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GENETIC RELATIONSHIP BETWEEN YIELD AND YIELD COMPONENTS OF MAIZE

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One of the objectives of this paper was to determine relationship between grain yield and yield components, in S_1 and HS progenies of one early synthetic maize population. Grain yield was in high significant, medium strong and strong association with all studied yield components, in both populations. The strongest correlation was recorded between grain yield and 1000-kernel weight (S_1 progenies r_g = 0.684**; HS progenies r_g = 0.633**). Between other studied traits, the highest values of genotypic

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coefficient of correlations were found between 1000-kernel weight and kernel depth in S_1 population, and 1000-kernel weight and ear length in HS population. Also, objective of this research was founding the direct and indirect effects of yield components on grain yield. Desirable, high significant influence on grain yield, in path coefficient analysis, was found for 1000-kernel weight and kernel row number, and in S_1 and HS progenies, and for ear length in population of S_1 progenies. Kernel depth has undesirable direct effect on grain yield, in both populations.

Key words: correlations, maize, path analysis

INTRODUCTION

Maize is one of the most important grown plants in the world, with very wide and variety utilisation. Because of that, the main goal of all maize breeding programs is to obtain new inbreds and hybrids that will outperform the existing hybrids with respect to a number of traits. In working towards this goal, particular attention is paid to grain yield as the most important agronomic characteristic. Grain yield is within great influence of environmental conditions, has complex mode of inheritance and low heritability (BOCANSKI *et al.,* 2009). Most of the yield components are less complex, and because of that using some other trait that is highly correlated with grain yield and has higher heritability, should make the selection of the best progenies more reliable (VASIC *et al.,* 2001; BEKAVAC *et al*., 2007, 2008).

Since yield components are interrelated, and develop sequentially at different growth stages, correlations may not provide a clear picture of the importance of each component in determining grain yield. *Path* coefficient *analysis* is often used to characterize yield component variations at the phenotypic and genotypic levels, and to identify plant breeding and/or crop management research priorities (BOARD *et al*., 1999) and expand physiological understanding of crop morphology. *Path* coefficient *analysis* provides more information among variables than do correlation coefficients since this *analysis* provides the direct effects of specific yield components on yield, and indirect effects via other yield components (GARCIA DEL MORAL *et al*., 2003).

MATERIAL AND METHODS

In this paper we studied S_1, and HS progenies of one early synthetic maize population, NSB, after five cycles of recurrent selection. Inbred line A632 was used as tester. During 1999 and 2000 progenies were evaluated in field experiments at two locations (Rimski Sancevi and Srbobran) according to Nested Design (incomplete block design; COCHRAN and COX, 1957). 80 genotypes were assigned at random to 4 sets. Two replications within set were used and 20 plants per plot were grown. The standard maize growing technique was practiced. Harvest was done by hand.

The data were recorded for grain yield (GY), ear length (EL), kernel row number (KRN), 1000-kernel weight (1000-KW) and kernel depth (KD). Grain yield was recorded on plot basis, while data for yield components were recorded on 10 randomly selected ears from each replication.

Analysis of variance and covariance were done by Nested Design (random model; COCHRAN and COX, 1957). Genetic correlation coefficients were based on ratio of joint variation and summary of individual variation two traits (HALLAUER and MIRANDA, 1988), and for testing significance of correlation coefficients we applied t- test. Standardized partial regression coefficients (path coefficients) and levels of their significance were calculated according to the method of the inverse symmetric correlation matrix (EDWARDS, 1979).

RESULTS AND DISCUSSION

In most breeding programs the strategy is based on selection for several traits simultaneously and, therefore, knowledge on the genetic association between traits is inevitably useful for the establishment of selection criteria (FARIAS and MIRANDA, 2001). In both studied population grain yield was in high significant and strong correlations with 1000-kernel weight (tab. 1). Although many authors found a strong genetic association between these two traits (ALVI *et al*., 2003; AHMAD and SALEEM, 2003; BOĆANSKI *et al*., 2009, RAFIQ *et al*., 2010), some authors have found a low (MALIK *et al*., 2005), even a negative (YOUSUF and SALEEM, 2001) correlations between grain yield and kernel weight. In population of S_1 progenies grain yield also was strongly associated with ear length and kernel depth, while between grain yield and kernel row number in this population medium strong and high significant correlations was found, which is in accordance with the results of BOĆANSKI *et al.* (2009). In second studied population (HS progenies) grain yield, was in medium strong correlations with kernel row number, ear length and kernel depth. Results which we get in population of S_1 progenies are similar to the results of several researches. Studying genetic correlations between grain yield and morphological traits of plant and ear, ALVI *et al.* (2003) established high significant and strong correlation between grain yield and ear length (r_g = 0.943**), but contra to the results which we get in both population for correlation between grain yield and kernel row number these author established strong correlations between these two traits (r_g = 0.7151**). Strong association between these traits (grain yield and kernel row number) in there research also established and NAJEEB *et al*. (2009), and RAFIQ *et al*. (2010), while YOUSUF and SALEEM (2001), AHMAD and SALEEM (2003) and MALIK *et al.* (2005) found low correlations between grain yield and kernel row number.

Table 1. Genetic correlations in S_1 (above diagonal) and HS (below diagonal) population

	KRN	*EL*	*KD*	*1000-KW*	*GY*
KRN		0.187	0.408**	0.124	0.537**
EL	0.210		0.458**	0.351**	0.684**
KD	0.324**	0.339**		0.638**	0.623**
1000-KW	-0.293	0.422**	0.406**		0.684**
GY	0.523**	0.454**	0.579**	0.633*	

** $p < 0.01$

In both studied population, between almost all yield components positive correlations was found. Negative correlation was established only between 1000-kernel weight and kernel row number (r_g = -0.293) in population of HS progenies, and that is in agreement with the results of MALIK *et al.* (2005) who also found negative and low correlation between these two traits. However, most of the researches who studied correlation between these traits found that are kernel weight and kernel row number is positively associated. So, YOUSUF and SALEEM (2001) and ALVI *et al.* (2003) found low association between 1000-kernel weight and kernel row number, BOĆANSKI *et al.* (2009) medium strong, while RAFIQ *et al.* (2010) established high significant and strong correlation between these two traits. Ear length was in high significant and medium strong correlations with kernel depth and 1000-kernel weight, in both population, and low correlations with kernel row number. ALVI *et al.* (2003) also found medium strong association between ear length and 1000-kernel weight (r_g = 0.5978), but contra to our results these authors found that ear length was strongly associated with kernel row number (r_g = 0.6273). Results which we get in this paper are also contra and to the results of BOĆANSKI *et al.* (2009) and RAFIQ *et al.* (2010).The direct effects, obtained in path coefficient analysis, in both studied population, indicated that grain yield at most depended upon 1000-kernel weight (tab. 2).

Table 2. Path coefficient analysis

Pathway	Population	
	S_1	HS
Kernel row number vs. grain yield		
Direct effect (p_1)	0.247**	0.828**
Indirect effect via ear length	0.087	-0.021
kernel depth	-0.043	-0.011
1000-kernel weight	0.066	-0.273
Ear length vs. grain yield		
Direct effect (p_2)	0.465**	-0.102**
Indirect effect via kernel row number	0.08	0.174
kernel depth	-0.048	-0.011
1000-kernel weight	0.188	0.393
Kernel depth vs. grain yield		
Direct effect (p_3)	-0.105	-0.033
Indirect effect via kernel row number	0.174	0.268
ear length	0.213	-0.035
1000-kernel weight	0.341	0.379
1000-kernel weight vs. grain yield		
Direct effect (p_4)	0.535**	0.932**
Indirect effect via kernel row number	0.053	-0.243
ear length	0.163	-0.043
kernel depth	-0.067	-0.014
Coefficient of determination (R^2_{y1234})	0.847**	0.958**

** $p < 0.01$

AHMAD and SALEEM (2003) and RAFIQ *et al*. (2010) also found the greatest direct effect of kernel weight on grain yield. High significant, desirable direct influence on grain yield was found and for kernel row number, in both studied population. These results are in agreement with results which AHMAD and SALEEM (2003) and NAJEEB *et al.* (2009) found in there research. ALVI *et al* (2003) and RAFIQ *et al* (2010) also found positive direct effect of kernel row number on grain yield, but it wasn't significant. Kernel depth have undesirable influence on grain yield, and in population of S_1 and HS progenies, but indirect effect of this trait on grain yield, via almost all other studied yield components was significant. Non-significant indirect effect of kernel depth on grain yield was recorded only via ear length, in population of HS progenies.

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GENETIČKA MEĐUZAVISNOST PRINOSA I KOMPONENTI PRINOSA ZRNA KUKURUZA

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I z v o d

Jedan od ciljev ovog istraživanja je bio da se utvrdi međuzavisnost prinosa zrna i komponenti prinosa, kod S_1 and HS potomstva jedne rane sintetičke populacije kukuruza. U obe proučavane populacije utvrđena je visoko značajna, srednje jaka i jaka međuzavisnost između prinosa zrna i svih proučavanih komponenti prinosa. Najjača korelativna veza ustanovljena je između prinosa i mase 1000 zrna (S_1 potomstvo $r_g = 0.684^{**}$; HS potomstvo $r_g = 0.633^{**}$). Između ostalih proučavanih osobina, u populaciji S_1 potomstava, najjača korelativna veza ustanovljena je između mase 1000 zrna i dubine zrna, dok je u drugoj proučavanoj populaciji najjača korelacija ustanovljena između mase 1000 zrna i dužine klipa. Takođe, cilj ovog rada je bio i utvrđivanje direktnog i indirektnog uticaja komponenti prinosa na prinos zrna. U path koeficijent analizi, visoko značajan i poželjan direktni uticaj na prinos zrna ustanovljen je za masu 1000 zrna i broj redova zrna na klipu, u obe proučavane populacije, i za dužinu klipa u populaciji S_1 potomstva. Dubina zrna pokazala je nepoželjan uticaj na prinos zrna, i u populaciji S_1 i HS potomstva.

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