Sorghum Research Reports

Germplasm

Geographic Distribution of Basic and Intermediate Races in the World Collection of Sorghum Germplasm

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Sorghum [*Sorghum bicolor* (L.) Moench] is of tropical origin, but it has also been adapted through selection to temperate regions. It is the staple food of many people in Africa, Asia and is a major feed crop in Argentina, Australia, Mexico, South Africa and the USA. It was probably domesticated in northeastern Africa, in an area extending from the Ethiopian-Sudanense border to Chad (Doggett 1970; de Wet et al. 1976). From this area, it spread to India, China, the Middle East, and Europe.

Sorghum is an immensely variable genus and is subdivided into five sections *Chaetosorghum, Heterosorghum, Parasorghum, Stiposorghum and Sorghum* (de Wet 1978). The sorghum section includes cultivated grain sorghum, a complex of closely related annual taxa from Africa, and a complex of perennial taxa from southern Europe and Asia. The range of genetic variability available in cultivated races and their wild relatives is extensive, and the extreme types are so different as to appear to be separate species (Prasada Rao and Mengesha 1988). Although collection and conservation of genetic resources of sorghum attracted the attention of botanists and breeders about three decades ago, they have become increasingly important in recent years due to the replacement of many landraces with genetically uniform varieties and hybrids, and the large-scale destruction of natural habitats of wild and weedy relatives by urbanization and industrialization (Prasada Rao and Ramanatha Rao 1995).

The genebank at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) currently conserves 36,774 accessions assembled from 90 countries (Table 1). As and when received, new sorghum germplasm accessions characterized for 23 morphological and agronomic traits during postrainy seasons at ICRISAT, Patancheru, India between 1974 and 2002. Following Harlan and de Wet (1972), and based on the inflorescence and spikelet characters that are most stable and least influenced by the environment, the germplasm accessions maintained at ICRISAT are classified into five basic races; Bicolor, Guinea, Caudatum, Kafir, and Durra and ten intermediate races; Guinea-bicolor, Caudatum-bicolor, Kafir-bicolor, Durra-bicolor, Guinea-caudatum, Guinea-kafir, Guinea-durra, Kafir-caudatum, Durra-caudatum, and Kafir-durra. These races have the following characteristics:

Bicolor: grain elongate, sometimes slightly obovate, nearly symmetrical dorso-ventrally; glumes clasping the grain, which may be completely covered or exposed as much as ¼ of its length at the tip.

Guinea: grain flattened dorso-ventrally, sublenticular in outlilne, twisting at maturity nearly 90 degrees between gaping involute glumes that are from nearly as long to longer than the grain.

Caudatum: grain markedly asymmetrical, the side next to the lower glume flat or in extreme cases even somewhat cancave, the opposite side rounded and bulging: the persistent style often at the tip of a beak pointing toward the lower glume; glumes of the length of grain or less.

Kafir: grain approximately symmetrical, more or less spherical: glumes clasping and variable in length.

Durra: grain rounded obovate, wedge-shaped at the base and broadest slightly above the middle; glumes very wide, the tip of a different texture from the base and often with a transverse crease across the middle.

Table 1. Proportion of various races and intermediate races based on 35652 sorghum germplasm accessions in ICRISAT genebank

Races/Intermediate races	Number of accessions	%
Bicolor	1443	4.05
Caudatum	7448	20.89
Caudatum-bicolor	1416	3.97
Durra	7788	21.84
Durra-bicolor	2336	6.55
Durra-caudatum	4304	12.07
Guinea	4781	13.41
Guinea-bicolor	333	0.93
Guinea-caudatum	3388	9.50
Guinea-durra	219	0.61
Guinea-kafir	106	0.30
Kafir	1274	3.57
Kafir-bicolor	136	0.38
Kafir-caudatum	404	1.13
Kafir-durra	276	0.77
Total	35652	100.00

In general, race Bicolor includes primitive forage sorghums with sweet stems. Kafir sorghums provide important staple food across the eastern and southern savanna from Tanzania to South Africa. Most commercially important male-sterile lines are derived from Kafir landraces as they are insensitive to photoperiod, a relatively unusual trait. Guinea sorghums are the oldest specialized group, which are mostly photoperiod sensitive, resistant to grain mold, and grown primarily in West Africa. Caudatum sorghums are of most recent origin, and are used for brewing traditional opaque beers in East African countries. Durra and Caudatum sorghums are widely used in crop improvement programs in Asia and Kafir in Southern Africa. Most of the present-day cultivars under cultivation in tropical countries are derived from Caudatum landraces. In this paper, we summarized the composition of the germplasm maintained at ICRISAT, and the distribution of its component races and intermediate races across various countries in the world.

The collection assembled at ICRISAT is predominantly represented by the basic races; Durra (21.8%), Caudatum (20.9%,), and Guinea (13.4%). Among the intermediate races, Durra-caudatum (12.1%), Guinea-caudatum (9.5%), and Durra-bicolor (6.6%) are represented (Table 1). Although ICRISAT's sorghum germplasm collection originated from 90 countries, for the purpose of this analysis, only countries where the number of accessions were 100 or more were considered. The analysis revealed that three countries namely; India, Uganda, and Zimbabwe are represented by all the five basic and ten intermediate races. USA, Zambia, and India

Table 2. Countrywise distribution of sorghum races and intermediate races

Country	B[1]	C	CB	D	DB	DC	G	GB	GC	GD	GK	K	KB	KC	KD	Total
Benin	1		2	1		2	184	4	3							197
Burkina Faso	7	4	9	23	5	7	414	5	68	2						544
Burundi		107	3	4	1	3	3	2	12						1	136
Cameroon	11	1313	34	364	20	275	202	37	219	2						2477
China	21	231	152	9	16	85	1	5	41		1	7	31	17	6	623
Ethiopia	149	401	125	1870	1063	457	15	10	191	10		6	2	3	10	4312
India	344	142	113	3575	543	380	773	25	144	56	1	12	10	6	34	6158
Kenya	26	748	27	5	6	38	10	1	103	2		1		1		968
Lebanon	18	30	51	23	13	142	2	2	36	12		17		12	2	360
Lesotho	4	8	7	1	1	2	1		63		9	103	4	60	6	269
Malawi	5	19	13	5	1	8	258	19	59	13				1		401
Mali	13	26	11	70	35	42	473	8	14	1				1		694
Niger	14	32	51	63	43	100	34	6	62	3						408
Nigeria	34	231	60	63	52	265	657	97	186	17		4	3	5	1	1675
Rwanda	2	220	1	44	1	19			2	1						290
Senegal	3	2	6	10	2	5	190	2	19							239
Sierra Leone							107									107
Somalia		11		424	I	3			2							441
South Africa	25	189	63	14	3	24	22	2	23		2	455	9	49	22	902
Sudan	83	992	124	228	47	310	42	10	510	27		23	11	39	2	2448
Tanzania	12	106	16	50	5	17	373	9	96	7		2	2	4		699
Togo	3	9	4	11	1	1	244	4	17							294
Uganda	38	1269	34	15	14	42	34	3	227	2	2	20	3	6	11	1720
USA	321	317	156	139	49	267	69	21	177	12	64	235	42	110	70	2049
Yemen	11	121	32	330	221	1339	1	1	90	8		2		1	5	2162
Zambia	22	52	50	3	1	10	86	6	128	1				1	1	361
Zimbabwe	13	238	68	74	10	110	256	10	535	19	10	149	3	27	45	1567
Total	1180	6818	1212	7418	2154	3953	4451	289	3027	195	89	1036	120	343	216	32501

1. B=Bicolor; C=Caudatum; CB=Caudatum-bicolor; D=Durra; DB=Durra-bicolor; DC=Durra-caudatum; G=Guinea; GB=Guinea-bicolor; GC=Guinea-caudatum; GD= Guinea-durra; GK=Guinea-kafir; K=Kafir; KB= Kafir-bicolor; KC=Kafir-caudatum; KD=Kafir-durra

are dominated by race Bicolor; West African countries including Sierra-Leone, Benin, Togo, Senegal, Burkina Faso, Mali, Malawi, and Tanzania by Guinea; East African countries by Caudatum; the southern African countries South Africa, Lesotho, Zimbabwe by Kafir; and Somalia, India and Ethiopia by Durra. Among the intermediate races, the majority of the Caudatum-bicolor accessions are from China, Lebanon, Zambia, and Niger; Durra-bicolor form Ethiopia, Niger, Yemen, and India; Durra-caudatum from Yemen, Lebanon, Niger, Nigeria, China, USA, Sudan, Cameroon, Ethiopia, and Zimbabwe; Guinea-caudatum from Zambia, Zimbabwe, Lesotho, Sudan, Niger, Malawi, Tanzania, Uganda, Burkina Faso, and Nigeria, and Kafir-caudatum from Lesotho, and South Africa (Table 2).

Natural selection for adaptation to environment and farmer's preference for specific uses or specific cropping systems is known to have accounted for most of the morpho-agronomic diversity in crops. This analysis reveals that racial divergence in sorghum is related to geographic origin and this enables breeders to narrow down their search to meet breeding objectives and germplasm collectors to target specific geographic areas for specific **races.**

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Sorghum Germplasm Collection from Drought-Prone Areas of Southern Maharashtra

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Introduction

Sorghum (*Sorghum bicolor* (L.) Moench], the second largest grain crop in India until the Green Revolution, presently occupies the third place in terms of area sown and fifth place in production amongst the food grains. Postrainy-season (*rabi*) sorghum is unique to India in that it is grown on residual soil moisture. It is a major cereal of the drought-prone areas and is grown over 5.89 million hectares, primarily in the states of Maharashtra, Kamataka, and Andhra Pradesh. Postrainy-season sorghum is a major source of food and fodder and an important component of the dryland economy of these states, particularly in Maharashtra, where 75% of the total area cultivated in the postrainy season is under this crop. The major constraints restricting yield improvement are drought on medium-to-shallow soils, shoot fly *(Atheri-gona soccata* Rondani), charcoal rot (*Macrophomina phaseolina* (Tassi) G Goid) and cold. The present exploration was undertaken to collect germplasm in the drought-prone areas of Maharashtra, so that it could be used in breeding programs for resistance to both biotic and abiotic stresses.

Materials and methods

The National Research Centre for Sorghum (NRCS), being the National Active Germplasm Site (NAGS) for sorghum, has been identified to explore, collect, characterize and evaluate sorghum germplasm under the National Agricultural Technology Project (NATP) on Rainfed Nutri-tious Production System 10 **(RNPS-10).** The NRCS has previously undertaken explorations in the drought-prone areas of Maharashtra to collect diverse sorghum germ-plasm. This exploration was undertaken to supplement the previous collections of Gopal Reddy et al. (1993; 1996) and Elangovan and Prabhakar (2001). Previous collectors observed that there was considerable variability in post-rainy-season sorghum in Maharashtra where missions targeted the districts of Buldana, Jalgaon, **Dhule, Aurangabad, Jalna, Parbhani,** Beed, Satara **and**