Classification of Sorghum Races in the Southern Africa Sorghum Germplasm

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Abstract

As a component of the characterization of indigenous sorghum germplasm collected in Zimbabwe from the 10 countries of the SADC region, a total of 1217 accessions, from 8 of the 10 countries, were classified for basic and hybrid races. The race classification exercise identified 5 basic races containing 600 accessions, and 10 intermediate hybrid races containing 611 accessions, and a wild group (Drummondii) of 6 accessions only. Both basic and hybrid races were found to be almost equally present in the SADC region's sorghum germplasm.

Introduction

Characterization of germplasm is an important first step, after collection, in the identification and evaluation of indigenous accessions. A significant component of characterization is the classification of the different types of accessions contained in the collection. Within the different types of sorghum accessions in the world, several forms have been identified. These were originally classified into cultivated (31 species) and related wild species (17 species) (Snowden 1936; 1955).

The various groups of sorghum and their distribution were further described by de Wet et al. (1970). It was not until later that a method of classification of the cultivated sorghums was developed by Harlan and de Wet (1972). They divided the cultivated sorghums (subspecies *bicolor*), into five basic races: Bicolor (B), Guinea (G), Caudatum (C), Kafir (K), and Durra (D); and 10 hybrid races which are com-

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binations, and really stable intermediate hybrids, of the basic races. These include Guinea-Bicolor (GB), Guinea-Caudatum (GC), Guinea-Kafir (GK), Guinea-Durra (GD), Caudatum-Bicolor (CB), Kafir-Bicolor (KB), Kafir-Caudatum (KC), Kafir-Durra (KD), Durra-Bicolor (DB), and Durra-Caudatum (DC). Harlan and de Wet (1972) used mature spikelet types for their classification.

Several reasons can be adduced for classifying cultivated sorghums into races. The most important of these are based on the uses to which the information derived is put. These include:

- identification of sources of such desirable traits as disease, pest, and drought resistance;
- identification of adaptation zones;
- forms of productivity and stability among diverse genotypes;
- local knowledge and farmer paradigms in sorghum cultivation; and
- better understanding and use of relationships among species, and genotypes within species, to improve the crop.

To achieve the above, and for purposes of conservation, ICRISAT, NARS of the 10 countries of SADC, and IPGRI, have collected and assembled 3010 sorghum germplasm accessions from the region (Mengesha and Appa Rao 1990). Out of these, 2234 are kept at SADC/ICRISAT SMIP at Matopos, Bulawayo, as a working collection. Some of these have been categorized with passport data (Appa Rao and Mushonga 1987), but not characterized and evaluated in detail.

Materials and Methods

A set of 1217 sorghum accessions, out of the 2234 that constitute sorghum germplasm from the SADC region, were sown, as a germplasm characterization exercise, at Aisleby and Muzarabani in the 1988/89 and 1992/93 crop seasons (the latter for Namibian germplasm only). Two replications were used in each location. These accessions were part of the total working collection of 12 343 cultivated sorghum germplasm accessions from all over the world that are being conserved at Matopos. They also represent germplasm from eight SADC countries: Angola, Botswana, Lesotho, Malawi, Namibia, Swaziland, Tanzania, and Zimbabwe.

Observations were recorded from two-row plots for 13 descriptors as described in 'Revised Sorghum Descriptors' (IBPGR and ICRISAT 1984). However, for the purposes of this study, only three of the descriptors, namely head shape, grain covering, and grain shape, were used in classifying the accessions into race groups.

At harvest, two head samples per accession were closely observed before threshing for their shape, the covering of the grain by glumes, and the shape of the grains. Observations were recorded for each accession in each replication at Aisleby and Muzarabani. The data were processed with simple analysis of variance, and for primary statistical parameters.

Results and Discussion

Total numbers and percentages for the different basic and intermediate hybrid races of sorghum for each of the eight SADC countries are shown in Table 1. There were no observed variations in head shape, glume covering, and grain shape of the 1217 germplasm accessions—an indication of the stability of these three descriptors with no environmental effect on their expression.

In the germplasm accessions classified (Table 1), all the five basic races—Bicolor (B), Guinea (G), Caudatum (C), Kafir (K) and Durra (D)—and the 10 hybrid races—DC, GB, CB, KB, DB, GC, GK, GD, KC, and KD—described earlier by Harlan and de Wet (1972), were identified, based on their classification method, using mature spikelets, and combined with classes of head and grain shapes.

Among the basic races Guinea was most abundant (276), followed by Kafir (132), Caudatum (118), and Durra (61). Bicolor was least-abundant with only 11 out of the 1217 accessions classified. Interestingly, among the intermediate hybrid races, this least-abundant basic race combined in nature with one of the abundant races to form a stable natural hybrid, CB (Caudatum-Bicolor). This race, with 149 accessions, was next to the most abundant intermediate race GC, which had 187 accessions. The third most abundant of the hybrids was DC with 124 accessions. These results are of significance for the relative importance of the races, and their combining abilities in crop improvement. Caudatum, with a frequency of only about 10.0%, was recorded as the best natural combiner. It produces, in nature, stable hybrids with three other races, G, B, and D, and forms the most abundant hybrid races in the region. These Caudatum hybrid races occur with 15.4% (GC), 12.3% (CB), and 10.2% (DC) frequencies, relative to the remaining seven races that range from 0.6% (KB) to 3.7% (KD). The Kafir race has the least ability to combine with other races in nature, as indicated from the relative frequencies (percentages) of occurrence of the intermediate hybrid races.

A wild and weedy sorghum group, Drummondii (DR), appeared in the germplasm only from Angola and Namibia, both with only six accessions (0.5% of the total). It tends to be important in Angola due to its relative frequency of 20.0% in the country's very small germplasm collection. The weedy form might have resulted from a crossing of cultivated and wild sorghum as suggested by de Wet et al. (1970).

Table 1 presents the significant differences in the relative frequencies and distribution of sorghum germplasm in southern Africa. Interestingly, Kafir, which is absent from western Africa and restricted more to eastern and southern Africa (de Wet 1972), was found in only five of the eight countries studied. Except for Namibia, where it is only 2.3% of the accessions, it is fairly abundant in Botswana (17.0%), Lesotho (13.8%), Swaziland (28.0%), and Zimbabwe (16.2%).

Another interesting observation in this study is the appearance of Durra in significant proportions in Botswana (20.0%) and Namibia (14.7%). This is a new, important finding. In the description by de Wet et al. (1970), the Durra sorghums were restricted to western Africa and eastern Africa above latitude 5°S. The finding of Caudatum (21.7%) and Durra-Caudatum (20.9%) in Namibian sorghum germplasm is also new to the distribution presented by de Wet et al. (1970), and possibly not

Table 1. Classification of sorghum germplasm from southern Africa into basic and intermediate hybrid races for eight SADC countries.

	Basic races					Intermediate hybrid races[1]										
Country	Bicolor B	Guinea G	Caudatum C	Kafir K	Durra D	DC	GB	CB	KB	DB	GC	GK	GD	KC	KD	DR
Angola	6	1	1	-	1	-	-	3	-	-	2	-	-	-	-	4
	(30)[2]	(5.0)	(5.0)	-	(5.0)	-	-	(15.0)	-	-	(10.0)	-	-	-	-	(20.0)
Botswana	-	11	4	17	20	14	2	8	-	3	5	1	-	3	12	-
	-	(11.0)	(4.0)	(17.0)	(20.0)	(14.0)	(2.0)	(8.0)	-	(3.0)	(5.0)	(1.0)	-	(3.0)	(12.0)	-
Lesotho	-	1	2	15	1	20	1	29	5	2	28	1	-	4	-	-
	-	(0.9)	(1.8)	(13.8)	(0.9)	(18.3)	(0.9)	(26.6)	(4.6)	(1.8)	(25.7)	(0.9)	-	(3.7)	-	-
Malawi	3	153	10	-	1	4	11	5	-	1	32	-	9	-	-	-
	(1.3)	(66.8)	(4.4)	-	(0.4)	(1.7)	(4.8)	(2.2)	-	(0.4)	(14.0)	-	(3.9)	-	-	-
Namibia	-	7	28	3	19	27	-	-	-	-	22	5	2	5	3	2
	-	(5.4)	(21.7)	(2.3)	(14.7)	(20.9)	-	-	-	-	(17.1)	(3.9)	(1.6)	(3.9)	(2.3)	(1.6)
Swaziland	-	1	3	12	-	1	8	11	-	1	4	-	-	1	1	-
	-	(2.3)	(7.0)	(28.0)	-	(2.3)	(18.6)	(25.6)	-	(2.3)	(9.3)	-	-	(2.3)	(2.3)	-
Tanzania	-	17	12	-	4	3	3	2	1	2	21	-	2	-	-	-
	-	(25.0)	(17.6)	-	(5.9)	(4.4)	(4.4)	(2.9)	(1.5)	(2.9)	(30.9)	-	(2.9)	-	-	-
Zimbabwe	2	85	58	85	15	55	3	91	1	11	73	5	5	8	29	-
	(0.4)	(16.2)	(11.0)	(16.2)	(2.9)	(10.5)	(0.6)	(17.3)	(0.2)	(2.1)	(13.9)	(0.9)	(1.0)	(1.5)	(5.4)	-
Total	11	276	118	132	61	124	28	149	7	20	187	12	18	21	45	6
	(0.9)	(22.7)	(9.7)	(10.9)	(5.0)	(10.2)	(2.3)	(12.3)	(0.6)	(1.6)	(15.4)	(1.0)	(1.5)	(1.7)	(3.7)	(0.5)

1. Hybrid races are combinations of the basic races.
2. Numbers in parentheses are percentages.

hitherto recorded by any other study. With the abundance in Namibia of the two hybrid races, GC and DC, it can be hypothesized that the country could be an area of natural hybridization of Caudatum and Durra followed by their diversification into intermediate hybrid races. This phenomenon could be useful when parents are chosen for crop improvement in the SADC region, generally, and Namibia, specifically.

Bicolor is almost absent from southern Africa, except for Angola where 30.0% of the accessions are Bicolor types. This is in line with the distribution of cultivated sorghums given by de Wet et al. (1970).

Malawi is predominantly a Guinea-sorghum country (67% G, 14% GC). Tanzania (25.0%), Zimbabwe (16.2%), and Botswana (11.0%) follow in the importance of Guinea in their sorghum germplasm. Frequencies to those in Malawi were recorded in Nigeria for Guinea sorghums (Prasada Rao et al. 1985).

Figure 1 shows the distribution of sorghum races with average rainfall for the eight SADC countries studied. From the frequencies of sorghum-race distribution, it is observed that in Tanzania, Malawi, and Angola (countries between latitudes 2 and 17°S, and with high average annual rainfall between 809 and 1320 mm), basic sorghum races were equally or more frequently observed than hybrid races. In contrast, in Namibia, Zimbabwe, Botswana, Swaziland, and Lesotho (countries further away

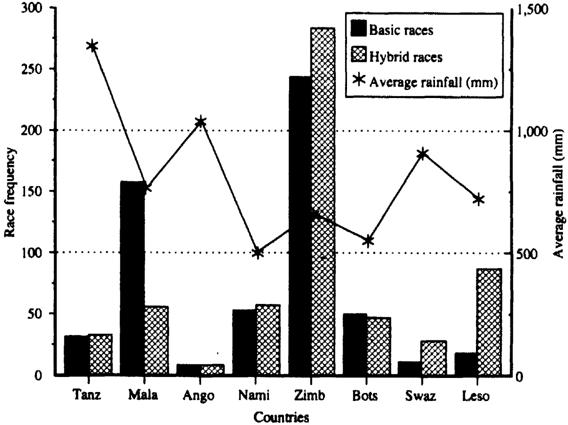

Figure 1. Distribution of sorghum races with average annual rainfall for eight SADC countries.

from the equator, between latitudes 17 and 32°S, and with lower average annual rainfall of 500–900 mm), hybrid sorghum races were more, or as frequently, observed as the basic races.

Using the analysis of patterns of allozyme variation in wild and cultivated sorghum, Aldrich et al. (1992) characterized the geographic distribution of genetic diversity in both sorghum types. Their analysis showed that levels of genetic diversity are greater in wild sorghum than in cultivated sorghum, although variability within the cultivated sorghums was more than in wild sorghums, according to de Wet et al. (1970). In using allozyme analysis for crop improvement, it would be necessary to study the correspondence between Guinea and Caudatum of southern Africa and those of western Africa. The expected results would facilitate sorghum breeders to capitalize on genetic diversity and variability across the two regions.

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