Diversity in pearl millet germplasm from Central African Republic

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Received 22 February 1995, accepted in revised form 14 July 1995

ISSN 0925-9864
OFFPRIN
Honorable Minister for Rural Development, CAR during December 1988–January 1989 and 129 pearl millet samples were collected. This paper describes the diversity observed in these collections when evaluated under uniform conditions at IAC Patancheru, India.

Materials and methods

The areas covered, route followed and sampling procedure adapted were described elsewhere (Appa Rao et al., 1990). All the 129 accessions collected by ICRISAT and 17 collected by ORSTOM were evaluated at ICRISAT Asia Center (IAC), Patancheru (17° 25’ N latitude and 78° E longitude) in alluvials, for several morpho-agronomic characters during rainy and postrainy seasons. Rainy season crop was grown during June to October and the postrainy season crop was raised during November to March. Accessions were grown in an augmented block design. Each accession was planted in 2 rows of 4 m length with 75 cm spacing between rows and 10 cm between plants within a row. Life saving irrigations was given during rainy season, while in postrainy season, the crop was irrigated at regular intervals. Fertilizers were applied at the rate of 100 kg nitrogen and 40 kg phosphorus ha⁻¹ during both seasons. Observations were recorded as per the descriptors for pearl millet (IBPGR & ICRISAT, 1993) on time to flowering, plant height, spike length and spike thickness during rainy and postrainy season. On the other hand, observations on grain characters were recorded during postrainy season only. Data were analyzed using GENSTAT software. A hierarchical cluster analysis of Ward’s minimum variance method (Ward, 1963) was applied over nine selected characters using the cluster procedure of SAS (1985), which produced a dendrogram showing successive fusion of individuals, which ultimately culminates into a single cluster.

Results and discussion

Table 1. Diversity in pearl millet germplasm from Central African Republic, evaluated at IAC, Patancheru

<table>
<thead>
<tr>
<th>Character</th>
<th>Range</th>
<th>Mean ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to flower – R²</td>
<td>57–140</td>
<td>128 ± 1.1</td>
</tr>
<tr>
<td>Days to flower – PR</td>
<td>57–132</td>
<td>73 ± 0.8</td>
</tr>
<tr>
<td>Plant height (cm) – R</td>
<td>140–410</td>
<td>311 ± 6.1</td>
</tr>
<tr>
<td>Plant height (cm) – PR</td>
<td>75–310</td>
<td>155 ± 2.6</td>
</tr>
<tr>
<td>Total tillers (no.)</td>
<td>1–6</td>
<td>3 ± 0.1</td>
</tr>
<tr>
<td>Productive tillers (no.)</td>
<td>1–4</td>
<td>3 ± 0.1</td>
</tr>
<tr>
<td>Spike exertion (cm)</td>
<td>–18–13</td>
<td>5 ± 0.3</td>
</tr>
<tr>
<td>Spike length (cm) – R</td>
<td>11–35</td>
<td>20 ± 0.3</td>
</tr>
<tr>
<td>Spike length (cm) – PR</td>
<td>8–34</td>
<td>21 ± 0.3</td>
</tr>
<tr>
<td>Spike thickness (mm) – R</td>
<td>14–33</td>
<td>19 ± 0.2</td>
</tr>
<tr>
<td>Spike thickness (mm) – PR</td>
<td>14–30</td>
<td>22 ± 0.3</td>
</tr>
<tr>
<td>1000 grain mass (g)</td>
<td>5–13</td>
<td>9 ± 0.2</td>
</tr>
</tbody>
</table>

* Based on 146 accesses.
² R = Rainy season, PR = Postrainy season.

in rainy season and from 75 to 310 cm with a mean of 155 ± 2.6 cm during postrainy season, indicating the sensitivity of the material to daylength and temperature. All the accessions from CAR except IP 7959, flowered late in rainy season when compared to postrainy season. IP 7959 flowered late by 6 days during postrainy season. IP 17396 and IP 17401 flowered early in rainy season by as many as 70 days indicating their high photoperiod sensitiveness. IP 17401 is also highly temperature and photoperiod sensitive for plant height and grew 250 cm more in rainy season than in postrainy season. None of the accessions grew tall during postrainy season than during rainy season. The rainy season at IAC is characterized by long days and high temperature compared to postrainy season. During the rainy season, the mean maximum and minimum temperatures were 30.8 °C and 21.8 °C respectively and in postrainy season it was 30.4 °C and 14.2 °C respectively. The daylength decreases from 13.93 h in June to 12.47 h in October in rainy season and varies from 11.91 h in December to 12.7 h in March. The differences in flowering time and plant height in postrainy season compared to rainy season could be attributed to sensitivity differences in daylength and temperature. In general, plant height was reported to vary depending on the growing season (Carberry & Campbell, 1985). Pearl millet from CAR produces few basal tillers ranging from 1 to 6 with an average of 3 ± 0.1.

Spike length is one of the most important yield contributing trait of pearl millet. Pearl millet spikes from CAR are small ranging in length from 11 to 35 cm.
in rainy season and 8 to 34 cm in postrainy season. However, the mean spike length did not vary much with the season. Spike thickness which is measured in millimeters at the maximum diameter of the spike depends mainly on the length of involucré, rachis thickness, and grain size, especially grain length. Like spike length, spike thickness was also stable as the range and mean were almost the same during both the seasons. However, IP 7958 which was not affected much due to planting season for flowering, produced long and thick spikes during postrainy season when compared to that in rainy season. Landraces from southern Africa produce shorter spikes compared to those from West Africa (Clement, 1985). Frequency distribution of different spike shapes shows the predominance of cylindrical spike shape (49%) followed by candle (34%) and conical (11%) shapes (Table 2). The other spike shapes found in low proportion were club, lanceolate and oblanceolate (Fig. 1). Grain size varied considerably from 5 to 13 g per 1000 grain, which is considerably high. About 52% of the pearl millet accessions from CAR produce grey colored grain followed by cream or white color. However, other grain colors such as ivory, yellow, grey brown, brown and purple also found. Grain shape is predominantly globular (58%), followed by oblanceolate, obovate, elliptical, and hexagonal (Table 2). Globular grain shape is a characteristic feature of the race globosum, which is widely distributed in western Africa (Brunken et al., 1977; Bono, 1973; Kumar & Appa Rao, 1987).

The cluster analysis indicated a clear 2 and 16 cluster partition (Fig. 2). For the 2 cluster partition, the two groups were designated as A and B containing 60 and 82 accessions respectively (Fig. 2). Because of incomplete data, 4 accessions did not fall into any group. Accessions of group B are late maturing, tall and produce larger spikes with large grains compared to the accessions of group A. When 16 cluster partition was considered, these subgroups or clusters were designated as 1 to 16 continuously and group A and B were subdivided into 8 subgroups each. Group A contained 1, 2, 3, 4, 5, 6, 7, 8 clusters and group B contained 9, 10, 11, 12, 13, 14, 15, 16 clusters. Eight clusters of group A consisted 17, 1, 15, 11, 2, 1, 9 and 4 accessions respectively (Table 3). The accessions of all clusters of group A, except the cluster number 5, and 6 flowered late during both rainy and postrainy season (Table 4). The lone accession IP 6051 which formed cluster number 2 behaved uniquely and flowered late in both rainy (137 ± 0.0 days) and postrainy (90 ± 0.0 days) season, and produced long spikes (32 ± 0.0 cm)

<table>
<thead>
<tr>
<th>Character</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spike shape</td>
<td></td>
</tr>
<tr>
<td>Cylindrical</td>
<td>49.3</td>
</tr>
<tr>
<td>Conical</td>
<td>10.6</td>
</tr>
<tr>
<td>Candle</td>
<td>33.8</td>
</tr>
<tr>
<td>Others</td>
<td>6.3</td>
</tr>
<tr>
<td>Grain shape</td>
<td></td>
</tr>
<tr>
<td>Obovate</td>
<td>15.1</td>
</tr>
<tr>
<td>Oblanceolate</td>
<td>22.6</td>
</tr>
<tr>
<td>Globular</td>
<td>57.5</td>
</tr>
<tr>
<td>Others</td>
<td>4.8</td>
</tr>
<tr>
<td>Grain color</td>
<td></td>
</tr>
<tr>
<td>Ivory</td>
<td>4.1</td>
</tr>
<tr>
<td>Cream</td>
<td>26.9</td>
</tr>
<tr>
<td>Yellow</td>
<td>11.0</td>
</tr>
<tr>
<td>Grey</td>
<td>51.7</td>
</tr>
<tr>
<td>Others</td>
<td>6.2</td>
</tr>
</tbody>
</table>

when compared to the spikes of genotypes in other clusters indicating the true nature of the genotype for flowering. On the other hand, cluster 6 which consists only one accession (IP 7959) also performed differently and flowered early in both rainy (98 ± 0.0 days) and postrainy (60 ± 0.0 days) season. Cluster 6 was very close to cluster 5 which consists only two accessions (IP 6068 and IP 7957), possibly due to the close resemblance for flowering time. Accessions of these two clusters are early among all the clusters of group A. Cluster 4 consisting 11 accessions produced large grains (8.1 ± 0.2 g) when compared to other clusters of group A, indicating its superiority for this trait.

The clusters 9, 10, 11, 12, 13, 14, 15, 16 which were included in group B contained 2, 1, 10, 5, 10, 16, 4 and 34 accessions respectively (Table 3). Cluster 9 and 10 which consist 2 (IP 7958, IP 12918) and 1 accession (IP 7960) respectively are characterized by early flowering (78 ± 0.0 and 80 ± 0.0 days) and large spikes (34 ± 1.5 and 25 ± 0.0 cm) with large grain (10 ± 0.9 and 11 ± 0.0 g). Accessions of all the other clusters were late in flowering and produced long spikes with large grain but, did not differ much for all these traits. Based on these results, it can be concluded that all the clusters of group B except cluster
9 and 10 are the best sources of genotypes promising for fodder as well as grain. Accessions grouped into cluster 9 and 10 appear to be a good source for grain as they are early with reasonably good spike and grain size. In general, pearl millet germplasm from CAR is a good source for medium sized semi-compact heads with grey and cream or white colored globular grain. Several accessions with white lustrous, corneous grain from CAR are being used (Rai & Kumar, 1994) to
develop improved cultivars with high yield potential for grain as well as fodder.

The above clustering provided a structure to select a limited number of pearl millet germplasm accessions from Central African Republic for use in crop improvement program for Central African Republic and/or any other region with similar agroclimatic conditions. The clustering indicates that the data reduction through computer can simplify sampling of large collections for research purposes and or otherwise in establishing a core collection (Brown, 1989). This data reduction also helps in resolving the problem of redundancy in many genebanks (Holden, 1984).

Acknowledgements

We gratefully acknowledge the help of Mr G Swaminathan, Statistics Unit, ICRISAT in analyzing the data. Our thanks are due to Mr G Dasaratha Rao, Mr S Nagachandra Rao, Mr D Bapa Rao, Mr B Manik Reddy and Mr A Bhaskar Rao of GRD, ICRISAT for their help in evaluating the germplasm.

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