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# Studies on genetic variability, heritability and genetic advance for yield and other traits in little millet (*Panicum sumatrense* L.) genotypes

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## ABSTRACT

The present investigation was carried out to assess the nature and magnitude of genetic variability parameters of sixteen yield attributing traits in 35 little millet germplasm collections: The experiment was laid out in Randomized Complete Block Design at Agricultural college farm, Bapatla during *Kharif*, 2021 The analysis of variance showed highly significant differences among the genotypes for all the characters studied, indicating the presence of adequate variability. Further, coefficient of variation studies indicated that the estimates of PCV were higher than the corresponding GCV values for all the traits indicating the influence of environment on expression of these characters. High PCV and GCV were recorded for grain iron and manganese contents indicating the existence of high variability for these traits among the studied genotypes. High heritability, along with high expected genetic advance as percent of mean, was observed for days to 50% flowering, leaves per main tiller, grain iron, manganese and protein contents implying that the inheritance of these traits were probably controlled by additive gene effects predominantly. Hence, direct phenotypic selection will be rewarding with respect to improvement these traits.

**Keywords:** *Expected genetic advance as percent of mean, Genotypic coefficient of variation, Heritability, Phenotypic coefficient of variation.*

Little millet (*Panicumm sumatrense* L.) is a self-pollinated and allotetraploid crop (2n = 4x = 36) belonging to the family *Poaceae* and sub family *Panicoideae*. It is locally known as samalu, samai, kutki and mejhari. This is one of the hardiest small millet crop grown extensively in tropics by tribal and poor farmers and is the staple food for the low income groups in some countries of the world. It is said to be indigenous to Indian subcontinent due to the luxuriant presence of its wild ancestor *Panicum psilopodium* throughout India (Selvi *et al.*, 2014). Little millet grains contain fibre and minerals such as zinc (2.04 to 8.00 mg/g), iron (1.49 to 23.38 mg/g) and calcium (1.14 to 13.15 mg/g) and others like potassium, magnesium (Selvi *et al*., 2015). Little millet is comparable with other cereals, such as rice and wheat as a source of protein, fat, carbohydrates and crude fibre, apart from minerals and vitamins. It also contains phytochemicals, such as phenolic acids, flavonoids, tannins and phytate. (Pradeep and Guha, 2011)

In India little millet is cultivated in an area of 2.91 lakh hectares with a production of 1.02 lakh tones and productivity of 349 kg/ha. The major little millet growing states are Andhra Pradesh, Chhattisgarh, Madhya Pradesh, Odisha, Tamil Nadu, Karnataka, Jharkhand and Gujarat (Anuradha *et al.*, 2021).

Choosing an effective breeding method requires a better understanding of the genetic basis of the traits. Genetic improvement depends on magnitude of genetic variation, heritability and genetic advance of characters of economic importance. Hence knowledge on the variability parameters like GCV, PCV, heritability and expected genetic advance as percent of mean is of great significance to exploit the traits in breeding programmes.

## MATERIALS AND METHODS

The present investigation was carried out during *Kharif*, 2021 Agricultural college farm, Bapatla, Andhra Pradesh. The experimental material in the present investigation consists of thirty five genotypes of little millet evaluated in Randomized Complete Block Design. Each entry was represented by two rows of 3m length. The spacing of 22.5 cm between rows and 10cm within rows was followed. Observations were recorded for sixteen characters *viz.,* days to 50% flowering, plant height (cm), flag leaf length (cm), flag leaf width (cm), leaves per plant, panicle length (cm), tillers per plant, productive tillers per plant, days to maturity, test weight (g), grain iron content (mg/100g), grain zinc content (mg/100g), grain manganese content (mg/100g), grain copper content (mg/100g), grain protein content (%) and grain yield per plant (g). Among the traits, data for days to 50% flowering and days to maturity were recorded on plot basis and the remaining traits, observations were recorded on five randomly chosen plants from each plot.

Analysis of variance and summary statistics was calculated as per Panse and Sukathme (1967). Phenotypic and genotypic coefficients of variation (PCV and GCV) were computed as per Burton and Devane (1953). Heritability in broad sense was computed as per Allard (1960). Genotypic and phenotypic correlations were calculated according to Falconer (1981). Heritability and genetic advancement were categorized into low, medium and high as per Johnson *et al.,* (1955).

## RESULTS AND DISCUSSION

The mean sum of squares due to genotypes was highly significant at 1% level of significance for all the characters studied in the present investigation. This indicated the existence of considerable variability for all characters studied among the genotypes. Hence, it offers a better scope for further improvement of breeding material by the selection of promising genotypes in little millet breeding programme. The mean sum of squares of various characters was presented in Table 1. The parameters of genetic variability such as mean, range, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and expected genetic advance as percentage of mean (GA) were estimated for all the quantitative characters and are presented in table 2.

The days to 50% flowering ranged from 43.00 days to 73.33 days with a mean of 53.32 days whereas plant height ranged from 56.88 cm to 105.33 cm with a mean of 80.10 cm. On the other hand, flag leaf length ranged from 14.92 cm to 27.27 cm with a mean of 21.01 cm and flag leaf width varied from 0.55 cm to 1.13 cm with a mean of 0.79 cm. The range of leaves per main tiller was from 7.60 to 13.60 with a mean of 10.54; panicle length varied from 15.97 cm to 26.87 cm with an average of 21.86 cm; tillers per plant ranged from 6.47 to 10.80 with a mean of 7.99 and productive tillers per plant ranged from 4.93 to 7.93 with a mean of 5.95. Further, the number of days to maturity ranged from 80.33 to 106.33 with an average of 86.13 and test weight ranged from 1.80 g to 3.23 g with a mean of 2.37 g.

Considering the nutritional traits estimated from the grain sample, the grain iron content varied from 1.88 mg/100g to 4.51 mg/100g with a mean of 2.62 mg/100g; the grain zinc content ranged from 1.46 mg/100g to 2.73 mg/100 g with a mean of 1.78 mg/100g; the grain manganese content extended from 0.59 mg/100g to 1.46 mg/100g with a mean of 0.97 mg/100g; the grain copper content varied from 0.25 mg/100g to 0.47 mg/100g with a mean of 0.34 mg/100g and the grain protein content ranged from 5.24% to 9.57% with a mean of 7.07%. The grain yield per plant ranged from 4.96 g to 9.85 g with a mean of 7.06 g.

The experimental material had wide range of variability and favourable mean performance for most of the traits studied and these possible combinations could be exploited for simultaneous improvement of grain yield and other yield attributing traits.

The PCV was higher in magnitude than the magnitude of GCV for all the traits, indicating the presence of influence of environment on the expression of these traits. High estimates of GCV and PCV were observed for grain iron (28.61, 24.50) and manganese (23.92, 20.13) contents. This meant that genotypes had a great deal of intrinsic variability, making them more useful for selection. Likewise, high estimates of variability were also reported by Karvar *et al.* (2021) in foxtail millet for grain iron content and Anuradha *et al.* (2018) in pearl millet for grain manganese content which corroborates with the findings of the present study.

High PCV and moderate GCV was observed for flag leaf width (24.32, 18.10), grain zinc content (20.82, 13.00), grain copper content (21.15, 13.88) and grain yield per plant (24.27, 15.76). Similar findings were observed in the studies of Kavya *et al.,*

(2017) in foxtail millet for flag leaf width; Asungre *et al.* (2021) in pearl millet for grain zinc content and Anuradha *et al.*, (2021) in little millet.

Among the studied traits, days to 50% flowering (14.39, 14.04), flag leaf length (16.68, 11.50), leaves per main tiller (18.15, 14.09), test weight (16.35, 12.31) and grain protein content (19.50, 15.54) had moderate PCV and GCV values indicating moderate genetic variability for these characters. These results are in accordance with that of Madhavilatha *et al.* (2020) in little millet for days to 50% flowering; Selvi *et al.* (2014) in little millet for flag leaf length; Vikram *et al.* (2020) in barnyard millet for leaves per main tiller; Venkataratnam *et al.* (2019) for test weight and Patel *et al.* (2018) in little millet for grain protein content.

**Table 1 Analysis of variance for grain yield and other traits in little millet (*Panicum sumatrense*)**

| Source of variations | d.f | Days to 50% flowering | Plant height (cm) | Flag leaf length (cm) | Flag leaf width (cm) | Leaves per main tiller | Panicle length (cm) | Tillers per plant | Productive tillers per plant |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean sum of squares | | | | | | | |
| Genotypes | 34 | 170.95** | 334.32** | 23.96** | 0.08** | 8.07** | 16.36** | 2.18** | 1.35** |
| Replications | 2 | 1.55 | 123.33 | 7.36 | 0.02 | 9.82** | 8.66 | 0.27 | 0.06 |
| Error | 68 | 2.79 | 167.56 | 6.44 | 0.02 | 1.45 | 4.79 | 0.76 | 0.34 |

| Source of variations | d.f | Days to maturity | Test weight (g) | Seed iron content (mg/100g) | Seed zinc content (mg/100g) | Seed manganese content (mg/100g) | Seed copper content (mg/100g) | Seed protein content (%) | Grain yield per plant (g) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean sum of squares | | | | | | | |
| Genotypes | 34 | 96.95** | 0.32** | 1.39** | 0.25** | 0.13** | 0.01** | 4.32** | 5.41** |
| Replications | 2 | 4.72 | 0.06 | 0.05 | 0.39* | 0.25** | 0.01* | 0.1 | 1.34 |
| Error | 68 | 3.24 | 0.07 | 0.15 | 0.08 | 0.02 | 0.01 | 0.69 | 1.7 |

**Table 2 Estimates of variability, heritability and expected genetic advance as per cent of mean for grain yield and other traits in little millet (*Panicum sumatrense*)**

| S.No. | Character | Mean | Range | | Coefficient of variation | | Heritability | Expected Genetic advance as % of mean |
|---|---|---|---|---|---|---|---|---|
| | | | Minimum | Maximum | PCV (%) | GCV (%) | (broad sense) (%) | |
| 1 | Days to 50% flowering | 53.32 | 43 | 73.33 | 14.39 | 14.04 | 95.26 | 28.23 |
| 2 | Plant height (cm) | 80.1 | 56.88 | 105.33 | 18.65 | 9.31 | 24.91 | 9.57 |
| 3 | Flag leaf length (cm) | 21.01 | 14.92 | 27.27 | 16.68 | 11.5 | 47.57 | 16.35 |
| 4 | Flag leaf width (cm) | 0.79 | 0.55 | 1.13 | 24.32 | 18.1 | 55.36 | 27.74 |
| 5 | Leaves per main tiller | 10.54 | 7.6 | 13.6 | 18.15 | 14.09 | 60.26 | 22.53 |
| 6 | Panicle length (cm) | 21.86 | 15.97 | 26.87 | 13.45 | 8.98 | 44.61 | 12.36 |
| 7 | Tillers per plant | 7.99 | 6.47 | 10.8 | 13.91 | 8.59 | 38.13 | 10.93 |
| 8 | Productive tillers per plant | 5.95 | 4.93 | 7.93 | 13.84 | 9.77 | 49.85 | 14.21 |
| 9 | Days to maturity | 86.13 | 80.33 | 106.33 | 6.82 | 6.49 | 90.59 | 12.72 |
| 10 | Test weight (g) | 2.37 | 1.8 | 3.23 | 16.35 | 12.31 | 56.62 | 19.07 |
| 11 | Seed iron content (mg/100g) | 2.62 | 1.88 | 4.51 | 28.61 | 24.5 | 73.33 | 43.22 |
| 12 | Seed zinc content (mg/100g) | 1.78 | 1.46 | 2.73 | 20.82 | 13 | 38.96 | 16.71 |
| 13 | Seed manganese content (mg/100g) | 0.97 | 0.59 | 1.46 | 23.92 | 20.13 | 70.79 | 34.89 |
| 14 | Seed copper content (mg/100g) | 0.34 | 0.25 | 0.47 | 21.15 | 13.88 | 43.08 | 18.77 |
| 15 | Seed protein content (%) | 7.07 | 5.24 | 9.57 | 19.5 | 15.54 | 63.57 | 25.53 |
| 16 | Grain yield per plant (g) | 7.06 | 4.96 | 9.85 | 24.27 | 15.76 | 42.15 | 21.07 |

Whereas, moderate PCV to low GCV was observed for plant height (18.65, 9.31), panicle length (13.45, 8.98), tillers per plant (13.91, 8.59) and productive tillers per plant (13.84, 9.77) indicating the existence of less amount of variation among the genotypes which is in agreement with the findings of Anuradha *et al*. (2017) in little millet for plant height; Anuradha *et al.* (2021) in little millet for panicle length and productive tillers per plant and Sao *et al.*, (2017) in kodo millet for tillers per plant.

Low GCV and PCV were noticed for days to maturity (6.82, 6.49) indicating a limited range of variability for these traits, limiting the possibilities for effective selection. Similar kind of findings were also reported by Anuradha *et al*. (2021) in little millet.

The proportion of variability transferred from parent to offspring could be studied by calculating heritability parameters. Table 2 revealed the estimates of heritability in broad sense for sixteen traits studied, which ranged from 24.91 to 95.26 per cent. Heritability estimates coupled with expected genetic advance as per cent of mean indicates the probable mode of gene action and assist in choosing an appropriate breeding methodology.

High heritability coupled with high expected genetic advance as per cent of mean was observed for days to 50% flowering (95.26%, 28.23%), leaves per main tiller (60.26%, 22.53%) and grain iron (73.33%, 43.22%), manganese (70.79%, 34.89%) and protein (63.57%, 25.53%) contents indicating the presence of additive gene action and scope for genetic improvement through simple selection for these traits. Such results were also indicated by Anuradha *et al.*, (2021) in little millet for days to 50% flowering; by Vikram *et al.* (2020) in barnyard millet for leaves per main tiller; by Patel *et al.* (2018) in little millet for grain iron and protein contents and by Srilatha (2020) in foxtail millet for grain manganese content.

High heritability and moderate expected genetic advance as per cent of mean was observed for days to maturity (90.59%, 12.72%). whereas, indicating the operation of both additive and non-additive gene action and simple selection is ineffective. These results are in accordance with those of Anuradha *et al*. (2021) in little millet.

Moderate heritability and high expected genetic advance as percent of mean were reported for flag leaf width (55.36%, 27.74%) and grain yield per plant (42.15%, 21.07%) which also indicates the operation of both additive and non-additive gene action and ineffectiveness of simple selection. Similar results were reported by Anuradha *et al.* (2020) in little millet for grain yield per plant.

Moderate heritability coupled with moderate expected genetic advance as percent of mean was observed for flag leaf length (47.57%, 16.35%), panicle length (44.61%, 12.36%), tillers per plant (38.13%, 10.93%), productive tillers per plant (49.85%, 14.21%), test weight (56.62%, 19.07%) and grain zinc (38.96%, 16.71%) and copper (43.08%, 18.77%) contents indicating the presence of non-additive gene action and improvement through simple selection is not rewarding. These findings are in conformity with Katara *et al.* (2019) in little millet for panicle length; Subramanian *et al.* (2010) in kodo millet for tillers per plant; Anuradha *et al.* (2020) in little millet for productive tillers per plant and Dhanalakshmi *et al.* (2019) in barnyard millet for test weight.

Plant height (24.91%, 9.57%) recorded low heritability and low expected genetic advance as percent of mean, indicating the operation of non-additive gene action in governing the inheritance of this character. These results are in consonance with Anuradha *et al.*, (2020) in little millet.

Analysis of variance revealed substantial differences among genotypes for all the traits with sufficient variability and scope for selecting suitable genotypes. In the current study it is clear that grain iron and manganese contents had high variability among the genotypes. The traits, days to 50% flowering, leaves per main tiller and grain iron, manganese and protein contents had high heritability, genetic advance as percent of mean and these may be controlled by additive gene action, hence simple selection among genotypes with respect to these traits would be effective.

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