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COMBINING ABILITY OF EIGHT WHITE MAIZE *(Zea mays L.)* INBRED LINES FOR GRAIN YIELD AND OTHER TRAITS IN DIALLEL CROSSES

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ABSTRACT

All possible combinations were made in 2005 season between eight diverse white inbred lines of maize in a half diallel at Gemmeiza Agric. Res. Station to obtain 28 single crosses. The 28 F_1's and one check were planted at three locations i.e. Sakha, Gemmeiza and Sids Agricultural Research. Stations in a randomized complete block design, with four replications, in 2006 summer season. Combined analysis of variance for the three locations was performed for number of days from planting date to 50% silking emergence, plant height, ear height, ear position %, stand %, ear length, ear diameter, no. of rows/ear, weight of 100-kernel and grain yield. Estimates of combining ability effects according to Griffing (1956) Method-4 Model-1 were determined. The results could be summarized as follows:

Significant differences were found between the three locations for all studied traits except for Stand % and no of rows/ear. Both additive and non additive gene actions were found to be important in controlling for all studied traits except for additive gene action for weight of 100 kernels. However, the additive gene action seemed to be more important than the non additive gene action in the expression of silking date, plant height, ear position%, ear length, ear diameter, no. of rows/ear and grain yield. While, the non additive gene action was more important in the inheritance of ear height, stand% and weight of 100 kernels. The interaction between locations with both types of combining ability was detected significant for most of the studied traits. However, the additive gene action was more affected by the environment than the non additive gene action for all studied traits, except for ear height, ear position%, stand% and ear length traits. The best combiners for GCA effects were the parental inbred line; P_1 for grain yield, ear position%, ear diameter and no. of rows/ear; P_3 for grain yield, weight of 100 kernels, silking date (toward earliness), ear height and ear position% (toward low ear placement); P_5 for plant height and ear height (toward shorter plants low ear placement) and stand%; P_6 for grain yield, stand% and ear length; P_7 for grain yield and no. of rows/ear. The four crosses i.e., (P_1 x P_4), (P_1 x P_5), (P_3 x P_7) and (P_6 x P_8) had desirable SCA effects for grain yield and exhibited significant superiority over the commercial SC-129 hybrid for grain yield, ear diameter and no. of rows/ear. These crosses could be used as good hybrids in maize breeding program.

Keywords: maize, diallel analysis, combining ability, gene action.

INTRODUCTION

Diallel analysis provides information a bout the components of genetic variation and helps the breeder in the selection of desirable plants for crossing programs and also in deciding a suitable breeding procedure for the genetic improvement of various quantitative traits. Combining ability analysis supply the breeder with useful information regarding the choice of parents for developing superior hybrids, the determination of the most effective breeding method, and the inheritance of grain yield and other desirable traits. Sprague and Tatum (1942), firstly defined general (GCA) and specific (SCA) combining abilities and they found that the GCA was relatively more important than SCA unselected inbred lines, whereas the SCA was more important than GCA for previously selected lines for influencing yield. Furthermore, they interpreted GCA as an indication of genes having largely additive effects and SCA as indication of genes having dominance and epistatic effects. Piovarci (1973), found that the ratio of variance due to GCA and SCA was 2:1 for grain yield, 5:1 for ear length and 45:1 for no. of rows/ear, indicating the predominant role of additive gene action in the expression of these traits. Mahmoud (1989), showed that GCA was more important than SCA in the inheritance of number of days to 50% silking. Mokbel (1988) reported that the magnitude of the ratio of GCA to SCA variances was high for plant height and no. of ears/plant, suggesting the importance of additive gene action in the inheritance of these traits. Pajic (1986), Sedhom (1992), El-Shamarka (1995), El-Shenawy *et al.*(2002) and Singh and Jha (2004), found that non additive effects controlled in the inheritance of grain yield, ear length, ear diameter, plant height and ear height. Al-Naggar (1991) and Mosa (2001), revealed that the additive effects was more important in the inheritance of silking date and no. of rows/ear. El-Rouby *et al.* (1973), El-Shenawy *et al.* (2002) and Mosa (2003), reported that the magnitude of the interactions for GCA x locations was higher than SCA x locations for silking date, no. of ears/100 plants, plant height, no. of rows/ear and grain yield traits.

The main objective of this investigation was to study the type of gene action for eight white maize inbred lines and their interactions with locations and to choose the best yielding crosses to be used in the maize breeding program.

MATERIALS AND METHODS

Eight white maize inbred lines developed at Gemmeiza Agricultural Research Station isolated from different populations were used in this study; i.e., Gm.W.POP-F.17 (P_1), A.E.D.1-F.18 (P_2), A.E.D.2-F.8 (P_3), Tep # 5-F.7 (P_4), Comp # 5-F.15 (P_5), Laposta-F.19 (P_6), Tuxpina-F.19 (P_7) and Giza-2-F.110 (P_8). In 2005 growing season, all possible crosses without reciprocals, among the eight parents in a half Diallel mating design were made. The 28 F_1's and one white commercial hybrid Giza-129 were grown in a randomized complete block design with four replications at three locations i.e., Sakha, Gemmeiza and Sids Agricultural Research Station during 2006 growing season. The experimental consisted of a single row, 6 m long, 80 cm apart. Sowing was made in hills evenly spaced at 25 cm along the row at the rate of three kernels per hill. The seedlings were thinned to one plant per hill after 21 days from planting. All agronomic field practices were performed as usually recommended for maize cultivation. Data were recorded on number of days from planting date to date of 50% silking emergence number, plant height (cm), ear height (cm), ear position (%) (this is trait could be used as one of valuable selection criteria over plant and ear heights in the breeding programs for low ear placement), stand (%) [(stand trait is uniformity relates to yield per unit area , Fasoula and Tollenaar (2005) and its equal = no. of plants at harvest*100)/(no. of total plants)], ear length (cm), ear diameter (cm), no. of rows/ear, weight of 100 kernels (g) and grain yield (ard/fed) adjusted to 15.5% moisture content (one ardab = 140 kg, one feddan = 4200 m^2),. An ordinary analysis of variance for the data was performed for each location then combined over locations according to Steel and Torrie (1980). The genetic analysis for the Diallel crosses was computed according to Griffing,s (1956) Method-4, Model-1.

RESULTS AND DISUSSIONS

Mean squares of the diallel analysis combined over three locations for ten traits are presented in Table (1). Locations mean squares were significant or highly significant for all studied traits except stand% and no. of rows/ear, indicating over all differences between the three locations for these traits. Mean squares due to general and specific combining abilities (GCA and SCA) were significant or highly significant for all studied traits except GCA for weight of 100 kernel, indicating that both additive and non additive gene actions were important in controlling all studied traits except the trait of weight of 100 kernels where the additive gene action was the most important. The results are in agreement with those obtained by Surya and Ganguli (2004), Singh and Jamwal (2004), Turgut and Duman (2004), Amer (2002), Mosa (2005) and Ji Hee *et al.* (2006). However, the ratio of GCA/SCA was more than unity for silking date, plant height, ear position%, ear length, ear diameter, no. of rows/ear and grain yield. This indicated that the additive gene action played a more an important role than non additive gene action in the inheritance of these traits. Meanwhile, the GCA/SCA ratio was less than unity for ear height, stand% and weight of 100 kernels, indicating that the non additive gene action played the most important role in the inheritance of these traits. These results are in agreement with those obtained by Mareno-Gonzalez and Dudly (1981), Nawar *et al.* (1981), Dawood *et al.* (1994), Amer *et al.* (1998), Ogunbodede *et al*., (2000), Amer (2002) and Singh *et al*., (2002) for silking date, plant height and no. of rows/ear; Rameeh *et al*., (2000) and Mosa (2005) for no. of days to 50% silking, plant height, ear length, no. of rows/ear and grain yield. The results revealed that the GCA x locations were significant or highly significant for silking date, ear diameter, weight of 100 kernels and grain yield. While, mean squares of SCA x locations were significant or highly significant for no. of days to 50% silking, plant height, ear height, ear position%, stand% and grain yield. The magnitude of GCA x locations was larger than SCA x locations for all studied traits, except for ear height, ear position%, stand% and ear length, indicating that the additive components of genetic variation is highly affected by the environment than the non additive components. Similar results were obtained by Debnath and Sarkar (1987), Mahmoud (1996), Abd El-Maksoud *et al.* (2004), Singh and Jha (2004) and Mosa (2005), they suggested that the additive effects were biased by interaction with environments than the non additive effects.

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Mean performance of the 28 F_1crosses and the check hybrid SC-129 for ten traits over three locations are given in Table (2). The results showed that the four crosses; i.e. P_1 x P_4 (27.96 ard/fed), P_1 x P_5 (28.30 ard/fed), P_3 x P_7 (29.13 ard/fed) and P_6 x P_8 (27.98 ard/fed); were significantly superior than the check hybrid SC-129 (24.40 ard/fed) for grain yield. The first three crosses; (P_1 x P_4), (P_1 x P_5) and (P_3 x P_7) significantly surpassed the check SC 129 for ear diameter and no. of rows/ear. Whereas, the 4th cross (P_6 x P_8) exhibited similar values to those the check hybrid SC 129 for same traits. The crosses (P_1 x P_2), (P_1 x P_3), (P_3 x P_5) and (P_3 x P_6), although exhibited similar yields to that of the check SC 129, they were significantly of earlier maturity.

Estimates of general combining ability effects of the eight inbred lines for ten traits over three locations are shown in Table (3). The results showed inbred line P_3 to possess desirable GCA effects for days to 50% silking toward earliness, ear height, ear position%, weight of 100 kernels and grain yield. Inbred line P_1 had highest GCA effects for ear position%, ear diameter, no. of rows/ear and grain yield. While, inbred line P_5 had the highest negative GCA effects for plant and ear height toward shorter plants and lower ear placement. Inbred line P_6 showed positive and significant GCA effects for stand%, ear length and grain yield. Inbred line P_7 exhibited desirable GCA effects for no. of rows/ear and grain yield. These results suggest utilizing the above inbred lines in maize breeding programs to improve those traits.

Estimates of specific combining ability effects of 28 crosses for the studied traits over three locations are given in Table (4). Desirable specific combining ability effects were obtained for grain yield; in the crosses (P_1 x P_4), (P_1 x P_5), (P_2 x P_7), (P_3 x P_4), (P_3 x P_7) and (P_6 x P_8), for no. of days to 50% silking (toward earliness); in the crosses (P_1 x P_2), (P_1 x P_3), (P_3 x P_5), (P_3 x P_6), (P_4 x P_5), (P_6 x P_8) and (P_7 x P_8), for plant height (toward shorter plants); in the cross (P2 x P8), (P_3 x P_6), for ear height; in the crosses (P_1 x P_2), (P_3 x P_6) and (P_3 x P_7) and for ear position%; in the crosses (P_1 x P_2), (P_5 x P_8) and (P_6 x P_7), for the stand%; in the crosses (P_1 x P_2), (P_2 x P_7), (P_2 x P_8), (P_3 x P_4) and (P_6 x P_8), for ear length; in the crosses (P_1 x P_5) and P_6 x P_8), for ear diameter; in the crosses (P_2 x P_4), (P_3 x P_7) and (P_3 x P_8) and for weight of 100 kernels; in the crosses (P_1 x P_2) and (P_7 x P_8).

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تقدير القدرة على التآلف لثمانى سلالات بيضاء من الذرة الشامية (*Zea mays L.*) لصفة المحصول وبعض الصفات الأخرى فى نظام الدياليل الغير كامل

سمير ثروت محمود موسى و رزق صلاح حسانين على
مركز البحوث الزراعية – معهد بحوث المحاصيل الحقلية – برنامج بحوث الذرة الشامية

تم عمل التهجينات الممكنة بين ثمانية سلالات بيضاء من الذرة الشامية بنظام التزاوج الدائرى الغير كامل فى محطة البحوث الزراعية بالجميزة موسم ٢٠٠٥ وذلك بغرض الحصول على ٢٨ هجين فردى. وفى الموسم الزراعى ٢٠٠٦ تم تقييم الـ٢٨ هجين فى ثلاثة تجارب بالإضافة إلى هجين المقارنة (هجين فردى ١٢٩) فى محطات البحوث الزراعية بسخا ، الجميزة وسدس فى تصميم القطاعات كاملة العشوائية فى أربعة مكررات وكذلك التحليل المشترك لثلاث مواقع عمل للصفات، محصول الحبوب ، عدد الأيام حتى ظهور ٥٠% من حراير النورات المؤنثة ، ارتفاع النبات ، ارتفاع الكوز ، موقع الكوز% ، نسبة النباتات القائمة عند الحصاد ، طول الكوز ، قطر الكوز ، عدد الصفوف بالكوز ووزن ١٠٠ حبة). وقدرت القدرة على الإئتلاف وراثياً تبعاً للطريقة الرابعة للموديل الأول عن جرفنج ١٩٥٦ . ويمكن **تلخيص أهم النتائج المتحصل عليها فى النقاط التالية:**

١ – كان التباين الراجع للمواقع معنوياً لجميع الصفات المدروسة فيما عدا صفتى نسبة النباتات القائمة عند الحصاد وعدد الصفوف بالكوز.

٢ – تبين أن الفعل الوراثى المضيف والفعل الوراثى الغير مضيف لهما دوراً مهماً فى وراثة جميع الصفات ما عدا الفعل الجينى المضيف لصفة وزن ١٠٠ حبة حيث دوره غير معنوى ومع ذلك تبين أن الفعل المضيف للجين أكثر أهمية فى وراثة صفات التزهير ، ارتفاع النبات ، موقع الكوز ، طول الكوز ، قطر الكوز ، عدد الصفوف بالكوز وصفة محصول الحبوب. بينما كان الفعل الجينى الغير مضيف للجين أكثر أهمية فى وراثة صفات ارتفاع الكوز ، نسبة النباتات القائمة عند الحصاد وزن ١٠٠ حبة.

٣ – أظهر تفاعل كل من القدرة العامة والخاصة على التآلف مع المواقع معنوية فى معظم الصفات المدروسة. وكان الفعل الجينى المضيف أكثر تأثراً بالبيئة من الفعل الجينى الغير مضيف فى معظم الصفات المدروسة.

٤ – أوضحت النتائج أن أفضل السلالات فى القدرة على التآلف كانت السلالة P_1 لصفات محصول الحبوب ، قطر الكوز ، عدد الصفوف بالكوز وموقع الكوز والسلالة P_3 لصفات محصول الحبوب ، التزهير (تجاة التبكير) ، ارتفاع الكوز ، موقع الكوز وزن ١٠٠ حبة والسلالة P_5 لصفات ارتفاع النبات ، ارتفاع الكوز ونسبة النباتات القائمة عند الحصاد والسلالة P_6 لصفات محصول الحبوب ، نسبة النباتات القائمة عند الحصاد وطول الكوز وأظهرت السلالة P_7 قدرة إئتلاف لصفات المحصول وعدد الصفوف فى الكوز فى حين أظهرت السلالة P_6 قدرة إئتلاف لصفات محصول الحبوب ، نسبة النباتات القائمة عند الحصاد وطول الكوز.

٥ – أظهرت النتائج تفوق أربعة هجن فردية وهى (P_1 x P_4), (P_1 x P_5), (P_3 x P_7) and (P_6 x P_8) كانت تمتلك قدرة خاصة مرغوبة على الإئتلاف لصفة محصول الحبوب وكذلك تفوقت معنوياً على هجين المقارنة الهجين الفردى ١٢٩ فى صفات محصول الحبوب ، وقطر الكوز وعدد الصفوف بالكوز. وبذلك يمكن الاستفادة من هذه الهجن كهجن جديدة مبشرة فى برنامج تربية الذرة الشامية.

Table (1): Mean squares of the diallel analysis combined over three locations for ten traits.

S.O.V	D.F.	Silking date (days)	Plant height (Cm.)	Ear height (Cm.)	Ear Position %	Stand %	Ear length (Cm.)	Ear diameter (Cm.)	No. of rows/ear	Weight of 100-kernel (g)	Grain yield (ard/fed)
Locations	2	32.955**	56217.65**	20551.78**	267.748*	383.048	355.539**	12.108**	2.021	3516.324**	1641.829**
Reps/Loc.	9	1.678	378.71	611.36	56.695	239.079	3.003	0.126	1.684	21.401	54.449
GCA	7	46.356**	2084.268**	561.852**	45.996**	300.900**	10.836*	0.168**	1.788**	21.528	322.452**
SCA	20	35.268**	697.632**	569.22**	36.240**	324.876**	9.192**	0.096*	1.176*	22.260*	93.900**
GCA x Loc.	14	11.648**	440.771	250.449	14.278	114.238	2.752	0.076*	0.642	44.660**	100.391**
SCA x Loc.	40	8.767**	399.699*	329.116**	27.990**	146.898*	4.035	0.043	0.634	16.962	57.438**
Error	252+	2.927	270.892	161.78	12.065	93.639	4.233	0.052	0.606	13.597	19.727
GCA/SCA		1.314	2.988	0.987	1.269	0.926	1.179	1.75	1.520	0.967	5.046
GCAxLoc./SCAxLoc		1.329	1.103	0.761	0.512	0.778	0.682	1.767	1.059	2.633	1.748

***,** significant at 0.05 and 0.01 levels of probability, respectively.**
+ including the check

Table (2): Mean performance of the 28 F_1crosses and the check hybrid SC-129 for ten traits over three locations.

Cross	Silking date (days)	Plant height (Cm.)	Ear height (Cm.)	Ear Position%	Stand %	Ear length (Cm.)	Ear diameter (Cm.)	No. of rows/ear	Weight of 100-kernel (g)	Grain yield (ard/fed)
P_1xP_2	60.00	284.67	152.92	53.62	90.667	19.98	4.63	14.233	29.41	25.51
P_1xP_3	59.67	287.83	161.50	56.13	85.000	19.07	4.53	14.367	26.63	25.75
P_1xP_4	63.75	291.33	166.08	57.08	84.000	19.57	4.72	14.650	26.62	27.96
P_1xP_5	64.00	282.00	169.08	59.98	89.667	20.38	4.74	14.617	27.89	28.30
P_1xP_6	64.00	283.08	170.50	60.28	86.667	19.15	4.65	14.900	28.28	23.23
P_1xP_7	64.08	281.92	168.00	59.67	80.667	19.25	4.63	14.383	27.38	25.14
P_1xP_8	64.25	284.75	166.08	58.14	87.333	19.87	4.64	14.467	26.23	27.08
P_2xP_3	63.33	267.83	154.25	57.63	82.667	18.65	4.47	13.783	26.97	17.64
P_2xP_4	63.33	267.08	158.08	59.19	82.667	19.33	4.62	14.467	27.17	19.35
P_2xP_5	64.58	258.67	150.08	57.78	79.667	17.68	4.36	13.383	26.68	17.68
P_2xP_6	65.25	286.33	169.42	59.08	83.667	20.37	4.51	14.192	25.50	21.89
P_2xP_7	64.33	292.00	172.58	59.02	91.667	18.77	4.38	14.350	25.13	24.51
P_2xP_8	63.58	267.75	158.25	59.10	92.333	17.83	4.53	14.267	27.64	19.99
P_3xP_4	62.17	286.33	163.33	57.06	93.667	20.38	4.56	14.367	27.89	27.60
P_3xP_5	59.92	269.33	154.75	57.44	94.000	19.00	4.62	14.283	30.45	23.63
P_3xP_6	59.00	271.33	152.67	56.27	90.333	20.05	4.48	13.717	30.53	27.54
P_3xP_7	62.33	276.00	160.92	58.28	89.667	20.67	4.71	14.700	29.20	29.13
P_3xP_8	64.75	289.33	171.17	59.13	81.167	20.62	4.72	14.333	27.04	21.65
P_4xP_5	62.83	260.08	152.92	58.78	91.333	19.20	4.92	14.400	27.18	16.78
P_4xP_6	64.17	273.83	161.33	58.78	91.667	18.68	4.63	14.400	26.25	22.24
P_4xP_7	63.50	276.25	160.58	58.10	85.667	18.68	4.59	14.667	27.67	20.92
P_4xP_8	65.42	280.33	170.67	61.15	77.833	19.73	4.53	13.783	27.73	20.15
P_5xP_6	64.58	279.83	172.25	61.51	93.333	20.13	4.64	14.333	29.01	23.53
P_5xP_7	64.42	266.25	163.67	62.47	89.333	19.55	4.60	14.667	28.18	20.43
P_5xP_8	63.83	265.50	154.00	57.93	93.000	17.72	4.58	13.783	26.62	19.30
P_6xP_7	62.42	279.58	157.42	56.43	95.000	20.30	4.50	14.633	27.51	25.50
P_6xP_8	60.17	282.17	163.75	57.98	96.333	20.98	4.58	14.183	28.95	27.98
P_7xP_8	63.08	281.00	166.75	59.27	83.667	19.03	4.48	14.417	29.45	23.62
SC 129	61.75	245.75	163.67	58.45	91.666	20.47	4.51	13.83	33.88	24.40
LSD 0.05	1.368	13.17	10.18	2.77	7.743	1.64	0.182	0.623	2.95	3.55
0.01	1.799	17.31	13.38	3.65	10.176	2.16	0.239	0.819	3.88	4.67

Table (3). Estimates of general combining ability effects of the eight inbred lines for ten traits over three locations.

Inbred lines	Silking date (days)	Plant height (Cm.)	Ear Height (Cm.)	Ear Position%	Stand %	Ear length (Cm.)	Ear diameter (Cm.)	No. of rows/ear	Weight of 100-kernel (g)	Grain yield (ard/fed)
P_1	-0.323	8.747**	3.069*	-0.735*	-1.994	0.185	0.086**	0.251**	-0.229	3.274**
P_2	0.455*	-3.129	-3.361*	-0.653	-2.185*	-0.590**	-0.090**	-0.239**	-0.884*	-2.786**
P_3	-1.754**	0.816	-2.961*	-1.230**	0.139	0.373	0.010	-0.093	0.819*	1.615**
P_4	0.580**	-1.309	-0.458	0.134	-1.472	-0.096	0.017	0.057	-0.547	-1.388**
P_5	0.413*	-10.240**	-3.167*	1.097**	2.444*	-0.415	0.001	-0.16*	0.370	-2.269**
P_6	-0.351	2.177	1.931	0.171	3.556**	0.585**	-0.006	0.041	0.372	1.288**
P_7	0.413*	1.649	2.361	0.654	0.01	0.015	-0.022	0.199*	0.120	0.997*
P_8	0.566*	1.288	2.486	0.562	-0.667	-0.063	0.006	-0.066	-0.022	-0.731
LSD g_i 0.05	0.36	3.55	2.74	0.73	2.09	0.44	0.05	0.16	0.79	0.95
0.01	0.48	4.68	3.61	0.98	2.75	0.58	0.06	0.22	1.04	1.26

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

Table (4): Estimates of specific combining ability effects of 28 crosses for the studied traits over three locations.

Cross	Silking date (days)	Plant height (Cm.)	Ear Height (Cm.)	Ear Position%	Stand %	Ear length (Cm.)	Ear diameter (Cm.)	No. of rows/ear	Weight of 100-kernel (g)	Grain yield (ard/fed)
P_1xP_2	-3.230**	1.462	-9.042**	-3.468**	6.714**	0.938	0.054	-0.080	2.837**	1.698
P_1xP_3	-1.355**	0.685	-0.958	-0.383	-1.147	-0.948	-0.138*	-0.093	-1.649	-2.462*
P_1xP_4	0.395	6.310	1.222	-0.789	-0.536*	0.027	0.039	0.041	-0.292	2.691*
P_1xP_5	0.812*	5.907	6.931*	1.149	1.214	1.163*	0.081	0.171	0.066	3.973**
P_1xP_6	1.575**	-5.427	3.250	2.375**	-2.897	-1.071*	-0.006	0.306	0.448	-4.659**
P_1xP_7	0.895*	-6.065	0.319	1.275	-5.341*	-0.401	-0.006	-0.326	-0.201	-2.452*
P_1xP_8	0.909*	-2.871	-1.722	-0.158	1.992	0.293	-0.025	-0.020	-1.209	1.209
P_2xP_3	1.534**	-7.440	-1.778	1.043	-3.369	-0.590	-0.028	-0.186	-0.652	-4.510**
P_2xP_4	-0.800	-6.065	-0.347	1.204	-1.758	0.568	0.115*	0.348	0.913	0.201
P_2xP_5	0.617	-5.552	-5.639	-1.133	-8.675**	-0.762	-0.126*	-0.572**	-0.495	-0.584
P_2xP_6	2.048**	9.698*	8.597**	1.093	-5.786**	0.921	0.029	0.088	-1.70*	0.034
P_2xP_7	0.367	15.893**	11.333**	0.543	5.770**	-0.110	-0.088	0.132	-1.795*	2.975**
P_2xP_8	-0.536	-7.996*	-3.125	0.718	7.103**	-0.970*	0.043	0.270	0.863	0.186
P_3xP_4	0.242	9.240*	4.403	-0.319	7.048**	0.649	-0.043	0.102	-0.064	4.050**
P_3xP_5	-1.841**	1.171	-1.472	-0.899	3.464	-0.415	0.032	0.183	1.577	0.965
P_3xP_6	-1.994**	-9.246*	-8.653**	-1.147	-1.313	-0.365	-0.096	-0.533**	1.651	1.316
P_3xP_7	0.575	-4.052	-0.833*	0.386	1.575	0.821	0.146**	0.335	0.577	3.198**
P_3xP_8	2.839**	9.643*	9.292**	1.319	-6.258**	0.849	0.126*	0.191	-1.439	-2.557*
P_4xP_5	-1.258**	-5.954	-5.708	-0.921	2.409	0.260	-0.100*	0.149	-0.324	-2.891**
P_4xP_6	0.839*	-4.621	-2.389	0.006	1.631	-1.257*	0.039	0.001	-1.259	-0.981
P_4xP_7	-0.591	-1.677	-3.569	-1.161	-0.813	-0.687	0.022	-0.615**	0.409	-2.016
P_4xP_8	1.173**	2.768	6.589*	1.981*	-7.980**	0.440	-0.072	-0.026	0.617	-1.055
P_5xP_6	1.423**	10.310*	11.236**	1.810*	-0.619	0.513	0.072	0.098	0.583	1.184
P_5xP_7	0.492	-2.746	2.222	2.243**	-1.063	0.499	0.047	0.316	0.009	-1.625
P_5xP_8	-0.244	-3.135	-7.569*	-2.207**	3.270	-1.257*	-0.006	-0.345	-1.416	-1.023
P_6xP_7	-0.744	-1.829	-9.125**	-2.864**	3.492	0.249	-0.047	0.134	-0.667	-0.107
P_6xP_8	-3.147**	1.115	-2.917	-1.231	5.492*	1.010*	0.008	-0.094	0.916	3.212**
P_7xP_8	-0.994*	0.476	-0.347	-0.422	-3.619	-0.371	-0.075	0.024	1.70*	0.027
LSD 0.05	0.81	7.87	6.08	1.66	4.62	0.97	0.10	0.37	1.70	2.12
0.01	1.07	10.36	8.00	2.18	6.09	1.28	0.13	0.49	2.32	2.79

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