

COLLECTION AND EVALUATION OF PEARL MILLET GERMPLASM FROM MAHARASHTRA

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ABSTRACT

Two germplasm collection missions were launched in Maharashtra in 1978 and 1981 during which 437 and 146 accessions of pearl millet [*Pennisetum americanum* (L.) Leeke] were collected. Both collections were evaluated at ICRISAT Centre, Patancheru during rainy and postrainy seasons. Considerable variation in plant height, days to flowering, spike, and grain characters was observed. During the rainy season, they grew tall (225 cm), flowered early (52 days), and produced short (18.7 cm long) but stout (23 mm wide) conical to spindle-shaped spikes with medium sized (8.5 mg) grey grains. In the postrainy season, growth was reduced (151 cm), they flowered early, and the spike size reduced compared to the rainy season. Most of the accessions are intermediate between the races *globosum* and *typhoides*. Based on shape and size of the spike, grain, and glumes, all the accessions were classified into nine cultivar groups and a key was developed to identify them. Some accessions appear to be good sources for tillering and earliness.

Key words: Pearl millet, collection, evaluation, cultivar groups.

Maharashtra state in India is the third largest producer of pearl millet [*Pennisetum americanum* (L.) Leeke]. It is grown over an estimated 1.7 million ha producing 0.76 million tonnes annually [1]. Evolution of ecotypes with specific adaptations has been promoted by diverse geographic and other factors: 16°4'–25°1' N, 72°6'–80°9' E, and 90–600 m altitude; edaphic factors like gravelly and coarse to deep black cotton soils of light to heavy texture; environmental factors like rainfall (500–3000 mm); minimum (17°–28° C) and maximum temperatures (30°–43° C); cultivation practices like sole, mixed or intercropping systems; and food preferences.

The Rockefeller Foundation had collected 77 samples [2], of which only 45 accessions are available at ICRISAT and the rest were either lost or contaminated [3]. Hence, an expedition to collect germplasm was undertaken during September–October 1978, during which 437 accessions of pearl millet were collected. During October–November 1981 another expedition covered the remaining areas and collected 146 accessions of mostly late-maturing types from farmers' fields. Of the 583 samples collected during both the expeditions, 8 were of wild species of *Pennisetum* and 575 were cultivated. This paper describes the two pearl millet germplasm collection expeditions, and evaluation done in farmers' fields and at ICRISAT Centre, Patancheru.

MATERIALS AND METHODS

The two collection missions named Expedition I and II were launched during September–October 1978 and October–November 1981, respectively. The collective team for Expedition I included G. Harinarayana, Coordinator, AICPMIP, Pune; L. H. Jadhav, Millet Breeder, Rahuri; and S. Appa Rao, ICRISAT. Expedition II included V. Ramanatha Rao and C. Rajagopal Reddy, ICRISAT. The teams were assisted by several researchers from the agricultural universities. Expedition II complemented Expedition I in covering the area

(Fig. 1) and different maturity groups. Data concerning latitude, longitude, topography, soil types, and other ecological factors as well as agricultural practices were collected for each sample [4, 5].

Collection strategy. The areas covered and routes followed were decided mainly by considering the area under millet cultivation in each district, extent of genetic erosion, and the time of crop maturity. All important millet growing areas in the kharif (rainy) season were sampled systematically to obtain an adequate representation of genetic diversity. Because little information is available on the distribution of variation in cultivated fields, "Coarse Grid" sampling of Allard [6] was followed to ensure that the sampling sites represented as broad a range of environments as possible. Attempts were made to collect obvious variants occurring in the target population with a frequency greater than 0.05 as suggested by Marshall and Brown [7]. To capture maximum variation, the top 5–10 cm of at least 30 randomly selected spikes were collected. This sample was enriched with a biased sample of rare phenotypic variants in accordance with Bennett [8]. As the expeditions were planned to coincide with harvesting time of pearl millet, it was possible to obtain samples from farmers' fields. In case the crop was harvested, samples were taken from threshing floors, farmers' seed stores, granaries, or local markets. The accessions collected during Expeditions I and II were 437 and 146, respectively.

Agronomic evaluation. All the accessions except the eight wild relatives were evaluated at the ICRISAT Centre, Patancheru (17°27' N) with the sowing dates of 20 November (postrainy) 1981 and 18 June (rainy) 1982. For confirmation, representative accessions were evaluated with three replications during the 1982 rabi (postrainy) season. Each accession was planted in 4 rows, 4 m long, spaced at 75 cm, with the plant stand thinned to 10 cm within rows. Two supplementary irrigations were given during the rainy season, and every 14 days during the postrainy season. Fertilizer applications were 80 kg N and 40 kg P₂O₅/ha. Morphological and agronomical characters were recorded at the appropriate development stages on five randomly selected plants as per the pearl millet descriptors [9]. Considering mainly the spike, glumè and grain characters, the accessions were classified into nine different cultivar groups, as was done in maize by Anderson and Cuttler [10].

RESULTS AND DISCUSSION

Comparison of pearl millet in farmers' fields and at research station. At the time of collecting the samples, a few morphologically distinct types were evaluated in farmers' fields and at ICRISAT Centre, Patancheru. Of the several characters studied, spike and grain characters were fairly comparable under both the situations (Table 1). Plant height was drastically reduced in those accessions which were collected from fields experiencing severe drought. In general, plants grew taller, produced larger and thicker spikes with larger grains at ICRISAT Centre during the rainy season compared to farmers' fields. This may be because of good management conditions at the research station while moisture stress reduced plant height in the farmers' fields.

Agronomic evaluation. Frequency distributions for days to 50% flowering, plant height, spike length, and spike thickness of the entire collection during the rainy and postrainy seasons showed considerable variation (Fig. 2). During the rainy season, delay in flowering was accompanied by increased plant height compared to the postrainy season. The differences in flowering might have been due to differences in day length and/or temperature. Most of the accessions produced short, stout, conical to spindle shaped spikes.

The ranges, means and standard deviations of 12 morphological characters are shown in Table 2. Compared to pearl millet from West Africa [11], pearl millet from Maharashtra produced thin stems with about 10 short and narrow leaves (Tables 1 and 2). They produced 2-4 tillers with conical spikes. The rachis is thin with long pedicels. The short bristles with monoaristation are ciliate to plumose. The grey grains are obovate to elliptical, and endosperm is mostly starchy.

Table 1. Comparison of representative accessions of pearl millet germplasm in the farmers' fields (original place of collection) in Maharashtra and at ICRISAT Centre, Patancheru during rainy and postrainy seasons*

Character	Farmers' fields			ICRISAT Centre, Patancheru					
	rainy season			rainy season			postrainy season		
	mean	SD	range	mean	SD	range	mean	SD	range
Plant height (cm)	168.7	8.36	70-295	225.4	39.16	135-310	151.3	20.86	120-200
Spike length (cm)	14.4	5.79	7-28	18.7	2.48	11-17	15.1	2.62	10-22
Spike thickness (mm)	19.8	5.18	12-32	23.0	1.96	16-29	23.9	4.16	17-30
Tillers (No.)	2.6	4.18	1-9	2.3	1.12	1-5	2.0	3.49	1-5
Pedicel length (mm)	4.6	2.98	1-11	4.9	1.86	1-12	4.7	2.63	1-11
Rachis diameter (mm)	3.6	1.42	2-7	3.8	0.87	2-8	3.5	1.25	2-7
Bristle length**	2.0	3.68	1-8	2.3	5.43	1-8	2.1	4.19	1-7
Grains per involucre	2.2	1.43	1-3	2.4	1.02	1-3	2.1	0.36	2-3
1000-grain weight (g)	7.0	1.81	3.7-12.9	8.0	2.87	5.2-11.4	8.2	1.25	5.5-11.9
Overall plant aspect**	4.2	6.35	2-8	5.7	1.87	3-8	4.8	4.83	3-7

* Data are based on a study of 575 landrace populations grown in uniform nurseries at Patancheru, India with dates of planting on June 18, 1982 (rainy) and November 20, 1981 (postrainy seasons).

** Based on a visual score of 1-9, indicating the agronomic disirability: 3—poor, 5—average and 7—good.

Diversity in the populations. The germplasm samples collected from the farmers' fields show considerable variation of plant height, maturity, spike shape, size and grain characters within as well as between the accessions. Most accessions from Maharashtra and obovate grain shape and were classified as race *typhoides* following the classification of Brunken et al. [12]. Some accessions produced globular to abovate grains, suggesting that they are intermediate between races *globosum* and *typhoides*. Race *globosum* is mostly found in Ghana [12]. The occurrence of intermediate races in Maharashtra could be due to natural crossing of local germplasm with recent introductions from Ghana. Mass selection from Ghana germplasm resulted in the development of high yielding cultivars like Improved Ghana and Pusa Moji [13, 14, 15]. This cultivar was popular in Maharashtra. Introductions from Ghana were also crossed with the indigenous material, and new cultivars developed [16]. Such contamination may transfer some desirable genes into local germplasm which may be more useful than local material.

Table 2. Range, mean, and standard deviation (SD) of some morphological characters in pearl millet germplasm from Maharashtra*

Character	Rainy season			Postrainy season		
	mean	SD	range	mean	SD	range
Stem thickness (mm)	9.2	1.77	5.7-14.4	7.6	2.36	4.5-13.1
Leaf blade length (cm)	56.6	4.50	48-63	48.7	3.73	39-56
Leaf blade width (mm)	36.4	4.51	27-43	32.3	6.38	23-27
Leaf number	10.3	1.50	8-12	9.8	2.43	8-11
Spike exertion (cm)	11.3	3.35	5.4-16.1	9.6	4.37	4.8-14.7
Bristle ornamentation**	2.5	2.3	2-3	2.3	0.46	2-3
Bristle aristation**	1.8	1.2	1-2	1.9	0.17	1-2
Grain length (mm)	3.3	0.94	2.4-4.3	3.2	0.42	2.2-4.0
Grain width (mm)	2.1	0.37	1.3-2.7	2.0	0.28	1.4-2.6
Grain shape**	2.0	3.87	1-5	1.8	4.26	1-5
Grain color**	4.4	3.74	3-8	4.7	2.19	3-8
Endosperm texture**	5.4	1.47	3-8	5.7	1.12	3-7

* Data are based on a study of 575 landrace populations grown in uniform nurseries of Patancheru, India.

** See Pearl Millet Descriptors, IBPGR/ICRISAT (1981).

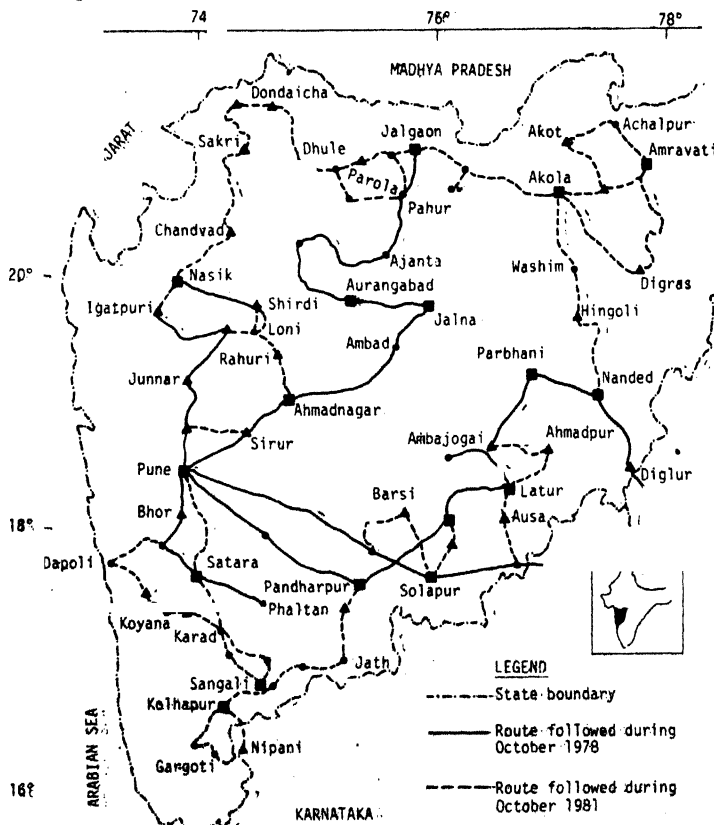


Fig. 1 Routes followed and areas covered during 1978 and 1981 collection missions in Maharashtra.

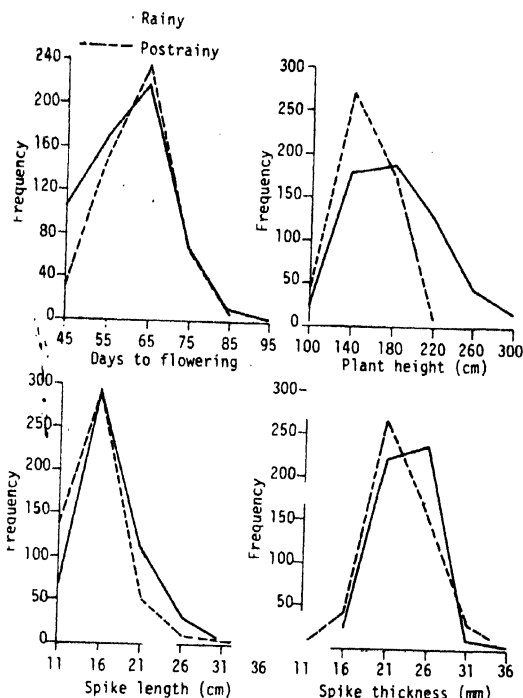


Fig. 2 Effects of two planting dates at ICRI SAT Centre on days to 50% flowering, plant height, spike length, and spike thickness of pearl millet germplasm from Maharashtra.

Table 3. Key of different cultivar groups of pearl millet from Maharashtra

- 1. Grain covering by glumes incomplete
 - 3. Long bristles (30 mm), spikes cylindrical, spike length breadth ratio more than 8 cultivar group-1
 - 3. Short bristles (6 mm)
 - 4. Spikes conical to spindle, spike length breadth ratio more than 7 cultivar group-2
 - 4. Spikes conical to spindle, spike length breadth ratio less than 7 cultivar group-3
 - 5. Spikes cylindrical to candle, spike length breadth ratio more than 9 cultivar group-4
 - 5. Spikes conical to spindle
 - 6. Spike length breadth ratio less than 8 cultivar group-5
 - 6. Spike length breadth ratio more than 8 cultivar group-6
 - 7. Segregation for spike shape, size and bristle length, mixture of different types in different proportions cultivar group-7
- 1. Grain covering by glumes complete
 - 8. Spikes lanceolate, length breadth ratio of spikes more than 9 cultivar group-8
 - 8. Spikes spindle, length breadth ratio of spikes less than 9 cultivar group-9

Cultivar groups. Development of germplasm pools was suggested [17, 18] to minimize genetic drift during rejuvenation and to facilitate utilization of germplasm. As considerable variation was observed within different accessions, the expression of majority of plants was considered for the purpose of classification. Therefore, considering the grain covering by glumes, spike shape, length/ breadth ratio of the spike, and bristle length, all the accessions were classified into nine cultivar groups and a key for the identification of different groups was developed (Table 3). The number of accessions belonging to each cultivar group is given in Table 4. Though different accessions of a particular cultivar group vary for plant height, flowering, and spike size (Fig. 3), variation between cultivar groups was much larger (Table 4). Each cultivar group was adapted to distinct agroclimatic conditions and farming systems. For example, the early flowering cultivar group 3 is usually grown as a sole crop where a rabi (postrainy) crop is also taken. Cultivar group 8, a late-maturing type, is grown as a mixed crop in areas where a postrainy season crop is not possible.

Wild relatives. Different species of *Pennisetum* found were *P. pedicellatum* around Kolhapur, *Pennisetum hchenackeri* around Radhanagari, *Pennisetum purpureum* near Chiplun, and *Cenchrus ciliaris* around Solapur. These wild relatives were found in isolated pockets. Of these, *Cenchrus* was the most common and grew along the bunds and in the millet fields.

Genetic erosion. Commercial hybrids are replacing the traditional cultivars around Nirdana, Jalgaon, and Dhule. The area under improved cultivars like ICMV 1(earlier WC-C75) and others is rapidly increasing. However, the traditional cultivars are still grown for several reasons: 1) strong preference food, 2) good quality stover, 3) high cost of hybrids cultivation, and 4) adaptability to drought and diseases. Hence, some farmers still grow traditional cultivars.

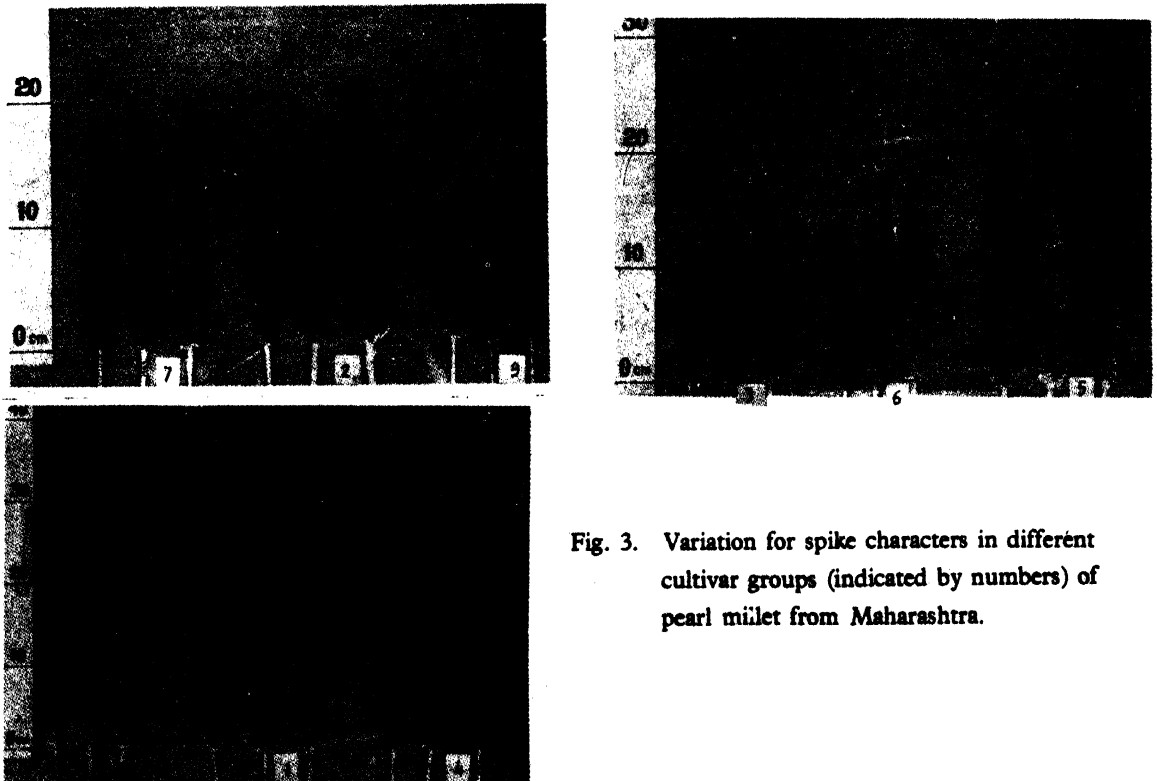


Fig. 3. Variation for spike characters in different cultivar groups (indicated by numbers) of pearl millet from Maharashtra.

Table 4. Range and mean for selected characters of different cultivar groups of pearl millet from Maharashtra

Cultivar group	Number of accessions	Days to 50% flowering			Plant height (cm)			Spike length (cm)			Spike thickness (mm)			1000-grain weight (g)			
		kharif ²	range	mean	kharif ²	range	mean	kharif ²	range	mean	kharif ²	range	mean	kharif ²	range	mean	kharif ²
1	10	67-84	75.1	63-72	69.1	165-245	192.7	140-200	170.1	15-25	19.2	16-27	22.3	5.6-10.6	8.50		
2	196	49-69	62.8	61-76	65.3	180-310	205.7	145-195	175.0	12-21	16.0	18-26	20.0	5.6-11.9	8.54		
3	196	52-79	62.1	52-68	60.3	140-210	177.6	145-170	157.5	13-20	15.3	19-27	24.0	7.1-10.4	8.78		
4	10	61-74	66.4	64-75	66.8	162-240	205.1	135-190	172.2	16-27	21.8	18-29	23.3	6.9-11.9	8.90		
5	19	79-85	82.5	70-75	73.0	188-200	190.2	175-183	180.5	15-19	17.6	22-27	24.3	7.7-11.9	9.80		
6	17	53-63	58.5	56-64	61.9	139-160	147.6	125-140	130.0	15-20	16.7	19-22	20.8	7.1-10.7	7.96		
7	50	45-66	57.2	57-64	61.3	135-170	142.1	120-180	140.5	12-21	15.8	18-23	21.1	5.5-11.4	8.27		
8	17	65-66	65.5	70-74	72.0	240-250	245.0	170-180	184.2	22-27	24.5	26-27	26.4	6.5-8.2	7.33		
9	60	42-63	50.2	51-64	56.6	138-190	148.0	120-180	147.5	11-19	14.9	18-28	21.6	6.6-9.3	8.20		

¹ Of the 583 samples collected, 8 were wild relatives and only 575 were cultivated.

² Planted on June 18, 1982.

³ Planted on November 20, 1981.

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