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# Genetic Variability for Morpho-agronomic Traits in Core germplasm Collections of Finger Millet (*Eleusine coracana* (L.) Gaertn.) based on third and Fourth Degree Statistics and their Origin

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***ABSTRACT:*** *The study of distribution properties such as coefficients of skewness and kurtosis provides insight about the nature of gene action and number of genes controlling the traits respectively. They are more powerful than first and second degree statistics which reveal interaction genetic effects. The objective of present investigation to know the genetics of yield and and yield attributes using smaller (622 accessions) and manageable sub sets (known as core collections) which capture maximum variability of the entire global collections (5949 accessions) has been developed in finger millet. Quantitative traits seldom had relationship with any of the morphological traits such as grain colour, plant pigmentation and nature of ear head and geographical origin. The pattern of distribution suggested involvement of an excess of dominant genes with complementary or duplicate epistasis in the inheritance of most of the traits.*

***Key words:*** *Finger millet, skewness, kurtosis.*

## INTRODUCTION

Finger millet (*Eleusine coracana* Gaertn.) ranks fourth in importance among millets in the world after sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*) and foxtail millet (*Setaria italica*) (Upadhyaya et al. 2007). Wide adaptability, nutritional quality, dual-purpose (grain and dry fodder) nature of crop and high multiplication rate of finger millet makes it one of the ideal crops for use as a staple food crop and as an indispensable crop component in mixed crop-livestock system of farming prevalent in semi-arid tropics. Skewness, the third degree statistics and kurtosis, the fourth degree statistics were estimated (Snedecor and Cochran, 1994) to understand the nature of distribution of quantitative traits among core finger millet germplasm accessions. They are more powerful than first and second degree statistics which reveal interaction genetic effects.

## MATERIAL AND METHODS

The material for the present study comprised of 622 core finger millet germplasm accessions procured from ICRISAT, Patancheru, India and four check varieties, PR 202, VR 708, GPU 28 and MR 2. Twenty four days-old seedlings of accessions and check varieties transplanted in the experimental plots of Zonal Agricultural Research Station (ZARS), Mandya, Karnataka on 1$^{st}$ August 2008 in an Augmented design. Recommended agronomic and plant protection practices were followed during crop growth period to raise a good crop. Ten competitive plants in each entry were labelled for recording data on six quantitative traits. Most of the core accessions were collected from Africa (59 %) and Asia (36 %). The origins of 3.5 per cent of the accessions are unknown. The remaining accessions were collected from USA, Europe and United Kingdom.

**Statistical Analysis:** The adjusted mean values of each entry for six quantitative traits were used to estimate coefficients of skewness and kurtosis using 'STATISTICA' software program. Genetic expectations of skewness (-3/2 $d^2h$) reveal the nature of genetic control of the traits (Fisher *et al.* 1932). The parameters 'd' represent additive gene effects and 'h'

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represents dominance gene effects. Kurtosis indicates the relative number of genes controlling the traits (Robson, 1956).

A visual rating or scoring was adopted for recording data on qualitative characters based on Distinctiveness (D), Uniformity (U) and Stable (S) test criteria of Protection of Plant Varieties and Farmers (PPV&FR) Act (2001) authority of India. The accessions were classified into two categories as brown and white, purple and green and fisty and non-fisty based on grain colour, plant pigmentation and nature of ear head, respectively (Table 1). The accessions were also classified into two categories as those originating from Asia and African countries. The differences between six quantitative traits mean values of accessions belonging to two defined categories based on different criteria was tested for statistical significance using two-sample 't' test assuming unequal variances to examine the relationship, if any of six quantitative traits with grain colour, plant pigmentation and nature of ear head and geographical origin.

**Table 1**
**Descriptions of Qualitative Characters in Finger Millet**

| *Sl. No.* | *Traits* | *Time recording observation* | *Score* | *Classified as* |
|---|---|---|---|---|
| 1. | Plant pigmentation | At flowering | 0 | Not pigmented |
| | | | + | pigmented |
| 2. | Nature of ear head | At maturity | F | Fisty |
| | | | NF | Non fisty |
| 3. | Grain color | At dough stage | W | White |
| | | | B | brown |

## RESULTS AND DISCUSSION

**Qualitative traits variation:** While the accessions with green and purple plant pigmentation were in equal frequency, those with brown grains and non-fisty ear heads were predominant (Table 4). Upadhyaya *et al.* (2007) have reported predominance of accessions with brown grains, non-fisty ear heads and green plant pigmentation among 909 finger millet germplasm accessions originating from southern and eastern Africa.

**Relationship of quantitative traits with geographical origin:** The results indicated statistically significant differences between accessions originating from Asia and African countries for only 1000-grain weight (Table 2). Thus, the results indicated the accessions originating from different countries are comparable. The crosses between parents originating from Asian and African countries are expected to be highly productive resulting from complementation of different sets of genes for quantitative traits.

**Relationship of qualitative traits with quantitative traits:** The results indicated absence of any relationship of qualitative traits with any of the quantitative traits investigated. These results suggest independent genetic control of quantitative and qualitative traits investigated (Table 3).

**Table 2**
**Estimates of Quantitative Traits Mean Values of Core Finger Millet Germplasm Accessions Classified based on Geographical Origin**

| *Quantitative trait* | *Geographical origin* | | | |
|---|---|---|---|---|
| | *Asia* | *Africa* | *'t' statistic* | *Probability* |
| No. of accessions | 223 | 365 | -- | -- |
| Days to 50% flowering | 72.380 | 71.803 | 1.252 | 0.211 |
| Plant height (cm) | 103.892 | 103.473 | 0.525 | 0.600 |
| Number of productive tillers $plant^{-1}$ | 5.105 | 5.029 | 0.927 | 0.354 |
| Number of fingers ear $head^{-1}$ | 7.548 | 7.514 | 0.391 | 0.696 |
| 1000-grain weight (g) | 2.494 | 2.424 | 2.281 | 0.023 |
| Grain yield $plot^{-1}$ (g) | 0.430 | 0.417 | 1.096 | 0.274 |

**Table 3**
**Estimates of Quantitative Traits Mean Values of Core Finger Millet Germplasm Accessions Classified based on Grain Color, Plant Pigmentation and Nature of Ear Head**

| *characters* | *Grain colour* | | | | *Plant pigmentation* | | | | *Nature of ear head* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Brown* | *White* | *'t' statistic* | *Probabi-lity* | *Green* | *Purple* | *'t' statistic* | *Probabi-lity* | *Non fisty* | *fisty* | *'t' statistic* | *Probabi-lity* |
| No. of accessions | 614 | 08 | - | - | 313 | 309 | - | - | 601 | 21 | - | - |
| Days to 50% flowering | 71.98 | 71.13 | 0.44 | 0.672 | 72.1 | 71.84 | 0.59 | 0.553 | 71.95 | 72.69 | -0.46 | 0.653 |
| Plant height(cm) | 103.68 | 99.74 | 1.19 | 0.271 | 103.9 | 103.25 | 0.95 | 0.344 | 103.65 | 103.30 | 0.10 | 0.924 |
| Number of Productive tillers plant$^{-1}$ | 5.07 | 4.97 | 0.25 | 0.808 | 5.00 | 5.13 | -1.71 | 0.089 | 5.08 | 4.94 | 0.57 | 0.573 |
| Number of fingers ear head$^{-1}$ | 7.54 | 7.19 | 1.24 | 0.255 | 7.55 | 7.51 | 0.49 | 0.627 | 7.55 | 7.73 | -0.65 | 0.524 |
| 1000-grain weight (g) | 2.46 | 2.46 | -0.03 | 0.978 | 2.46 | 2.46 | -0.05 | 0.957 | 2.44 | 2.48 | -0.49 | 0.631 |
| Grain yield plot$^{-1}$ | 0.42 | 0.44 | -0.28 | 0.785 | 0.42 | 0.43 | -1.17 | 0.243 | 0.42 | 0.40 | 0.87 | 0.394 |

**Nature of genetic control:** Considering that the number of germplasm accessions evaluated in the present study is large and assuming that the observed variability is comparable to that of F„ population representing a mixture of purelines, inferences on the relative number of genes and nature of genetic control of different traits and their implications on effectiveness of selection are discussed.

Negatively skewed platykurtic distribution is an evidence for involvement of a large number of dominant genes with majority of them having increasing effects and duplicate type of epistasis in the inheritance of days to 50 per cent flowering (Figure 1) and grain yield plot$^{-1}$ (Figure 6). The inheritance of number of productive tillers plant$^{-1}$ appear to be controlled by fewer numbers of dominant genes with majority of them having increasing effects and duplicate type of gene interaction as indicated by its negatively skewed leptokurtic distribution (Figure 3). Genetic gain in respect of all these traits manifesting negatively skewed distribution will be rapid under mild selection from the existing variability (Roy, 2000).

The expression of accessions for plant height appears to be controlled by equal frequency of genes with increasing and decreasing effects with the absence of epistasis as evidenced by near normal (mesokurtic) distribution (Figure 2). As variation for plant height is attributable to predominantly additive genetic variation (as variation is due to mixture of pure-lines), simple pure-line selection would be highly effective in enhancing plant height by striking a balance between stover yield and lodging tolerance.

The number of fingers ear head$^{-1}$ seems to be under the control of genes with increasing and decreasing effects in equal frequency and complementary type of interaction as indicated from mesokurtic and positively skewed distribution (Figure 4). Leptokurtic and positively skewed distribution (Figure 5) suggested the involvement of

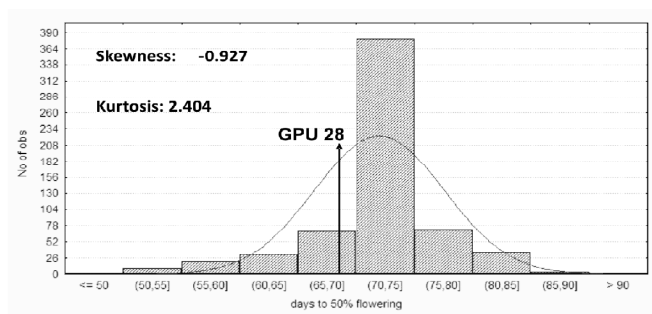


**Figure 1: Platykurtic and Negatively Skewed Distribution of Days t 50% Flowering in Finger Millet Core Germplasm Accessions**

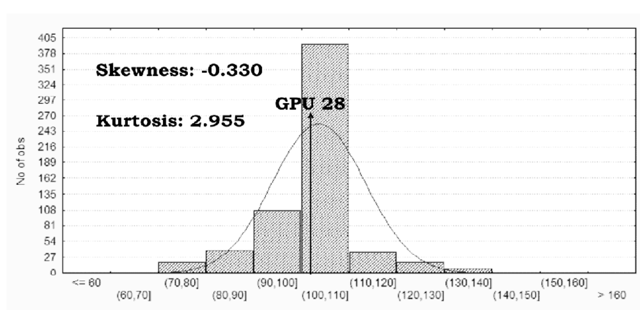


**Figure 2: Normal/ Mesokurtic and Negatively Skewed Distribution of Plant Height in Finger Millet Core Germplasm Accessions**

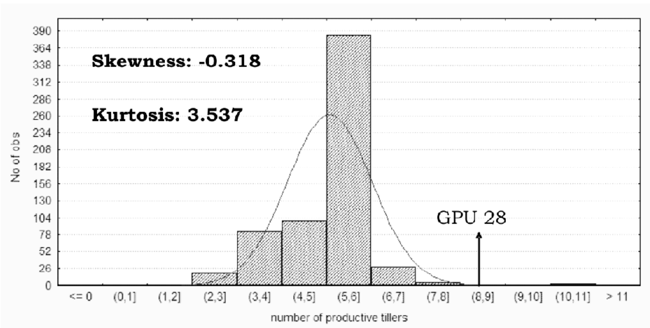


**Figure 3: Leptokurtic and Negatively Skewed Distribution of Number Productive tillers Plant$^{-1}$ Finger Millet Core Germplasm Accessions**

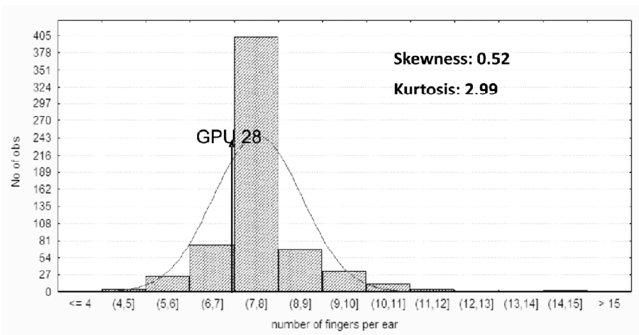


**Figure 4: Platykurtic and Positively Skewed Distribution of Number of Fingers Ear head$^{-1}$ Finger Millet Core Germplasm Accessions**

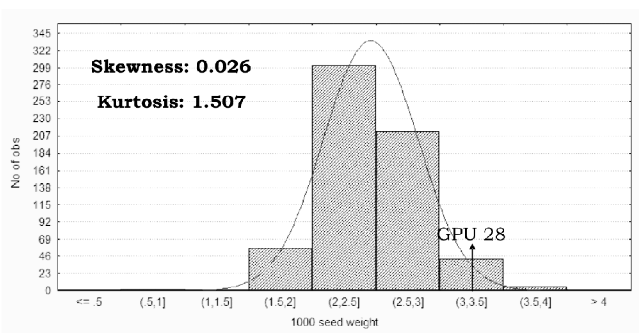


**Figure 5: Platykurtic and Positively Skewed Distribution of 1000 Grain Weight (g) in Finger Millet Core Germplasm Accessions**

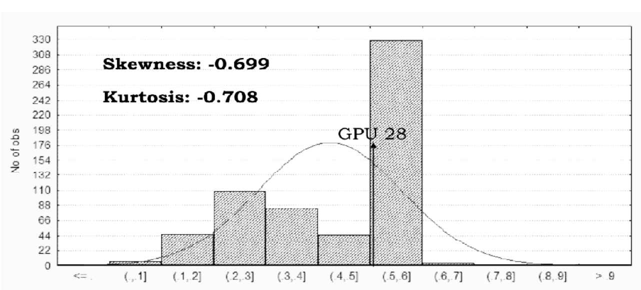


**Figure 6: Mesokurtic and Negatively Skewed Distribution of Grain Yield Plot$^{-1}$ (g) in Finger Millet Core Germplasm Accessions**

relatively fewer number of segregating genes with majority of them having decreasing effects and dominance-based complementary type of interaction in the inheritance of 1000-grain weight. Development and identification of superior inbred lines derived from heterotic (which exploit dominance gene action) crosses appears to be a better strategy for genetic enhancement of finger millet for these traits.

In general, the distribution pattern of accessions suggested that dominance and dominance-based epistasis is the major cause for significant variation and non-normal distribution of majority of the traits investigated in the present study. Sumathi *et al.* (2005) and Krishnappa *et al.* (2009) have also reported involvement of dominance gene action in the inheritance of several economic traits in finger millet.

## REFERENCES

Fisher, R. A., Immer, F. R., and Tedin, O., (1932), The genetical interpretation of statistics of the third degree in the study of quantitative inheritance. *Genetics*, **17**: 107-124.

Krishnappa M., Ramesh S., Chandraprakash J., Jayarame Gowda, Bharathi and Dayal Doss. Genetic analysis of economic traits in finger millet. e-Journal of SAT Agricultural Research (Accepted for publication in December 2009).

Roy, D., (2000), Plant breeding – The Analysis and Exploitation of Variability. Narosa Publishing House. New Delhi. India.

Robson, D. S., (1956), Application of $K_4$ statistics to genetic variance component analysis. Biometrics. **12**: 433-444.

Snedecor, G. W. and Cochran, W. G., (1994), Statistical Methods. Fifth Edition. Iowa State University Press. Ames. Iowa, USA.

Sumathi P., John Joel A and Muralidharan V. (2005), Combining ability and heterosis for grain yield and its contributing traits in finger millet under irrigated conditions. International Sorghum and Millets Newsletter. 46: 92-95.

Upadhyaya H. D., Gowda C. L. L. and Gopal Reddy V. (2007), Morphological diversity in finger millet germplasm introduced from southern and eastern Africa. *eJournal of SAT Agricultural Research* 3(1): 1-3.