

Character Association and Path Analysis under Stress and Non-stress Conditions in Pearl Millet

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Abstract: Correlation and path coefficient analyses were carried out in 58 genotypes of pearl millet under stress (rainfed) and non-stress (irrigated) conditions. Under non-stress condition grain yield per plot was associated positively and significantly with plant height, productive tillers per plant and grain yield per plant, and negatively with days to 50% flowering. Under stress conditions grain yield per plot was associated positively with early vigor in addition to above traits. Path coefficients analysis revealed that under non-stress condition, grain yield per plant and plant height had higher positive direct influence on grain yield per plot, while 50% flowering had high negative direct effect on grain yield per plot. Productive tillers per plant had the highest positive direct effect on grain yield per plant. Under stress condition, grain yield per plant, plant height and early vigor had positive direct effect on grain yield per plot, while productive tillers per plant and early vigor directly influenced grain yield per plant. Thus, for improving grain yield of pearl millet under stress environments, besides productive tillers per plant, plant height and earliness, emphasis should also be given to early vigorous growth.

Key words: *Pennisetum glaucum* (L.) R. Br., correlation, path analysis.

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an important kharif cereal crop of the arid regions. Though Rajasthan contributes maximum to country's area (47%) and production (30%), its productivity is lowest (300-460 kg ha⁻¹) among pearl millet growing states. To develop high yielding varieties, knowledge about association of yield components with grain yield under arid environments is essential. Some information on this aspect is available from relatively high rainfall areas (Phul *et al.*, 1974; Navale *et al.*, 1995). However, information is scanty from arid regions where it is the only kharif cereal crop that can be grown successfully to sustain human and livestock. Further, association of different yield components and their direct and indirect effects on grain

yield may be altered under harsh conditions of arid regions compared to regions with better environment. The present study was therefore conducted to ascertain the nature and magnitude of interrelationships of grain yield with its components under stress and non-stress environments.

Material and Methods

Fifty eight genotypes of pearl millet were grown in a randomized block design in two sets, each having three replications, at the Central Arid Zone Research Institute, Jodhpur. One set was kept rainfed (stress environment), while the second set (non-stress) was irrigated at ten day interval by the amount of water equivalent to cumulative pan evaporation. Each genotype was grown in six rows of 3 m each, spaced

at 50 cm with a plant to plant distance of 15 cm. Data were recorded on five random plants for plant height, productive tillers per plant, ear length, ear girth and grain yield per plant. Data on early vigor (1 to 5 score; 1 = poor growth, 5 = excellent growth), days to 50% flowering and grain yield per plot were recorded on plot basis. Data were subjected to analysis of variance. Correlation and path analysis were carried out following Dewey and Lu (1959).

Results and Discussion

Analysis of variance revealed significant differences for most of the traits, both under stress and non-stress environments. Ear girth was non-significant under stress environment, but showed significant differences among genotypes under non-stress condition.

Correlations under non-stress environment

The phenotypic and genotypic correlation coefficients among eight quantitative

characters under non-stress environment are presented in Table 1. The genotypic correlations in general were higher than the phenotypic correlations, revealing the influence of environment. Grain yield per plot showed significant positive association with plant height, productive tillers/plant and grain yield per plant. The association was the strongest with grain yield per plant. Similar results have been reported by Reddy and Sharma (1982) and Navale *et al.* (1995). Productive tillers per plant also showed positive association with grain yield per plant, while plant height showed positive association with ear length and ear girth. Days to 50% flowering had significant negative association with grain yield, indicating that simultaneous selection for earliness and grain yield per plot was possible. Reddy and Sharma (1982) and Navale *et al.* (1995) also reported negative association between these characters. It was further observed that under non-stress environment,

Table 1. Phenotypic and genotypic (in parentheses) correlations under non-stress conditions in pearl millet

Character	Plant height	Tillers/plant	Days to flowering	Ear length	Ear girth	Grain yield/plant	Grain yield/plot
Early vigor	0.184 (0.712)	-0.009 (-0.490)	-0.251 (0.055)	0.158 (0.798)	0.098 (1.043)	0.093 (0.282)	0.176 (0.492)
Plant height		0.035 (-0.183)	0.162 (0.274)	0.635** (0.635)	0.336* (0.189)	0.187 (0.194)	0.307 (0.357)
Tillers/plant			-0.230 (-0.411)	0.060 (-0.153)	-0.052** (-0.560)	0.581** (0.638)	0.435* (0.503)
Days to flowering				0.125 (0.215)	0.047 (-0.066)	-0.175 (-0.206)	-0.320* (-0.431)
Ear length					0.237 (-0.031)	0.191 (0.258)	0.201 (0.292)
Ear girth						0.035 (-0.059)	0.162 (0.120)
Grain yield/plant							0.688** (0.797)

*, ** Significant at 5 and 1% level of probability, respectively.

Table 2. Phenotypic and genotypic (in parentheses) correlations under stress conditions in pearl millet

Character	Plant height	Tillers/plant	Days to flowering	Ear length	Ear girth	Grain yield/plant	Grain yield/plot
Early vigor	0.411* (0.961)	0.078 (0.139)	-0.196 (0.123)	0.232 (0.581)	0.269* (0.734)	0.272* (0.734)	0.340* (0.731)
Plant height		0.146 (0.183)	-0.210 (-0.024)	0.659** (0.711)	0.414* (0.210)	0.318* (0.382)	0.357* (0.404)
Tillers/plant			-0.348 (-0.609)	0.134 (0.335)	0.057 (-0.250)	0.587** (0.690)	0.333* (0.433)
Days to flowering				-0.101 (0.124)	-0.142 (0.458)	-0.375* (-0.492)	-0.531** (-0.670)
Ear length					0.322* (-0.445)	0.279* (0.460)	0.155 (0.254)
Ear girth						0.239 (1.138)	0.262 (1.039)
Grain yield/plant							0.542** (0.622)

*, ** Significant at 5 and 1% level of probability, respectively.

only productive tillers per plant showed positive association, both with grain yield per plant as well as grain yield per plot, while most of the traits showed association with grain yield per plot.

Correlations under stress environment

Phenotypic and genotypic correlation coefficients under stress environments are given in Table 2. As observed under non-stress environment, genotypic correlation coefficients had higher values compared to phenotypic correlation coefficients. Early vigor score, which had no association with grain yield per plant or grain yield per plot under non-stress environment, showed positive significant association with plant height, grain yield per plant as well as grain yield per plot, indicating the importance of early vigor in crop growth and development and ultimately grain yield under stress environment. Plant height showed positive

significant association with ear length, ear girth, grain yield per plant and grain yield per plot. Productive tillers per plant were positively associated with grain yield per plant and grain yield per plot, but negatively associated with days to 50% flowering. Like stress environment, days to 50% flowering had negative significant association with grain yield, both at plant and plot level. Thus selection for higher grain yield and early types should be possible and is desirable in view of the short moisture availability period to this crop in the arid regions. Ear length was positively associated with ear girth and grain yield per plant, but not with grain yield per plot. Unlike non-stress environment, most of the component traits showed association both with grain yield per plant as well as grain yield per plot. Grain yield per plant had strong positive association with grain yield per plot under both stress and non-stress environments.

Table 3. Direct (diagonal) and indirect effects of various traits on grain yield/plot under non-stress and stress (in parenthesis) conditions in pearl millet

Character	Early vigor	Plant height	Tillers/plant	Days to flowering	Ear length	Ear girth	Grain yield/plant
Early vigor	0.019 (0.118)	0.044 (0.092)	0.000 (-0.002)	0.060 (0.068)	-0.009 (-0.036)	0.008 (NE)	0.054 (0.099)
Plant height	0.004 (0.048)	0.240 (0.224)	0.001 (-0.003)	-0.039 (0.073)	-0.038 (-0.101)	0.029 (NE)	0.109 (0.116)
Tillers/plant	0.000 (0.009)	0.008 (0.033)	-0.041 (-0.023)	0.055 (0.121)	-0.004 (-0.021)	-0.005 (NE)	0.339 (0.214)
Days to flowering	-0.005 (-0.023)	0.039 (-0.047)	-0.010 (0.008)	-0.239 (-0.347)	-0.007 (0.015)	0.004 (NE)	-0.102 (-0.137)
Ear length	0.003 (0.027)	0.152 (0.148)	0.002 (-0.003)	-0.003 (0.035)	-0.059 (-0.153)	0.020 (NE)	0.112 (0.102)
Ear girth	0.002 (NE)	0.080 (NE)	-0.002 (NE)	-0.011 (NE)	-0.014 (NE)	0.086 (NE)	0.021 (NE)
Grain yield/ plant	0.002 (0.032)	0.045 (0.071)	0.024 (-0.014)	0.042 (0.130)	-0.011 (-0.043)	0.003 (NE)	0.584 (0.365)

NE = Not estimated, as differences among genotypes for ear girth were non-significant under stress; Residual (non-stress) = 0.4248; Residual (stress) = 0.5296.

Path analysis

Direct and indirect effects of component traits on grain yield per plot and grain yield per plant are given in Table 3 and 4, respectively. As is evident from Table 3, grain yield/plant had the highest positive direct effect on grain yield/plot. These two traits were also strongly associated with each other. Days to 50% flowering had high negative direct effect on grain yield per plot. Productive tillers per plant did not show direct influence over grain yield per plot, rather it influenced grain yield per plot via grain yield per plant. Other traits which had poor direct effects influenced grain yield per plot indirectly via grain yield per plant.

Keeping grain yield per plant as dependent variable, it was observed that under both environments productive tillers per plant had the highest positive direct effect on grain yield per plant. These two

traits also had very strong and positive association with each other in both environments. Thus, yield per plant can be improved by selecting for higher number of productive tillers per plant. Early vigor, plant height and ear length, which showed positive association with grain yield per plant under stress environment, also had positive direct effects on grain yield per plant and hence their role in improving grain yield under stress environment.

The study revealed that while plant height, productive tiller per plant and earliness were useful in improving grain yield per plot in pearl millet under non-stress environment, it was early vigor, plant height, productive tiller and earliness that were more important under stress environment. Therefore, emphasis should be given to these traits while selecting for high grain yield under stress environment in pearl millet.

Table 4. Direct (diagonal) and indirect effects of various traits on grain yield/plant under non-stress and stress conditions (in parentheses) in pearl millet

Character	Early vigor	Plant height	Tillers/plant	Days to flowering	Ear length	Ear girth
Early vigor	0.047 (0.146)	-0.021 (-0.034)	-0.005 (0.039)	0.016 (0.028)	0.013 (0.025)	0.000 (NE)
Plant height	0.009 (0.060)	0.115 (0.083)	0.019 (0.073)	-0.010 (0.030)	0.054 (0.072)	0.001 (NE)
Tillers/plant	0.000 (0.011)	0.004 (0.012)	0.557 (0.449)	0.015 (0.050)	0.005 (0.015)	0.000 (NE)
Days to flowering	-0.012 (-0.029)	0.019 (-0.017)	-0.128 (-0.173)	-0.065 (-0.144)	0.011 (-0.011)	0.000 (NE)
Ear length	0.007 (0.034)	0.073 (0.054)	0.033 (0.067)	-0.008 (0.015)	0.085 (0.109)	0.001 (NE)
Ear girth	0.005 (NE)	0.039 (NE)	-0.029 (NE)	-0.003 (NE)	0.020 (NE)	0.004 (NE)

NE = Not estimated, as differences among genotypes for ear girth were non-significant under stress; Residual (non-stress) = 0.6227; Residual (stress) = 0.5569.

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