

Morphological diversity in finger millet germplasm introduced from Southern and Eastern Africa

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Introduction

Finger millet (*Eleusine coracana*) [family *Poaceae* (*Gramineae*)] ranks fourth in importance among millets in the world after sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*) and foxtail millet (*Setaria italica*). Finger millet is an annual robust grass, mainly grown as a grain cereal in the semi-arid tropics and subtropics of the world under rainfed conditions. It is mentioned in archaeological records pertaining to early African agriculture in Ethiopia that date back 5000 years (source: <http://www.fao.org/ag/AGP/AGPC/doc/Gbase/safricadata/eleucor.htm>). It is a staple food crop in the drought prone areas in the world, and is considered as an important component of food security. Finger millet grain can be stored for years without storage pests, which makes it a perfect food grain commodity for famine-prone areas (National Research Council 1996). While grains are used for human consumption, the crop residues are excellent source of dry matter for livestock especially in dry season. Finger millet straw makes good fodder and contains up to 61% total digestible nutrients (National Research Council 1996).

The availability of diverse genetic resources is a prerequisite for genetic improvement of any crop including finger millet. Besides the availability of genetic resources, their characterization is essential for the effective utilization in crop improvement programs. In this article, an attempt has been made to present the characterization of finger millet germplasm introduced from Southern and Eastern African countries and unknown origin. However, in this introduced collection, some accessions from Nepal (Asia) were also received.

Materials and methods

The material for the study consisted of 909 finger millet germplasm accessions introduced from the genebank at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Bulawayo, Zimbabwe during 2001. The germplasm accessions were sown in second fortnight of July 2002 at ICRISAT, Patancheru, India located between 17°25' latitude and 78° longitude at 545 m asl in Alfisols, and harvested in December 2002. Each

accession was sown in a single row of 4 m length and 0.75 m apart. The plants were thinned before three weeks after sowing maintaining 0.1 m between plants. Fertilizers were applied at the rate of 100 kg ha⁻¹ of diammonium phosphate (nitrogen = 18% and phosphate = 46%) as a basal dose, and 100 kg ha⁻¹ of urea (nitrogen = 46%) as top dressing. Data were recorded on plant pigmentation and growth characters like plant height, and time to 50% flowering and inflorescence characters such as inflorescence length, width and exertion as per the descriptors for finger millet (IBPGR 1985).

Results and discussion

Plant pigmentation and growth characters. Based on plant color, the germplasm accessions were classified into green or pigmented. More than 50% green plant accessions were from Kenya, Nepal, Zambia and Zimbabwe. Among the 909 accessions, 65.3% were green plant type accessions and 34.7% were pigmented type accessions (Table 1).

Growth habit and time to flower. Finger millet normally has three types of growth habit – decumbent, erect and prostrate. In the collection only two types (decumbent and erect) were present with dominance of erect types (92.8%) (Table 1), while the prostrate types were completely absent. The mean plant height ranged from 90 (Tanzania) to 104 cm (Uganda). The range varied from 50–120 cm in the accessions from Zimbabwe to 85–130 cm (Ethiopia, Malawi, Uganda and Zaire) (Table 2), indicating that the dwarf plant (up to 75 cm) accessions occurred in Zimbabwe with greater frequency (6.5%) than in the entire collection (4.5%) from Southern and Eastern Africa. The mean time to 50% flowering ranged from 65 (Ethiopia) to 81 days (unknown origin). However, the range varied from 62–96 days in the accessions from Kenya to 73–81 days in accessions from Tanzania and Zaire (Table 2), indicating that early flowering accessions occurred in Kenya, and late flowering accessions were found in Tanzania and Zaire.

Inflorescence length and width. The mean of inflorescence length ranged from 88 (Malawi and

Zambia) to 104 mm (Ethiopia) (Table 2). The mean of inflorescence width ranged from 55 (Zaire) to 103 mm (Nepal). The range varied from 40–215 mm in the accessions from Kenya, Zimbabwe and unknown origin to 60–180 mm in accessions from Nepal, Ethiopia and Tanzania (Table 2), indicating that narrowest inflorescence width accessions were found in Kenya, Zimbabwe and unknown origin, while the widest width accessions were found in Nepal, Ethiopia and Tanzania. Similarly the mean of panicle exertion ranged from 75 (Zimbabwe) to 110 mm (Uganda). However, the range varied from 0 (Kenya, Nepal, Zimbabwe and unknown origin) to 80 mm in accessions from Tanzania and Zaire (Table 2), indicating that accessions with no exertion occurred in Kenya, Nepal and Zimbabwe and maximum exertion accessions were found in Tanzania and Zaire. (Due to single accession from South Africa it is ignored.)

Grain color. A wide range of grain colors (dark brown, light brown, *ragi* brown, reddish brown and white) were observed in finger millet germplasm collection introduced from Southern and Eastern Africa. Majority of the accessions were light brown (57.2%), followed by reddish brown (22.3%), dark brown (10.2%), *ragi* brown (8.4%) and white (1.9%).

Classification

Based on inflorescence compactness and shape, finger millet is classified into different races (*Elongata*, *Plana*, *Compacta* and *Vulgaris*). Each of these races is further classified into subraces. The race *Elongata* has three

subraces, *laxa*, *reclusa* and *sparsa*; *Plana* also consists of three subraces, *seriata*, *confundere* and *grandigluma*; the race *Compacta* has no subrace, while the race *Vulgaris* has four subraces, *lilicea*, *stellata*, *incurvata* and *digitata* (Prasada Rao et al. 1993). In this introduced collection, majority of accessions belonged to race *Vulgaris* (60.3%) followed by race *Plana* (22.2%), race *Compacta* (15.6%) and race *Elongata* (1.9%).

Race *Vulgaris*. This race is commonly found in Africa and Asia. The inflorescence fingers are reflexed in subrace *lilicea*, twisted in subrace *stellata*, incurved in subrace *incurvata* giving fist-like appearance, and top curved in subrace *digitata*. In the collection, all four subraces, *lilicea* (1.7%), *stellata* (5.4%), *incurvata* (22.0%) and *digitata* (31.2%), were observed.

Race *Plana*. This race is characterized by large spikelets that are arranged in two, almost even rows along the rachis, giving the inflorescence branch a flat ribbon-like appearance. In the subrace *seriata*, the spikelets are serially arranged giving a typical ribbon-like appearance. In the subrace *confundere*, the fertile florets are numerous and almost surround the rachis at maturity thus giving a compact appearance to the panicle. Subrace *grandigluma* is characterized by large pointed glumes, which are several times longer than the spikelets. In this collection, all three subraces, *seriata* (3.0%), *confundere* (18.2%) and *grandigluma* (1.0%), were found.

Race *Compacta*. Members of this race are commonly referred to as cockscomb finger millets in both Africa and India. Spikelets are composed of nine or more florets,

Table 1. Geographic distribution of plant pigmentation and growth habit of finger millet germplasm accessions introduced from Southern and Eastern Africa.

Country	Number of accessions	Pigmentation		Growth habit	
		Green	Purple	Decumbent	Erect
Ethiopia	4	3	1	1	3
Kenya	502	292	210	23	479
Malawi	4	3	1		4
Nepal (Asia)	32	28	4	6	26
South Africa	1	1			1
Tanzania	3	2	1		3
Uganda	28	9	19	3	25
Zaire	2		2		2
Zambia	9	7	2	1	8
Zimbabwe	199	142	57	19	180
Unknown	125	110	15	10	115
Total	909	597	312	63	846

Table 2. Geographic diversity for time to 50% flowering, plant height and inflorescence length, width and exertion in finger millet germplasm accessions introduced from Southern and Eastern Africa.

Country	Number of accessions	Time to 50% flowering (days)		Plant height (cm)		Inflorescence length (mm)		Inflorescence width (mm)		Panicle exertion (mm)	
		Range	Mean±SE	Range	Mean±SE	Range	Mean±SE	Range	Mean±SE	Range	Mean±SE
Ethiopia	4	63-69	65.2±1.4	85-115	93.7±7.2	85-120	103.7±7.5	60-90	76.2±6.9	70-115	97.5±10.1
Kenya	502	62-96	74.9±0.2	65-135	100.5±0.5	30-180	95.2±0.9	40-120	69.2±0.5	0-215	102.3±1.4
Malawi	4	72-85	75.7±3.1	85-130	98.7±10.5	70-100	87.5±6.3	55-75	62.5±4.3	55-110	90.0±12.4
Nepal (Asia)	32	63-94	74.1±1.1	75-125	91.7±2.0	55-135	92.0±4.1	60-180	102.9±5.7	0-155	95.6±5.9
South Africa	1	79	79.0±0.0	120	120.0±0.0	160	160.0±0.0	150	150.0±0.0	110	110.0±0.0
Tanzania	3	73-76	75.0±1.0	70-100	90.0±10.0	60-110	88.3±14.8	60-65	61.7±1.7	80-105	96.7±8.3
Uganda	28	66-80	72.9±0.7	85-120	103.7±1.8	70-120	93.7±3.1	50-110	68.2±2.4	45-155	110.3±4.9
Zaire	2	73-81	77.0±4.0	85-100	92.5±7.5	100	100.0±0.0	50-60	55.0±5.0	80-135	107.5±27.5
Zambia	9	65-87	75.1±2.5	75-110	94.4±4.1	55-120	87.2±6.6	50-70	60.0±2.2	30-185	95.0±15.3
Zimbabwe	199	63-83	71.8±0.2	50-120	93.0±0.8	55-130	89.2±1.2	40-100	64.9±0.7	0-145	74.5±2.1
Unknown	125	65-96	80.8±0.6	70-180	100.6±1.4	50-190	91.9±2.1	40-215	66.8±1.7	0-215	89.5±3.2

sometimes with the inflorescence axis divided at the base, ascending and incurved at the tip to form a fist-like inflorescence. *Compacta* has no subbraces and represented 15.6% of the collection.

Race *Elongata*. This race is morphologically the most distinct of the four races of finger millet (Prasada Rao et al. 1993). It is characterized by long slender inflorescence branches, digitately arranged, spreading and curved outward at the time of maturity. Subrace *laxa* has long open fingers with spikelets arranged in narrow rows on inflorescence branches, closely resembling wild africana, while subrace *reclusa* has short open fingers without any curving out of finger branches. Subrace *sparsa* also has open fingers but spikelets are arranged in clusters on the inflorescence branch with naked space in between. In this collection, this race was represented by subbraces *laxa* (0.4%) and *sparsa* (1.5%), whereas the subrace *reclusa* was not found.

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References

IBPGR. 1985. Descriptors for finger millet (*Eleusine coracana* (L.) Gaertn). Rome, Italy: International Board for Plant Genetic Resources. 20 pp.

National Research Council. 1996. Lost crops of Africa. Vol. 1. Grains. Washington, DC, USA: National Academy Press. 383 pp.

Prasada Rao KE, de Wet JMJ, Gopal Reddy V and Mengesha MH. 1993. Diversity in the small millets collection at ICRISAT. Pages 331-346 in *Advances in small millets* (Riley KW, Gupta SC, Seetharam A and Mushonga JN, eds.). New Delhi, India: Oxford and IBH Publishing Co. Pvt. Ltd.