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RELATIONSHIP AMONG YIELD COMPONENTS AND SELECTION CRITERIA IN LATE SOWN CONDITION FOR YIELD IMPROVEMENT IN PEARL MILLET [*PENNISETUM GLAUCUM* (L.) R. BR.]

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ABSTRACT
To study of genetic variability, correlation among the yield components and their direct and indirect effects on grain yield. Analysis of variance revealed highly significant difference for all the characters except number of tillers per plant. High GCV and PCV was observed for test weight (25.88, 25.98) followed by grain yield per plant (22.15, 26.24). High heritability coupled with high genetic advance was recorded for test weight and grain yield per plant. The character association revealed highly significant positive association of grain yield per plant with plant height ($r_{g=}$ 0.411, r_p = 0.351), panicle length ($r_{g=}$ 0.279, r_p = 0.259), biological yield per plant ($r_{g=}$ 0.420, r_p = 0.332) and harvest index ($r_{g=}$ 0.924, r_p = 0.708) at both levels. Path coefficient analysis revealed high positive direct effect on harvest index followed by biological yield per plant, days to maturity and panicle length at both levels. These yield components may be good selection criteria to improve grain yield in pearl millet.

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an annual and cross pollinated crop, have chromosome number of 2n = 14. The term millet is brooding applied over 140 species belonging to the Genus *Pennisetum* (Stoskopf *et al*., 1985). It is sown as a dual purpose crop across a wide range of semi arid regions of the world, where it is the stable food for millions of people. Today millet cover the food needs for more than 500 million people, areas planted primarily with millet are estimated by 15 m ha annually in Africa and 14 m ha in Asia (Rai *et al.,* 2007). The crop is grown commonly under the most difficult farming conditions, including those in drought –stricken areas, where soil fertility is low and food supplies are dependent on rainfall. Pearl millet growing in areas suffers from erratic rainfall which has high variability within and between years (Vanderlip, 1991). The short rainy season and fluctuation in rainfall expose the crop to drought stress; therefore, there is a need to breed for drought tolerant and early maturing cultivars. Grain yield as a character in pearl millet as well as in all crop plants is quantitative in nature and is poly genetically controlled. Selection on the basis of grain yield character alone is usually not very effective and efficient. However, selection based on its components and secondary characters could be more efficient and reliable. The progress of selection is more important in any crop improvement and this progress is depends on the existence of genetic variability for yield and yield contributing characters and their heritability (Allard, 2000). Heritability in conjunction with genetic advance has a greater role to play in determining the effectiveness of selection of a character (Berwal *et al.,* 1997). Knowledge of the association and interrelationship between yield and its components and among the component characters themselves can improve the efficiency of selection in plant breeding (Izge *et al*., 2006). Therefore, the present study was conducted to assess genetic variability, correlation and path analysis among pearl millet genotypes to determine criteria for selection that could be effectively used to identify the desirable genotypes with high yield potential.

MATERIALS AND METHODS

The present investigation comprised selected ten inbred *viz.*, 26-30, 31-40, 41-50, RIB-20, 61-70, 71-75, 75-80, 51-60, RIB-135-144 and 101-105 were crossed in a diallel fashion excluding reciprocals during *kharif* season 2011. These ten parents and their 45F_1's were evaluated in RBD with three replications at Agronomy Farm, Jobner (Jaipur) during 28th July, 2012. Each entry was sown in a two row of 5.0m length with row-to-row and plant-to-plant distances of 45 cm and 15 cm, respectively. The observation were recorded on five randomly selected plants from each replication and genotypes, for the characters namely; days to 50 percent flowering, days

to maturity, number of tillers per plant, plant height, panicle length, panicle girth, biological yield per plant, dry fodder yield per plant, grain yield per plant, harvest index, test weight and protein content while, days to 50% flowering and days to maturity were recorded on plot basis. All the recommended agronomic cultural practices and plant protection measures were followed. Replication wise mean data for each character were subjected for analysis of variance (Singh and Choudhary, 1995), coefficient of variance (Burton, 1953), heritability in board sense (Johnson *et al.,* 1955), genetic advance (Johnson *et al.*, 1955), correlation (Searle *et al.*, 1961) and Path analysis (Sewall Wright, 1921 and Deway and Lu., 1959) were calculated as per statistical method.

RESULTS AND DISCUSSION

The analysis of variance revealed that the highly significant differences for all the characters except number of tillers per plant and the experimental materials were genetically divergent from each other (Table 1). This indicates that there is ample scope for selection of promising genotypes to enhancing genetic yield potential of Pearl millet. A broad range of variation was observed for grain yield per plant (3.62-14.80), plant height (65.2-183), days to 50% flowering (45.33-57.67), panicle length (9.23-24.69), panicle girth (2.44-7.23), test weight (3.11-8.12), harvest index (11.47-28.04) and biological yield per plant (32-79.47) (table 2). Maximum phenotypic coefficient of variance (PCV) was observed for dry fodder yield per plant (29.53%) followed by harvest index (27.47%), grain yield per plant (26.24%), test weight (25.98%), biological yield per plant (21.68%), panicle length (21.42%) and panicle girth (20.28%) and minimum for days to maturity (5.37%) and days to 50% flowering (6.60%). The genotypic coefficient of variance (GCV) was also maximum for test weight (25.88%) followed by grain yield per plant (22.15%), harvest index (20.31%), plant height (15.77%), panicle girth (15.52%), dry fodder yield per plant (15.28%) and panicle length (14.60%) and minimum for days to maturity (4.31%), productive tillers per plant (4.81%) and days to 50% flowering (6.21%). Similar results were found by Vetriventhan and Nirmala kumari (2007) and Singh *et al.* (2014).

The higher PCV and GCV values for most of the characters could be evidence for the existence of a wide range of variation for such characters. In general, the PCV values for most characters were closer than the corresponding GCV values showing little environment effect on the expression of these characters. Selection on a phenotypic basis may be effective for the genetic improvement of such traits. High heritability values were exhibited for test weight (99.18%), plant height (97.39%), protein content (96.55%), days to 50% flowering (88.36%) and grain yield per plant (71.27%) showed that these characters were governed by additive genes. High heritability related to grain yield per plant, days to maturity, plant height and protein content were obtained in the studied conducted previously (Bhoite *et al.,* 2008 and Meena kumari and Naga rajan, 2008). The high heritability magnitude indicates the reliability with which the high chance of the genotype to be recognized by its phenotypic expression (Bhoite *et al.,* 2008). Moderate heritability value were observed for panicle girth (58.59%) and harvest index (54.69%) and low heritability

value was observed for productive tillers per plant (11.62%), dry fodder yield per plant (26.78%), biological yield per plant (29.16%) and panicle length (46.45%) suggesting selection for these characters would not be effective due to predominant

Table 1: Analysis of variance for different characters in pearl millet

Source of variance (g)	d.f.	Days to 50%flowering	Days to maturity	Productive tillers per plant	Plant height (cm)	Panicle length (cm)	Panicle girth (cm)	Biological yield per plant (g)	Dry fodder yield per plant (g)	Harvest index (%)	Test weight (g)	Protein content (%)	Grain yield per plant
Replication	2	3.32	8.01	0.05	58.61	1.86	0.95	107.04	47.94	3.84	0.02	0.17	5.48
Treatment	54	31.29**	41.22**	0.03	1319.85**	27.65**	1.69**	230.28**	154.90**	57.17**	5.41**	6.02**	17.82**
Error	108	1.32	6.42	0.02	11.67	7.67	0.32	103.02	73.86	12.37	0.01	0.07	2.11
S.Em+		0.66	1.46	0.08	1.97	1.6	0.33	5.86	4.96	2.03	0.07	0.15	0.84
C.D. at 5%		1.86	4.10	0.23	5.53	4.48	0.92	16.43	13.91	5.69	0.20	0.43	2.35

** Significant at 1% level

Table 2: Estimation of parameters of Mean, range, Coefficient of Variability, Heritability and Genetic advance for different character in pearl millet

Parameters /Characters		Days to 50% flowering	Days to maturity	Productive tillers per plant	Plant height (cm)	Panicle length (cm)	Panicle girth (cm)	Biological yield per plant (g)	Dry fodder yield per plant (g)	Harvest index (%)	Test weight (g)	Protein content (%)	Grain yield per plant (g)
Mean		50.9	79.01	1.07	132.39	17.67	4.35	55.61	34	19.02	5.18	11.18	10.33
Range		45.33-57.67	70.67-85	1-1.47	65.2-183	9.23-24.69	2.44-7.23	32-79.47	21.27-59.07	11.47-28.04	3.11-8.12	8.23-13.54	3.62-14.80
C.V.%		2.25	3.21	13.27	2.58	15.68	13.05	18.25	25.27	18.49	2.34	2.38	14.07
Variance	s^2g	9.33	11.6	-0.01	420.13	8.6	0.25	41.08	35.65	17.78	1.79	4.11	1.95
	s^2p	9.79	13.78	0	424.02	11.16	0.35	75.42	60.27	21.9	1.8	4.82	1.98
	s^2e	0.44	2.14	0.01	3.89	2.56	0.11	34.34	24.62	4.12	0.004	0.7	0.02
Coefficient	GCV	6.21	4.311	4.814	15.773	14.602	5.529	11.712	15.285	20.318	25.881	22.158	12.603
of variance	PCV	6.606	5.373	14.121	15.982	21.423	20.287	21.687	29.537	27.472	25.987	26.246	12.826
Heritability (%)		88.36	64.37	11.62	97.39	46.45	58.59	29.16	26.78	54.69	99.18	96.55	71.28
Genetic advance (G.A.)		6.121	5.629	0.036	42.453	3.623	1.064	7.246	5.541	5.887	2.751	2.851	3.98
G.A. over mean %		12.03	7.13	3.38	32.06	20.5	24.48	13.03	16.29	30.95	53.09	25.51	38.53

Table 3: Genotypic (r_g) and Phenotypic (r_p) correlation coefficient among yield and its component under study in pearl millet

Characters	r	Days to 50%flowering	Days to maturity	Productive tillers per plant	Plant height	Panicle length	Panicle girth	Biological yield per plant	Dry fodder yield per plant	Harvest plant	Test weight	Protein content	Grain yield per plant
Days to 50% flowering	r_g	-	0.906**	0.460**	-0.257**	-0.270**	-0.003	-0.063	0.039	-0.054	-0.209**	-0.100	-0.113
	r_p	-	0.704**	0.161*	-0.233**	-0.151	0.024	-0.028	0.001	-0.035	-0.199*	-0.094	-0.101
Days to maturity	r_g		-	0.034	-0.136	-0.085	0.183*	-0.116	-0.067	-0.083	-0.293**	0.053	-0.143
	r_p		-	0.138	-0.125	-0.047	0.121	-0.034	-0.056	-0.045	-0.239**	0.046	-0.074
Productive tillers per plant	r_g			-	0.298**	-0.220**	0.173*	0.733**	1.00**	-0.388**	0.206**	-0.216**	-0.185*
	r_p			-	0.106	0.104	0.091	0.326**	0.367**	-0.134	0.058	-0.082	0.050
Plant height	r_g				-	0.718**	0.377**	0.934**	0.755**	0.009	0.061	-0.002	0.411**
	r_p				-	0.527**	0.290**	0.533**	0.424**	-0.014	0.060	-0.004	0.351**
Panicle length	r_g					-	0.314**	0.530**	0.164*	0.067	0.286**	0.296**	0.279**
	r_p					-	0.285**	0.461**	0.327**	-0.092	0.190*	0.209**	0.259**
Panicle girth	r_g						-	0.240**	0.162*	-0.124	0.218**	0.144	-0.019
	r_p						-	0.224**	0.175*	-0.077	0.166*	0.107	0.079
Biological yield per plant	r_g							-	0.916**	0.046	0.141	-0.142	0.420**
	r_p							-	0.920**	-0.398**	0.078	-0.075	0.332**
Dry fodder yield per plant	r_g								-	-0.319**	0.098	-0.229**	0.039
	r_p								-	-0.565**	0.050	-0.107	0.082
Harvest index	r_g									-	0.073	0.117	0.924**
	r_p									-	0.048	0.084	0.708**
Test weight	r_g										-	0.197*	0.101
	r_p										-	0.193*	0.085
Protein content	r_g											-	0.061
	r_p											-	0.047
Grain yield per plant	r_g												-
	r_p												-

** and * significant at 1% and 5% level, respectively

Table 4: Genotypic (G) and Phenotypic (P) path coefficient analysis showing direct and indirect effect of eleven components on grain yield per plant in pearl millet

Characters	Path	Direct effect	Days to 50%flowering	Days to maturity	Productive tillers per plant	Plant height	Panicle length	Panicle girth	Biological yield per plant	Dry fodder yield per plant	Harvest index	Test weight	Protein content
Days to 50%	G	-1.032	-	0.774	0.043	0.244	-0.086	0.000	-0.045	0.015	-0.057	0.025	0.008
flowering	P	-0.077	-	0.024	-0.007	0.016	-0.002	0.000	-0.026	0.000	-0.034	0.006	-0.001
Days to maturity	G	0.854	-0.935	-	0.003	0.129	-0.027	0.000	-0.083	-0.025	-0.089	0.034	-0.004
	P	0.035	-0.054	-	-0.006	0.009	-0.001	0.000	-0.032	0.011	-0.043	0.007	0.000
Productive	G	0.093	-0.475	0.029	-	-0.282	-0.070	0.000	0.526	0.417	-0.415	-0.024	0.017
tillers per plant	P	-0.041	-0.012	0.005	-	-0.007	0.001	0.000	0.306	-0.070	-0.130	-0.002	-0.001
Plant height	G	-0.949	0.266	-0.116	0.028	-	0.229	0.000	0.670	0.282	0.009	-0.007	0.000
	P	-0.069	0.018	-0.004	-0.004	-	0.007	0.000	0.501	-0.081	-0.014	-0.002	0.000
Panicle length	G	0.319	0.278	-0.073	-0.020	-0.681	-	0.000	0.381	0.061	0.071	-0.034	-0.023
	P	0.013	0.012	-0.002	-0.004	-0.036	-	0.000	0.433	-0.062	-0.089	-0.006	0.001
Panicle girth	G	0.000	0.003	0.157	0.016	-0.358	0.100	-	0.172	0.060	-0.132	-0.026	-0.011
	P	-0.001	-0.002	0.004	-0.004	-0.020	0.004	-	0.210	-0.033	-0.075	-0.005	0.001
Biological	G	0.717	0.065	-0.099	0.068	-0.887	0.169	0.000	-	0.343	0.049	-0.017	0.011
yield per plant	P	0.939	0.002	-0.001	-0.013	-0.037	0.006	0.000	-	-0.175	-0.386	-0.002	0.000
Dry fodder	G	0.374	-0.040	-0.057	0.104	-0.717	0.052	0.000	0.657	-	-0.341	-0.011	0.018
yield per plant	P	-0.191	0.000	-0.002	-0.015	-0.029	0.004	0.000	0.864	-	-0.547	-0.001	-0.001
Harvest index	G	1.067	0.055	-0.071	-0.036	-0.008	0.021	0.000	0.033	-0.119	-	-0.009	-0.009
	P	0.969	0.003	-0.002	0.005	0.001	-0.001	0.000	-0.374	0.108	-	-0.001	0.001
Test weight	G	-0.118	0.216	-0.250	0.019	-0.058	0.091	0.000	0.101	0.036	0.078	-	-0.015
	P	-0.029	0.015	-0.008	-0.002	-0.004	0.002	0.000	0.074	-0.010	0.047	-	0.001
Protein content	G	-0.078	0.103	0.045	-0.020	0.002	0.095	0.000	-0.102	-0.085	0.125	-0.023	-
	P	0.006	0.007	0.002	0.003	0.000	0.003	0.000	-0.071	0.020	0.081	-0.006	-

Residual Effect (G) = 0.038 and (P) = 0.037

effects of non additive genes in this population. Maximum genetic advance over mean % was observed on test weight (53.09) followed by grain yield per plant (38.53), plant height (32.06) and harvest index (30.95) indicating the presence of additive gene effects; while the same was minimum for productive tillers per plant (3.38), days to maturity (7.12), days to 50% flowering (12.02), biological yield per plant (13.03) and dry fodder yield per plant (16.29). High heritability coupled with high genetic advance over mean percent was recorded for test weight, grain yield per plant, protein content, plant height and harvest index indicated that improvement in this trait could be done through selection feasible indicating selection for these characters would be more effective. Phenotypic and genotypic correlation coefficient of seed yield

per plant with other characters is presented in table 3. Grain yield per plant had significant positive association with plant height ($r_{g=}$ 0.411, r_p = 0.351), panicle length ($r_{g=}$ 0.279, r_p = 0.259), biological yield per plant ($r_{g=}$ 0.420, r_p = 0.332) and harvest index ($r_{g=}$ 0.924, r_p = 0.708) and negative association with days to 50% flowering ($r_{g=}$ - 0.101, r_p = -0.113) and days to maturity ($r_{g=}$ -0.074, r_p = - 0.143) at both genotypic and phenotypic levels indicating that these are the major yield attributing traits. The negative association of grain yield per plant with days to 50% flowering and days to maturity suggested that early maturity genotypes would give high grain yield. Similar results were observed by (Ezeaku and Mohammed, 2006; Izge *et al*., 2004; Arun kumar, 2013 and Kalpande *et al.,* 2015). The genotypic correlation coefficient value for most of the characters were higher in magnitude than the corresponding phenotypic values showing the existence of inherent association among the traits. The path coefficient analysis was done with twelve characters using estimates of direct and indirect effects of eleven characters on grain yield per plant based on phenotypic and genotypic correlation coefficient (table 4). High and positive phenotypic and genotypic direct effects on harvest index was exhibited by grain yield per plant (0.969, 1.067) followed by biological yield per plant (0.939, 0.717), days to maturity (0.035, 0.854) and panicle length (0.013, 0.319). Positive direct effect of days to maturity, panicle length, biological yield per plant and harvest index associated with positive correlation with grain yield per plant suggested that these yield components may be good selection criteria to improve grain yield of Pearl millet. Similar results were found (Ezeaku and Mohammed, 2006; Izge *et al*., 2004; Arunkumar, 2013 and Kalpande *et al.,* 2015). Residual effect was found to be 0.038 for genotypic level and 0.037 for phenotypic level showing the variability in the grain yield in Pearl millet was contributed by the characters studied in path analysis.

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