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PATH COEFFICIENT ANALYSIS IN LOCAL PEARL MILLET GERMPLASM FOR GRAIN MINERALS AND AGRONOMIC CHARACTERS

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ABSTRACT

Path coefficient analysis for grain minerals and quality traits affecting grain yield was accomplished in 61 indigenous germplasm lines of pearl millet. Maximum direct effect on grain yield was contributed by crude fat content which is positive and highly significant ($P < 0.01$) followed by number of productive tillers ($P < 0.01$), hundred grain weight and panicle length ($p<0.05$). The rest of the yield attributes showed moderate to low positive direct effect on grain yield plant^{-1}. Productive tillers per plant, panicle length, 100-grain weight and crude fat content had positive and significant indirect effect on grain yield. These results interestingly showed that either higher grain yield or seed weight often have higher crude fat content which increased the feed value in poultry farms. It was also noted that, breeding for high grain minerals as well as other quality characters did reduce the yield potential of the cultivars.

Key words: Path co-efficient, Germplasm, Pearl millet, Minerals, Yield.

INTRODUCTION

Pear millet is a staple food source for millions of African families as well as parts of Western India families living in the Semi Arid Tropics (SAT) regions. Despite its importance and ability to provide consistent yields, very little research and resources have been directed towards understanding genetic principle and its incorporation to its breeding programme. This cereal crop contributes significantly to food and nutritional security of the rural and urban poor people in drier areas where it is valued equally for its grain and fodder purposes (Khairwal *et al.* 2007). Nearly 50 per cent of the millet area is now under hybrid cultivars, for instance pearl millet grown on 9 mha of which open-pollinated varieties (OPV) just 11% (0.9 mha) of area and rest of them under hybrids. To tailor the yield potential of the crop, plant knowledge on associations among components traits is pre-request for achieving genetic improvement in any crop (Chaudhry *et al.* 2003). The complex nature of yield is associated with a number of component characters which are interrelated among them. Such interdependence of the contributory factors often affects their direct relationship with yield, thereby making correlation coefficients unreliable as selection indices (Khairwal *et al.*, 1999).

The path analysis revealed that, total productive tillers had positive direct effect followed by earhead girth and plant height on grain yield, thus, direct selection for these traits could be rewarding for the improvement of grain yield (Vetriventhan and Nirmalakumari, 2007). Earlier workers Poongodi and Palanisamy (1995), Santhose (2002) and Salunke *et al.* (2006) reported the similar finding. Arulselvi *et al.* (2008) reported that 1000 grain weight has positive direct effect on grain yield, whereas plant height had negative direct effect on grain yield. Ear head girth had positive indirect effect on grain yield through earhead length followed by 1000 grain weight. Plant height exerted positive indirect effect through earhead length towards grain yield. The negative indirect effect was observed in days to 50 per cent flowering through 1000 grain weight on grain yield, and 1000 grain weight through days to 50 per cent flowering (Arulselvi *et al.*, 2008, Khairwal *et al.* (1990), Anarase *et al.*, (2001) and Manojkumar *et al.* (2002). Further, path-coefficient

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analysis revealed that 1000-grain weight, fodder yield per plant, ear girth, plant height, number of grains per cm^2 and total and effective tillers per plant contributed directly and positively to their correlations with grain yield (Anarase, 1995). These findings revealed that selection on the basis of direct and indirect effects was more useful than selection for yield *per se.* However, the knowledge on interrelationship between grain minerals and grain yield was limited in pearl millet, therefore, to determine yield attributing characters on grain yield the present study was conducted to investigate direct and indirect effect of componential traits on grain yield.

MATERIALS AND METHODS

Sixty one indigenous pearl millet germplasm were selected from the germplasm collection maintained by Millet Breeding Station (MBS) earlier and now held by Department of Plant Genetic Recourses at Tamil Nadu Agricultural University (TNAU), Coimbatore were used in the present study. These entries were planted during the rainy season 2006 in a randomized complete block design (RCBD) under the prevailing environmental conditions at the MBS, TNAU, Coimbatore which lies between 11° North latitude and 77° East longitude. All the genotypes were sown in a RCBD with three replications. In each replication, 61 genotypes were grown in 4m long rows with the spacing of 60cm between rows and 15 cm between the plants. Initially, extra seed was planted (three to four seeds/hill) and later the plants were thinned to maintain an optimum population density (20-25 plants/ plot). The crop was grown under uniform conditions to minimize environmental variability to the maximum possible extent. The Data were recorded on randomly selected five plants in each plot at each replication for eight morphological (Days to 50% flowering, plant height (cm), number of productive tillers per plant, ear head length (cm), ear head girth (mm), days to maturity, 100 grain weight (g), grain yield per plant (g)) and seven grain nutritional quality traits (protein (%), crude fat (%), calcium (mg), phosphorus (mg), phytic acid (mg), iron (mg) and zinc (ug)).

After thrashing, cleaning and weighing, the grains from each entry were dried in hot air oven at 60^0 C for 6 hours. The grains were then ground in Willey mill separately, and labeled properly and were stored in butter paper cover for further analysis. The crude protein content was estimated using method suggested by Humphries (1956). The crude fat determined by Soxhlet apparatus with petroleum ether (A.O.A.C., 1960). Phytic acid estimation was done based on the method of Wheeler and Fernel (1971), estimation of calcium in pearl millet grain sample following versenate titration method as suggested by Jackson (1973). Phosphorous from the grain sample was determined as per Vanadomolybdo phosphoric yellow color method of Piper (1966). Finally, the iron and zinc estimation were done by using Atomic Absorption Spectrophotometer by following the method proposed by Jackson (1973). The path coefficient was worked out by the method suggested by Dewey and Lu (1959) using WindoStat Statistical Package. By keeping yield as dependent variable and the other fourteen traits as independent variables, simultaneous equations which expressed the basic relationship between the path coefficients were solved to arrive the direct and indirect effects contributed by fourteen traits on yield by themselves and also through other traits.

RESULTS AND DISCUSSION

The direct and indirect effects of all the traits on grain yield were partitioned from the genotypic correlation matrix by path analysis and were carried out using coefficient of all the traits with grain yield plant per plant (Table1). In this study, the response variable grain yield (GY) and fourteen predictor variables, path analysis was possible to rank plant characteristics according to magnitude of their effect on grain yield. Present study revealed that, maximum direct effect on grain yield was contributed mostly by number of productive tillers (0.666; $P<0.01$), crude fat content (0.714; $P < 0.01$) followed by hundred grain weight (0.626; $P<0.05$) and panicle length (0596; $p<0.05$) which is positive and highly significant. The results of present investigation agree those of with Virk, (1988); Anarase, (1995); Vetriventhan and Nirmalakumari (2007); Arulselvi *et al.* (2008) for number of productive tiller. Vetriventhan and Nirmalakumari (2007); Arulselvi *et al.* (2008) for panicle length, Anarase, (1995);

TABLE 1. Direct (diagonal values) and indirect effects of fourteen traits on grain yield in pearl millet.

Characters	DTF	PH (cm)	PTP (No.)	PL (cm)	PG (cm)	DTM	100GW (g)	CP (%)	CF (%)	Pp (mg)	P (mg)	Ca (mg)	Fe (mg)	Zn (ug)	GYP (g)
DTF	0.078	0.028	0.025	0.002	0.005	0.011	-0.020	0.009	-0.011	-0.010	-0.005	0.008	-0.002	0.001	0.056
PH (cm)	0.003	0.010	0.003	0.002	0.001	0.003	0.001	0.002	0.001	-0.001	-0.001	-0.001	0.000	0.001	0.229
PTP (No.)	0.112	0.092	0.347	0.179	0.014	0.091	0.081	0.084	0.144	0.038	0.010	0.067	-0.011	-0.014	0.666**
PL (cm)	0.002	0.018	0.047	0.091	0.035	0.034	0.026	0.026	0.039	0.028	0.008	0.006	-0.016	-0.014	0.596*
PG (cm)	0.011	0.017	0.006	0.060	0.156	0.032	-0.005	0.059	0.036	-0.031	-0.045	-0.031	-0.022	-0.007	0.311
DTM	-0.024	-0.052	-0.042	-0.060	-0.033	-0.161	-0.068	-0.033	-0.035	-0.033	-0.029	-0.020	0.026	0.021	0.320
100GW (g)	-0.128	0.025	0.114	0.138	-0.016	0.206	0.488	-0.023	0.339	0.050	0.083	0.064	-0.092	-0.078	0.626*
CP (%)	0.032	0.047	0.065	0.076	0.100	0.055	-0.012	0.266	-0.022	0.018	0.023	-0.022	-0.038	-0.019	0.370
CF (%)	-0.030	0.028	0.089	0.092	0.050	0.047	0.149	-0.018	0.214	0.012	0.008	0.017	0.001	0.002	0.714**
Pp (mg)	-0.016	-0.015	0.013	0.037	-0.024	0.024	0.012	0.008	0.007	0.119	0.101	0.019	-0.014	-0.021	0.097
P (mg)	0.006	0.007	-0.002	-0.008	0.024	-0.015	-0.014	-0.007	-0.003	-0.071	-0.084	-0.022	0.006	0.011	0.058
Ca (mg)	0.004	-0.002	0.008	0.003	-0.008	0.005	0.006	-0.004	0.003	0.007	0.011	0.042	0.000	-0.006	0.093
Fe (mg)	0.003	0.001	0.004	0.021	0.017	0.019	0.022	0.017	0.000	0.014	0.008	-0.001	-0.117	-0.107	-0.064
Zn (ug)	0.003	0.026	-0.009	-0.036	-0.011	-0.031	-0.038	-0.017	0.002	-0.041	-0.030	-0.034	0.215	0.235	0.005

Residual effect - 0.368   * - Significance at 1% probability level   ** - Significance at 1% probability level

Days to 50 % flowering (DTF); Plant height (PH); Productive tillers (PTP); Panicle length (PL); Panicle girth (PG); Days to maturity (DTM); Hundred grain weight (100GW); Grain yield per plant (GYP); Crude protein(CP); Crude fat (CF); Phytate phosphorus (Pp); phosphorus (P); Calcium (Ca); Iron (Fe) and Zinc (Zn).

Vetriventhan and Nirmalakumari (2007); Meena Kumari and Nagarajan, (2008) for seed weight and Hicks *et al.* (2002); Kriegshauser *et al.* (2006) for crude fat content on the grain weight. Hicks *et al.* (2002) demonstrated that large-seeded lines and their hybrids generally express higher crude protein and fat content and lower starch concentrations than conventional hybrids. The impact of these differences in seed size and composition increases the feed value in poultry industries in both developed and developing countries. The rest of the yield attributes showed moderate to negligible low positive direct effect on grain yield plant^{-1}. The nature of casual effects of independent variable on the dependent variable (grain yield) represented by the path diagram generated by using the path coefficient of each variable (Fig. 1). In case of grain mineral contents there were neither appreciable direct effects nor contrary negative effect on grain yield, indicating the possibility of simultaneous effective improvement of nutritional quality of grain and thus this might not reduce the productivity. This finding agree with that of Arulselvi *et al.* (2007), who reported grain yield

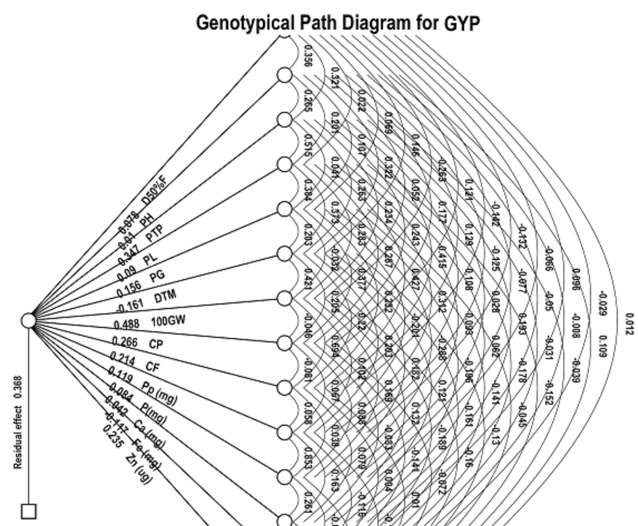

FIG. 1. Nature of causal system of variables for the path co-efficient analysis in pearl millet (both unilateral and bilateral path way), Days to 50 % flowering (D50%F); Plant height (PH); Productive tillers (PTP); Panicle length (PL); Panicle girth (PG); Days to maturity (DTM); Hundred grain weight (100GW); Grain yield per plant (GYP); Crude protein(CP); Crude fat (CF); Phytate phosphorus (Pp); phosphorus (P); Calcium (Ca); Iron (Fe) and Zinc (Zn).

has no correlation with grain minerals in pearl millet. The residual effect of 0.368 indicated the adequacy of the traits chosen for path analysis (Figure 1). However, about 37 per cent of variability was uncounted and there might be a few more componential characters other than those studied in the present investigation, which might have been accountable for manipulating the grain yield of pearl millet. Therefore selection on the basis of direct and indirect effects is much more useful than selection for yield per se alone.

The present investigation revealed that productive tiller^{-1}, panicle length, seed weight and fat content had significant positive direct effect on grain yield and these attributes could be utilized for selection in breeding programme. The remnant of characters had low direct or very low indirect effect via other characters on yield per plant. Interestingly, none of grain minerals and quality characters was not affecting the grain yield either way (positively or negatively) with exemption of crude fat. Hence improving grain minerals will not be compromising the yield potential of the cultivar and vice-versa.

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