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**Research Article**

# Characterization of barnyard millet (*Echinochloa frumentacea* (Roxb.) Link.) landraces for agro-morphological traits and disease resistance

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**Abstract**
Barnyard millet (Echinochloa frumentacea) is one of the quickest growing minor cereal crop grown by tribal and poor farmers in marginal soils under rainfed conditions. In the present study, 49 land races of barnyard millet were collected from five districts of Madhya Pradesh during 2008-09 and 2009-10 and evaluated for agro-morphological traits and grain smut. Significant variation in all the studied characters was recorded except in days to 50% flowering. Susceptibility index (SI) of grain smut ranging from 0.0 to 15.3 with a mean of 8.45 was recorded. Highest coefficient of variation (CV) was recorded in grain smut (65.3%) followed by number of basal tillers (30.9%) and grain yield plant$^{-1}$ (21.2%) where as lowest CV was noted in days to 50% flowering (2.6%). Quantitative grouping of land races showed that 83.7% land races were erect and 16.3% have prostrate growth habit. Twenty seven land races were semi dwarf and 15 were tall. Low tillering capacity was recorded in 61.2% land races. Majority of land races were medium maturing, medium inflorescence length, medium grain yield per plant and medium test weight. Degree of lodging was observed in all the land races at maturity. Plant height had significant positive correlation with flag leaf length, inflorescence length and SI of grain smut, where as negative correlation was with flag leaf width and grain yield per plant. Strong positive association between length of lower raceme and 1000 grain weight was recorded, while strong negative correlation between length of lower raceme and days to 50% flowering and between days to 50% flowering and 1000 grain weight was observed. Positive correlation between 1000 grain weight and grain yield per plant was also noted. Five land races namely -RBM 57, 77, 78, 81 and 82 were completely free and RBM 58 was resistant to grain smut.

**Key words**
Barnyard millet, land races, characterization, agro-morphological traits, disease resistance

## Introduction

Barnyard millet (Echinochloa frumentacea) is an important small seeded coarse cereal crop grown by tribal and poor farmers in undulating fields for food and feed. In India, the crop is grown in about 1.95 lakh hectares with annual production of 1.67 lakh tonnes and 857 kg ha$^{-1}$ productivity (Anon, 2011). It is a self pollinated crop belongs to family Poaceae and is the quickest growing among the small millets. The grains are nutritious and recommended to the patients of celiac diseases. Grain smut caused by Ustilago panici frumentace (= Ustilago trichophora) is an important fungal disease and reported to cause 6.5 to 60.8% grain yield loss (Jain et al, 1997) in different genotypes of barnyard millet. In the present investigation, land races of barnyard millet were evaluated for qualitative and quantitative characters along with important biotic stresses. A comprehensive collection of germplam and their evaluation leads to identification of genotypes of high yield potential and other useful economic characters like disease and insect-pest resistance. Conservation of such valuable germplasm for further utilization is important. Few studies on crop biodiversity, genetic divergence, genetic variability, stability and host resistance have been carried out in barnyard millet ( Dhagat et al, 1978, Mishra et al, 1988, Rao and Agrawal, 2000, Jain and Joshi, 2005 and Gupta et al , 2009b ), but more studies are essential in this neglected and underutilized crop. Keeping this in view, land races of different

small millets were collected from actual area of its cultivation and evaluated for agro-morphological characters, yield traits and grain smut resistance.

## Materials and methods

Barnyard millet land races were collected from five districts namely Rewa, Satna, Sidhi, Singrauli and Shahdol of Madhya Pradesh through roving field survey. The collections were made through personal visit, local contact with farmers and personnel of agriculture department during the year 2008-09 and 2009-10. About 100 g of seed were collected along with passport information about the sample like name of the farmer, village, block and district. The collected samples were numbered, kept in cloth bags and cleaned in the laboratory for further evaluation.

Forty nine land races of barnyard millet were sown in two rows of 3.0 m length in augmented design at experimental area of Agriculture College Rewa (M.P.) in two consecutive years 2009-10 and 2010-11. Row to row and plant to plant spacing of 25.0 cm and 7.5 cm, respectively were maintained and recommended packages of practices were adopted for optimum crop growth. Ten plants of each land races were tagged to recorded different agro-morphological traits at appropriate stages of plant

growth. Ten quantitative traits namely plant height (cm), number of basal tillers, flag leaf length (cm) and width (cm), peduncle length (cm), length of inflorescence (cm), length of lower raceme (cm), days to 50% flowering, grain yield plant$^{-1}$ (g) and 1000 grain weight (g) were recorded as per standard procedure. Qualitative traits like growth habit, plant pigmentation, culm branching, inflorescence colour, inflorescence shape and compactness, degree of lodging at maturity, shape of lower raceme, branching of lower raceme and spikelet arrangement were also recorded. Grain smut incidence (%) was recorded at dough stage by counting healthy and smutted plants in each row, where as smut severity (%) was recorded by estimating percent grains transformed into smut sori per panicle (Nagaraja et al , 2007). Susceptibility index was calculated as square root of smut incidence x smut severity in each land races of barnyard millet and land races were grouped in different category of reaction. The range, mean, standard deviation and coefficient of variation for quantitative traits were calculated. Grouping of land races were done on the basis of qualitative and quantitative traits.

**Results and discussion**

A total of 49 land races of barnyard millet were collected from five districts covering 9 blocks of Madhya Pradesh representing varied latitude, longitude and altitude . Maximum 26 land races were collected from Singrauli district followed by 13 land races from Satna, 7 from Shahdol, 2 from Sidhi and 1 from Rewa district. Pooled data of quantitative characters recorded in 49 barnyard millet races are presented in table 1. Average plant height ranging from 65.1 to 128.9 cm was maximum in RBM 73 and minimum in RBM 80. Variation in basal tillers, peduncle length, inflorescence length and length of lower raceme ranged 1.0 to 4.6, 2.6 to 10.0 cm, 9.8 to 19.2 cm and 1.8 to 5.9 cm, respectively. Average days to 50% flowering were 38 days with a range of 35 to 45 days. Grain yield per plant ranging from 2.9 to 13.2 g was maximum in RBM 81 and minimum in RBM 75, where as highest 1000 grain weight was recorded in RBM 80 and minimum in RBM 76. Variability analysis of barnyard millet land races for yield, its component characters and susceptibility index of grain smut on the basis of pooled data are presented in Table 2. Large variation in all the characters except days to 50% flowering period was recorded. Maximum coefficient of variation (CV) was recorded in susceptibility index of grain smut (44.15%) followed by number of basal tillers (38.19%) , grain yield per plant ( 33.61%) and peduncle length (33.53%), where as minimum CV was in days to 50% flowering (4.23%) and 1000 grain weight (7.86%) . Higher variability in productive tillers per plant, grain yield per plant and other yield attributing traits was also reported by Bandyopadhyay (1999), Mehta et al (2005), Mehta et al (2007), Channappagoudar et al (2008) and Gupta et al (2009a) in barnyard millet.

Grouping of barnyard millet land races on the basis of quantitative traits (table 3) revealed that 7 (14.3%) land races were dwarf, 27 (55.1%) were semi-dwarf and 15 (30.6%) were tall. Low tillering capacity was recorded in 30 land races (61.2%) where as higher number of basal tillers was recorded only in 6 land races (12.3%). Majority of the land races were medium maturing (87.8%) and only 3 (6.1%) were early. Medium inflorescence length and medium length of lower raceme was recorded in 59.2% and 73.4% land races, respectively. Higher grain yield potential was recorded in only 4 land races namely RBM 81, RBM 32, RBM 82 and RBM 37.

Correlation coefficients among agro-morphological traits and susceptibility index (SI) of grain smut presented in table 4 showed significant positive or negative correlation in 25 character pairs at 5% probability. Plant height had significant positive correlation with flag leaf length, inflorescence length and SI of grain smut, where as negative correlation was with flag leaf width and grain yield per plant. Strong positive association between length of lower raceme and 1000 grain weight was recorded, while strong negative correlation between length of lower raceme and days to 50% flowering and between days to 50% flowering and 1000 grain weight was observed. Positive correlation between 1000 grain weight and grain yield per plant was noted. SI of grain smut was positively correlated with plant height and flag leaf length, where as negative association with basal tillers, length of lower raceme, 1000 grain weight and grain yield per plant, was recorded. Inflorescence length was positively correlated with flag leaf length. Rao and Aggarwal (2000) reported positive association of ear length and number of tillers with grain yield. However, Kumar et al (2000) found that plant height, harvest index and test weight were not correlated with grain yield in barnyard millet. Mehta et al (2007) reported that plant height, days to 50% flowering; weight of panicle had higher direct effect on grain yield. Gupta et al (2009) observed strong positive association between peduncle length and inflorescence length. Further, inflorescence was strongly positively correlated with flag leaf blade length. Days to maturity were positively correlated with flag leaf length and grain yield was positively correlated with internodes length, flag leaf width and raceme number. These reports are in confirmation with the present findings.

Qualitative traits namely growth habit, plant pigmentation, culm branching , colour of

inflorescence, shape, inflorescence compactness , degree of lodging at maturity , shape of lower raceme, Branching of lower raceme and spikelet arrangement are presented in table 5. Wide variation in qualitative traits was recorded. Grouping of land races on the basis of qualitative traits are presented in Table 6. It is apparent from the data that 83.7% land races were erect and 16.3% have prostrate growth habit. Majority of the land races were medium maturing with medium inflorescence length, medium grain yield per plant and medium test weight. Plant pigmentation was recorded in 40 land races (81.64%) and culm branching was found in 43 land races (87.76%). Green inflorescence colour was recorded in 47 land races, where as two land races were light purple. Inflorescence shape in all the land races was pyramidal. Similarly, degree of lodging at maturity was observed in all the land races. Inflorescence compactness was intermediate in 75.5% land races. Branching of lower raceme was not observed in any land race. Spikelet arrangement in one side of the rachis was observed in 8 land races, where as it was around the rachis in rest of the land races. Slender shape of lower raceme was observed in 47 (95.6%) land races. Susceptibility index (SI) of grain smut varied from 0.0 to 15.3 with a mean of 8.45 was recorded. Five land races namely RBM 57, 77, 78, 81 and 82 were completely free from grain smut, where as RBM 58 was resistant to grain smut. Twenty eight (57.2%) land races namely RBM 22, 27, 28, 30, 31, 32, 33, 35, 36, 38, 39, 47, 51, 52, 54, 55, 56, 59, 62, 63, 64, 65, 68, 69, 71, 73, 76 and 84 were moderately resistant and 15 (30.6% ) namely RBM 26, 34, 37, 44, 46, 48, 50, 53, 66, 67, 70, 72, 74, 75, and 80 were susceptible (Table 7). None of the land races were highly susceptible to grain smut. Earlier Resistant sources in barnyard millet for grain smut were also identified by Jain and Joshi (2005) and Nagaraja and Mantur (2008). Gupta et al (2009) grouped 257 barnyard millet accessions into 7 groups based on origin and reported that genes determining grain yield and susceptibility to grain smut were at most loosely linked and smut resistance along with grain yield in barnyard millet can be enhanced by adopting proper breeding strategy.

## Conclusion

It may be concluded from the present study that large and significant variation in all the characters except flowering period exists among 49 land races of barnyard millet. Majority of the land races were medium maturing with medium inflorescence length, medium grain yield per plant and medium test weight. Inflorescence shape in all the land races was pyramidal. Similarly, degree of lodging at maturity was observed in all the land races. Desirable characters like plant height, number of basal tillers, flag leaf length, length of lower raceme, 1000 grain weight and susceptibility index may be considered while performing selection for determination of grain yield. It is suggested that early maturing, higher yielder with higher test weight land races namely RBM 37 and RBM 81 and grain smut resistant land races namely RBM 57, 58, 77, 78, 81 and 82 may be utilized in hybridization programmme.

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Table 1. Agro-morphological characters of barnyard millet land races (average of 2 years ).

| S. No | Entry No. | Plant height (cm) | Basal tillers | Flag leaf length (cm) | Flag leaf width (cm) | Peduncle length (cm) | Inflorescence length (cm) | Length of lower raceme (cm) | Days to 50% flowering | 1000 grain weight (g) | Grain yield Plant$^{-1}$ (g) | Grain smut (SI) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | RBM 22 | 90.7 | 1.0 | 29.4 | 3.3 | 6.0 | 12.6 | 3.9 | 36 | 3.68 | 7.28 | 8.30 |
| 2 | RBM 26 | 75.3 | 1.0 | 16.4 | 2.9 | 6.5 | 9.7 | 4.2 | 37 | 2.77 | 3.17 | 12.25 |
| 3 | RBM 27 | 86.6 | 1.2 | 18.2 | 2.2 | 7.9 | 14.3 | 3.6 | 37 | 2.71 | 4.38 | 9.95 |
| 4 | RBM 28 | 84.4 | 1.2 | 23.2 | 2.2 | 5.0 | 12.5 | 3.1 | 37 | 3.02 | 6.67 | 9.20 |
| 5 | RBM 30 | 92.1 | 1.6 | 23.4 | 1.9 | 5.7 | 14.8 | 3.3 | 37 | 3.51 | 8.04 | 9.90 |
| 6 | RBM 31 | 97.8 | 1.1 | 22.2 | 2.3 | 6.3 | 13.9 | 3.7 | 37 | 3.34 | 7.11 | 7.15 |
| 7 | RBM 32 | 97.0 | 1.8 | 25.3 | 2.1 | 7.9 | 16.0 | 3.9 | 37 | 3.49 | 11.28 | 7.10 |
| 8 | RBM 33 | 93.3 | 1.6 | 25.0 | 2.3 | 10.0 | 11.8 | 3.0 | 37 | 3.38 | 6.81 | 8.15 |
| 9 | RBM 34 | 80.3 | 1.1 | 24.6 | 2.8 | 7.9 | 13.8 | 5.2 | 36 | 3.49 | 5.68 | 11.80 |
| 10 | RBM 35 | 88.1 | 1.6 | 24.2 | 2.2 | 7.2 | 15.2 | 2.8 | 35 | 3.54 | 8.08 | 7.40 |
| 11 | RBM 36 | 89.1 | 1.3 | 23.5 | 2.4 | 7.3 | 14.0 | 2.7 | 35 | 3.42 | 5.34 | 9.15 |
| 12 | RBM 37 | 88.6 | 2.0 | 12.9 | 2.6 | 5.2 | 12.8 | 4.8 | 35 | 3.70 | 10.35 | 10.50 |
| 13 | RBM 38 | 92.2 | 2.2 | 23.8 | 2.2 | 5.5 | 12.9 | 3.3 | 37 | 3.64 | 6.44 | 9.75 |
| 14 | RBM 39 | 91.0 | 2.1 | 16.9 | 2.1 | 3.8 | 11.0 | 4.0 | 37 | 3.43 | 9.95 | 5.20 |
| 15 | RBM 44 | 79.1 | 1.3 | 17.2 | 2.5 | 3.8 | 13.8 | 5.1 | 39 | 3.09 | 6.39 | 10.05 |
| 16 | RBM 46 | 92.1 | 1.9 | 25.2 | 2.3 | 4.5 | 14.0 | 4.3 | 40 | 2.77 | 6.20 | 11.55 |
| 17 | RBM 47 | 83.2 | 3.5 | 22.5 | 2.2 | 4.4 | 12.8 | 4.1 | 38 | 3.39 | 7.51 | 8.35 |
| 18 | RBM 48 | 88.0 | 1.1 | 22.2 | 2.4 | 4.9 | 14.1 | 4.4 | 40 | 3.56 | 5.01 | 10.45 |
| 19 | RBM 50 | 90.8 | 2.1 | 23.0 | 2.4 | 5.1 | 15.3 | 4.5 | 42 | 3.29 | 6.03 | 15.30 |
| 20 | RBM 51 | 93.0 | 1.5 | 26.0 | 2.4 | 5.7 | 14.5 | 2.9 | 37 | 3.34 | 4.90 | 6.40 |
| 21 | RBM 52 | 101.2 | 1.5 | 23.0 | 2.1 | 3.3 | 14.4 | 4.5 | 38 | 3.23 | 6.22 | 9.50 |
| 22 | RBM 53 | 92.0 | 1.5 | 21.8 | 1.6 | 3.4 | 16.7 | 4.3 | 38 | 3.21 | 5.92 | 14.25 |
| 23 | RBM 54 | 94.0 | 3.8 | 19.2 | 1.1 | 3.9 | 16.6 | 4.1 | 38 | 2.96 | 9.00 | 8.25 |
| 24 | RBM 55 | 96.7 | 1.6 | 22.9 | 1.8 | 5.7 | 17.6 | 5.0 | 38 | 3.11 | 6.17 | 6.60 |
| 25 | RBM 56 | 95.2 | 2.6 | 17.2 | 1.4 | 4.7 | 14.3 | 4.1 | 38 | 3.31 | 9.54 | 7.70 |
| 26 | RBM 57 | 77.7 | 1.5 | 12.2 | 2.4 | 3.2 | 12.5 | 5.2 | 38 | 3.12 | 3.70 | 0.00 |
| 27 | RBM 58 | 75.7 | 1.8 | 11.1 | 2.4 | 2.6 | 14.5 | 5.8 | 39 | 3.05 | 5.58 | 1.70 |
| 28 | RBM 59 | 92.0 | 1.6 | 21.9 | 1.6 | 4.0 | 16.2 | 3.7 | 38 | 3.55 | 5.92 | 8.65 |
| 29 | RBM 62 | 101.1 | 1.8 | 21.9 | 1.2 | 6.1 | 16.1 | 5.0 | 38 | 3.13 | 5.98 | 9.00 |
| 30 | RBM 63 | 107.1 | 2.1 | 22.0 | 1.4 | 4.0 | 17.5 | 4.5 | 38 | 3.22 | 7.92 | 8.30 |
| 31 | RBM 64 | 115.1 | 2.5 | 25.5 | 1.7 | 3.2 | 16.3 | 4.6 | 38 | 3.10 | 7.09 | 6.65 |
| 32 | RBM 65 | 108.2 | 2.4 | 24.0 | 1.5 | 5.9 | 18.0 | 4.7 | 38 | 3.24 | 5.94 | 9.35 |
| 33 | RBM 66 | 109.2 | 2.1 | 24.8 | 1.4 | 5.7 | 15.7 | 3.9 | 38 | 3.32 | 5.18 | 10.05 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | RBM 67 | 104.7 | 2.0 | 18.9 | 1.0 | 7.1 | 14.6 | 4.3 | 38 | 3.15 | 5.78 | 10.10 |
| 35 | RBM 68 | 100.7 | 2.9 | 21.1 | 1.4 | 5.3 | 16.2 | 4.1 | 38 | 3.39 | 7.37 | 8.60 |
| 36 | RBM 69 | 111.3 | 1.9 | 20.1 | 1.1 | 3.4 | 15.4 | 4.3 | 38 | 3.26 | 6.05 | 8.50 |
| 37 | RBM 70 | 118.1 | 1.6 | 24.0 | 1.5 | 5.0 | 19.2 | 4.7 | 38 | 3.03 | 7.03 | 12.70 |
| 38 | RBM 71 | 119.5 | 2.3 | 21.8 | 1.7 | 3.5 | 16.4 | 4.0 | 37 | 3.24 | 4.47 | 8.95 |
| 39 | RBM 72 | 119.9 | 2.3 | 19.1 | 1.2 | 3.3 | 16.3 | 4.6 | 37 | 3.26 | 9.42 | 10.50 |
| 40 | RBM 73 | 128.9 | 2.4 | 21.6 | 1.6 | 6.6 | 17.3 | 4.4 | 38 | 3.34 | 4.59 | 9.40 |
| 41 | RBM 74 | 106.9 | 1.6 | 20.0 | 1.2 | 5.3 | 14.9 | 3.1 | 38 | 3.35 | 3.84 | 13.85 |
| 42 | RBM 75 | 101.8 | 1.7 | 21.9 | 1.5 | 3.0 | 15.9 | 3.5 | 38 | 3.11 | 2.86 | 13.60 |
| 43 | RBM 76 | 93.2 | 1.9 | 23.7 | 1.6 | 3.1 | 16.7 | 3.7 | 36 | 2.63 | 3.45 | 8.65 |
| 44 | RBM 77 | 96.6 | 2.4 | 9.9 | 2.0 | 3.9 | 11.8 | 4.9 | 39 | 3.36 | 3.96 | 0.00 |
| 45 | RBM 78 | 92.8 | 2.0 | 11.1 | 2.1 | 2.7 | 14.7 | 5.9 | 39 | 3.57 | 4.12 | 0.00 |
| 46 | RBM 80 | 65.1 | 2.6 | 15.7 | 1.3 | 2.7 | 9.9 | 1.8 | 45 | 3.75 | 5.56 | 12.95 |
| 47 | RBM 81 | 76.3 | 4.6 | 13.0 | 2.1 | 3.1 | 14.0 | 5.2 | 37 | 3.50 | 13.20 | 0.00 |
| 48 | RBM 82 | 81.1 | 3.5 | 11.1 | 1.9 | 3.7 | 13.7 | 5.3 | 39 | 3.53 | 10.43 | 0.00 |
| 49 | RBM 84 | 74.0 | 3.5 | 16.2 | 1.1 | 6.1 | 12.0 | 2.7 | 39 | 3.00 | 8.20 | 9.00 |
| | Mean | 94.5 | 2.0 | 20.5 | 1.9 | 5.0 | 14.6 | 4.1 | 38 | 3.28 | 6.55 | 8.45 |

Table 2. Variations in different agro-morphological traits and grain smut in barnyard millet (average of 2009-10 and 2010-11)

| Character | Range | | Mean | Standard Deviation | CV ( %) |
|---|---|---|---|---|---|
| | Minimum | Maximum | | | |
| Plant height (cm) | 65.1 | 128.9 | 94.48 | 13.31 | 14.09 |
| No. of basal tillers | 1.0 | 4.6 | 2.03 | 0.77 | 38.19 |
| Flag leaf length (cm) | 9.9 | 29.5 | 20.47 | 4.62 | 22.58 |
| Flag leaf width (cm) | 1.0 | 3.4 | 1.94 | 0.54 | 27.65 |
| Peduncle length (cm) | 2.6 | 10.0 | 5.00 | 1.68 | 33.53 |
| Inflorescence length (cm) | 9.8 | 19.2 | 14.62 | 2.05 | 14.00 |
| Lower raceme length (cm) | 1.8 | 5.9 | 4.15 | 0.86 | 20.62 |
| Days to 50% flowering | 35.0 | 45.0 | 38.12 | 1.61 | 4.23 |
| 1000 grain weight (g) | 2.6 | 3.8 | 3.28 | 0.26 | 7.86 |
| Grain yield per plant (g) | 2.9 | 13.2 | 6.55 | 2.20 | 33.61 |
| Grain smut (SI) | 0.0 | 15.3 | 8.45 | 3.73 | 44.15 |

Table 3. . Quantitative grouping of 49 Barnyard millet land races on the basis of pooled data

| S. No. | Character | Group | Frequency | Percent (%) |
|---|---|---|---|---|
| 1 | Plant height (cm) | Dwarf (up to 80.0 cm) | 7 | 14.3 |
| | | Semi-dwarf (80.1 to 100.0 cm) | 27 | 55.1 |
| | | Tall (> 100.0 cm) | 15 | 30.6 |
| 2 | Basal tillers | Low (up to 2) | 30 | 61.2 |
| | | Medium 92.1 to 3.0) | 13 | 26.5 |
| | | High(> 3) | 6 | 12.3 |
| 3 | Flag leaf length (cm) | Low (up to 15.0 cm) | 7 | 14.3 |
| | | Medium (15.1 to 25.0 cm) | 37 | 75.5 |
| | | High (> 25.0 cm) | 5 | 10.2 |
| 4 | Flag leaf width (cm) | Low (up to 1.5 cm) | 12 | 24.5 |
| | | Medium (1.6 to 2.5 cm) | 32 | 65.3 |
| | | High (> 2.5 cm) | 5 | 10.2 |
| 5 | Peduncle length (cm) | Low (up to 4.0 cm) | 20 | 40.8 |
| | | Medium (4.1 to 10.0 cm) | 28 | 57.1 |
| | | High (>10.0 cm) | 1 | 2.1 |
| 6 | Length of Inflorescence (cm) | Low (up to 10.0 cm) | 2 | 4.1 |
| | | Medium (10.1 to 15.0 cm) | 29 | 59.2 |
| | | High (> 15.0 cm) | 18 | 36.7 |
| 7 | Length of lower raceme (cm) | Low (up to 3.0 cm) | 6 | 12.3 |
| | | Medium (3.1 to 5.0 cm) | 36 | 73.4 |
| | | High (> 5.0 cm) | 7 | 14.3 |
| 8 | Days to 50% flowering | Early (up to 35 days) | 3 | 6.1 |
| | | Medium (36 to 40 days) | 43 | 87.8 |
| | | Late ( > 40 days) | 3 | 6.1 |
| 9 | Grain yield (g) | Low | 12 | 24.5 |
| | | Medium | 33 | 67.3 |
| | | High | 4 | 8.2 |
| 10 | 1000 grain weight (g) | Low ( up to 3.0 g) | 8 | 16.4 |
| | | Medium (3.1 to 3.5 g) | 28 | 57.1 |
| | | High (> 3.5 g) | 13 | 26.5 |

Table 4. Correlation coefficients among quantitative traits in barnyard millet land races.

| Character | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | -0.03 | 0.39* | -0.47* | 0.02 | 0.69* | 0.10 | -0.20 | -0.08 | -0.32* | 0.38* |
| 2 | | -0.37* | -0.43* | -0.33* | 0.05 | 0.32* | -0.19 | 0.33* | -0.01 | -0.33* |
| 3 | | | 0.06 | 0.44* | 0.37* | -0.41* | -0.26 | -0.03 | 0.01 | 0.54* |
| 4 | | | | 0.24 | -0.49* | 0.14 | -0.26 | 0.17 | 0.08 | -0.15 |
| 5 | | | | | -0.08 | -0.33* | -0.38* | 0.06 | -0.04 | 0.26 |
| 6 | | | | | | 0.27 | -0.12 | -0.21 | -0.07 | 0.15 |
| 7 | | | | | | | -0.94* | 0.89* | -0.06 | -0.44* |
| 8 | | | | | | | | -0.87* | -0.16 | 0.23 |
| 9 | | | | | | | | | 0.35* | -0.34* |
| 10 | | | | | | | | | | -0.34* |

*Significance at 5% probability

1. Plant height 2. Basal tillers 3. Flag leaf length 4. Flag leaf width 5. Peduncle length
6. Inflorescence length 7. Length of lower raceme 8. Days to 50% flowering
9. 1000 grain weight 10. Grain yield per plant 11. Grain smut (SI)

Table 5. Pooled data of qualitative characters in 49 land races of barnyard millet.

| S. No. | Entry No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | RBM 22 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 2 | 0 | 2 |
| 2 | RBM 26 | 1 | 1 | 1 | 5 | 1 | 2 | 7 | 3 | 0 | 2 |
| 3 | RBM 27 | 1 | 1 | 1 | 5 | 1 | 2 | 7 | 3 | 0 | 2 |
| 4 | RBM 28 | 1 | 1 | 1 | 5 | 1 | 2 | 7 | 3 | 0 | 2 |
| 5 | RBM 30 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 6 | RBM 31 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 7 | RBM 32 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 8 | RBM 33 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 9 | RBM 34 | 3 | 0 | 1 | 5 | 1 | 2 | 3 | 3 | 0 | 1 |
| 10 | RBM 35 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 11 | RBM 36 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 12 | RBM 37 | 3 | 0 | 1 | 5 | 1 | 2 | 3 | 3 | 0 | 1 |
| 13 | RBM 38 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 14 | RBM 39 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 15 | RBM 44 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 16 | RBM 46 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 17 | RBM 47 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 18 | RBM 48 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 19 | RBM 50 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 20 | RBM 51 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 21 | RBM 52 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 22 | RBM 53 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 23 | RBM 54 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 24 | RBM 55 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 25 | RBM 56 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 26 | RBM 57 | 3 | 0 | 1 | 5 | 1 | 2 | 3 | 3 | 0 | 1 |
| 27 | RBM 58 | 3 | 0 | 1 | 5 | 1 | 2 | 3 | 3 | 0 | 1 |
| 28 | RBM 59 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 29 | RBM 62 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 30 | RBM 63 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 31 | RBM 64 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 32 | RBM 65 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 33 | RBM 66 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 34 | RBM 67 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 35 | RBM 68 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 36 | RBM 69 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 37 | RBM 70 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 38 | RBM 71 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 39 | RBM 72 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 40 | RBM 73 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 41 | RBM 74 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |
| 42 | RBM 75 | 1 | 1 | 1 | 5 | 2 | 2 | 7 | 3 | 0 | 2 |
| 43 | RBM 76 | 1 | 1 | 1 | 5 | 2 | 2 | 7 | 3 | 0 | 2 |
| 44 | RBM 77 | 3 | 0 | 0 | 5 | 1 | 2 | 3 | 3 | 0 | 1 |
| 45 | RBM 78 | 3 | 0 | 0 | 5 | 1 | 2 | 3 | 3 | 0 | 1 |
| 46 | RBM 80 | 1 | 0 | 0 | 5 | 1 | 2 | 7 | 1 | 0 | 2 |
| 47 | RBM 81 | 3 | 0 | 0 | 5 | 1 | 2 | 3 | 3 | 0 | 1 |
| 48 | RBM 82 | 3 | 0 | 0 | 5 | 1 | 2 | 3 | 3 | 0 | 1 |
| 49 | RBM 84 | 1 | 1 | 1 | 5 | 1 | 2 | 5 | 3 | 0 | 2 |

1. Growth habit 2. Plant pigmentation 3. Culm branching 4. Colour of inflorescence 5. Inflorescence shape 6. Inflorescence compactness 7. Degree of lodging at maturity 8. Shape of lower raceme 9. Branching of lower raceme 10. Spikelet arrangement

Table 6. Grouping of 49 Landraces of Barnyard Millet on the basis of qualitative characters

| S .No. | Character | Group | Frequency | Percent (%) |
|---|---|---|---|---|
| 1. | Growth habit | Erect | 41 | 83.67 |
| | | Decumbent | 00 | 00.00 |
| | | Prostrate | 08 | 16.33 |
| 2. | Plant pigmentation | Absent | 09 | 18.36 |
| | | Present | 40 | 81.64 |
| 3. | Culm branching | Absent | 06 | 12.24 |
| | | Present | 43 | 87.76 |
| 4. | Colour of inflorescence | Green | 47 | 95.92 |
| | | Light purple | 02 | 4.08 |
| | | Dark purple | 00 | 00.00 |
| 5. | Inflorescence shape | Cylindrical | 00 | 00.00 |
| | | Pyrimicidal | 49 | 100.00 |
| | | Globose/Elliptical | 00 | 00.00 |
| 6. | Inflorescence compactness | Open | 08 | 16.33 |
| | | Intermediate | 37 | 75.51 |
| | | Compact | 04 | 8.16 |
| 7. | Degree of lodging at maturity | Low | 00 | 00.00 |
| | | Intermediate | 49 | 100.00 |
| | | High | 00 | 00.00 |
| 8. | Shape of lower raceme | Straight | 01 | 2.04 |
| | | Curved | 01 | 2.04 |
| | | Slender | 47 | 95.62 |
| 9. | Branching of Lower raceme | Absent | 49 | 100.00 |
| | | Present | 00 | 00.00 |
| 10. | Spikelet arrangement | One side of rachis | 08 | 16.33 |
| | | Arranged around rachis | 41 | 83.67 |

Table 7. Grouping of barnyard millet land races on the basis of resistance / susceptibility against grain smut.

| Reaction | Susceptibility index of grain smut | Frequency | Land races |
|---|---|---|---|
| Highly resistant | 0 | 5(10.2) | RBM 57, 77, 78, 81 and 82 |
| Resistant | < 5 | 1(2.0) | RBM 58 |
| Moderately Resistant | 5.1 to 10.0 | 28(57.2) | RBM 22, 27, 28, 30, 31, 32, 33, 35, 36, 38, 39, 47, 51, 52, 54, 55, 56, 59, 62, 63, 64, 65, 68, 69, 71, 73, 76 and 84 |
| Susceptible | 10.1 to 20 | 15 (30.6) | RBM 26, 34, 37, 44, 46, 48, 50, 53, 66, 67, 70, 72, 74, 75, and 80 |
| Highly susceptible | >20 | 0 | - |

*Figures in parenthesis are percent of total land races