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Research Article

Genetic divergence studies in foxtail millet (*Setaria italica* L.)

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Abstract

Present investigation was made to study the nature and magnitude of genetic divergence in 66 foxtail millet genotypes using multivariate analysis through Mahalanobis 'D^2 statistics. The analysis suggested considerable genetic divergence among the material. D^2 statistics resulted in five clusters. Based on relative magnitude of D^2, the genotypes were grouped into five different non-overlapping clusters. Cluster I, having 36 genotypes, emerged with highest number of entries; cluster II were constituted by 15 genotypes. Cluster III comprising 13 genotypes. Cluster IV and V having one genotype each. The maximum intra-cluster distance was observed for cluster II, followed by cluster III and cluster I. The highest inter-cluster distance was recorded between cluster IV and III followed by cluster IV and V, then cluster IV and I followed by cluster III and I. Among the 13 characters studied highest contribution in manifestation of genetic divergence was exhibited by grain iron content (ppm) followed by flag leaf length, grain zinc content (ppm), straw weight, flag leaf area, plant height, flag leaf width, panicle weight and grain yield.

Key words

Foxtail millet, Genetic Divergence, D^2, Canonical analysis

Introduction

Millet is one of the oldest cereals and resources of farmers in the drought prone area of the world. Millets are able to grow in poor soils in the drier regions and in the hottest climates, where no other cereal can grow and yield high (Howarth *et al*., 2002). Foxtail millet (*Setaria italica* L.) is one of the oldest cultivated millet crop serving as food grain in Asia and as forage/fodder in America, Australia and Africa. Foxtail millet ranks second in the world's total production of millets and is an important staple food for millions of people in southern Europe and Asia (Marathee, 1993). According to Vavilov (1926), the principal centre of diversity for foxtail millet is East Asia, including China and Japan. Several hypotheses concerning the origin and domestication of foxtail millet have been proposed (Kawas and Sakamoto, 1984; Nguyen and Pems, 1985; Vavilov, 1926). A multiple domestication hypothesis is widely accepted. Foxtail millet is non-glutinous, like buckwheat and quinoa, and it is not an acid forming food, so it is soothing and easy to digest. The millet bran is used as animal feed in China extensively. The protein in foxtail millet is relatively high with leucine and methionine. Some foxtail millet varieties contain 100% amylopectin, and the starches contained in foxtail, proso and barnyard millets are more digestible than maize starch. There is wide genetic diversity available and characterizing these resources is prerequisite for the genetic improvement of its cultivars. The generalized distance concept of Mahalanobis' is based on multivariate analysis of quantitative traits. It is used to measure the genetic divergence and to classify the genetic stock into distinct groups. Intercrossing between more divergent parents is expected to generate a broad spectrum of variability and selection to be adopted in the segregating generations. Considering this, the present study was taken up in foxtail millet to understand the diversity available in the genetic stocks.

Materials and method

Sixty six accessions from National Bureau of Plant Genetic Resources (NBPGR), Dr. PDKV, Akola and some districts of Maharashtra were collected and grown in *kharif* 2014 in the Field of agricultural botany, Biotechnology Centre, Department of Agricultural Botany, Dr. Panjarao Deshmukh agricultural University, Akola. Each accession accommodated in one row with row spacing of 45 cm and plant to plant distance of 10 cm. All accessions were raised in Randomized Block Design with three replications. Data were recorded on various morphological traits such as number of tillers, days to 50 per cent flowering, flag leaf length (cm), flag leaf width (cm), flag leaf area (cm^2), panicle length (cm), panicle weight (g), plant height (cm), straw weight (g), 1000 grain weight (g), grain Zinc content (ppm), grain Fe content (ppm) and grain yield/plant (g). The mean data recorded on ten random plants per entry in each plot were subjected to analysis of variance as well as multivariate analysis of D^2 statistics according to Mahalanobis' (Mahalanobis, 1936) The genotypes were grouped on the basis of minimum generalized distance using Tocher's method as described by Rao (Rao, 1952).

Result and discussion

The analysis of variance showed highly significant differences among the genotypes for 10 out of 13 characters studied. Wilk's criterion has shown highly significant differences among the genotypes for the aggregate effect of all the characters. The Mahalanobis D^2 cluster analysis grouped all the 66 foxtail millet accessions of the present investigation into five distinct non-overlapping clusters (Table 1 and Fig. 2). The discrimination of genotypes into discrete clusters suggested presence of high degree of genetic diversity in the material evaluated. Presence of substantial genetic diversity among the parental material screened in the present study indicated that this material may serve as good source for selecting the diverse parents for hybridization programme aimed at isolating desirable segregants for seed yield, grain iron content and other important characters.

The estimate of intra and inter cluster distance estimated that the highest intra cluster distance is of cluster II (3122.35) followed by cluster III (2335.98) and cluster I (1914.78). Cluster IV and cluster V are having one genotype each hence the intra cluster distance for these two clusters was found to be (0.00). Inter cluster distance was found highest between the clusters III and IV (15878.08), followed by cluster IV and V (11650.90). Cluster I having 36 genotypes, emerged with highest number of entries; cluster II were constituted by 15 genotypes. Cluster III comprising 13 genotypes while cluster IV and V having one genotype each (Table 2 and Fig.1).

The cluster means of different characters in various clusters gives clear idea about parent selection for improvement of various traits. Cluster mean (Table 3) for number of tillers is highest in cluster V (8.13). Cluster mean for days to 50 per cent flowering was lowest in cluster IV (43.33). Cluster mean for flag leaf length is highest in cluster IV (84.06) followed by cluster II (68.57). Cluster mean for flag leaf width is highest in cluster IV (2.74) followed by cluster III (2.61) and cluster II (2.59). Cluster mean for flag leaf area is highest in cluster V (98.47) followed by cluster IV (86.85). Cluster mean for plant height is highest in cluster II (151.65) followed by cluster V (148.60) and cluster IV (146.60). Cluster mean for panicle length is highest in cluster II (18.92). Cluster mean for panicle weight is maximum in cluster IV (14.04). The cluster mean for 1000 seed weight is nearly same for all the clusters it is not contributed to genetic diversity of population. Cluster mean for straw weight was maximum for cluster IV (50.40). Cluster mean for grain iron content and grain zinc content was found higher for cluster III (54.33) and cluster IV (48.73) cluster mean for grain yield/plant was higher for cluster II (9.05). Hence, for bio-fortification (Zn, Fe) we can select the parents from these two clusters.

The above discussion showed wide variation between clusters. The discrimination of genotypes into discrete clusters suggested presence of high degree of genetic diversity in the material evaluated. Presence of substantial genetic diversity among the parental material screened in the present study indicated that this material may serve as good source for selecting the diverse parents for hybridization programme aimed at isolating desirable segregants for seed yield and other important characters. Grain iron content was 1098 times ranks first and contributes 51 per cent of total genetic divergence. It is important to establish an breeding programme for biofortification for grain iron content which is helpful for the peoples in tribal areas where they eat this crop as major food crop particularly in Melghat region of Maharashtra state (India), south India particularly Tamil Nadu and Andhra Pradesh.

References

Howarth, C. J. and Yadav, R.S. 2002. Successful marker assisted selection for drought tolerance and diseases resistance in Pearl millet. *IGER Innovation*: 18-21.

Kawas, M. and Sakamoto, S. 1984. Variation, geographical distribution and genetic analysis of esterase isozyme in foxtail millet, *Setaria italica* (L.) P. Beauv. *Theor. Appl. Genet.* **67**: 523-533.

Mahalanobis, P.C. 1936. "*On the Generalized Distance in Statistics*" Proceedings of National Institute of Sciences (India), pp. 49-55.

Marathee, J.P. 1993. *Structure and characteristics of the world millet economy*. Pages 159–178 in Advances in small millets (Riley KW, Gupta SC, Seetharam A and Mushonga JN, eds.). New Delhi, India: Oxford & IBH.

Nguyen, E. van and Pems, J. 1985. Genetic diversity of foxtail millet (*Setaria italica*). In: P Jacquard *et al. (*Eds). Genetic Differentiation and Dispersal in Plants, pp. 98-104. NATO ASI series, Vol. G5, *Springer- Verlag*, Berlin, Heidelberg.

Rao, C.R. 1952. *Advanced Statistical Methods in Biometrical Research*. John Willey and Sons, Inc, New York: 357-363.

Vavilov, N.I. 1926. *Studies on the Origin of Cultivated Plants.* Inst. Appl. Bot. Plant Breed., Len'ingrad. p. 248.

Table 1. Cluster composition based on D^2 statistics in foxtail millet genotypes

Cluster	No. of genotypes	Accessions included in cluster
Cluster I	36	IC97111, IC120166, IC120177, IC58243, IC97123, C97172, IC41898, IC97109, IC97086, IC97295, IC97087, IC41883, IC28439, IC97182, IC120406, IC120175, IC120148, IC97179, AKL, IC120201, IC120407, IC120404, IC325968, IC120251, IC120200, IC344225, LEPAKSHI, IC120394, IC120204, IC120164, IC97174, IC120208, IC480117, IC120234, IC120210, IC120165
Cluster II	15	IC120255, IC120408, IC120346, IC120191, IC120244, IC120250, PRASAD, IC120207, IC120221, IC120212, IC200125, IC120213, IC344224, IC120228, IC120355
Cluster III	13	IC120150, IC120163, IC97189, IC120160, IC120159, IC97175, IC120179, IC120235, IC120239, IC403579, IC120158, IC97177, IC120192
Cluster IV	1	JLG
Cluster V	1	IC372606

Table 2. Estimates of average intra- and inter-cluster distances in pigeon pea

Clusters	**I**	**II**	**III**	**IV**	**V**
I	1914.78	5933.18	8230.42	8586.36	6202.50
II		3122.35	5700.02	7918.81	6601.87
III			2335.98	15878.08	8219.74
IV				0.00	11650.90
V					0.00

Table 3. Cluster mean of 13 characters in foxtail millet

	Number of tillers	Days to 50% flowering	Flag leaf length (cm)	Flag leaf width (cm)	Flag leaf area (cm^2)	Plant height (cm)	Panicle length (cm)	Panicle weight (gm)	1000 seed weight (gm)	Straw weight (gm)	Grain iron content (ppm)	Grain zinc content (ppm)	Grain yield/ plant (gm)
Cluster I	6.77	54.87	40.60	2.37	51.98	138.28	17.19	4.08	2.49	23.86	20.78	36.42	5.88
Cluster II	6.63	57.07	68.57	2.59	69.23	151.65	18.92	4.31	2.35	26.48	37.03	31.36	9.05
Cluster III	5.83	57.05	41.09	2.61	62.27	145.96	18.52	4.65	2.5	32.04	54.33	37.89	4.93
Cluster IV	4.07	43.33	84.06	2.74	86.85	146.60	13.42	14.04	2.51	50.40	10.88	48.73	3.58
Cluster V	8.13	52.00	37.9	1.45	98.47	148.60	17.87	3.04	2.31	18.37	29.89	8.44	3.94

Table 4. Per cent contribution of characters towards genetic diversity

Source	Times rank 1^{st}	Contribution
Number of tillers	1	0.05%
Days to 50% flowering	1	0.05%
Flag leaf length	549	25.59%
Flag leaf width	26	1.21%
Flag leaf area	58	2.70%
Plant height	57	2.66%
Panicle length	0	0.00%
Panicle weight	19	0.89%
1000 seed weight	4	0.19%
Straw weight	75	3.50%
Grain iron content	1098	51.19%
Grain zinc content	246	11.47%
Grain yield	11	0.51%

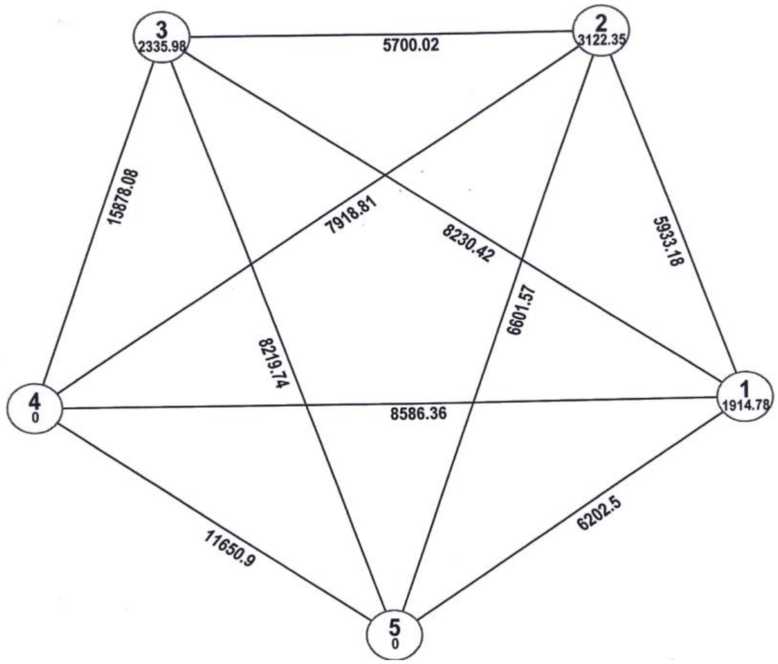

Fig. 1: Cluster diagram showing Euclidean^2 distance

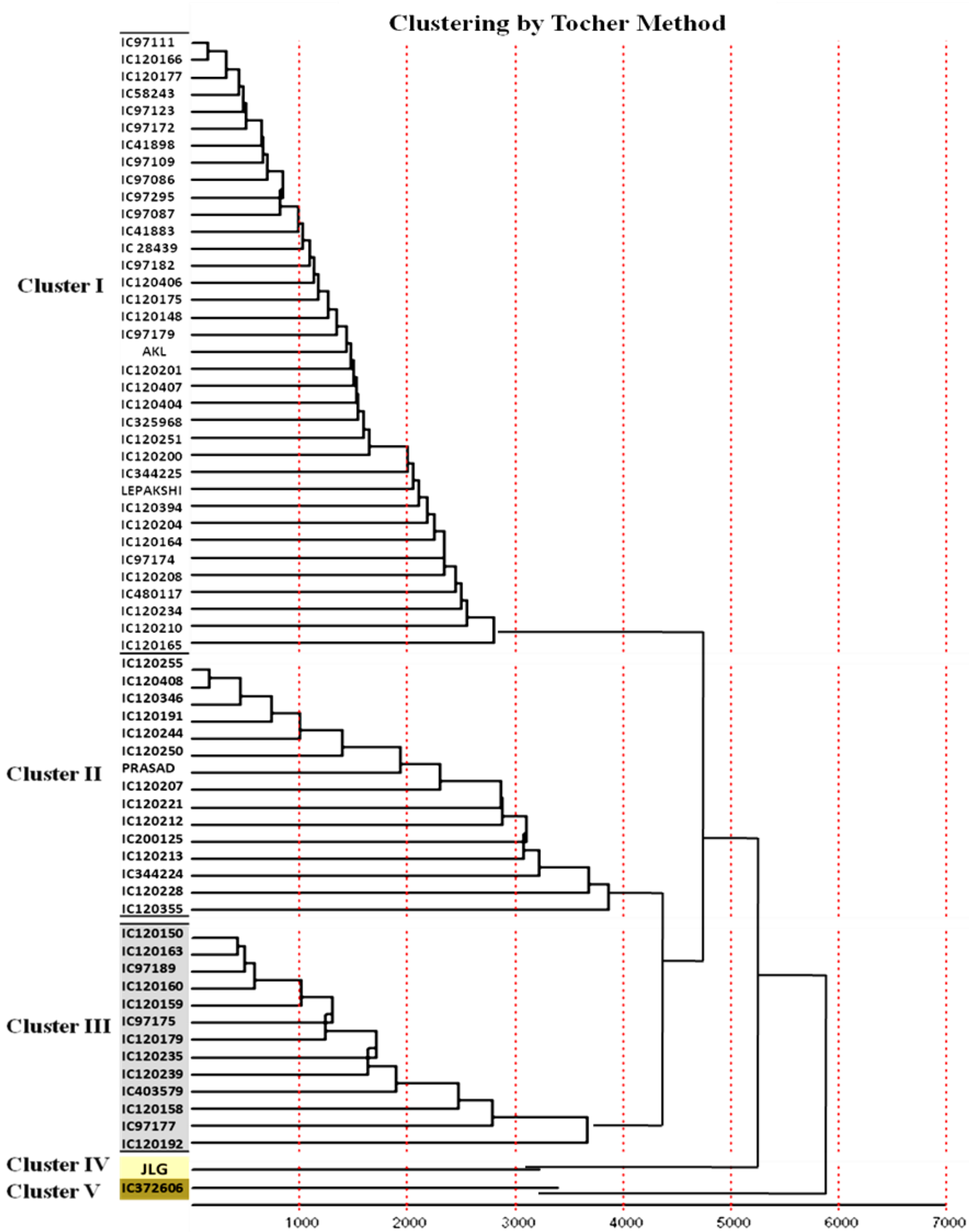

Fig. 2. Ward's minimum variance dendrogram