Marker assisted heterotic grouping of Sudanese sorghum landraces

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Introduction

Sorghum (*Sorghum bicolor*) is the basic foodstuff of the Sudanese population. Sudan is one of the most important centers of sorghum diversity and the presumed center of domestication where sorghum ranks first in terms of total acreage (8 mil.ha) and production (4.2 mil.t) with an average yield of 528 kg/ha (FAO, 2005). However, yield per unit area is very low in comparison to the world average (1390 kg/ha). The only released sorghum hybrid variety is susceptible to *Striga* and sensitive to drought stress. Therefore, the development of better adapted hybrids has been projected. The aim of this study was to determine genetically distinct pools based on the utilization of the genetic variability of the Sudanese germplasm for the development of hybrids and open-pollinated varieties.

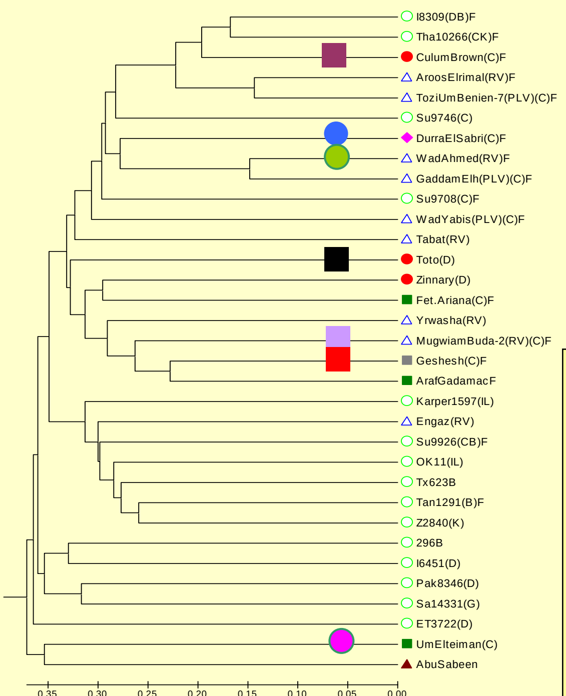

Fig. 1 UPGMA-Dendrogram showing relationships among Sudanese landraces and inbred lines selected for the crosses

Table 1 Observed heterosis (H) in diallel crosses (Exp. 1)

Cross	Cross type	H. (%)
■ x ■	**Inter-group**	132
■ x ■	**Inter-group**	-16
■ x ■	**Inter-group**	-28
■ x ■	Intra-group	-40
■ x ■	Intra-group	-118
■ x ■	Intra-group	-154
● x ●	**Inter-group**	38
● x ●	Intra-group	18
● x ●	**Inter-group**	-64

Results experiment 1

Maximum heterosis was expected from crosses between genetically diverse parents, but our results do not confirm this expectation. However, inter-group crosses showed a tendency to either higher positive or less negative heterosis than intra-group crosses. As molecular markers may only provide useful predictors of heterosis if the markers are tightly linked with loci controlling plant performance, it seems that this requirement was probably not fulfilled in our study.

Fig. 2 Test of fertility restoration in sorghum hybrids

Materials and Methods

Genetic distances, calculated by employing molecular markers (microsatellites) were used as the basis to produce diallel crosses among representatives of genetically different clusters. In addition, 31 landraces and inbred lines were selected for the production of testcrosses with 2 cytoplasmic male sterile (ms) lines derived from different gene pools (Fig. 1). The landraces, inbred lines, and testcrosses were evaluated in regular yield trials at two test sites in Sudan, Wad Medani (irrigated) and Damazin (rainfed) in 2005, while the diallel crosses (in generation F_2) were evaluated at Wad Medani only. Fertility restoration percentage was assessed in the F_1 generation.

Table 2 Performance of the landraces (t/ha grain yield) *per se* and their testcrosses (Exp. 2)

	Wad Medani			Damazin		
Names		Tx623A	IS296A		Tx623A	IS296A
	LR/IL	TC	TC	LR/IL	TC	TC
GESHESH	1.01	1.03	1.21	0.46	0.44	0.54
DURAELS	0.12	0.45	0.13	0.50	0.93	1.01
FETARNA	0.14	1.22	0.55	0.33	0.68	0.82
ABUSABH	1.38	1.64	1.63	0.15	0.47	0.56
UMELTMN	0.73	0.98	0.23	0.33	0.70	0.68
MUGBUDA	0.40	1.83	2.18	0.38	0.55	1.32
WADAHMD	0.28	1.59	0.40	0.80	0.52	0.98
ENGAZSU	0.91	0.61	0.22	0.49	0.47	0.98
AROSELR	0.38	2.00	0.13	0.27	0.41	0.10
TABATOI	0.55	0.91	0.57	0.59	0.32	0.71
GADMELH	0.38	1.43	0.31	0.65	0.69	0.95
TOZIUMB	0.24	1.01	1.61	0.40	0.55	0.89
WADYABS	0.07	0.86	0.40	0.50	0.59	0.92
KAR1597	0.03	0.81 ▲	0.33	0.07	0.20 ▲	0.43
ETH3722	1.01	1.20	0.38	0.07	0.10	0.22
IND8309	1.13	1.42	0.38	0.23	0.75	0.45
PAK8346	0.20	0.19	0.02	0.21	0.17	0.25
SUD9708	1.01	1.09	0.20	0.48	0.72	0.54
SUD9746	0.33	1.94	0.35	0.73	0.62	1.12
TAN1291	0.44	1.02	0.71	0.16	0.42	0.89
Average	0.54	1.16	0.60	0.39	0.52	0.72

LR/IL = Landraces or Inbred Lines; TC = Testcrosses

▲ = Yield of the released hybrid (suitable for irrigation)

Results experiment 3

The fertility restoration percentage was assessed with respect to A_1 (milo) cytoplasm by selfing F_1s. Most of the Sudanese male parental lines produced fertile hybrids i.e. they were restorers. Two hybrids with the ICRISAT tester showed complete sterility across environments (see Fig. 2).

Results experiment 2

The testcrosses performed better than the landraces in the two testing sites. It was observed that most of the experimental hybrids out-yielded the released hybrid. Crosses with tester Tx623A from USA gave on average double the yield at Wad Medani (irrigated) compared to Damazin (rainfed), while crosses with ICRISAT tester (IS296A) gave slightly higher yield at Damazin. This may be due to the better adaptation of IS296A to arid conditions.

Conclusion

Our diversity study based on molecular markers was able to determine the genetic distances between adapted Sudanese sorghum landraces. Results of the field evaluation of crosses between genetically distant (**inter**-group) and similar (**intra**-group) landraces were limited due to experimental problems (low germination, bird damage). Therefore, heterotic groups based on molecular markers could not be verified in the field. However, testcrosses with testers of different adaptation were promising to produce high yielding hybrids, even under rainfed conditions. Sudanese sorghum landraces proved to be effective restorers of fertility in hybrids.