10.7251/AGSY1303387P

COMBINING ABILITY ANALYSIS OF ZP MAIZE INBRED LINES FOR GRAIN YIELD AND YIELD COMPONENTS

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Abstract

A half diallel cross was used to evaluate combining abilities of six maize inbred lines and their hybrid combinations for grain yield, ear length, number of kernel rows per ear and number of kernels per row. Analysis was done using Griffing's formula (1956), method 2, mathematic model I. General and specific combining ability (GCA and SCA) mean squares were significant for all traits. GCA/SCA ratios revealed that additive gene effects had larger importance in inheritance of all of investigated traits than non-additive effects. Furthermore, obtained results showed that inbred lines L4 and L5 had the best GCA effects for grain yield, while inbred line L4 had the highest GCA values for ear length and number of kernels per row. Inbred line L6 was the best general combiner for number of kernel rows per ear. The hybrid combinations those exhibited significant SCA effects involved low x high, average x high and high x high GCA parents. According to obtained results, we could be concluded that inbred lines L4, L5 and L6 have high frequency of favorable alleles for most of the investigated traits and can be used in further breeding programs for new hybrids development.

Key words**:** maize, general and specific combining abilities, yield

Introduction

Maize is a one of the leading crops in worlds agricultural production. According to FAO statistical datas for 2011. year, 883.5 million tons of maize has been produced (http://www.fao.org). Serbia finds itself on 19. position on top twenty producing states in the world with 6.5 million produced in 2011. In order to follow world's increasing demands in production, creation of new and higher yielding hybrids is needed.

Such creation is achieved through evaluation of germplasm of unknown background. Whenever new and exotic germpasm is reached, it needs to be tested in order to see its breeding capacities and values. Such valuation is reached through field tests and statistical analysis of tested material. One of those techniques for testing material of uncertain genetic background is testing for combining abilities, introduced by Griffing (1956). Concept of combining abilities, even though, presented more than 50 years, still represents powerful tool for germplasm evaluation. It consists of general and specific combining abilities (GCA and SCA), where GCA stands for average value questioned trait of one parent crossed with other parents and SCA represents value of certain combination of two parents (Borojevic, 1981). GCA represents breeding value, ie. part of the variance that is fixed in parent components, so valuation through GCA represents selection of parents for creation of new populations and creation of new inbred lines. SCA, on the other hand, represents unreliable part of variance, as consequence of acting non-additive variance, which is happens in F1 offspring by crossing genetically distant inbred lines (Abuali et al. 2012). Observed genotypes with higher values of combining abilities, can result in improved hybrids when they are crossed to other materials from the maize germplasm collection (Čamdžija et al. 2011).

Materials and methods

Six selected inbred lines were chosen for testing the GCA/SCA performance. Based on empirical data it is assumed they belong to the same heterotic group. Lines are crossed in 2009th by the method of incomplete diallel without reciprocal combination [n (n-1)/2]. As a result of derivative crossing, 15 hybrid combinations were obtained among the tested lines. The following year, inbred lines and hybrid combinations were tested in two separate experiments by RCB design at two locations in two replicates. Plot size was $6m^2$, and genotypes were sown at density of 69999 plants per hectare. Grain yield was measured for each elementary plot, and after harvesting and measuring the yield of each genotype, ten ears were selected from each replicate for analysis yield components. Yield components that were analysed were ear length, number of kernel rows and number of kernels per row. Analysis of combining ability was done by Griffing (1956), method 2, the mathematical model 1. All calculations were done in excel software.

Results and discussion

It is determined by analysis of variance, in Table 1, that both GCA and SCA values were significantly high (p<0,01). GCA/SCA ratio was somewhat higher than unity for questioned traits. For grain yield and number of kernels per row ratio was little above unity (1), suggesting equal contribution of additive and non-additive gens, which is in accordance with Aguiar et al. (2003). On the other hand, highly significant values of GCA and SCA variances were found for ear length (p<0,01) and GCA/SCA ratio was 3.26 and 26.63 for ear length and number of kernel rows suggesting much greater role of additive genes in formation of these two traits in offspring. Similar results were found by Shalim et al. (2006) for ear length and Živanovic et al. (2010) for number of row kernels.

Table1. Medium of squares of combining abilities of tested inbred lines

Source	df[1]	GY[2]	EL[3]	NKR[4]	NKPR[5]
GCA	5	5.90**	6.35**	8.50**	32.34**
SCA	15	5.13**	1.94**	0.32*	18.34**
Error	20	0.31	0.09	0.1	0.64
GCA/SCA		1.15	3.26	26.63	1.76

[1] degree of freedom; [2]grain yield; [3] ear length; [4] number of kernel rows;[5] number of kernels per row

Even though both variances were significant for number of kernels per row, additive genes were predominant, that conclusion is in accordance with Vančetovic and Drinic (1993), who also found higher contribution of additive genes in heridation of the same trait.

Table 2. GCA values of tested inbred lines

Line	GY[1]	EL[2]	NKR[3]	NKPR[4]
L1	-0.69*	-0.29	-0.63**	-1.95**
L2	-0.78**	-0.63**	-0.38*	-2.01**
L3	-0.74*	-0.41*	-0.47**	-0.82
L4	1.05**	1.53**	-0.93**	3.23**
L5	0.93**	0.59**	0.58**	0.82
L6	0.24	-0.80**	1.83**	0.73
p<0.01	0.79	0.42	0.46	1.13
p<0.05	0.58	0.31	0.33	0.83

[1] grain yield; [2] ear length; [3] number of kernel rows; [4] number of kernels per row

Based on the data presented in Table 2 it can be seen that in inbred lines L4 and L5 recorded highly significant positive values of general combining ability for grain yield, indicating a high frequency of favorable alleles for grain yield in the two inbred lines. Inbred lines L4 and L5 had the highest values of GCA for ear length, while highly significant negative values were recorded in inbred lines L2 and L6. The highest value of GCA was observed in lines L6, and the lowest in lines L4, which was expected given that the value of the number of kernel rows per ear and ear length are negatively correlated (Zarei, 2012). Highly significant negative values of GCA for number of kernels per row had lines L1 and L2, and a highly significant positive value recorded in the line L4, which can therefore be used in further breeding programs as sources of genes for this certain trait.

Table 3. Values of specific combining ability of valued hybrid combinations

Genotype	GY[1]	EL[2]	NKR[3]	NKPR[4]
L1xL2	-0.43	-0.55	0.11	-0.58
L1xL3	-0.28	-0.31	-0.61	-0.53
L1xL4	2.09**	0.75*	0.06	3.27**
L1xL5	1.40	0.59*	0.14	1.74
L1xL6	1.80*	0.08	0.39	2.28**
L2xL3	0.13	-0.48	-0.16	-0.21
L2xL4	1.55*	0.99*	-0.50	3.57**
L2xL5	1.46*	0.83*	0.39	3.16**
L2xL6	0.44	0.42	-0.76	2.74*
L3xL4	0.86	0.57	0.09	-1.06
L3xL5	1.32	0.71	0.48	3.11**
L3xL6	1.03	0.50	0.03	2.50*
L4xL5	2.20**	2.27**	0.24	3.66**
L4xL6	0.97	1.76**	-0.91*	5.30**
L5xL6	1.70*	-0.35	0.38	0,47
p<0.01	1.93	1.03	1.11	2.78
p<0.05	1.41	0.75	0.82	2.03

[1] grain yield; [2] ear length; [3] number of kernel rows; [4] number of kernels per row

The highest SCA values for grain yield, as well as for ear length were recorded in hybrid combinations L4xL5 (Table 3), i.e. highest values were obtained by crossing the lines with the highest GCA values for the mentioned traits. The hybrid combination L3xL5 had highest SCA values for number of kernel rows, and it is a case of crossing of inbred lines with the negative and positive GCA value. Borojevic (1981) points out that the high SCA values are often obtained by crossing one parent with high GCA and one with low GCA. In hybrid combination L4xL6, the highest SCA value was recorded for the number of kernels per row. In this case, it is the combination of lines with a higher and average value of GCA.

Conclusion

It can be concluded that inbred lines used in this research differ each other by examined traits. Depending on the goal of breeder, certain inbred line matches different breeding purpose. In this case, inbred lines L4 and L5 are recommended for breeding programme based directly on grain yield *per se.* L4 inbred line, also proved to be the best general combiner for ear length and number of kernels per row, so L4 line can be included in breeding programmes concerning those traits.

L6 was the best general combiner for number of kernel rows per ear. New and modern maize hybrids are characterized by greater number of kernel rows per ear, allowing greater number of kernels per ear. Concerning that fact, L6 inbred line should be involved in breeding programme concerning greater number of kernel rows per ear.

According to obtained results, we could be concluded that inbred lines L4, L5 and L6 have high frequency of favorable alleles for most of the investigated traits and should be used in further breeding programs for new hybrids development.

Acknowledgments

This research was supported by the Ministry of Education, Science and Technological development of Republic of Serbia through the Project TR31068

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