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CORRELATIONS BETWEEN AGRONOMIC TRAITS IN MAIZE POPULATIONS

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Abstract: Correlations between important agronomic traits were studied in three maize populations which need to be improved for a few agronomic traits in order to choose an efficient breeding strategy. Random sets of S_1 families of the populations were evaluated in a 12 × 12 triple lattice in savanna zone in Benin. The traits studied were: earliness (days to 50% anthesis, silking and maturity, number of leaves), grain yield, and harvest index. Linear phenotypic correlation coefficients were estimated for all pairs of traits and tested for significance. Days to 50% anthesis, days to 50% silking, and days to 50% maturity were highly and positively correlated in the three populations. Grain yield was not linearly correlated with cycle duration. Harvest index was highly and positively correlated with grain yield and negatively correlated with days to 50% silking. Therefore, selection for days to 50% anthesis, silking or maturity (any of the three variables) can improve the populations for earliness. Similarly, selection for high harvest index may increase grain yield in the populations. It should be, then, relatively easy to improve the three populations for earliness, grain yield, and harvest index.
Keywords: agronomic traits, Benin, breeding, correlation, maize, populations.

Introduction

Maize (*Zea mays* L.) is cultivated throughout the world and plays an important role in human and animal feeding. The demand is continuously increasing and cannot be satisfied without strong technological interventions (Shiferaw et al., 2011). Maize is the most important cereal crop in sub-Saharan Africa (IITA, 2009) and Africa produced in 2012 more than 69 millions tons of that crop (FAO, 2013).

In Benin, maize is the most cultivated food crop; but, its production is limited by numerous constraints including deficiencies of the cultivars (Abadassi, 2014a). Several improved varieties have been introduced notably from the International Institute of Tropical Agriculture (IITA) and the International Maize and Wheat Improvement Center (CIMMYT). But, they don't satisfy producers and consumers' needs and should, therefore, be improved for important agronomic traits. Knowledge of the correlations between agronomic traits is essential in breeding programmes. It helps breeders to choose the most appropriate selection

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strategy. Correlations between some agronomic traits in maize have been studied by authors such as Chase and Nanda (1967), Jacquot (1970), El-Lakany and Russel (1971), Monteagudo (1971), Allen et al. (1973), Josephson and Kincer (1977), Fakorede (1979), Muldoon et al. (1984), Reddy et al. (1986), Helms and Compton (1987), Kim and Hallauer (1989), Hébert et al. (1990), Agbaje et al. (2000), Yousuf and Saleem (2001), Gyenes-Hegyi et al. (2002), Buhinicek et al. (2007), Barros et al. (2010), Golam et al. (2011), and Nzuve et al. (2014). But, the results vary with traits, population, and location. For certain pairs of traits like (grain yield, harvest index), no correlation information was found in literature. The present work was, therefore, undertaken to determine the correlations between important agronomic traits in maize populations introduced or developed in Benin which need to be improved for a few agronomic traits.

Materials and methods

Three populations were studied:

- EV8443SR, an elite population bred by IITA and CIMMYT from Population 43 of CIMMYT and cultivated in Benin and other African countries
- EV8443SR × FS14 F_1 (EF), a tropical-temperate population resulting from the cross between EV8443SR and FS14, a temperate synthetic bred by the French National Institute of Agricultural Research
- EV8443SR × (EV8443SR × FS14) (EFE), a tropical-temperate population obtained in backcrossing EV8443SR × FS14 to EV8443SR.

The three populations are late-maturing and have relatively low grain yields and harvest indexes. They need, then, to be improved for earliness, grain yield, and harvest index.

Random sets of 40 S_1 families from EV8443SR and 50 S_1 families from EFE and EF were grown for evaluation in Benin, at Bembéréké (savanna zone, latitude: 9°58'N; longitude: 2°44'E; altitude: 358 m). The experimental design used was a 12×12 triple lattice. Each entry was planted in two 2 m rows separated by 0.80 m. Consecutive hills along each row were 0.50 m apart. The plots were overplanted and thinned to 2 plants per hill (50000 plants.ha^{-1}). Fertilization and weeding were optimal. Rainfall was sufficient and well distributed.

The traits studied were: earliness (days to 50% anthesis, silking and maturity (dried husks), number of leaves), grain yield, and harvest index. Days to 50% anthesis, silking, and maturity (days after planting) were recorded on a plot basis. Grain yield was noted per plot at 15% moisture. Harvest index (hi) was calculated by the formula:

hi = ew/epw

with ew = weight of the ears harvested on the plot; epw = weight of all the plants harvested on the plot.

For each population, the simple linear phenotypic correlation coefficient r between two traits X and Y was estimated as follows:

$r = Cov(X,Y) / [V(X)V(Y)]^{1/2}$

where Cov (X,Y) = phenotypic covariance of X and Y; V(X) = phenotypic variance of X; V(Y) = phenotypic variance of Y.

The coefficients were tested for significance following the procedure described by Gomez and Gomez (1984).

Results and discussion

Tables 1 to 3 give the simple linear phenotypic correlation matrix per population. Days to 50% anthesis, days to 50% silking and days to 50% maturity were highly (significance at the 1% level) and positively correlated in all populations. That result is in agreement with

Table 1. Simple linear correlation matrix of the variables in population EV8443SR

Variables	Days to 50% anthesis	Days to 50% silking	Number of leaves	Days to 50% maturity	Harvest index	Grain yield
Days to 50% anthesis	1					
Days to 50% silking	0.823^{**}	1				
Number of leaves	0.442^{**}	0.484^{**}	1			
Days to 50% maturity	0.685^{**}	0.730^{**}	0.290^{ns}	1		
Harvest index	-0.199^{ns}	-0.350^{*}	-0.226^{ns}	-0.121^{ns}	1	
Grain yield	-0.006^{ns}	-0.091^{ns}	0.202^{ns}	0.140^{ns}	0.544^{**}	1

** Highly significant (1% level); * Significant (5% level); ^{ns} non significant

Table 2. Simple linear correlation matrix of the variables in population EV8443SR × FS14 F_1 (EF)

Variables	Days to 50% anthesis	Days to 50% silking	Number of leaves	Days to 50% maturity	Harvest index	Grain yield
Days to 50% anthesis	1					
Days to 50% silking	0.831^{**}	1				
Number of leaves	0.580^{**}	0.462^{**}	1			
Days to 50% maturity	0.712^{**}	0.645^{**}	0.323^{*}	1		
Harvest index	-0.238^{ns}	-0.344^{*}	-0.171^{ns}	-0.049^{ns}	1	
Grain yield	-0.111^{ns}	-0.401^{**}	-0.014^{ns}	0.003^{ns}	0.548^{**}	1

** Highly significant (1% level); * Significant (5% level); ^{ns} non significant

Table 3. Simple linear correlation matrix of the variables in population EV8443SR × (EV8443SR ×FS14) (EFE)

Variables	Days to 50% anthesis	Days to 50% silking	Number of leaves	Days to 50% maturity	Harvest index	Grain yield
Days to 50% anthesis	1					
Days to 50% silking	0.701^{**}	1				
Number of leaves	0.236^{ns}	0.151^{ns}	1			
Days to 50% maturity	0.475^{**}	0.572^{**}	0.226^{ns}	1		
Harvest index	-0.268^{ns}	-0.585^{**}	0.053^{ns}	-0.393^{**}	1	
Grain yield	-0.050^{ns}	-0.333^{*}	0.454^{**}	0.012^{ns}	0.554^{**}	1

** Highly significant (1% level); * Significant (5% level); ^{ns} non significant

those obtained by Kim and Hallauer (1989) and Buhinicek et al. (2007). Those authors found also that days to anthesis and days to silking were highly and positively correlated. Any of the three variables is, therefore, sufficient for efficient selection for earliness in the populations studied. Number of leaves was significantly and positively correlated with the three other earliness variables studied in EF, not significantly correlated with them in EFE, and significantly and positively correlated with days to 50% anthesis and days to 50% silking in EV8443SR. Correlation between days to silking and number of leaves was earlier reported by Chase and Nanda (1967).

Grain yield was not significantly correlated with any of the four earliness variables studied in EV8443SR. It was negatively correlated with days to 50% silking in EFE and EF and positively correlated with number of leaves in EFE. The absence of significant linear correlation between grain yield and cycle duration is unusual in maize. Generally, the two variables are positively correlated. However, that result is in agreement with those obtained by Abadassi (2013, 2014b). The dissimilarity observed may be due to the genetic constitution of the populations. The non-correlation between grain yield and cycle duration may facilitate selection for satisfactory levels of earliness and grain yield.

Harvest index was significantly and negatively correlated with days to 50% silking in EV8443SR and EF, and days to 50% silking and days to50% maturity in EFE. It was highly and positively correlated with grain yield in the three populations. Harvest index may be highly heritable in maize (Hay and Gilbert, 2001). Hence, selection for high harvest index may permit to increase grain yield in the three populations studied.

Conclusion

Days to 50% anthesis, days to 50% silking, and days to 50% maturity were highly and positively correlated in the three maize populations studied. Grain yield was not linearly correlated with cycle duration. Harvest index was highly and positively correlated with grain yield and negatively correlated with days to 50% silking in the three populations. Therefore, selection for days to 50% anthesis, silking or maturity (any of the three variables) can improve the populations for earliness. Similarly, selection for high harvest index may increase grain yield in the populations studied. It should be, then, relatively easy to improve the three populations for earliness, grain yield, and harvest index.

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