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Correlation and Path Coefficients Analysis in Pearl Millet (*Pennisetum americanum* L.)

Muhammad Hussain Chaudhry, Ghulam Mahboob Subhani, Muhammad Saleem Shaheen and [1]Usman Saleem
Maize and Millets Research Institute, Yusafwala, Sahiwal, Pakistan
[1]University of Agriculture, Faisalabad, Pakistan

Abstract: An experiment (comprised of 4 CMS lines and 4 open pollinated promising strains of pearl millet and their 16 hybrids) was conducted at MMRI, Sahiwal, during Kharif 1998 to ascertain the information of genetic variability, correlation, path and regression coefficients. Mean squares for plant height, leaf area, head length, head girth, biological yield per plot and grain yield per plot were highly significant and significant for number of leaves per main tiller. Genotypic coefficient of variability (GCV%) and phenotypic coefficient of variability (PCV%) were higher for plant height, biological yield/plot, harvest index and grain yield/ plot. The PCV% was higher than GCV% for all the traits studied. High genetic advance as percentage of mean and high heritability estimates 93.88, 86.83, 74.81 and 68.62% were observed for grain yield/plot, biological yield/plot, harvest index and plant height, respectively. Genotypic correlation coefficients were higher than phenotypic correlation coefficients for almost all the traits. Grain yield/plot was positively and significantly correlated with all traits. Positive direct effect of biological yield/plot (0.7238), harvest index (0.5976) and plant height (0.1419) on grain yield/plot was noted. Regression coefficients of biological yield and harvest index were significant and positive. This study indicated the presence of very high genetic variability for grain yield, biological yield, harvest index and plant height. Similarly analysis of correlation path and regression coefficients revealed the importance of biological yield, harvest index, head girth and plant height.

Key words: Path-analysis, regression coefficients, biological yield, grain yield, pearl millet

Introduction

Pearl Millet is an important feed and food crop in rainfed areas of the Punjab province. It's per acre low yield invites attention for systematic and concerted efforts to develop cultivars having high yield potential. To tailor make plant knowledge on association among component traits is pre-requisite for achieving fast genetic improvement. Limited information on peal millet is available regarding this aspect, however, some earlier reports on high phenotypic and genotypic coefficients of variation for grain yield/plant is available (Abraham *et al.*, 1989; Harer and Karad, 1998; Kulkarni *et al.*, 2000). Broad sense high heritability estimates for days to 50% flowering (Abraham *et al.,* 1989; Kulkarni *et al.*, 2000); grain yield and plant height (Harer and Karad, 1998) were observed. Significant and positive correlation coefficients for grain yield with days to flowering, head length, plant height, ear girth, flag leaf area and biomass were observed by Abraham *et al.* (1989), Harer and Karad (1998), Kulkarni *et al.* (2000), Sukhchain and Sindhu (1992) and Yadav *et al.* (2001). Direct effect of biological yield, harvest index, days to flowering, ear length, ear girth and plant height on grain yield was reported by Godowat and Chaudhry (1990), Harer and Karad (1998), Kulkarni *et al.* (2000) and Sukhchain and Sindhu (1992). The present study was planned to understand the association of various characters with yield and its components in pearl millet. Also to establish the importance of different traits in selection of parents for the evolution of a new variety.

Materials and Methods

Four Cytoplasmic male sterile lines i.e. ICMS-841, ICMS-843, ICMS-863 and Tift-23E were crossed with each of the four open pollinated good performing strains i.e. ICMV-94131, ICMV-94133, ICMV-94472 and ICMV-94475 in isolations during kharif-1997 at Maize and Millets Research Institute, Yusafwala, Sahiwal. The sixteen crosses (4 line x 4 tester) along with their eight parents were sown in randomized complete block design with three replications during kharif-1998. Seed was hand drilled in four rows of 5 meters long kept 75 cm apart from each other. On germination plants were thinned out and a distance of 15 cm was maintained between adjacent parts. Fertilizer and other agronomic practices were kept uniform according to the recommendations throughout the growth period as per recommendations for pearl millet. Data on days to 50% anthesis, plant height, number of leaves per main tiller, leaf area, head length, head girth, biological yield per plot and grain yield per plot were recoded. Averaged data were analyzed using the techniques developed by Steel and Torrie (1980). Genotypic and phenotypic coefficients of variability,

heritability estimates in broad-sense and genetic advance as percentage of mean were estimated. Path coefficient analysis was done.

Results and Discussion

The genotypic differences were highly significant for days to 50% anthesis, plant height, leaf area, head length, head girth, biological yield per plot and grain yield per plot except number of leaves per main tiller which were significant at 5% level (Table 1). Highly significant differences indicated the presence of genetic variability in the material. High genotypic coefficient of variability (GCV) and phenotypic coefficient of variability (PCV) for plant height, leaf area, biological yield, harvest index and grain yield suggested the effectiveness of selection for these traits (Table 2). The results are congruent with the findings of Abraham *et al.* (1989), Harer and Karad (1998) and Kulkarni *et al.* (2000). The phenotypic coefficient of variability (PCV) was higher than genotypic coefficient of variability (GCV) for all the traits. Small environmental effect indicated through minimum differences between GCV and PCV for days to 50% anthesis, plant height, biological yield, harvest index and grain yield was depicted in the high heritability estimates for these traits as observed by Kulkarni *et al.* (2000). Heritability estimates and genetic advance as percentage of mean were high for grain yield followed by biological yield, harvest index, plant height and head girth. Results are parallel to the study of Harer and Karad (1998). Moderate heritability (59.71%) was observed for days to 50% anthesis contrary to Abraham *et al.* (1989) and Kulkarni *et al.* (2000) whom reported the high heritability estimates which may be due to genetic and environmental differences.

Genotypic correlation coefficients were higher than their respective phenotypic correlation coefficients except for the correlation coefficients of harvest index with head length (Table 3). Correlation of days to 50% anthesis with plant height, leaf area, head length, head girth, biological yield and grain yield was positive and significant. Plant height was also significantly and positively correlated with all traits. Correlation of number of leaves per main tiller with leaf area, head length, head girth, biological yield, harvest index and grain yield was positive and significant. Leaf area and head length were highly correlated (0.918). Association of head length and head girth with biological yield, harvest index and grain yield was positive and significant. Similarly positive and significant correlation between biological yield, harvest index and grain yield was found. Harvest index was also correlated with grain yield in the same way. Grain yield was positively and significantly correlated with days to 50% anthesis, plant height, number of leaves per main tiller, leaf area, head length, head girth, biological yield and harvest index. The results are in agreement with findings of Abraham *et al.* (1989), Harer and Karad (1998), Kulkarni *et al.* (2000), Yadav *et al.* (2001). A strong association was observed between grain yield and biological yield followed by harvest index, head girth and plant height, respectively.

Direct and indirect effects for the characters are given in Table 4. Days to 50% anthesis had a poor direct effect on grain yield and a positive indirect effect was noted via biological yield, plant height and harvest index. Plant height had also positive direct effect on grain yield and positive indirect effect through biological yield followed by harvest index. Results corroborate with the findings of Khairwal *et al.* (1990). Number of leaves per main tiller had negative direct effect on grain yield whereas maximum

Table 1: Analysis of variance of different morphological traits in pearl millet

Source of Variation	df	Days to 50% anthesis	Plant height (cm)	No. of leaves/ main tiller	Leaf area (cm^2)	Head length (cm)	Head girth (cm)	Biological yield/plot (kg)	Harvest index (%)	Grain yield (kg)
Replications	2	4.764	1937.79	3.937	7508.86	2.514	1.365	17.800	2.145	0.019
Genotypes	23	20.657**	4018.40**	1.497*	2213.95**	25.624**	3.251**	35.067**	1.556**	0.282**
Error	46	3.793	531.63	0.702	896.11	4.950	0.574	1.688	0.157	0.006

*,** = Significant at 0.05 & 0.01 level of probability respectively.

Table 2: Estimates of genetic parameters in pearl millet

Parameters/ Characters	Days to 50% anthesis	Plant height (cm)	No. of leaves/ main tiller	Leaf area (cm^2)	Head length (cm)	Head girth (cm)	Biological yield/plot (kg)	Harvest index (%)	Grain yield (kg)
Mean	58.89	221.79	11.63	210.34	26.29	9.52	22.67	5.93	1.35
Minimum	54.00	126.00	9.40	106.56	19.40	7.00	15.60	4.35	0.85
Maximum	67.00	298.00	13.60	300.51	36.00	12.20	30.60	8.07	2.30
GCV%	3.96	15.37	4.43	9.96	9.98	9.92	14.71	11.52	22.50
PCV%	5.12	18.56	8.46	17.37	13.09	12.72	15.79	13.31	23.22
H^2 (Broad-sense)	59.71	68.62	27.40	32.90	58.20	60.86	86.83	74.81	93.88
Genetic Advance (GA)	3.78	58.30	0.56	12.40	4.13	1.52	6.41	1.22	0.61
GA as percentage of mean	6.42	26.27	4.79	5.91	15.72	15.97	28.29	20.54	44.91

Table 3: Genotypic (bold) and phenotypic correlation coefficients of different morphological traits in pearl millet

Characters	Days to 50% anthesis	Plant height (cm)	No. of leaves/ main tiller	Leaf area (cm^2)	Head length (cm)	Head girth (cm)	Biological yield/plot (kg)	Harvest index (%)	Grain yield (kg)
Days to 50% anthesis		0.37*	0.337*	0.497*	0.323*	0.441*	0.474*	0.017	0.327*
Plant Height (cm)	0.210		0.872*	0.769*	0.866*	0.885*	0.752*	0.286*	0.597*
No. of leaves/main tiller	0.156	0.519**		0.655*	0.439*	0.629*	0.655*	0.372*	0.595*
Leaf Area (cm^2)	0.193	0.467**	-0.329**		0.918*	0.665*	0.618*	-0.012	0.336*
Head Length (cm)	0.161	0.614**	0.278*	0.553**		0.783*	0.700*	0.286*	0.580*
Head Girth (cm)	0.210	0.675**	0.195	0.542**	0.422**		0.790*	0.364*	0.665*
Biological Yield/Plot (kg)	0.329**	0.594**	0.372**	0.422**	0.506**	0.552**		0.382*	0.851*
Harvest Index (%)	-0.043	0.212	0.076	-0.064	0.290*	0.258*	0.201		0.803*
Grain Yield (Kg)	0.205	0.487**	0.276	0.227	0.488**	0.490**	0.797**	0.749**	

*, ** = Significant at 0.05 and 0.01 level of probability, respectively.

Table 4: Path analysis of different morphological traits in pearl millet

Characters	Days to 50% anthesis	Plant height (cm)	No. of leaves/ main tiller	Leaf area (cm^2)	Head length (cm)	Head girth (cm)	Biological yield/plot (kg)	Harvest index (%)	r_g
Days to 50% anthesis	0.0699	0.0525	-0.0266	-0.0478	0.0090	-0.0833	0.3431	0.0102	0.327*
Plant height (cm)	0.0259	0.1419	-0.0689	-0.0739	0.0241	-0.1673	0.5443	0.1709	0.597*
No. of leaves/ main tiller	0.0236	0.1237	-0.0790	-0.0629	0.0122	-0.1189	0.4741	0.2223	0.595*
Leaf area (cm^2)	0.0348	0.1091	-0.0571	-0.0961	0.0255	-0.1257	0.4473	-0.0072	0.336*
Head length (cm)	0.0226	0.1229	-0.0347	-0.0882	0.0278	-0.1480	0.5067	0.1709	0.580*
Head girth (cm)	0.0309	0.1256	-0.0497	-0.0639	0.0218	-0.1890	0.5718	0.2175	0.665*
Biological yield/ plot (kg)	0.0332	0.1067	-0.0517	-0.0594	0.0195	-0.1493	0.7238	0.2283	0.851*
Harvest index (%)	0.0012	0.0406	-0.0531	0.0012	0.0080	-0.0688	0.2765	0.5976	0.803*

Table 5: Regression coefficients and standard errors of different morphological traits in pearl millet

Independent variables		Regression coefficient 'b'	S.E. of 'b'
Days to 50% anthesis	X_1	0.00132	0.00098
Plant Height (cm)	X_2	-0.00023	0.00012
No. of leaves/ main tiller	X_3	-0.00350	0.00352
Leaf Area (cm^2)	X_4	0.00013	0.00013
Head Length (cm)	X_5	-0.00211	0.00159
Head Girth (cm)	X_6	-0.01136**	0.00348
Biological Yield/ Plot (kg)	X_7	0.06273**	0.00107
Harvest Index (%)	X_8	0.24838**	0.00388
Intercept		-1.3981	
Coefficient of Determination (R-square)		0.995	
Multiple R		0.997	

** = Significant at 0.01 level of probability.

Table 6: Regression analysis of variance in pearl millet

Source of variation	df	MS
Regression (Grain Yield/plot - Biological yield/ plot+ Harvest index + Head Girth)	3	2.2575**
Residual	68	0.00065
Total	71	
Regression (Grain Yield/plot - Biological yield/ plot + Harvest index +Plant Height)	3	2.2574**
Residual	68	0.00065
Total	71	
Biological yield/ plot	1	4.0377
Harvest index	1	2.7172**
Head Girth or Plant height	1	0.0171**
	1	0.0168**

** = Significant 0.01 level of probability.

Table 7: Significant contribution of traits on grain yield of pearl millet

Traits	R^2	% Contribution
Grain Yield/plot - Biological yield/plot	0.592	59.20
Grain Yield/plot - Biological yield /plot + Harvest index	0.991	99.10
Grain Yield/plot - Biological yield /plot + Harvest index + Head Girth or Plant Height	0.994	99.40
Grain Yield/plot – All traits	0.995	99.50

positive direct effect was noted through biological yield followed by harvest index. Biological yield, harvest index and plant height respectively had maximum direct effect on grain yield. The results are in line with the findings of Khairwal *et al.* (1990), Godowat and Chaudhry (1990) Sukhchain and Sindhu (1992) and Harer and Karad (1998). The regression coefficients of biological yield and harvest index were positive and significant with a unit increase in the grain yield to the extent of 0.0673 and 0.2484 g, respectively (Table 5). This analysis revealed that grain yield was mainly dependent on biological yield and harvest index. The regression analysis of variance and its sequential analysis have also confirmed these results (Table 6). Biological yield, harvest index and either by plant height or head girth were important independent variables for the gain of 99.40% variability in grain yield (Table 7). The coefficient of determination (R^2) exhibited that 59.20% of the variation in grain yield was contributed by biological yield, 40.10% by harvest index, 0.30% either plant height or head girth (Table 7). Following multiple regression equation was established from the regression coefficients given in Table 5.

$$Y = -1.3981 + 0.00132X_1 - 0.00023X_2 - 0.0035X_3 + 0.00013X_4 - 0.00211X_5 - 0.01136X_6 + 0.06273X_7 + 0.24838X_8 = 1.348$$

The coefficient of determination (R^2) and multiple correlation (R) were highly significant (Table 5). This clearly demonstrates the importance of combined relationship between a dependent variable grain yield and a series of independent variables.

The results discussed above have indicated presence of sufficient amount of genetic variability among the genotypes for all the traits. The traits like days to 50% anthesis, plant height, biological yield per plot, harvest index and grain yield were not influenced much by the environment. Therefore, it was exhibited in the high heritability estimates of these traits along with high genetic advance as percentage of mean. It suggested that the selection would be effective in early generations for the improvement of these traits. Correlation studies and path coefficients analysis have indicated the importance of biological yield, harvest index, plant height, days to 50% anthesis and head girth for the improvement of grain yield. Regression coefficients analysis has also depicted that biological yield, harvest index, plant height and head girth had high contribution for obtaining the maximum grain yield. The study has demonstrated that selection for biological yield, harvest index, plant height and head girth would be as important as direct selection for grain yield in pearl millet.

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