Characterization of ICRISAT-bred sorghum restorer lines[1]

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Introduction

Increased demand for food triggered by the fast-growing human population, the need to sustain biodiversity, and the spurt in investments in agricultural research by private sector have resulted in seeking the Intellectual Property Rights (IPR) for the valuable research products. This has led to the introduction of plant variety protection legislations across the world particularly in European countries and in the USA. International efforts to harmonize the IPRs across countries to improve trade has led to various conventions [including Union Pour la Protection des Obtentions Végétales (UPOV) 1991] leading to the establishment of guidelines on Plant Breeder's Rights (PBRs). This was followed by Uruguay round of deliberations resulting in Trade Related Intellectual Property (TRIPs) rights in 1995. The Article 27.3 (b) of TRIPs agreement makes it mandatory for the member countries to provide protection for plant varieties either by patents, by an effective *sui-generis* system, or any combination thereof for effective protection of intellectual property. The Government of India enacted a Protection of Plant Varieties and Farmers Rights (PPV&FR) act during 2001, and consequently National Plant Authority has been established to facilitate the registration of plant varieties.

The "Protection of Plant Varieties (PPV) Act" in general, requires registration of plant varieties/hybrids, for which protection is sought. The four essential parameters for granting protection to varieties/hybrids are: **N**ovelty (N), **D**istinctiveness (D), **U**niformity (U) and **S**tability (S). A variety is deemed to be **N**ovel if it is not known publicly previously or commercially exploited prior to a specific period at the time of seeking protection under the act. **D**istinctiveness refers to the specific characters of the variety that differentiates it from the other varieties. **U**niformity indicates the absence of intra-genotypic differences within a variety rendering it to be uniform. **S**tability denotes the consistent performance of the variety for the trait(s) when tested across seasons and locations. For granting protection to any new variety/ hybrid under the PPV act, testing for the three parameters, D, U and S is essential and it is designated as the DUS-testing procedure.

The DUS-testing procedure depends on the crops and their economic importance in various countries or various geographic regions within the countries. In India, the Indian Council of Agricultural Research (ICAR) is the nodal agency for developing the DUS-test guidelines. National Test Guidelines have been developed for 35 crops including sorghum. Directorate of Sorghum Research (DSR), Hyderabad, India, has developed the DUS-test guidelines for sorghum in consultation with sorghum scientists in India (Table 1).

The Consultative Group on International Agricultural Research (CGIAR) established in 1971 to contribute to food security in developing countries, has a global mandate of conserving the plant genetic resources (PGR) of mandate crops, and their improvement for adaptation to targeted geographic regions. The enactment of *sui-generis* Protection of Plant Varieties Acts in several countries will have significant implications on the nature of International Public Goods (IPGs) (including improved varieties, breeding lines, and hybrid parents) developed by CGIAR centers. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) established in 1972 has the responsibility of conserving genetic resources and developing improved breeding products of sorghum, pearl millet, chickpea, pigeonpea, and groundnut. ICRISAT has to ensure that its improved

1. Besides the authors, several other scientists [LR House (late), JW Stenhouse, SZ Mukuru (Late), KV Ramaiah, MJ Vasudeva Rao, BL Agarwal, DS Murty, Bholanath Verma, H Doggett, R Bandyopadhyay, KF Nwanze, SL Taneja, K Leuschner R, Jambunathan, SD Singh, LK Mughogho, and Suresh Pande] have contributed to the development of the sorghum hybrid parents at ICRISAT.

Table 1. Description of characters and type of measurements in sorghum as per DUS-test guidelines for sorghum[1].

Sl. No.	Characteristics	States	Node[2]	Stage of observation	Type of assessment[3]
1	Seedling : anthocyanin coloration of coleoptile	green	1	seedling	VS
		purple	2		
2	Leaf sheath: anthocyanin coloration	tan	1	5 leaf	VS
		red	2		
		purple	3		
3[4]	Leaf : midrib color (5th fully developed leaf)	white	1	5 leaf	VS
		dull green	2		
		yellow	3		
		brown	4		
		purple	5		
4 (*)	Plant: time of panicle emergence (50% of the plants with complete panicle emergence)	very early (<56 days)	1	panicle emergence	VG
		early (56–65 days)	3		
		medium (66–75 days)	5		
		late (76–85 days)	7		
		very late (>85 days)	9		
5	Plant: natural height of foliage up to the base of flag leaf	very short (<76 cm)	1	panicle emergence	MS
		short (76–150 cm)	3		
		medium (151–225 cm)	5		
		tall (226–300 cm)	7		
		very tall (>300 cm)	9		
6 (*)	Flag leaf: extension of discoloration of midrib	absent or very weak	1	panicle emergence	VG
		weak	3		
		medium	5		
		strong	7		
		very strong	9		
7 (*)	Flag leaf: intensity of green coloration of midrib compared to blade (if not discolored)	paler	1	panicle emergence	VG
		same color	2		
		darker	3		
8 (*)	Flag leaf: yellow coloration of midrib	absent or weak	1	panicle emergence	VS
		medium	5		
		strong	9		
9	Glume: anthocyanin coloration of pubescence (a covering of soft and short hair)	absent or weak	1	flowering	VS
		medium	5		
		strong	7		
10 (*)[4]	Lemma: arista formation	absent or weak	1	flowering	VS
		medium	5		
		strong	9		
11 (*)	Stigma: anthocyanin coloration	absent or weak	1	flowering	VS
		medium	5		
		strong	9		
12 (*)	Stigma: yellow coloration	absent or weak	1	flowering	VS
		medium	5		
		strong	7		
13	Stigma: length	short	3	flowering	MS
		medium	5		
		long	9		
14	Flower with pedicel: length of flower	very short	1	flowering	MS
		short	3		
		medium	5		
		long	7		
		very long	9		
15	Anther: length	short	3	flowering	MS
		medium	5		
		long	7		
16[4]	Anther: color of dry anther	yellow	1	end of flowering	VG
		pink grey	2		
		dark yellow	3		
		orange	4		
		red	5		

contd.

Table 1. (contd.)

Sl. No.	Characteristics	States	Node[2]	Stage of observation	Type of assessment
17 (*)	Glume : color	green	1	physiological maturity	VG
		straw	2		
		brown	3		
		light red	4		
		red	5		
		yellow	6		
		purple	7		
		black	8		
18(*)	Plant: height	very short (<76 cm)	1	maturity	MS
		short (76–150 cm)	3		
		medium (151–225 cm)	5		
		long (226–300 cm)	7		
		very long (>300 cm)	9		
19	Stem : diameter (at lower one third height of plant)	small (<2 cm)	3	maturity	MS
		medium (2–4 cm)	5		
		large (>4 cm)	7		
20	Stalk : juiciness	juicy	1	maturity	
		dry	2		
21[4]	Stalk : sweetness	sweet	1	maturity	
		insipid	2		
22	Leaf: length of blade of the third leaf from top	short (< 41 cm)	3	maturity	MS
		medium (41–60 cm)	5		
		long (61–80 cm)	7		
		very long (>80 cm)	9		
23	Leaf: width of blade of the third leaf from top	narrow (<4.1 cm)	3	maturity	MS
		medium (4.1–6.0 cm)	5		
		broad (6.1–8.0 cm)	7		
		very broad (>8.0 cm)	9		
24	Panicle : length without peduncle	very short (<11 cm)	1	maturity	MS
		short (11–20 cm)	3		
		medium (21–30 cm)	5		
		long (31–40 cm)	7		
		very long (>40 cm)	9		
25	Panicle : length of branches (middle third of panicle)	short (<5.1 cm)	3	maturity	MS
		medium (5.1–10 cm)	5		
		long (10.1–15 cm)	7		
		very long (>15 cm)	9		
26 (*)	Panicle : density at maturity (ear head compactness)	very loose	1	maturity	VG
		loose	3		
		semi loose	5		
		semi compact	7		
		compact	9		
27 (*)	Panicle : shape	reversed pyramid	1	maturity	VG
		panicle broader in upper part	2		
		symmetric	3		
		panicle broader in lower part	4		
		pyramidal	5		
28 (*)	Neck of panicle : visible length above sheath	absent or very short (<5.1 cm)	1		
		short (5.1–10 cm)	3		
		medium (10.1–15 cm)	5		
		long (15.1–20 cm)	7		
		very long (>20cm)	9	maturity	MS
29	Glume length	very short (25% of grain covered)	1	maturity	MS
		short (50% of grain covered)	3		
		medium (75% of grain covered)	5		
		long (100% of grain covered)	7		
		very long (longer than the grain)	9		

contd.

Table 1. (contd.)

Sl. No.	Characteristics	States	Node[2]	Stage of observation	Type of assessment
30	Shattering	low	3	maturity	VG
		medium	5		
		high	7		
31	Threshability	freely threshable (<11% unthreshed grain)	1	maturity	VG
		partly threshable (11–50% unthreshed grain)	5		
		difficult to thresh (>50% unthreshed grain)	7		
32	Grain : form	Single	1	maturity	VS
		Twin	2		
33 (*)[4]	Caryopsis: color after threshing	white	1	after threshing	VG
		chalky white	2		
		pearly white	3		
		yellow	4		
		red	5		
		light brown	6		
		dark brown	7		
34	Grain : weight of 1000 grains	very low (<16 g)	1	after threshing	MG
		low (16–25 g)	3		
		medium (26–35 g)	5		
		high (36–45 g)	7		
		very high (>45 g)	9		
35	Grain: shape in dorsal view	narrow elliptic	1	after threshing	VG
		elliptic	2		
		circular	3		
36	Grain: shape in profile view	narrow elliptic	1	after threshing	VG
		elliptic	2		
		circular	3		
37	Grain: size of mark of germ	very small	1	after threshing	VG
		small	3		
		medium	5		
		large	7		
		very large	9		
38	Grain: tannin content	absent or very low	1		
		low	3		
		medium	5		
		high	7		
		very high	9	after threshing	MG
39	Grain: texture of endosperm (in longitudinal section)	fully vitreous (100% corneous)	1	after threshing	VG
		¾ vitreous (75% corneous)	3		
		half vitreous (50% corneous)	5		
		¾ farinaceous (25% corneous)	7		
		fully farinaceous (0% corneous)	9		
40[4]	Grain: color of vitreous albumen	white	1	after threshing	VG
		pale yellow	2		
		yellow	3		
		orange	4		

contd.

Table 1. (contd.)

Sl. No.	Characteristics	States	Node[2]	Stage of observation	Type of assessment
41	Grain : lustre	non-lustrous	1	after threshing	VG
		medium	5		
		lustrous	7		

* Characteristics that should be observed every growing season for examination of all lines and should always be included in the description of the material, except when the state of expression of a preceding characteristic or regional environmental conditions render this impossible.
[1]Adopted from D (Distinctiveness), U (Uniformity), S (Stability) testing guidelines of Indian Council of Agricultural Research (ICAR), New Delhi, India.
[2]Nodes (1 to 9) are for the purpose of electronic data processing.
[3]Type of assessment of characteristics
MG : Measurement by a single observation of a group of plants or parts of plants.
MS : Measurement of a number of individual plants or plant parts.
VG : Visual assessment by single observation of a group of plants or plant parts.
VS : Visual assessment by observation of individual plants or plant parts.
[4]Observation deviated presented in the following Table.

List of observations deviated from the DUS-test guidelines for sorghum.

Sl. No.	Characteristics	DUS-testing		ICRISAT	
		States	Node	States	Node
3	Leaf : midrib color (5th fully developed leaf)	white	1	brown	1
		dull green	2	green	2
		yellow	3	white	3
		brown	4		
		purple	5		
10 (*)	Lemma: arista formation	absent or weak	1	absent or weak	1
		medium	5	short	3
		strong	9	medium	5
				Long	9
16	Anther: color of dry anther	yellow	1	yellow	1
		pink grey	2	pink grey	2
		dark yellow	3	dark yellow	3
		orange	4	orange	4
		red	5	red	5
				light orange	6
				dark orange	7
21	Stalk: Sweetness	sweet	1	Brix reading (%)	
		insipid	2		
33	Caryopsis: color after threshing	white	1	white	1
		chalky white	2	chalky white	2
		pearly white	3	pearly white	3
		yellow	4	light yellow/yellow	4
		red	5	red	5
		light brown	6	light brown/brown	6
		dark brown	7	dark brown	7
				cream	8
				light red	9
40	Grain: color of vitreous albumen	White	1	White	1
		pale yellow	2	pale yellow	2
		yellow	3	yellow	3
		orange	4	purple	4

For characteristics 4, 5, 18, 19, 21 to 25, 28, 29 and 34 actual values are presented in Tables instead of node values.

Table 2. Pedigrees of ICRISAT-bred designated sorghum R-lines characterized at ICRISAT, Patancheru, India as per DUS[1] test guidelines.

S. No.	Designation	Pedigree
High-yielding (medium-maturity) sorghum R-lines		
1	ICSR 144	(FLR 266 × CSV 4)-2-2-2-3-2
2	ICSR 21001	(ICSP2B/R MFR S2-407-1 × E 36-1)3-3-2-2-2
3	ICSR 21002	(ICSV 575 × S 53-1 × ICSP2B/R MFR-S2 Bulk 7} × ICSB 6}1-1-1
4	ICSR 21008	(E 36-1 × ICSB 17)12-1-3
5	ICSR 21009	(E 36-1 × ICSB 17)12-3-1
6	ICSR 21010	(E 36-1 × ICSB 17)12-3-2
7	ICSR 21011	(E 36-1 × ICSB 17)12-3-3
8	ICSR 21012	(ICSB2B/R MFRS2-407-1 × E 36-1)3-3-2-1-1-1
9	ICSR 24001	[(Pearl unknown#35×ICSR 124)-1-1-1-3-1-1-1×ICSB 79]-5-1-2-1-1
10	ICSR 24002	[(Pearl unknown#35×ICSR 124)-1-1-1-3-1-1-1×ICSB 79]-5-1-2-1-2
11	ICSR 24003	[ICSR 161 × IS 30469 C-140-2]-1-1-2-1
12	ICSR 24004	[ICSR 89028 × (ICSB 203 × ICSB 665)-2-1-1-2]-1-1-1-1
13	ICSR 24005	[[{SPV462 ×(ICSB 11 × SP 36257)-6-1-1-1-5-1-3-2} × 296B]-7-1-1-2-1-1-1×HR 91075]-3-1-1
14	ICSR 24006	[[{SPV462 ×(ICSB 11 × SP 36257)-6-1-1-1-5-1-3-2} × 296B]-11-1-1-1-1-2-1×[(IS 23528 × ICSV 112) × PS 29159]-4-2-2]-2-1-1
15	ICSR 24007	(PMS 7B × KR 188)-15-1-2
16	ICSR 24009	[[ICSR 161 × (ICSB 203 × ICSB 665)-2-1-1-2]×[(IS 23528 × ICSV 112) × PS 29159]-4-2-2]-1-1-1
17	ICSR 24010	[ICSV 95001 × ICSB 677]-1-1-1
18	ICSR 25003	[[SPV462×(ICSB102×PS28060-2)-1-2-2-1-5-3]×296B]-2-1-1-1-1 × ICSB 440]-2-1-3-2-1-1
19	ICSR 93005	IS 18361-1-1
20	ICSR 93007	IS 19173-2
21	ICSR 93010	IS 33844-1-3
22	ICSR 93011	IS 18372-1-2
23	ICSR 93012	IS 720-1
24	ICSR 93014	IS 3254-1
25	ICSR 93020	IS 3375-1
26	ICSR 93022	B 92101
27	ICSR 93023	B 92104
28	ICSR 93025	B 92143
29	ICSR 93028	B 92148
30	ICSR 93033	NTJ 2122
31	ICSR 93035	SSG 59-3 (N)
32	ICSR 93036	SSG 59-3 (YM)
33	ICSR 94005	Mali-sor-84-1
34	ICSR 94006	Mali-sor-84-2
35	ICSR 94010	[((IS 3443 × DJ 6514)-1-1-1-1-1) × (Good Grain 1485)]-2-1-1-1
36	ICSR 94011	[((IS 3443 × DJ 6514)-1-1-1-1-1) × ICSV 107]-1-1-1-3
37	ICSR 94012	[((IS 3443 × DJ 6514)-1-1-1-1-1) × ICSV 107]-27-1-1-2
38	ICSR 94015	[(M 35-1 × (SC 108-3 × CS 3541) derivative)-3-2-1 × F5-6]-5-2-3-1-1
39	ICSR 94016	[(M 35-1 × (SC 108-3 × CS 3541) derivative)-3-2-1 × F5-6]-5-2-3-1-2
40	ICSR 94017	[(((IS 12622C × 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2) × (((IS 3443 × DJ 6514)-1-1-1-1-1) × (((IS 12622C × 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2))]-8
41	ICSR 94018	[(((IS 12622C × 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2) × (((IS 3443 × DJ 6514)-1-1-1-1-1) × (((IS 12622C × 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2))]-10
42	ICSR 94019	[(IS 9899 × (((IS 12622C × 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2)) × (ICSV 107 × ((Bulk Y × CS 3541)-25-1-1-1))]-4-2-1
43	ICSR 94020	[((((IS 12622C × 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2) × ((IS 3443 × DJ 6514)-1-1-1-1-1)) × (((IS 12622C × 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2)]-12-2
44	ICSR 94026	[(C 138 × (((IS 12622C × 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2)) × ((FLR 101 × IS 1082)-4-5-2)]-1-2-1
45	ICSR 94027	Late Hegari
46	ICSR 94030	((Rs/R × EN 3255-4)-1-5-1-1-1 × R 1224)-1-2-1-1-1
47	ICSR 94031	(IS 5622 × CS 3541)-6-1-1-6-2
48	ICSR 94032	[((IS 1082 × SC 108-3)-1-1-1-1-1) × (((IS 12622C × 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2)]-1-7-2-1-1
49	ICSR 94033	[((IS 1082 × SC 108-3)-1-1-1-1-1) × (((IS 12622C × 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2)]-1-7-2-1-4
50	ICSR 94070	Mali Sor-84-3

contd.

Table 2. contd.

S. No.	Designation	Pedigree
51	ICSR 94071	Mali Sor-84-4
52	ICSR 94072	Mali Sor-84-7
53	ICSR 94128	[((IS 12579C × DJ 6514)-15-1-1-1-1) × (((IS 12622C × 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2)]-16-1-3-3-2
54	ICSR 94129	[IS 12573C × (SC 108-3)-16-2-1-1-1 × ICSP 1R MFR-1]-5-2-1
55	ICSR 94130	[(IS 9899 × (((IS 12622C x 555) × ((IS 3612C × 2219B)-5-1 × E 35-1))-5-2)) × (ICSV 107 × ((Bulk Y × CS 3541)-25-1-1-1))]-4-2-1
56	ICSR 94147	Swati - 8
57	ICSR 94149	Swati -10
58	ICSR 94153	IS 5476-1
59	ICSR 94154	IS 5476-2
60	ICSR 94155	IS 5476-3
61	ICSR 94156	IS 5476-4
62	ICSR 94157	IS 5476-5
63	ICSR 94185	IS 33843-3
64	ICSR 94312	Swati -12
65	ICSR 94313	Swati -13
66	ICSR 94366	IS 33844-10
67	ICSR 94368	IS 33844-12
68	ICSR 94374	M 35-1-4-1
69	ICSR 94375	M 35-1-5
70	ICSR 94377	M 35-1-16
71	ICSR 94378	M 35-1-20
72	ICSR 94379	M 35-1-21
73	ICSR 94381	M 35-1-25
74	ICSR 94385	M 35-1-30
75	ICSR 94386	M 35-1-33
76	ICSR 94387	M 35-1-38
77	ICSR 94392	M 35-1-72
78	ICSR 94393	M 35-1-76
79	ICSR 94405	(555 × GPR 168)-1-1
80	ICSR 94406	(555 × GPR 168)-19-2-7
81	ICSR 94407	(GPR 148 × Framida)-39-2-4-1-2-1
82	ICSR 94410	(UchV2 × IS 3962)-8-1-1-2-4
83	ICSR 94454	M 35-1-23-2
High-yielding (late-maturity) sorghum R-lines		
1	ICSR 21003	(ICSV 575 × S 53-1 × ICSP2B/R MFR-S2 Bulk 7} × ICSB 6}1-1-2-1
2	ICSR 21004	(ICSV 575 × S 53-1 × ICSP2B/R MFR-S2 Bulk 7} × ICSB 6}1-1-2-2
3	ICSR 21005	(PS 21303 × SPV 386)1-3-2-2-1
4	ICSR 21006	(ICSB 37 × ICSV 705)13-2-2-1-1
5	ICSR 21007	(E 36-1 × ICSB 17)12-1-1
6	ICSR 24008	(PMS 7B × KR 188)-15-1-3
7	ICSR 25001	[ICSB 416 × AKMS 14B]-2-5-2-1-1-1
8	ICSR 25002	[ICSB 416 × 27B]-1-1-2-2-1
9	ICSR 25004	[ICSB 416 × 27B]-1-1-2-1-1
10	ICSR 25005	[ICSB 416 × AKMS 14B]-2-6-4-1-1-1
11	ICSR 93008	IS 18762
12	ICSR 93029	M 35-1-34
13	ICSR 94014	(IS 3443 × DJ 6514)-1-1-1-1-1
14	ICSR 94141	Swati - 2
15	ICSR 94143	Swati - 4
16	ICSR 94145	Swati - 6
17	ICSR 94146	Swati - 7
18	ICSR 94148	Swati - 9
19	ICSR 94151	NTJ-2-2
20	ICSR 94158	IS 5631-1
21	ICSR 94162	IS 5631-5
22	ICSR 94163	IS 5631-6
23	ICSR 94165	IS 5631-8
24	ICSR 94170	IS 18361-6
25	ICSR 94174	IS 18372-2

contd.

Table 2. contd.

S. No.	Designation	Pedigree
26	ICSR 94175	IS 18372-4
27	ICSR 94176	IS 18372-5
28	ICSR 94177	IS 18372-6
29	ICSR 94178	IS 18372-7
30	ICSR 94181	IS 23509-1
31	ICSR 94182	IS 23509-2
32	ICSR 94184	IS 33843-2
33	ICSR 94190	IS 33844-2
34	ICSR 94193	IS 33844-6
35	ICSR 94317	Swati -17
36	ICSR 94318	Swati -18
37	ICSR 94321	Swati -21
38	ICSR 94324	Swati -24
39	ICSR 94369	IS 33844-13
40	ICSR 94370	IS 33844-14
41	ICSR 94371	IS 33844-15
42	ICSR 94372	IS 33844-16
43	ICSR 94373	IS 33844-17
44	ICSR 94390	M 35-1-52
45	ICSR 94455	M 35-1-28

1. D = Distinctiveness; U = Uniformity; and S = Stability.

breeding lines are freely disseminated to public sector and private seed companies, and to the farmers in the Semi-Arid Tropics (SAT), and at the same time also prevent others from falsely claiming and taking proprietary rights on them, which might limit ICRISAT's role to make such products freely available to its clientele. The revised ICRISAT's Material Transfer Agreement (MTA) for breeding materials (products of its own research) includes conditions that the recipient should not seek IPR/ownership of the materials in the form received. In addition, ICRISAT has evolved strategies in consultation with IPR experts that do not unduly impede its main focus of developing and sharing improved research products for sustainable crop production.

Strategy for protecting ICRISAT products

ICRISAT seeks to protect its research products from other parties by characterizing them as per DUS testing guidelines, place them in the public domain, and establish a *prior art* for the research products. As an immediate strategy, ICRISAT intends to characterize all the available sorghum hybrid parents (689 A/B-lines and 883 R-lines) developed and designated in three phases as per the DUS-test guidelines, and place them in public domain (circulating hard copies and through uploading the information on the ICRISAT website: www.icrisat.org) to make them accessible to all parties interested in increasing the production and productivity of its mandate crops. This process had begun in 2004, and so far, 269 A/B-lines and 156 R-lines in 2006 as set I (Reddy et al. 2006), and 334 A-/B-lines and 171 R-lines as set II (Reddy et al. 2007) after characterization were placed in public domain.

This publication contains data on morphological characterization of 128 R-lines (Table 2), 83 R-lines in the medium-maturity group (65–75 days to 50% flowering), and 45 lines in late-maturity group (more than 75 days to 50% flowering) as Set III, for different traits as stipulated in the DUS-test guidelines for sorghum and other traits of interest, including grain yield (Reddy et al. 2006).

Material and methods

A total of 128 R-lines developed at ICRISAT over the years were evaluated in two trials in two years: (1) medium-maturity (83 R-lines) trial; and (2) late-maturity (45 R-lines) trial during the 2006 and 2009 rainy seasons under high fertility in Vertisols (deep black soils) at the research farm, ICRISAT, Patancheru, India. The experimental site is located at an altitude of 545 m above mean sea level, latitude of 17.53° N and latitude of 78.27° E. The site receives an average annual rainfall of 897 mm (average of 32 years from 1974 to 2005). The entries were planted in two rows, 2 m long, with a row spacing of 0.75 m and 0.1 m between the plants within a row, following a randomized complete block design (RCBD) in three replications. The planting was carried out on 21st June in the 2006 rainy season and on 17th June in the 2009 rainy season. The recommended crop

Table 3. Procedures for recording data on additional traits other than those stipulated in the DUS-test guidelines for sorghum.

Trait	Procedure
Days to seedling emergence	Number of days required for 50% of the seeds to germinate.
Seedling vigor	Scored visually on a 1 to 9 scale (1 = most vigorous and 9 = least vigorous) at 7 days after emergence (DAE). Plant height, pseudo stem thickness, spread of leaf canopy and/or the length and breadth of the leaves.
Leaf glossiness	Scored on a 1 to 9 scale, where 1 = glossy and 9 = non-glossy at 10 DAE.
Plant agronomic aspect	Scored on a 1 to 5 scale (1 = very good, 2 = good, 3 = average, 4 = below average, and 5 = poor). Plant height, plant color, panicle shape and size, and grain color and size were considered while scoring.
Panicle yield (t ha^{-1})	Panicles from 20 representative plants in each entry were weighed and used to estimate panicle yield in t ha^{-1}.
Grain yield (t ha^{-1})	Threshed grain from 20 representative panicles in each entry were weighed and used to estimate grain yield in t ha^{-1}.
Plant color	Leaf sheath color noted as tan or non tan.

production and protection packages were followed to raise a healthy crop.

Data collection. The data were recorded for all the 41 traits (except grain tannin content) as stipulated in the DUS-test guidelines (Reddy et al. 2006). The tannin content of the grain was not estimated as most of the lines are white sorghums, which do not contain tannins (Rooney 2005). Data were also recorded on other traits (ancillary) (not stipulated in the DUS-test guidelines for sorghum) such as days to seedling emergence, seedling vigor, leaf glossiness, plant agronomic aspect, panicle and grain yields, and plant color (Table 3). Owing to the poor grain quality of the rainy season harvested grain, data on grain traits (grain color, grain shape, grain germ size, endosperm texture, albumen color, grain luster, and 1000-grain mass could not be recorded. However, the data on all these traits were recorded in the postrainy season in 2006 (Annexure I-1 to I-2). The replication-wise data (averaged over individual plants) for days to seedling emergence, seedling vigor, leaf glossiness, plant agronomic aspect, 1000-grain mass (g), and panicle and grain yields were subjected to analyses of variance. For other traits, mean scores are presented across replications.

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Detailed information for various characteristics (Annexure I-1 to I-2) and salient features of restorer lines along with pictures are available at http://www.icrisat.org/ci-enewsletter.htm