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Research Note

Genetic variability and character associations for grain yield and other secondary traits in little millet (*Panicum sumatrense* L.) at Eastern Ghats Zone of Odisha

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Abstract
A set of thirty genotypes of little millet were studied using thirteen morphological traits to assess genetic variability, character association and their effects on grain yield during *Kharif* 2022 at Centurion University, Paralakhemundi, Odisha in a randomized block design with three replications. Analysis of variation revealed significant ($p \leq 0.01$) variation in the studied genotypes for all the traits recorded. The characters *viz*., number of productive tillers, test weight and grain yield had high genotypic (GCV) and phenotypic coefficient of variation (PCV) whereas characters *viz*., number of productive tillers, number of braches per panicle, culm length, culm diameter, test weight and grain yield had high genetic advance coupled with high heritability. Most of the traits except days to 50% flowering, days to maturity and flag leaf length showed strong significant ($p \leq 0.01$) positive associations with grain yield at genotypic and phenotypic levels. The traits such as plant height, number of productive tillers, culm length, test weight, flag leaf length and breadth recorded positive direct effect on grain yield that indicates direct improvement of these traits could be beneficial for the improvement of little millet cultivars with higher grain yield.

Keywords: Genetic Variability, Heritability, Correlation, Path Analysis, *Panicum sumatrense*

Little millet is a small-grained cereal crop that belongs to the family Poaceae sub family *Panicoideae*. It is a self-pollinated and tetraploid crop with chromosome number 2n = 4x = 36. Little millet is adapted to both tropical as well as sub- tropical climates and can grow in both rainfed and irrigated conditions. It can also strive well under unfavorable climatic situations such as drought for longer period. It is an important catch crop in some tribal farms in India. It originated in Southeast Asia. Its grain is 1.8–1.9 mm long, round and smooth. Its colour varies from grey to straw white. It is native to India and is also called Indian millet with separate identifications such as *kutki* in Hindi, *samai* in Tamil, *suan* in Odia, *samalu* in Telugu, *sama* in Bengali, *kuri* in Gujarati, *sava* in Marathi, *saame* in Kannada and *chama* in Malayalam. The crop was widely cultivated across India, China, Sri Lanka, Nepal, and Western Myanmar. In India, Andhrapradesh, Odisha, Madhya Pradesh, Jharkhand, Uttar Pradesh and Karnataka are the major little millet growing states (Madhavilatha *et al*., 2020; Anuradha *et al*., 2022).

In India, little millet is grown in an area of 2.91 lakh hectares with a production of 1.02 lakh tons and a productivity of 349 kg/ha (Khyathi *et al*., 2022). Among all the Indian states, little millet is widely grown in the state of Odisha mainly on the hills of the Eastern Ghats and the Chotanagpur Plateau. To ensure farming of little millet is remunerative for the farmers, the Odisha Millets

Mission (OMM), a flagship programme launched by the Department of Agriculture and Farmers' Empowerment (DA&FE), Government of Odisha, has initiated a benchmark price initiative and other subsidy based input system. As per reports of OMM, small millets are being cultivated in Odisha in an area of 35.25 ha with a production of 18.01 MT and the productivity of 511 kg/ha. Bolangir, Boudh, Dhenkanal, Gajapati, Ganjam, Kalahandi, Kandhamal, Keonjhar, Koraput, Malkangiri, Mayurbhanj, Nabarangpur, Nayagarh, Nuapada, Rayagada, Sambalpur and Sundargarh are the major small millet growing districts in Odisha state.

A wider range of genetic variability assists in the process of selecting promising genotypes. Estimates of genetic variability along with the heritability would give a better understanding on the quantity of genetic gain projected out of selection methods (Burton, 1952). Heritability estimates along with genetic advance are more accurate in predicting the genetic gain under selection than the heritability estimates alone (Johnson *et al.,* 1955). Grain yield is a complex quantitative trait and is the result of many variables. Hence, knowledge on association of grain yield with other secondary traits is valuable for the better selection of specific traits that are strongly associated with the yield. Correlation coefficients (*r* values) estimate both magnitude and direction of the association between the yield and other traits. Path coefficient analysis is helpful to distinguish direct and indirect effects for the recorded traits and grain yield enables us to compare the causal factors on the genetic basis of their relative contributions. Both correlation and regression studies helps in understanding the cause and effects of studied factors on grain yield that would allow a plant breeder for more effective selection. The production and productivity of little millet crop is low mainly due to the unavailability of improved varieties (Suryanarayana and Sekhar, 2018). Hence the present study aims at estimation of variability parameters, correlation and path analysis in available little millet germplasm that would helpful for future breeding programme.

The experimental material consisted of 30 diverse genotypes of little millet including a local check (**Table 1**) that were collected from Agriculture Research Station, Vizianagaram, Acharya N. G. Ranga Agricultural University, Andhra Pradesh. The material was from the All India Coordinated Research Project (AICRP) on small millet germplasm pool and being tested under multi-location trial (MLT) stage. The experiment was carried out at PG Research Farm, Centurion University of Technology and Management, Paralakhemundi, Odisha during *Kharif,* 2022. The soil of the experimental site was sandy loam in texture, non-saline and neutral range in pH. The site of experiment is situated at geographical coordinates of 84.14^0 E and 18.79^0 N and 145 m above mean sea level under Eastern Ghats zone of Odisha. The plant material was sown in Randomized Complete Block Design in three replications. Direct sown method was followed and the spacing between rows and the spacing plants in a row was 20 cm and 10 cm, respectively. All the cultural practices which are essential for a healthy crop stand equally practiced to the three replications. Five plants selected randomly from the plot in each replication and observations were recorded for 13 traits *viz*., days to 50% flowering, days to maturity, plant height (cm), number of productive tillers per plant, number of branches per panicle, panicle length (cm), culm length (cm), culm diameter (cm), flag leaf length (cm), flag leaf breadth (cm), 1000 seed weight (g), harvest index (%) and grain yield per plant (g).

Statistical analysis: The variability among 30 test genotypes for different characters were tested for significance by using analysis of variance technique (Fisher *et al.,* 1918). The significance test was carried out by referring to standard 'F' table values proposed by Fisher and Yates (1963). The estimates of mean sum of squares from ANOVA were utilized for calculation of environmental, genotypic and phenotypic variances. Environmental, genotypic and phenotypic variances were assessed as per the method proposed by Lush (1940) as well as estimation of phenotypic, genotypic and environmental coefficients of variation as per Burton (1952). The PCV and GCV were classified as follows as per Sivasubramanian and Madhavamenon (1973). The heritability and genetic advance as percent of mean was estimated as per Johnson *et al.* (1955). Phenotypic and genotypic correlations were worked out using the formula given by Pearson (1902) and Falconer (1964). Path coefficient analysis was done as proposed by Wright (1921) and elaborated by Dewey and Lu (1959) to calculate the direct and indirect contribution of various traits to yield. All the statistical analyses were performed in variability (Popat *el al*., 2020) package in RStudio (RStudio Team, 2023).

Mean performance: The mean performance along with range, coefficient of variation, critical difference at 5% of significance, standard error of mean of 30 little millet genotypes including a local check for the studied traits are presented in the **Table 1**. The genotypes *viz*., RLM 369 followed by LMET 8, LMET 17, RLM- 204, LMET 15 and LMET 6 showed early maturity. Among the genotypes, GPUL- 12, JK 8, VS-20, LMET 25, VS-31 and LMET-17 exhibited superior performance for the number of branches per panicle. The genotypes such as GPUL-12 (28.47 g) followed by WV-168 (28.46 g), VS-31 (28.33 g), LMET-17 (27.83 g) and VS-12 (24.23 g) recorded higher performance for grain yield per plant.

Analysis of variance: The data recorded from the 13 characters for 30 little millet genotypes was subjected to ANOVA and the results are presented in the **Table 2**. It showed significant differences among the genotypes for all the characters studied. The

Table 1. Mean performance of 30 little millet genotypes for thirteen characters evaluated during *Kharif* 2022

S.No.	Character	DFF	DM	PH	TILLERS	BPP	PL	CL	CD	FLL	FLB	TW	HI	GYP
1	LMET 17	53.00	66.00	126.20	9.73	8.93	31.75	113.67	0.63	27.97	**1.14**	5.33	27.02	27.83
2	RLM-204	53.00	66.33	**138.80**	11.33	**11.10**	32.99	**122.40**	0.64	**29.27**	**1.16**	5.93	**30.96**	**31.42**
3	LMET 6	55.33	68.67	132.67	8.83	8.73	29.00	104.63	0.46	26.93	0.86	3.60	28.71	20.22
4	LMET 26	58.33	72.33	119.00	6.40	6.83	31.20	103.53	0.50	25.56	0.83	3.00	20.32	19.15
5	RLM 369	48.33	**62.33**	119.00	7.23	8.03	30.90	**83.57**	0.50	23.50	0.80	3.55	27.32	18.98
6	IIMR- LM- 4001	**73.33**	**87.00**	**125.23**	6.67	8.47	28.98	102.97	0.92	23.41	0.81	3.64	23.05	22.69
7	LMET 5	58.67	73.67	122.57	9.63	9.60	30.67	98.00	0.47	26.97	0.80	3.23	27.09	21.01
8	IIMRLM - 8004	53.33	66.67	120.67	9.70	7.57	30.28	84.03	0.47	25.27	0.80	2.47	25.02	20.04
9	TNPSU-237	53.67	67.67	123.00	7.20	7.57	**33.00**	99.27	0.45	25.20	0.86	5.53	27.80	22.02
10	IIMRLM- 4004	60.33	74.33	125.93	6.60	6.27	30.20	107.43	0.66	26.91	0.82	3.93	28.72	23.07
11	VS-12	66.00	80.33	133.87	6.63	6.40	32.00	109.53	0.90	25.47	0.89	5.61	27.12	24.23
12	LMG- 28	58.33	71.33	128.80	6.73	6.67	31.30	112.10	**0.41**	25.43	0.80	4.24	25.58	23.77
13	LMET-1	59.33	73.00	124.00	6.50	5.50	29.33	106.80	0.53	24.27	**0.74**	3.83	24.79	20.82
14	LMET 8	**45.67**	65.00	129.00	8.37	8.17	29.74	100.73	0.45	24.50	0.83	5.33	25.87	23.55
15	IIMR LM- 8005	57.00	68.00	127.67	6.07	6.70	30.58	96.47	0.48	25.53	0.81	5.97	25.41	23.89
16	WV - 168	59.67	73.00	129.00	6.80	7.77	31.13	110.20	**0.96**	26.58	0.87	**6.23**	24.85	28.46
17	LMET- 4	66.33	80.00	129.67	7.27	7.40	31.95	112.33	0.58	24.83	0.88	6.22	27.77	23.22
18	DHLM-22-3	59.33	73.00	119.67	5.80	7.97	29.85	92.92	0.49	23.21	0.82	4.06	20.86	17.20
19	LMET 28	59.00	72.00	127.33	9.57	7.97	31.70	103.63	0.56	**22.53**	0.79	4.20	23.89	21.99
20	LMET 15	53.00	67.00	117.33	7.80	9.47	28.68	99.27	0.47	23.28	**0.73**	2.26	**18.18**	16.46
21	TNPSU-239	59.00	73.33	122.60	5.83	7.87	31.97	93.50	0.45	23.60	0.82	3.44	20.35	18.48
22	VS-20	59.33	73.33	121.33	**4.63**	9.37	29.57	84.93	0.48	24.40	0.77	3.29	20.88	**16.21**
23	**JK 8 (Check)**	58.33	72.67	120.23	6.03	9.93	29.40	84.88	0.52	**22.83**	0.83	**2.16**	21.30	17.65
24	VS -31	54.67	73.00	128.00	7.27	9.10	31.73	114.55	0.60	28.27	0.87	5.17	27.45	28.33
25	LMET 25	58.67	73.33	**125.67**	10.80	9.23	32.27	105.80	0.53	25.38	0.78	4.77	24.56	21.21
26	LMET 24	59.33	72.67	127.27	9.00	8.43	32.37	108.13	0.53	24.11	0.78	5.60	25.30	21.43
27	GPUL-12	53.67	71.00	128.60	**11.50**	10.38	32.70	**122.37**	0.60	28.40	0.95	6.01	27.02	28.47
28	DHLM-11-3	55.33	70.00	**113.33**	5.17	**4.27**	**27.83**	87.09	0.52	24.87	0.79	4.39	18.82	18.13
29	LMET-19	53.00	67.33	124.47	5.37	5.60	30.01	86.92	0.52	23.57	0.89	5.43	23.48	18.52
30	DPLV-1 LM	67.00	81.00	121.17	5.23	4.60	**33.00**	87.47	0.51	27.93	0.81	4.40	20.83	19.80
Mean		**57.64**	**71.84**	**125.07**	**7.52**	**7.86**	**30.87**	**101.30**	**0.56**	**25.33**	**0.84**	**4.43**	**24.68**	**21.94**
Range	Minimum	45.67	61.00	112.00	4.20	4.20	20.00	68.20	0.40	19.70	0.69	3.00	16.50	12.85
	Maximum	74.00	88.00	140.00	13.00	11.00	36.00	120.00	0.90	30.04	1.26	6.65	32.11	36.60
CV		2.681	2.364	2.572	11.307	11.414	8.795	5.049	11.006	5.023	7.476	9.939	9.95	11.611
CD 5%		2.5	2.73	5.29	1.45	1.51	4.35	7.97	0.1	2.07	0.1	0.74	4.01	4.18
SEm		0.88	0.96	1.86	0.51	0.53	1.53	2.81	0.03	0.73	0.03	0.26	1.41	1.47

CV= Coefficient of variation; C.D 5%= Critical difference at 5% of significance; S.Em = Standard error of mean
*Bold values indicated maximum and minimum values
DFF=Days to 50% flowering, DM=Days to maturity , PH=Plant height (cm) , TILLERS=Number of productive tillers per plant , BPP=Number of branches per panicle , PL=Panicle length (cm) , CL=Culm length (cm) , CD=Culm diameter (cm) , FLL=Flag leaf length (cm) , FLB=Flag leaf breadth (cm) , TW=1000 seed weight (g) , HI=Harvest Index , GYP=Grain yield per plant (g).

results revealed that there was a substantial variation among the genotypes studied and a greater chance for improvement of yield and yield attributing traits through the selection of genotypes. Similar variability studies were made in little millet genotypes by Selvi *et al.* (2015) and Anuradha *et al.* (2017).

Table 2. Analysis of variance for yield and yield component characters recorded from 30 little millet genotypes studied during *Kharif* 2022

S. No.	Name of the character	Mean sum of square (MSS)		
		Replication (df=2)	Treatment (df=29)	Error (df=58)
1	Days to 50% flowering	6.81	92.98**	2.34
2	Days to maturity	4.57	81.23**	2.80
3	Plant height (cm)	21.91	92.75**	10.48
4	Number of productive tillers per plant	0.03	8.59**	0.79
5	Number of branches per panicle	1.83	5.55**	0.86
6	Panicle length (cm)	3.27	18.12**	7.10
7	Culm length (cm)	16.44	489.69**	23.84
8	Culm diameter (cm)	0.01	0.02**	0.004
9	Flag leaf length (cm)	2.35	10.9**	1.6
10	Flag leaf breadth (cm)	0.002	0.02**	0.003
11	1000 seed weight (g)	0.13	2.12**	0.2
12	Harvest Index	98.04**	31.69**	6.03
13	Grain yield per plant (g)	87.19**	48.63**	6.56

**=significant at 1% (p≤0.01), *=significant at 5% (p≤0.05)
df= degrees of freedom
DFF=Days to 50% flowering, DM=Days to maturity , PH=Plant height (cm) , TILLERS=Number of productive tillers per plant , BPP=Number of branches per panicle , PL=Panicle length (cm) , CL=Culm length (cm) , CD=Culm diameter (cm) , FLL=Flag leaf length (cm) , FLB=Flag leaf breadth (cm) , TW=1000 seed weight (g), HI=Harvest Index, GYP=Grain yield per plant (g)

Genetic variability parameters: Any crop improvement program depends on the variability present in the available germplasm. Higher amount of variation is necessary for breeders to carry out effective selection of genotypes. All the characters studied were higher than the genotypic coefficients of variation indicating that variation is not only due to genotype but also due to environmental influence. However narrow difference between PCV and GCV indicated a slight influence of environment on the expression of these characters. The estimates on genotypic and phenotypic coefficients of variation, heritability and genetic advance as per cent of mean are furnished in **Table 3**.

High GCV and PCV were recorded for grain yield per plant, number of productive tillers per plant and test weight indicating the variability among the accessions for the traits. Similar results were recorded by Nirmalakumari *et al.* (2010) and Jyothsna *et al.* (2016). Heritability estimates were high for all the studied traits expect plant height and harvest index. It showed that the above characters were slight influenced by environmental conditions and direct phenotypic selection would be more effective. Heritability will be more meaningful if it is combined with genetic advance as the estimates of broad sense heritability (H) have limitation as it includes both additive and epistatic gene effects. High heritability coupled with high genetic advance was observed for characters such as number of productive tillers, number of braches per panicle, culm length, culm diameter, test weight and grain yield indicating the importance of additive gene action in governing the inheritance of these traits. Hence direct selection for these traits is effective for improvement of these traits. Similar findings were reported earlier by Padmaja (1998), Ashok *et al*. (2016) and Anuradha *et al.* (2017) for high heritability of these traits.

Character association studies: Correlation coefficients estimates the mutual relationship in terms of magnitude and direction between various studied characters and determines the component traits on which selection can be relied upon for genetic improvement of grain yield. Findings of correlation studies revealed that plant height, number of productive tillers per plant, number of branches per panicle, panicle length, culm length, culm diameter, flag leaf breadth, 1000 seed weight showed high positive and significant correlation with grain yield per plant at both phenotypic and genotypic levels (**Table 4**). This indicates that selection based on the above characters having strong positive association would improve the grain yield in little millet. In addition, the significant correlations between these component traits suggest the possibility of simultaneous improvement of these traits by simple selection. These results are in accordance with findings of Venkataratnam *et al.* (2019) for number of productive tillers, plant height and days to 50% flowering. Shinde *et al.* (2018) for plant height and days to 50% flowering and Jyothsna *et al.* (2016) for days to 50%

Table 3. Mean, variability, heritability and genetic advance as percent of mean for grain yield and yield components in 30 little millet genotypes evaluated during *Kharif* 2022

S. No.	Character	Mean	Range		CV (%)	GCV (%)	PCV (%)	Heritability (broad sense)	GA as percent mean (GAM)
			Minimum	Maximum					
1	Days to 50% flowering	57.64	45	74	2.681	9.63	10	92.81	19.12
2	Days to maturity	71.84	61	88	2.364	7.213	7.591	90.30	14.12
3	Plant height (cm)	125.07	112	140	2.572	4.16	4.891	72.34	7.28
4	Number of productive tillers per plant	7.52	4.2	13	11.307	20.46	23.379	76.61	36.897
5	Number of branches per panicle	7.86	4.2	11	11.414	15.35	19.126	64.38	25.366
6	Panicle length (cm)	30.87	20	36	8.795	6.32	10.83	34.08	7.6
7	Culm length (cm)	101.30	68.2	120	5.049	12.89	13.842	86.69	24.721
8	Culm diameter (cm)	0.56	0.4	0.9	11.006	15.6	19.1	66.67	26.238
9	Flag leaf length (cm)	25.33	19.7	30.04	5.023	7.013	8.627	66.09	11.7451
10	Flag leaf breadth (cm)	0.84	0.69	1.26	7.476	10.32	12.75	65.52	17.2162
11	1000 seed weight (g)	4.43	3	6.65	9.939	21.25	23.974	75.23	30.956
12	Harvest Index	24.68	16.5	32.11	9.950	11.85	15.475	58.65	18.698
13	Grain yield per plant (g)	21.94	12.85	36.6	11.611	22.973	24.565	68.12	28.858

CV= Coefficient of variation; C.D. 5% = Critical difference at 5% of significance; GAM = Genetic advance as percent mean

Table 4. Genotypic (lower to the diagonal) and phenotypic (upper to the diagonal) correlation coefficients (*r*) among yield and yield components in 30 little millet genotypes

	DFF	DM	PH	TILLERS	BPP	PL	CL	CD	FLL	FLB	TW	HI	GYP
DFF	**1.00 ****	0.80**	-0.02	-0.22*	-0.07	-0.05	0.19	0.41**	-0.26 *	-0.19	-0.01	-0.18	0.04
DM	0.87 **	**1.00****	0.22 *	-0.12	0.05	0.03	0.17	0.47**	-0.22*	-0.14	0.07	0.01	0.16
PH	-0.03	0.25	**1.00****	0.37**	0.34**	0.41**	0.50**	0.33**	0.21*	0.43**	0.51**	0.61**	0.62**
TILLERS	-0.28	-0.14	0.53 **	**1.00****	0.53**	0.33**	0.40**	0.03	0.13	0.33**	0.14	0.43**	0.45**
BPP	-0.09	0.06	0.49 **	0.68 **	**1.00****	0.09	0.10	-0.04	0.14	0.35**	-0.06	0.29**	0.27**
PL	-0.05	0.06	0.90 **	0.50 **	0.14	**1.00****	0.45**	0.14	0.12	0.26*	0.35**	0.42 **	0.43**
CL	0.21	0.20	0.62**	0.53 **	0.10	0.76**	**1.00****	0.39**	0.20	0.32**	0.47**	0.49 **	0.67**
CD	0.55 **	0.6 **	0.51**	0.09	0.14	0.42*	0.54**	**1.00****	-0.02	0.06	0.32**	0.12	0.35**
FLL	-0.36 *	-0.32	0.30	0.17	0.12	0.33	0.18	-0.05	**1.00****	0.46**	0.24*	0.30**	0.19
FLB	-0.27	-0.22	0.54**	0.40*	0.48**	0.51**	0.45*	0.15	0.62**	**1.00****	0.43**	0.49 **	0.47**
TW	-0.03	0.12	0.67**	0.14	0.05	0.87**	0.60**	0.32	0.33	0.60 **	**1.00****	0.37**	0.53**
HI	-0.26	-0.01	0.82**	0.76**	0.42 *	0.82**	0.66**	0.24	0.43*	0.54**	0.56**	**1.00****	0.60**
GYP	0.02	0.20	0.79**	0.65**	0.48**	0.89**	0.84**	0.39*	0.27	0.68**	0.63**	0.72**	**1.00****

**=significant at 1% (p≤0.01), *=significant at 5% (p≤0.05)

DFF=Days to 50% flowering, DM=Days to maturity , PH=Plant height (cm) , TILLERS=Number of productive tillers per plant , BPP=Number of branches per panicle , PL=Panicle length (cm) , CL=Culm length (cm) , CD=Culm diameter (cm) , FLL=Flag leaf length (cm) , FLB=Flag leaf breadth (cm) , TW=1000 seed weight (g) , HI=Harvest Index , GYP=Grain yield per plant (g)

flowering reported similar findings as the present study. Path analysis: Findings from path analysis of grain yield revealed that traits *viz.,* days to 50% flowering, days to maturity, plant height, number of productive tillers per plant, culm length, flag leaf length, flag leaf breadth, 1000 seed weight contributed maximum to the grain yield by having a significant positive association and direct effect on grain yield per plant at genotypic (**Table 5**). The characters such as number of branches per panicle, panicle length, culm diameter and harvest index showed

Table 5. Direct and indirect genotypic effects of yield components on grain yield per plant in 30 little millet genotypes

	DFF	DM	PH	TILLERS	BPP	PL	CL	CD	FLL	FLB	TW	HI	GYPP
DFF	**0.267**	0.053	-0.046	-0.299	0.054	0.014	0.043	-0.186	-0.004	-0.127	-0.006	0.267	**0.027**
DM	0.233	**0.060**	0.320	-0.152	-0.002	-0.018	0.041	-0.203	-0.004	-0.104	0.021	0.013	**0.205**
PH	-0.010	0.015	**1.253**	0.569	-0.287	-0.246	0.128	-0.175	0.004	0.254	0.121	-0.828	**0.798****
TILLERS	-0.074	-0.008	0.667	**1.068**	-0.395	-0.139	0.109	-0.031	0.002	0.189	0.025	-0.762	**0.651****
BPP	-0.024	0.0003	0.620	0.728	**-0.579**	-0.039	0.021	-0.049	0.001	0.226	0.009	-0.429	**0.484****
PL	-0.014	0.004	1.130	0.544	-0.084	**-0.273**	0.155	-0.143	0.004	0.239	0.158	-0.823	**0.898****
CL	0.057	0.012	0.788	0.575	-0.060	-0.209	**0.203**	-0.185	0.002	0.211	0.110	-0.661	**0.844****
CD	0.147	0.036	0.650	0.099	-0.085	-0.116	0.111	**-0.338**	-0.0007	0.074	0.058	-0.240	**0.397****
FLL	-0.096	-0.020	0.380	0.189	-0.073	-0.091	0.037	0.019	**0.013**	0.289	0.060	-0.437	**0.272**
FLB	-0.072	-0.013	0.681	0.432	-0.280	-0.140	0.092	-0.053	0.008	**0.467**	0.109	-0.546	**0.684****
TW	-0.010	0.007	0.839	0.151	-0.030	-0.237	0.123	-0.108	0.004	0.281	**0.181**	-0.563	**0.639****
HI	-0.071	-0.0008	1.037	0.813	-0.248	-0.224	0.134	-0.081	0.005	0.255	0.102	**-1.0009**	**0.721****

Index residual effect = 0.053

DFF=Days to 50% flowering, DM=Days to maturity , PH=Plant height (cm) , TILLERS=Number of productive tillers per plant , BPP=Number of branches per panicle , PL=Panicle length (cm) , CL=Culm length (cm) , CD=Culm diameter (cm) , FLL=Flag leaf length (cm) , FLB=Flag leaf breadth (cm) , TW=1000 seed weight (g) , HI=Harvest Index , GYP=Grain yield per plant (g).

strong significant positive association with grain yield even though they have recorded negative direct effect on grain yield at genotypic level. The negative direct effect of number of braches per panicle was compensated by high indirect positive effect of number of tillers per plant while in panicle length, culm diameter and harvest index by higher positive indirect effect of plant height. Similar results were reported in little millet Nandini *et al.* (2016) for number of tillers per plant, panicle length and plant height by Nirmalakumari *et al.* (2010) for days to 50% flowering, plant height, total number of effective tillers per plant and flag leaf length; and by Jyothsna *et al*. (2016) for number of productive tillers per plant, days to 50% flowering and flag leaf length.

The findings revealed the existence of substantial variation in the little millet genotypes studied. According to the estimated genetic parameters number of productive tillers per plant, test weight and grain yield could be useful for simple selection methods. Based on results from character association and direct and indirect effects of various traits, grain yield improvement in little millet is possible through simultaneous improvement of plant height, number of productive tillers per plant, culm length, flag leaf length, flag leaf breadth and 1000 seed weight.

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