

COLLECTION AND PRELIMINARY EVALUATION OF
PEARL MILLET GERMPLASM FROM UTTAR PRADESH

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ABSTRACT

A germplasm collection expedition to Uttar Pradesh, India organised by ICRISAT in collaboration with the Indian Grassland and Fodder Research Institute, Jhansi and Chandrasekhar Azad University of Agriculture and Technology, Kanpur, during October, 1979, collected 456 accessions of traditional cultivars of pearl millet (*Pennisetum americanum* (L.) Lecke) and six samples of wild *Pennisetums*, mainly from farmer's fields. When the accessions were evaluated at Patancheru, wide variations were observed in days to flower, plant height, as well as the shape and size of the spike and grain. Most of the accessions grew tall (193-291 cm), flowered in 50-80 days in *khari* season, but in *rabi* season they mostly flowered in 56-77 days accompanied by a reduction in plant height (107-196 cm). To facilitate constitution of germplasm pools, all the accessions were classified into seven cultivar groups considering the shape, length and thickness of the spike, and based on them a key was developed for identifying them.

PEARL Millet, *Pennisetum americanum* (L.) Lecke, is grown over an estimated 981,500 ha. producing 657,600 tonnes in Uttar Pradesh which ranks fourth in area and third in grain production in India (Government of India, 1979). Uttar Pradesh, a northern state of India, lies between 23° 28' N latitude. Tropical monsoon climate prevails here. The mean monthly temperature in most millet-growing areas of the state during the crop growth being around 30°C, the maximum often reaches 40°C (Tiwari, 1973). The region receives most of its rainfall during the southwest monsoon, the rainfall gradually decreasing as one moves westwards and southwards. The southwestern parts of the state receive the least rainfall, usually less than 700 mm/annum. The crop is usually grown in alluvial and sandy loam soils covering two-thirds of the state. It is also grown in calcareous soils in the eastern part of the state, in medium deep black soils in the southern parts of Agra and Jhansi districts and in red sandy soils in the Bundelkhand area.

Pearl millet is mostly grown as a rainfed crop except around Etawah, Mainpuri and Lalgunj where we saw a few millet fields being irrigated from wells. In the areas sampled, millet was intercropped with pigeonpea (*Cajanus cajan*), black gram (*Vigna mungo*) or moth bean (*Vigna acconitifolia*) if it was grown as a grain crop for human consumption. Fodder millet was usually intercropped with cluster bean (*Cyamopsis tetragonaloba*), sann hemp (*Crotalaria juncea*) or cowpea (*Vigna unguiculata*).

Realizing that the traditional cultivars of pearl millet are gradually being replaced by high-yielding improved cultivars and should be saved from extinction,

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the Rockefeller Foundation, in collaboration with the Indian Agricultural Research Institute, collected 142 accessions from Uttar Pradesh (Rachie, 1963) and evaluated those for 39 characters (Murty *et al.*, 1967). Those accessions were mostly contaminated and modified by allogamy during rejuvenation; this was why Harlan (1973) suggested that a new start should be made to collect them again. Accordingly, ICRISAT staff, in collaboration with the Indian Grassland and Fodder Research Institute (IGFRI), Jhansi and Chandra Sekhar Azad University of Agriculture and Technology (CSAUAT), Kanpur, collected 456 accessions of cultivated and six wild *Pennisetums* from Uttar Pradesh during October, 1979. This paper deals with the collection and preliminary evaluation of this germplasm and attempts to differentiate the accessions into identifiable races and to discuss their potential for use in pearl millet improvement.

MATERIALS AND METHODS

The collecting team consisting of Masood Ali (IGFRI), Ramswarup (CSAUAT), Appa Rao and Rajagopal Reddy (ICRISAT) obtained samples from farmers' fields, threshing floors or local markets. All the samples were numbered serially followed by 'SAR', an abbreviation of the collectors' names. Figure 1 gives the route followed, and the sampling sites visited.

Sampling: The coarse grid sampling method (Allard, 1970) was followed and the sampling sites represented a range of environments. Attempts were made to collect the top 5–10 cm portion of the spike from more than 30 plants wherever possible. However, most of the accessions were represented by 5–10 spikes only because farmers were reluctant to spare more spikes. This random sample was enriched with a biased sample of rare phenotypic variants, as suggested by Bennett (1970). Information on the local cultural practices and special characteristics of the cultivars grown were gathered from the farmers donating the accessions.

Agronomic Evaluation: Seeds of individual accessions multiplied by "cluster-bagging" method (Appa Rao, 1980) were used for evaluation at Patancheru, in the Alfisol fields in the post-rainy (*rabi*) and the rainy (*khariif*) seasons, the planting dates being November 23, 1979 and June 27, 1980, respectively. In general, the *khariif* season was characterised by long photoperiod and high temperature, while the *rabi* season was characterised by short photoperiod and low temperature. Each accession was grown in four, 4 m long rows, 75 cm apart with 12 cm. distance between the plants. The fertilisers applied were N at 80 kg/ha, and P₂O₅ at 40 kg/ha. Supplemental irrigations were given whenever necessary. Standard descriptors (IBPGR/ICRISAT, 1981) were recorded. Considering the shape, length and thickness of the spike, all the accessions were classified into different races, using the definition of a race as "a group of related individuals with enough characteristics in common to permit their recognition as a group" (Anderson and Cuttler, 1942).

RESULTS AND DISCUSSION

During the mission, most of the pearl millet growing areas were covered and 456 cultivated and six wild *Pennisetum* accessions collected (Appa Rao and Rajagopal Reddy, 1979). The sampling sites represented a range of environments. Even then, the collection cannot be considered complete because of the small sample size. Marshall and Brown (1975) suggested that the sampling schedule should ensure collection of at least one copy of each variant occurring in the target populations (individual fields) with frequency greater than 0.05. All the material collected was shared by IGFRI, Jhansi, CSAUAT, Kanpur, Millet Coordinator, Pune and ICRISAT.

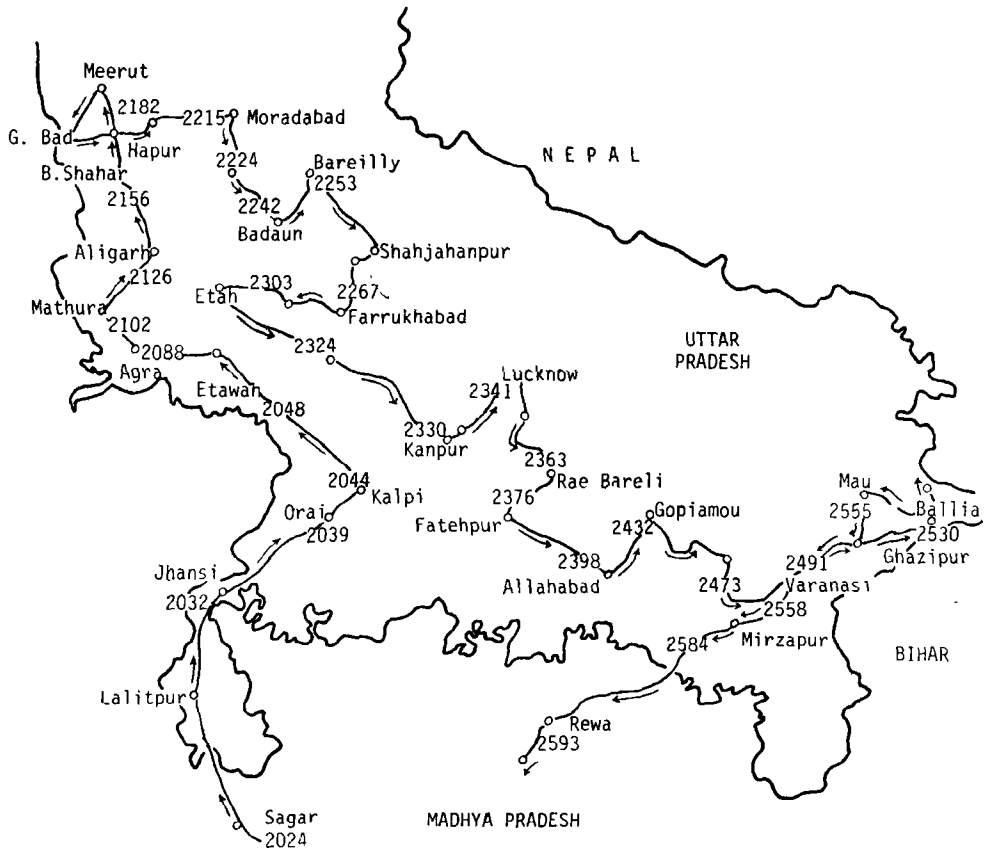


Fig. 1. Route and location of pearl millet accessions collected from Uttar Pradesh in October 1979. Numbers in the map refer to SAR collection numbers.

Agronomic Evaluation: Wide range of variability was observed in several descriptors (Table 1), and the environment in which the accessions were grown also considerably influenced the character expression (Fig. 2). In general, most of the accessions flowered a week earlier in the *kharif* than in the *rabi* season. The delayed flowering during *rabi* may be due to low temperature and/or short day length. Ong and Everard (1979) reported that in pearl millet the time to anthesis can be reduced by imposing short days. Time of planting drastically altered plant height with a mean of 250 cm in the *kharif* and 140 cm in the *rabi*.

The reduction in plant height during the *rabi* might be due to low temperature. It has been shown that low temperature decreased plant height (Fussell *et al.*, 1980). The reduction in height occurred through a reduction in the internode length rather than the node number. Spike length appeared to be a stable character being similar in both the seasons with a mean of 22.5 cm in the *kharif* and 21.8 cm in the *rabi*. The reduction in plant height during the *rabi*

did not influence the spike length. Spike thickness was also a stable character with a mean of 22.7 mm in the *kharif* and 21.6 mm in *rabi*. Several vegetative characters such as leaf number and size and stem thickness were reduced in the *rabi* than in the *kharif* season. Most of the accessions had short bristles except 15 accessions whose bristles grew beyond the grain surface. Grain shape was predominantly obovate, mostly gray in colour with partly corneous endosperm.

TABLE 1

Ranges and means of some morpho-agronomical characters in pearl millet germplasm collected from Uttar Pradesh

Characters	Kharif		Rabi	
	Range	Mean	Range	Mean
Days to 50% flowering	48-80	67	50-79	73
Plant height (cm)	162-291	250	84-198	140
Productive tillers (No.)	1.4- 4.6	2.3	1.4- 4.1	2.1
Stem thickness (mm)	5.1-13.2	9.3	5.0-12.3	8.9
Node number	7.0-17.0	11.4	7.0-15.0	10.1
Leaf blade length (cm)	45.0-82.1	60.3	41.2-77.3	58.2
Leaf blade width (mm)	25.4-45.3	35.3	23.0-42.1	32.9
Spike length (cm)	14.2-33.8	22.5	12.6-38.0	21.8
Spike thickness (mm)	17.2-33.0	22.7	15.0-29.4	21.6
Bristle length (mm)	4.9-38.2	6.1	4.8-36.4	5.9
1000 grain weight (g)	6.3- 8.2	7.3	6.3- 8.0	7.2
Endosperm texture*	2.3- 8.0	4.2	2.2- 8.0	4.2

*Scored on 1 to 9 scale, 1=corneous, 9=starchy.

Development of Germplasm Pools: To minimize genetic drift during seed increase and rejuvenations, Burton (1979) suggested formation of logical groups. Therefore, considering spike shape which is a stable character, all the accessions were classified into seven logical groups (Table 2). To facilitate easy identification, a key was developed based on shape, length and thickness of the spike and relative length of the bristles (Table 3). As the crop is allogamous, considerable variation within a landrace population was observed for plant height, flowering and spike characters (Fig. 3). For the purpose of classification, the most predominant shape within an accessions was considered. Figure 4 depicts the typical head specimens for each of the cultivar groups.

Group 1: Commonly grown around Mirzapur, Mathura, Etah and Godial. It was characterized by very thin, long, cylindrical spikes with elliptical bold grains. It was usually intercropped with cowpea or cluster beans.

Group 2: It was extensively grown around Mathura and Aligarh mostly as a sole crop. It was the tallest of all during both the seasons. Spikes were very long, stout, and spindle shaped with very bold pyriform gray grain with almost starchy endosperm.

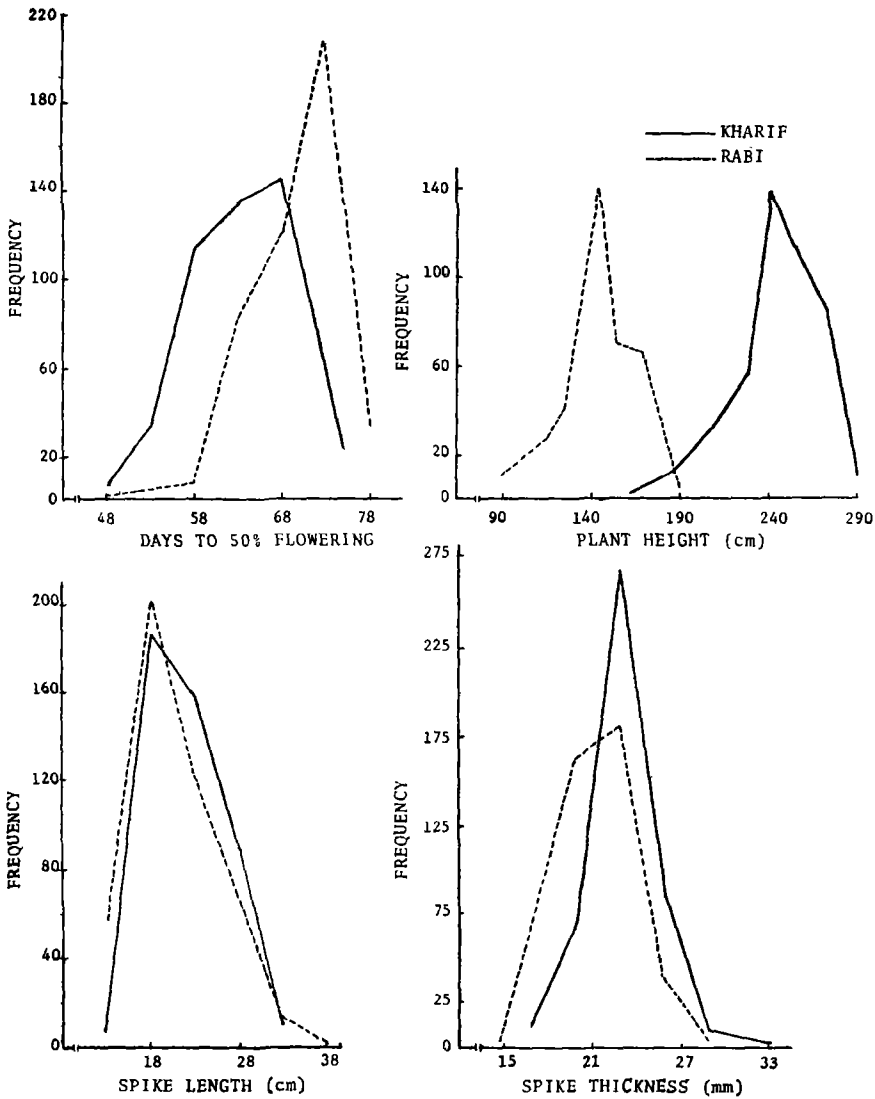


Fig. 2. Effects of two dates of planting on days to 50% flowering, plant height, spike length and spike thickness of pearl millet germplasm from Uttar Pradesh.

Group 3: Grown extensively around Mainpuri, Allahabad, Rae Bareli, Aligarh, Meerut and Etawah. It was mostly grown on the banks of the rivers Ganges and Jamuna where predominantly sandy soils occur. It was usually planted early to facilitate growing a second crop of wheat or chickpea.

TABLE 2
Ranges and means for selected characters of different cultivar groups of pearl millet

Culti- var group	Days to 50% flowering				Plant height (cm)				Spike length* (cm)				Spike thickness*			
	Kharif*		Rabi**		Kharif*		Rabi**		(cm)		(mm)		1000 grain weight (g)*			
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean		
1	54-65	61	61-73	66	231-272	251	123-169	150	22-34	27	20-23	22	7.4-8.4	7.8		
2	55-65	62	63-74	70	260-278	270	134-167	156	23-33	27	22-25	23	6.4-9.8	8.2		
3	50-66	61	56-77	69	215-291	245	107-196	147	17-28	23	18-25	22	6.2-8.9	7.4		
4	52-67	63	62-74	71	193-282	254	126-152	139	22-27	24	18-27	23	5.9-8.6	7.5		
5	62-69	67	63-75	71	236-272	253	143-167	156	19-21	20	24-27	26	6.2-8.8	7.4		
6	63-72	67	64-74	68	222-260	240	124-148	135	17-22	19	21-24	22	6.0-7.1	6.4		
7	76-80	78	69-77	72	226-266	243	122-161	133	17-19	18	19-24	21	6.1-7.2	6.5		

*Planted on June 27, 1980, **Planted on November 23, 1979.

TABLE 3

Key for identifying different cultivar groups of pearl millet from Uttar Pradesh

1. Spike shape candle to cylindrical	
3. Spike shape candle	Cultivar group-1
3. Spike shape cylindrical	
4. Bristle length shorter than grain surface	Cultivar group-3
4. Bristle length longer than grain surface	Cultivar group-4
2. Spike shape conical to spindle	
5. Spike shape conical	
6. Spike thickness more than 24 mm	Cultivar group-5
6. Spike thickness less than 24 mm	Cultivar group-6
5. Spike shape spindle	
7. Spike length more than 20 cm	Cultivar group-2
7. Spike length less than 20 cm	Cultivar group-7

Group 4: Common around Pratapgarh and was characterized by cylindrical spikes with elliptical small grains in which the bristles grew beyond the grain surface.

Group 5: It was observed in the Mirzapur and Ghazipur districts and was characterized by very stout, short and conical spikes with elliptical, gray, and corneous grains.

Group 6: It was found in the Sikandarpur, Farrukhabad, Fatehgarh, and Lalganj areas. Spikes were short, stout, and conical with small and corneous grains. Most accessions of this type flowered in about the same time in both the *kharif* and *rabi* seasons.

Group 7: A rare cultivar group, grown mostly around Gopiamou in Pratapgarh district. It was late-maturing, spikes thin, short, and conical with small elliptical, and gray grain with a corneous endosperm. At times, the whole grain is cooked like rice.

These different cultivar groups appeared to retain their characteristics due to geographic isolation, differences in flowering time, and specific local adaptability aided by selection of a particular head-type for seed purpose by the farmer. However, intermediate forms between cultivar groups were commonly encountered. All the 456 accessions were constituted into seven different germplasm pools by mixing together seeds from all the accessions that fall within a cultivar group. This seed mixture will be planted in an isolated field to allow the plants within a group to intermate naturally. At maturity approximately equal number of seeds from each plant will be harvested to reconstitute the particular germplasm pool.

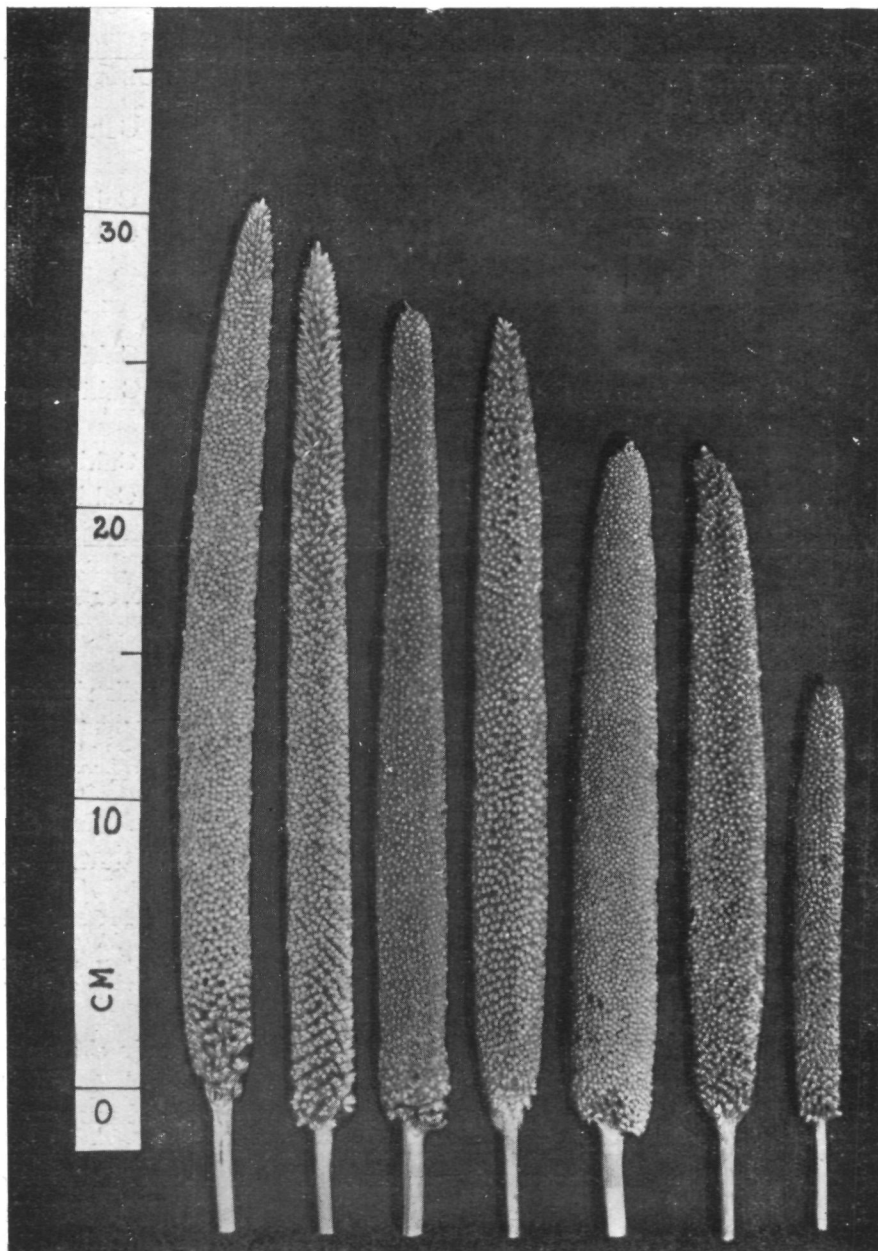


Fig. 3. Variation in shape, length and thickness of spike within a group.

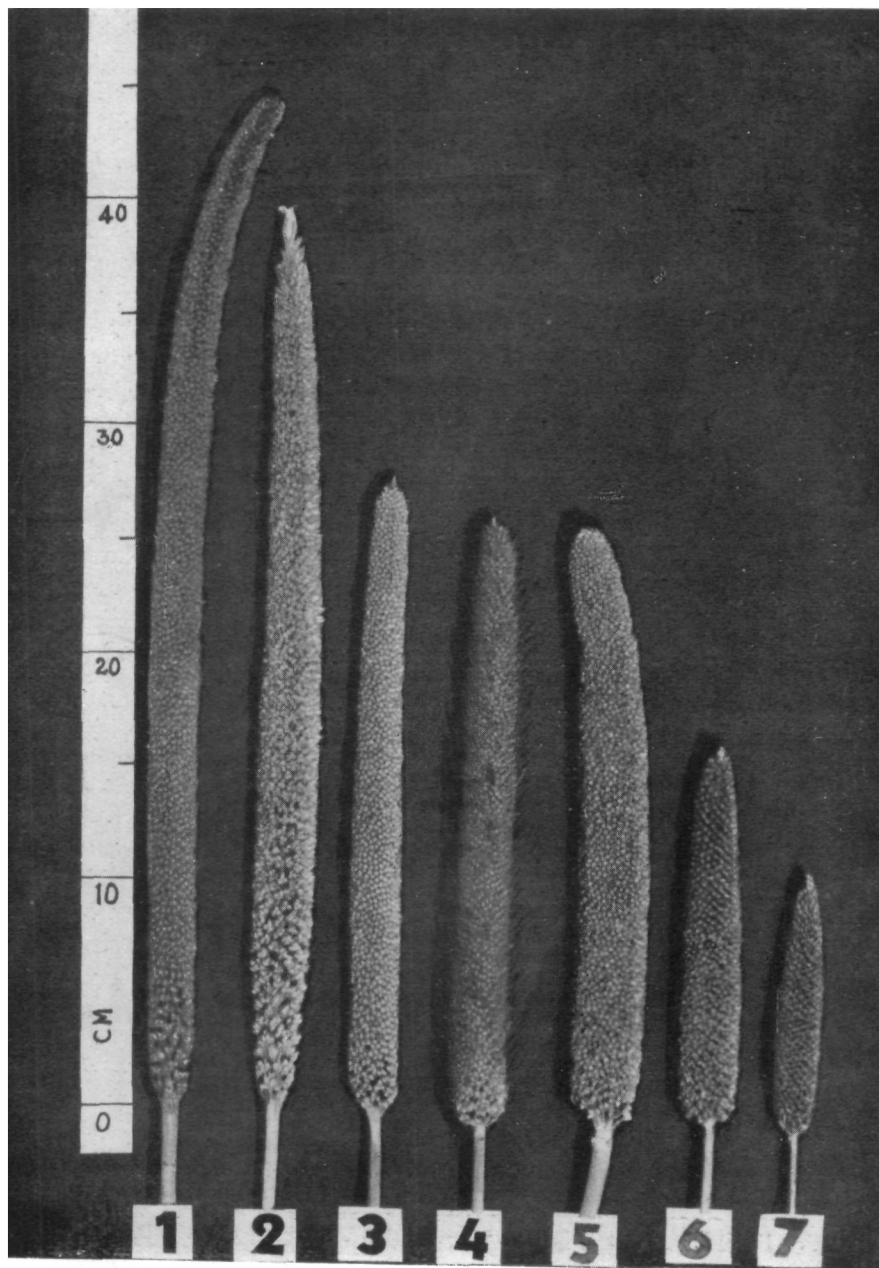


Fig. 4. Spike types of seven cultivar groups of pearl millet collected from Uttar Pradesh.

CONCLUSION

Traditional cultivars with low yield potential were extensively cultivated even though the farmers were aware of the existence of such high-yielding hybrids as BJ 104 and BK 560. The reasons given by local farmers for choosing cultivars varied from place to place and from farmer to farmer. Most of the farmers realized that the hybrids yielded more than the traditional cultivars but were not preferred because, the farmers believed that (1) hybrids needed more inputs such as irrigation; fertilizers, and plant protection; (2) hybrids were prone to severe bird damage because they matured earlier than the local varieties; (3) traditional cultivars tasted better than the hybrids; (4) the traditional cultivars produced more good-quality stover. The preference for locals was so strong that a few well-to-do farmers reserved some area to produce enough grain for domestic consumption and grew hybrids on a commercial scale for marketing. Hybrids were, however, popular in western parts, especially in Agra, Aligarh, and Meerut districts. As the traditional cultivars are well known for their local adaptability and strong preference for grain quality, the local germplasm should be used in millet improvement programme. These accessions appear to be good source for earliness and tillering, while the spike length and grain size need to be improved. The West African germplasm specially from Ghana and Mali possess these attributes.

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