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Genetic Diversity Analysis in Pearl Millet (*Pennisetum glaucum*) Hybrids under Arid Region

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ABSTRACT: Selection plays the most important role in any successful crop improvement programme. The goal of this study was to determine the diversity of ninety pearl millet hybrids that were examined in RCB design at the ARS in Bikaner during the 2017 *kharif* season. The results found that hybrids were divided into nine groups, with cluster I having 43 hybrids, cluster III having 24 hybrids, and cluster II having 17 hybrids, while the remainder were unique. Cluster III had the greatest intra-cluster distance, whereas clusters II and IX had the greatest inter-cluster distance. RMS 7A × BIB 177, RMS 7A × BIB 12, RMS 7A × BIB 49, and RMS 7A × BIB 175 are high yielding hybrids that fall into three separate clusters: cluster I, cluster II, and cluster III. As a result, these various hybrids might be recommended for enhancing pearl millet yield and productivity in the dry zone.

Keywords: Bajra, Diversity, Hybridization, Selection.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) R.Br.), also known as "Bajra," "Bari," "Sajja," "Combination," "Ganti," and "Kambam," is a coarse cereal in the Poaceae family. Because of the protogynous nature of its hermaphrodite flowers, pearl millet is a highly cross-pollinated plant. Pearl millet can thrive in a number of soil types, including sandy, light-textured soil, and it can even grow in acidic, low-fertility soil. After rice, wheat, and sorghum, pearl millet is the world's sixth most significant cereal crop and India's fourth most important cereal crop. It was first found in West Africa and then spread to India. Pearl millet grains are high in nutrients and are consumed by around 10% of India's population as a staple food. The states of Rajasthan, Uttar Pradesh, Gujarat, Maharashtra, Haryana, Karnataka, Tamil Nadu, Madhya Pradesh, and Andhra Pradesh are the leading producers of pearl millet. The average production of pearl millet in Rajasthan is approximately 8.72 qtls/ha, which is extremely low due to the state's dry climate and poor producing cultivars.

In a cross-pollinated crop like pearl millet, hybrid variants have a clear advantage over composites and synthetic kinds. Pearl millet breeding strategies have been directed at maximising hybrid vigour for grain and forage yields (Ouendeba *et al.* 1993). Multivariate analysis, using the D^2 statistic (1928), has been used to determine the degree of divergence at the genotypic level and to examine the proportional contribution of various traits to the overall divergence. This study serves as a foundation for categorising germplasm collections into more or less homogeneous groups, hence lowering the size of the germplasm collection to be examined. The D^2 statistic has been effectively utilised in multivariate analysis to choose divergent genotypes in order to leverage heterosis and bring together a greater frequency of desired genes in segregants. Previously diversity studies were analysed by numerous researchers such as Tomar et al. (1995) carried out cluster analysis in 21 bajra genotypes and assigned the genotypes to four clusters, Berwal and Khairwal (1997) grouped 42 bajra accessions into nine clusters, Mahavar *et al.* (2004) evaluated hundreds of bajra accessions and grouped into three clusters. Vidyadhar and Devi (2007) evaluated 78 pearl millet accessions and grouped into six groups, Govindaraj *et* *al*. (2011) studied sixty one pearl millet accessions and grouped into eight clusters. Kumar *et al*. (2017) evaluated 50 hybrids of pearl millet and grouped into 10 clusters. As a result, understanding genetic divergence helps a breeder to choose appropriate and divergent genotypes for use in breeding methods.

MATERIALS AND METHODS

The current study used 87 hybrids and three checks of pearl millet received from the AICRP on Pearl Millet, ARS, Bikaner. During the *kharif* season 2017-18, the experiment materials were grown in RBD with two replications with 60 cm row to row spacing and 15 cm between plants, and the entire prescribed package of procedures were followed to create a good and robust crop stand. Data were recorded on ten agronomic traits viz., days to 50 per cent flowering, days to maturity, plant height (cm), number of effective tillers per plant, ear head length (cm), ear head diameter (cm), test weight, harvest index, biological yield per plant (g) and Seed yield per plant (g). Character observations, such as days to 50 per cent flowering and days to maturity were recorded on a plot-by-plot basis, with the remaining attributes being recorded on a five-plant basis for each trait. Mahalanobis (1928) evaluated the genetic divergence in pearl millet hybrids using the D^2 statistic, as recommended by Rao (1952).

RESULTS AND DISCUSSION

D^2 analysis (Mahalanobis, 1928) was carried out to estimate genetic divergence among 90 genotypes of pearl millet. Grouping of the genotypes was done by Tocher's method. The test of significance for multiple measurements using 'V' statistics confirmed significant differences among the genotypes for all the observed characters which indicated that the substantial amount of genetic variability was present in the genetic material. All the 90 genotypes were clustered in 9 clusters.

Average intra and inter cluster divergence. Average intra and inter cluster D^2 values among 90 genotypes (Table 1) revealed that clusters IV, V, VI, VII, VIII and IX showed minimum intra cluster values (0.00). The intra-cluster distance was maximum (34.03) in cluster III followed by cluster I (32.91) and cluster II (29.49). Average inter cluster D^2 values were also calculated. The maximum (777.23) inter-cluster distance was observed between clusters II and cluster IX and minimum (48.98) inter-cluster distance was present between clusters VIII and cluster IX. The clusters II and IX having maximum inter-cluster distance showed that their members were far apart from each other, while members of clusters VIII and IX having minimum inter-cluster distance were quite close. Other inter-cluster distances were categorized as low (<50), medium (50-100) and high (>100). The clusters I and III, I and VIII, I and IX, II and III, II and IV, II and V, II and VI, II and VIII, II and IX, III and VI, III and VII, III and VIII, III and IX, IV and VIII, IV and IX, V and VI, V and VIII, V and IX, VI and VIII, VI and IX, VII and VIII, VII and IX had high inter-cluster distances. The clusters I and II, I and IV, I and V, I and VI, I and VII, II and VIII, III and IV, III and V, IV and V, IV and VI, IV and VII, V and VII, VI and VII had medium inter-cluster distances while clusters I and I, II and II, III and III, VIII and IX, had low inter-cluster distance. These results are in agreement to the earlier findings by Vidyadhar and Devi (2007); Govindaraj *et al.* (2011); Kumari *et al.* (2016); Kumar *et al.* (2017).

Table 1: Average intra and inter-cluster distance based on corresponding D^2 values.

Clusters	I	II	III	IV	V	VI	VII	VIII	IX
I	32.91	86.04	125.05	60.06	56.46	78.3	53.7	369.43	432.16
II		29.49	316.81	178.35	157.8	103.67	88.02	670.72	777.23
III			34.03	80.68	80.86	217.17	152.84	111.12	139.82
IV				0	98.87	59.19	86.02	294.04	289.23
V					0	160.5	76.5	233.23	317.31
VI						0	80.33	527.17	540.79
VII							0	348.26	459.52
VIII								0	48.98

The distribution pattern of all the genotypes in 9 different clusters is presented in Table 2. Maximum numbers of genotypes (43) were present in cluster I followed by cluster II with (17), and cluster III with (24) genotypes. Rest of the clusters namely IV, V, VI, VII, VIII, IX had single genotype in each cluster. Based upon the cluster mean performance the cluster III had high mean values for number of effective tillers per plant. While cluster IV had high mean value for harvest index (%) and seed yield per plant (g). While cluster V had high mean value for plant height (cm) and ear head length (cm). Cluster VI had high mean values for ear head diameter (cm). Cluster VII had high mean values for biological yield per plant (g). Cluster VIII had high mean values for days to maturity. Cluster IX had high mean values for days to 50% flowering and test weight (g). Present study is corroborative with the findings of Savery and Parsad (1995); Tomar *et al.* (1995); Mahawar *et al.* (2004); Vidyadhar and Devi (2007); Kumari *et al.* (2016); Kumar *et al.* (2017).

Table 2: Clustering pattern of different hybrids in different clusters.

Cluster	Number	Genotypes
I	43	ICMA 843-22A × BIB 114, ICMA 843-22A × BIB 184, ICMA 843-22A × BIB 46, ICMA 843-22A × BIB 190, ICMA 843-22A × BIB 182, ICMA 843-22A × BIB 36, RMS 7A × BIB 49, ICMA 97111A × BIB 17, ICMA 97111A × BIB 68, ICMA 843-22A × BIB 17, ICMA 843-22A × BIB 4, ICMA 843-22A × BIB 49, RMS 7A × BIB 190, ICMA 843-22A × BIB 59, RMS 7A × BIB 184, RMS 7A × BIB58, RMS 7A × BIB 73, ICMA 97111A × BIB 49, ICMA 843-22A × BIB 27, ICMA 97111A × BIB 30, ICMA 97111A × BIB 3, ICMA 97111A × BIB 12, ICMA 843-22A × BIB 127, ICMA 97111A × BIB 56, ICMA 843-22A × BIB 174, RMS 7A × BIB 57, ICMA 843-22A × BIB177, RMS 7A × BIB 159, RMS 7A × BIB 68, RMS 7A × BIB 104, RMS 7A × BIB 55, ICMA 97111A × BIB 95, ICMA 97111A × BIB 58, ICMA 843-22A × BIB 62, RMS 7A × BIB 59, ICMA 843-22A × BIB 55, ICMA 97111A × BIB 55, ICMA 843-22A × BIB 3, RMS 7A × BIB 74, ICMA 97111A × BIB 38, ICMA 843-22A × BIB 68, RMS 7A × BIB 172, ICMA 97111A × BIB 88
II	17	ICMA 843-22A × BIB 129, ICMA 97111A × BIB 14, ICMA 843-22A × BIB 100, ICMA 97111A × BIB 57, ICMA 843-22A × BIB 58, RHB-177(Check), RMS 7A × BIB 88, ICMA 97111A × BIB 73, ICMA 97111A × BIB 47, RMS 7A × BIB 175, RMS 7A × BIB 75, MPMH-17(Check), ICMA 843-22A × BIB 56, ICMA 843-22A × BIB 88, HHB67-1 Imp.(Check), ICMA 97111A × BIB 61, ICMA 97111A × BIB 60
III	24	RMS 7A × BIB 124, RMS 7A × BIB 166, RMS 7A × BIB 154, RMS 7A × BIB 123, RMS 7A × BIB 36, RMS 7A × BIB 100, ICMA 97111A × BIB 20, RMS 7A × BIB 163, RMS 7A × BIB 114, RMS 7A × BIB 14, ICMA 843-22A × BIB 14, ICMA 97111A × BIB 35, RMS 7A × BIB 122, ICMA 97111A × BIB 72, ICMA 843-22A × BIB163, RMS 7A × BIB 17, ICMA 843-22A × BIB 172, RMS 7A × BIB 3, RMS 7A × BIB 177, RMS 7A × BIB 147, RMS 7A × BIB 12, RMS 7A × BIB 62, ICMA 97111A × BIB 91, RMS 7A × BIB 56
IV	1	ICMA 843-22 A × BIB 147
V	1	ICMA 97111 A × BIB 59
VI	1	ICMA 843-22 A × BIB 124
VII	1	RMS 7A × BIB 129
VIII	1	RMS 7A × BIB 168
IX	1	RMS 7A × BIB 133

Contribution of various characters towards total divergence. Contribution of individual character towards total divergence in parental lines of pearl millet was calculated as per the method given by Singh and Chaudhary (1979) and has been presented in hybrids of pearl millet in Fig. 1 respectively. A perusal of the relative contribution of various characters in hybrids of pearl millet indicated that test weight, ear head diameter, biological yield and days to maturity significantly contributed towards total divergence in hybrids of pearl millet. In hybrids of pear millet, test weight (73.26) had highest contribution towards total divergence, which was followed by ear head diameter (13.91), biological yield (3.25), and days to maturity (3.0) while, plant height (1.75), seed yield per plant (1.7), ear head length (1.15), no. of effective tillers per plant (0.8), harvest index (0.7), days to 50 percent flowering (0.5) poorly contributed towards total divergence. The characters like test weight, ear head diameter were the major contributing characters in total about 87.17 percent of the total divergence. Thus, these eight characters are important and should be considered while selecting in hybrids of pearl millet genetically diverse genotypes. Similarly, other clusters like I and II were also having good hybrids for different character combinations. Thus these clusters may provide promising hybrids. These results are in agreement to the earlier findings by Vidyadhar and Devi (2007); Kumari *et al.* (2016); Kumar *et al.* (2017).

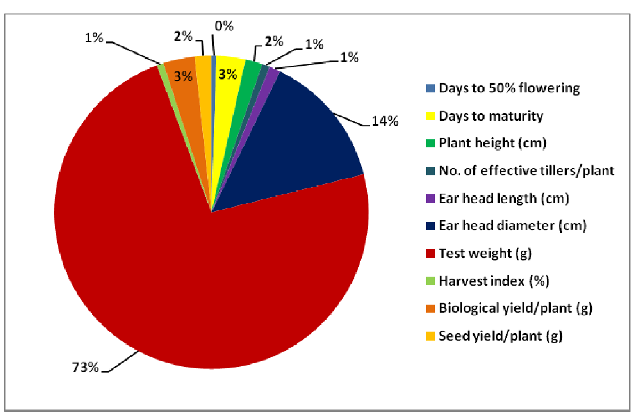

Fig. 1. Relative contribution of studied traits in pearl millet hybrids.

CONCLUSION

Maximum inter cluster value was found between cluster II and cluster IX followed by cluster II and cluster VIII. Maximum intra cluster value was found between cluster III followed by II and cluster I. Hybrids belonging to these different clusters may be recommended for diverse situation for sustainable production of pearl millet. Five high yielding hybrids namely RMS 7A × BIB 177, RMS 7A × BIB 68, RMS 7A X BIB 49, RMS 7A X BIB 175 and RMS 7A × BIB 12 were belonging to three clusters *viz.*, cluster I, cluster II and cluster III. Out of these five hybrids, two hybrids, RMS 7A × BIB 68 and RMS 7A × BIB 49 belongs to cluster I, one hybrid RMS 7A × BIB 175 belongs to cluster II and two hybrids RMS 7A × BIB 177 and RMS 7A × BIB 12 belong to cluster III. These above mentioned diverse hybrids, therefore, can be recommended for increasing pearl millet production and productivity in arid zone. Identified hybrids in pearl millet using diversity studies can be evaluated in multi-environmental testing and developed as varieties.

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Conflict of Interest. None.

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