Original Research Article

Grouping of disease resistant sorghum genotypes based on cluster analysis multivariate tool

Abstract:

Sorghum is the fifth leading cereal grain worldwide after wheat, rice, maize and barley in terms of production and cultivated area. One of limiting factor for the production of sorghum is disease incidence which majorly affects the crop yield. The current study is based on the secondary data collected from All India Co-ordinated Research Project (AICRP) on Sorghum, Dharwad Centre. Forty-four genotypes were grown in Initial advanced hybrid trials and forty-three genotypes which were grown in Varietal trial were studied for disease incidence of Downy mildew, Charcoal rot and Rust. All the genotypes were clustered based on the disease scores by using Hierarchial Clustering method. The between group linkage and dendogram grouped Forty-four hybrids into two clusters and forty-three varieties into three clusters. Results shows that CSV 22 and CSV 29 R are highly resistant to charcoal rot and resistant to both downy mildew and rust whereas SPV2758 and SPV2746 were highly susceptible to downy mildew, resistant to rust and moderately resistant to charcoal rot. The identified genotypes in this study can be used as multiple disease resistant source in breeding programme for varietal/ hybrid development.

Introduction:

Sorghum bicolor (L.) Moench commonly known as 'Jowar' is one of India's most important millets belonging to the 'Poaceae' family. Sorghum is the fifth leading cereal grain worldwide after wheat, rice, maize and barley in terms of production with a cultivated area of about 40.67 m ha (Million hectares) and total production of 57.61 MMT (Million metric tons) (FAOSTAT, 2017). In India, it is cultivated on 3.84 m ha with the production and productivity of 3.76 m. t. and 979 kg ha^{-1} respectively (Anon., 2018). The major sorghum cultivating states are Maharashtra, Karnataka, Rajasthan, Tamil Nadu and Andhra Pradesh. It is being grown in two seasons *viz.*, *kharif* season as a rainfed crop and *rabi* season under remaining soil moisture conditions. In Karnataka, it is cultivated on 10.90 lakh hectares of which 1.16 lakh hectares in *kharif* and 9.74 lakh hectares in *rabi* with production and productivity of 11.50 lakh tons and

1,052 kg ha^{-1} respectively (Anon., 2016). The major sorghum cultivating regions in Karnataka are Kalburgi, Vijayapura, Belagavi, Gadag, Bagalkote and Raichur.

Charcoal rot caused by *Macrophomina phaseolina* (Tassi.) Goid is a major disease among biotic stresses in post rainy season and it causes major loss in grain and fodder yield. In India, almost all the cultivated hybrids and varieties are susceptible to charcoal rot (Jahagirdar, 2007). The disease is well characterized by poor grain filling, premature leaf senescence and crop lodging. Internally, the stem pith of infected plants becomes disintegrated and the separated, fibro vascular bundles are covered with the small black sclerotial bodies of the fungus which give the stem a blackened appearance, hence the name charcoal rot.

The sorghum crop is hampered by several biotic stresses, one of the most devastating diseases is downy mildew. The disease is caused by a soil-borne *Peronosclerospora sorghi* fungus but, it is also transmitted through air borne conidia or sporangia.

Rust is caused by *Puccinia purpurea Cooke*. The symptoms are usually observed in plants aged 1to 1.5 months. Minute flecks of different color (purple, tan or red) first appear on lower leaves. In resistant varieties the symptoms develop no further. In susceptible ones, as they fill with spores, the flecks turn into powdery, purplish, slightly raised pustules, circular to elongated in shape. They are loosely scattered or in patches and may darken even further as the plant matures.

Cluster analysis is one of the important Multivariate tool which is mainly used for grouping. Cluster analysis is applied to group the varieties grown in Hybrid trials which are resistant to major Rabi diseases like charcoal rot, rust and downy mildew. And further to make an appropriate selection of resistant source. The paper focuses on selection of disease resistant Sorghum genotypes for agricultural purpose.

Materials and Methods:

The study is based on the secondary data collected on disease incidence of Downy mildew, Charcoal rot and Rust from Forty-four genotypes which were grown in Initial advanced hybrid trials and forty-three genotypes which were grown in Varietal trial in All India Co-ordinated

Research Project (AICRP) on Sorghum, Dharwad Centre. In the present study Cluster analysis is done in an attempt to combine cases into groups. Hierarchical Clustering method based on squared Euclidian distance was done by using statistical software SPSS16.

Result and discussion:

Hierarchical cluster analysis was used to group the genotypes which are grown in advance varietal trials and advanced hybrid trials in the year 2019. Distances were calculated based on squared Euclidean distance by Agglomeration method.

Clustering of genotypes grown in advanced hybrid trials.

Grouping of 44 genotypes, which are grown in advanced hybrid trials based on the scores of major disease like, charcoal rot, downy mildew percentage, and rust. The genotypes classified into two clusters each containing 26 and 18 genotypes respectively which are presented in **Table-1.** For downy mildew disease the mean performance of the clusters were 20 and 9 respectively. It indicates that cluster I was susceptible and cluster II is moderately resistant. Similarly for rust the mean performance of clusters were 2.9 and 3 which shows all genotypes were resistant respectively. The mean performance of the clusters was given in **Table-2.**

Among 18 genotypes in cluster II, eight genotypes like CSV 22, CSV 29 R(Deep soil), SPH 1897, CSV 29R, SPV 2468, SPV 2640, SPV 2644, SPV 2649 and M 35-1 shows the multiple disease resistance . In these 8 genotypes CSV 22 and CSV 29 R can be used as multiple disease resistant source in breeding programmes for varietal/ hybrid development as they are highly resistant to charcoal rot and resistant to both downy mildew and rust. The similarity between these two genotypes was more because of less distance between them (*i.e.*, 3.576). and the dendogram of cluster analysis is presented in **Fig.1.**

The present study was supported by Umamaheshwari (2008) who used Tocher's method of hierarchal cluster analysis for grouping of 41 sorghum genotypes based on 11 quantitative characters to study the genetic differentiation of landraces and varieties through morphological and molecular markers.

Clustering of Genotypes grown in Initial varietal trials (IVT)

On the basis of cluster analysis, 43 genotypes were grouped into three clusters **(Table-3)** Maximum number of genotypes was grouped into cluster II (*i,e.* 32) and cluster I and cluster III contains 9 and 2 genotypes.

In IVT 43 genotypes were grown in the year 2019 which were grouped into three clusters. Cluster I contains genotypes which are resistant and moderately resistant to both charcoal rot and rust but Susceptible to downy mildew.

Cluster II contains more genotypes which were moderately resistant to charcoal rot, resistant to rust and susceptible to downy mildew. Whereas, Cluster III had genotypes which were highly susceptible to downy mildew, resistant to rust and moderately resistant to charcoal rot. The dendrogram is presented in **Fig.2.**

Reference:

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Umamaheshwari, 2008, Genetic differentiation of landraces and varieties in sorghum through morphological and molecular markers. *M.Sc. (Agri.) Thesis*, TNAU, Tamil Nadu.

Verma, A., Dhanik, J., Agarwal, D., Arya, N. and Nand, V., 2018, Qualitative phytochemical and cluster analysis of genotypic extracts of coriander leaves and seeds from Tarai and Kumaun regions of Uttarakhand, Himalayan state of India. *Int. J. Chem. Studies*., 6 (2): 1566-1571.

Table -1. Clusters of genotypes in Initial advanced hybrid trial (IAHT)

	No. of	**Genotypes**

	genotypes	
Cluster I	**26**	SPH1903, SPV2653, SPV2654, SPV2655, SPV2658, SPV2660, CSH 13 ,CSH 15R , M35-1 , Phule Anurada, SPH1869, SPH1931, SPV2635, SPV2636, SPV2639, SPV2641, SPV2642, SPV2643, SPV2647, SPV2648, CSH 15R, SPV2656, CSV26, Phule Maule, CSH13, SPV2747.
Cluster II	**18**	SPV2562, SPV2657, SPV2659, SPV2661, SPV2662, CSV 29R, E36-1, SPH1897, SPV2468, SPV2638, SPV2640, SPV2644, SPV2645, SPV264, SPV2649, CSV 22, CSV 29R, M35-1.

Table -2. Cluster means of genotypes

	Charcoal rot index	Downy mildew	Rust
Cluster I	**15**	**20**	**2.9**
Cluster II	**14**	**9**	**3**

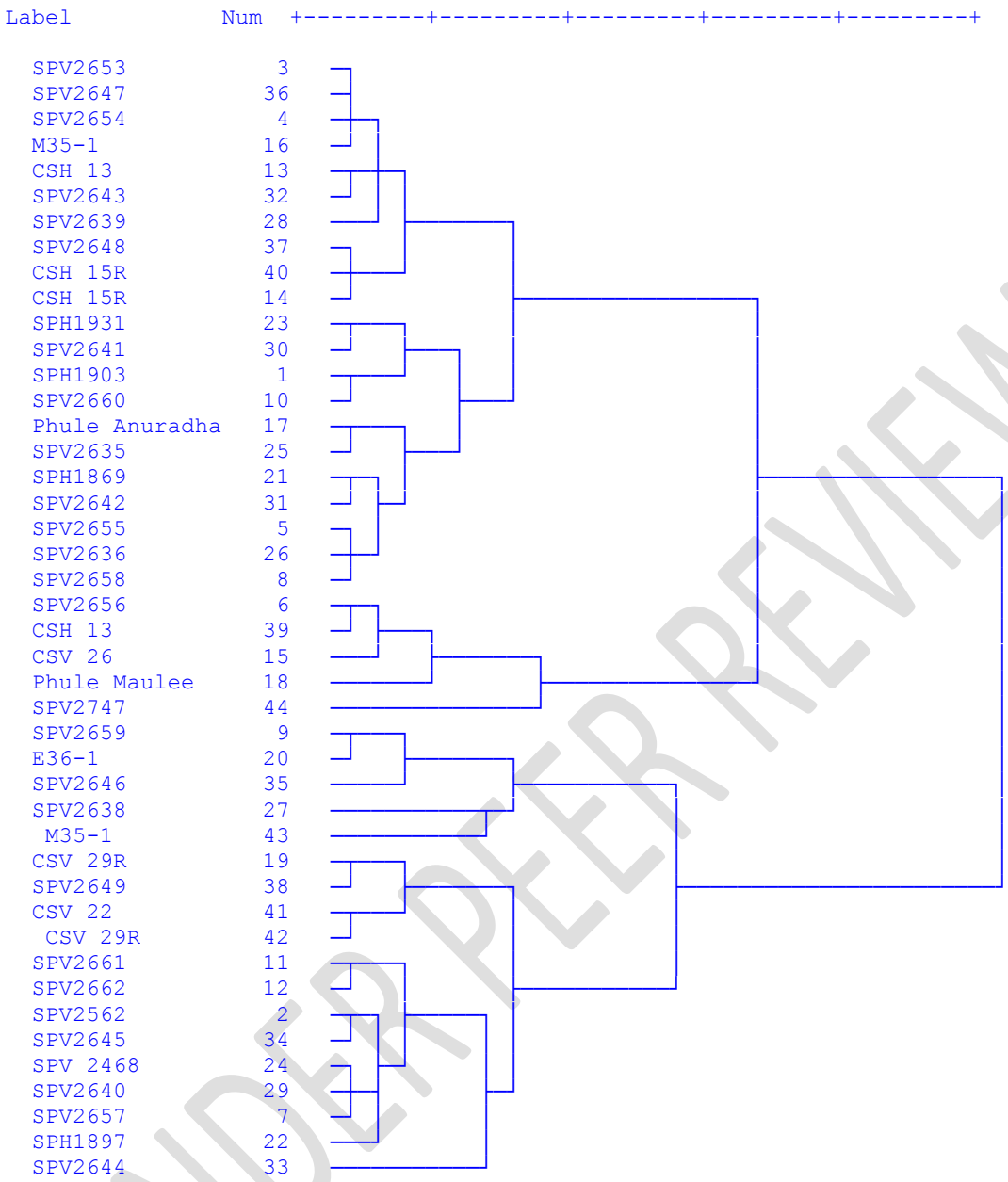

Fig. 1. Dendrogram using Average Linkage (Between Groups) for genotypes of IAHT

Table -3. Clusters of genotypes in Initial varietal trial (IVT)

	No. of genotypes	Genotypes
Cluster I	**9**	SPV2748, SPV2756, SPV2760, CSH13, Phule Maule, CSV13, SPV2740, SPV2741 , SPV2745.
Cluster II	**32**	SPV2749, SPV2750, SPV2751, SPV2752, SPV2753, SPV2754, SPV2755, SPV2757, SPV2759, CSH 15R, CSH 39R, CSV 26, Phule Anuradha, SPH1963, SPH1964, SPH1965, SPV2732, SPV2733, SPV2734, SPV2735, SPV2736, SPV2737, SPV2738, SPV2739, SPV2742, SPV2743, SPV2744, CSH 13, CSH 15R, CSH 39R, CSV 22, CSV 29R
Cluster III	**2**	SPV2758, SPV2746.

Table -4. Cluster means of genotypes

	Charcoal rot index	Downy mildew	Rust
Cluster I	**10**	**15**	**3**
Cluster II	**16**	**22**	**3**
Cluster III	**22**	**33**	**3**

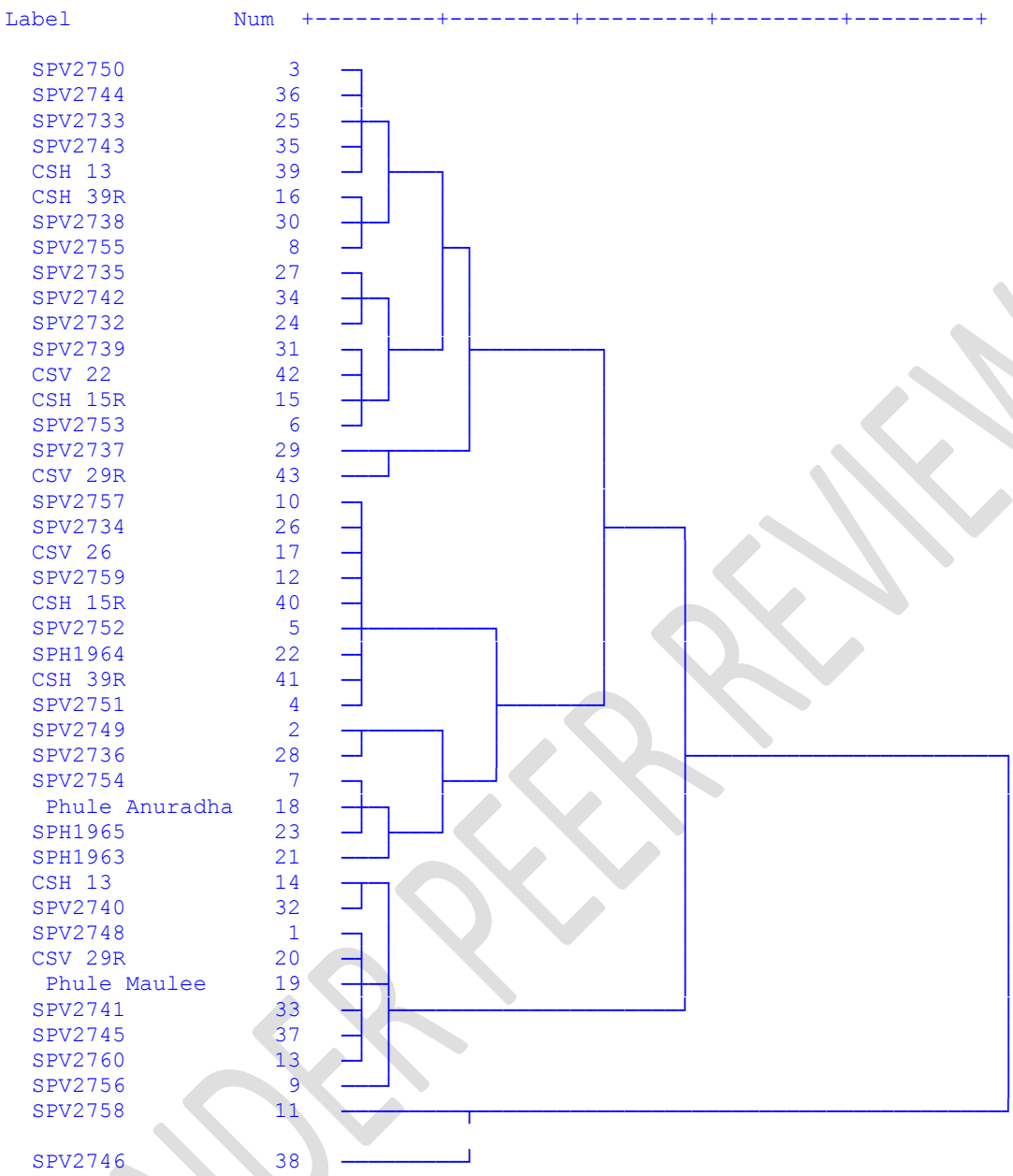

Fig. 2. Dendrogram using Average Linkage (Between Groups) for genotypes of IVT