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EVALUATION OF SORGHUM GERMPLASM FOR GENETIC DIVERSITY USING D^2 STATISTICS

S. B. Doijad *et al.,*

KEYWORDS

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S. B. DOIJAD*, A. B. BAGADE, H. V. KALPANDE AND A. W. MORE
Department of Genetics and Plant Breeding,
Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402, Maharashtra, INDIA
e-mail: smi.doij@gmail.com

ABSTRACT

The D^2 statistics was applied to assess the diversity among 61 genotypes of sorghum. The analysis of variance revealed significant differences among the genotypes for all the characters under study. The genotypes were grouped into 15 clusters, where comprised of maximum number of 47 genotypes, while the rest of the clusters had one genotype each. Inter-cluster difference was maximum between the clusters XV and XIV (7.21)) followed by XV and IX (7.04) and cluster I showed highest intra-cluster value (3.28) which indicated that genotypes included in these clusters may give heterotic response and thus better segregants. Relative water content (17.76%) contributed the most to the genetic divergence of the genotypes followed by grain weight (16.23%), panicle weight (14.97%), days to 50% flowering (9.84%), plant height (8.80%) and fodder weight (6.34%).

***Corresponding author**

INTRODUCTION

Sorghum is one of the most important cereal crop grown in Africa, Asia, USA, Australia, and Latin America. Its importance after wheat, maize, rice and barley is because of its good adaptation to a wide range of ecological conditions, low input cultivation and diverse uses (Aruna *et al.*, 2011). With the present scarcity situation, sorghum cultivation is the heart of dryland agriculture, being C_4 plant it can utilize sunlight and water efficiently (Godbharle *et al.*, 2010). As a drought tolerant crop, it allows farmers to use one third less water than similar crops such as corn. Sorghum crop exhibits considerable differences in plant traits, panicle and grain characteristics including physiological responses to selection and is highly influenced by environmental factors (Ezeaku *et al.*, 1997).

In any crop improvement programme, study of genetic diversity is an essential prerequisite for hybridization. Genetic diversity can be worked out with the help of D2 analysis which has given by Mahalanobis (1936). For the first time use of this technique for assessing the genetic variability in plants was suggested by Rao (1952). In the present investigation efforts has been made to study genetic diversity amongst 61 genotypes of sorghum for 16 characters. The divergent lines belonging to different and distantly located clusters have a high probability of giving heterotic hybrids or superior progenies than those parental line belonging to same cluster or group processing low genetic distance (Kumar *et al.*, 2015).

As information on the nature and degree of genetic divergence would help the plant breeder in choosing the right type of parents for breeding programme, more emphasis should be given on the study of genetic diversity among the genotypes of sorghum with respect to yield related growth characters (Shinde *et al.*, 2013). So present investigation was undertaken to study genetic diversity among 61 genotypes of sorghum.

MATERIALS AND METHODS

The present field experiment on sorghum (*Sorghum bicolor* L. Moench) was conducted on the experimental farm at Sorghum Research Station, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.) during *rabi* 2013-14. The experiment was laid out in randomized block design with three replications (Panse and Sukhatme, 1967). The experimental material was sown at 23rd October, 2013 with plot size of 1 row of 2 m length and spacing of 45 x 15 cm. The standard agronomic practices were followed throughout the period of crop growth. The observations were recorded on five randomly selected plants from each entry per replication for plant stand, days to 50 % flowering, seedling vigour, number of leaves, leaf length, leaf breadth, plant height, panicle length, panicle girth, chlorophyll content %, relative water content, 100 seed weight, panicle weight, shootfly deadheart %, fodder weight and grain weight.

The data was subjected to statistical analysis. Wilk's criteria was used to test the significance of pooled differences in mean values for all the sixteen characters (Wilk, 1932). Genetic diversity was studied using Mahalanobis's (1936) D^2 statistic and clustering of genotypes was done according to Tocher's method as described

by (Rao, 1952).

RESULTS AND DISCUSSION

Analysis of variance revealed the significant differences among genotypes for all characters under study. Based on D^2 statistics and Tocher's method 61 genotypes were grouped into 15 clusters with a variable number of entries revealing the presence of considerable amount of genetic diversity in the material (Table 1). The cluster I comprised of maximum number of 47 genotypes, while the rest of the clusters had one genotype each. The pattern of distribution of genotypes into various clusters was at random suggesting that the genetic diversity was not related to geographic diversity. Similar results were reported by Kumar *et al.* (2010) in genetic divergence studies in *rabi* sorghum.

Average intra and inter-cluster D^2 (Table 2) values among all genotypes revealed that the solitary clusters showed intra-cluster value of 0.00, while cluster I (3.28) showed maximum intra-cluster distance. The inter-cluster D^2 values ranged from 2.76 to 7.21. Minimum inter-cluster D^2 values were observed between clusters IX and II indicating the close relationship among the genotypes included in these clusters. Maximum inter-cluster values were observed between the clusters XV and XIV (7.21) followed by XV and IX (7.04) which indicated that genotypes included in these clusters may give heterotic response and thus better segregants. These results are in conformity with Shivani and Sreelakshmi (2013).

The cluster means and contribution of each trait towards divergence are presented in (Table 3). The data revealed considerable differences among the clusters for most of the characters studied. Cluster X recorded highest mean for leaf length, chlorophyll content and grain weight, whereas cluster IV recorded highest mean for plant height and leaf breadth and lowest mean for seedling vigour and cluster VIII recorded highest mean for panicle weight. Cluster XIV recorded lowest mean for days to 50% flowering and shootfly deadheart %.

Among the 16 characters studied relative water content contributed the most (17.76%) to the genetic divergence of the genotypes followed by grain weight (16.23%), panicle weight (14.97%), days to 50% flowering (9.84%), plant height (8.80%) and fodder weight (6.34%). However, plant stand

Table 1: Distribution of sorghum genotypes in fifteen different clusters

Cluster No.	Number of genotypes included	No. of genotypes
Cluster I	IS 22040, IS10876, IS 6154, IS 22291, IS 21425, IS 10978, Gcp_Sb_0510, IS 2179, IS 25910, IS 20665, IS 20700, IS 10234, IS 29496, IS 29375, IS 2367, IS 19053, IS 6973, IS 25596, IS 14446, IS 5867, SSM 379, IS 3971, IS 303, IS 20713, E 36-1, IS 9911, IS 29569, IS 25442, Gcp_Sb_0659, IS 13, IS 1127, IS 9713, E 36-1, IS 20763, SSM 547, IS 9586, IS 19026, IS 22325, IS 4027, IS 3121, IS 29472, IS 2398, IS 2430, IS 6193, IS 32050, IS 4821, IS 20724	47
Cluster II	SSM 1370	1
Cluster III	IS 31693	1
Cluster IV	IS 27	1
Cluster V	IS 2807	1
Cluster VI	IS 29409	1
Cluster VII	IS 9713	1
Cluster VIII	IS 15526	1
Cluster IX	Parbhani Moti	1
Cluster X	SSM 501	1
Cluster XI	IS 30441	1
Cluster XII	IS 18922	1
Cluster XIII	IS 8348	1
Cluster XIV	IS 30619	1
Cluster XV	IS 4027	1

Table 2: Average intra and inter cluster distances (D^2) for fifteen clusters of *rabi* sorghum germplasm

	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI	Cluster VII	Cluster VIII	Cluster XI	Cluster X	Cluster XI	Cluster XII	Cluster XIII	Cluster XIV	Cluster XV
Cluster I	3.28	3.95	3.84	3.94	3.93	4.09	3.73	4.18	4.64	4.18	3.89	4.13	4.20	4.71	4.77
Cluster II		0.00	4.39	4.61	2.87	3.27	3.69	4.25	2.76	5.46	3.67	4.65	2.92	3.26	5.83
Cluster III			0.00	4.56	4.71	4.30	5.04	5.00	5.19	4.75	3.52	3.82	5.16	4.83	4.21
Cluster IV				0.00	3.33	3.62	2.90	5.23	5.25	3.29	4.72	5.15	4.24	5.23	5.16
Cluster V					0.00	2.85	2.91	4.47	4.26	4.54	4.12	5.29	3.37	4.60	5.47
Cluster VI						0.00	3.23	5.23	3.97	4.41	4.03	4.86	3.44	4.92	5.17
Cluster VII							0.00	5.10	4.72	4.07	4.91	4.93	3.01	4.53	5.56
Cluster VIII								0.00	4.65	5.00	3.88	4.95	5.39	5.43	6.09
Cluster IX									0.00	5.60	4.24	5.41	4.23	3.77	7.04
Cluster X										0.00	4.60	5.95	5.39	5.85	4.99
Cluster XI											0.00	5.16	5.33	4.42	5.84
Cluster XII												0.00	5.12	4.90	5.19
Cluster XIII													0.00	4.89	5.20
Cluster XIV														0.00	7.21
Cluster XV															0.00

Table 3: Cluster means for sixteen characters in *rabi* sorghum.

Cluster No.	Plant stand	Days to 50% flowering	Seedling vigour	Number of leaves	Leaf length (cm)	Leaf breadth (cm)	Plant height (cm)	Panicle length (cm)	Panicle girth (cm)	Chlorophyll content%	Relative water content%	100 seed weight(g)	Panicle weight (g)	Shootfly deadheart %	Fodder weight (g)	Grain weight (g)
I	24.47	74.38	3.11	7.07	54.82	4.90	165.35	16.40	14.71	51.09	64.59	2.64	48.89	64.00	274.43	62.85
II	22.00	64.33	3.67	6.67	51.19	5.03	138.33	18.30	13.73	49.90	83.72	2.15	53.00	57.57	219.33	60.00
III	25.00	76.33	4.00	6.00	49.41	3.85	137.67	14.63	12.83	40.39	64.77	2.98	45.00	87.63	211.33	48.00
IV	21.33	69.33	2.67	7.67	61.23	5.56	232.00	16.20	13.00	54.78	69.65	2.05	38.33	68.82	221.33	51.33
V	17.67	70.67	2.67	6.67	56.63	5.50	208.67	19.30	13.33	54.69	82.41	2.91	52.00	70.07	222.00	55.67
VI	20.33	74.33	2.67	6.67	50.63	4.54	215.00	14.97	13.57	38.99	81.88	2.28	48.67	52.29	156.67	67.67
VII	22.00	67.67	3.33	8.33	56.37	4.97	211.33	18.87	15.20	54.13	82.39	2.92	45.00	56.01	307.00	63.67
VIII	25.00	69.67	3.67	7.00	62.17	4.27	163.67	18.53	13.03	55.87	58.35	2.82	59.00	56.51	144.00	81.00
IX	30.67	62.67	2.33	6.00	59.33	5.20	125.00	13.83	14.23	45.79	83.96	2.05	52.00	48.33	166.70	64.00
X	24.67	78.67	2.67	7.33	64.06	4.89	186.67	14.33	14.83	57.19	66.65	3.01	38.67	74.42	127.00	88.00
XI	21.67	69.33	3.00	6.33	49.97	5.36	121.33	16.43	12.23	41.73	60.69	3.20	48.00	73.13	185.67	87.00
XII	25.00	70.67	4.33	6.33	43.23	3.94	189.33	16.07	16.67	45.81	57.90	2.26	54.33	53.11	194.67	33.00
XIII	20.67	69.67	3.67	7.67	58.69	5.03	184.67	12.97	14.84	50.45	88.44	1.74	52.33	56.06	330.33	59.00
XIV	19.00	57.33	3.33	6.33	52.85	5.14	96.00	18.50	15.53	51.12	76.76	3.00	44.00	48.05	171.76	39.67
XV	23.33	98.00	5.00	7.00	54.97	4.67	197.67	15.20	14.13	52.20	63.99	2.08	49.33	70.30	280.33	56.00

Table 4: Percentage contribution of different characters towards genetic divergence in *rabi* sorghum.

Sr. No.	Characters	Percentage contribution
1	Plant stand	0.77
2	Days to 50% flowering	9.84
3	Seedling vigour	1.80
4	Number of leaves	1.69
5	Leaf length (cm)	2.95
6	Leaf breadth (cm)	1.86
7	Plant height (cm)	8.80
8	Panicle length (cm)	3.93
9	Panicle girth (cm)	4.81
10	Chlorophyll content %	1.42
11	Relative water content	17.76
12	100 seed weight (g)	2.90
13	Panicle weight (g)	14.97
14	Shootfly deadheart %	3.93
15	Fodder weight (g)	6.34
16	Grain weight (g)	16.23

indicated narrow range of diversity among the genotypes under study.

The data on inter-cluster distances were used to select genetically diverse and agronomically superior genotypes. The genotypes exceptionally good with one or more characters were seemed to be desirable. Inter-crossing of divergent groups would lead to greater opportunity for crossing over, which releases hidden potential variability by disrupting the undesirable linkages (Thoday, 1960). The progeny derived from such diverse crosses are expected to have wide spectrum of genetic variability, providing a greater scope for isolating transgressive segregants in advanced generations.

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