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CORRELATION AND PATH ANALYSIS OF GRAIN YIELD AND MORPHOLOGICAL TRAITS IN TEST–CROSS POPULATIONS OF MAIZE

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Abstract

One of the goals of this paper was to determine correlation between grain yield, like the most important agronomic trait, and traits of the plant and ear that are influencing on the grain yield, in two test–cross populations, which are formed by crossing progenies of NSU_1 population after 17 cycles of phenotypic recurrent selection and two testers, 568/II NS and B73. At 568/II NS testcrosses, grain yield had the highest value of genotypic coefficient of correlations with kernel row number. In second studied population the highest value of coefficient of correlations also was found between grain yield and kernel row number, but that relation was negative. Path coefficient analysis provides more information among variables than do correlation coefficients. Because of that goal of this study also was founding the direct and indirect effects of morphological traits on grain yield. Desirable, high significant influence on grain yield, in path coefficient analysis, was found for ear height, in both studied populations. Plant height, in both testcross populations, kernel row number and oil content, at B73 testcrosses, has high significant undesirable effect on grain yield.

Introduction

Maize have very wide and variety utilization and because of that, the main goal of all maize breeding programs is to obtain new inbred 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. Besides that the attention should be paid to the quality of kernel itself i.e., chemical composition, mainly if we take into consideration one of the most important maize uses in developed countries as livestock feed (Laurie *et al*., 2004).

High oil maize hybrids have a change chemical structure and bigger biology value than standard maize hybrid. Typical yellow dent maize contains around 4–4.3% oil (dry weight basis) while high oil maize generally has oil content of 6% or more and higher quality proteins than normal yellow dent corn. High oil maize we used in industry to get quality maize oil and it is attractive as a livestock feed because it has greater energy than normal maize and can replace some of the more expensive sources of fats and proteins.

During selection on oil content it came to correlative response on other traits. Because of that one of the goals of this study was to confirm correlations between grain yield and morphological traits of plant and ear, as well as between oil content and morphological traits. 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 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, Arshad *et al*., 2004, 2006; Aycicek & Yildirim, 2006). Because of that goal of this study also was founding the direct and indirect effects of morphological traits on grain yield.

Material and Methods

The genetic material evaluated in the present study was developed by crossing progenies of high oil maize population after 17 cycles of recurrent selection, and two testers, 568/II NS and B73. During 2006 and 2007 testcrosses were evaluated in field experiments at one location (Rimski Sancevi) according to Nested Design (incomplete block design; Cochran & Cox, 1957). 96 genotypes were assigned at random to 4 sets. Two replications within set were used and 20 plants plot were grown. Each plot consisted of one, 5-m long row, 0.24 m between plants and spaced 0.75 m between plots. The standard maize growing technique was practiced. Harvest was done by hand. The data were recorded on 10 randomly taken competitive plants for plant length (PH) and ear height (EH), ear length (EL), kernel row number (KRN), 100–kernel weight (KW), grain yield plant (GY) and kernel oil content (KOC). Oil content was determined by NMR (nuclear magnetic resonance spectroscope).

Analysis of variance and covariance were done by Nested Design (random model; Cochran & Cox, 1957). Genetic and phenotypic correlation coefficients were based on ratio of joint variation and summary of individual variation two traits (Hallauer & 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 order to obtain the level of relation between studied traits, we calculated genetic coefficient of correlation. At B73 testcrosses grain yield was in medium strong correlation with kernel row number (Table 1) that is in agreement with results of Sumathi *et al*., (2005) and Bocanski *et al*., (2009). In NSU_1 × B73 we also found medium strong correlations between these two traits, but that relation was negative. Negative correlations between grain yield and kernel row number was also found (Yousuf & Saleem 2001), but contra to our results they found low correlation between these two traits. Negative values of coefficient of correlations were found between grain yield and plant height, in both studied populations, and between grain yield and ear length in population where we used 568/II NS like a tester. These results are similar to the results of Yousuf & Saleem (2001). Who found low and negative correlations between grain yield and plant height, but they determined that grain yield was in negative association with 100-kernel weight. In contrasted to the results which we found in this paper, Alvi *et al.*, (2003), Akbar *et al*., (2008) and Bocanski *et al.*, (2009) found positive correlations between grain yield and morphological traits of plant.

In both studied populations grain yield was in low correlations with kernel oil content. At B73 testcrosses that relation was negative (r = –0.110) what is in agreement with results of Sumathi *et al*., (2005). In the second studied population (NSU_1 × 568/II NS) grain yield was positively associated with kernel oil content. This result is in agreement with the result of Sallem *et al*., (2008). Oil content was in positive correlations and with ear length and 100-kernel weight, in both studied population and with plant height and kernel row number in NSU_1 × 568/II NS, and ear height in population where we used line B73 like a tester. Our results are similarly to the findings of Sreckov *et al*., (2007) who studied genetic potential of these two populations after 16 cycles of phenotypic recurrent selection. At 568/II testcrosses they found low positive relation between kernel oil content and ear length and kernel row number. They also found positive correlation between oil content and plant height and 100–kernel weight, but contrary to our results that relation was medium strong. Also, contrary to our results they established positive correlations between kernel oil content and ear height. Opposite to the results that we get at B73 testcrosses, these authors found medium strong, positive association between kernel oil content and ear length, and medium strong negative relation between oil content and kernel row number.

Path coefficient analysis indicate that greatest influence on grain yield have ear height, in both testcross population (Tables 2 and 3). These results are in agreement with results of Akbar *et al*., (2008), but contra to the results of Alvi *et al*., (2003). The greatest undesirable effect on grain yield was established for plant height in both studied populations. Sumathi *et al*., (2005) also found negative influence of plant height on grain yield, but that influence wasn't significant. High significant, negative values of path coefficient also was found for kernel row number (p_4 = –0.514**) and kernel oil content (p_6 = –0.533**) in NSU_1 × B73 population. These results are contrary to the results of most of the authors. Alvi *et al*., (2003) and Sumathi *et al*., (2005) found positive direct effect of kernel row number on grain yield and Sumathi *et al*., (2005) also found negative influence of kernel oil content on grain yield, but it wasn't significant.

Table 1. Genetic correlations in NSU_1 × 568/II NS (above diagonal) and in NSU_1 × B73 (below diagonal).

Trait	PH	EH	EL	KRN	KW	KOC	GY
PH		0.786**	0.372*	-0.186	0.081	0.111	-0.281
EH	0.427**		0.109	-0.056	0.078	-0.030	0.033
EL	0.217	0.466		-0.106	0.364	0.126	-0.043
KRN	-0.274	-0.156	-0.181		-0.408	0.086	0.305
KW	0.238	0.147	0.085	-0.375		0.125	0.175
KOC	-0.020	0.373	0.015	-0.251	0.133		0.113
GY	-0.210	0.283	0.156	-0.311	0.119	-0.110	

*= p<0.05
**= p<0.01

Table 2. Direct (diagonal) and indirect effects of studied traits on grain yield in NSU_1 × 568/II NS population.

Trait	PH	EH	EL	KRN	KW	KOC
PH	**-0.860****	-0.676	-0.320	0.160	-0.070	-0.095
EH	0.548	**0.698****	0.076	-0.039	0.054	-0.021
EL	0.046	0.013	**0.123**	-0.013	0.045	0.015
KRN	-0.052	-0.016	-0.030	**0.281**	-0.115	0.024
KW	0.020	0.019	0.087	-0.098	**0.240**	0.030
KOC	-0.005	-0.005	0.020	0.014	0.030	**0.160**

**= p<0.01

Table 3. Direct (diagonal) and indirect effects of studied traits on grain yield in NSU_1 × B73 population.

Trait	PH	EH	EL	KRN	KW	KOC
PH	**-0.661****	-0.282	-0.143	0.181	-0.157	0.013
EH	0.315	**0.738****	0.344	-0.115	0.109	0.275
EL	-0.029	-0.063	**-0.134**	0.024	-0.011	-0.002
KRN	0.141	0.080	0.093	**-0.514****	0.193	0.129
KW	0.014	0.008	0.005	-0.022	**0.058**	0.008
KOC	-0.199	-0.199	-0.008	0.134	0.008	**-0.533****

**= p<0.01

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