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Identifying Key Yield and Quality Determinants in Finger Millet (*Eleusine coracana* (L.) Gaertn) through Correlation and Path Analysis

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ABSTRACT: A field experiment was conducted at Agricultural research station, Perumallapalle, Tirupati with 316 finger millet genotypes in an Augmented block design and observations were recorded for 16 yield and quality traits. Grain yield plant^{-1} is positively correlated with harvest index followed fodder yield plant^{-1}, finger number on main ear, productive tillers per plant^{-1}, ear head length and 1000 grain weight. Hence, there is an immense scope for selection for high-yielding finger millet genotypes with these associations and in contrary it showed a negative correlation with calcium content. The path analysis revealed that fodder yield plant^{-1}, followed by productive tillers plant^{-1}, ear head length, finger number on main ear and finger width showed positive direct effect on grain yield. The selection of these traits will be rewarding for the improvement of grain yield.

Keywords: Correlation, path analysis, Augmented block design and finger millet.

INTRODUCTION

Finger millet is an important staple crop known for its nutritional value and resilience to adverse environmental conditions. The quality traits of finger millet are of significant importance due to their direct impact on human nutrition and health. High-quality finger millet grains contribute to enhanced protein, calcium, iron, zinc, essential amino acids, dietary fiber, and minerals, making it a valuable crop for combating malnutrition and promoting overall well-being. Additionally, improved quality traits can enhance the versatility and value of finger millet-based products, potentially opening up new market opportunities for farmers and food industries. To enhance its productivity and nutritional quality, understanding the interrelationships between yield and quality traits is crucial. This study aims to explore the correlations between various yield and quality traits in finger millet and to identify key direct and indirect factors influencing yield and quality.

The grain yield is a complex trait and influenced by various traits. Understanding the interactions between yield and its contributing attributes can greatly improve the effectiveness of breeding programmes through the application of appropriate selection indices. After that, path coefficient analysis is done to assess each variable's respective direct and indirect influence on the yield. Path analysis is a statistical method that breaks down correlation coefficients into direct and indirect effects. It helps breeders to identify the specific contributions of independent traits to a dependent trait, enabling the selection of yield components through indirect means. By examining the relationships between different traits and their path coefficients, the optimal combination of yield-contributing traits for maximizing grain yield can be determined.

MATERIALS AND METHODS

In the study 316 finger millet germplasm lines were sown in an augmented design along with six checks. The design consists of 5 blocks and each contains 62 germplasm lines and six checks. The experiment was conducted at ARS, perumallapalle during *kharif*, 2022. Observations were recorded for 12 yield characters and 4 quality traits *viz*., days to maturity, plant height, number of productive tillers plant^{-1}, ear head length, finger number on the main ear, finger length, finger width, fodder yield plant^{-1}, grain yield plant^{-1}, 1000 grain weight, harvest index, protein, calcium, iron and zinc. The quality analysis of protein content was conducted using the Lowry's method, while calcium content was determined by titration with EDTA (Ethylenediaminetetraacetic acid). The assessment of iron and zinc content was carried out using the Di-acid method, and the readings were recorded using an Atomic Absorption Spectrophotometer (AAS). The correlation between all the characters under study is estimated according to the methods given by Searle

(1961). Path coefficients were obtained according to the procedure suggested by Wright (1921) sand as elaborated by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Correlation. Harvest index followed by fodder yield plant^{-1}, finger number on main ear, productive tillers plant^{-1}, ear head length and 1000 grain weight were strongly correlated with grain yield plant^{-1} indicating favourable gene associations for high grain yield in the present investigation (Table 1). Hence, there is an immense scope for selecting high-yielding finger millet genotypes with all desirable ear characters. These results were in accordance with Jadhav *et al*. (2015) in finger millet who reported significant positive association of 1000-seed weight, productive tillers plant^{-1}, number of fingers on main ear, finger length with grain yield plant^{-1}. Anuradha *et al*. (2017) also reported a positive association between 1000 - grain weight, number of productive tillers plant^{-1}, fodder yield plant^{-1} and panicle length towards grain yield plant^{-1}. In the present study, quality traits were not showed any significant positive association with grain yield. However, calcium content showed a significant negative correlation with grain yield which indicates selecting genotypes with high yield will result in low calcium genotypes. Further non-significant associations were noticed for the grain yield and quality traits studied indicating the ineffectiveness of simultaneous selection for yield and quality traits in finger millet.

Inter se associations among yield and nutrient traits. Harvest index had significant and positive correlation with finger number on main ear however it showed significant negative association with fodder yield plant^{-1}, plant height, calcium and iron content. Fodder yield plant^{-1} exhibited significant and positive correlation with productive tillers plant^{-1}, plant height, finger width and days to maturity. This association reveals that high fodder yield genotypes show late maturity with high number of productive tillers. The finger number on main ear positively correlated with ear head length and in contrast, it showed negative association with plant height. The association states that dwarf plants with lengthy ear heads produce high number of fingers per ear. The traits finger length, finger number on main ear, finger width, zinc content and plant height recorded significant and positive correlation with ear head length. This interaction revealed that the plants with long ear heads bear more fingers with significant finger length and width. Thousand grain weight has significant and positive association with grain yield plant^{-1} and fodder yield plant^{-1}. This suggests selecting more test weight will improve grain yield plant^{-1} and fodder yield plant^{-1}.

Path analysis. The study of direct and indirect effects of yield and quality traits on grain yield plant^{-1} was undertaken in the present investigation and the results obtained are presented in Table 2. An analysis of these results revealed maximum direct positive effect showed by the harvest index (0.830) followed by fodder yield plant^{-1} (0.792), days to 50% flowering (0.044), finger width (0.041), ear head length (0.037), productive tillers plant^{-1} (0.029), finger length (0.028), iron content (0.023), zinc content (0.021), protein content (0.019) and finger number on main ear (0.016). In contrast, the direct negative effects were shown by calcium content (-0.029), plant height (-0.045) and days to maturity (-0.057).

Similar results were reported by Bezaweletaw *et al.* (2006) for finger number and productive tillers plant^{-1}, Lule *et al.* (2012); Jadhav *et al.* (2015) for finger length, Anuradha *et al.* (2013); Jayashree and Nagrajaiah (2013); Jadhav *et al*. (2015) for days to maturity and negative direct effect of seed protein content. Kumar *et al.* (2014) for fodder yield plant^{-1} and harvest index, Suman *et al.* (2018); Gohel and Chaudhari *et al*. (2018) for harvest index, fodder yield^{-1} and number of productive tillers^{-1}, Vidhate *et al.* (2020) for finger width and iron content, Wolie and Dessalegn (2011); Eric *et al.* (2016); Negi *et al*. (2016) for productive tillers plant^{-1} and Mahanthesha *et al*. (2018) for finger width, finger length and number of productive tillers plant^{-1}, and Chavan *et al*. (2019) for fodder yield plant^{-1} and in finger millet.

Table 1: Correlation coefficients among grain yield and quality traits in finger millet germplasm lines.

	DFF	DTM	PH	PTP	EHL	FNE	FL	FW	FYP	GYP	TGW	HI	Pro	Ca	Fe	Zn
DFF	**1.000**	0.975**	-0.119*	0.157	0.046	0.003	0.063	0.153**	0.112	0.127	0.069	0.044	-0.084	-0.245**	-0.018	-0.339**
DTM		**1.000**	-0.110*	0.136*	0.065	-0.001	0.061	0.132*	0.133*	0.131*	0.083	0.034	-0.057	-0.231**	-0.040	-0.337**
PH			**1.000**	-0.003	0.157**	-0.186**	0.243**	0.036	0.239**	-0.058	0.017	-0.276**	0.085	0.039	0.124*	0.073
PTP				**1.000**	-0.071	-0.013	-0.081	0.008	0.337**	0.279**	0.087	-0.013	-0.095	-0.108	0.080	-0.167**
EHL					**1.000**	0.263**	0.590**	0.196**	0.077	0.179**	-0.028	0.062	0.060	-0.056	0.082	0.192**
FNE						**1.000**	-0.089	-0.041	-0.094	0.327**	-0.051	0.439**	0.066	-0.062	-0.108	0.078
FL							**1.000**	0.293**	0.041	-0.005	0.086	-0.109	0.089	0.046	0.137*	0.164**
FW								**1.000**	0.154**	0.138*	0.000	-0.020	-0.035	0.009	0.105	-0.088
FYP									**1.000**	0.485**	0.178**	-0.383**	-0.033	-0.037	0.178**	-0.085
GYP										**1.000**	0.178**	0.551**	0.051	-0.189**	0.025	-0.034
TGW											**1.000**	0.050	0.051	0.086	0.032	-0.073
HI												**1.000**	0.075	-0.158**	-0.171**	0.006
Pro													**1.000**	0.170**	-0.279**	0.261**
Ca														**1.000**	-0.013	0.255**
Fe															**1.000**	0.078
Zn																**1.000**

*** P <= 0.05; ** P <= 0.01**

DFF: Days to 50 % flowering; DM: Days to maturity; PH: Plant height (cm); PTP: Number of productive tillers plant $^{-1}$; EHL: Earhead length (cm); FNE: Finger number on main ear FL: Finger length (cm); FW: Finger width (cm); FYP: Fodder yield plant $^{-1}$ (gr); GYP: Grain yield plant $^{-1}$ (gr); TGW: 1000 Grain weight (gr)HI : Harvest index (%); PR: Protein content (gr); Ca : Calcium content (mg); Fe: Iron content (mg) and Zn: Zinc content (mg).

Table 2: Path coefficient analysis showing direct and indirect effect of various characters on grain yield plant $^{-1}$.

	DFF	DM	PH	PTP	EHL	FNE	FL	FW	FYP	TGW	HI	PR	Ca	Fe	Zn
DFF	**0.044**	-0.056	0.006	0.005	0.002	0.000	0.002	0.003	0.082	0.000	0.044	-0.001	0.006	0.001	-0.007
DM	0.043	**-0.057**	0.005	0.004	0.002	0.000	0.002	0.002	0.097	0.000	0.028	-0.001	0.006	0.000	-0.007
PH	-0.006	0.007	**-0.045**	-0.001	0.006	-0.005	0.008	0.008	0.250	0.000	-0.307	0.001	-0.001	0.003	0.001
PTP	0.008	-0.009	0.001	**0.029**	-0.002	0.000	-0.002	0.001	0.266	0.000	0.016	-0.002	0.003	0.003	-0.004
EHL	0.002	-0.004	-0.008	-0.002	**0.037**	0.004	0.017	0.010	0.059	0.000	0.066	0.001	0.001	0.003	0.004
FNE	0.000	0.001	0.013	0.000	0.010	**0.016**	-0.002	-0.004	-0.074	0.000	0.371	0.001	0.001	-0.001	0.002
FL	0.004	-0.005	-0.012	-0.002	0.022	-0.001	**0.028**	0.014	0.034	0.000	-0.069	0.001	-0.001	0.004	0.003
FW	0.003	-0.003	-0.008	0.000	0.009	-0.001	0.009	**0.041**	0.209	0.000	-0.045	0.001	0.000	0.004	-0.001
FYP	0.005	-0.007	-0.014	0.010	0.003	-0.002	0.001	0.011	**0.792**	-0.001	-0.317	-0.001	0.001	0.004	-0.002
TGW	0.003	-0.005	-0.003	0.003	-0.001	-0.001	0.002	0.005	0.136	**-0.003**	0.061	0.000	-0.002	0.001	-0.002
HI	0.002	-0.002	0.017	0.001	0.003	0.007	-0.002	-0.002	-0.303	0.000	**0.830**	0.002	0.004	-0.003	0.001
PR	-0.003	0.002	-0.002	-0.003	0.003	0.001	0.002	0.002	-0.031	0.000	0.095	**0.019**	-0.004	-0.006	0.006
Ca	-0.010	0.011	-0.002	-0.003	-0.002	-0.001	0.001	0.000	-0.028	0.000	-0.106	0.003	**-0.029**	-0.001	0.005
Fe	0.002	0.000	-0.006	0.004	0.004	-0.001	0.005	0.007	0.143	0.000	-0.092	-0.005	0.001	**0.023**	0.002
Zn															**0.021**

Residual = 0.11659

DFF: Days to 50 % flowering; DM: Days to maturity; PH: Plant height (cm); PTP: Number of productive tillers plant $^{-1}$; EHL: Earhead length (cm); FNE: Finger number on main ear FL: Finger length (cm); FW: Finger width (cm); FYP: Fodder yield plant $^{-1}$ (gr); GYP: Grain yield plant $^{-1}$ (gr); TGW: 1000 Grain weight (gr)HI : Harvest index (%); PR: Protein content (gr); Ca : Calcium content (mg); Fe: Iron content (mg) and Zn: Zinc content (mg).

CONCLUSIONS

Investigation of character association in finger millet germplasm lines reveals a significant correlation among various traits in the genotypes under investigation. Days to 50% flowering are positively correlated with days to maturity and finger width but negatively correlated with plant height, calcium and zinc content. Days to maturity showed positive correlations with productive tillers plant^{-1}, finger width, fodder and grain yield plant^{-1} and negative correlation with calcium and zinc content. Plant height is positively correlated with ear head length, finger length, fodder yield plant^{-1} and iron while negatively correlated with finger number on the main ear and harvest index. These interrelationships provide valuable insights for targeted breeding strategies to enhance crop performance and quality.

The path analysis results revealed that harvest index and fodder yield plant $^{-1}$ have high positive, direct effect on grain yield plant^{-1}. Considering the nature and magnitude of character association and their direct and indirect effects, it can be inferred that improvement of grain yield plant^{-1} is possible through the simultaneous manifestation of harvest index and fodder yield plant^{-1}.

FUTURE SCOPE

The associations identified in the present study may be used for selecting high yielding genotypes with more nutrient content.

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Conflict of Interest. None.

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