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Correlations among grain yield and its components in maize populations

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Abstract

Correlations among grain yield and its components were studied in five maize populations which need to be improved for grain yield with the aim of choosing an efficient breeding strategy. Random sets of S_1 families of the populations were evaluated in triple lattices in savanna zone in Benin. Linear phenotypic correlation coefficients were computed for all pairs of traits and tested for significance. Grain yield was highly and positively correlated with number of grains per ear in the five populations. It was significantly and positively correlated with grain weight and not significantly correlated with number of ears per plant in the populations EV8443SR, EV8443SR × FS14 (EF) and EV8443SR × (EV8443SR × FS14) (EFE). In the population EV8443SR × (EV8443SR ×DEA) (EDE), grain yield appeared significantly and positively correlated with number of ears per plant and not correlated with grain weight. In EV8443SR × DEA (ED), grain yield was highly and positively correlated with grain weight and not significantly correlated with number of ears per plant. Therefore, selection for high number of grains per ear may increase grain yield in the five populations studied. Similarly, grain weight may be used for indirect selection for grain yield in the populations EV8443SR, EFE, EF and ED.

Keywords: Benin, breeding, correlation, grain yield, grain yield components, maize.

Introduction

Maize is an important cereal crop grown worldwide. It is, in Benin, the most cultivated food crop; but, the grain yields are relatively low (FAO, 2013). Among the causes of that situation appear the deficiencies of the cultivars (Abadassi, 2014). Improved varieties introduced from the International Institute of Tropical Agriculture (IITA) and the International Maize and Wheat Improvement Center (CIMMYT) have been popularized for decades in the country. But, they are little appreciated and cultivated by producers and consumers and should be improved for essential agronomic traits. Promising populations developed from some of the varieties need to be improved for few traits including grain yield. Correlations between traits determine the choice of the most efficient selection strategy. In maize, correlations studies have been conducted by several researchers including 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 (1984), 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), Bocanski et al. (2009), Barros et al. (2010), Nastasic et al. (2010), Yusuf (2010), Golam et al. (2011), Inamullah et al. (2011), Nzuve et al. (2014), Abadassi (2015) and Bikal and Deepika (2015). But, the results vary with traits, population, and location. This work was, therefore, initiated to determine the correlations between grain yield and its components in five maize populations introduced or developed in Benin which need to be improved for grain yield.

Materials and Methods

One elite tropical population (EV8443SR) and four tropical-temperate populations [EV8443SR × FS14 (EF), EV8443SR × (EV8443SR × FS14) (EFE), EV8443SR × DEA (ED), EV8443SR × (EV8443SR × DEA) (EDE)] were studied.

Random sets of 40 S1 families of EV8443SR and 50 families of each of the other populations were evaluated in Benin, at Bembéréké (Northern Benin, savanna zone, latitude: 9°58'N; longitude: 2°44'E; altitude: 358 m). The experimental design used was a 12 × 12 triple lattice for the three populations of the cross EV8443SR x FS14 (EV8443SR, EF and EFE) and a 10 x 10 triple lattice for the two other populations (ED and EDE) . Each family 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, weeding and rainfall were appropriate.

The traits studied were: grain yield, number of ears per plant, number of grains per ear and 1000 grain weight. Grain yield and 1000 grain weight were recorded per plot at 15% moisture. Number of ears per plant (nep) and number of grains per ear (nge) were calculated as follows:

nep = ne/nph
with ne = number of ears harvested on the plot; nph = number of plants harvested on the plot

nge = (gwe/tgw) ×1000
gwe = grain weight per ear
tgw = 1000 grain weight.

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

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

Cov (X,Y) = phenotypic covariance of X and Y; V(X) = phenotypic variance of X; V(Y) = phenotypic variance of Y.
Test of significance of the coefficients was performed as indicated by Gomez and Gomez (1984).

Results and Discussion

Tables 1 to 5 show the simple linear phenotypic correlation matrix per population. Grain yield was highly and positively correlated with number of grains per ear in the five populations studied. That result agrees with those reported by Agbaje et al. (2001). Those researchers noted also a significant and positive correlation between grain yield and number of grains per ear in maize. Therefore, selection for high number of grains per ear may increase grain yield in the populations studied.

Grain yield was significantly and positively correlated with grain weight and not significantly correlated with number of ears per plant in the three populations of the cross EV8443SR × FS14 (EV8443SR, EFE and EF). In the population EDE, grain yield appeared significantly and positively correlated with number of ears per plant and not correlated with grain weight. In ED, grain yield was highly and positively correlated with grain weight and not significantly correlated with number of ears per plant. Positive significant correlation between grain yield and grain weight was earlier reported by Bocanski et al. (2009), Nastasic et al. (2010), Yusuf (2010), Inamullah et al. (2011) and Bikal and Deepika (2015). However, El-lakany and Russel (1971) and Golam et al. (2011) did not find any correlation between the two traits. Monteagudo (1971) and Inamullah et al. (2011) showed also a significant correlation between grain yield and number of ears per plant. On the basis of the results obtained, grain weight may be used for indirect selection for grain yield in the populations EV8443SR, EFE, EF and ED.

Number of grains per ear and grain weight were highly and negatively correlated in EV8443SR and EFE and not correlated in EF and EDE. They were highly and positively correlated in ED. Inamullah et al. (2011) found also a positive significant correlation between number of grains per ear and grain weight in maize hybrids. Number of ears per plant was significantly and negatively correlated with grain weight in EV8443SR and EF and with number of grains per ear in EFE, EF and EDE. Those results are in discordance with those presented by Yousuf and Saleem (2001) and Inamullah et al. (2011). Yousuf and Saleem (2001) did not find any correlation between number of ears per plant and grain weight whereas Inamullah et al. (2011) identified positive correlation between number of ears per plant and grain weight or number of grains per ear. Populations genetic architecture may be responsible for the dissimilarities observed.

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

Traits	Grain yield	Number of ears per plant	Number of grains per ear	1000 grain weight
Grain yield	1	0.253^{ns}	0.593^{**}	0.500^{**}
Number of ears per plant		1	-0.299^{ns}	-0.510^{*}
Number of grains per ear			1	-0.464^{**}
1000 grain weight				1

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

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

Traits	Grain yield	Number of ears per plant	Number of grains per ear	1000 grain weight
Grain yield	1	0.252^{ns}	0.612^{**}	0.301^{*}
Number of ears per plant		1	-0.288^{*}	-0.770^{**}
Number of grains per ear			1	-0.274^{ns}
1000 grain weight				1

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

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

Traits	Grain yield	Number of ears per plant	Number of grains per ear	1000 grain weight
Grain yield	1	-0.200^{ns}	0.752^{**}	0.361^{*}
Number of ears per plant		1	-0.451^{**}	0.115^{ns}
Number of grains per ear			1	-0.730^{**}
1000 grain weight				1

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

Table 4. Simple linear correlation matrix of the traits in population EV8443SR × DEA (ED)

Traits	Grain yield	Number of ears per plant	Number of grains per ear	1000 grain weight
Grain yield	1	0.155^{ns}	0.738^{**}	0.453^{**}
Number of ears per plant		1	-0.134^{ns}	-0.164^{ns}
Number of grains per ear			1	0.680^{**}
1000 grain weight				1

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

Table 5. Simple linear correlation matrix of the traits in population EV8443SR × (EV8443SR ×DEA) (EDE)

Traits	Grain yield	Number of ears per plant	Number of grains per ear	1000 grain weight
Grain yield	1	0.700^{**}	0.767^{**}	0.219^{ns}
Number of ears per plant		1	-0.382**	-0.250^{ns}
Number of grains per ear			1	-0.134^{ns}
1000 grain weight				1

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

Conclusion

Grain yield was highly and positively correlated with number of grains per ear in the five populations studied. It was significantly and positively correlated with grain weight and not significantly correlated with number of ears per plant in the three populations of the cross EV8443SR × FS14 (EV8443SR, EFE and EF). In the population EDE, grain yield appeared significantly and positively correlated with number of ears per plant and not correlated with grain weight. In ED, grain yield was highly and positively correlated with grain weight and not significantly correlated with number of ears per plant. Number of grains per ear and grain weight were highly and negatively correlated in EV8443SR and EFE and not correlated in EF and EDE. They were highly and positively correlated in ED. Number of ears per plant was significantly and negatively correlated with grain weight in EV8443SR and EF and with number of grains per ear in EFE, EF and EDE. Therefore, selection for high number of grains per ear may increase grain yield in the five populations studied. Similarly, grain weight may be used for indirect selection for grain yield in the populations EV8443SR, EFE, EF and ED.

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