Annals of Agric. Sci., Moshtohor **ISSN 1110-0419**
Vol. 54(2) (2016), 291–296 **http://annagricmoshj.com**

Combining Ability and Type of Gene Action Analysis of Yield and Yield Components for Some White Maize Inbred Lines

H. E. Mosa; ia.i. El-gazzar and m.a.a. Hassan
Maize research department, fcri, arc, Egypt

Corresponding author: mosasayed@yahoo.com

Abstract

Combining ability analysis were conducted for grain yield, its components, plant and ear heights and days to 50% silking in a half diallel cross involving eight white maize inbred lines. The resulting 28 hybrids and two commercial hybrids (SC10 and SC128) were grown at Sakha, Gemmeiza and Mallawy Research Stations in 2014 growing season. Both general and specific combining ability and their interaction with locations were significantly for most traits. However, the additive gene effects was most responsible for controlling the inheritance of ear height, ear length, ear diameter, number of rows/ear and number of kernels/row while the non additive gene effects was higher than additive gene effects for days to 50% silking, plant height and grain yield. Also, the non-additive gene effects was more interacted with locations than additive gene effects for most studied traits. The best general combiner inbred line was P_3 for earliness, P_8 for short plant and ear heights, P_5 for ear length, number of kernels/row and grain yield, P_7 for ear diameter and P_1 for number of rows/ear. The best hybrid for specific combining ability was P4 x P_7 for grain yield.

Keywords: *Maize, combining ability, additive gene effects, non-additive gene effects.*

Introduction

The conventional crop breeding methodology mainly depends upon the development of inbred lines of maize from open pollinated varieties or other heterogeneous sources and their evaluation through different techniques to evolve desirable hybrids for commercial use. Diallel crosses have been used in genetic research to determinate the inheritance of a trait among a set of genotypes to identify superior parents for hybrids development (Yan and Hunt, 2003). The variance of general combining ability GCA and specific combining ability SCA are related to the type of gene action involved. Variance for GCA includes additive portion while that of SCA includes non-additive portion of total variance arising largely from dominance and epistatic deviations (Rojas and Sprague, 1952), superiority of a line on the basis of combining ability estimates can only be decided precisely after knowing the purpose of a certain breeding program whether, it is to develop high yielding open pollinated varieties or the superior combination of hybrids. Lines which had higher GCA effects can be used in synthetic variety development more effectively. However, when high yield specific combination are desired, especially in hybrid maize development, SCA effects could help in the selection parental material for hybridization.

The objectives of this study were to estimate the genetic parameters and to determine suitable parents and promising crosses for eight traits in 8 x 8 half diallel crosses.

Materials and Methods

Eight white inbred lines, P_1 (Sk-6001/6), P_2 (Sk-6005/8), P_3 (Sk-5001/65), P4 (Sk-5002/36), P_5 (Sd-34), P_6 (Sk-8), P_7 (Sk-12) and P_8 (Sk-13) obtained from the Maize Research Department, Field Crops Research Institute, (FCRI), Agricultural Research Center (ARC), Egypt were crossed in a 8 x 8 half diallel mating scheme in the 2013 growing season. The resulting 28 F_1 hybrids and two commercial hybrids SC10 and SC128 were grown at three Agricultural Research Stations, Sakha, Gemmeiza and Mallawy in 2014 growing season. The plots were represented by 1 row, while the row to row and plant to plant distances were kept 80 cm and 25 cm, respectively, with 25 plants per row after thinning. The experiment design was a randomized complete block design with 4 replications. All agronomic and cultural practices were applied as recommended in the three locations. Data were recorded for days to 50% silking, plant and ear heights (cm), ear length and diameter (cm), number of rows/ear, number of kernels/row and grain yield (ard/fed) adjusted based 15.5% grain moisture (one ardab=140 kg and one feddan = 4200 m^2). Combined analysis across three locations for 30 hybrids was carried out when homogeneity of variance was detected, which locations were considered as random effects and hybrids were considered as fixed effects (Steel and Torrei, 1980) and further the 28 hybrids were analysed for combining ability using method-4, model-1 (Griffing, 1956).

Results and Discussion

Combined analysis of variance for eight traits across three locations are presented in Table (1).

Differences among three locations (L) were found to be highly significant for all studied traits, indicating markedly differences between the three locations in their climate and soil conditions.

Table 1. Combined analysis of variance for eight traits across three locations.

SOV	df	Days to 50% silking	Plant Height	Ear height	Ear length	Ear diameter	No. of rows/ear	No. of kernels/ row	Grain yield
Locations (Loc)	2	554.919**	91166.336**	38581.96**	936.36**	7.921**	172.672**	4.394.84**	3601.06**
Rep./Loc	9	3.535	470.517	223.07	5.956	0.138	2.492	112.52	27.07
Hybrids (H)	27	17.626**	1172.865**	555.339**	18.809**	0.258*	7.548**	69.373**	105.39**
Checks (C)	1	45.37	2035.04	2185.04	0.327	0.54	1.5	2.67	2.73
H vs. C	1	22.27	1742.06	161.39	0.05	0.26	22.81	0.898	232.42*
H x L	54	3.197**	301.645**	232.7**	3.72**	0.156*	1.959**	21.82*	45.9**
Ch x L	2	3.375*	378.3*	735.79**	2.49	0.24	0.62	2.73	3.65
H vs. Ch x L	2	11.22**	363.199*	171.924	5.44	0.077	2.95	54.07*	3.96
Error	261	0.830	118.743	79.59	1.860	0.083	0.951	13.15	10.38

Significant at 0.05 and 0.01 levels of probability, respectively

In Table 2. Sakha location produced high means for eight traits while the reverse was obtained, at Mallawy location. Frey (1964) defined the stress environment as one in which mean performance for certain attribute is low. Regarding to Table 1, the differences among the hybrids were significant or highly significant for all studied traits while the differences among check (C) and hybrids vs checks (H vs C) were not significant for all traits except (H vs C) for grain yield. Also, the H x L interaction was significant or highly significant for all traits, while C x L and H vs C x L were not significant for most traits. Comstoc and Moll (1963) defined the genotypes x environments, interaction as the differential response of genotypes to the change in environments.

Table 2. Means of three locations for eight traits**.**

Location	Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/ row	Grain yield (ard/fed)
Sakha	65.18 a	287.96 a	162.10 a	23.86 a	5.00 a	15.70 a	46.36 a	38.77 a
Gemmeiza	64.17 b	264.20 b	143.75 b	22.29 b	4.70 b	15.11 b	44.35 a	31.27 b
Mallawy	61.05 c	233.0 c	126.25 c	18.43 c	4.49 c	13.42 c	35.02 b	28.10 c
CV%	1.44	4.16	6.19	6.33	6.10	6.61	8.65	9.85
LSD 0.05	0.534	6.328	4.358	0.712	0.108	0.461	3.095	1.518
LSD 0.01	0.77	9.129	6.286	1.028	0.156	0.664	4.464	2.189

Mean performance of 28 hybrids and two checks for eight traits across three locations are shown in Table (3). The earlier hybrids were P_2 x P_3, SC128 and P_3 x P_5, while the highest hybrids for plant and ear heights were P_3 x P_4, SC10 and P_2 x P_4. Meanwhile, the shortest hybrids was P_7 x P_8 for plant height and P_5 x P_8 for ear height. Also, the highest hybrids were P_3 x P_4, P_5 x P_7, P_5 x P_6 and P_4 x P_5 for ear length, P_2 x P_5 and P_3 x P_6 for ear diameter, P_1 x P_7 and P_1 x P_6 for number of rows/ear, P_5 x P_6, P_5 x P_7 and P_3 x P_4 for number of kernels/row. For grain yield, the hybrids P_4 x P_7, P_4 x P_5, P_5 x P_7 and P_6 x P_7 gave the highest grain yield (over >36 ard/fed). Moreover, they were not significant out yield compared to two checks SC10 and SC128. These hybrids will be tested in yield trails for further evaluation.

Estimates of mean squares for general (GCA) and specific (SCA) combining ability and their interactions with locations are presented in Table (4). The mean squares values for GCA and SCA were significant for all studied traits except GCA for grain yield and SCA for ear height, ear diameter and number of kernels/row, indicating that both additive and non additive gene effects were involved in determining the performance of single progeny in most traits. The interaction mean squares due to GCA x L and SCA x L were significant for all traits except SCA x L for ear length, number of rows/ear and number of kernels/row, meaning that both additive and non-additive gene effects were affects by environment in most traits. These results agree with Nass *et al*. (2000), Mosa (2003), Glover *et al*. (2005), Bidhendi *et al*. (2012) and Umar *et al*. (2014)

Table 3. Mean performance of 28 F_1 hybrids and two checks SC10 and SC128 for eight traits across locations

Cross		Days to 50% silking	Plant height (cm)	Ear height (cm)	Ear length (cm)	Ear diameter (cm)	No. of rows/ear	No. of kernels/ row	Grain yield (ard/fed)
P_1x	P_2	63.16	269.58	151.58	19.31	4.80	14.73	38.15	32.77
	P_3	62.75	260.16	138.00	20.28	4.66	15.46	39.28	31.16
	P_4	64.83	259.58	145.41	20.36	4.63	14.75	39.51	29.02
	P_5	62.58	269.16	144.83	22.46	4.68	15.71	42.46	29.96
	P_6	63.50	257.08	141.83	20.31	4.86	16.15	38.78	34.30
	P_7	64.33	263.91	139.50	19.60	4.96	16.90	40.36	33.95
	P_8	62.75	252.00	137.25	20.30	4.78	15.58	40.28	33.00
P_2 x	P_3	60.41	260.41	141.66	20.96	4.56	13.48	40.28	30.47
	P_4	65.16	278.16	157.08	20.21	4.60	14.35	37.85	34.16
	P_5	63.91	268.50	154.41	22.26	5.01	13.78	44.63	32.74
	P_6	63.16	266.25	152.91	22.26	4.81	14.50	42.86	35.10
	P_7	63.08	253.00	146.08	20.06	4.68	14.58	39.71	27.62
	P_8	63.25	259.75	148.33	21.61	4.91	14.08	41.36	34.87
P_3 x	P_4	64.58	288.00	156.50	23.83	4.60	15.35	45.41	34.34
	P_5	61.41	257.50	139.25	22.51	4.60	13.96	43.76	32.48
	P_6	62.16	260.58	138.25	22.00	4.97	14.96	42.11	32.27
	P_7	63.16	270.75	147.00	22.55	4.75	15.10	43.20	28.16
	P_8	65.33	258.58	140.50	21.58	4.48	14.03	41.90	28.00
P_4 x	P_5	64.91	267.58	143.33	23.28	4.58	14.28	45.10	36.53
	P_6	65.66	259.33	140.16	20.06	4.50	14.01	38.70	27.62
	P_7	64.58	262.75	145.50	21.56	4.63	15.43	42.98	37.37
	P_8	64.83	264.08	152.16	21.53	4.68	14.53	40.76	31.80
P_5 x	P_6	62.83	252.17	138.25	23.35	4.80	13.93	46.10	35.19
	P_7	63.33	266.08	146.66	23.70	4.90	15.31	46.06	36.31
	P_8	62.83	243.50	131.91	22.16	4.73	14.25	44.20	32.56
P_6 x	P_7	63.41	247.83	136.91	21.88	4.93	15.60	41.93	36.07
	P_8	64.25	255.33	139.83	21.03	4.71	15.03	42.61	27.69
P_7 x	P_8	62.83	240.25	132.83	21.83	4.83	15.21	42.73	34.43
SC-10		63.92	279.17	156.08	21.37	4.48	13.57	42.43	36.06
SC-128		61.17	260.75	137.00	21.60	4.78	14.06	41.77	35.38
LSD 0.05		1.46	14.18	12.45	1.57	0.322	1.14	3.81	5.53
LSD 0.01		1.91	18.57	16.30	2.06	0.422	1.50	4.99	7.25

Table 4. Estimates of mean squares for general and specific combining ability and their interactions with locations.

SOV	df	Days to 50% silking	Plant height	Ear height	Ear length	Ear diameter	No. of rows/ear	No. of kernels/ row	Grain yield
GCA	7	39.6**	2460.03**	1258.47*	49.284**	0.504*	22.44**	192.0**	77.68
SCA	20	10.764**	722.35**	309.24	8.148**	0.168	2.34**	26.436	115.09**
GCA x L	14	5.37**	452.06**	351.73**	7.3**	0.152*	4.97**	25.71*	38.01**
SCA x L	40	2.43**	249.00**	191.02**	2.46	0.16**	0.9	20.46	48.59**
Error	243	0.85	121.984	83.447	1.8	0.085	1.11	14.43	10.43

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

The improvement of maize yield depends on the knowledge of type of gene action involved in its inheritance and also the genetic control of related traits so the results in Table (5) exhibited magnitude of additive gene effects (K^2GCA) higher than non-additive gene effects (K^2SCA) for ear height, ear length, ear diameter, number of rows/ear and numbers of kernels/row, indicating that the additive gene effect was most responsible for controlling inheritance of these trait. While, the non-additive gene effects was higher, than additive gene effects for days to 50% silking, plant height and grain yield, meaning that important of additive gene effects in the inheritance of these traits. On the other side the interaction between the non-additive gene effects with locations (σ^2SCA x L) was higher than interaction between additive gene effects with locations (σ^2GCA x L) in most traits, indicating that the non-additive gene effects was more interacted with the environment, than additive gene effects. These results support the findings of Kalla *et al*. (2001), Medici *et al*. (2004), Mosa (2005), Machado *et al*. (2009), Gichuru *et al*. (2011) Shahrokhi *et al*. (2013) and Mosa *et al*. (2015).

Table 5. Estimates of genetic components and their interaction with locations.

Genetic parameters	Days to 50% silking	Plant height	Ear height	Ear length	Ear diameter	No. of rows/ear	No. of kernels/row	Grain yield
K^2GCA	0.47	27.88	12.59	0.580	0.004	0.242	2.300	0.550
K^2SCA	0.69	39.44	9.85	0.474	0.0006	0.120	0.498	5.540
σ^2GCA x L	0.188	13.75	11.17	0.229	0.002	0.161	0.470	1.140
σ^2SCA x L	0.395	31.75	26.89	0.165	0.018	0.000	1.500	9.540

Estimates of general combining ability effects of each parental lines for eight traits are presented in Table (6). The best general combiner inbred lines were P_3 and P_5 for earliness, P_8 for short plant and ear heights, P_5 for ear length number of kernels/row and grain yield, P_7 for ear diameter and P_1 and P_7 for number of rows/ear. Malik *et al*. (2004) stated that the lines which had higher GCA effects can be used in synthetic variety development more effectively.

Table 6. Estimates of general combining ability (GCA) effects of each parental lines for eight traits across locations

Inbred	Days to 50% silking	Plant height	Ear height	Ear length	Ear diameter	No. of rows/ear	No. of kernels/ row	Grain yield
P_1	-0.142	0.586	-1.430	-1.347**	0.037	0.920**	-2.406**	-0.554
P_2	-0.434	4.614	7.513**	-0.670*	0.037	-0.710*	-1.404*	0.042
P_3	-0.822**	4.670	-0.972	0.499	-0.090	-0.235	0.445	-1.768*
P_4	1.635**	8.586**	5.527*	0.021	-0.156**	-0.177	-0.493	0.559
P_5	-0.50*	-0.579	-1.388	1.502**	0.023	-0.421	3.173**	1.40*
P_6	0.038	-4.899	-3.138	0.029	0.068	0.070	-0.029	0.124
P_7	-0.003	-3.899	-2.083	0.077	0.092*	0.728*	0.618	1.072
P_8	0.218	-9.079**	-4.027*	-0.111	-0.004	-0.174	0.095	-0.855
LSD g_i 0.05	0.50	5.01	4.02	0.64	0.092	0.52	1.19	1.40
LSD g_i 0.01	0.76	6.96	6.14	0.88	0.13	0.73	1.66	2.01

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

Estimates of the specific combining ability effects for 28 hybrids are presented in Table (7). The desirable hybrids for specific combining ability effects were P_1 x P_8, P_2 x P_3, P_3 x P_5 and P_7 x P_8 for earliness, P_2 x P_3 and P_5 x P_8 for short plant and ear heights and P_3 x P_4 and P_5 x P_7 for high plant and ear heights, P_1 x P_5, P_2 x P_6, P_2 x P_8 and P_3 x P_4 for ear length, P_2 x P_5 and P_3 x P_6 for ear diameter, P_1 x P_7, P_2 x P_4 and P_3 x P_4 for number of rows/ear, P_2 x P_6 and P_3 x P_4 for number of kernels/row and P_4 x P_7 for grain yield. In general, the good specific combiners for different studied traits involved parents with high x high, high x low, low x high and low x low general combinations. Also, can be used above hybrids as a potential single crosses combinations and tested further evaluation.

Table 7. Specific combining ability effects of 28 hybrids for eight traits across locations

Cross	Days to 50% silking	Plant height	Ear height	Ear length	Ear diameter	No. of rows/ear	No. of kernels/ row	Grain yield
P_1x P_2	0.204	3.24	1.643	-0.199	-0.014	-0.302	0.062	0.787
P_3	0.177	-6.23	-3.454	-0.402	-0.017	-0.043	-0.654	0.983
P_4	-0.198	-10.73**	-2.538	0.159	0.013	-0.818**	0.518	-3.481*
P_5	-0.323	8.02*	3.796	0.779*	-0.117	0.392	-0.199	-3.4*
P_6	0.063	0.26	2.546	0.101	0.021	0.334	-0.679	2.232
P_7	0.940*	6.09	-0.843	-0.663	0.102	0.425*	0.257	0.934
P_8	-0.865*	-0.65	-1.149	0.226	0.010	0.011	0.696	1.909

Table 7 Cont.

P_2 x P_3	-1.865**	-10.01*	-8.732*	-0.396	-0.117	-0.396	-0.657	-0.301
P_4	0.427	3.83	0.185	-0.669	-0.019	0.411*	-2.152	1.060
P_5	1.302**	3.33	4.436	-0.099	0.216*	0.089	0.965	-1.176
P_6	0.024	5.39	4.865	1.373**	-0.028	0.314	2.401*	2.432
P_7	-0.018	-8.86*	-3.204	-0.874*	-0.181	-0.26	-1.396	-5.989**
P_8	-0.073	3.08	0.990	0.865*	0.144	0.142	0.776	3.187
P_3 x P_4	0.232	13.60**	8.087*	1.779**	0.110	0.936**	3.564**	3.046
P_5	-0.810*	-7.73	-2.246	-1.019**	-0.069	-0.202	-1.572	0.369
P_6	-0.587	-0.33	-1.496	-0.063	0.235*	0.306	-0.199	1.417
P_7	0.454	8.84*	6.198	0.440	0.016	-0.218	0.237	-3.637*
P_8	2.399**	1.85	1.643	-0.338	-0.158	-0.382	-0.54	-1.877
P_4 x P_5	0.232	-1.56	-4.663	0.226	-0.022	0.056	0.521	2.089
P_6	0.454	-5.49	-6.079	-1.519**	-0.150	-0.702**	-2.677*	-5.558**
P_7	-0.587	-3.08	-1.802	-0.066	-0.036	0.056	0.960	3.441*
P_8	-0.560	3.44	6.81*	0.090	0.105	0.059	-0.735	-0.398
P_5 x P_6	-0.254	-3.49	-1.079	0.284	-0.031	-0.54*	1.057	1.184
P_7	0.288	9.42*	6.282*	0.587	0.049	0.184	0.376	1.362
P_8	-0.435	-7.98*	-6.824*	-0.758	-0.025	0.02	-0.968	-0.463
P_6 x P_7	-0.157	-4.51	-1.718	0.242	0.038	-0.024	-0.554	2.371
P_8	0.454	8.17*	3.143	-0.419	-0.086	0.311	0.651	-4.078*
P_7 x P_8	-0.921*	-7.91*	-4.913	0.334	0.010	-0.163	0.121	1.719
LSD S_{ij} 0.05	0.76	7.77	6.81	0.770	0.190	0.40	2.20	3.43
LSD S_{ij} 0.01	1.02	10.39	9.1	1.000	0.260	0.62	2.97	4.59

Significant at 0.05 and 0.01 levels of probability, respectively.

References

Bidhendi, M.Z.; R. Choukan; F. Darvish; K. Mostafavi and E. Majidi (2012). Classification of maize inbred lines into heterotic groups using diallel analysis. International Journal Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering, 6: 556-559.

Comstoc, R.E. and H.F. Moll (1963). Genotype-environmental interactions. National Academy of Science, National Research Council, Publication, 982: 164-196.

Frey, K.J. (1964). Adaptation reaction of oat strains selected under stress and non-stress environmental conditions. Crop Sci. 4: 55-58.

Gichuru, L.; K. Njoroge; J. Ininda and L. Peter (2011). Combining ability of grain yield and agronomic traits in diverse maize lines with maize streak virus resistance for eastern Africa region. Agric. Biol. J. N. Am. 2: 432-439.

Glover, Max A.; D.B. Willmot; L.L. Darrah; B. E. Hibbard and X. Zhu (2005). Diallel analysis of agronomic traits using Chinese and U.S. Maize germplasm. Crop Sci. 45: 1096-1102.

Griffing, B. (1956). Concepts of general and specific combining ability in relation to diallel crossing systems. Aust. J. Biological Sci. 9: 463-493.

Kalla, V.; R. Kumar and A.K. Basandrai (2001). Combining ability analysis and gene action estimates of yield and yield contributing characters in maize. Crop Res. Hisar 22: 102-106.

Machado, J.C.; J.C. Souza; M.A. Ramalho and J.L. Lima (2009). Stability of combining ability effects in maize hybrids. Scien. Agric. 66: 494-498.

Malik, S.I.; H.N. Malik; N.M. Minhas and M. Munir (2004). General and specific combining ability studies in maize diallel crosses. Int. J. Agric. Biol. 6: 856-859.

Medici, L.O.; M.B. Pereira; P.J. Lea and R.A. Azevedo (2004). Diallel analysis of maize lines with contrasting responses to applied nitrogen. J. Agric. Sci. 142: 535-541.

Mosa, H.E. (2003). Heterosis and combining ability in maize (*Zea mays* L.). Minufiya J. Agric. Res. 28: 1375-1386.

Mosa, H.E. (2005). Combining ability of eight yellow maize (*Zea mays* L.) inbred lines for different characters in diallel crosses. J. Agric. Res. Tanta Univ. 31: 604-615.

Mosa,H.E.; M.A.A.Hassan and S.M.Abo El-Haress (2015). Combining ability for new maize inbred lines for grain yield and some agronomic traits. Minufiya J.Agric.Res. 40:109-117.

Nass, L.L.; M. Lima; R. Vencovsky and P.B. Gallo (2000). Combining ability of maize inbred lines evaluated in three environments in Brazil. Science and Agriculture 57: 129-134.

Rojas, B.A. and G.F. Sprague (1952). A comparison of variance in corn yield trails. III. General and specific combining ability and their interaction with locations and years. Agron. J. 44: 462-466.

Shahrokhi, M.; S.K. Khorasani and A. Ebrahimi (2013). Study of genetic components in various maize (*Zea mays* L.) traits using generation mean analysis method, International Journal of Agronomy and Plant Production, 4:405-412.

Steel, R.G.D. and J.H. Torrie (1980). Principles and Procedures of Statistics. A Biometrical Approach, 2nd Ed. Mc Graw Hill, N.Y. USA.

Umar, U.U.; S.G.Ado ; D. A. Aba and S.M. Bugaje (2014). Estimates of combining ability and gene action in maize(*Zea mays* L.) under water stress and non-stress conditions. Journal of Biology, Agriculture and Healthcare, 4:247-254.

Yan, W. and A. Hunt (2003). Biplot analysis of diallel data. Crop Sci. 42: 21-30.

تحليل القدرة على الائتلاف وطبيعة الفعل الجينى للمحصول ومكوناته لبعض سلالات الذرة الشامية البيضاء

حاتم الحمادى موسى ، إبراهيم عبد النبى إبراهيم الجزار ، محمد عرفة على حسن

قسم بحوث الذرة الشامية . معهد بحوث المحاصيل الحقلية . مركز البحوث الزراعية

تم تحليل القدرة على الائتلاف لصفة المحصول ومكوناته وارتفاع النبات والكوز وتاريخ خروج 50% من حرائر النورات المؤنثة لـ 8 سلالات بيضاء وضعت فى نظام التزاوج النصف دائرى حيث قيمت 28 هجين الناتجة واثنين من الهجن التجارية فى ثلاث محطات بحثية هى سخا والجميزة وملوى خلال موسم نمو 2014. كان تباين القدرة العامة والخاصة على الائتلاف وتفاعلهما مع المواقع معنوياً أو عالى المعنوية فى معظم الصفات ومع ذلك تأثيرات الفعل الوراثى المضيف أكثر تحكماً فى صفات ارتفاع الكوز وطول الكوز وقطر الكوز وعدد الصفوف بالكوز وعدد الحبوب بالصف بينما تأثيرات الفعل الوراثى غير المضيف هى الأكثر أهمية فى صفات تاريخ ظهور 50% من حرائر النورات المؤنثة وارتفاع النبات ومحصول الحبوب. أظهرت النتائج أيضا أن تأثيرات الفعل الوراثى الغير مضيف أكثر تأثراً بالبيئة من تأثيرات الفعل الوراثى المضيف فى معظم الصفات. كانت أفضل السلالات فى القدرة العامة على الائتلاف هى السلالة P_3 لصفة التبكير و P_8 لقصر ارتفاع النبات والكوز و P_5 لزيادة طول الكوز وعدد الحبوب بالصف ومحصول الحبوب و P_7 لقطر الكوز و P_1 لعدد الصفوف بالكوز. أفضل هجين فى القدرة الخاصة على الائتلاف لمحصول الحبوب هو $P4 \times P_7$