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Correlation studies on quality and other economic traits in pearl millet

N Anuradha, C Tara Satyavathi, C Bharadwaj, Jayant Bhat and T Lakshmi Pathy

N Anuradha
Acharya NG. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, Andhra Pradesh, India

C Tara Satyavathi
Project Coordinating unit, ICAR - All India Coordinated Research Project on Pearl millet, Jodhpur, Rajasthan, India

C Bharadwaj
Division of Genetics, ICAR-Indian Agricultural Research Institute, New Delhi, India

Jayant Bhat
Regional Research center, ICAR-Indian Agricultural Research Institute, Dharwad, Karnataka, India

T Lakshmi Pathy
Division of Crop Improvement, ICAR-Sugarcane Breeding Institute, Coimbatore, Tamil Nadu, India

Correspondence
N Anuradha
Acharya NG. Ranga Agricultural University, Agricultural Research Station, Vizianagaram, Andhra Pradesh, India

Abstract
Millets are abundant sources of micronutrients, dietary fiber and health beneficial polyphenols. Among millets, pearl millet (*Pennisetum glaucum* (L.) R. Br.) is rich source of Fe, Zn and protein content. Information on genetic variability, heritability and association of characters helps in better selection and improvement of quantitative traits. Hence, 130 inbred lines of pearl millet were studied for variability, heritability and association of grain yield with other quantitative traits including micronutrients. Significant variations were observed for all traits studied through analysis of variance of 130 pearl millet inbreds. Grain yield, Fe and Zn recorded genotypic coefficient of variation of 22.23, 36.76 and 29.28, respectively indicating greater genetic variability for grain yield and micronutrients in the population. High heritability coupled with high genetic advance for yield and micronutrients suggest that these traits are predominantly governed by additive genes. Grain yield was positively and significantly associated with panicle length, panicle diameter, plant height, number of productive tillers per plant, panicle yield per plant, Cu and Mn content, whereas it was negatively significant with days to 50% flowering. The association between grain yield and Fe, Zn was non-significant. Hence, there is an opportunity to select an early entry with high yield and high micronutrient content.

Keywords: pearl millet, Fe, Zn, variability, heritability, correlation

Introduction
The incidence of micronutrient malnutrition, diabetes and obesity are increasing day by day in the present life style. To combat this issue, public sector and few NGOs are creating awareness among public to consume millets which are naturally rich sources of micronutrients, dietary fiber and health beneficial polyphenols (Devi *et al*., 2014) [1]. Millets include, pearl millet, sorghum, finger millet, foxtail millet, little millet, barnyard millet and proso millet. Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is a crop of food, fodder and nutritional importance. It is mostly grown in arid and semi arid regions of Africa and India because of its ability to grow with little amount of water and its adaptability to harsh climatic conditions. It is a highly cross pollinated crop and lot of variability is present in this crop for various characters (Bhasker *et al*., 2016) [2].

Crop improvement is possible only when variation exists in the population and it also depend upon the inheritance pattern of a trait. Hence, study on genetic variability and heritability plays a pivotal role in plant breeding. Quantitative characters like grain yield, micronutrient content are governed by many minor genes with collective effect and moreover influenced by the surrounding environment in which they are being grown. Knowledge on association of easily heritable traits with quantitative traits help in indirect selection of low heritable traits (Basavaraj *et al*., 2017) [3]. This necessitates, understanding on variability, heritability and association of characters, for a selection to become realizable. Therefore, the present study was aimed to gather information on variability, heritability and association of characters in 130 pearl millet inbred lines for 13 different traits.

Material and Methods
The study included, 129 pearl millet inbred lines and one open pollinated check variety, *viz.*, ICTP 8203Fe, which were evaluated at ICAR-IARI, Regional Research center, Dharwad during *kharif*, 2014. Each genotype was sown in randomized block design with three replications of two rows of 4m length. Inter row spacing followed was 70 cm and between plants, it was 15 cm. Fertilizers were given as per the schedule of 35-40-30 kg 'NPK' per ha as

basal dose and 35kg 'N' as top dressing, at the time of panicle initiation. Observations were recorded on quantitative characters including micronutrient content (grain yield per plant in g, panicle yield per plant in g, days to 50% flowering, number of productive tillers per plant, panicle length in cm, panicle Diameter in cm, plant height in cm, thousand seed weight in g, and mineral nutrients *viz*., grain zinc content in mg/kg, grain iron content in mg/kg, grain copper content in mg/kg, grain manganese content in mg/kg, total phosphorus content in mg/100g,).

Replicated values were subjected to analysis of variance (Panse and Sukathme, 1967) [4] and then. calculation of phenotypic and genotypic coefficients of variation (PCV and GCV) (Burton and Devane, 1953) [5]. Heritability in broad sense Allard (1960) [6]; genotypic and phenotypic correlations (Falconer (1981) [7] were also computed. Categorization of heritability and genetic advance, into low, medium and high was according to Johnson *et al.,* (1955) [8].

Results and Discussion

Greater variability in the initial breeding material ensures better chances of producing desired forms of a crop plant. Hence, the concept of germplasm conservation evolved with the primary objective of collection and preservation of genetic variability in a crop species, so as to make it available to the present and future generations (Babu *et al.,* 2012) [9]. Greater variability do exist in advanced breeding inbred lines developed for attaining different breeding objectives. Genotypes included in this study were collection of various inbreds developed by utilizing Indian and African germplasm source.

The ANOVA results indicated significant differences at 1% level of significance among the genotypes for all the traits studied (Table 1). Highest coefficient of variation was observed for panicle yield followed by grain yield and least for panicle diameter (Table 1). The difference in range of variation for different traits varied from 1.34 cm for panicle diameter to 239.26 mg/100g for total P content.

As obvious PCV was higher than GCV. Slight variation in GCV and PCV, emphasized negligible role of environment in influencing the inheritance of traits under study and effectiveness of phenotypic selection in improvement of these traits. All characters studied expressed high broad sense heritability (> 60%), indicating the reliability of phenotypic value. Heritability estimates of traits varied from 76.94 for panicle length to 94.40 for Mn content. All micronutrients studied had higher heritability values indicating their scope of improvement for these characters through phenotypic selection.

Genetic advance is, a useful indicator of the progress that can be expected as a result of exercising selection on the pertinent population. Heritability in conjunction with genetic advance would give a more reliable index of selection value (Johnson *et al*., 1955) [8]. Estimates of genetic advance were high for plant height, Fe content and total protein content. All these three traits also showed high heritability indicating the role of additive gene action (Panse and Sukahtme, 1957) [4] and can be improved through simple or progeny selection methods. Low values of genetic advance were displayed by panicle diameter, number of productive tillers and thousand seed weight. High heritability coupled with moderate genetic advance for Zn content and grain yield indicates improvement of these traits by intermating superior segregants developed from recombination breeding (Samadia, 2005) [10].

Genotypic and phenotypic correlations indicated positive and significant association of grain yield with other agronomic characters except for days to 50% flowering where it was negative and significant. This situation provides an opportunity for developing an early entry with more grain yield (Manoj *et al*., (2016) [11]. Grain yield was also positively associated with Cu and Mn contents among micronutrients. This indicates that high yielders were also high in Cu and Mn contents and indirect selection can be effective in their improvement. Among micronutrients, Fe content had significant positive correlation with other micronutrients, where as low significant negative correlation was between Mn and Zn contents. However, presence of genuine associations between traits needs elimination of spurious correlations and other latent variables, for which partial correlations and path analysis may be employed.

Table 1: ANOVA of 130 pearl millet genotypes.

Source of Variations	df	Mean Squares												
		PH	PL	PD	NPT	PY	GY	TSW	DFF	Zn	Fe	TP	Cu	Mn
Replications	2	2.95	0.72	0.01	0.00	13.99	33.81	0.02	0.93	21.49	24.03	221.78	0.03	0.70
Treatments	129	1536.83**	28.79**	0.25**	1.25**	356.16**	133.26**	5.67**	100.77**	356.95**	1536.97**	5051.79**	16.03**	62.07**
Error	258	53.28	2.62	0.01	0.07	45.86	11.72	0.12	3.31	15.09	30.97	228.15	0.38	1.20

** significant at 1% level

Where PH: Plant height in cm, PL: Panicle length in cm, PD: Panicle diameter in cm, NPT: Number of productive tillers per plant, PY: Panicle yield per plant in g, GY: Grain yield per plant in g, TSW: Thousand seed weight in g, DFF: Days to 50% flowering, Fe: Grain Fe content in mg/kg, Zn: Grain Zn content in mg/kg, TP: Total P content in mg/100g, Cu: Grain Cu content in mg/kg, Grain Mn content in mg/kg.

Table 2: Summary statistics of 130 pearl millet genotypes

Character	PH	PL	PD	NPT	PY	GY	TSW	DFF	Zn	Fe	TP	Cu	Mn
Mean	111.92	20.17	2.24	2.61	54.00	28.63	8.59	59.13	36.46	60.94	304.07	8.40	17.95
C.V.	6.52	8.02	4.90	9.91	12.54	11.96	3.96	3.08	10.65	9.13	4.97	7.38	6.11
C.D. 5%	11.73	2.60	0.18	0.42	10.89	5.50	0.55	2.92	6.24	8.95	24.28	1.00	1.76
Minimum	62.72	13.09	1.47	1.27	29.79	11.61	5.4	40.62	21.7	31.22	188.71	3.39	8.52
Maximum	157.53	31.24	2.81	5.36	93.38	53.99	11.3	59.11	73.27	139.12	427.97	15.48	30.35
Difference of Max and Min	94.81	18.15	1.34	4.09	63.59	42.38	5.90	18.49	51.57	107.90	239.26	12.09	21.83

Where PH: Plant height in cm, PL: Panicle length in cm, PD: Panicle diameter in cm, NPT: Number of productive tillers per plant, PY: Panicle yield per plant in g, GY: Grain yield per plant in g, TSW: Thousand seed weight in g, DFF: Days to 50% flowering, Fe: Grain Fe content in mg/kg, Zn: Grain Zn content in mg/kg, TP: Total P content in mg/100g, Cu: Grain Cu content in mg/kg, Grain Mn content in mg/kg.

Table 3: Genetic parameters of 130 pearl millet genotypes.

Trait	PH	PL	PD	NPT	PY	GY	TSW	DFF	Zn	Fe	TP	Cu	Mn
GCV	19.87	14.64	12.47	24.06	18.84	22.23	15.83	9.64	29.28	36.76	13.19	27.19	25.09

ECV	6.52	8.02	4.90	9.91	12.54	11.96	3.96	3.08	10.65	9.13	4.97	7.38	6.11
PCV	20.91	16.69	13.37	26.02	22.63	25.24	16.32	10.12	31.15	37.88	14.09	28.18	25.82
H^2 (Broad Sense)	90.27	76.94	87.01	85.51	69.28	77.56	94.09	90.76	88.31	94.19	87.57	93.14	94.40
Genetic Advance	43.53	5.34	0.54	1.20	17.44	11.55	2.72	11.19	20.67	44.79	77.30	4.54	9.02
GAM	38.89	26.46	23.97	45.84	32.30	40.33	31.64	18.92	56.67	73.50	25.42	54.06	50.21

Where PH: Plant height in cm, PL: Panicle length in cm, PD: Panicle diameter in cm, NPT: Number of productive tillers per plant, PY: Panicle yield per plant in g, GY: Grain yield per plant in g, TSW: Thousand seed weight in g, DFF: Days to 50% flowering, Fe: Grain Fe content in mg/kg, Zn: Grain Zn content in mg/kg, TP: Total P content in mg/100g, Cu: Grain Cu content in mg/kg, Grain Mn content in mg/kg.

Table 4: Phenotypic correlation of yield and related traits in 130 pearl millet genotypes

Trait	PH	PL	PD	NPT	PY	GY	TSW	DFF	Zn	Fe	TP	Cu
PL	0.404**											
PD	0.306**	0.268**										
NPT	0.138**	0.094^{NS}	0.030^{NS}									
PY	0.266**	0.244**	0.235**	0.355**								
GY	0.270**	0.288**	0.265**	0.472**	0.757**							
TSW	0.041^{NS}	0.091^{NS}	0.280**	-0.033^{NS}	0.156**	0.171**						
DFF	0.196**	0.165**	0.045^{NS}	-0.169**	-0.052^{NS}	-0.107*	-0.086^{NS}					
Zn	0.039^{NS}	0.049^{NS}	0.066^{NS}	-0.145**	-0.088^{NS}	-0.099^{NS}	0.063^{NS}	0.117*				
Fe	-0.064^{NS}	0.089^{NS}	0.069^{NS}	-0.162**	0.015^{NS}	-0.041^{NS}	0.068^{NS}	0.039^{NS}	0.362**			
TP	0.072^{NS}	0.067^{NS}	-0.012^{NS}	-0.056^{NS}	-0.033^{NS}	-0.052^{NS}	0.100*	0.181**	0.209**	0.148**		
Cu	-0.068^{NS}	0.030^{NS}	-0.044^{NS}	0.126*	0.202**	0.238**	0.169**	0.021^{NS}	-0.048^{NS}	0.156**	-0.039^{NS}	
Mn	0.070^{NS}	0.040^{NS}	0.098^{NS}	0.162**	0.157**	0.234**	0.217**	0.027^{NS}	-0.160**	0.135**	-0.054^{NS}	0.249**

Where PH: Plant height in cm, PL: Panicle length in cm, PD: Panicle diameter in cm, NPT: Number of productive tillers per plant, PY: Panicle yield per plant in g, GY: Grain yield per plant in g, TSW: Thousand seed weight in g, DFF: Days to 50% flowering, Fe: Grain Fe content in mg/kg, Zn: Grain Zn content in mg/kg, TP: Total P content in mg/100g, Cu: Grain Cu content in mg/kg, Grain Mn content in mg/kg.

Table 5: Genotypic correlation of yield and related traits in 130 pearl millet genotypes.

Trait	PH	PL	PD	NPT	PY	GY	TSW	DFF	Zn	Fe	TP	Cu
PL	0.336**											
PD	0.264**	0.172**										
NPT	0.062^{NS}	-0.058^{NS}	-0.054^{NS}									
PY	0.164**	0.029^{NS}	0.134**	0.256**								
GY	0.204**	0.138**	0.170**	0.445**	0.774**							
TSW	-0.019^{NS}	-0.011^{NS}	0.244**	-0.109*	0.061^{NS}	0.099^{NS}						
DFF	0.154**	0.083^{NS}	-0.018^{NS}	-0.267**	-0.197**	-0.232**	-0.141**					
Zn	0.064^{NS}	0.089^{NS}	0.092^{NS}	-0.144**	-0.076^{NS}	-0.095^{NS}	0.084^{NS}	0.138**				
Fe	-0.067^{NS}	0.105*	0.079^{NS}	-0.178**	0.016^{NS}	-0.050^{NS}	0.073^{NS}	0.041^{NS}	0.353**			
TP	0.081^{NS}	0.086^{NS}	-0.017^{NS}	-0.063^{NS}	-0.038^{NS}	-0.076^{NS}	0.111*	0.202**	0.259**	0.177**		
Cu	-0.121*	-0.050^{NS}	-0.096^{NS}	0.086^{NS}	0.156**	0.211**	0.143**	-0.016^{NS}	-0.089^{NS}	0.132**	-0.032^{NS}	
Mn	0.036^{NS}	-0.033^{NS}	0.065^{NS}	0.132**	0.104*	0.208**	0.196**	-0.005^{NS}	-0.209**	0.110*	-0.051^{NS}	0.207**

Where PH: Plant height in cm, PL: Panicle length in cm, PD: Panicle diameter in cm, NPT: Number of productive tillers per plant, PY: Panicle yield per plant in g, GY: Grain yield per plant in g, TSW: Thousand seed weight in g, DFF: Days to 50% flowering, Fe: Grain Fe content in mg/kg, Zn: Grain Zn content in mg/kg, TP: Total P content in mg/100g, Cu: Grain Cu content in mg/kg, Grain Mn content in mg/kg.

References

1. Devi PB, Vijayabharathi R, Sathyabama S, Malleshi NG, Priyadarisini VB. Health benefits of finger millet (*Eleusine coracana* L.) polyphenols and dietary fiber: a review. Journal of food science and technology. 2014; 51(6):1021-1040.
2. Bhasker K, Shashibhushan D, Murali Krishna K, Bhave MHV. Genetic Variability, Heritability and Genetic Advance of Grain Yield in Pearl Millet [*Pennisetum glaucum* (L.) R. Br.]. International Journal of Pure and Applied Bioscience. 2017; 5(4):1228-1231.
3. Basavaraj PS, Biradar BD, Sajjanar GM. Genetic variability studies for quantitative traits of restorer (R) lines in Pearl Millet [*Pennisetum glaucum* (L.) R. Br.]. International Journal of Current Microbiology and Applied Sciences. 2017; 6(8):3353-3358.
4. Panse VG, Sukhatme PV. Genetics and quantitative characters in relation to plant breeding. Indian Journal of Genetics. 1957; 17:312-328.
5. Burton GW, Devane EW. Estimating heritability in tall fescue (*Festuca arundiraceae*) from replicated clonal material. Agronomy Journal. 1953; 45:478-481.
6. Allard RW. Principles of Plant Breeding. John Wiley and Sons Inc., New York. 1960, 485.
7. Falconer DS. Introduction to Quantitative Genetics. 2nd ed. Longman, London, 1981.
8. Johnson HW, Robinson HF, Comstock RE. Estimate of genetic and environmental variability in Soybeans. Agronomy Journal. 1955; 47:314-318.
9. Babu VR, Shreya K, Dangi KS, Usharani G, Nagesh P. Genetic variability studies for qualitative and quantitative traits in popular rice (*Oryza sativa* L) hybrids of India. International Journal of Scientific and Research Publication. 2012; 2:2250–3153.
10. Samadia DK. Genetic variability studies in Lasora (*Cordia myxa* Roxb.). Indian Journal of Plant Genetic Resources. 2005; 18(3):236-240.
11. Manoj K, Gupta PC, Shekhawat HVS. Correlation studies among pearl millet [*Pennisetum glaucum* (L.) R. Br.] hybrids. Electronic Journal of Plant Breeding. 2016; 7(3):727-729.