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Evaluation of pearl millet germplasm from Rajasthan

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ABSTRACT

A set of 380 accessions of pearl millet [*Pennisetum americanum* (Linn.) K. Schum. = *P. typhoides* (Burm. f.) Stapf & C. E. Hubb.] collected from Rajasthan during 1977 and 1982, evaluated at Patancheru, Hyderabad, during the rainy and post-rainy seasons showed desirable traits like early-maturity, good tillering, drought tolerance and adaptation to arid and semi-arid conditions. In general, they flowered in 60 days, grew tall (200 cm) and produced short (22 cm) but many (3.3) spikes during the rainy season. 'Jakhana', 'Sulkhana', 'Gullisita', 'Karauli' and 'Barmer' were found to be more advanced as they produce basal tillers, longer spikes with non-shattering spikelets and small glumes that partly covered the grain. 'Chadi' and 'Desert' types produced several nodal tillers with sequential maturity of spikes with shattering spikelets having glumes that almost covered the grain.

Pearlmillet [*Pennisetum americanum* (Linn.) K. Schum. = *P. typhoides* (Burm. f.) Stapf & C.E. Hubb.] has been under cultivation in Rajasthan (23°30' to 30°12'N; 60°30' and 78°12'E) from ancient times (Vishnu-Mittre, 1968). Wide variations in weather and cultivation practices have contributed to the evolution of different ecotypes. The local germplasm has several desirable characters including drought tolerance, and mass selection from these landraces has resulted in the production of improved cultivars like 'RSJ' and 'RSK' (Vyas, 1983; Gill, 1983). Of the 168 accessions evaluated by Murty *et al.* (1967) for 19 characters, 121 are available and the rest were either lost or contaminated (Appa Rao, 1980). Hence, the International Crops Research Institute for the Semi-Arid Tropics and the Agricultural Research Station, Durgapura, Jaipur, jointly collected 380 accessions from Rajasthan during September-October 1977. Out of these, 122 representative

accessions were also evaluated for 12 characters at Durgapura by Vyas (1983). This paper describes the evaluation and characterization of this entire collection, and indicates its possible use in pearl millet improvement.

MATERIALS AND METHODS

The details of the expedition, areas covered, collection strategy, and sampling procedures were reported by Appa Rao (1978). Subsequently 17 samples were collected by ICRISAT physiologists in 1982. The entire collection was evaluated during the rainy and post-rainy seasons (planted on 20 June 1978 and 22 November 1978). The representative landraces were further evaluated in 1980 and 1981 rainy seasons with 3 replications, and the observations were confirmed in 1983. Characterization and agronomic evaluation procedures are similar to those followed by Appa Rao *et al.* (1983) for Uttar Pradesh collection. The morphological and agronomical characters were recorded as per the Standard Pearl millet Descriptors (IBPGR/ICRISAT, 1981).

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RESULTS AND DISCUSSION

Characteristics of Rajasthan Pearl millet

At Patancheru, plants grew up to 2 m, with thin stems (5.6–9.6 mm), narrow (22–34 mm) and short (48–59 cm) leaf-blades, and good nodal tillers (1.2–6.4). The maturity of the spikelets was sequential, unlike in the germplasm from West Africa evaluated by Bono (1972). Nodal tillering may be a good survival mechanism for adaptation to low and unpredictable rainfall. Most of the pearl millet types of Rajasthan generally flower early, produce very small spikes, which shatter their spikelets very easily. These shattering types have very small grain completely covered by glumes. The pedicels are generally very short (2.2 mm), and it is difficult to separate the grain from the glumes. They resemble the weedy forms of West Africa (Brunken *et al.*, 1977). However, we did not find any *Pennisetum violaceum* in the areas we travelled; hence their existence may be due to self-perpetuation. The second possibility is introgression of pearl millet with *Cenchrus*, the most common companion weed throughout the arid zone. As the species of *Pennisetum* and *Cenchrus* show a more or less continuous variation, Correll and Johnston (1970) did not consider them as separate genera, and Read and Basha (1974) reported that hybrids were produced between them. Pearl millet in Rajasthan has bristles partly fused towards the base and thick glumes like *Cenchrus*. As these forms are grown in vast areas in arid regions, they may be specially adapted to the prevailing harsh conditions.

Agronomic evaluation

Frequency distributions for flowering, plant height, spike length, and thickness of the entire collection during the 1978 rainy and post-rainy seasons are given in Fig. 1. The trend remained the same in subsequent cultivations. During the post-rainy season, flowering was delayed with reduction in spike length and thickness. The ranges, means, and standard errors of 17 morphological characters are given in Table 1. All the accessions from Rajasthan flowered in long days in

contrast to several short-day types found in West Africa by Bono (1972).

While the common name of pearl millet in India is 'bajra', the local types of Rajasthan are often called 'bajri' to denote characteristically small-seeded, small-headed, and non-synchronous tillering genotypes. However, our collections were not typically all 'bajri'. Considerable variation was also observed in days to maturity, plant height, tiller number, leafiness, spike length, spike girth, grain number, and grain size. In the material evaluated by Vyas (1983) at Jaipur, the widest range was in plant height, followed by grain yield, spike length, grain density per square centimetre, and 1,000-grain weight. High heritability was observed by Vyas (1983) for all characters except number of nodes, and high heritability coupled with high genetic advance was observed only for number of effective tillers, grain yield, and ear length.

Variation and adaptation

Rajasthan pearl millet types differed from each other in flowering, plant height, spike size (Table 2), and several other characters.

The 'Jakhra' type produces thin, long, cylindrical spikes curved towards the tip. The rachis is very thick and spikelets did not shatter easily. The glumes partly enclosed the grey obovate grains. This type produces 2–4 synchronous basal tillers. It is extensively grown as a sole crop in Alwar district on fertile soils where the rainfall is about 650 mm and a second crop of chickpea or wheat is usually grown. The 'Karauli' type produces 2–4 synchronous tillers with thick, long, lanceolate spikes and dark-grey grain. It is largely found in central to eastern regions where the rainfall is 600–750 mm.

The 'Barmer' type produces thin, medium-long, cylindrical, compact spikes. It is extensively grown in sandy to sandy-loam soils of western Rajasthan where the rainfall is less than 300 mm. It is grown mixed with clusterbean [*Cyamopsis tetragonaloba* (Linn.) Taub.], mothbean [*Vigna aconitifolia* (Jacq.) Marechal],

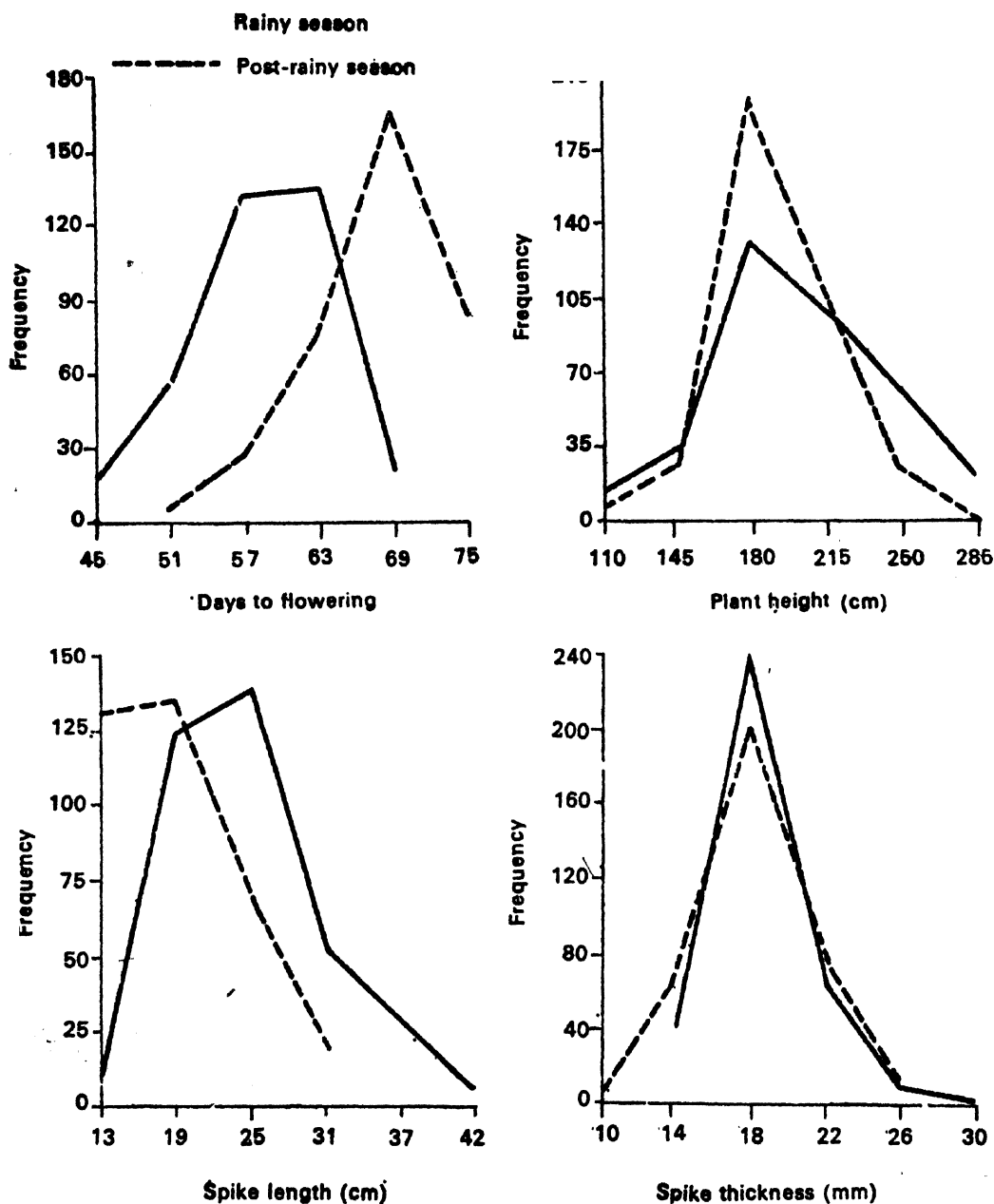


Fig. 1. Effects of planting dates on days to 50% flowering, plant height, spike length, and spike thickness of pearl millet germplasm from Rajasthan.

watermelon (*Cucumis melo* Linn.) and cucumber (*Cucumis sativus* Linn.). The 'Sulkhania' type generally has 1 or 2 basal tillers, produces spikes more than

1 m long in its original habitat in the Ratnagarh area in Churu district, where it is grown at wide spacing. But at Patancheru the spike length was drasti-

Table 1. Ranges, means, and standard errors (SE) of some morphological characters of pearl millet germplasm from Rajasthan

Character	Mean \pm	SE	Range
Stem thickness (mm)	7.4	0.177	5.6-9.6
Tiller number	3.3	0.025	1.2-6.4
Leaf number	9.5	0.090	8.6-10.4
Leaf-blade length (cm)	53.4	0.536	48.1-59.9
Leaf-blade width (mm)	29.9	0.590	22.1-33.6
Spike exertion (cm)	8.0	0.066	1.9-15.5
Spike density*	5.8	0.045	4.0-8.0
Rachis diameter (mm)	3.4	0.115	1.0-6.2
Bristle length*	1.8	0.021	1.0-5.0
Bristle ornamentation*	2.1	0.023	2.0-3.0
Bristle aristation*	1.9	0.018	1.0-2.0
Pedice length (mm)	2.2	0.084	1.0-5.0
Grains/involucre	1.8	0.021	1.0-2.0
Grain shape*	2.6	0.025	1.0-5.0
Grain length (mm)	3.3	0.054	2.2-5.3
Grain width (mm)	1.9	0.024	1.0-2.5
Endosperm texture*	4.8	0.026	2.0-7.0

*See Pearl millet Descriptors, IBPGR/ICRISAT, 1981.

cally reduced (Table 2). The 'Gullisita' type produces spindle-shaped, short, stout spikes. The rachis is thin, the pedicels are long, and the grain is globular to obovate. It produces 3-5 synchronous basal tillers and is commonly grown as a sole crop on fertile alluvial soils of Ganganagar, usually with irrigation and fertilizers.

The above 5 types are considered relatively more advanced because (i) they produce predominantly basal tillers, (ii) the grains are partly covered by the glumes, and (iii) the pedicels are long and the spikelets do not shatter. Except for 'Sulkhania' they are all adapted for close spacing.

The 'Chadi' type produces conical to spindle-shaped, very short, relatively thick spikes. Because it produces several nodal tillers with sequential maturity, harvesting more than once is necessary. The sequential maturity may be the main factor responsible for their adaptation to arid regions including poor crop stand. This type is extensively grown on sand-dunes with limited moisture, invariably mixed with a variety of pulses and cucurbits. It was reported to be drought-resistant (Vyas, 1977). It produces very thin

stems, with very short and narrow leaf-blades. The small grains are completely covered by the glumes and it is difficult to separate them.

The 'Desert' type resembles the 'Chadi' type except for its thin, small cylindrical spikes. 'Chadi' and 'Desert' types are considered primitive because of the thin stems, short, narrow leaf-blades, profuse nodal tillering, sequential flowering, and spikelet shattering with only slight disturbance. Because of these characters they resemble the weedy intermediate forms ('Shibras') commonly found in West Africa (Brunken *et al.*, 1977).

Different types of landraces described above retain their characters because of geographic isolation, differences in flowering time, and selection of a particular type by farmers for seed. However, intermediate types were found because of migration and different types growing together in adjacent fields.

Several other types are also common in isolated areas, especially along main roads and in the vicinity of urban areas. Recent West African introductions which produce very large spikes were commonly found. We saw a special type called 'Charfooti'. Farmers told us that it was

Table 2. Ranges and means for selected characters of different pearl millet landraces from Rajasthan

Landrace	Days to 50% flowering				Plant height (cm)				Spike length (cm)				Spike thickness (mm)				Grain weight (mg)			
	Rainy season		Post-rainy season		Rainy season		Post-rainy season		Rainy season		Post-rainy season		Rainy season		Post-rainy season		Rainy season		Post-rainy season	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
'Jakharana'	45-59	52.0	61-79	70.0	175-265	220.0	180-210	195.0	19.0-40.0	29.5	15-25	20.0	8.2-10.4	9.30						
'Sulkhanian'	60-65	62.5	59-76	67.5	195-260	227.5	185-225	205.0	16.0-34.0	25.0	10-26	18.0	7.3-10.1	8.70						
'Gullisita'	54-71	62.5	66-76	71.0	170-295	232.5	175-235	205.0	11.0-29.0	20.0	12-33	22.5	6.1-9.7	7.50						
'Karauli'	53-71	62.0	60-77	68.5	185-310	247.5	165-270	217.5	13.0-39.0	26.0	12-31	21.5	5.9-10.1	8.00						
'Barmer Local'	49-69	59.0	59-78	68.5	135-275	205.0	155-245	200.0	11.0-37.0	24.0	11-33	22.0	6.0-10.9	8.45						
'Desert'	49-64	56.5	51-76	63.5	120-255	187.7	153-210	181.5	10.0-25.5	17.8	10-22	16.0	5.6-8.1	6.85						
'Chadi'	47-61	54.0	56-77	66.5	125-265	195.0	155-200	177.5	10.0-35.0	22.5	9-27	18.0	6.1-9.7	7.90						

recently introduced from Pakistan. It resembles the 'Gero' type from northern Nigeria (Appa Rao *et al.*, 1984). Hybridization of such novel types with local germplasm will produce intermediate forms.

Genetic erosion

Several factors are causing genetic erosion of pearl millet in Rajasthan. Commercial hybrids like 'BJ 104', 'BK 560', 'CJ 104', and new varieties developed at Durgapura and elsewhere are fast replacing the traditional cultivars. With the advent of irrigation through the Rajasthan canal, cotton and pigeonpea are replacing pearl millet. The desert is spreading into traditional millet areas. Because of frequent drought, crop failures are common and farmers get their seed from distant markets. The 'Gullisita' and 'Gwalda' types lost their typical spike shape through contamination by pollen from other cultivars. However, there is no immediate threat to the local germplasm, especially that from western Rajasthan, because it may not be easy to replace the locally adapted landraces. Collection from this area was therefore mainly to enrich the gene bank and to see if it can be utilized in millet improvement activities.

Because these traditional cultivars have evolved over centuries and are adapted to low rainfall, they appear to be good sources for drought tolerance, early flowering, profuse nodal tillering, and local adaptability. They could be used in future breeding programmes to improve local ecotypes for drought-prone areas.

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