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RESEARCH ARTICLE

Genetic diversity analysis in germplasm lines of *Rabi* sorghum [*Sorghum bicolor* (L.) Moench] based on quantitative traits

■ SANTOSH KHADAKABHAVI, G. GIRISH, P. S. DHARMARAJ AND R. LOKESHA

SUMMARY

Genetic divergence in 121 germplasm lines of *Rabi* sorghum was assessed using Mahalanobis D^2 analysis. All the genotypes were grouped into 13 clusters where, cluster-I was the largest with 68 genotypes followed by cluster-XIII with 38 genotypes. Whereas, cluster-II, to cluster-XII consisted of two genotypes in each clusters. The intra cluster distance was maximum in cluster-XIII and cluster-I followed by cluster-XII and cluster-XI whereas inter cluster distance was maximum between cluster-X and cluster-XI. The genotypes in clusters-VI showed high mean values for most of the characters studied. Grain yield per plant contributed maximum to divergence followed by 1000 grain weight, panicle length, plant height and days to 50 per cent flowering, these traits can be utilized for future crop improvement programme.

Key Words : Genetic diversity, Inter-cluster, Intra-cluster, D^2 analysis, Sorghum

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Sorghum is the third most important cereal crop cultivated extensively in India after wheat and rice. The area under *Rabi* sorghum is fairly consistent over many years but the progress in productivity is much slower compared to *Kharif* season. The *Rabi* sorghum matures in clear weather as such quality of both grain and fodder is better than that of *Kharif.* But genetic improvement of *Rabi* sorghum is given importance in recent years (Sameer kumar *et al.*, 2010). Exploitation of existing genetic variability is pre requisite for any crop improvement. However, reports on genetic diversity among the *Rabi* sorghum is very limited. In the present study, D^2 analysis has been applied to assess the diversity among the 121 *Rabi* sorghum germplasm lines, to identify the divergent types suitable for hybridization programme. Diversity analysis provides information on deciding choice of parents from distantly related clusters to secure yield improvement in sorghum.

MEMBERS OF THE RESEARCH FORUM

Author to be contacted :
SANTOSH KHADAKABHAVI, Department of Genetics and Plant Breeding, Agricultural Research Station (U.A.S.), GULBARAGA (KARNATAKA) INDIA
Email: santoshssk04@gmail.com

Address of the Co-authors:
G. GIRISH, P.S. DHARMARAJ AND R. LOKESHA, Department of Genetics and Plant Breeding, Agricultural Research Station (U.A.S.), GULBARAGA (KARNATAKA) INDIA

MATERIAL AND METHODS

The experimental material comprised of 121 germplasm lines of sorghum collected from Gulbarga, Bijapur, Dharwad, Coimbatore, NRC of sorghum Solapur and ICRISAT Hyderabad. They were evaluated at Agriculture research station gulbarga during *Rabi* 2011. Evaluation was carried out in 11 x 11 simple lattice design with two replications of 4 meter length and each genotype was sown in one row with spacing of 45 cm between the rows and 15 cm plant to plant. All the recommended practices were followed to raise good crop of *Rabi* sorghum. In each genotype, five plants were selected randomly and used for collecting data on stem girth (cm), plant height (cm), panicle length (cm), panicle width (cm), 1000 grain weight (g), grain yield per plant (g), days to

50% flowering and, days to maturity. The data were subjected to statistical analysis using (Mahalanobis.,1936) D^2 statistics and Tochers method as described by Rao (1952) for determining group constellation. Average inter and intra cluster distances were estimated as per the procedure outlined by Singh and Choudhary (1977).

RESULTS AND DISCUSSION

The analysis of variance showed highly signification differences among the genotypes for all the characters studied. The per cent contribution of different characters to the total diversity is presented in Table 1. Grain yield per plant (ranked first, 1763 times out of 7260 total number of combinations) contributed 24.28 per cent to the divergence of genotypes followed by 1000 grain weight (20.44%), panicle length (17.41%), plant height (14.85%), days to 50 per cent flowering (14.83%), panicle width (4.45%), days to maturity (2.19%) and stem girth (1.54%). These observations are in accordance with the results of Asthana *et al.* (2002) and Umakanth *et al.* (2003).

Based on D^2 values, 121 genotypes were grouped into thirteen clusters. Among them cluster-I was the largest with 68 genotypes followed by cluster-XIII with 38 genotypes. These results are in accordance with the studies conducted by Rohman *et al.* (2004). While cluster-II to Cluster-XIII were smallest comprising two genotypes each (Table 2). The intra cluster distance ranged from 1.38 in cluster-II to maximum distance of 8.43 in cluster-XIII. This revealed the presence of divergent genotypes within different clusters. The inter cluster D^2 values ranged widely with minimum value of 2.26 between cluster II and cluster-IV and maximum value of 9.35 between cluster-X and cluster-XI indicating high diversity among the genotypes and it was desirable to select genotypes from

Table 1 : Per cent contribution of characters towards divergence in one hundred twenty one germplasm lines of sorghum

Sr. No.	Characters	Times ranked	Contribution
1.	Grain yield per plant (g)	1763	24.28
2.	1000 grain weight (g)	1484	20.44
3.	Panicle length (cm)	1264	17.41
4.	Plant height (cm)	1078	14.85
5.	Days to 50 per cent flowering	1077	14.83
6.	Panicle width (cm)	323	4.45
7.	Days to maturity	159	2.19
8.	Stem girth (cm)	112	1.54

Table 2 : Clustering pattern of one hundred twenty one germplasm lines of sorghum

Clusters	No. of genotypes	Name of the genotypes
I	61	Afzalpur-1, Afzalpur-3, Athanur-1, Athanur-2, Athanur-3, Award, Balaganur-2, Bommanhalli, chaavdapur-2, Chadchanna mudi jola, Channdrakanth, Chicknagur, Chincholli-1, Chincholli-1-1, Chincholli-1-2, Chincholli-3, Chittapur Maldandi 5, Chittapur maldandi-3, Chittapur maldandi-4, Chittapur Maldandi-1, Chittapur-1, Chittapur-4, Chvadapur-1, COS-26, CSV-14R, CSV-15R, CSV-18, CSV-216R, CSV-22, Dharmapur dwarf, DSV-4, Engalagi phule malege, Engalagi-2, Engalagi-1, Gavur-1, Gavur-3, Gola-3, Gola-4, Gola -5, Gola-1, Gola-2, Gotur-1, GRS-1, Gulbarga-1, Gulbarga-2, Gundugurthi, Gundutheni-1, Gundutheni-2, Hadgatti-1, Hadgatti-2, Hagarga-1, Hagarga-2, Hattigudur cross, Hattigudur cross -1, Hebbal -3, Hebbal-1, Hebbal-2, Hebbal-6, Hebbal-5, Hebbala- 4, Honnad
II	2	M-35-1, Sonnur-2.
III	2	Niralkodi jewargi cross-1, Sugur-1.
IV	2	Nagur(GLB), Sonnur Selection.
V	2	Konnur-2, Mangalagi-4-1.
VI	2	Mangallagi-7, Tengalli-2.
VII	2	Mudabi, Thandur-2.
VIII	2	Niralkodi jewargi cross-2, Thandur -1.
IX	2	Mangalagi-9, Rawar-1.
X	2	Phule vasundra, SPV-86.
XI	2	Malkhed 2, Sugur-5.
XII	2	Sugur-3, Tengalli-5.
XIII	38	IS 27036, IS 6920, IS 7530, IS 1159, IS2293, JP-1-5, Kodikal-2, Kolkora, Konnur-1, Konnur-3, Konnur-4, Kouta award, Malkhed 1, Mangalagi-1, Mangalagi-2, Mangalagi-4, Mangalagi-5, Mangalagi-6, Mangalagi-8, Mudbal 3, Nalwar-2, phule chitra, Phule Mule, PKV Kranthi, Raddewadagi-1, Raddewadagi-2, Sapnapalli, Savalagi-2, Savalagi-3, Shankar kante-2, Sharnashirsagi, Sirgapur, Sugur-4 ,Tengalli-1, Tengalli-4, E36-1, Tengalli-7, AKR- 150.

clusters showing high inter cluster distance (Table 3). Diversity among the clusters varied from 2.26 to 9.35 inter cluster distances. These results are in accordance with the findings of Arunkumar *et al.* (2004). Cluster-X and cluster-XI showed maximum inter cluster distance (9.35) followed by inter cluster distance (8.93) between cluster-X and cluster-VIII. The lowest inter cluster distance (2.26) was noticed between cluster-II and cluster-IV. These observations are in accordance with the results of Sridhar *et al.* (2003). The two genotypes present in cluster-X were early to flowering and genotypes fall under cluster-II were with high in grain yield per plant, 1000 grain weight, moderate panicle length and plant height. Whereas, two genotypes of cluster-IV had maximum plant height. Hence, these genotypes can be used in further breeding program to generate new varieties and hybrids.

The clusters mean for eight characters (Table 4) revealed considerable variation among the clusters. The characters *viz*., days to 50% flowering 67 (cluster-X) to 82 days (cluster-XI), days to maturity 111 (cluster-I) to 116 days (cluster-V), stem girth 2.01 (cluster-XI) to 1.74 cm (cluster-VII), plant height 192.50 (cluster-XII) to 137.75 cm (cluster-IV), Panicle length 13.90 (cluster-IX) to 10.05 cm (cluster-IV), panicle width 4.41cm (cluster-V) to 3.82 cm (cluster-I), 1000 grain weight 42.70 g (cluster-II) to 26.21 g (cluster-VI) and grain yield per plant 49.15 (cluster-II) to 30.65 g (cluster-XI).

Based on the overall score across eight traits, the clusters were ranked. Accordingly, cluster-XII with overall score of 37across the eight characters secured first rank followed by cluster-XIII, cluster-V, cluster-III, cluster-II, cluster-VIII, cluster-IX, cluster-X, cluster-XI, indicating the presence of most promising genotypes in them and can be extensively used for further breeding programme to generate new material. Since the results of this study indicated the maximum divergent clusters were cluster-X (Phule vasundra, SPV-86.) and cluster-V (Konnur-2, Mangalagi-4-1) followed by cluster-XI (Malkhed 2, Sugur-5), cluster-XII (Sugur-3, Tengalli-5),

Table 3 : Average intra and inter cluster distance of one hundred twenty one germplasm lines of sorghum

Clusters	1	2	3	4	5	6	7	8	9	10	11	12	13
1	5.60	5.66	5.18	4.95	5.27	5.64	4.74	6.01	5.06	6.83	6.41	5.80	7.40
2		1.38	5.08	2.26	5.29	4.78	5.34	4.08	6.63	8.51	5.31	5.95	7.94
3			1.39	4.89	4.87	3.06	4.60	5.39	4.34	6.52	5.05	2.34	7.23
4				1.44	4.31	4.21	4.10	3.94	5.42	7.26	5.25	5.75	7.22
5					1.64	5.48	2.68	5.80	3.86	4.04	6.78	5.81	6.26
6						1.64	5.11	5.29	4.95	7.07	5.17	3.43	7.77
7							1.72	6.37	3.71	4.01	7.19	5.85	6.36
8								1.77	5.97	8.93	2.95	5.34	7.84
9									1.80	4.16	5.88	4.34	6.32
10										1.95	9.35	7.16	7.18
11											2.00	4.46	8.26
12												2.03	7.62
13													8.43

Table 4 : Cluster wise mean performance of 121 germplasm lines of sorghum for yield and yield attributing characters

Clusters	No. of genotypes per cluster	Days to 50% flowering	Days to maturity	Stem girth (cm)	Plant height (cm)	Panicle length (cm)	Panicle width (cm)	1000 grain weight (g)	Grain yield per plant (g)	Overall score	Rank
I	61	73.00 (5)	111.00 (1)	1.84 (7)	159.46 (7)	12.38 (8)	3.82 (11)	35.98 (6)	37.50 (6)	51	9
II	2	76.00 (7)	113.00 (2)	1.96 (2)	142.75 (12)	10.20 (12)	4.05 (6)	42.70 (1)	49.15 (1)	43	5
III	2	75.00 (6)	114.00 (3)	1.79 (10)	186.00 (2)	11.75 (10)	4.09 (5)	39.15 (2)	39.20 (4)	42	4
IV	2	75.00 (6)	113.00 (2)	1.88 (5)	137.75 (13)	10.60 (11)	3.96 (9)	35.11 (8)	36.20 (9)	63	11
V	2	71.00 (3)	116.00 (5)	1.84 (7)	149.25 (10)	12.70 (6)	4.41 (1)	37.82 (4)	38.35 (5)	41	3
VI	2	76.00 (8)	115.00 (4)	1.82 (9)	172.00 (3)	10.05 (13)	4.09 (5)	26.21 (13)	34.90 (10)	65	12
VII	2	70.00 (2)	114.00 (3)	1.74 (11)	153.25 (9)	12.05 (9)	3.90 (10)	34.76 (9)	36.50 (8)	61	10
VIII	2	79.00 (10)	113.00 (2)	1.83 (8)	143.25 (11)	12.90 (5)	4.22 (3)	38.15 (3)	40.30 (3)	45	6
IX	2	72.00 (4)	113.00 (2)	1.89 (4)	169.50 (4)	13.90 (1)	4.02 (7)	26.69 (11)	34.30 (12)	45	6
X	2	67.00 (1)	115.00 (4)	1.82 (9)	166.00 (5)	13.20 (4)	4.31 (2)	26.54 (12)	34.85 (11)	48	7
XI	2	82.00 (11)	114.00 (3)	2.01 (1)	162.25 (6)	13.25 (3)	4.01 (8)	36.31 (5)	30.65 (13)	50	8
XII	2	76.00 (9)	113.00 (2)	1.90 (3)	192.50 (1)	12.45 (7)	4.22 (3)	33.58 (10)	42.45 (2)	37	1
XIII	38	71.00 (3)	113.00 (2)	1.86 (6)	156.91 (8)	13.54 (2)	4.12 (4)	35.32 (7)	36.89 (7)	39	2

cluster-IX(Mangalagi-9, Rawar-1), cluster-V (Konnur-2, Mangalagi-4-1) and cluster-II (M-35-1, Sonnur-2). The crosses between the germplasm lines in these clusters would yield high heterotic hybrids and desirable segregants in subsequent generations.

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