# Characterization of Sorghum Germplasm Collected from Gujarat

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The preliminary characterization of 107 accessions of sorghum landraces was carried out at DSR, Hyderabad and SDAU, Deesa (Gujarat) during *kharif* 2008 to 2010. The data on qualitative and quantitative descriptors were recorded using minimal descriptors. The accessions studied, exhibited good variability in both qualitative and quantitative traits. The preliminary characterization of sorghum landraces revealed that stem fresh and dry weight, plant height, ear head length and width, days to 50% flowering and days to maturity are the most variable characters. The qualitative characters have also shown high variability. High positive and significant correlation was observed among days to flowering, plant height, number of leaves/plant, stem thickness, stem fresh and dry weight, leaf length and days to maturity which help to identify early genotypes with high biomass. The positive significant correlation of grain yield/plant with 100-seed weight may help to select the high grain yielding genotypes. Based on the results of the mean over the environment (location x year) some potential accessions identified for significantly high brix per cent (E 147, E 151, ERN 22, E 148 and E159) for sweet sorghum breeding, the fodder lines with high stem fresh and dry weight (ERN 9, ERN 11, ERN 17, ERN 7 and ERN 16), for high grain yield (E 145, EJN 13, ERN 31 and EJN 31) and early maturity (EJN 7, EJN 9, EJN11, EJN 15 and EJN 24). These potential germplasm may be used in the forage, dual purpose, grain and sweet sorghum varietal improvement programme.

**Key Words: Evaluation, Genetic Resource, Sorghum**

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## Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is an important semi-arid crop which can tolerate any adverse climatic conditions. It originated and domesticated in Africa about 5,000-8,000 years ago (De Candolle, 1884). Indian subcontinent is the secondary centre of origin of this important cereal. Sorghum is popularly known as "Jowar" in India. It is a multipurpose and bioenergy crop; the grain, stem and glume are the useful parts. It is used as human food, livestock feed, in alcohol production, fuel, malt and other industrial productions (Elangovan, 2005). The crop in the country stands at the third place in context of importance after wheat and rice. Sorghum is cultivated in 7.53 mha, of which 2.89 mha is cultivated during rainy and *kharif* season with a production of 3.05 mt in India (Anonymous 2010). The major sorghum growing states are Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Tamil Nadu.

Plant genetic resources represent the inter and intra-specific reservoir of potentially useful genetic material. Landraces or farmer varieties constitute the basic material for developing any variety or hybrid. An autochthonous landrace is a variety with a high capacity to tolerate biotic and abiotic stress, resulting in high yield stability and an intermediate yield level under a low input agricultural system. It is well established fact that the progress in improvement of a crop depends on the degree of variability in the desired character in the base material *vis-a-vis* germplasm collection. The study of relationships among quantitative traits is important for assessing the feasibility of joint selection of two or more traits and hence for evaluating the effect of selection for secondary traits on genetic gain for the primary trait under consideration. A positive genetic correlation between two desirable traits makes the job of the plant breeder easy for improving both traits simultaneously. High diversity in sorghum is distributed through out India, including Gujarat. Collection and characterization of sorghum germplasm is an important activity for identifying potential germplasm for utilization in the varietal improvement programme and to avoid duplication. Hence, in order to capture the landrace diversity from unsurveyed and surveyed areas, exploration was undertaken during 2008 to 2010 in Gujarat and a total of 107 accessions collected were characterized to access the variability and identify the promising accessions for different traits.

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## Materials and Methods

One hundred seven sorghum genotypes collected from different district of Gujarat were evaluated at Directorate of Sorghum Research, Hyderabad and Sorghum Research Station, Sardarkrushinagar Dantiwada Agricultural University, Deesa (Gujarat) during *kharif* 2008 to *kharif* 2010. All the accessions were evaluated in Augumented Block Design with three check varieties *viz.,* CSV 15, SPV 462 and CSV 25 in each block. DSR, Hyderabad located at latitude of 27.19° N and longitude 78.24° E and at an elevation of 538 M msl and Deesa is situated at latitude of 24.5° N and longitude 72° E and at an elevation of 136 M msl. The soil of the field was sandy to deep sandy loam in texture with pH value of 7.5 to 8.5 having good physical and chemical properties. The experimental unit was a single-row plot of 6.75 m long, spaced at 0.60 m apart. NPK 120:40:00 fertilizers was applied as half basal dose of nitrogen and full dose of phosphorus at the time of sowing and half nitrogen applied after one month of sowing. Plots were thinned down after two weeks of crop emergence and plant-to-plant distance of 0.10 m was maintained. The experimental years showed different temperature regimes, humidity, rain fall and sunshine hours during the crop durations. All other recommended agronomical practices were followed to raise a good crop in both the seasons. The data on qualitative and quantitative characters were recorded using the minimal descriptor developed by NBPGR (Mahajan *et al*., 2000) and list of sorghum descriptors released by Anonymous (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 characteristics.

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## Results and Discussion

The data of characterization and preliminary evaluation of 107 sorghum accessions recorded for 28 agro-morphological and bio-chemical characters revealed a wide range of variability in both qualitative and quantitative characters. The range of variability and frequency observed in qualitative traits are given in Table 1. Majority of the accessions showed gray purple leaf pigmentation (66 acc.), dark green leaf colour (40 acc.), drooping leaf orientation (33 acc.), white midrib colour (60 acc.), semi compact earheads (54 acc.) and symmetric earhead shape (59 acc.), grayed red glume colour (56 acc.) with medium glume covering

**Table 1. Characterization and preliminary evaluation of sorghum germplasm**

| S.No. | Characters | Variations | Frequency |
|---|---|---|---|
| 1. | Seedling vigour | Good | 20 |
| | | Poor | 19 |
| | | Very good | 33 |
| | | Unclassified | 35 |
| 2. | Leaf pigmentation | Grayed purple | 66 |
| | | Yellow green | 41 |
| 3. | Leaf colour | Dark green | 40 |
| | | Unclassified | 67 |
| 4. | Leaf orientation | Drooping | 33 |
| | | Erect | 7 |
| | | Unclassified | 67 |
| 5. | Midrib colour | Dull green | 2 |
| | | Grayed purple | 1 |
| | | White | 60 |
| | | Yellow green | 44 |
| 6. | Ear head shape | Panicle broader in lower part | 9 |
| | | Panicle broader in upper part | 1 |
| | | Pyramidal | 19 |
| | | Reversed pyramid | 10 |
| | | Symmetric | 59 |
| | | Unclassified | 9 |
| 7. | Ear head compactness | Compact | 25 |
| | | Loose | 7 |
| | | Semi compact | 54 |
| | | Semi loose | 11 |
| | | Very loose | 1 |
| | | Unclassified | 9 |
| 8. | Glume colour | Grayed orange | 4 |
| | | Grayed purple | 29 |
| | | Grayed red | 56 |
| | | Yellow white | 8 |
| | | Unclassified | 10 |
| 9. | Glume covering | Long | 22 |
| | | Medium | 44 |
| | | Short | 25 |
| | | Very long | 6 |
| | | Very short | 1 |
| | | Unclassified | 9 |
| 10. | Presence of awns | Absent | 24 |
| | | Present | 78 |
| | | Unclassified | 5 |
| 11. | Seed size | Bold | 56 |
| | | Medium | 9 |
| | | Small | 1 |
| | | Very bold | 1 |
| | | Unclassified | 40 |
| 12. | Grain colour | Grayed orange | 20 |
| | | Grayed white | 3 |
| | | White | 49 |
| | | Yellow orange | 14 |
| | | Yellow white | 14 |
| | | Unclassified | 7 |
| 13. | Stay-green | Stay green | 67 |
| | | Unclassified | 40 |

| S. No. | Characters | Variations | Frequency |
|---|---|---|---|
| 14. | Races | Bicolor | 5 |
| | | Caudatum | 3 |
| | | Durra | 37 |
| | | Durra bicolor | 8 |
| | | Durra caudatum | 9 |
| | | Guinea | 2 |
| | | Guinea caudatum | 1 |
| | | Kafir | 2 |
| | | Unclassified | 40 |
| 15. | Lustrous | Lustrous | 10 |
| | | Non-lustrous | 90 |
| | | Unclassified | 7 |
| 16. | Remarks | Early flowering | 7 |

(44 acc.), bold seeded (56 acc.), stay green (67 acc.) (non-senescence), grain colour white (49 acc.) and durra race (37 acc.). Sorghum landraces are consistent for morphological characters, and 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).

The quantitative characters also showed wide variation in the evaluated sorghum germplasm. The results of descriptive statistical analysis are presented in Table 2. In quantitative traits, the days to 50% flowering (46 – 106 days), plant height (145 – 478 cm), number of leaves per plant (5 - 21), leaf length (5.33 - 89.80 cm), leaf width (2.52 – 11.00 cm), earhead length (7.93 - 55 cm), earhead width (0.65 – 11.06 cm), stem thickness (1.134 – 3.00 cm), stem fresh weight (120 – 2000 g/plant), stem dry weight (30 – 1083 g/plant), Brix (4-18 %) and grain yield (0.00 – 108 g/plant), 100-seed weight (1.12 – 3.08 g) and days to maturity (85 – 165 days) showed wider range. The preliminary characterization of sorghum landraces revealed that stem dry weight, stem fresh weight, plant height, ear head width and ear head length and 50% flowering and days to maturity are the most variable characters because they showed higher standard deviation and variance. The qualitative characters have also shown good variability. Earlier reports by Elangovan *et al*. (2007, 2009) and Jadav *et al*. (2011) have also showed the presence of variation for the quantitative traits in sorghum accessions. Appa Rao *et al*. (1999) evaluated over 4,000 accessions from 11 major sorghum growing states in India for morphological and agronomical characters. They found that days to flowering, plant height, panicle length, erect and compact panicles are more frequent. The present study also observed variability in the different agro-morphological characteristics.

**Table 2. Descriptive statistical analysis of quantitative characters in sorghum germplasm (over the environments)**

| Characters | Range pooled over the environment | | Mean | SD | SE | Variance | CV(%) |
|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | | | | | |
| Days to 50% flowering (days) | 46 | 106 | 76 | 16.00 | 1.55 | 256.13 | 21.05 |
| Number of leaves | 5 | 21 | 15 | 3.54 | 0.34 | 12.53 | 23.60 |
| Leaf length (cm) | 50.33 | 89.80 | 71.76 | 9.16 | 0.89 | 83.90 | 12.76 |
| Leaf width (cm) | 2.52 | 11.00 | 7.95 | 1.37 | 0.13 | 1.88 | 17.23 |
| Plant height (cm) | 145 | 478 | 318 | 79.83 | 7.72 | 6373.57 | 25.10 |
| Ear head length (cm) | 7.93 | 55.00 | 18.72 | 9.63 | 1.04 | 92.81 | 51.44 |
| Ear head width (cm) | 0.65 | 11.06 | 5.33 | 1.86 | 0.20 | 3.45 | 34.89 |
| Stem thickness (cm) | 1.14 | 3.00 | 2.01 | 0.35 | 0.03 | 0.12 | 17.41 |
| Stem fresh weight (g/plant) | 120 | 2000 | 784 | 423.51 | 49.91 | 179364.61 | 54.02 |
| Stem dry weight (g/plant) | 30 | 1083 | 368 | 247.48 | 23.92 | 61247.24 | 67.25 |
| Brix (%) | 4 | 18 | 12 | 2.74 | 0.32 | 7.53 | 23.17 |
| Grain yield (g/plant) | 4 | 108 | 25 | 20.85 | 2.03 | 434.51 | 83.40 |
| 100-seed weight(g) | 1.12 | 3.08 | 1.92 | 0.45 | 0.06 | 0.20 | 23.43 |
| Days to 85 maturity (days) | 165 | 118 | 16.25 | 1.78 | 263.97 | 13.77 | |

Fodder yield and seed yield are the complex characters controlled by several components which reflect positive and negative effect on these traits. Thus, to achieve rational improvement in the yield and their component traits, knowledge of mechanism of correlation provides a basis for formulating suitable breeding methods for yield improvement. On the basis of pooled data, the genotypic and phenotypic correlation coefficients among different characters were almost similar, including stem fresh and dry weight, grain yield/plant and their related characters. Hence we are presenting here the genotypic correlation coefficient only (Table 3). High positive and significant correlation was observed among days to flowering with, plant height, number of leaves/plant, stem thickness, stem fresh and dry weight, leaf length and days to maturity which help to identify early genotypes with high biomass. The positive significant correlation of grain yield/plant with 100-seed weight may help to select the high grain yielding genotypes.

These traits also showed i-nter correlation with each other. Elangovan *et al.* (2009) and Jain *et al.* (2011) also reported similar type of associations for one or more traits in sorghum germplasm.

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**Table 3. Correlation coefficient in yield and yield contributed traits in sorghum germplasm (pooled)**

| Characters | DFL | NOL | LL | LW | PH | EHL | EHW | ST | SFW | SDW | BX | GY | SW | DM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50% flowering (days) | 1.00 | | | | | | | | | | | | | |
| Number of leaves | 0.69** | 1.00 | | | | | | | | | | | | |
| Leaf length (cm) | 0.52** | 0.37** | 1.00 | | | | | | | | | | | |
| Leaf width (cm) | 0.46** | 0.47** | 0.53** | 1.00 | | | | | | | | | | |
| Plant height (cm) | 0.71** | 0.73** | 0.42** | 0.46** | 1.00 | | | | | | | | | |
| Earhead length (cm) | -0.04 | -0.07 | 0.41** | -0.21 | -0.03 | 1.00 | | | | | | | | |
| Earhead width (cm) | -0.04 | -0.01 | 0.54** | 0.19 | -0.02 | 0.41** | 1.00 | | | | | | | |
| Stem thickness (cm) | 0.57** | 0.51** | 0.68** | 0.73** | 0.46** | 0.17 | 0.33** | 1.00 | | | | | | |
| Stem fresh weight (g) | 0.69** | 0.61** | 0.64** | 0.50** | 0.62** | 0.03 | -0.04 | 0.56** | 1.00 | | | | | |
| Stem dry weight (g) | 0.69** | 0.54** | 0.61** | 0.47** | 0.51** | 0.00 | 0.22 | 0.61** | 0.94** | 1.00 | | | | |
| Brix (%) | 0.16 | 0.20 | 0.10 | -0.06 | 0.15 | -0.06 | -0.27 | 0.08 | 0.17 | 0.21 | 1.00 | | | |
| Grain yield (g/plant) | -0.29 | -0.09 | -0.19 | 0.20 | -0.02 | 0.09 | 0.08 | -0.08 | -0.20 | -0.34** | -0.26 | 1.00 | | |
| 100-seed weight (g) | 0.09 | 0.00 | 0.04 | 0.14 | -0.07 | -0.11 | 0.03 | 0.08 | 0.26 | 0.22 | -0.01 | 0.35** | 1.00 | |
| Days to maturity (days) | 0.54** | 0.41** | 0.45** | 0.42** | 0.50** | -0.05 | 0.31** | 0.55** | 0.27 | 0.47** | 0.12 | -0.13 | -0.08 | 1.00 |

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Based on the results of the mean over the environment (location x year) some of the accessions identified as positional donors for different characters are presented in Table 4. These accessions showed significantly higher mean values over the environments than the best check. The identified positional donors for the high brix per cent are E 147 and E 151 with 18 % ; ERN 22, E 148 and E 159 with 17 % for sweet sorghum breeding; the fodder line with stem fresh and dry weight are ERN 9 (2000 and 1083.3 g/plant), ERN 11 (1833.33 and 1083.3 g/plant), ERN 17 (1583.3 and 1000 g/plant), ERN 7 (1666.7 and 1000 g/plant) and ERN 16 (1566.7 and 666.7 g/plant). The high grain yield accessions are E 145(108 g/plant), E (73 g/plant), EJN 13 (69 g/plant), ERN 31(67 g/plant) and EJN 31(66 g/plant). Some accessions viz., E 145 (3.1 g), E 150(2.8 g), ERN 3 (2.8 g), ERN 24(2.7 g) and E 176 (2.6 g) showed high 100-seed weight. The early maturing entries were EJN 7, EJN 9, EJN 11, EJN 15 and EJN 24 which matured in 85 days. These potential germplasm may be used in the forage, dual purpose, grain and sweet sorghum varietal improvement programme.

As a prerequisite for efficient utilization of the germplasm, it must be properly evaluated, characterized and documented with a workable retrieval system so that any group of entries carrying any desired characteristics could be easily retrieved and used in breeding programme

**Table 4. Five top ranking accessions selected on the basis of average of different characters (Mean pooled over environments and significantly superior then the best check)**

| S. No. | Days to 50 % flowering | Plant height (cm) | Stem fresh weight (g) | Stem dry weight (g) | Grain yield / plant (g) | 1000-Seed weight (g) | Days to maturity | Brix (%) |
|---|---|---|---|---|---|---|---|---|
| 1 | EJN 15 (IC 585185) 46 | E 152 (IC 568369) 478 | ERN 9 (IC 568524) 2000 | ERN 9 (IC 568524) 1083.3 | E 145 (IC 568362) 108 | E 145 (IC 568362) 3.1 | EJN 7 (IC 585177) 85 | E 147 (IC 568364) 18 |
| 2 | EJN 9 (IC 585179) 48 | EJN 2 (IC 585172) 450 | ERN 11 (IC 568526) 1833.33 | ERN 11 (IC 568526) 1083.3 | E 171 (IC 568388) 73 | E 150 (IC 568367) 2.8 | EJN 9 (IC 585179) 85 | E 151 (IC 568368) 18 |
| 3 | EJN 11 (IC 585181) 48 | EJN 1 (IC 585171) 436 | ERN 17 (IC 568532) 1583.3 | ERN 17 (IC 568532) 1000 | EJN 13 (IC 585183) 69 | ERN 3 (IC 568518) 2.8 | EJN 11 (IC 585181) 85 | ERN 22 (IC 568547) 17 |
| 4 | EJN 4 (IC 585174) 50 | ERN 6 (IC 568521) 435 | ERN 7 (IC 568522) 1666.7 | ERN 7 (IC 568522) 1000 | ERN 31 (IC 568546) 67 | ERN 24 (IC 568539) 2.7 | EJN 15 (IC 585185) 85 | E 148 (IC 568365) 17 |
| 5 | EJN 7 (IC 585177) 50 | ERN 8 (IC 568523) 432 | ERN 16 (IC 568531) 1566.7 | ERN 16 (IC 568531) 666.7 | EJN 31 (IC 585201) 66 | E 176 (IC 568393) 2.6 | EJN 24 (IC 585194) 85 | E 159 (IC 568376) 17 |

(Gebrekidan, 1982). The present study revealed sufficient genetic variability for quantitative, qualitative and morphological characters among the germplasm collected from Gujarat, which can be exploited for developing superior varieties and hybrids in sorghum. Different accessions have different promising traits. Therefore, a gene pool can be generated by crossing the germplasm lines of interest which can be further used as source material to develop promising lines in sorghum.

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