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GENERAL AND SPECIFIC COMBINING ABILITY FOR YIELD IN A DIALLEL CROSS AMONG 18 MAIZE POPULATIONS (*Zea mays* L.)

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ABSTRACT

A study was carried out on diallel crosses among 18 maize populations. An analysis was conducted on ear weight data using Griffing's Method 2, Model I to determine general and specific combining ability effects.

General combining ability (GCA) was found to be significant but specific combining ability (SCA) was not. Both location x GCA and location x SCA interactions were found to be significant.

The results showed that populations CMS 06 and CMS 05 have the highest GCA effects. The cross (CMS 07 x CMS 10) gave the highest SCA effect.

INTRODUCTION

Population improvement and hybridization are major factors in successful maize breeding programs, especially in developing countries where both population and hybrid seeds are in similar demand. The yield traits of exotic introductions can be improved by introgression of their germ plasm with high-yielding local cultivars or by the direct use of well-identified introduced potentialities.

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The breeding procedure to be applied should be based on a good understanding of the inheritance of quantitative agronomic traits estimated by diallel cross analysis. Different methods have been proposed by Yates (1947), Hayman (1954, 1958, 1960) and Griffing (1956). The objective of this study was to estimate general and specific combining ability effects for yield for crosses of introduced populations.

MATERIALS AND METHODS

A diallel set of 18 populations and their F_1 hybrids were used in this study. Parental populations are shown in Table III. Only two of these are composites developed at the CNPMS, Sete Lagoas, MG, using three Brazilian cultivars plus one exotic introduction. They are: CMS 06 (Maya, Centralmex, Dentado Composto and Tuxpeño 1), and CMS 07 (Cateto Colombia, Cateto Sete Lagoas, Flint Composto and Mezcla Amarilla) with dent and flint endosperm, respectively. The remaining 16 populations are exotic materials introduced from CIMMYT (Mexico).

A quadratic rectangular 13 x 14 lattice was used at each of two locations: Sete Lagoas (MG) and Piracicaba (SP) in 1978/79. Experimental plots consisted of two rows 5 meters long and 75 cm apart. Hills within rows were 50 cm apart, with two plants per hill after thinning. Yield is reported as ear weight (Kg/ha).

The data were analyzed statistically by analysis of variance, and the statistical procedure described by Griffing (1956), Method 2, Model I, was used to estimate general and specific combining ability.

RESULTS AND DISCUSSION

The combined analysis of variance for ear weight is shown in Table I. General combining ability was highly significant ($P < 0.01$) but specific combining ability was not. This agrees with the results obtained by Sprague and Tatum (1942) in a study on unselected materials, where genetic effects were more important for general combining ability than for specific combining ability. Gamble (1962) and Robinson *et al.* (1949) also obtained similar results for grain yield. In the present study, treatment x location interaction was significant and could be attributed mostly to a highly significant general combining ability x location interaction. This suggests that the general combining ability effects were not consistent over the two environments. The specific combining ability x location interaction was highly significant. This was due to a failure of the magnitude of these effects to be relatively the same over the two environments.

Table I -Combined analysis of variance of total ear weight of 18 populations of corn and their 153 population crosses grown at two locations.

Source	d.f.	M.S.
Locations (L)	1	1389850562.81**
Treatments (T)	170	318499.45**
General (G)	17	872856.45**
Specific (S)	153	80141.62
T x L	170	220909.09**
G x L	17	405173.70**
S x L	153	198559.41**
ERROR	1020	104728.96

**Significant at the 0.01 probability level.

The mean yields for total ear weight of 18 parents and their possible crosses are shown in Table II. Analysis of variance (Table I) showed no significance for SCA, therefore an average heterosis of 10.88% was obtained for mean yield of population crosses.

The estimates of general combining ability and mean yield for total ear weight of each population are presented in Table III. It can be seen that 10 out of 18 populations had above-average yields and population CMS 06 had the highest yield. Populations CMS 05 and CMS 06 exhibited the highest general combining ability effects followed by CMS 04, CMS 10, CMS 03, CMS 14, CMS 12, CMS 11, CMS 15 and CMS 07.

The large mean square for general combining ability suggests that the general combining ability effects are the important thing to consider for an interpopulation breeding program, principally for synthesizing composites using these populations. The significance of general combining ability indicates that these populations were different for frequencies of additive favorable alleles.

Table II - Mean total ear weight (kg/ha) of 18 parent and their 153 population crosses averaged over two locations.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	3642	4071	3329	4349	3547	3622	4759	4168	4954	4369	4199	4669	5276	5183	4457	4790	3485	4679
2		3952	3692	3233	3137	3163	4286	3921	3676	3344	4127	4647	4044	3431	4096	4499	3922	4161
3			3352	4176	3362	3418	4803	4498	4465	3834	4239	4368	4602	4108	3700	4791	4545	4412
4				4294	3923	4032	4941	4021	4688	3876	3784	4070	4635	4368	3983	4805	4381	4350
5					2568	3559	3880	4111	4051	3913	3459	4518	4396	4070	4461	4860	4159	4289
6						2652	4427	4296	4084	4447	3892	3628	4790	4888	3536	4183	3527	3772
7							4129	5042	4914	4885	4727	4948	5268	5123	5087	5146	4683	4519
8								4531	5046	4197	4740	4536	4644	4296	4511	4115	4413	4635
9									4271	4603	4255	4289	4247	3937	4043	4808	4499	5019
10										3453	4280	4651	4425	4191	3954	4944	3804	4813
11											3008	4600	4120	4450	4556	5055	4147	3801
12												4328	4767	3453	4998	4820	4152	4304
13													4074	4208	3853	4164	4501	4948
14														4344	4732	4938	4297	4019
15															3808	4590	4747	4403
16																5232	4684	4918
17																	4064	5494
18																		3673

Table III - Mean total ear weight(Kg/ha) and estimates of general combining ability effects ($\hat{g}_i$) for each of 18 populations tested in two locations.

Population	Mean yield (Kg/ha)	$\hat{g}_i$ (Kg/ha)
01 CMS 21	3642	-2.28
02 CMS 23	3952	-289.98
03 CMS 22	3352	-154.95
04 CMS 24	4294	-21.54
05 CMS 16	2568	-314.62
06 CMS 17	2652	-360.80
07 CMS 05	4129	320.63
08 CMS 04	4531	126.18
09 CMS 03	4271	110.32
10 CMS 02	3453	-65.13
11 CMS 01	3008	-102.12
12 CMS 14	4328	110.50
13 CMS 12	4074	107.96
14 CMS 11	4344	45.39
15 CMS 15	3808	18.77
16 CMS 06	5232	358.36
17 CMS 07	4064	16.31
18 CMS 10	3673	111.93
$\bar{X}$	3854	
Standard Error ($\hat{g}_i - \hat{g}_j$); $i \neq j$		102.34

The estimates of specific combining ability effects and mean yield of the best 20 population crosses are shown in Table IV. The best cross combination, which exhibited maximum specific combining ability effect for ear yield, was CMS 07 x CMS 10, involving a Brazilian composite and an introduced population. Hence, the best interpopulation cross involved parents of different origin. This is in agreement with the data reported by Singh *et al.* (1977) who showed that higher specific combining ability effects can be obtained by crossing materials of greater genetic diversity. However, maximum heterosis occurs at an optimal of intermediate level of genetic diversity, as suggested by Moll *et al.* (1965).

Table IV - Estimates of specific combining ability effects ($\hat{s}_{ij}$) for total ear weight and mean yield (Kg/ha) of the 20 best crosses among 18 populations over two locations.

Crosses	$\hat{s}_{ij}$ (Kg/ha)	Mean Yield (Kg/ha)
01. CMS 07 x CMS 10	790.85	5494
02. CMS 17 x CMS 11	778.75	4888
03. CMS 21 x CMS 12	649.79	5276
04. CMS 21 x CMS 11	642.23	5183
05. CMS 17 x CMS 02	558.28	4447
06. CMS 23 x CMS 14	461.45	4647
07. CMS 16 x CMS 15	438.19	4461
08. CMS 14 x CMS 15	416.44	4998
09. CMS 16 x CMS 06	398.47	4860
10. CMS 21 x CMS 03	392.30	4954
11. CMS 16 x CMS 14	389.33	4518
12. CMS 02 x CMS 10	360.16	4813
13. CMS 15 x CMS 07	347.02	4747
14. CMS 04 x CMS 03	345.71	5046
15. CMS 22 x CMS 07	343.48	4545
16. CMS 03 x CMS 12	340.21	4247
17. CMS 01 x CMS 06	333.22	5055
18. CMS 04 x CMS 01	327.41	4740
19. CMS 05 x CMS 12	320.62	5268
20. CMS 16 x CMS 12	299.75	4396
Standard Error ($\hat{s}_{ij}$ - $\hat{s}_{ik}$)*	446.08	
Standard Error ($\hat{s}_{ij}$ - $\hat{s}_{kl}$)**	434.18	

*for $i \neq j, k$; $j \neq k$

**for $i \neq j, k, l$; $j \neq k, l$ and $k \neq l$

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RESUMO

Efetuou-se um estudo dos cruzamentos dialélicos entre 18 populações de milho. Os dados de peso de espiga foram analisados de acordo com o Método 2, Modelo I, de Griffing, para se determinarem os efeitos das capacidades geral e específica de combinação.

Produção (peso de espiga) foi altamente significativa ($P < 0.01$) para capacidade geral de combinação (CGC), mas não para capacidade específica de combinação (CEC). Produção, também, foi altamente significativa para as interações local x CGC e local x CEC.

Os resultados mostraram que as populações CMS 06 e CMS 05 apresentaram os maiores efeitos de CGC. No cruzamento CMS 07 x CMS 10 evidenciou-se o maior efeito da CEC.

REFERENCES

Gamble, E.E. (1962). Gene effects in corn (*Zea mays* L.). III-Relative stability of the gene effects in different environments. *Can. J. Plant. Sci 42*: 628-634.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. Biol. Sci.* 9: 463-493.

Hayman, B.I. (1954). The theory and analysis of diallel crosses. *Genetics 39*: 789-809.

Hayman, B.I. (1958). The theory and analysis of diallel crosses. II. *Genetics 43*: 63-85.

Hayman, B.I. (1960). The theory and analysis of diallel crosses. III. *Genetics 45*: 115-172.

Robinson, H.F., Comstock, R.E. and Harvey, P.E. (1949). Estimates of heritability and the degree of dominance in corn. *Agron. J. 41*: 353-359.

Sprague, G.F. and Tatum, L.A. (1942). General and specific combining ability in single crosses of corn. *J. Am. Soc. Agron. 34*: 923-932.

Singh, T.P., Jha, P.B. and Akthar, S.A. (1977). A diallel cross analysis of some quantitative traits in maize. *Mysore J. Agric. Sci. 11*: 462-465.

Yates, E. (1947). The analysis of data from all possible reciprocal crosses between a set of parental lines. *Heredity 1*: 287-301.

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