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Full Length Research Paper

Genetic variability and path coefficient analysis in pearl millet (Pennisetum glaucum (L.) (R.Br)

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The range, mean genotypic, phenotypic and environmental coefficients of variations and heritability estimates for five agronomic characters in pearl millet (Pennisetum glaucum (L) R. Br. studied showed a wide range of variations and highly significant genotype difference. The genotypic correlation coefficients were higher than phenotypic and environmental coefficients for the characters studied. All the characters were highly significant and positively correlated with grain yield genotypically. Path coefficients analysis revealed the true nature of cause and effect relationship of plant height. Panicle length, tiller count, head weight and grain mass with grain yield. Genotypic correlation is correlation of breeding value and was used to calculate direct and indirect effects of plant height, panicle length, tiller count, head weight and grain mass on grain yield.

Key words: Genetic, variability, path coefficients, heritability, pearl millet.

INTRODUCTION

Pearl millet is the most drought tolerant of all the domesticated cereals. Pearl millet grown on soils that are too sandy and light textured, acidic, dry and infertile where no other cereals will yield any grain and in regions with 200-800mm of annual rainfall. Over 40% of utilizable arable land (about 5 million hectares) are devoted to millet production as sole crop in sudanian and sahelian agro ecological zone of Nigeria.

Pearl millet proved basic diet for millions of people that live in the arid and semi arid tropics of Africa and Asia. In Nigeria the processed grain is used as "tuwo", "kunu", and "akamu", a local porridge is also made into fermented bread like "roti", "kira", "dosa", and burukutu a local fermented beer. It is more nutritious than sorghum and can supply about 9.8g of protein per day. Prolamines of pearl millet have high level of lysine and tryptophan than sorghum and that explains why pearl millet proteins generally have a higher digestibility than sorghum protein (Hoseney et al 2000).

Understanding the interrelationship among various agronomic characters usually results in progress during selection in plant breeding. (Manga et al 1988 and Singh et la 1980) made a detailed studies on the genetic variability for different quantitative characters in pearl millet and they found that it is difficult to know whether the observed variability is heritable or due to environmental factor. It is therefore necessary to divide the observed variability into heritable and non-heritable components. The aim of this study was to obtain detailed information on the range, magnitude of variation of some important agronomic characters and nature of these characters associated with yield in pearl millet. (Pennisetum glaucum (L.) R.Br.

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MATERIALS AND METHODS

Ninety (90) genotypes consisting of eighty-one (81) hybrids and nine (9) inbred lines of pearl millet were grown in lattice design with three replications in five environments i.e Samaru 2004, Bagauda 2004, Maiduguri 2004 and Samaru 2005 and Bagauda 2005. Each plot consisted of 2 rows of 5m long. Inter and intra row spacing of 75cm and 50cm were used. All cultural practices for pearl millet production were observed. From each plot 5 plants were selected at random and tagged

Table 1. Phenotypic Variability of the Characters under Study.

Character	Range	General means	SE ±	F- value	Mean squares
Plant height	181.0- 228.33	203.75	16.50	1.85	486.2171 **
Panicle length	24.93- 40.80	32.44	3.10	2.34	22.011332 **
Tiller count	4.80-6.00	5.37	0.78	1.20	07385227 **
Head weight	1651.60- 2708.27	2250.0	572.20	1.46	509967.4 **
Grain Mass	7.51- 9.77	8.66	0.85	0.84	13805.073**
Grain yield	1183- 2293	1821	551	1.38	0.5312759 **

Table 2. Estimate of genotypic, phenotypic and environmental variance, genotypic and phenotypic coefficients of variation and heritability in broad sense.

Character	Genotypic variance σ^2_g	Phenotypic variance σ^2_{ph}	Environmental variance σ^2_{ev}	Genotypic coefficients of variance CV	phenotypic coefficients of variance CV	Heritability in Broad sense $h^2_{(b)}$
Plant height	55.13196	395.6865	263.7007	3.64	9.76	14.31
Panicle length	6.09736	19.82240	9.41230	7.61	13.72	31.50
Tiller count	0.01996	0.67837	0.61726	2.63	15.34	39.00
Head weight	15248.1	106561.5	341359	5.50	14.54	14.30
Grain Mass	931.7425	17499.442	16567.7	231.07	1001.40	5.30
Grain yield	0.02965	0.4559	0.38568	0.01	0.04	4.5

for recording observations on plants height, panicle length, tiller count, head weight, grain mass and grain yield. For grain yield, the 2 rows plots were harvested and threshed and the grain yield was estimated in $kgha^{-1}$. Statistical analysis was based in plot means and heritability in broad sense was calculated by the formula of Burton and DeVane 1952.

$$H = \frac{\sigma^2_g}{\sigma^2_{ph}}$$

where H = heritability. σ^2_g and σ^2_{ph} are Genotypic and phenotypic variance respectively.

Genotypic, phenotypic and environmental component of variance and covariance were computed from analysis of variance and were used to estimate genotypic, phenotypic and environmental correlation coefficient. The path coefficient analysis as applied by (DeWey and Lu 1959) was further utilized in partitioning the genotypic correlation coefficients into direct and indirect effects of plant height, panicle length, tiller count, head weight and grain mass on grain yield.

RESULTS AND DISCUSSIONS

The range, general means, standard error of the mean, F- value and mean square are summarized in (Table 1). Highly significant different in respect of all the characters studied were observed. A high range of variation were observed in traits like plant height, head weight and grain yield whereas variation as recorded by panicle length, tiller count and grain mass were low. The genotypic coefficients of variation value range from 0.01 to 0.4 for grain yield been the lowest to 1001.4 to 231.7 for grain mass been the highest. Heritability in the broad sense was calculated for various quantitative characters ranges from 4.5% to 39%. Tiller count recorded the highest broad sense heritability value of 39% followed by panicle length 31.5%. Grain yield recorded the lowest broad sense heritability (Table 2).

In order to study the relationship between various agronomic characters with each other and the grain yield; genotypic, phenotypic and environmental correlation coefficients were calculated from variance and covariance components. In most cases genotypic correlation coefficients were higher than phenotypic and environmental correlation coefficients. Genotypic correlation is the correlation of breeding value and therefore reference will be made to it in the remaining part of this paper. Plant height, panicle length, head weight, were highly significant and positively correlated with grain yield. Plant height is positively associated with panicle length, head weight but negatively associated with tiller count. Panicle length is highly significant and positively associated with tiller count and head weight. Tiller count is positively associated with grain mass (Table 3). The positive association of panicle length and tiller count to grain yield indicated that long panicle and more productivity tillers enhance higher grain yield in pear millet.

Path coefficient technique was further use to analysis correlations which involved the partitioning of genotypic

Table 3. Estimate of Genotypic, phenotypic and Environment Correlation Coefficients.

Character		panicle length	Tiller count	Head weight	Grain mass	Grain yield
Plant height	G	0.948**	- 0.973**	0.295*	0.131	0.667**
	P	0.468**	- 0.996**	0.065	0.063	0.108
	E	0.155	0.272*	0.241	0.157	0.048
Panicle length	G		0.625**	0.538**	- 0.011	0.303 **
	P		0.327**	0.095	- 0.027	0.045
	E		0.021	0.038	- 0.029	0.001
Tiller count	G			0.972**	0.624**	0.422**
	P			0.089	0.248*	0.084
	E			0.128	0.290*	0.068
Head weight	G				0.869**	0.957**
	P				0.227	0.925**
	E				0.198	0.711**
Grain mass	G					0.777**
	P					0.485**
	E					0.370**

Note: G = Genotypic P = Phenotypic and E = Environmental correlation coefficients.
*and ** significant of P = 0.05 and P = 0.01 levels respectively.

Diagram of path coefficient analysis figure 1.

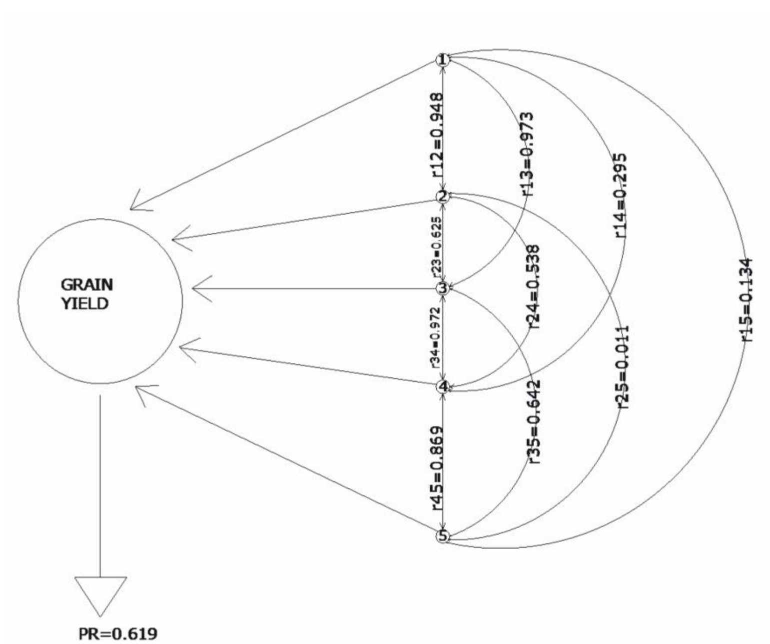

Figure 1. Path diagram and coefficients of factors influencing grain yield in pearl millet.
Keys:
1 = Plant height 2 = Panicle length 3 = Tiller count
4 = Head weight 5 = Grain mass 6 = Grain yield
P_R = Residual

correlations coefficient into direct effects (unidirectional path ways P) and direct effect through alternative pathways P x correlation coefficient (r). Grain yield was considered as a resultant variable whereas, plant height, panicle length, tiller count, head weight and grain mass as casual variable. The path coefficient were obtained by

Table 4. Path Coefficient Analysis Showing Direct and Indirect Effects of Plant Height, Panicle Length, Tiller Count, Head Weight and Grain Mass on Grain Yield.

Character	Direct effect path Coefficient (p)	indirect effect path coefficient (p x r)	correlation coefficient (r)
Plant height Vs grain yield			
Direct effect (P_{16})	0.113		
Indirect via panicle length ($r_{12}P_{26}$)		1.207	
Indirect via tiller count ($r_{13}P_{36}$)		- 0.314	
Indirect via head weight ($r_{14}P_{46}$)		- 0.685	
Indirect via grain mass ($r_{15}P_{56}$)		- 0.347	
Total			**0.667**
Panicle Vs grain yield			
Direct effect ($V_{11}P_{16}$)	1.273		
Indirect effect via plant length ($V_{12}P_{26}$)		0.017	
Indirect effect via tiller count ($r_{23}P_{36}$)		0.200	
Indirect effect via head weight ($V_{24}P_{46}$)		1.250	
Indirect effect via grain mass ($V_{25}P_{56}$)		0.028	
Total			**0.303**
Tiller count Vs grain yield			
Direct effect (P_{56})	0.323		
Indirect effect via plant height($V_{13}P_{16}$)		0.110	
Indirect effect via panicle length ($V_{23}P_{26}$)		0.795	
Indirect effect via head weight ($V_{34}P_{36}$)		- 2.289	
Indirect effect via grain mass ($V_{45}P_{56}$)		1.661	
Total			**0.411**
Head weight Vs grain yield			
Effect (P_{46})	-2.324		
Indirect effect via plan height ($V_{14}P_{16}$)		0.033	
Indirect effect via panicle length ($V_{24}P_{26}$)		0.685	
Indirect effect via tiller count ($V_{34}P_{36}$)		0.314	
Indirect effect via grain mass ($V_{45}P_{46}$)		2.249	
Total			**0.957**
Grain mass Vs grain yield			
Direct effect (P_{56})	1.588		
Indirect effect via plant height ($V_{11}P_{26}$)		0.105	
Indirect effect plant height ($V_{26}P_{26}$)		0.015	
Indirect effect via tiller count ($V_{36}P_{36}$)		0.207	
Indirect effect via head weight ($V_{46}P_{46}$)		2.209	
Total			**0.777**
Residual			**0.619**

the solution of simultaneous equation through the method of least square by (DeWey and Lu 1959). Path coefficient analysis of interrelationships of the plant height, panicle length, head weight, tiller count and grain mass with yield is shown diagrammatically in (figure 1). The doubled arrowed line indicated mutual association as measured by correlation coefficients and the singled arrowed line represent direct effect in one direct as measured by path coefficient. Resident factor unaccounted for and considered independent of the other variable was represented as P x 5 in the diagram (figure 1). Estimates of direct effect path coefficient and indirect path coefficients are presented in (Table 4).

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