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Correlation and path analysis studies for parents and F_1 crosses in barnyard millet [*Echinochloa frumentaceae* (Roxb.) Link] for nutritional characters

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ABSTRACT

Association analysis was studied in twenty F1 crosses and five parents of barnyard millet to find out the association of nutrient characters and their direct and indirect effects on single plant yield. The results exhibited that the nutrient traits are inter-related and improvement of yield will bring about the simultaneous improvement of the nutrient characters also. Total phenols and iron content recorded moderate positive direct effects on single plant yield. Total anti-oxidant activity and zinc content had low negative direct effects on single plant yield that were neutralized by positive indirect effects of other traits. The analysis revealed that the improvement of yield will simultaneously bring improvement on total phenols and iron content directly and on total anti-oxidant activity and zinc content indirectly.

Key words: Association analysis, F1 crosses, Iron content, Total anti-oxidant activity, Total phenols, Zinc content.

INTRODUCTION

Barnyard millet, fast growing crop in the dry land with minimum inputs has promising range of nutrient grains for the alleviation of micro nutrient deficiency in the developing countries around the world. In comparison to major food crop such as rice it has higher fiber content i.e., 9.8g/100g, fat content 5.8g/100g, calcium 14mg/100g, iron content 18.6mg/100g *etc*. Recent years have seen several food products being developed using grains of barnyard millet including flakes, biscuits, snacks, breads *etc*. (Joshi, 2013). Considering the importance of the crop for the present society, it is the requirement of the time to improve the nutritional quality of the crop along with the grain yield.

Correlation coefficient is a statistical measure which is used to find out the degree (strength) and direction of relationship between two or more variables. Correlation analysis is a tool which provides information on the magnitude and intensity of association among yield components and yield. Path coefficient analysis is simply a standardized partial regression coefficient, which splits the correlation coefficient into the measures of direct and indirect effects of a set of yield attributing characters on grain yield. The path coefficient analysis allows partitioning of correlation coefficients into direct and indirect contributions (effects) of various traits towards dependent variable and thus, helps in assessing the cause-effect relationship. The result of such association analysis aids in selection for the selected trait along with other important traits also. To decide upon the selection criteria, knowledge on correlation should be accompanied by the understanding of magnitude of contribution of direct and indirect effects. Hence, in the present study association of various characters is studied using correlation and path analysis.

MATERIALS AND METHODS

The material comprised of five parents *viz*., CO 2, ACM 145, ACM 161, ACM 331 and ACM 332 and 20 crosses (F_1 crosses) generated by crossing the five parents in full diallel mating design in the crossing block at the Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Tamil Nadu Agricultural Institute, Madurai during 2014. The F_1 crosses and the parents were analyzed for iron (Fe) and zinc (Zn) mineral content by triple acid extract method (Piper, 1966) and quantified in Atomic Absorption Spectrophotometer. The total phenol and total anti-oxidant activity in seeds of the F_1 crosses and the parents were analyzed by Folin Ciocalcetu and DPPH (2, 2-diphenyl-1-picrylhydrazyl) method, respectively. All the four nutritional analyses were replicated twice each. The data collected were analyzed for correlation co-efficient and path analysis using the following method.

Correlation analysis: The genotypic correlation between yield and its component traits and among themselves was worked out as per the method suggested by Johnson *et al.* (1955).

$$\text{Genotypiccorrelation coefficient } rg(xy) = \frac{COV.g_{(xy)}}{\sqrt{\sigma^2 g_x \times \sigma^2 g_y}}$$

Where,

rg(xy) = genotypic correlation coefficients,

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Cov.g(xy) = genotypic covariance between the traits 'x' and 'y',
σ2g.x = genotypic variance of the trait 'x',
σ2g.y = genotypic variance of the trait 'y',
x = independent variable x and
y = dependent variable y.

The significance of genotypic correlation coefficient was tested by referring to the standard table given by Snedecor and Cochran (1967).

Path coefficient analysis: Path coefficient analysis was carried out as suggested by Dewey and Lu (1959). The simple correlation coefficients already estimated at genotypic level were utilized for this purpose. By keeping yield as dependent variable and other yield attributing characters as independent variables, the following equations were formed and solved simultaneously for estimating the various direct and indirect effects.

r1y = p1Yr11 + p2Yr12 + p3Yr13 + …… + p6Yr16
r2y = p1Yr21 + p2Yr22 + p3Yr23 + …… + p6Yr26
.
.
r6y = p1Yr61 + p2Yr62 + p3Yr63 + …… + p6Yr66

Where,
1, 2 ……6 = Independent variables,
y = Dependent variable (grain yield per plant),
r1y, r2y….. r6y = coefficient of correlation between independent and dependent variables and
p1Y, p2Y ….p6Y = Coefficient of correlation between independent and dependent variable 'y'.

RESULTS AND DISCUSSION

The nutritional traits, total phenols and iron content had positive and significant association with yield (Table-1). The magnitude of phenotypic and genotypic correlation co-efficient for total phenols and iron content were 0.48 and 0.52 and 0.48 and 0.71 respectively. Total anti-oxidant activity and zinc content recorded non-significant correlation coefficients at both levels. Total phenols recorded positive and significant correlation coefficient with total anti-oxidant activity (0.54 and 0.57), iron content (0.34 and 0.45) and zinc content (0.51 and 0.62) at phenotypic and genotypic levels. Total anti-oxidant activity was positively and significantly correlated with zinc content (0.45 and 0.62) at phenotypic and genotypic levels. Phenotypic and genotypic correlation coefficient of iron content was positive and significant with zinc content (0.39 and 0.58). Zinc content had no association with any of the trait.

Total phenol content and iron content also correlated significantly and positively with single plant yield indicating that these nutritional traits would increase along with increasing yield. Govindaraj *et al.* (2009) in nutritional studies of finger millet revealed similar results of positive correlation between total phosphorus content and grain. Total phenols showed strong significant positive relationship with total anti-oxidant activity in F_1 grains. Dykes and Rooney (2006) observed in their experiment that total antioxidant capacity in a blend of rice, sorghum and soybean flour is due to the presence of vitamin E, carotenoids, and polyphenols.

The present study is in agreement with this statement indicating that increase in total phenols will increase the total anti-oxidant activity also. Ashrani *et al.*(2010) also reported that in cereals anti-oxidant activity increased with increase in carotenoids and polyphenols. Vanisha *et al.* (2011) reported in pearl millet that the micronutrient content in grains increase together with improvement and are inherited together to the further generation. In the present study, similar result was observed as the micronutrient iron exhibited significant positive association with zinc content indicating improvement of iron content and zinc content could be made together. In addition, total phenols showed strong positive relationship with iron and zinc contents and total anti-oxidant activity was significantly and positively related to zinc content only. Girish *et al.* (2014) also presented the idea of simultaneous improvement of micronutrients in minor millets due to their close association.

The path analysis showed that the direct effect of total phenols on single plant yield was positive and high (0.584). Total anti-oxidant activity exhibited negative direct effect on single plant yield (-0.338) while iron content and zinc content showed direct effect of 0.691 and -0.305 respectively on single plant yield. The nutrient traits also showed negative indirect effects through one another towards yield (Table 2).

Table 1: Phenotypic (above the diagonal) and genotypic (below the diagonal) correlation co-efficients among yield and nutrient traits

Character	Total Phenols (mg/100g)	Total anti-oxidant activity (mg/100g)	Fe (mg/100g)	Zn (mg/100g)	Single plant yield (g)
Total Phenols (mg/100g)	**1**	0.54*	0.34*	0.51*	0.48*
Total anti-oxidant activity (mg/100g)	0.57*	**1**	0.19	0.45*	-0.02
Fe (mg/100g)	0.45*	0.19	**1**	0.39*	0.48*
Zn (mg/100g)	0.62*	0.62*	0.58*	**1**	0.13
Single plant yield (g)	0.52*	-0.06	0.71*	0.25	**1**

Significant at 5%

Table 2: Direct and indirect effects as partitioned by phenotypic path analysis

Character	Total Phenols (mg/100g)	Total anti-oxidant activity (mg/100g)	F e (mg/100g)	Zn(mg/100g)	Single plant yield (g)
Total Phenols (mg/100g)	**0.584**	-0.193	0.313	-0.188	0.520*
Total anti-oxidant activity (mg/100g)	0.333	**-0.338**	0.133	-0.188	-0.060
Fe (mg/100g)	0.264	-0.065	**0.691**	-0.178	0.710*
Zn(mg/100g)	0.359	-0.208	0.403	**-0.305**	0.250

Residual effect= 0.531

Total phenols and iron content recorded positive direct effects on single plant yield and total anti-oxidant activity and zinc content had negative direct effects on single plant yield. Similar results were found in crude fat content, iron and zinc on grain yield of pearl millet in the study conducted by Govindaraj and Selvi (2012). However, total anti-oxidant activity and zinc content had positive correlation towards single plant yield. This may be attributed due to negative indirect effect.Total phenols recorded high positive indirect effect through iron content that compensated the negative indirect effects through total anti-oxidant activity and zinc content towards single plant yield. Similarly, Aml *et al.* (2012) reported traits with positive correlation between kernels per head and grain yield but negative indirect effects through 1000 grain weight in sorghum. Total anti-oxidant activity exhibited negative indirect effect through zinc content and positive indirect effect through total phenols and iron content. Iron content had positive indirect effect on single plant yield through total phenols and negative effects through total anti-oxidant activity and zinc content.

Zinc content recorded positive indirect effects through total phenols and iron content and negative indirect effect through total anti-oxidant activity on single plant yield. Similar results have also been reported earlier by Bello *et al.* (2010) inmaize in which the negative indirect value attributed by number of grains per ear are most likely be neutralized in most cases by the positive direct effects via other characters and *vice-versa*. Thus, selection has to be done considering the total of all the direct and indirect effects. The residual effect is low (<1) in the study indicates that most of the attributing character towards grain yield is included in the path analysis.From the traced out pathways, it is evident that the improvement of yield will simultaneously bring improvement on total phenols and iron content directly and on total anti-oxidant activity and zinc content indirectly.

CONCLUSION

Correlation studies revealed that single plant yield exhibited significant positive correlation with total phenol content and iron content. Selection for yield will also improve the total phenol content and iron content. All nutritional traits were inter-correlated among themselves. Total phenols and iron content recorded positive direct effects on single plant yield and total anti-oxidant and zinc content had negative direct effects on single plant yield. Thus, improvement of yield will simultaneously bring improvement on total phenols and iron content directly and on total anti - oxidant activity and zinc content indirectly.

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