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Characterization and Evaluation of Sorghum [*Sorghum bicolor* (L.) Moench] Germplasm from Karnataka, India

Sorghum [*Sorghum bicolor* (L.) Moench] also known as Jowar has originated and domesticated in Africa about 5000 – 8000 years ago (De Candolle 1890). Indian subcontinent is the secondary origin of this most important cereal. High diversity in sorghum is distributed throughout India. Elangovan (2004) reported that durra racial diversity is maximum in collection of Karnataka. Through number of surveys conducted earlier, about 1100 accessions were collected. In order to rescue the landrace diversity from unsurveyed and under surveyed areas, four explorations were undertaken during 2000-2003 in Karnataka under the National Agricultural Technological project (Mission Mode – Plant Biodiversity) and a total of 157 accessions were collected by National Research Centre for Sorghum (NRCS), Hyderabad. Characterization and evaluation of germplasm are the pre-requisite for the utilization of the available diversity in the crop improvement programme. Hence, the accessions were characterized to assess the variability and identify the promising accessions for different traits. Preliminary evaluation of 157 accessions of sorghum at the NRCS, Rajendranagar, Hyderabad and Solapur during rabi 2002-03 and 2003-04 was conducted. The centres are located at $17^0$19' N latitude and $78^0$24' E longitude and at an altitude of 538 m above MSL and $17^0$04' N latitude and $75^0$54' E longitudes respectively with temperature varying with minimum of 10^0C to a maximum of 30^0C during the cropping season. The soil type is sandy loam. The accessions were raised in an Augmented Block Design (ABD) with check varieties (M35-1, Swati and CSV-15) in each block. The accessions were grown in 4 m rows with a row spacing of 60 cm and plant to plant spacing of 10 cm. Standard agronomic and plant protection practices were followed during the cropping season. The data on qualitative and quantitative characters were recorded using minimal descriptor developed by NBPGR (Mahajan et al., 2000) and list of sorghum descriptors released by (Anon., 1993). Five representative plants in each accession were tagged for recording the qualitative and quantitative characters. Brix percentage of each accession was estimated by refractometer. Descriptive statistical analysis was done for the quantitative characters.

Table 1. Characterization and preliminary evaluation of sorghum

Characters	Variation	Frequency
Seedling vigour	Average	8
	Good	58
	Poor	8
	Very good	25
Leaf pigmentation	Non-tan	18
	Tan	81
Leaf colour	Dark green	129
	Light green	21
Leaf orientation	Drooping	57
	Erect	93
Midrib colour	Colourless	13
	Dull green	17
	Green	4
	Pale green	29
	Purple	11
	White	76
Earhead shape	Elliptical	67
	Oblong	28
	Ovate	8
	Round	1
	Semi loose	1
Earhead compactness	Compact	52
	Loose	7
	Semi compact	79
	Semi loose	7
Glume colour	Black	18
	Brown	42
	Dark brown	4
	Light red	1
	Pink	1
	Purple	2
	Red	14
	Straw	38
	Yellow	8
Glume covering	100%	13
	25%	28
	50%	14
	75%	11
	Above 100%	38
Presence of awns	Absent	19
	Present	126
Seed size	Bold	64
	Medium	68
	Very bold	12
Seed colour	Brown	1
	Light yellow	1
	Orange	7
	Pearly white	86
	Pink	1
	White	47
	Yellow	1
Race	Bicolor	6
	Durra	31
	Durra bicolor	38
	Durra caudatum	1
Lustre	Lustrus	11
	Non-lustrus	19

The 157 sorghum accessions were characterized and evaluated for 28 agro-morphological and one bio-chemical character. Wide range of variability was recorded in both qualitative and quantitative characters. Majority of the accessions showed tan type, dark green leaf colour, erect leaf orientation, and stay green types (non-senescence). However, variation was observed in seedling vigour, midrib colour, earhead shape, earhead compactness, glume colour, glume covering, seed size, seed colour, and races. Sorghum landraces are consistent for morphological characters, the importance of the midrib color, grain color, grain size, glume color, glume hairiness, and grain shape were used by the farmers in naming the sorghum landraces (Teshome *et al.,* 1997). Audilakshmi *et al.,* (1999) evaluated twenty-two sorghum genotypes for grain mould response an observed that harder grain, higher levels of seed phenols, and darker glumes contributed to grain mould resistance. The variability of glume colour available in the present study may be utilized for screening for grain mold resistance in sorghum. The range of variability and frequency observed in qualitative traits are given in table 1.The quantitative characters also showed wide variation in the evaluated sorghum germplasm. The results of descriptive statistical analysis are presented in table 2. The characters of stem dry weight (70 - 665 g), stem fresh weight (110 - 1040 g), grain yield (3 – 75 g), brix (3 – 25 percent), and 100-seed weight (0.6 – 4.5g) are the highly variable based on the CV percentage. The brix percentage ranged from 3 - 25. The chance of deriving sweet stalk sorghum may be possible from the high brix accessions. The variability presents in the grain yield can be used to derive grain sorghum and stem fresh weight and stem dry weight can be used as fodder sorghum. A p p a

Table 2. Statistical analysis of quantitative characters

Characters	Range	Min.	Max.	Mean	SE	SD	CV %
Days to 50% flowering (days)	53	66	119	77.5	0.73	9.04	11.66
Number of leaves	14	8	23	12.38	0.2	2.49	20.11
Leaf length (cm)	62	50	112	70.18	0.78	9.81	13.98
Leaf width (cm)	4.6	5.3	9.9	7.73	0.08	1.04	13.45
Plant height (cm)	252	141	393	229.46	4.37	54.53	23.76
Earhead length (cm)	25.6	8.8	34.4	16.82	0.37	4.66	27.71
Earhead width (cm)	6.3	3.6	9.9	5.82	0.1	1.26	21.65
Stem thickness (cm)	1.9	1	2.9	1.61	0.02	0.26	16.15
Stem fresh weight (g)	930	110	1040	382.96	17.62	188.91	49.33
Stem dry weight (g)	595	70	665	208.13	10.59	113.53	54.55
Brix (%)	22	3	25	13.59	0.47	5.08	37.38
Grain yield (g)	72	3	75	40.37	1.41	16.94	41.96
100-seed weight (g)	4	0.6	4.5	2.67	0.07	0.85	31.84
Days to maturity (days)	22	106	128	117.29	0.66	5.09	4.34

Table 3. Correlation coefficient of yield attributing characters

Characters	DFL	NOL	LFL	LFW	PHT	EHL	EHW	STS	SFW	SDW	BRX	GRY	SWT	DYM
Days to 50% flowering (days)	1													
Number of leaves	0.29**	1												
Leaf length (cm)	0.37**	0.82**	1											
Leaf width (cm)	0.09	0.58**	0.61**	1										
Plant height (cm)	0.14*	0.90**	0.80**	0.55**	1									
Earhead length (cm)	0.20**	0.44**	0.47**	0.21**	0.53**	1								
Earhead width (cm)	0.48**	0.02	0.01	0.05	0.09	0.38**	1							
Stem thickness (cm)	0.59**	0.60**	0.62**	0.52**	0.45**	0.22**	0.29**	1						
Stem fresh weight (g)	0.43**	0.74**	0.71**	0.47**	0.65**	0.51**	0.14	0.72**	1					
Stem dry weight (g)	0.49**	0.76**	0.73**	0.50**	0.65**	0.50**	0.16*	0.77**	0.94**	1				
Brix (%)	0.09	0.58**	0.53**	0.42**	0.56**	0.30**	0.15	0.17*	0.33**	0.27**	1			
Grain yield (g)	0.22**	0.59**	0.51**	0.31**	0.65**	0.25**	0.55**	0	0.45**	0.43**	0.44**	1		
100-seed weight (g)	0.45**	0.48**	0.34**	0.13	0.56**	0.09	0.59**	0.15*	0.30**	0.26**	0.28**	0.69**	1	
Days to maturity (days)	0.21	0.26*	0.27*	0.22*	0.1	0.11	0.35**	0.13	0.14	0.15	0.01	0.08	0.11	1

** Significant at 1% level; * Significant at 5% level

· DFL=Days to 50% flowering (days), NOL=Number of leaves, LFL=Leaf length (cm), LFW=Leaf width (cm), PHT=Plant height (cm), EHL=Earhead length (cm), EHW=Earhead width (cm), STS=Stem thickness (cm), SFW=Stem fresh weight (g), SDW=Stem dry weight (g), BRX=Brix (%), GRY=Grain yield (g), SWT=100-seed weight (g), DYM=Days to maturity (days)

Rao, *et al.* (1999) evaluated over 4000 accessions from 11 major sorghum growing states in India for morphological and agronomical characters. He found that days to flowering, plant height, panicle length, erect and compact panicles are more frequent. The present study also observed the similar variability in plant height.

The correlation coefficients of grain yield/fodder yield showed that the grain yield and number of leaves, plant height and earhead width are showed positive correlation; and 100-seed weight also showed positive correlation with plant height, earhead width and grain yield. The dry fodder (stem dry weight) yield and some major fodder-yield attributing characters showed high positive correlation with stem fresh weight, number of leaves, leaf length, leaf width, plant height, and stem thickness (Table 3). Amsalu Ayana, Endashaw Bekele (2000), also reported similar results.

The identified potentional donors for sorghum varietal improvement programme are as follows, the high brix (>20 percent) are IC – 308607, IC – 308611, IC – 308612, IC – 308615, IC – 308619, IC – 308650, and IC – 305913 for sweet sorghum breeding; the fodder line with stem dry weight (>500g/plant) are IC – 308641 and IC – 308643;. The high yield (>70g/plant) accessions are IC – 345191, IC – 345195, IC – 345206; and more 100-seed weight (>4.2g) in IC – 345186, IC – 345188, IC – 345191, IC – 345199, and IC – 345202. The early maturing entries are IC – 305906, IC – 305913, and IC - 305933

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