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# Genetic variability of quantitative traits in finger millet genotypes

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### Abstract
Finger millet (*Eleusine coracana*) is one among the small millets which is known for its high nutritional value. Finger millet is having substantial genetic variation which is to be exploited for crop improvement. Keeping this in view the present topic was aimed to study the genetic variability, heritability and correlation of grain yield and yield related traits in 10 finger millet genotypes obtained from all over India. Analysis of Variance revealed significant variation for many traits studied. There was wide range of variation in days to 50% flowering (83 to 100 days) and grain yield (24.0 to 35.1 q/ha). Considering both earliness and yield, VL 352 can be suggested as a better variety for grain yield and KOPN 942 for fodder yield. Genotypic Coefficient of Variation (GCV) ranged from low to moderate. Days to 50% flowering, days to maturity, finger length, finger width and leaf length recorded high heritability with moderate GAM indicating presence of both additive and non-additive gene action. Though grain yield had moderate heritability, its moderate GAM indicates both types of gene action which responds to some extent for selection.

**Keywords:** finger millet, variability, heritability, correlation

### Introduction
Finger millet (*Eleusine coracana*), is an important small millet grown extensively in diverse regions of India and Africa. Among small millets, finger millet ranks first in area and production. Among cereals and millets its position in production is sixth after wheat, rice, maize, sorghum and bajra. In India, it is extensively cultivated and consumed in Karnataka followed by Andhra Pradesh, Tamil Nadu, Odisha, Maharashtra, Uttar Khand and Bihar.

Finger millet consumption has wide range of advantages because of its high nutritive values. It contains 5-8% good quality protein, *Eleusinian* which our body can easily absorb. It also has key essential amino acids, tryptophan, methionine, threonine, valine, isoleucine and cysteine which are required for good health. It is lower in fat content (1.3%) and majority is unsaturated fat. The dietary fiber (15–20%) present in it gives fullness to the stomach and thus help in losing weight. It is rich in minerals especially its calcium content is five to thirty times more than other cereals. This calcium is essential for good bone growth and to fight against osteoporosis. It also contains phosphorous, iron and potassium which helps in managing anemia. People sensitive to gluten can use finger millet in their food as it is gluten free. Keeping in view of all these health benefits, finger millet is considered as nutria cereal or super cereal (Bhatt *et al.*, 2011; Chandrasekara and Shahidi, 2011; Devi *et al.*, 2014; Goron and Raizada 2015) [5, 7, 8, 10].

To explore health benefits of finger millet consumption, cultivation of this crop is needed. Farmers tend to grow the crop when they can make profit by growing this crop. For making profits, high yielding varieties in finger millet are needed. To develop high yielding varieties by a plant breeder, exploitation of existing genetic variability for economic traits plays a pivotal role. In pursuit, to develop such high yielding varieties, a breeder has to know how much variability is present in the existing gene pool and the heritability of traits to be enhanced. Also to predict genetic gain under selection genetic advancement along with heritability estimates are needed (Johnson *et al.*, 1955) [11]. Interrelationship between different traits can be studied by knowing the association of characters with one another which provides a scope for better response to selection of traits (Bezaweletaw *et al.*, 2006; Singamsetti *et al.*, 2018) [4, 16]. The present study was aimed to explore genetic variability and heritability of various quantitative traits in finger millet genotypes.

### Material and Methods
In the present investigation, 10 finger millet genotypes including one local check variety, Sri Chaitanya were evaluated at Agricultural Research Station, Vizianagaram, Andhra Pradesh during *kharif*, 2017.

Genotypes were sown in a randomized complete block design (RCBD) in three replications with a spacing of 22.5 × 10 cm per each entry. Each genotype was grown in 10 lines of 3 m length. Fertilizers, 50-40-25 NPK kg/ha and need based plant protection measures were taken to raise a healthy crop. Observations were recorded on plant height (cm), ear length(cm), finger length(cm), finger width(cm), flag leaf length (cm), flag leaf width(cm), productive tillers per plant, days to 50% flowering & maturity, fodder yield(t/ha) and grain yield(q/ha).

Analysis of variance and summary statistics was calculated as per Panse and Sukathme (1967) [14]. Phenotypic and genotypic coefficients of variation (PCV and GCV) were computed as per Burton and Devane (1953) [6]. Heritability in broad sense was computed as per Allard (1960) [1]. 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) [11].

**Results and Discussion**

Crop improvement depends on the genetic variability studies and utilization of the same for breeding purpose by choosing proper lines. These studies are required to assess the amount of role played by the environment in determining a character and also to judge how much easily a chosen character can be transformed to the next generation.

The results from ANOVA (Table 1) revealed significant variability ($p < 0.01$) in 10 finger millet genotypes studied for days to 50% flowering, days to maturity, finger length, finger width, leaf length, leaf width, grain yield and fodder yield. Similar variations were reported by Anuradha *et al*., 2017, 2018; Singamstti *et al*., 2018) [2, 3]. The summary statistics and mean values (Table 2) indicated that days to 50% flowering ranged from 83 to 100 days while days to maturity from 110 to 132 days. The earliest in terms of flowering and duration was KOPN 942 while GPU 67 was late. In the present study three were early varieties (KOPN 942, VL 352 and VL 386) while remaining eight were having longer duration for maturity. There was almost 2cm difference between the shortest (PR 10-35) and longest finger (Sri Chaitanya). Leaf length ranged from 33.9 to 47.5cm, where longest booting leaf was observed in PR 202. Grain yield also varied for 24 q/ha. Highest yielder was GPU 67 with a yield of 35.1 q/ha, while in early maturing types, the highest yield was obtained in VL 352 (30.2q/ha). The yield difference between early (26.33 q/ha) and late varieties (30.61q/ha) was not significant hence early variety, VL 352 can be suggested as a better culture while considering both higher grain yield and earliness. Fodder yield ranged from 59.5q/ha (VL 352) to 106.3 q/ha (PR 202) while the mean fodder yield was 85.43 q/ha. In terms of fodder yield KOPN 942 is a better culture while considering the duration also.

Phenotypic Coefficient of Variation (PCV) was higher than Genotypic Coefficient of Variation (GCV) for all traits studied GCV (Table 3). GCV ranged from low to moderate (1.22 to 14.16). Highest GCV and PCV were observed for fodder yield, leaf width and grain yield indicating large variability of these two traits among finger millet genotypes. GCV and PCV are low for ear length and plant height indicating lesser variability for these two traits.

Highest heritability estimates were observed for days to 50% flowering and days to maturity. Other characters, plant height, number of fingers/ear, finger length, finger width, leaf length and leaf width were observed to have high heritability while number of productive tillers per plant and grain yield were observed to have moderate heritability. Genetic Advance as per cent Mean (GAM) ranged from low to high. High GAM were observed for fodder yield and leaf width while low GAM was observed for plant height, number of productive tillers per plant, number of fingers/ear and ear length. Similar results were reported earlier by Patil *et* al., (2013) [15]; Jyothsna *et al.*, 2016 [12], Mahanthesha *et al.*, 2017 [13]; Anuradha *et al*., 2017 [2] & 2018; Singamsetti *et al*., 2018 [16].

High heritability with moderate GAM were observed for days to 50% flowering, days to maturity, finger length, finger width and leaf length indicating presence of both additive and non-additive gene action. Number of productive tillers per plant showed moderate heritability with low GAM indicating non-additive gene action. Leaf width and fodder yield exhibited high heritability with high GAM indicating predominance of additive gene action which responds well to selection. Hence, direct selection for these traits is rewarding. Grain yield had moderate heritability with moderate GAM indicating both additive and non-additive gene action. Hence, grain yield can be selected via other traits on which it is associated with. Association of various characters gives an approach about simultaneous selection of characters.

Days to 50% flowering and days to maturity were highly and significantly associated in positive direction. Leaf length showed positive significance with days to 50% flowering, days to maturity and finger width while it had negative significant association with number of finger per ear. Similar is the case with grain yield which showed positive significance with days to 50% flowering and negative significant association with number of finger per ear. The dependency on number of fingers per ear is however not possible because of predominance of non-additive gene action as it had low GAM. The negative association of leaf length and grain yield with number of fingers per ear may not hinder selection of both traits. However, path coefficient analysis can give the correct picture of direct and indirect association of traits for simultaneous selection of different traits. Grain yield can be increased by selecting genotypes with longer duration.

**Table 1:** ANOVA of 10 finger millet genotypes.

| Source of variations | DF | Mean Squares | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Days to 50% flowering | Days to Maturity | Plant Height (cm) | No. of Prod. Tillers | No. of fingers/ Ear | Ear Length (cm) | Finger Length (cm) | Finger width (cm) | Leaf Length (cm) | Leaf width (cm) | Grain Yield (q/ha) | Fodder Yield (t/ha) |
| Treatments | 9 | 107.17** | 176.73** | 86.86 | 0.157 | 0.74 | 0.74 | 1.27** | 0.015** | 57.96** | 0.10** | 54.13* | 563.67* |
| Replications | 2 | 2.63 | 4.03 | 122.53 | 0.004 | 0.22 | 0.04 | 0.22 | 0.002 | 14.33 | 0.02 | 1.83 | 340.23 |
| Error | 18 | 1.00 | 1.51 | 39.37 | 0.090 | 0.32 | 0.70 | 0.19 | 0.003 | 9.99 | 0.01 | 13.86 | 124.92 |

** Significant at 1% level

**Table 2:** Mean values and Summary Statistics of 10 finger millet genotypes.

| S. No | Entry | Days to 50% flower | Days to Maturity | Plant height (cm) | No. of prod. tillers | No. of fingers/ ear | Ear length (cm) | Finger length (cm) | Finger width (cm) | Flag leaf length (cm) | Flag leaf width (cm) | Grain Yield (q/ha) | Fodder Yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | PR 10-35 | 95.0 | 126.3 | 124.0 | 2.2 | 7.5 | 8.8 | 6.1 | 1.0 | 38.8 | 1.6 | 32.0 | 92.3 |
| 2 | BR 14-3 | 88.0 | 116.7 | 108.3 | 2.4 | 8.2 | 8.4 | 6.2 | 1.0 | 33.9 | 1.1 | 28.2 | 87.2 |
| 3 | KOPN 942 | 82.7 | 109.3 | 120.3 | 2.4 | 7.6 | 9.7 | 7.8 | 1.0 | 35.1 | 1.1 | 27.7 | 91.3 |
| 4 | VL 386 | 86.3 | 115.7 | 116.8 | 2.3 | 8.7 | 10.1 | 7.3 | 1.0 | 35.1 | 1.1 | 21.1 | 67.8 |
| 5 | VL 352 | 86.0 | 114.7 | 119.1 | 2.5 | 7.2 | 8.9 | 7.1 | 1.1 | 37.5 | 1.2 | 30.2 | 59.5 |
| 6 | GPU 45 | 91.0 | 121.0 | 115.8 | 2.9 | 7.6 | 8.9 | 7.3 | 1.1 | 37.4 | 1.2 | 28.2 | 79.7 |
| 7 | GPU 67 | 99.7 | 131.3 | 112.3 | 2.1 | 7.5 | 8.9 | 6.5 | 1.1 | 37.6 | 1.5 | 35.1 | 86.4 |
| 8 | PR 202 | 96.3 | 128.3 | 123.4 | 2.3 | 7.3 | 8.8 | 6.9 | 1.2 | 47.5 | 1.0 | 28.2 | 106.3 |
| 9 | VR 900 | 99.3 | 130.0 | 111.9 | 2.5 | 7.1 | 9.1 | 7.5 | 1.1 | 44.5 | 1.1 | 31.8 | 97.9 |
| 10 | Sri Chaitanya (LC) | 95.0 | 126.0 | 111.1 | 2.3 | 7.4 | 9.4 | 8.0 | 1.2 | 41.9 | 1.3 | 30.8 | 85.8 |
| | Mean | 91.93 | 121.93 | 116.31 | 2.40 | 7.61 | 9.09 | 7.05 | 1.09 | 38.91 | 1.23 | 29.77 | 85.43 |
| | Minimum | 82.7 | 109.3 | 108.3 | 2.1 | 7.1 | 8.4 | 6.1 | 1.0 | 33.9 | 1.0 | 21.1 | 59.5 |
| | Maximum | 99.7 | 131.3 | 124.0 | 2.9 | 8.7 | 10.1 | 8.0 | 1.2 | 47.5 | 1.6 | 35.1 | 106.3 |
| | CD (5%) | 1.72 | 2.11 | 10.76 | 0.51 | 0.97 | 1.44 | 0.75 | 0.09 | 5.42 | 0.19 | 6.38 | 19.17 |
| | CV (%) | 1.09 | 1.01 | 5.40 | 12.49 | 7.44 | 9.23 | 6.20 | 5.08 | 8.12 | 9.24 | 12.50 | 13.08 |

**Table 3:** Genetic parameters of 10 finger millet genotypes.

| S. No | | Days to 50% flower | Days to Maturity | Plant height (cm) | No. of prod. tillers | No. of fingers/ ear | Ear length (cm) | Finger length (cm) | Finger width (cm) | Flag leaf length (cm) | Flag leaf width (cm) | Grain Yield (q/ha) | Fodder Yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | GCV | 6.47 | 6.27 | 3.42 | 6.23 | 4.91 | 1.22 | 8.50 | 5.94 | 10.28 | 13.70 | 12.31 | 14.16 |
| 2 | PCV | 6.56 | 6.35 | 4.63 | 9.53 | 6.52 | 5.46 | 9.22 | 6.63 | 11.30 | 14.71 | 17.55 | 19.28 |
| 3 | ECV | 1.09 | 1.01 | 5.4 | 12.49 | 7.44 | 9.23 | 6.20 | 5.08 | 8.12 | 9.24 | 12.50 | 13.08 |
| 4 | $H^2$ (Broad Sense) | 97.24 | 97.47 | 54.67 | 42.74 | 56.63 | 5.95 | 84.93 | 80.37 | 82.77 | 86.84 | 49.21 | 53.93 |
| 5 | Genetic Advance | 12.08 | 15.54 | 6.06 | 0.2 | 0.58 | 0.05 | 1.14 | 0.12 | 7.49 | 0.32 | 5.29 | 18.30 |
| 6 | GAM | 13.14 | 12.75 | 5.21 | 8.39 | 7.61 | 0.56 | 16.13 | 10.97 | 19.26 | 26.31 | 17.78 | 21.40 |

**Table 4:** Phenotypic correlation of yield and other characters in 10 finger millet genotypes.

| S. No | | Days to Maturity | Plant height (cm) | No. of prod. tillers | No. of fingers/ ear | Ear length (cm) | Finger length (cm) | Finger width (cm) | Flag leaf length (cm) | Flag leaf width (cm) | Grain Yield (q/ha) | Fodder Yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Days to 50% flower | 0.995** | -0.17 | -0.294 | -0.492 | -0.370 | -0.206 | 0.546 | 0.691* | 0.398 | 0.665* | 0.556 |
| 2 | Days to Maturity | | -0.129 | -0.304 | -0.463 | -0.367 | -0.228 | 0.565 | 0.702* | 0.405 | 0.626 | 0.532 |
| 3 | Plant height (cm) | | | -0.094 | -0.197 | 0.118 | -0.101 | -0.060 | 0.211 | 0.078 | -0.154 | 0.107 |
| 4 | No. of prod. tillers | | | | -0.104 | -0.102 | 0.337 | 0.052 | -0.081 | -0.416 | -0.234 | -0.231 |
| 5 | No. of fingers/ ear | | | | | 0.385 | -0.169 | -0.602 | -0.647* | -0.180 | -0.747* | -0.355 |
| 6 | Ear length (cm) | | | | | | | -0.169 | -0.172 | -0.207 | -0.573 | -0.283 |
| 7 | Finger length (cm) | | | | | | | 0.358 | 0.192 | -0.432 | -0.260 | -0.106 |
| 8 | Finger width (cm) | | | | | | | | 0.780** | -0.117 | 0.329 | 0.250 |
| 9 | Flag leaf length (cm) | | | | | | | | | -0.151 | 0.302 | 0.606 |
| 10 | Flag leaf width (cm) | | | | | | | | | | 0.624 | -0.056 |
| 11 | Grain Yield (q/ha) | | | | | | | | | | | 0.326 |

## Conclusion

Significant variations were observed for many traits studied among ten finger millet genotypes. GCV and PCV were low to moderate for the traits studied indicating low to moderate variability in the present population. Among all genotypes GPU 67 is the highest yielder but while considering the advantage of duration VL 352 is better culture which had on par grain yield but is significantly earlier than GPU 67. Grain yield recorded moderate heritability with moderate GAM indicating presence of both additive and non-additive gene action. It showed positive significant association with days to 50% flowering indicating that grain yield can be improved by selecting long duration genotypes. However, path coefficient analysis gives a better insight of the association and simultaneous selection of different characters.

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