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Genetic variability, heritability and correlation of quantitative traits in little millet genotypes

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Abstract
Little millet (*Panicum sumatrense* Roth. ex. Roem. and Schultz.) is one of the small millets which is known for its nutritional value. Crop improvement is possible through exploitation of variability present in the population and understanding heritability of various traits. Hence, the present investigation was undertaken to study the genetic variability, heritability and correlation of grain yield and yield related traits. Analysis of Variance of 30 little millet genotypes revealed significant variation for all the traits studied. Grain yield recorded genotypic coefficient of variation of 23.52, while phenotypic coefficient of variation was 26.61 q/ha. Heritability ranged from 0.67 (plant height) to 0.99 (days to 50% flowering, days to maturity), while heritability for yield was 0.78. Number of tillers per plant, panicle length and fodder yield were observed to be highly and positively associated with grain yield. The present findings indicate the presence of large variability and high heritability for yield and other related traits which can be exploited for little millet improvement.

Keywords: little millet, variability, heritability, correlation

Introduction
Present agriculture is dominated by few crop species. Moreover only few varieties are preferred by farmers with an aim to have higher yields. Some of the agricultural crops are slowly disappearing from cultivation in plain areas. Small millets are such neglected crops. Finger millet, foxtail millet, little millet, kodo millet, proso millet and barnyard millet are considered as small millets. These millets are grown and conserved by traditional tribal farmers.

Little millet belongs to the family Poaceae, sub-family Panicoideae and the tribe Paniceae (Rachie, 1975) [1]. It is grown indigenously in the tropics and sub tropics. It is a drought tolerant crop and requires less amount of water to complete its life cycle. Hence, it can provide us with food security in unfavourable climatic conditions. In addition, it is rich in vitamin B, minerals like potassium, phosphorus, iron, zinc and magnesium. Therefore it can address nutritional sensitive agriculture, which aims at nutritional enhancement to combat the present scenario of micronutrient malnutrition (Arunachalam *et al.,* 2005 [2]; Kundgol *et al.,* 2014 [3]; Selvi *et al.,* 2015) [4].

The foremost pre-requisite in crop breeding is, exploitation of genetic variability existing in the crop for yield and related traits. This leads to development of a better variety which can address the growing demand of a population. In a quest, to develop such varieties, a breeder has to know the heritability of traits to be enhanced. Also genetic advancement along with heritability estimates help in predicting the gain under selection (Johnson *et al.,* 1955) [5]. The association of characters with one another helps us to understand the interrelationships with one another and thus provides a hope for selection of low heritable triats *via* highly heritable traits (Bezaweletaw *et al.,* 2006) [6]. The present study was aimed to explore genetic variability and heritability of various quantitative traits in little millet genotypes. Also correlation of yield and other important traits was studied.

Material and Methods
In the present study, 30 little millet genotypes including three national and one local check varieties, *viz.,* OLM 203, JK 8, BL 6 and Pedda Sama were evaluated at Agricultural Research Station, Vizianagaram, Andhra Pradesh during *kharif*, 2016. Genotypes were sown in a randomized complete block design (RCBD) in three replications with a spacing of 22.5 × 7.5 cm per each entry. Each genotype was grown in 10 lines of 3 m length. All the recommended practices were followed to raise a healthy crop. Observations were recorded on plant height (cm), panicle length (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) [7]. Phenotypic and genotypic coefficients of variation (PCV and GCV) were computed as per Burton and Devane (1953) [8]. Heritability in broad sense was computed as per Allard (1960) [9]. Genotypic and phenotypic correlations were calculated according to Falconer (1981) [10]. Heritability and genetic advancement were categorized into low, medium and high as per Johnson *et al.*, (1955) [5].

Results and Discussion

Genetic variability studies outline the basis for crop improvement. It also helps us to know the main root cause of variation whether it is sensitive to environment or not, whether it can be transformed to the next generation or not, based on this breeding programme can be planned.

The results from ANOVA (Table 1) revealed existence of enormous variability ($p < 0.01$) in 30 little millet genotypes under study for all the characters considered. Substantial variation was reported by earlier workers (Sasamala *et al*., 2015 [11]; Selvi *et al*., 2015 [4] Jyothsna *et al*., 2016 [12]). All the summary statistics were presented in table 2 while in table 3 the mean values of all traits studied in 30 little millet genotypes were presented. The range of variation was high in all the traits studied. Early flowering was noticed in LM 74 and WV 126 was late in flowering. Highest grain yield was recorded in LM 148 (21.26q/ha) with an average yield of 12.70 q/ha. The coefficient of variation was maximum (14.30 %) for fodder yield followed by grain yield (12.45%). Grain yield ranged from 7.69 to 21.26 q/ha with a mean of 12.70 q/ha. The difference in duration was from 67 to 127 days with a mean of 88.58 days. PCV of all the traits was higher than GCV (Table 4). GCV ranged from low to high (8.89 to 28.65). Highest GCV and PCV were observed for fodder yield, days to 50% flowering and grain yield indicating large variability of these two traits among little millet genotypes. GCV and PCV are low for plant height indicating lesser variability of this trait in the population.

Heritability was high for all the characters studied while genetic advance as per cent mean (GAM) ranged from moderate to high for the traits studied. Plant height had high heritability with moderate GAM indicating presence of both additive and non-additive gene action while remaining traits had high heritability with high GAM which indicates predominance of additive genes which responds well to simple selection. Hence, direct selection for these traits is rewarding. Similar results were reported earlier by Patil *et al*., (2013) [13] and Sasamala *et al*., (2015) [12].

Association of different characters gives an insight about simultaneous selection of characters. In this study, both phenotypic and genotypic correlations (Table 5 & 6) were significantly high and were in positive direction for grain yield with panicle length, number of productive tillers per plant and fodder yield. Similar findings were reported by Jyothsna *et al*., (2016) [12]. This means selection of these traits will lead to simultaneous improvement in grain yield. Days to 50% flowering was highly and positively associated with days to maturity and negatively associated with plant height, number of productive tillers per plant and fodder yield. But, there is no association of days to 50% flowering with grain yield in the present study. Hence, in this population of 30 genotypes, selection for panicle length and number of productive tillers per plant will lead to higher grain yield.

Table 1: ANOVA of 30 little millet genotypes.

Source of Variations	df	Mean Squares						
		Days to 50% flowering	Plant Height (cm)	Panicle Length (cm)	No. of Prod. Tillers	Days to maturity	Grain Yield (q/ha)	Fodder Yield (t/ha)
Replications	2	0.40	2.40	5.82	1.04	7.81	0.05	0.34
Treatments	29	870.54**	412.10**	40.94**	11.00**	892.04**	29.26**	17.14**
Error	58	1.71	58.62	2.23	0.63	4.47	2.50	1.33

** significant at 1% level

Table 2: Summary statistics of 30 little millet genotypes

Character	Days to 50% Flowering	Plant Height (cm)	Panicle Length (cm)	No. of Productive Tillers/ Plant	Days to Maturity	Grain Yield (q/ha)	Fodder Yield (t/ha)
Mean	59.40	122.14	29.07	9.00	88.58	12.70	8.06
C.V.	2.20	6.27	5.14	8.83	2.39	12.45	14.30
C.D. 5%	2.14	12.51	2.44	1.30	3.45	2.58	1.88
Minimum	36.67	91.47	19.47	5.27	67.33	7.69	4.16
Maximum	96.33	143.60	37.33	12.80	127.33	21.26	13.51

Table 3: Mean values of seven traits studied in 30 little millet genotypes

S. No	Genotype	DFF	PH	PL	NPT	DM	GY	FY
1	LM 485	50.0	127.93	22.60	11.67	76.67	8.99	13.51
2	LM 206	51.7	133.80	32.20	9.33	86.33	12.93	9.51
3	LM 115	48.3	129.73	31.67	9.93	74.33	14.84	10.51
4	LM 114	39.7	126.53	29.00	11.33	68.00	14.87	11.77
5	LM 101	53.7	124.80	26.73	10.87	81.67	16.18	9.78
6	LM 148	48.3	120.80	28.07	12.80	75.67	21.26	11.34
7	LM 95	65.0	131.67	28.00	8.80	89.67	8.28	5.73
8	LM 289	45.3	129.60	27.13	9.07	74.00	8.25	7.06
9	LM 74	36.7	127.67	26.67	9.60	71.33	9.33	7.61
10	LM 419	53.0	124.80	36.13	10.60	83.67	12.95	12.53
11	LM 60	50.0	131.40	27.00	10.53	80.33	15.14	10.38
12	LM 512	53.0	131.60	28.20	9.07	84.67	15.93	9.20
13	LM 73	55.3	111.67	28.80	10.27	81.00	16.85	11.62

14	Pedda sama*	65.3	131.07	27.93	8.87	90.67	14.71	5.70
15	VS9	50.7	123.20	28.80	10.40	80.33	7.69	8.34
16	BL 150	65.3	118.93	30.7	5.87	94.33	12.29	7.78
17	TNPSU 174	57.0	133.87	30.6	7.80	83.33	12.84	7.41
18	RLM 238	41.0	107.80	29.7	7.33	68.33	12.25	4.16
19	OLM 203*	82.0	100.80	27.8	7.87	112.00	11.34	6.32
20	KOPLM 53	94.7	106.00	35.0	8.73	127.33	14.64	6.19
21	GPUL 2	94.7	112.80	31.3	6.93	126.00	13.09	6.62
22	DHLtMV 14-1	65.3	126.20	27.3	11.60	92.67	11.48	7.45
23	BL 6*	62.0	124.33	34.0	7.40	94.33	14.00	6.53
24	TNPSU 171	54.7	128.93	37.3	9.87	86.67	17.34	6.80
25	WV 126	96.3	91.47	19.5	5.40	122.33	9.84	6.88
26	JK 8*	38.7	105.67	25.9	9.87	67.33	10.63	5.45
27	DLM 95	95.0	106.73	26.7	9.07	124.33	11.62	6.41
28	DHLT 28-4	58.0	128.80	28.2	6.67	90.67	10.37	6.76
29	GPUL 3	52.3	143.60	27.2	5.27	82.67	9.60	5.83
30	VS11	59.0	122.13	32.2	7.23	86.67	11.50	6.47

DFF: Days to 50% flowering, PH: Plant height in cm, PL: Panicle length in cm, NPT: Number of productive tillers per plant, DM: Days to maturity, GY: Grain yield in q/ha and FY: Fodder yield in t/ha

Table 4: Genetic parameters of 30 little millet genotypes

	Days to 50% Flowering	**Plant Height (cm)**	**Panicle Length (cm)**	**No. of Productive Tillers/ Plant**	**Days to Maturity**	**Grain Yield In (q/ha)**	**Fodder Yield (t/ha)**
GCV	28.65	8.89	12.35	20.65	19.42	23.52	28.50
PCV	28.73	10.87	13.38	22.46	19.56	26.61	31.89
ECV	2.20	6.27	5.14	8.83	2.39	12.45	14.30
H^2 (Broad Sense)	0.99	0.67	0.85	0.85	0.99	0.78	0.80
Genetic Advance	34.95	18.27	6.83	3.52	35.17	5.44	4.23
GAM	58.84	14.96	23.50	39.11	39.70	42.82	52.46

Table 5: Phenotypic correlation of yield and related traits in 30 little millet genotypes

Character	**Plant Height (cm)**	**Panicle Length (cm)**	**No. of Productive Tillers**	**Days to Maturity**	**Grain Yield (q / ha)**	**Fodder Yield (t/ha)**
Days to 50% Flowering	-0.49**	-0.03	-0.40**	0.98**	0.05	-0.32**
Plant Height (cm)		0.19	0.15	-0.47**	0.01	0.19
Panicle length (cm)			0.03	0.03	0.32**	-0.02
No. of Productive Tillers/ Plant				-0.42**	0.34**	0.57**
Days to Maturity					-0.05	-0.33**
Grain Yield (q/ha)						0.32**

Table 6: Genotypic correlation of yield and related traits in 30 little millet genotypes

Character	**Plant Height (cm)**	**Panicle Length (cm)**	**No. of Productive Tillers**	**Days to Maturity**	**Grain Yield (q / ha)**	**Fodder Yield (t/ha)**
Days to 50% Flowering	-0.61**	-0.03	-0.43**	0.99**	-0.06	-0.35**
Plant Height (cm)		0.24	0.22	-0.57	0.03	0.29
Panicle length (cm)			-0.01	0.03	0.42**	-0.04
No. of Productive Tillers/ Plant				-0.45**	0.40**	0.71**
Days to Maturity					-0.06	-0.36**
Grain Yield (q/ha)						0.38**

Conclusion

Significant variation for all the traits studied was observed in the present study among 30 little millet genotypes. GCV and PCV were low to high for the traits studied indicating low to high variability in the present population. Higher variability is exhibited by fodder yield, days to 50% flowering and grain yield where GCV and PCV are high. Grain yield is highly associated with number of productive tillers per plant, panicle length and fodder yield which are predominantly controlled by additive gene action. Hence, selection of grain yield via these traits is effective.

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