Characterization and Preliminary Evaluation of National Collections of Barnyard Millet (*Echinochloa* species) Germplasm

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Barnyard millet (*Echinochloa* species) which is known as *sawan* is cultivated as fodder and cereal in concentrated pockets in many states in India. The states growing barnyard millet are Uttaranchal, parts of western Uttar Pradesh, North Bihar, Maharashtra and Northeastern states. The grains are nutritious and cooked as rice after shelling. It is one of the quickest growing crops, some cultivars coming to harvest in 6-8 weeks.

Barnyard millet belongs to genus *Echinochloa* of the family Graminae. Several *Echinochloa* species, particularly *Echinochloa frumentacea* (Roxb.) Link, *Echinochloa colona* (L.) Link, *Echinochloa crusigalli* (L.) Beauv and *Echinochloa utilis* (Ohwi and Yabuno) are cultivated in Asia including China, Korea, Japan, USSR as well as India. They are also grown in USA and central African countries. Probably, different species of *Echinochloa* were domesticated in different parts of Asia. It is believed that *Echinochloa frumentacea* in China, *Echinochloa colona* in India and *Echinochloa crusigalli* in Japan, are domesticated.

Barnyard millet is one of the mandate crops of All India Coordinated Small Millets Improvement Project (AICSMIP) where research efforts are made in areas of crop improvement, crop production and crop protection. Many improved varieties have been released for cultivation in different states. As part of crop improvement activity, a modest collection of barnyard millet germplasm is maintained at the Active Collection Site (ACS), AICSMIP, Bangalore. These collections have been assembled partly through collection expeditions made within the country through NBPGR and also pooling of collections available elsewhere.

There was little information on the extent and kind of diversity present in the collections maintained at ACS. So, characterization and preliminary evaluation of the accessions maintained was considered essential.

Some 719 accessions collected from 7 Indian states and one exotic from Japan, were characterized and primarily evaluated during *kharif* season 2000 at the main research station, UAS, GKVK, Bangalore which is situated at about 130° N latitude and 77° 37' E longitude at an altitude of 890 metres above mean sea level (Table 1).

Table 1. Source of germplasm

State/country	No. of accessions
Bihar	261
Japan	1
Karnataka	1
Madhya Pradesh	147
Orissa	5
Tamil Nadu	9
Uttaranchal	277
Uttar Pradesh	18
Total	719

Each accession was grown in space planted 3 metre long rows following a spacing of 25 cm between rows and 10 cm within row. The crop was raised adopting the recommended package. For characterization, 12 descriptors were considered, *viz.*- growth habit, degree of culm branching, degree of lodging at maturity, senescence, colour of inflorescence, inflorescence shape, compactness of inflorescence, shape of lower racemes, branching of lower racemes, spikelet arrangement, grain shape and grain colour. All these characters are having relatively high heritability and show stable expression with least environmental influence. The scoring for thesecharacters was done as per the procedures given in *Echinochloa* descriptors of IBPGR (IBPGR, 1983). For preliminary evaluation, only four quantitative characters were included. They are plant height, number of basal tillers, length of inflorescence and days to flowering. The metric data collected from five plants for the quantitative characters were subjected to statistical analysis to work mean, range and coefficient of variability. Regarding characterization, grouping was done based on their segregation to different categories and frequencies were worked out.

The germplasm showed wide range of variability in plant height (73.8-169.2 cm), number of basal tillers (2-21), length of inflorescence (9.8-26.4) and days to flowering (34-52). High CV was observed for number of basal tillers (42.9%) followed by days to flowering (32.3) (Table 2 and Fig. 1).

Table 2. Variability for different quantitative characters of barnyard millet germplasm (Total number=719)

Character	Range	Mean	SE	CV %
Plant Height	73.8-169.2	108.4	0.5	12.6
No. of basal tillers	2-21	4.2	0.1	42.9
Length of Inflorescence	9.8-26.4	17.0	0.1	15.3
Days to flowering	34-52	9.6	0.1	32.3

Morphological characters exhibited large variability. Growth habit was found to be erect (647) and decumbent type (72), where as colour of the inflorescence ranged from green (198) to light purple (318) and dark purple (203). Inflorescence shape was mostly pyramidal (638) followed by elliptic (54) and cylindrical (27), while a majority of the germplasm accessions had semi-compact type of inflorescence (441) and 192 were compact and 86 were of open type. Spikelets were arranged around the rachis (702) and also on one side of rachis in some

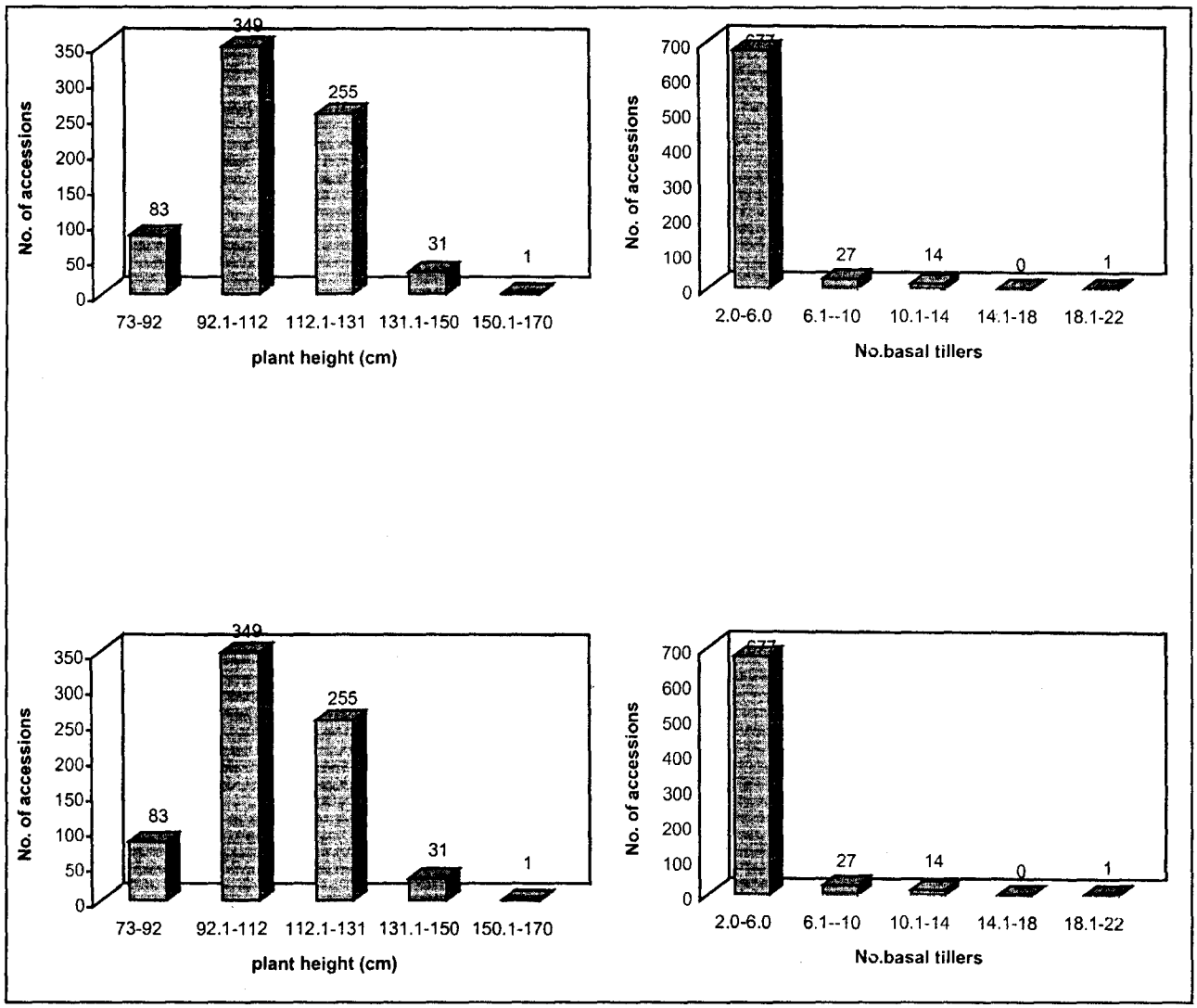

Fig. 1. Frequency distribution for plant height, number of basal tillers, length of inflorescence and days to 50% flowering

Table 3. Statewise grouping of barnyard millet accessions (719) for qualitative characters

Descriptor/ descriptor state	Bihar	Karnataka	Tamil Nadu	Madhya Pradesh	Orissa	Uttar-anchal	Uttar Pradesh	Japan	Total
Growth habit									
Erect	236 (36.47)	1 (0.15)	9 (1.39)	113 (19.46)	3 (0.46)	273 (42.19)	11 (1.7)	1 (0.15)	647
Decumbent	25 (34.32)	0	0	34 (47.22)	2 (2.77)	4 (5.55)	7 (9.72)	0	72
Degree of culm branching									
Low	218 (36.45)	0	4 (0.67)	109 (18.22)	4 (0.67)	243 (41.4)	14 (2.34)	1 (0.17)	598
Medium	42 (35.89)	1 (0.85)	5 (4.27)	35 (29.91)	1 (0.85)	29 (24.78)	4 (3.42)	0	117
High	1 (25.1)	1 (1.29)	0	3 (75)	0	0	0	0	4
Degree of lodging at maturity									
Low	30 (38.96)	0	0	11 (14.26)	0	36 (46.78)	0	0	77
Intermediate	42 (45.65)	0	0	0	0	33 (35.86)	17 (18.47)	0	92
High	189 (34.36)	1 (0.18)	9 (1.63)	119 (21.64)	5 (0.9)	208 (37.81)	18 (3.27)	1 (0.18)	550
Senescence									
Actively growing	147 (37.4)	0	4 (1.01)	66 (16.79)	0	170 (43.25)	6 (1.52)	0	393
Dead	114 (34.96)	1 (0.3)	5 (1.53)	81 (24.85)	5 (1.53)	107 (32.82)	12 (3.68)	1 (0.3)	326
Inflorescence colour									
Green	44 (22.22)	1 (0.50)	3 (1.51)	103 (52.02)	5 (2.52)	23 (11.67)	18 (9.0)	1 (0.5)	198
Light Purple	127 (39.94)	0	2 (0.62)	33 (10.37)	0	156 (49.06)	0	0	318
Dark Purple	90 (44.33)	0	4 (1.97)	11 (5.41)	0	98 (48.27)	0	0	203
Inflorescence shape									
Cylindrical	1 (1.18)	0	0	42 (77.77)	5 (9.2)	4 (7.4)	2 (3.7)	0	54
Pyramidal	260 (40.75)	1 (0.16)	9 (1.4)	95 (14.94)	0	256 (40.25)	16 (2.51)	1 (0.16)	638
Globose	0	0	0	10	0	17	0	0	27
Compactness of inflorescence									
Open	29 (33.72)	0	0	37 (43.02)	5 (5.8)	15 (17.44)	37 (43.02)	0	86
Intermediate	138 (31.29)	1 (0.23)	6 (1.36)	102 (23.13)	0	183 (41.49)	102 (23.13)	0	441
Compact	94 (48.95)	0	3 (1.56)	8 (4.16)	0	79 (41.14)	8 (4.16)	1 (0.52)	192
Shape of lower racemes									
Straight	49 (23.44)	1 (0.47)	1 (0.47)	44 (21.05)	5 (2.39)	105 (50.23)	4 (0.91)	0	209
Curved	212 (42.65)	0	8 (1.6)	92 (18.5)	0	170 (34.2)	14 (2.8)	1 (0.20)	497
Slender	0	0	0 (84.61)	11	0 (15.38)	2	0	0	13

Contd.

Table 3 Contd.

Descriptor/ descriptor state	Bihar	Karnataka	Tamil Nadu	Madhya Pradesh	Orissa	Uttar-anchal	Uttar Pradesh	Japan	Total
Branching of lower racemes									
Absent	149 (30.84)	1 (0.2)	4 (0.8)	102 (21.12)	5 (1.02)	218 (45.15)	4 (0.8)	0	483
Present	112 (47.45)	0	5 (2.11)	45 (19.06)	0	59 (25.0)	14 (5.93)	1 (0.4)	236
Spikelet arrangement									
Outside the rachis	1 (5.8)	0	0	9 (52.95)	5 (29.41)	1 (5.8)	1 (5.8)	0	17
Around the rachis	260 (37.03)	1 (0.14)	9 (1.28)	138 (19.66)	0	276 (39.32)	17 (2.42)	1 (0.14)	702
Grain shape									
Plano concave	195 (50.52)	1 (0.26)	4 (1.04)	110 (28.49)	3 (0.77)	65 (16.83)	8 (2.07)	0	386
Hemispherical	62 (19.56)	0	4 (1.26)	34 (10.72)	2 (0.63)	205 (64.67)	9 (2.84)	1 (0.32)	317
Elliptical	4 (25.0)	0	1 (6.25)	4 (25.0)	0	7 (43.75)	1 (6.25)	0	16
Grain colour									
Straw white	21 (36.84)	0	0	29 (50.88)	1 (1.75)	6 (10.52)	0	0	57
Grey + straw white	204 (34.46)	1 (0.17)	9 (1.52)	101 (17.66)	3 (0.51)	258 (43.58)	15 (2.53)	1 (0.17)	592
Grey	20 (45.45)	0	0	0	0	3 (21.42)	3 (21.42)	0	44
Brownish Grey	8 (57.14)	0	0	14 (33.53)	0	10 (22.72)	0	0	14
Light Grey	8 (66.66)	0	0	3 (25.1)	1 (8.33)	0	0	0	12

accessions. For grain shape, accessions were either plano-concave (379) or hemispherical (317) with some showing elliptical nature. As regards grain colour, there are 4 shades extending from straw white to gray. Some accessions showed mixture of two seed colour groups *viz.*- gray + straw white (585).

State-wise grouping of morphological characters (Table 3) did not reveal concentration of any group to a specific state. Promising entries identified for different agronomic characters are provided in Table 4. These include accessions showing higher plant height, higher number of basal tillers, longer inflorescence and early flowering.

Table 4. Promising entries identified for different agronomic characters

Character	Range	Accessions
Plant height	> 125 cm	GECH 153, 201, 202, 403, 409, 410, 413
No. of basal tillers	> 11 cm	GECH 720, 705, 707, 708, 712, 721, 723, 724, 725
Length of inflorescence	> 23 cm	GECH 193, 146, 148, 155, 321, 383, 403, 406, 529, 639
Days to flowering	35 days	GECH 8, 10, 11, 30, 106, 595, 626, 633, 690, 692, 698, 700, 702, 706, 707, 708, 710, 711, 714, 715, 717, 718, 730, 739, 744, 747, 752

Reference

IBPGR (1983) *Echinochloa Millet Descriptors*. IBPGR Secretariat, Rome.