Identification of combining ability patterns for pearl millet hybrid breeding in West Africa

Felix T. Sattler[1*], Anna Pucher[1], Ousmane Sy[2], A Issaka[3], C. Tom Hash[4], Bettina I.G. Haussmann[1]

Introduction

- West African (WA) pearl millet production is still based on open pollinated varieties (OPVs). Hybrid breeding based on heterotic groups could potentially deliver yield increases.
- Due to high admixture in WA pearl millet germplasm, developing heterotic groups by means of diversity analysis does not seem constructive, but needs to be complemented by combining ability studies.

Goal of this study: Inform and guide sustainable pearl millet hybrid breeding in WA

Specific Objectives:

i) Determine the yield superiority of population hybrids over OPVs in WA pearl millet.

ii) Initiate establishment of heterotic groups among WA pearl millet populations based on combining ability patterns.

iii) Estimate further quantitative-genetic parameters to inform pearl millet breeding programs in WA.

Materials and Methods

- 2015: 120 pearl millet population hybrids derived from 16-WA-parent diallel were tested with parents at four locations in Niger and Senegal.
- 2016: 136 populations hybrids derived from a 17-WA-parent diallel (previous 16 plus 1) tested with parents at five locations in Niger and Senegal.
- Parental OPVs originated from Mauritania (1), Niger (10), Nigeria (1) and Senegal (5).
- 20 individuals per parental OPV analyzed with microsatellite markers.

Conclusions

- Impressive panmictic midparent heterosis (PMPH) shows the potential of pearl millet population hybrids for WA.
- High and complex genotype-by-environment (GxE) interactions underline the need to select for yield stability.
- Genetic distances on SSR level hardly support heterotic grouping.
- Selected germplasm from Niger *vs.* Senegal as basis for establishment of heterotic groups in WA pearl millet.

Preliminary results

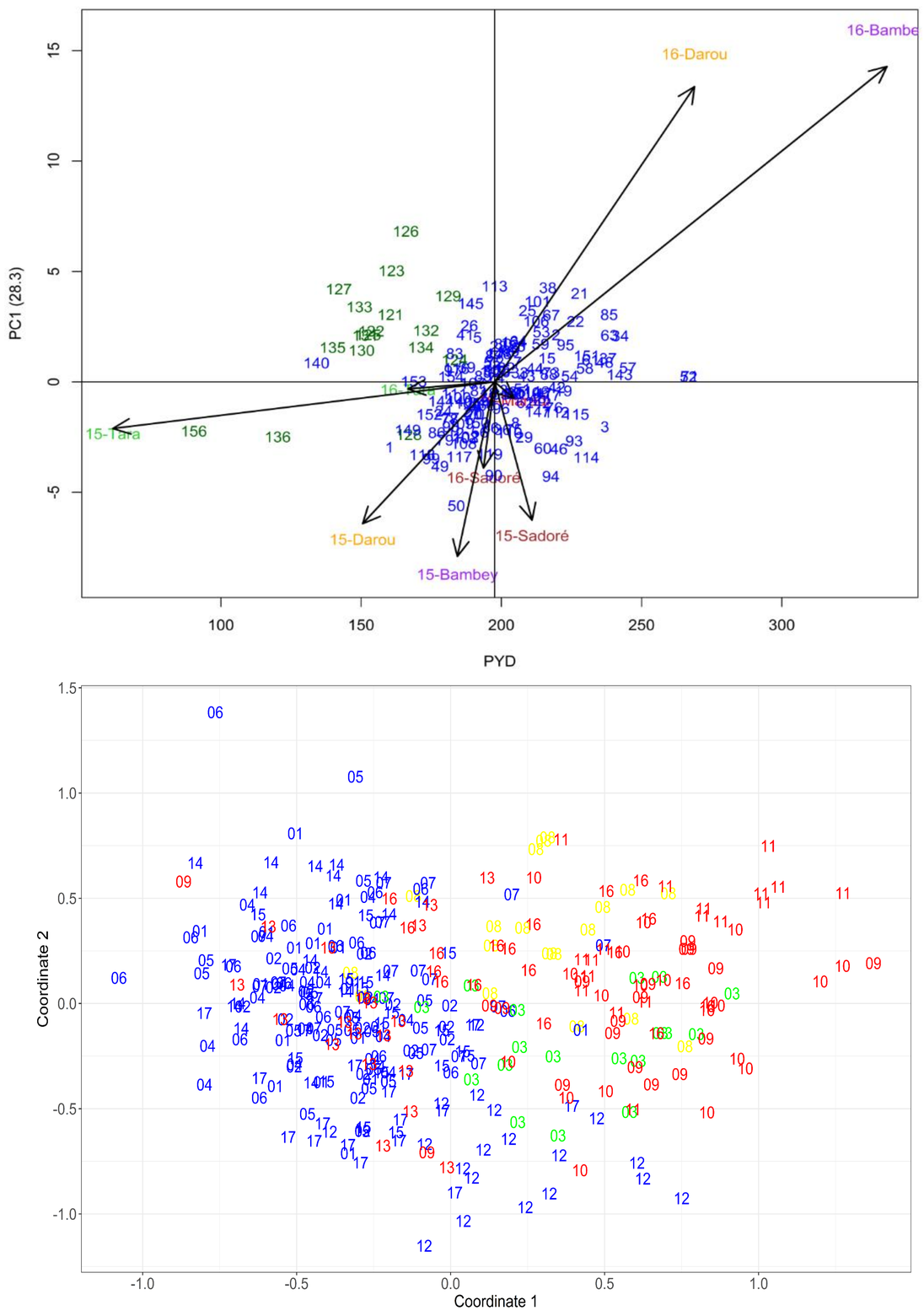

Figure 1. PC1 of additive main effects and multiplicative interaction (AMMI) plotted against adjusted means for panicle yield (PYD; g*m^{-2}) illustrating relationships among test sites and 136 pearl millet hybrids (blue), their 17 parental OPVs (green) evaluated in nine environments (Niger: Sadoré and Tara in 2015 and 2016, and Maradi in 2016; Senegal: Bambey and Darou in 2015 and 2016).

Figure 2. Principal Coordinates Analysis (PCoA), estimated from SSR marker data of 19 individual plants each of 17 pearl millet parental populations (01 – 17), originating from Mauritania (yellow), Niger (blue), Nigeria (green), and Senegal (red).

Table 1. Estimated variance components, GCA/SCA ratio, heritabilities, mean and range of absolute values, relative PMPH, as well as correlation of mean GCA and hybrid performance for panicle yield (PYD; g*m^{-2}) over two years with 120 pearl millet hybrids in year one at four locations and 136 at five locations in year two.

	PYD
σ^2_{GCA}	24.17
σ^2_{GCAxL}	0
σ^2_{GCAxY}	0
$\sigma^2_{GCAxLxY}$	381.48***
σ^2_{SCA}	74.65*
σ^2_{SCAxL}	11.59
σ^2_{SCAxY}	40.71
$\sigma^2_{SCAxLxY}$	0
σ^2_{GCA} / $\sigma 2_{SCA}$	0.32
$H^2_{hybrids}$	0.42
$H^2_{parents}$	0.72
Hybrid mean range	198 (129-256)
Parental mean range	145 (84-187)
PMPH %	26 (5-49)
r (mean GCA, HP)	0.58***

*, **, *** Significant at p<0.05, p<0.01, and p<0.001, respectively.

Figure 3. Population hybrid with highest average panicle yield (256 g*m^{-2}) originated from Nigerien 'H80-10Gr' and Senegalese 'Thialack 3'.

- The majority of hybrids showed higher yields than the parents and satisfactory yield stability, with the PMPH ranging from 5 to 49 % (Table 1 & Fig. 1).
- Hybrid performance was more determined by Specific Combining Ability (SCA) than General Combining Ability (GCA) variance, while GxE Interaction variances were large and GxE patterns complex (Table 1 & Fig. 1).
- A Principal Coordinate Analysis (PCoA) based on binary genetic distances confirmed strong admixture among parental populations (Fig. 2)
- SSR-based Nei's Genetic Distance (Nei's D) and SCA, and Nei's D and hybrid performance was uncorrelated (R^2 :-0.07, R^2: 0.05)
- Inter-country crosses mean panicle yield was significantly higher than Intra-country crosses (Niger *vs* Senegal: 205 g*m^{-2}, Niger *vs* Niger &Senegal *vs* Senegal: 195 g*m^{-2}; p<0.001).

Affiliations: [1] University of Hohenheim, Germany; [2] ISRA, Senegal; [3] INRAN, Niger; [4] formerly: ICRISAT, Niger

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*Felix_Sattler@uni-hohenheim.de