with those obtained by Rezaei and Roohi (2004) for EH, Srdić *et al.* (2007) for GY, Aly and Mousa (2011) for DTS, PHT, EHT, EP % and GY, Bisen *et al*. (2020) for DTS and PHT and Onejeme *et al.* (2020) for DTS, PHT, EHT and GY traits. The ratio of GCA/SCA was more than unity for all the studied traits, revealing the importance of additive gene action in the genetic control of these traits. Similar results were obtained by Dawood *et al.* (1994) and Amer (2002) for DTS, PHT and EHT, Bello and Olaoye (2009) for DTS, PHT and GY, Aly and Mousa (2011) for DTS, PHT, ED and GY, Haydar (2020) for GY, El-Hosary (2020) for DTS and Onejeme *et al.* (2020) for DTS, PHT traits. The mean squares due to GCA x Loc and SCA x Loc were highly significant for all the studied traits, meaning that both additive and non-additive gene effects were affected by environmental. However, the magnitude of GCA x Loc were larger than SCA x Loc interaction for DTS, Epos %, LWR % and GY, indicating that the additive components of gene variation are highly affected by the environment than non-additive components for these traits under this study (Amer 2002 and Aly and Mousa 2011).

Table 2. Estimates of general (GCA) and specific (SCA) combining abilities variances and their interaction with locations for all the studied traits across three locations.

sov	df	DTS (days)	PHT (cm)	EHT (cm)	Epos%	LWR %	GY ard.fed^{-1}
GCA	9	29.89**	4733.42**	3726.65**	136.49**	26.47**	223.42**
SCA	35	7.47**	641.72**	437.61**	24.62**	10.42*	105.86**
GCA x Loc	18	6.30**	330.55**	235.68**	31.74**	21.27**	56.45**
SCA x Loc	70	4.03**	403.08**	332.88**	25.69**	13.03**	26.54**
Error	264	1.01	113.86	80.72	12.93	6.91	12.08
GCA/SCA		4.00	7.37	8.51	5.54	2.54	2.11
GCA x Loc/ SCA x Loc		1.56	0.82	0.70	1.23	1.63	2.12

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

DTS = days to 50% silking (days) PHT = plant height, cm EHT = ear height, cm Epos% = ear position % LWR = late wilt resistant % GY = grain yield ard. fed^{-1}

Mean performances of the 45 crosses and the two checks for six traits across three locations are presented in Table 3. The results showed that, for DTS, the crosses ranged from 62.78 days for cross Sd-3180 x Sd-25 to 69.00 days for cross Sk-1 x Sd-15. General, 42 crosses were significantly earlier than the earliest check cross SC-168 (67.89 days) and two of them the earliest (Sd.3180 x Sd.25 (62.78 days) and Gm. 6052 x Sd. 25 (63.67 days)). 14 out of 45 crosses were significantly shorter than the check SC-3444. On the same direction, 4 crosses were significantly shorter than the shortest check cross SC-168. For EHT trait, 7 crosses had significantly lower ear placement compare with the best check hybrid SC-3444 (130.67 cm). For Epos %, the best crosses were Sd.3118 x Sd.3180 (52.24%), Sd.3180 x Mall.5035 (51.72%) and Sd.3180 x Sd.21 (50.34%). For LWR %, 24 crosses showed 100% resistance. For grain yield the results showed that, two crosses: Sk-1 x Sd-15 (38.45 Ard. Fed^{-1}) and Gm-6052 x Gz-658 (38.28 Ard. Fed^{-1}) were significantly superior than higher check hybrid SC-3444 (34.51 Ard. Fed^{-1}). Furthermore, 7 crosses; Sd-3118 x Gm-6052 (36.58), Sd-3180 x Sk-1 (36.81 Ard. Fed^{-1}), Sd-3180 x Sd-15 (35.91 Ard. Fed^{-1}), Sd-3180 x Sd-21

(36.08 Ard. Fed^{-1}), Sk-1 x Sd-21 (35.99 Ard. Fed^{-1}), Mall-5035 x Sd-21 (34.78 Ard. Fed^{-1}) and Gz-658 x Sd-21 (35.58 Ard. Fed^{-1}) did not differ significantly than the highest check SC3444 (34.51 ard fed^{-1}).

Table 3. Mean performances of the 45 crosses and the two check hybrids for all the studied traits across three locations.

Cross	DTS(days)	PHT(cm)	EHT(cm)	Epos%	LWR%	GY ard.fed^{1}
Sd-3118 x Sd-3180	64.22	237.44	124.33	52.24	100.00	30.36
Sd-3118 x Sk-1	65.67	236.11	128.22	54.31	99.56	23.74
Sd-3118 x Mall-5035	64.78	235.44	128.00	54.11	100.00	25.38
Sd-3118 x Gm-6052	66.11	251.00	141.00	56.23	100.00	36.58
Sd-3118 x Gz-658	65.89	244.33	142.78	58.10	99.56	28.67
Sd-3118 x Sd-3/2013	65.78	242.89	137.78	56.99	100.00	31.95
Sd-3118 x Sd-15/2013	65.00	238.56	143.78	60.03	100.00	32.74
Sd-3118 x Sd-21/2015	65.44	226.56	127.11	55.86	100.00	31.08
Sd-3118 x Sd-25/2013	66.11	243.44	134.67	55.16	100.00	30.68
Sd-3180x Sk-1	66.56	239.78	133.89	56.18	100.00	36.81
Sd-3180x Mall-5035	66.00	212.67	110.22	51.72	100.00	32.18
Sd-3180x Gm-6052	65.56	235.89	126.56	53.84	100.00	28.38
Sd-3180x Gz-658	66.22	224.11	126.56	56.59	100.00	34.45
Sd-3180x Sd-3/2013	66.00	239.44	135.44	56.72	99.11	33.15
Sd-3180x Sd-15/2013	66.00	238.56	137.00	57.43	100.00	35.91
Sd-3180x Sd-21/2015	64.22	222.67	112.00	50.34	100.00	36.08
Sd-3180x Sd-25/2013	62.78	223.22	123.22	55.27	98.67	29.22
Sk-1 x Mall-5035	65.78	221.67	122.00	55.07	97.78	22.81
Sk-1 x Gm-6052	66.89	243.22	138.56	57.24	98.67	33.43
Sk-1 x Gz-658	66.33	221.67	121.44	54.76	98.22	22.05
Sk-1 x Sd-3/2013	67.67	260.11	150.00	57.84	98.67	29.93
Sk-1 x Sd-15/2013	69.00	263.89	154.44	58.48	99.56	38.45
Sk-1 x Sd-21/2015	66.22	233.00	124.22	53.36	99.56	35.99
Sk-1 x Sd-25/2013	66.89	250.00	141.89	56.82	100.00	28.49
Mall-5035 x Gm-6052	66.00	253.11	137.44	54.32	99.11	32.01
Mall-5035 x Gz-658	66.67	212.22	120.67	57.04	100.00	34.16
Mall-5035 x Sd-3/2013	66.89	228.11	127.11	55.77	99.11	30.52
Mall-5035 x Sd-15/2013	66.44	247.67	150.11	60.66	100.00	32.76
Mall-5035 x Sd-21/2015	65.78	217.44	126.78	58.37	100.00	34.78
Mall-5035 x Sd-25/2013	64.44	226.33	127.44	56.60	99.56	28.88
Gm-6052 x Gz-658	66.33	244.11	143.33	59.03	100.00	38.28
Gm-6052 x Sd-3/2013	65.44	261.22	156.11	59.58	93.78	32.49
Gm-6052 x Sd-15/2013	66.00	252.89	150.89	59.86	100.00	33.43
Gm-6052 x Sd-21/2015	64.00	248.89	146.78	58.57	99.56	34.17
Gm-6052 x Sd-25/2013	63.67	244.67	141.11	57.46	98.67	29.57
Gz-658 x Sd-3/2013	67.44	245.56	144.67	58.96	99.56	30.73
Gz-658 x Sd-15/2013	66.33	239.22	144.67	60.47	100.00	33.26
Gz-658 x Sd-21/2015	65.78	217.44	119.44	54.87	100.00	35.58
Gz-658 x Sd-25/2013	64.56	240.67	136.56	56.80	98.67	27.68
Sd-3/2013 x Sd-15/2013	66.89	252.56	147.67	58.40	100.00	32.97
Sd-3/2013 x Sd-21/2015	64.89	221.00	119.44	54.26	100.00	27.65
Sd-3/2013 x Sd-25/2013	64.44	243.22	136.78	56.38	95.11	29.50
Sd-15/2013 x Sd-21/2015	66.89	240.33	134.33	55.98	100.00	33.41
Sd-15/2013 x Sd-25/2013	64.11	234.44	133.11	56.66	99.56	28.90
Sd-21/2015 x Sd-25/2013	66.44	235.56	129.33	54.94	98.22	30.74
SC-168	67.89	230.44	133.00	57.70	100.00	33.80
SC-3444	68.56	243.89	130.67	53.65	100.00	34.51
LSD 0.05	0.93	9.85	8.30	3.32	2.43	3.21
LSD 0.01	1.22	12.95	10.91	4.36	3.19	4.22

DTS = days to 50% silking (days) PHT = plant height, cm EHT = ear height, cm Epos% = ear position % LWR = late wilt resistant % GY = grain yield ard. fed^{-1}

General combining ability (GCA) effects for the ten inbred lines for all the studied traits across three locations are shown in Table 4. The results showed that the inbred lines, Sd.3118, Sd.3180, Gm.6052, Sd.21 and Sd.25 had negative and significant GCA effects for DTS toward earliness, Sd. 3180, Mall. 5035 and Sd. 21 showed negative and significant GCA effects for PHT and EHT toward short plant and ear heights, Sd.3180 and Sd.21 showed negative and significant GCA effects for Epos% toward low ear placement. The best inbred lines for GCA effects were Sd.3118, Sd.15 for LWR% and Sd.3180, Gm.6052, Sd.15 and Sd.21 for GY. From above results the inbred lines Sd.3180 and Sd.21 had desirable GCA effects for all the studied traits.

Table 4. General combining ability (GCA) effects of the ten inbred lines for all the studied traits across three locations.

Parental line	DTS (days)	PHT (cm)	EHT (cm)	Epos %	LWR %	GY ard/fed-1
Sd-3118	-0.39**	2.16	-0.01	-0.61	0.63*	-1.60**
Sd-3180	-0.57**	-8.09**	-9.82**	-2.20**	0.47	1.87**
Sk-1	1.11**	3.87**	0.86	-0.48	-0.26	-1.84**
Mall-5035	0.08	-10.48**	-7.25**	-0.53	0.19	-1.32**
Gm-6052	-0.26*	12.07**	9.25**	1.03**	-0.53*	1.79**
Gz-658	0.43**	-6.14**	-0.96	1.09**	0.24	0.11
Sd-3/2013	0.42**	6.96**	5.90**	0.87*	-1.09**	-0.64
Sd-15/2013	0.57**	8.71**	11.03**	2.50**	0.63*	2.23**
Sd-21/2015	-0.31**	-9.45**	-8.54**	-1.42**	0.41	1.94**
Sd-25/2013	-1.08**	0.37	-0.46	-0.23	-0.70*	-2.54**
S.E. Gi	0.113	1.193	1.005	0.402	0.294	0.389
LSd 0.05	0.22	2.34	1.97	0.79	0.58	0.76
0.01	0.29	3.07	2.59	1.04	0.76	1.00

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

DTS = days to 50% silking (days) PHT = plant height, cm EHT = ear height, cm Epos% = ear position % LWR = late wilt resistant % GY = grain yield ard. fed^{-1}

Specific combining ability (SCA) effects of 45 crosses for all the studied traits across three locations are illustrated in Table 5. The results showed that the nine crosses; Sd-3118 x Gm-6052, Sd-3118 x Sd-3, Sd-3118 x Sd-25, Sd-3180 x Sk-1, Sk-1 x Sd-15, Sk-1 x Sd-21, Mall-5035 x Gz-658, Mall-5035 x Sd-21 and Gm-6052 x Gz-658 had positive and significant SCA effects for grain yield toward high yielding. One cross; Sk. 1 x Sd. 25 have positive and significant SCA effects for LWR % trait. Regarding, DTS, PHT and EHT traits, five crosses; Sd.3118 x Sk.1, Sk.1 x Mall.5035, Sk.1 x Gz.658, Sd-3 x Sd.21 and Sd.15 x Sd.25 had significantly negative SCA effects for the previous traits toward earliness, shorter plants and lower ear placement. In addition that, nine crosses; Sd.3118 x Sd.3180, Sd.3118 x Mall.5035, Sd.3118 x Sd.15, Sd.3180 x Sd.21, Sd.3180 x Sd.25, Gm.6052 x Sd.21, Gm.6052 x Sd.25, Gz.658 x Sd.25 and Sd.3 x Sd.25 had negative and significant SCA effects for DTS toward earliness. Five crosses; Sd-3118 x Sd.15, Sd.3180 x Mall.5035, Sd.3180 x Sd.25, Sk-1 x Gm-6052 and Mall-5035 x Gz-658 had negative and significant SCA effects for PHT toward shorter plants. For ear height, six crosses had negative and significant SCA effects toward lower ear placement; Sd-3180 x Mall-5035, Sd-3180 x Gm-6052, Sk.1 x Gm.6052, Mall.5035 x Gz.658, Mall.5035 x Sd.3 and Gz.658 x Sd.21 have negative and significant SCA effects. For ear position %, four crosses; Sd.3180 x Sd.21, Sk.1 x Gz.658, mall.5035 x Gm.6052 and Sd.15 x Sd.25. From the above results, the previous crosses can be recommended in maize breeding and production programs for release as new promising hybrids.

All possible simple correlation coefficient between all the studied traits are illustrated in Table 6. The correlation coefficients were weak, moderate and strong between all the studied traits. Grain yield showed positive and significant correlation with PHT (r=0.216), EHT (r=0.214) and LWR% (r=0.184), indicating that the indirect selection for linked traits with yield would be useful and effective for improving grain yield. These results are in conformity to the finding of Nataraj *et al.* (2014) and Hussain *et al.* (2016). PHT was positive and highly significant correlated with EHT (r=0.765), and negative significant with LWR% (r=-0.100). Positive and highly significant correlation showed between EHT and Epos % (r=0.682). Meanwhile, negative and highly significantly correlation were between DTS and both of EHT and Epos %. These results supported the finding of Aly and Mousa (2012), Alvi *et al.* (2013), Mathew (2015), Prasad and Shivani (2017), Bartaula *et al.* (2019) and Abebe *et al.* (2020).

The superiority% of crosses relative to check hybrid SC. 3444 for different traits are presented in Table 7. The results showed that the superiority% of crosses varied from trait to trait and also from cross to cross. For DTS, all crosses showed negative and significant superiority% (desirable) toward earliness except Sk.1 x Sk.3 and Sk-1 x Sd-15 and ranged from -8.43** for Sd.3180 x Sd.25 to 0.65 for Sk.1 x Sk.15. Similar results were obtained by Aly and Mousa (2011), Mousa and Aly (2011), Ram *et al.* (2015), Natol *et al.* (2017) and Abebe *et al.* (2020). For PHT, EHT and Epos%; 14, 7 and 1 crosses showed negative and significant superiority% (desirable) than check toward shorter plants and lower ear placement. The magnitude of superiority% for PHT ranged from -12.98 (Mall.5035 x Gz.658) to 8.200 (Sk.1 x Sd.15), for EHT ranged from -15.65 (Sd.3180 x Mall.5035) to 19.47 (Gm.6052 x Sd.3) and for Epos% ranged from -6.15 (Sd.3180 x Sd-.21) to 13.07 (Mall.5035 x Sd.15). Various workers (Melkamu *et al.* 2013and Natol 2017) also found positive and negative significant heterosis for PHT and EHT traits. Then, crosses with shorter plant and lower ear placement were desirable for loading resistance (Notal *et al.* 2017, Yazachew *et al.* 2017 and Abebe *et al.* 2020). For LWR %, the superiority% ranged from -6.22 (Gm.6052 x Sd.3) to zero for 24 crosses out the 45 crosses. For grain yield, superiority% of crosses than check SC.3444 ranged from -36.11% (Sk.1 x Gz.658) to 11.42% (Sk.1 x Sd.15). The best crosses for superiority% were Sk.1 x Sd-.15 (11.42%) and Gm.6052 x Gz.658 (10.92%). Meanwhile, seven crosses positive and not significant superiority% over check hybrid; Sd.3118 x Gm.6052, Sd.3180 x Sk.1, Sd.3180 x Sd.15, Sd,3180 x Sd.21, Sk.1 x sd.21, Mall.5035 x Sd.21 and Gz.658 x Sd.21. Numerous researchers were obtained similar results such as Amiruzzaman *et al.* (2010), Aly and Mousa (2011), Abebe *et al.* (2020) and Onejeme *et al.* (2020). General, the superiority% crosses than the check hybrid should be considered in breeding programs for higher yielding and other agronomic traits. These results were confirmed with the results by Uddin *et al.* (2006), Aly and Mousa (2011), Mohammed *et al.* (2016) and Onejeme *et al.* (2020).

Table 5. Specific combining ability (SCA) effects of 45 crosses for all the studied traits across three locations.

Crosses	DTS (days)	PHT (cm)	EHT (cm)	Epos %	LWR %	GY ard/fed^{-1}
Sd-3118 x Sd-3180	-0.610*	5.759	-0.031	-1.382	-0.438	-1.160
Sd-3118 x Sk-1	-0.846**	-7.532*	-6.823**	-1.029	-0.160	-4.674**
Sd-3118 x Mall-5035	-0.707*	6.148*	1.066	-1.179	-0.160	-3.260**
Sd-3118 x Gm-6052	0.974**	-0.838	-2.434	-0.617	0.562	4.834**
Sd-3118 x Gz-658	0.057	10.704**	9.552**	1.190	-0.660	-1.390
Sd-3118 x Sd-3/2013	-0.040	-3.838	-2.309	0.294	1.117	2.637**
Sd-3118 x Sd-15/2013	-0.971**	-9.921**	-1.434	1.705	-0.605	0.560
Sd-3118 x Sd-21/2015	0.349	-3.769	1.469	1.455	-0.383	-0.811
Sd-3118 x Sd-25/2013	1.793**	3.287	0.941	-0.438	0.728	3.264**
Sd-3180x Sk-1	0.224	6.384*	8.650**	2.423*	0.451	5.223**
Sd-3180x Mall-5035	0.696*	-6.380*	-6.906**	-1.982	0.006	0.370
Sd-3180x Gm-6052	0.599*	-5.699	-7.073**	-1.420	0.728	-6.537**
Sd-3180x Gz-658	0.571*	0.731	3.136	1.265	-0.049	1.221
Sd-3180x Sd-3/2013	0.363	2.968	5.164*	1.614	0.395	0.668
Sd-3180x Sd-15/2013	0.210	0.329	1.594	0.692	-0.438	0.556
Sd-3180x Sd-21/2015	-0.693*	2.593	-3.836	-2.470*	-0.216	1.018
Sd-3180x Sd-25/2013	-1.360**	-6.685*	-0.698	1.260	-0.438	-1.359
Sk-1 x Mall-5035	-1.207**	-9.338**	-5.809*	-0.352	-1.494*	-5.894**
Sk-1 x Gm-6052	0.252	-10.324**	-5.753*	0.267	0.117	1.617
Sk-1 x Gz-658	-0.998**	-13.671**	-12.656**	-2.282*	-1.105	-8.077**
Sk-1 x Sd-3/2013	0.349	11.676**	9.039**	1.022	0.673	0.548
Sk-1 x Sd-15/2013	1.529**	13.704**	8.358**	0.022	-0.160	6.203**
Sk-1 x Sd-21/2015	-0.373	0.968	-2.295	-1.172	0.062	4.036**
Sk-1 x Sd-25/2013	1.071**	8.134**	7.289**	1.101	1.617*	1.016
Mall-5035 x Gm-6052	0.390	13.912**	1.247	-2.606*	0.117	-0.025
Mall-5035 x Gz-658	0.363	-8.769**	-5.323*	0.057	0.228	3.811**
Mall-5035 x Sd-3/2013	0.599*	-5.977	-5.739*	-1.006	0.673	0.923
Mall-5035 x Sd-15/2013	0.002	11.829**	12.136**	2.250*	-0.160	0.287
Mall-5035 x Sd-21/2015	0.210	-0.241	8.372*	3.889**	0.062	2.605**
Mall-5035 x Sd-25/2013	-0.346	-1.185	0.955	0.929	0.728	1.183
Gm-6052 x Gz-658	0.377	0.579	0.844	0.486	0.951	4.823**
Gm-6052 x Sd-3/2013	-0.498	4.593	6.761**	1.246	-3.938**	-0.222
Gm-6052 x Sd-15/2013	-0.096	-5.491	-3.586	-0.110	0.562	-2.149*
Gm-6052 x Sd-21/2015	-1.221**	8.662**	11.872**	2.529*	0.340	-1.108
Gm-6052 x Sd-25/2013	-0.776**	-5.394	-1.878	0.225	0.562	-1.233
Gz-658 x Sd-3/2013	0.807**	7.134*	5.525*	0.564	1.062	-0.301
Gz-658 x Sd-15/2013	-0.457	-0.949	0.400	0.442	-0.216	-0.631
Gz-658 x Sd-21/2015	-0.137	-4.574	-5.253*	-1.231	0.006	1.982
Gz-658 x Sd-25/2013	-0.582*	8.815**	3.775	-0.490	-0.216	-1.439
Sd-3/2013 x Sd-15/2013	0.113	-0.713	-3.461	-1.410	1.117	-0.174
Sd-3/2013 x Sd-21/2015	-1.012**	-14.116**	-12.114**	-1.627	1.340	-5.200**
Sd-3/2013 x Sd-25/2013	-0.679*	-1.727	-2.864	-0.697	-2.438**	1.120
Sd-15/2013 x Sd-21/2015	0.835**	3.468	-2.350	-1.538	-0.383	-2.310*
Sd-15/2013 x Sd-25/2013	-1.165**	-12.255**	-11.656**	-2.053*	0.283	-2.342*
Sd-21/2015 x Sd-25/2013	2.043**	7.009*	4.136	0.164	-0.827	-0.211
SE sij	0.297	3.137	2.641	1.057	0.773	1.022
lsd 0.05 sij	0.58	6.15	5.18	2.07	1.52	2.00
lsd 0.01 sij	0.76	8.08	6.80	2.72	1.99	2.63

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

DTS = days to 50% silking (days) PHT = plant height, cm EHT = ear height, cm Epos% = ear position % LWR = late wilt resistant % GY = grain yield ard. fed^{-1}

Table 6. Simple correlation coefficient between all the studied traits across three locations

parents	DTS (days)	PHT(cm)	EHT(cm)	Epos%	LWR%	GY Ard. Fed^{-1}
DTS (days)	-----------	-0.035	-0.373**	-0.551**	-0.059	-0.034
PHT (cm)		-----------	0.765**	0.055	-0.100**	0.216**
EHT (cm)			-----------	0.682**	-0.020	0.214**
Epos %				-----------	0.077	0.083
LWR %					-----------	0.184**
GY Ard. Fed^{-1}						-----------

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

DTS = days to 50% silking (days) PHT = plant height, cm EHT = ear height, cm Epos% = ear position % LWR = late wilt resistant % GY = grain yield ard. fed^{-1}

Table 7. Estimates superiority % of 45 crosses relative to the check SC. 3444 for all the studied traits across three locations.

Crosses	DTS (days)	PHT (cm)	EHT (cm)	Epos %	LWR %	GY ard.fed^{-1}
Sd-3118 x Sd-3180	-6.32**	-2.64	-4.85	-2.61	0.00	-12.02*
Sd-3118 x Sk-1	-4.22**	-3.19	-1.87	1.24	-0.44	-31.20**
Sd-3118 x Mall-5035	-5.51**	-3.46	-2.04	0.87	0.00	-26.47**
Sd-3118 x Gm-6052	-3.57**	2.92	7.91*	4.82	0.00	6.00
Sd-3118 x Gz-658	-3.89**	0.18	9.27**	8.30**	-0.44	-16.92**
Sd-3118 x Sd-3/2013	-4.05**	-0.41	5.44	6.23*	0.00	-7.41
Sd-3118 x Sd-15/2013	-5.19**	-2.19	10.03**	11.91**	0.00	-5.12
Sd-3118 x Sd-21/2015	-4.54**	-7.11**	-2.72	4.12	0.00	-9.95*
Sd-3118 x Sd-25/2013	-3.57**	-0.18	3.06	2.81	0.00	-11.12*
Sd-3180x Sk-1	-2.92**	-1.69	2.47	4.72	0.00	6.66
Sd-3180x Mall-5035	-3.73**	-12.80**	-15.65**	-3.59	0.00	-6.77
Sd-3180x Gm-6052	-4.38**	-3.28	-3.15	0.37	0.00	-17.77**
Sd-3180x Gz-658	-3.40**	-8.11**	-3.15	5.49	0.00	-0.17
Sd-3180x Sd-3/2013	-3.73**	-1.82	3.66	5.73	-0.89	-3.94
Sd-3180x Sd-15/2013	-3.73*	-2.19	4.85	7.06*	0.00	4.05
Sd-3180x Sd-21/2015	-6.32**	-8.70**	-14.29**	-6.15*	0.00	4.53
Sd-3180x Sd-25/2013	-8.43**	-8.474*	-5.70	3.02	-1.33	-15.33**
Sk-1 x Mall-5035	-4.05**	-9.11**	-6.63*	2.65	-2.22	-33.91**
Sk-1 x Gm-6052	-2.43**	-0.27	6.04	6.71*	-1.33	-3.14**
Sk-1 x Gz-658	-3.24**	-9.11**	-7.06*	2.07	-1.78	-36.11**
Sk-1 x Sd-3/2013	-1.30	6.65**	14.80**	7.83*	-1.33	-13.28**
Sk-1 x Sd-15/2013	0.65	8.20**	18.20**	9.01**	-0.44	11.42*
Sk-1 x Sd-21/2015	-3.40**	-4.47*	-4.93	-0.54	-0.44	4.28
Sk-1 x Sd-25/2013	-2.43**	2.51	8.59**	5.92	0.00	-17.44**
Mall-5035 x Gm-6052	-3.73**	3.78	5.19	1.26	-0.89	-7.26
Mall-5035 x Gz-658	-2.76**	-12.98**	-7.65*	6.34*	0.00	-1.02
Mall-5035 x Sd-3/2013	-2.43**	-6.47**	-2.72	3.95	-0.89	-11.55*
Mall-5035 x Sd-15/2013	-3.08**	1.55	14.88**	13.07**	0.00	-5.09
Mall-5035 x Sd-21/2015	-4.05**	-10.84**	-2.98	8.80**	0.00	0.77
Mall-5035 x Sd-25/2013	-6.00**	-7.20**	-2.47	5.51	-0.44	-16.32**
Gm-6052 x Gz-658	-3.24**	0.09	9.69**	10.04**	0.00	10.92*
Gm-6052 x Sd-3/2013	-4.54**	7.11**	19.47**	11.06**	-6.22**	-5.86
Gm-6052 x Sd-15/2013	-3.73**	3.69	15.48**	11.58**	0.00	-3.14
Gm-6052 x Sd-21/2015	-6.65**	2.05	12.33**	9.17**	-0.44	-0.98
Gm-6052 x Sd-25/2013	-7.13**	0.32	7.99*	7.10*	-1.33	-14.31**
Gz-658 x Sd-3/2013	-1.62*	0.68	10.71**	9.90**	-0.44	-10.97*
Gz-658 x Sd-15/2013	-3.24**	-1.91	10.71**	12.71**	0.00	-3.62
Gz-658 x Sd-21/2015	-4.05**	-10.84**	-8.59**	2.28	0.00	3.10
Gz-658 x Sd-25/2013	-5.84**	-1.32	4.51	5.88	-1.33	-19.79**
Sd-3/2013 x Sd-15/2013	-2.43**	3.55	13.01**	8.86**	0.00	-4.46
Sd-3/2013 x Sd-21/2015	-5.35**	-9.39**	-8.59**	1.14	0.00	-19.87**
Sd-3/2013 x Sd-25/2013	-6.00**	-0.27	4.68	5.09	-4.89**	-14.54**
Sd-15/2013 x Sd-21/2015	-2.43**	-1.46	2.81	4.35	0.00	-3.19
Sd-15/2013 x Sd-25/2013	-6.45**	-3.87	1.87	5.61	-0.44	-16.26**
Sd-21/2015 x Sd-25/2013	-3.08**	-3.42	-1.02	2.42	-1.78	-10.94*
LSD 0.05	0.93	9.85	8.30	3.32	2.43	3.21
LSD 0.01	1.22	12.95	10.91	4.36	3.19	4.22

DTS = days to 50% silking (days) PHT = plant height, cm EHT = ear height, cm Epos% = ear position % LWR = late wilt resistant % GY = grain yield ard. fed^{-1}

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القدرة على التآلف وطبيعة الفعل الجينى بإستخدام نظام تزاوج الدياليل النصف دائرى لعشرة سلالات من الذرة الشامية

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أُستخدمت فى هذه الدراسة عشرة سلالات صفراء من الذرة الشامية مشتقة من مصادر وراثية مختلفة وذلك لدراسة القدرة الإئتلافية ، طبيعة الفعل الجينى والنسبة المئوية لتفوق الجيل الأول مقارنة بأعلى هجن المقارنة المستخدمة. فى الموسم الزراعى 2019 تم إجراء كافة التهجينات الممكنة بين السلالات فى نظام تزاوج الدياليل النصف دائرى بإستخدام طريقة جريفينج 1956 ، طريقة -4 نموذج -1 للحصول على 28 هجين بمحطة البحوث الزراعية بسدس. فى الموسم الزراعى 2020 تم تقييم الـ 45 هجين بالإضافة إلى هجينين كهجن مقارنة وهما هجين فردى 168 وهجين فردى بايونيير 3444 فى تصميم القطاعات كاملة العشوائية بثلاثة مكررات فى ثلاث محطات بحثية هى سخا ، سدس و النوبارية. أخذت البيانات على صفات عدد الأيام حتى ظهور 50% حريرة ، إرتفاع النبات ، إرتفاع الكوز ، النسبة المئوية لموقع الكوز على النبات، النسبة المئوية لمقاومة مرض الذبول المتأخر ومحصول الحبوب أردب/فدان.أظهرت نتائج التحليل المجمع وجود إختلافات معنوية بين الثلاثة مواقع لكافة الصفات المدروسة ماعد صفتى مقاومة المرض ومحصول الحبوب مشيراً إلى إختلاف الظروف المناخية للبيئات موقع الدراسة. أظهرت النتائج أن التباينات الراجعة للتراكيب الوراثية وكذلك تفاعلها مع المواقع عالى المعنوية لكل الصفات المدروسة. كانت تباينات كلاً من القدرة العامة والخاصة على التآلف عالية المعنوية لكافة الصفات المدروسة ، مشيراً إلى اهمية الفعل الجينى المضيف وغير المضيف فى وراثة مثل هذه الصفات. أظهرت النتائج إلى أن أفضل السلالات كانت سدس-3180 ، سدس-21 والتى تمتلك قدرة إئتلاف عامة ومرغوبة لصفات التبكير وقصر النبات وأفضلية موقع الكوز على النبات إلى جانب محصول الحبوب. أظهرت النتائج إمتلاك الهجينين سخا-1 x سدس-15 ، جميزة-6052 x جيزة-658 قدرة خاصة على التآلف وكذلك حققا نسبة مئوية للتفوق مقارنة بأفضل هجن المقارنة بالنسبة للمحصول بمقدار 11,42 و 10,92% على الترتيب ، لذا يوصى بإستخدام مثل هذه الهجن فى برامج تربية وإنتاج الذرة الشامية وإطلاقهم كهجن مبشرة بعد إجتيازهم الإختبارات المتقدمة اللازمة.