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EVALUATION OF COMBINING ABILITIES OF ZP INBRED LINES

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Abstract

In this study fifteen mothers, two fathers and their thirty hybrids were tested in order to evaluate their general and specific combining abilities (GCA and SCA). Mothers were pooled from three different sources (A, B and C) with five inbreds per source. Trials were set on location ZemunPolje in 2010 and 2011. Method choosen for evaluation of combining abilities was Line x tester method by Singh and Chaundary (1976). Other than GCA and SCA, trials were set in order to estimate components of genetic variance. The results of grain yield and variances of GCA and SCA discovered that there is high heterosis present within tested material. Source A proved to be the best source of good combiners, considering the fact that four of five inbreds in 2010 had significantly positive GCA values, A1 (1.76**), A2 (1.35**), A3 (1.35**), A4 (1.25**). Positive GCA values were found in 2011 in all source A inbreds, except A1 (-0.10) which had low negative GCA value, proving it's trend towards good combining abilities in different conditions. Concerning significantly positive SCA values, they were all created by crossing two opposite GCA combiners (crossing positive with negative general combiner), leading to a conclusion that negative GCA inbreds should not be discarded, since they know to create excellent hybrids. Ratio of GCA/SCA of 0.0925 in 2010 and 0.0188 in 2011 showed value far less than unity, stating that non-additive variance was far more predominant in inheritance of grain yield.

Key words: *maize, combining abilities, inbred × tester analysis*

Introduction

Maize represents one the most important agricultural species in the world. It's multiple usage and purpose as a food and as industrial raw material confirms the fact that it's significance is growing together with a area sown by this crop (Jocković et al., 2011).Agricultural area, suitable for maize production is limited, even though it is growing, the best way to improve maize production is to increase grain yield per unit area. Increasing grain yield per unit area is capable through complex of good rearing technique and usage of high yielding hybrids.

The basis of creating new high yielding hybrids lies in capability of recognising good inbred lines-material, whose combining abilities satisfy breeders goal. Method of evaluation of combining abilities have been first represented by Sprague and Tatum (1942), who defined combining abilities as general and specific combining abilities (GCA and SCA), where GCA is used to indicate an average performance of the inbreds in hybrid combinations, while SCA was used to point out cases in which performed combinations had been better or worse than expected according to the average performances of inbreds included into such combinations. Other than Sprague and Tatum (1942), Griffing (1956), Falconer (1960) determined that GCA was result of an additive genetic variance, while SCA was result of non-additive genetic variance (dominance and epistasis). Throught XX century a number of statistical methods have been made in the course of determination of combining abilities, e.g. diallel, top-cross, polly-cross and line x tester method. Diallel method is the most reliable one, but lacks when it

comes to appliance of the model in the case of evaluation of greater number of inbreds, where the costs and manual work increase significantly (Pataki, 2010). In the case of examination of higher number of inbreds, best way to to do that is to use line x tester method. Line x tester method was first presented by Kemthorne in (1957), but was adapted by Singh and Chondary (1977). This model represents case where numbers of inbreds are crossed to more than one tester, giving half-sib and full sub-offspring, allowing calculation of GCA and SCA. Atanaw et al. (2003), Shiri et all. (2010), Abuali et al. (2012), Meseka and Ishaaq (2012) obtained in their research through line x tester analysis of maize, that non-aditive variance is predominant in inheritance of grain yield. Analysis of combining abilities of the heterozygous genetic material (populations and varietes) showed additive variance was more important than non-additive for inheritance of grain yield (Vančetović, 1992; Delić,1993). On the other hand Atanaw et al. (2003) and Živanović et al. (2005) obtained significant SCA values by crossing one positive with one negative general combiner. Iqbal et al. (2007) obtained significant SCA cvalues by crossing negative to negative, and positive to positive combiners. Shiri et al. (2010) menaged to get significant SCA values by crossing negative with negative, pozitive with positive and positive with negative general combiner. The importance of accurate and fast evaluation of combining abilities is of the biggest importance for maize breeder, since it gives true background of value of used material. The aim of this study was to test materials combining abilities.

Materials and methods

In this study 17 inbred lines were used, 15 mothers and 2 testers. 15 mothers come from three genetic sources (five per source) A, B and C. Source A represents inbreds pulled out of selfed hybrid, source B represents inbreds derived from crossing public inbred lines B 14 and B 84, while third source C represents inbred lines obtained from crossing public inbred line B 14 to African germplazm, since Maize Research Institute “ZemunPolje” worked for years on maize winter generation in Zambia.

Two testers are elite inbred lines marked as Z1 and Z2 of Lancaster Sure Crop background, the difference is that Z1 is maturity group FAO 400 and Z2 FAO 600. These testers represent father components in number of commercial ZP hybrids ZP 341, ZP 454, ZP 600, ZP 606 and ZP 684. Maturity group of mothers are next: lines from source A represent maturity group FAO 600, lines from source B represent FAO 500 and lines are from source C maturity group FAO 400. Field trials were set in two repetitions in random block design on location “ZemunPolje” in 2010 and 2011. Plot size per genotype was 6 m^2. The yield was calculated in tonnes per hectar (t/ha) at grain moisture of 14%.

Planting and sawing were done by hand. All calculations were done in Excel by statistical approach Line x tester analysis (Singh and Chondary, 1977). Since this statistical approach does not include year x location interaction, every location was discussed separately.

Planting and harvest were done by hand. This experiment was set in order to evaluate combining abilities of 15 mothers.

Results and discussion

Results of grain yield and GCA of used parents (mothers and fathers) are presented in Table 1. The highest yielding mothers in 2010 was B1 obtaining 7.5 t/ha, other than that inbreds C4 achieved 6.7 t/ha, while B3 and C3 reached 6.4 t/ha. Mothers from source A showed highly significant GCA results, i.e. A1 (1.76**), A2 (1.35**), A3 (1.35**), A4 (1.25**). Only two more mothers showed positive but insignificant values, A5 (0.64) and B1 (0.67), while all others were negative. 2011 year was slightly different concerning results of grain yield and GCA. From the point of average yield it was lower with 5.2 t/ha, but still very good high yielding inbreds were found including B4 (6.8 t/ha), B3 (6.1 t/ha) and C3 (6.8 t/ha). The only inbreds that showed significant positive GCA values were A3 (1.06*) and C4 (1.20*). All

other mothers from source A had positive GCA, only inbred A3 had barely negative and insignificant GCA (-0.10). Comparing the results between two years, it can be seen that only one inbred line A3 has managed to have significant positive GCA value both years, while A2, A4 also had positive GCA values, but insignificant values. Inbred A1 even had negative GCA value in 2011. Looking from the point of absolute values inbreds B3, C3 and C4 had above average, stable and high yields in both years.

Table 1. Grain yield and GCA values for inbred lines and testers for grain yield

Genotype	2010		2011	
	Grain yield	GCA	Grain yield	GCA
A1	6.0	1.76**	4.6	-0.10
A2	5.2	1.35**	5.4	0.75
A3	4.3	1.30**	5.4	1.06*
A4	6.3	1.25**	4.3	0.43
A5	4.2	0.64	3.6	0.62
B1	7.5	0.67	5.3	0.52
B2	6.4	-0.89*	5.7	-0.80
B3	6.1	-0.33	6.1	-0.01
B4	6.1	-0.32	6.8	-0.99*
B5	5.1	-0.53	3.8	-1.62**
C1	5.3	-0.96*	5.6	-0.16
C2	6.0	-0.49	5.0	0.02
C3	6.4	-0.69	6.8	0.54
C4	6.7	-1.61**	6.3	1.20*
C5	5.7	-1.17**	3.3	-1.47**
Z1	5.2	-1.05**	4.3	-0.31
Z2	7.4	1.05**	5.5	0.31
Average	5.9	-	5.2	-
LSD inbreds 0.05	-	0.747	-	0.937
LSD inbreds 0.01	-	0.998	-	1.251
LSD testers 0.05	-	0.273	-	0.342
LSD testers 0.01	-	0.364	-	0.457

The three highest yielders in 2010th year were A4 × Z2 (14.4 t/ha), A2 × Z2 (13.7 t/ha) and A3 × Z1 (13.2 t/ha), while two combinations in 2010th year had highly significant positive SCA values, A3 × Z1 (1.43**) and A5 × Z1 (1.55**). Mother A3 had not only high grain yield but also great SCA value, that was made by crossing opposite general combiners. The second hybrid A5 × Z1 was also made by crossing opposite general combiners.

In 2011th three highest yielders were C4 × Z1 (13.6 t/ha), B3 × Z2 (13.4 t/ha) and A3 × Z2 (13.3 t/ha), where B3 × Z2 only had significantly positive SCA value of 1.35*. The second hybrid that had significantly positive SCA values was C5 × Z2 (1.39*). Both significantly postitive positive SCA combiners were created by crossing two oposite GCA combiners.

Comparing the results between two years, it can be concluded that combining two opposite general combiners gives high significant SCA values, which is in accordance with Atanaw et all. (2003) and Živanović et all. (2005), but opposite to Iqbal et all. (2007) and Shiri et all. (2010). Concerning the way of obtaning high SCA values, during the breeding process breeder should careful with discarding negative GCA combiners. Such a statment is in accordance with Živanović et all. (2010), who in his research concluded that material with negative GCA values should be kept, because they sometimes create excellent hybrid combinations. Non of the hybrids menaged to have significantly positive SCA value in both

years. Only hybrids A5 × Z1, B3 × Z2 and C5 × Z2 had positive SCA values in both years, but significantly positive in only one year.

Table 2.Grain yield and SCA values for hybrids for grain yield

Genotype	2010		2011	
	Grain yield	SCA	Grain yield	SCA
A1 × Z1	12.1	-0.10	11.6	0.27
A2 × Z1	12.0	0.21	13.1	0.90
A3 × Z1	13.2	1.43**	12.3	-0.21
A4 × Z1	11.1	-0.59	12.9	1.02
A5 × Z1	12.6	1.55**	12.2	0.09
B1 × Z1	11.9	0.78	12.3	0.34
B2 × Z1	9.9	0.35	10.8	0.12
B3 × Z1	9.5	-0.63	10.1	-1.35*
B4 × Z1	9.5	-0.61	10.6	0.09
B5 × Z1	9.5	-0.38	9.6	-0.20
C1 × Z1	9.2	-0.28	10.6	-0.72
C2 × Z1	9.9	-0.08	11.2	-0.30
C3 × Z1	9.0	-0.78	12.3	0.35
C4 × Z1	8.7	-0.17	13.6	0.99
C5 × Z1	8.6	-0.70	8.6	-1.39*
A1 × Z2	14.4	0.10	11.7	-0.27
A2 × Z2	13.7	-0.21	11.9	-0.90
A3 × Z2	12.4	-1.43**	13.3	0.21
A4 × Z2	14.4	0.59	11.5	-1.02
A5 × Z2	11.6	-1.55**	12.6	-0.09
B1 × Z2	12.5	-0.78	12.2	-0.34
B2 × Z2	11.3	-0.35	11.2	-0.12
B3 × Z2	12.8	0.63	13.4	1.35*
B4 × Z2	12.8	0.61	11.0	-0.09
B5 × Z2	12.4	0.38	10.7	0.20
C1 × Z2	11.9	0.28	12.6	0.72
C2 × Z2	12.1	0.08	12.4	0.30
C3 × Z2	12.6	0.78	12.3	-0.35
C4 × Z2	11.1	0.17	12.3	-0.99
C5 × Z2	12.1	0.70	12.0	1.39*
Average	11.5	-	11.8	-
LSD 0.05	-	1.057	-	1.325
LSD 0.01	-	1.411	-	1.769

Results in Table 3. show relation of GCA and SCA variances. Their relation discovers true nature of crossed parents. The values of GCA/SCA of 0.0925 in 2010 and 0.0188 in 2011 showed far less value than unity, stating that non-additive variance was predominant in inheritance of grain yield. Same results were gained by Atanaw et al. (2003), Živanović et al. (2005; 2010), Shiri et al. (2010).

Table 3. Components of genetic variance for grain yield

	ZemunPolje - 2010	ZemunPolje - 2011
Additive variance Va(F=1) GCA variance	0.0758	0.0123
Dominant variance Vd(F=1) SCA variance	0.8184	0.6557
GCA/SCA	0.0925	0.0188

Conclusion

It can be concluded that A source has the best promising combiners. Inbreds A1, A2, A3 and A4 had the best GCA values. In hybrid combinations good SCA values were gained with mothers A3, A5, B3 i C5. Mentioned mothers represent the best recommendation for further work in maize breeding. Results of grain yield and components of genetic variance showed the existence of high heterozis between used parents, which is basis for creation of high yielding hybrids.

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