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COMBINING ABILITY OF NINE WHITE MAIZE INBRED LINES FOR YIELD AND SOME AGRONOMIC TRAITS

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ABSTRACT: *Combining ability analysis was conducted for grain yield, yield components and some agronomic traits, i.e. days to 50% silking, plant and ear heights in a half- diallel cross system involving nine white maize inbred lines. The results indicated that variance due to both general (GCA) and (SCA) specific combining ability was highly significant for all studied traits, indicating the importance of both additive and non-additive gene effects in the inheritance of studied traits. The magnitude of the ratio of general to specific combining ability variance (δ^2 GCA, δ^2 SCA) indicated that the additive was more important than non-additive gene action in the inheritance of studied traits. Estimation of GCA effects of parents revealed that, parent P_2, P_3 and P_9 were the best combiner for grain yield and some of its components, while the best general combiner for earliness were P_1, P_7 and P_8. The best crosses P_1 X P_9 and P_3XP_9 had the positive SCA effects and the highest performance for grain yield. Such suppression inbred lines and crosses can be utilized in the national hybrid breeding program to produce high yielding hybrids.*

Key words: *White maize, GCA, SCA, Additive, Non-additive variance.*

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops in Egypt. It ranks the third among cereal crops, after wheat and rice. Maize is used as food, feed, and fodder. It also has several industrial uses such as oil extraction, starch, gluten, alcohol, glucose and ethanol production and many more products.

Diallel crosses in maize were developed by Sprague and Tatum (1942) who partitioned the variation among F_1 crosses resulting from inbred lines to general (G.C.A.) and specific (S.C.A.) combining ability. Matzinger et al. (1959) revealed that the G.C.A. variance is a function of additive variance, while S.C.A. variance is a function of the non-additive variance. Griffing (1956) gave a complete analysis of diallel crosses for fixed and random set of parents. El-Shamarka (1995), Abd El-Aty and Katta (2002) and Ibrahim *et al.* (2010) reported that specific combining ability effects were much more important in the inheritance of grain yield and its components. Meanwhile, Beck *et al.* (1991), El-Hosary *et al.* (1999), Abd El-Moula (2005), Derera *et al.* (2008), Vivek *et al.* (2010) and Sibiya *et al.* (2011) reported that general combining ability was more important in determining yield and other characters.

The main objectives of this study were: 1) to estimates general and specific combining ability for some quantitative characters in a set of nine inbred lines and 2) to identify the best promising crosses.

MATERIALS AND METHODS

Nine white maize inbred lines (Zea maize L.) were isolated at Mallawy Agriculture Research Station. National Maize Research Program.

In 2014 season, inbreeds were crossed at Mallawy Agriculture Research Station, a half diallel set of crosses were made among the nine parents giving a total of 36 F1 crosses.

In 2015 season, the resultant 36 F_1 crosses along with two commercial single cross hybrids as checks *i.e,* SC 10 and SC 128 were evaluated at two locations, *i.e*.

Mallawy, and Sakha Res. Stns. The experimental design was randomized complete block design (RCBD) with four replications. The plot size was one row, 6 m long and 0.8 m apart, with a distance of 25 cm between hills. All the recommended agronomic practices for maize production were applied at the proper time. Data were recorded for number of days to 50% silking, plant and ear height, ear length, ear diameter, no. of rows/ear, no. of kernels/row and grain yield ardab/ fad. adjusted at 15.5% moisture content and converted to ardab fed^{-1} (ardab = 140 kg).The statistical analysis of RCBD was performed based on plot means from data collected on individual plants, according to *Steel and Torrie (1980)*. Bartlett test was used to test the homogeneity of error variances for all studied traits and they found homogeneous. So, combined statistical analysis across locations was conducted. The combining ability analysis was done according *Griffing's (1956)* Method 4 Model 1 to estimate of general (GCA) and specific (SCA) combining ability variance and effects.

RESULTS AND DISCUSSION

Analysis of variance

Combined analysis of variance for all studied traits is presented in Table (1). Highly significant differences were obtained among locations for all studied traits. Significant differences were also found among genotypes, indicating a large amount of variability among genotypes for all studied traits. General (GCA) and specific (SCA) combining ability mean squares were significant for all traits, indicating that both additive and non-additive gene effects were important in the inheritance of these traits. The magnitude of GCA mean squares was greater than that for SCA for all the studied traits, indicating that additive gene effects were predominant in the inheritance of these traits. The interaction between genotypes and locations was significant for all the studied traits, this could be interpreted that genotypes were inconsistent over location. Significant interaction of general and specific combining ability with locations were obtained for all studied traits, except for ear diameter for GCA X Loc and SCAx Loc, indicating that the magnitude of all types of gene action fluctuated from one location to another. The magnitude of GCAxLoc mean squares was greater than that for SCAxLoc. for all the studied traits, except for days to 50% silking and ear diameter indicating that additive gene action was more affected by the environment than non-additive of these traits. The significant interaction of additive gene effects with locations for these traits indicated that, it would not be effective to make selection on the basis of evaluation in a single environment and more environments are required.

Similar findings were found by El-Itriby *et al* (1990), Gado *et al* (2000), Al-Naggar *et al* (2002), Alamine *et al* (2006) and Sedhom *et al* (2007) who indicated the relative importance of GCA in controlling the inheritance of yield and some agronomic attributes in maize. However, Salama *et al*. (1995), Sadek *et al.* (2001), Singh and Roy (2007) and Abdallah and Hassan (2009), reported that the non-additive type of gene action appeared to be more important in the inheritance of yield and other agronomic traits.

Mean performance

Mean performance of the tested 36 single crosses, along with the two commercial check hybrids, SC 10 and SC 128 for eight studied traits are presented in Table (2). No significant differences were observed among the two check hybrids for grain yield and its components, while for morphological traits, number of days to 50% silking and plant and ear heights, SC 128 had earlier flowering, shorter and lower ear heights than SC 10. The mean values of number of days to 50% silking ranged from 55.75 days for P1 X P8 to 60.75 days for P3

Table 1

Table 2. Mean performance for studied traits of 36 ingle crosses combined across the two locations, in 2015.

Crosses	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of rows per ear	No. of kernels per row	Grain yield (ard/fed)
P1 X P2	59.25	225.00	122.00	18.07	4.92	14.22	36.47	20.40
P1 X P3	58.12	243.50	137.50	18.72	5.30	13.88	37.85	29.04
P1 X P4	56.37	246.50	137.87	19.87	5.03	13.80	37.25	31.11
P1 X P5	56.87	248.50	137.50	19.27	5.05	13.52	36.27	30.68
P1 X P6	58.37	238.87	130.37	20.37	5.20	14.60	38.52	32.59
P1 X P7	56.50	245.12	135.12	18.70	4.95	13.85	37.97	26.94
P1 X P8	55.75	233.00	132.12	20.32	4.95	13.62	39.12	30.49
P1 X P9	57.25	255.62	144.87	22.02	5.33	15.80	44.50	39.35
P2 X P3	59.12	255.25	142.87	21.82	5.05	15.15	43.77	36.28
P2 X P4	57.50	246.62	136.87	20.27	5.10	14.95	37.62	31.44
P2 X P5	57.12	245.25	135.75	18.47	5.05	14.00	37.62	29.75
P2X P6	59.62	235.87	127.50	18.32	5.18	14.02	36.50	29.84
P2 X P7	57.62	247.37	135.50	21.07	5.18	15.65	42.42	35.00
P2 X P8	57.37	226.87	123.37	19.72	4.85	14.00	39.67	29.02
P2X P9	57.75	252.62	141.50	22.18	5.03	14.80	39.95	35.63
P3 X P4	58.37	258.25	143.37	19.97	5.00	14.62	38.05	31.25
P3 X P5	58.87	257.87	138.12	20.02	4.92	13.80	40.95	28.95
P3 X P6	59.87	240.00	140.00	19.77	4.90	14.10	38.92	31.88
P3 X P7	58.75	254.50	137.50	19.50	4.85	13.88	39.92	26.77
P3 X P8	58.00	246.87	136.62	19.75	4.85	13.30	40.15	26.08
P3 X P9	60.75	270.75	151.75	23.70	5.08	14.75	43.40	37.35
P4 X P5	57.87	243.75	126.50	19.35	4.90	12.85	36.98	26.84
P4 X P6	60.62	243.87	132.62	18.20	4.80	13.62	35.35	24.48
P4 X P7	57.75	244.62	133.75	20.02	4.92	13.33	40.70	30.73
P4 X P8	59.00	231.62	127.12	19.27	4.77	13.95	37.47	25.79
P4 X P9	58.25	255.37	140.62	21.45	4.90	13.20	39.67	34.00
P5 X P6	59.50	234.62	125.00	18.10	4.75	13.48	37.08	26.69
P5 X P7	56.87	243.25	125.87	18.82	4.75	13.12	38.73	27.20
P5 X P8	58.37	234.50	127.37	18.37	4.92	12.82	37.20	25.86
P5 X P9	58.75	245.87	133.37	21.08	4.95	13.58	42.85	32.89
P6 X P7	58.62	244.25	134.87	19.37	4.80	13.65	40.37	27.84
P6 X P8	57.87	222.87	121.00	18.60	4.78	13.45	37.97	27.29
P6 X P9	59.37	251.50	142.00	22.30	4.95	14.50	40.57	35.35
P7 X P8	56.50	236.75	127.37	20.27	4.70	12.80	38.70	30.96
P7 X P9	59.25	254.62	139.62	21.62	4.90	13.60	42.00	32.36
P8 X P9	58.62	252.75	137.75	22.78	4.87	13.80	41.20	35.31
Check								
SC10	62.25	290.62	172.75	20.50	4.65	12.80	41.82	35.36
SC128	61.50	267.00	159.37	20.02	4.80	13.40	40.67	36.52
LSD 0.05	0.78	6.66	6.70	0.58	0.18	0.42	1.58	1.67

X P9. In general, all crosses were earlier than the earliest commercial check hybrid SC128 (61.50 days). For plant and ear heights, the shortest plant height (222.87 cm) and lowest ear height (122.00) were obtained from the two crosses P6X P8 and P1 X P2, respectively. Whereas, the tallest plants (270.75 cm) and the highest ear placement (151.75 cm) were obtained from the crosses P3 X P4 and P3 x P9, respectively. All of F_1 crosses differ significantly from SC 128 for studied traits. The mean values of ear length ranged from 18.07 cm for P1 x P2 to 23.70 cm for P3 X P9. Ten crosses i.e. P1 X P4 and P1 X P7 differ significantly from the check hybrid SC 10 for this trait. Regarding ear diameter, the mean values ranged from 4.70 cm for the cross P7 X P8 to 5.33 cm for P1 X P9. Out of the 36 crosses, 13 crosses differ significantly from the check hybrid SC 128. The mean values for number of rows per ear ranged from 12.80 rows for P7 X P8 to 15.80 rows for P1 X P9. For this trait, 18 crosses, P1 X P2 surpassed significantly the check hybrid SC 128. Regarding number of kernels per row, the mean values ranged from 35.35 kernels for P4 X P6 to 44.50 kernels for P1 X P9. Out of the 36 crosses, 3 crosses i.e., P1 x P9, P2 x P3 and P3 x P9 differ significantly from the check hybrid SC 128.

With respect to grain yield, the mean values ranged from 20.40 ard fad $^{-1}$ for P1 X P2 to 39.35 ard fad $^{-1}$ for P1 X P9. One cross i.e. P1X P9 significantly out-yielded the check hybrid SC128, whereas, two crosses i.e. P1 X P9 and P3 X P9 significantly out-yielded the check hybrid SC 10.

General combining ability effects

The estimates of GCA effects (gi) of the parental inbred lines for the studied traits are presented in Table 3. Negative values of GCA effects would be of interest for earliness, shortness and lower ear placement traits; the positive effects were considered favorable for grain yield and its components. The best GCA effects for days to 50% silking, were inbred lines that showed significant negative estimate of GCA effects P1 (-0.940), P7 (-0.476) and P8 (-0.655) which can be considered the best combiner for earliness in the studied lines. With respect to plant height, negative significant GCA effects were obtained from the inbred lines P1, P2, P5, P6 and P8 (-3.250, -3.857, -2.850 and -10.143. Significant and negative GCA effects were detected for lines P5 (-4.528), P6 (-3.796) and P8 (-6.009) for ear height. So, these three parents P5, P6 and P8 lines are characterized by additive genes for shorter plants and low ear placement. On the other hand, inbred lines P3 and P9 exhibited significant positive GCA effects towards tallness and high ear placement.

With respect to grain yield and its component, comparing GCA effects of individual parents (Table 3) showed that the parental inbred lines P2, P3, P7 and P9 had the highest, positive and significant GCA effects for ear length (0.0.232, 0.317, 0.217 and 1.085, respectively). Meanwhile, P1 and P2 lines had positive and significant GCA effects (0.161 and 0.136) for ear diameter. Parents P1, P2, P6 and P9 had positive and significant GCA effects (0.302, 0.402, 0.309 and 0.296) for number of rows per ear, while the parental lines P3, P7 and P9 exhibited the highest positive and significant GCA effects (1.279, 0.586 and 2.122, respectively) for number of kernels per row. The positive and significant estimates of GCA effects for these inbred lines indicated that these inbred lines possess favorable additive genes for these traits.

With respect to grain yield (ard /fed), significant and positive GCA effects were obtained by P2, P3 and P9 (0.611, 0.648 and 5.522, respectively), indicating that these lines possess favorable additive genes for yield which can be utilized in the hybrid breeding program.

Table 3

In these connections inbred line P8 possess favorable genes for earliness, short plant and low ear placement, P1 and P2 for ear diameter and row number, P3, P7 and P9 for ear length and kernel number, P3 and P9 for grain yield, ear length and kernel number.

Specific combining ability effects

Estimates of SCA effects for the F_1 generation of the studied traits are presented in Table (4). Negative and significant and or highly significant SCA effects for days to 50% silking were obtained in six crosses. The best cross combinations for earliness were P1 X P4, P1 X P8, P2 X P5, P2 X P9, P3 X P4 and P6 X P9 , indicating that these combinations could be useful in areas that require early maturing hybrids. Concerning plant and ear heights, cross (P1 X P2) showed significant and negative SCA effects for plant and ear height, indicating that these cross involved inbreeds that are considered good combiners for shortness and lower ear placement. Meanwhile, two crosses P5 X P6 and P5 X P9 exhibited significant negative SCA effects for plant height. With respect to grain yield and its components, the study indicated that (P1 X P6, P3 X P5, P4 X P7 and P5 X P9); (P2 X P7); (P1 X P6, P1 X P9, P2 X P9 and P3 X P4); (P1 X P6, P2 X P3, P4 X P7, P5 X P9 and P6 X P7) crosses were the best cross combinations among all the studied hybrids for ear length, ear diameter, number of rows per ear and number of kernels per row respectively. Furthermore, the crosses P4 X P7, P1 X P5, P1 X P6, P1 X P8, P1 X P9, P2 X P3, P2 X P7, P3 X P6 and P7 X P8 exhibited the highest specific combining ability effects for grain yield. Out of these crosses there were three crosses P1 X P9, P2 X P3 and P2 XP7 gave the highest mean performance for grain yield (39.35, 36.28 and 35.00 ard/fed, respectively). These crosses represented the parental combinations of (low x high), (high x high) and (high x low) GCA effects. This suggests that either additive x additive or additive x dominance genetic interactions were involved in these crosses. For grain yield, the superiority of these crosses may be due to complementary and duplicate type of gene interactions. Hence, these hybrids could be exploited successfully in the national hybrid breeding program. Similar findings were reported earlier by Nawar and EL-Hosary (1985), Soliman *et al* (2001), Sadek *et al* (2002), Gabr *et al* (2008) and Abdallah *et al* (2009).

The previous results imply that the three parental inbred lines P_2, P_3 and P_9 possess favorable alleles for grain yield and most of yield components and may be considered as promising inbred lines. Moreover, the promising cross P_1xP_9 and , P_3xP_9 (39.35 and 37.35 ard fad^{-1}), which yielded as much as the highest yielding check hybrid may be released as a commercial hybrid by the Maize Research Program after further testing and evaluation.

Table 4. Estimates of Specific combining ability effects for studied traits of 36 single crosses combined across the two locations, in 2015.

Crosses	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of rows per ear	No. of kernels per row	Grain yield (ard/fed)
P1 X P2	2.227**	-16.330**	-11.638**	-0.029	-0.281**	-0.302	0.630	-10.220**
P1 X P3	0.138	-5.384	-3.031	-0.465	0.108	-0.463*	-1.387	-1.614*
P1 X P4	-0.808*	3.187	2.379	0.267	-0.009	-0.138	0.405	2.019**
P1 X P5	-0.200	9.937**	7.004*	-0.340	0.079	-0.074	-0.573	2.663**
P1 X P6	0.102	0.384	-0.853	0.749**	0.162	0.440*	1.755*	3.555**
P1 X P7	-0.218	2.366	1.147	-0.040	-0.135	0.086	-0.394	-2.458**
P1 X P8	-0.790*	2.955	3.112	0.267	-0.017	-0.031	0.894	2.267**
P1 X P9	-0.451	2.884	1.879	-0.408	0.094	0.483*	-1.330	3.787**
P2 X P3	0.370	1.473	2.040	0.485	-0.067	-0.213	2.269**	4.635**
P2 X P4	-0.451	3.919	3.325	0.042	0.065	-0.088	0.362	1.490
P2 X P5	-0.718*	7.294*	7.201*	-0.115	0.104	0.176	-0.091	0.748
P2X P6	0.084	1.741	-1.781	0.124	0.161	-0.259	-2.312**	-0.179
P2 X P7	0.138	5.223	3.468	-0.115	0.190*	-0.213	-0.662	4.604**
P2 X P8	-0.683	-3.812	-3.067	0.367	-0.067	0.244	1.302	-0.191
P2X P9	-0.969*	0.491	0.451	-0.758**	-0.106	0.658**	-1.498*	-0.887
P3 X P4	-1.040**	-0.634	0.683	-0.469	-0.020	0.626**	-1.580*	1.261
P3 X P5	0.067	3.741	0.433	0.849**	-0.031	0.265	1.441	-0.091
P3 X P6	-0.504	2.187	1.575	-0.287	-0.049	0.079	-0.280	11.825*
P3 X P7	0.299	-3.830	-3.674	-0.650**	-0.020	0.275	-1.280	-3.649**
P3 X P8	-0.272	0.008	0.415	0.106	0.022	-0.191	0.134	-3.162**
P3 X P9	0.942*	2.437	1.558	0.431	0.058	-0.377	0.684	0.794
P4 X P5	-0.129	0.062	-3.906	0.131	0.001	-0.135	-0.391	-0.507
P4 X P6	1.424**	4.009	1.486	-0.779**	-0.092	0.179	-0.837	-3.634**
P4 X P7	0.102	-3.259	-0.138	0.781**	0.112	0.050	2.237**	1.996*
P4 X P8	1.281**	-4.795	-1.549	-0.112	0.004	0.033	0.102	-1.761*
P4 X P9	-0.379	-2.491	-2.281	0.138	-0.059	-0.527**	-0.298	-0.865
P5 X P6	0.406	-10.491**	-5.388	-0.512	-0.152	-0.231	-0.616	-0.718
P5 X P7	-0.665	-3.634	-4.263	-0.126	-0.074	0.090	-0.716	-0.419
P5 X P8	1.013**	2.830	3.450	-0.519*	0.094	0.022	-1.052	-0.992
P5 X P9	0.227	-9.741**	-4.531	0.631*	-0.020	-0.113	1.998*	-1.522
P6 X P7	0.013	4.937	5.254	0.288	-0.017	-0.195	1.487*	-0.952
P6 X P8	-0.683	-4.973	-3.656	0.320	0.001	-0.088	-0.598	-0.331
P6 X P9	-0.843*	2.205	3.362	0.095	-0.013	0.076	1.402	0.435
P7 X P8	-0.504	0.884	-0.031	-0.219	-0.070	0.058	-0.248	2.975**
P7 X P9	0.835*	-2.687	-1.763	0.082	0.015	-0.153	-0.423	-2.935**
P8 X P9	0.638	6.902*	1.325	-0.212	0.033	-0.045	-0.534	1.194
SE Sij	0.356	3.08	3.091	0.265	0.086	0.199	0.739	0.770
SE(sij-sik)	0.504	4.355	4.371	0.376	0.122	0.281	1.045	1.089

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

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القدرة على التآلف لتسعة سلالات ذرة شامية بيضاء الحبوب لصفة المحصول وبعض الصفات الزراعية

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الملخص العربى

تم إستخدام تحليل القدرة على الآئتلاف لصفة المحصول ومكوناته ولبعض الصفات الزراعية الأخرى مثل عدد الأيام من الزراعة حتى ظهور 50% من الحريرة وإرتفاع النبات وإرتفاع الكوز وذلك بعمل التهجين الدائرى بين تسعة من سلالات الذرة الشامية البيضاء الحبوب (بدون الهجن العكسية). وقد دلت النتائج على أن كلا من تباين القدرة العامة وتباين القدرة الخاصة على الإئتلاف عالية المعنوية لكل الصفات تحت الدراسة وأن كلا من الفعل المضيف وغير المضيف يلعبان دورا هاما فى توريث جميع الصفات تحت الدراسة. وكان التباين الراجع للقدرة العامة على التآلف أكبر من ذلك الراجع للقدرة الخاصة على التآلف لجميع الصفات مما يدل على أن التباين الوراثى المضيف هو الأكثر أهمية فى وراثة هذه الصفات. وقد أظهرت السلالات P_2,p_3,p_9 تأثيرات عالية المعنوية وموجبة للقدرة العامة على الإئتلاف لصفة المحصول وبعض مكوناته، بينما أظهرت السلالات p7,p8 و p_1 أفضل تأثيرات للقدرة العامة على الإئتلاف لصفة التبكير، والسلالتان P6 وP8 أفضل تأثيرات للقدرة العامة على التآلف لصفتى قصر النبات وإنخفاض موقع الكوز على التوالى. بالنسبة للقدرة الخاصة على الإئتلاف فقد أظهر الهجينين P1XP9 و P3XP9 أفضل تأثيرات قدرة خاصة على التآلف لصفة المحصول بالإضافة لأفضل أداء لهذه الصفات. لذلك فإنه يمكن إستغلال هذه السلالات والهجن المتفوقة فى برنامج التربية للتبكير وإنتاج هجن عالية المحصول وذات إرتفاع نبات منخفض.

Table 1. Combined analysis of variances for all the studied traits of 36 single crosses in 2015.

S.O.V	d.f.	Mean squares							
		Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of rows per ear	No. of kernels per row	Grain yield (ard/fed)
Locations (Loc)	1	615.42**	81003.12**	36562.58**	3.08**	3.51**	1.25**	92.93**	74.15**
Rep/ (Loc)	6	2.92	155.31	107.03	1.23	0.036	0.30	13.62	3.09
Genotypes (G)	35	10.22**	968.82**	428.77**	5.38**	0.21**	2.24**	27.44**	128.91**
G x Loc	35	2.69**	382.39**	167.72**	3.35**	0.053*	1.44**	7.46**	55.77**
GCA	8	25.39**	3263.93**	1388.23**	17.20**	0.590**	7.16**	72.62**	286.96**
SCA	27	5.72**	288.79**	144.49**	1.88**	0.096**	0.79**	14.05**	82.07**
GCA x Loc	8	1.38*	850.49**	380.43**	8.06**	0.042	3.85**	11.74**	84.52**
SCA x Loc	27	3.09**	243.70**	104.70**	1.96**	0.055	0.73*	6.19**	47.00**
Pooled error	210	0.59	44.27	44.59	0.33	0.035	0.185	2.55	2.77
GCA/SCA		4.44	11.30	9.61	9.15	6.15	9.06	5.17	3.50
GCAxL/SCAxL		0.45	3.49	3.63	4.11	0.76	5.27	1.90	1.80

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

Table 3. Estimates of general combining ability effects for all the studied traits combined across the two locations, in 2015.

Parents	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of rows per ear	No. of kernels per row	Grain yield (ard/fed)
P1	-0.940**	-3.250**	0.562	-0.743**	0.161**	0.302**	-1.007**	-0.373
P2	-0.172	-3.857**	-1.385	0.232*	0.136**	0.402**	-0.114	0.611*
P3	0.792**	12.321**	7.758**	0.317**	0.022	0.138	1.279**	0.648*
P4	-0.012	1.875	0.472	-0.139	-0.035	-0.187*	-1.364**	-1.042**
P5	-0.119	-2.85*	-4.528**	-0.507**	-0.025	-0.426**	-0.610*	-1.994**
P6	1.077**	-6.696**	-3.796**	-0.497**	-0.032	0.309**	-0.789*	-0.977**
P7	-0.476**	1.321	-1.046	0.217*	-0.110**	-0.362**	0.586*	-0.611*
P8	-0.655**	-10.143**	-6.009**	0.035	-0.153**	-0.469**	-0.103	-1.785**
P9	0.506**	11.304**	7.972**	1.085**	0.036	0.292**	2.122**	5.522**
SE gi	0.137	1.185	1.189	0.102	0.033	0.076	0.284	0.296
SE gi - gj	0.205	1.178	1.784	0.153	0.05	0.114	0.426	0.445

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