Sorghum hybrids - A contribution to future agricultural productivity and food security in West Africa

Moctar Kante[1, @], Fred Rattunde[2], Willmar Leiser[3], Baloua Nébié[4], Bocar Diallo[5], Abdoulaye Diallo[5], Abocar Touré[5], Eva Weltzien[2], Bettina Haussmann[1].

TropenTag, Bonn, September 19-22, 2017

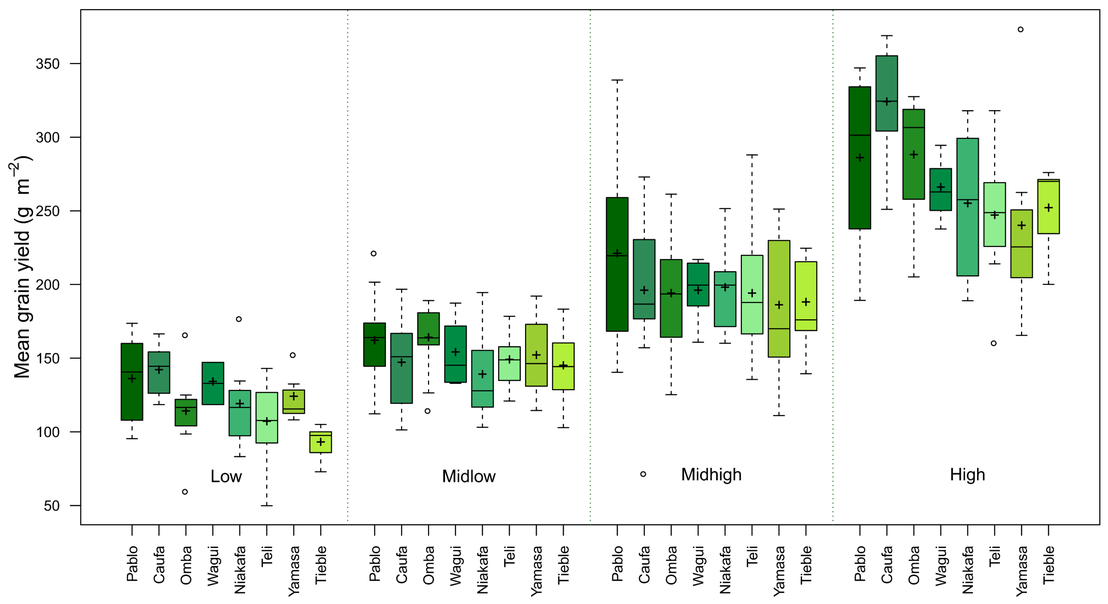
Experimental hybrid: Yield advantages and adoption by farmers

Farmer managed on-farm yield trials*

- Seven tall and eight short experimental sorghum hybrids vs 1 local check (Tieblé) and 14 pure lines.
- 3 Malian zones (Dioila, Koutiala, Mandé).
- 3 Years (2009-2011).
- Environments grouped based on their mean yield.

Table 1: Grain yields of the highest yielding short and tall sorghum hybrids, the local check Tieblé, and the hybrid yield superiority across low, intermediate and high productivity environments in Mali. Pablo and Fadda were the best overall yielding tall and short hybrids, respectively. The "low-" group of tall hybrids includes the low- and midlow- yielding groups of Fig. 1.

		Low	Intermediate	High
Short Hybrid Trials	Number of environments	9	8	10
	Fadda mean yield (g m^{-2})	153	212	284
	Tieble mean yield (g m^{-2})	116	161	217
	Superiority of Fadda over Tieble (%)	32	32	31
Tall Hybrid Trials	Number of environments	18	11	8
	Pablo mean yield (g m^{-2})	148	220	285
	Tieble mean yield (g m^{-2})	119	173	251
	Superiority of Pablo over Tieble (%)	24	27	14



Hybrids and the local check in different productivity groups

Figure 1: Individual trial grain yields (g m^{-2}) of hybrids and the local check 'Tieblé' within different productivity levels.

*Kante et al., 2017; Rattunde et al., 2013

Findings

- Tall and short hybrid yields superior to that of local check Tieblé.
- Larger relative yield superiority of short- (compared to tall-) hybrids over the local check (Table 1).
- Tall hybrid superiority over Tieblé larger in lower input environments (Fig 1).
- Hybrids, an option for farmers to increase yields in both low input as well as intensified production systems.
- Experimental hybrids used in these studies; more grain yield expected with high selection intensity hybrids.

Farmers and sorghum hybrids

- Participative breeding/selection for hybrid development.
- Best yielding experimental hybrids with good grain quality already adopted by farmers; seed demand increasing yearly.
- Adoption rates of 25 to 50% in the villages where the seeds were produced [a].
- Farmers cooperatives produce their own hybrid seeds.
- Capacity of farmer managed seed enterprises is being addressed by several research institutions and projects [b].

Current challenges: Tools for breeders

Sorghum hybrid breeding strategies for low input conditions

Breeding strategies for West African sorghum hybrid development

- 91 males (R lines) and 17 females (A lines).
- 2 different trial sets: female (16 A- and 7 R-lines) and male (3 A- and 89 R-lines) combining ability trials.
- 2 years (2015-2016) in 2 locations (Samanko, Kolombada, both in Mali).
- 2 Phosphorus (P) levels, high P (HP) and low P (LP) per location.

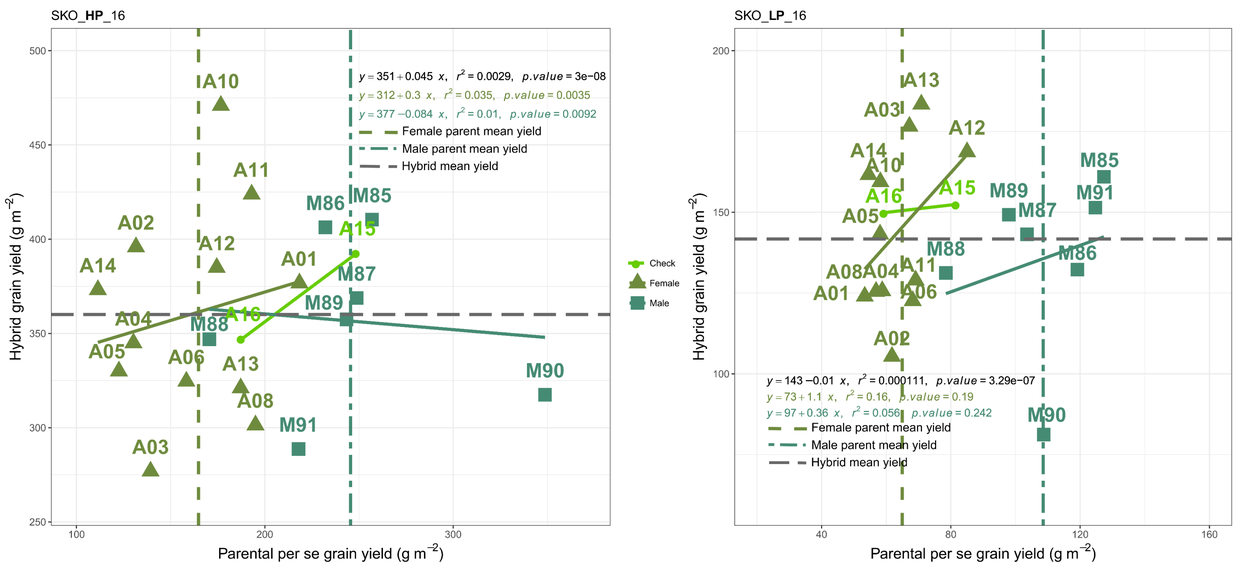


Figure 2: Correlations between parental means and test cross performance in Samanko HP (left) and LP (right) in 2016.

Results

- Moderate correlation between parental means in low- vs high-P conditions (r^2=0.43-0.61 in different locations).
- Low correlation between hybrid means in low- and high-P conditions (r^2=0.06-0.15 in different locations).
- Relatively high correlations of both hybrids and parents for heading date and plant height in different P conditions.
- Weak correlation between mean per se yields and test cross performance (Fig. 2).
- Stronger correlation between per se and test cross performance in LP environments.
- Early generation test cross evaluation essential.
- Female with high yield should be favored for hybrid seed production.

Pollen fertility restoration genes

Fertility restoration (A_1 cytoplasm) gene identification/validation and KASP marker development

- Leaf sampling and seed set visual scoring of 4 F_2 populations (Fig. 3), Samanko (Bamako-Mali) 2015.
- 220 plants per F_2 population.
- GBS-SNP markers.
- Seed from completely fertile F_2 panicles sowed for the validation trial.

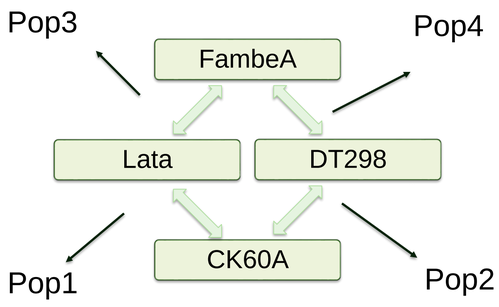


Figure 3: Parents of the four F_2 populations used in the mapping study.

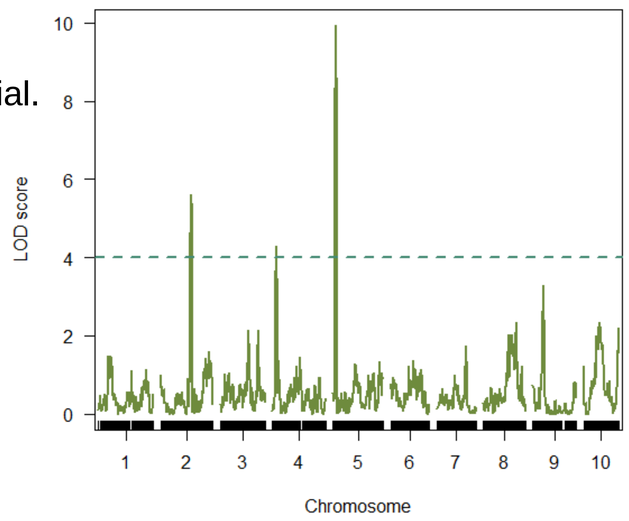


Figure 4: QTL scan of Pop2 (CK60AxDT298) population.

Table 2: QTL with significant LOD score for Pop2, Pop3 and Pop4 populations.

Population	Number of markers	Chr	Position (cM)	LOD	% Var. Explained	Confidence int. (Bayes) (cM)
Pop2	3859	2	109.3	5.3	8.7	103.0-111.0
		5	10.3	10.5	18.9	8.5-15.2
		9	29.8	4.2	6.0	25.0-34.0
Pop3	1574	2	24.6	16.0	31.0	24.0-25.2
Pop4	4119	5	24.0	10.1	17.4	22.0-25.0
		10	114.6	7.5	17.0	112.0-117.0

Results

- 6 main QTL found in Pop2, 3 and 4 populations (Fig. 4, Table 2).
- Same QTL regions found on chromosome 5 in Pop2 and Pop4 (same male parent).
- KASP markers based on SNPs flanking the QTL region on chromosome 2 (Pop3) explained over 80% of the phenotypic variance in a separate F_3 population.
- No common KASP marker existing for Pop2 and Pop4 QTL.

Affiliations: [1]Institute of Plant Breeding, Seed Science and Population Genetics-Univ. of Hohenheim. 70599, Stuttgart-Germany. [2]Univ. Of Wisconsin–Madison, Madison, WI. [3]State Plant Breeding Institute-Hohenheim University. 70599, Stuttgart-Germany. [4] International Crops Research Institute for the Semi-Arid Tropics, BP 320, Bamako, Mali; [5]Institut d'Economie Rurale. BP 262, Bamako-Mali.

Funding: McKnight Foundation, the Bill and Melinda Gates Foundation, Bundesministerium für Wirtschaftliche Zusammenarbeit (BMZ), BMZ-Heterosis Project (ICRISAT Project 13.1432.7-001.00).

References: Kante et al., 2017, doi: 10.2135/cropsci2016.09.0765; Rattunde et al., 2013, doi: 10.2135/cropsci2013.03.0182. a- *Advancing together, highlights from 10 years of CCRP in West Africa*. CCRP and The Mc Knight Foundation book. B-In Seed systems II project objectives. Available at http://ccrp.org/projects/seed-systems-ii

moctar.kante@uni-hohenheim.de