Estimation of Combining Ability for Plant and Ear Height in Maize

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Abstract:

Seven inbred lines of maize were studied in Line ×Tester analysis , using a randomized complete block design . Data were recorded on plant and ear height characters to determine the nature of combining effects and estimate the components of variance and genetic parameters . The value of specific combining ability variance was more than the general combining ability variance for the two triats ,indicating the importance of non – additive gene action . Narrow sense heritability ranged from 47.13% – 19.05% for plant and ear height respectively . Average degree of dominance was more than one for the two characters. Heterosis , measured as departure of F_1 from the mean of the parents value were observed for the two characters .

Key Words: Maize , Line × Tester analysis , combining ability , heterotic effect .

Introduction:

Plant and ear height are very important characters not only for describing new hybrids of maize ,but for green and dry matter production. The height of the main ear is a very important characteristic for breeding . the higher it is , the more ears can develop from the nodes below. However , if it is too high the weight of the ear may bend the stalk or even break it . Although lower ear height is unfavourable for yield and makes harvesting difficult , it does protect the stalk from excessive weight . Attempts have been made to breed in both directions , but practical experience shows that the ideal height is somewhere in between – neither too high , nor too low . It is important for the ears to be at the same height within a population [1]. In order to fulfil this requirement , to choose the best hybrid by crossed between inbred lines. It would be a considerable advantage to be able to estimate the combining ability of parents, gene effects and heterotic effects of crosses before making crosses among inbred lines. Line × Tester analysis programs have been applied to achieve this goal by providing a systematic approach for the detection of suitable parents and crosses for the investigated characters.In many studies, general combining ability (GCA) effects for parents and specific combining ability (SCA) for crosses were estimated in maize [2, 3, 4, 5, 6]. Additive gene effects for plant and ear height were found in maize [7] while [8,2,9] were found non – additive gene effects for the same characters in maize. In addition, heritability degrees varied from low to high for plant and ear height [8, 1, 10].

Maize [11] estimated 8.4% midparent heterosis for plant height. Midparent heterosis was found for plant height in the range of 37.9 – 56.4% [12] in maize.

The objective of this study was to estimate the genetic parameters and heterotic effects and to determine suitable parents and promising crosses for plant and ear height in Line × Tester analysis.

Tools and Methods:

Seven inbred lines of maize (*Zea mays* L.) divided into four lines, they are:SH, R153, ZP, OH40, and other three lines as testers : IK8, IK58, Agr 183. were crossed in Line × Tester mating system in 10/ 7/2007 growing season.In 4/3/2008 the parents and 12 hybrids, were grown in the fields of College of Agriculture at Tikrit University in a randomized complete block design with three replications. The plots were represented by two rows, 5 m long and spaced o.75 m apart. Plots were over planted then thinned to one plant per hill, with 25 cm spacing between hills. All cultural practices required were done as recommended. Fertilizers of P_2O_5 104 kg /ha at planting and urea N 46% were applied at planting and after 40 days at the rate of 320 kg / ha. Plot wise data were recorded on 10 plants of each entry randomized selection on plant and ear height. The statistical models and the F test used for ANOVA were identical to those used in Line × Tester study as described by [13]. Midparent heterosis values were calculated by using the mean of the parents, F_1 – MP/ MP × 100. The narrow and broad sense heritability degrees were calculated according to the methods of [14].

Results and Discustion:

Plant height for 7 parents and 12 hybrids (table 1) ranged from (150) cm (SH × IK58) to 101.67cm (R153 × Agr183) for the crosses , and it varied from 120.34for (R153) to 152.66 cm for the parents , while the highest ear height was 74.33 cm (R153 × IK58) and the lowest was 40.67 cm for (R153 × Agr183) and (ZP × IK58) , while it was in the range of 78.67(IK8) to 47.67 cm (SH) for the parents. The results indicated the presence of amoderate genetic variability among inbreds under investigation.

Table 1. Average values for plant and ear height.

Genotypes	Plant height cm	Ear height cm
SH	126.00	47.67
R153	120.34	51.66
ZP	122.66	61.00
OH40	118.67	54.67
IK58	152.66	63.33
Agr183	131.67	50.67
IK8	147.67	78.67
SH×IK58	150.00	52.34
SH×Agr183	133.33	71.00
SH×IK8	121.33	67.33
R153×IK58	106.67	74.33
R153×Agr183	101.67	40.67
R153×IK8	113.33	72.34
ZP×IK58	109.00	40.67
ZP×Agr183	133.67	57.34
ZP×IK8	127.34	60.33
OH40×IK58	125.00	60.67
OH40×Agr183	131.00	53.33
OH40×IK8	111.66	51.34
S.E.	1.625	1.690
L.S.D	3.283	3.414

The variance due to lines and testers was significant for plant and ear height (Table 2) . Also, the variances of interaction, the variances of crosses and parents were highly significant for plant and ear height. Similar resuilt were reported by [15] .

The ratio of GCA : SCA variances showed that SCA variances were greater than GCA variances indicating the predominance of the non – additive effects for plant and ear height, and that is consistent with other researchers' results [7].

Table 2. Analysis of variance for plant and ear height.

S.O.V.	df	MS	
		Plant height	Ear height
Replication	2	5.544	1.333
Genotypes	18	352.343**	610.489**
Parents	6	337.968**	553.492**
Par. vs. Cr.	1	0.727	1167.188**
Crosses	11	392.149**	590.969**
Lines	3	256.028**	1159.778**
Testers	2	177.194**	130.750**
L ×T	6	531.861**	459.972**
Error	36	4.285	3.963
GCA		69.495	21.191
SCA		152.003	175.859
GCA/SCA		0.457	0.121

** indicate significant differences at the 0.01 levels.

The data in (Table 3) showed that the line (SH) had better GCA with the values of 12.889 and 5.083 for plant and ear height respectively. The lines (ZP) and (OH40) showed better GCA for plant height , but they showed poor combiner with negative GCA values -5.694 and -3.361 respectively for ear height. While the line (R153) showed better GCA for ear height. The testers (IK58) and (Agr183) had better GCA for plant height , but they had poor combiner with negative GCA values -1.472 and -2.889 for ear height respectively. While the tester IK8 had better GCA for ear height and poor GCA for plant height.

Table 3. General combining ability effects for plant and ear height.

Lines	Plant height	Ear height
SH	12.889	5.083
R153	-14.778	3.972
ZP	1.333	-5.694
OH40	0.556	-3.361
SE(gi-gj)	0.938	0.976
Testers		
IK58	0.667	-1.472
Agr183	2.917	-2.889
IK8	-3.589	4.361
SE(gi-gj)	0.813	0.845

Data in (Table 4) showed SCA effects and cross (SH×IK58) indicated higher SCA 14.444 for plant height followed by the genotype (R153×IK8) with avalue of 9.694. The cross (R153×IK58) was the best specific combiner for ear height 13.621 followed by the cross (SH×Agr183) 10.330. The crosses (OH40×IK8) and (R153×Agr183) had the lowest SCA for not only plant height but also ear height.

Table 4. Specific combining ability effects for plant and ear height.

Crosses	Plant height	Ear height
SH×IK58	14.444	-9.851
SH×Agr183	-4.472	10.330
SH×IK8	-9.972	-0.584
R153×IK58	-1.222	13.621
R153×Agr183	-8.472	-18.899
R153×IK8	9.694	5.527
ZP×IK58	-15.000	-10.649
ZP×Agr183	7.417	7.443
ZP×IK8	7.583	3.193
OH40×IK58	1.778	7.028
OH40×Agr183	5.528	1.101
OH40×IK8	-7.306	-8.259
SE(sij-ski)	1.625	1.690

The estimates of genetic parameter (Table 5) shows a greater importance of the dominance devation in relation to additivity for plant and ear height. The average degree of dominance exceeded one for plant and ear height, which indicate that there is over dominance. High broad sens heritability observed for plant and ear height, while the estimated narrow sense heritability were 47.13 and 19.05% for plant and ear height respectively. and that is consistent with other researchers' results [1,10,15].

Table 5. Some genetic parameter fot plant and ear height

Genetic parameters	Plant height	Ear height
σ^2E	3.963	4.285
σ^2A	138.990	42.381
σ^2D	152.003	175.859
$h^2_{b.s}$	98.660%	98.080%
$h^2_{n.s}$	47.130%	19.050%
$\bar{a}$	1.479	2.881

Values of heterosis are given in (Table 6). Heterosis ranged from 11 (SH×IK58) to -29.83% (R153×IK58) for plant height, and ranged from 21.83 (SH×Agr183) to -21.495% (ZP×IK58) for ear height. Similar levels of high heterosis were reported [11,12,15].

Table 6. Heterosis for plant and ear height.

Crosses	Plant height(%)	Ear height (%)
SH×IK58	11.000**	-3.160*
SH×Agr183	4.495**	21.830**
SH×IK8	-15.505**	4.160**
R153×IK58	-29.830**	16.835**
R153×Agr183	-24.335**	-10.495**
R153×IK8	-20.675**	7.175**
ZP×IK58	-28.660**	-21.495**
ZP×Agr183	6.505**	1.505
ZP×IK8	-7.825**	-9.505**
OH40×IK58	-10.665**	1.670
OH40×Agr183	5.830**	0.660
OH40×IK8	-21.510**	-15.330**
S .E.	1.408	1.438

*and ** indicate significant differenced at the 0.05 and 0.01 levels respectively.

Conclusion: Estimation for SCA was higher than GCA for plant and ear height. The average degree of dominance indicated the presence of overdominance for plant and ear height. The narrow sense heritability estimates were moderate for plant height and low for ear height.

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تقدير القدرة على الائتلاف لصفات أرتفاع النبات والعرنوص في الذرة الصفراء

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الملخص:

استخدمت في هذه الدراسة سبع سلالات من الذرة الصفراء هجنت بموجب تحليل السلالة × الفاحص باستخدام تصميم القطاعات الكاملة المعشاة . تم دراسة صفتي ارتفاع النبات والعرنوص . أظهرت النتائج ان مكونات تباين القدرة الخاصة على الائتلاف كانت اكبر من مكونات القدرة العامة على الائتلاف للصفتين ، دلالة على اهمية الفعل الجيني غير الاضافي . تراوحت درجة التوريث بالمعنى الضيق بين 47.13% - 19.05% لصفتي ارتفاع النبات والعرنوص على التوالي. أزدادت تقديرات معدل درجة السيادة عن الواحد للصفتين، واختلفت قوة الهجين للصفتين والمقدرة مقارنة مع متوسط الابوين بالنقصان والزيادة.

الكلمات الدالة: الذرة الصفراء، تحليل السلالة xالفاحص، القدرة الائتلافية ، قوة الهجين .