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Correlation of yield and yield related traits of Tef (*Eragrostis tef* (Zucc.) Trotter) varieties in Ethiopia

Tegegn Belete[1]*,Temesgen Mathewos[2] and Gerba Daba[3]
[1]Ethiopian Institute of Agricultural Research, Jimma Agricultural Research Center, P.O. Box 192, Jimma, Ethiopia
[2,3]Jimma University College of Agriculture and Veterinary Medicine, P.O.Box, 307, Jimma, Ethiopia
***Corresponding author: tegegnbelete2011@gmail.com**

Abstract

The Objective of this study was to understand the relationship between yield and yield related traits of tef varieties using Pearson's correlation coefficient. The experiment was conducted using twenty-one tef varieties obtained from tef breeding program based at Debre Zeit Agricultural Research Center. Data were collected on plant basis of plant height, panicle length, culm length, fertile tillers per plant and lodging index by taking randomly five plants from plots and plot basis of grain yield, above ground biomass, harvest index, straw yield, thousand seed weight, days to heading, days to maturity and grain filling period. The trail was laid out using Randomized Complete Block Design with three replications at South and Southwestern part of Ethiopia in main cropping season of 2018. Results revealed that according to statistical analysis grain yield was positive and significantly correlated with fertile tillers per plant (r=0.815) and positive and highly significantly correlated with above ground biomass (r=0.935) and straw yield (r=0.94) at 0.05 significant level. None of the other traits were showed positive and significant relationship with grain yield. In conclusion, Fertile tillers per plant, above ground biomass and straw yield were considered as good criteria for improvement of grain yield of tef varieties suitable for breeding programs.

Keywords: Correlation, Eragrostis tef, Traits, Varieties.

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Tef [*Eragrostis tef* (Zucc.) Trotter] is the most important cereal of Ethiopia in terms of production, consumption and cash crop value. In Ethiopia, tef is annually grown on about 3 million ha with total grain production of over 5 million tons. As such, it accounts for about 30% of the total cultivated area and one-fifth of the gross grain production of all cereals cultivated in the country. In spite of its supreme economic and agricultural significance in Ethiopia, its productivity is relatively low with national average yield of about 1.7 t/ha. This has primarily been due to the very little scientific improvement done on the crop. Tef has still been an "orphan crop" since it is globally a very much under-researched crop owing to its localized importance. Scientific research on tef in Ethiopia began in the late 1950s.Improvement in any crop usually involves exploiting the genetic variability in specific traits and associations among them. Simultaneous improvement of these traits depends on the nature and degree of association between traits (Mnyenyembe and Gupta, 1998).Tef grain yield is determined by combined effect of various yield determination factors. Effective parental selection must not be totally dependent on the final yield of tef due to this combined effect of different traits.

To facilitate selection in breeding for high yield, therefore, it is logical to examine various components and give more attention to those having the greatest influence on yield. The ultimate expression of yield in crop plants is usually dependent upon the action and interaction of a number of important characters. Correlation, therefore, is helpful in determining the component characters of a complex trait, like yield. With more variables in correlation studies, indirect associations become more complex and important; consequently, a correlation study coupled with path analysis is more effective tool in the study of yield attributing characters. Hence, the present study was undertaken with the objective of to understand the interrelationships between yield and yield related traits of tef varieties using Pearson's correlation coefficient.

Materials and Methods

Twenty-one tef varieties were obtained from tef breeding program, Debre Zeit Agricultural Research Center (DZRAC) to conduct the experiment. The experiment was carried out in the field condition of 2018 main cropping season using randomized

complete block design (RCBD) with three replications. Sowing was done manually in rows and the spacing between rows and plants was 20cm and 10cm, respectively. Spacing between plots was 1 m, whereas that between replications was 1.5 m and the total plot size was 2mx2m.Seed rates was based on the recommendation which was 15kg/ha. Planting was done on the onset of rain in the respective locations.

As per the recommendations, plots were fertilized with 40 kg of N and 60 kg of P_2O_5per hectare for light soils and 60 kg N and 60kg P_2O_5 per hectare for black soils (Vertisols). All DAP was applied at planting, while urea was applied in split half at planting and the remaining half at tillering stage. All other relevant field trial management practices were carried out throughout the experimentation period across all locations as per the recommendations for the respective locations. Data were collected from different traits such as plant height, panicle length, number of fertile tillers, culm length and lodging index on plant basis (randomly taking five plants from the plot) and grain yield, above ground biomass, straw yield, harvest index and thousand seed weight on plot basis. The data also collected on phenological traits such as days to heading, days to maturity and grain filling period.

Table 1: Tef varieties used for the study

No.	Variety name	Common name	Released Center	Year of release
1.	DZ-Cr-387 RIL355)	Quncho	DZARC	2006
2.	DZ-01-1880	Guduru	Bako	2006
3.	23-Tafi Adi-72	Kena	Bako	2008
4.	DZ-01-3186	Etsub	Adet	2008
5.	DZ-Cr-438 RIL133 B	Kora	DZARC	2014
6.	DZ-Cr-438 RIL91A	Dagim	DZARC	2016
7.	DZ-Cr- 438 RIL7	Abola	Adet	2016
8.	DZ-Cr-429 RIL125	Negus	DZARC	2017
9.	DZ-Cr-442 RIL77C	Felagot	DZARC	2017
10.	DZ-Cr-457 RIL181	Tesfa	DZARC	2017
11.	DZ-Cr-419 (DZ-Cr-974 X PI 222988)	Heber -1	Adet	2017
12.	DZ-01-787	Wellenkomi	DZARC	1978
13.	DZ-Cr-255	Gibe	DZARC	1993
14.	DZ-01-99	Asgori	DZARC	1970
15.	DZ-01-974	Dukem	DZARC	1995
16.	DZ-01-1285	Koye	DZARC	2002
17.	DZ-01-2053	Holetta Key	Holetta	1998
18.	DZ-Cr-37	Tsedey	DZARC	1984
19.	DZ-CR-409 (sel. 50D)	Boset	DZARC	2012
20.	DZ-01-196	Magna	DZARC	1970
21.	DZ-01-354	Enatite	DZARC	1970

Results and Discussion

Correlation among 13 traits recorded from the twenty-one tef varieties in this study were below on table 2. The inter relationship of quantitative characters with yield determine the efficiency of selection in breeding programmes. It merely indicates the intensity of association. Phenotypic correlation reflects the observed relationship, while genotypic correlation underline the true relationship among characters. Selection procedures could be varied depending on the relative contribution of each.

Correlation of grain yield with other traits: Generally, increasing grain yield is the breeding objective in tef improvement program (Kebebew *et al*., 2011). However, direct selection based on crop yields is often a paradox in breeding programmes because yield is influenced by its component traits (Mustafa and Elsheikh, 2007). Hence, most of the economic traits including yield are polygenically

controlled and are much influenced by environmental factors, an understanding of inheritance and study of association between yield and its components is necessary for planning an effective selection program in identifying high yielding varieties (Firas *et al*., 2012).Accordingly, it is important to select indirectly for other traits in order to improve grain yield.

Correlation analysis was performed to understand the association of the yield with the agronomic characters of studied tef varieties. Pearson's correlation coefficients among yield and yield related traits of tef varieties were described in table 2. The degree of correlation between the traits is a key factor especially in complex and economic trait such as yield (Akinwale *et al*., 2011).Grain yield was positive and significantly correlated with fertile tillers per plant (r=0.815) and positive and highly significantly strong correlated with above ground biomass (r=0.935) and straw yield (r=0.94) at 0.05 significant level and hence simultaneous selection for this character might bring an improvement to grain yield per plant. Grain yield was positively and highly correlated with shoot biomass also reported by (Fano, 2013).Similarly, positive association between grain yield and biomass yield were also reported by Yifru and Hailu (2005) in tef. Number of fertile tillers per plant and biomass yield has positive correlation with grain yield which is also reported by Tsion (2016). On the other hand, grain yield was positive and non-significant with days to heading, grain filling period and culm length.Positive correlation coefficient among traits shows that the changes of two variables are in the same direction i.e. high value of one variable is associated with high value of other and vice versa. Days to heading was non significantly correlated with grain yield and was in contrary with Habte *et al*., 2011.Absence association of grain yield with phenological traits was similarly also reported by (Fano,2013).The presented study was supported the findings of Yifru and Hailu (2005) in tef. Similarly, Mihret (2012) found non-significant negative association for grain yield with days to flowering and day to maturity in sorghum. Laing *et al*. (1984) reported positive association for grain yield with days to physiological maturity as opposed to significant negative association obtained between the same traits in wheat (Waddington *et al*., 1987). Similar results to the present findings showing lack of correlation between grain yield and these phenologic traits were reported by Amsal (1994) in wheat. Grain filling period showed non-significant correlation with grain yield. Similar result was reported by Kebebew *et al*., 2002.Grain yield was also negatively,but non-significant correlated with harvest index, thousand seed weight, lodging index, days to maturity and days to heading. In present study, grain yield was negatively correlated with harvest index which was also similar reported with kebebew *et al* .,2002.

Yield related traits: Days to heading showed non-significant correlation with all traits. In contrary, Tsion (2016) reported that days to heading showed significant positive phenotypic association with days to maturity, grain filling period, plant height, panicle and culm length, seed weight and biomass yield. Similarly, Habte *et al*, (2015) reported days to heading also showed significant positive correlation with most of the traits; days to grain filling, days to maturity, plant height, culm and panicle length. Days to maturity was positively and highly significantly correlated with grain filling period. Similar result was reported by Tsion (2016).Days to maturity was non significantly correlated with plant height, panicle length, Culm length, fertile tillers, lodging index, thousand seed weight, above ground biomass, straw yield and harvest index.Tsion(2016) reported days to maturity revealed positive significant phenotypic association with grain filling period, plant height, panicle and culm length and biomass yield. In contrast, days to maturity showed significant negative relationship with number of total and fertile tillers per plant, lodging and harvest index.

Plant height showed positive and highly significantly correlated (r=0.948**) with culm length and non-significantly correlated with panicle length, culm length, fertile tillers, lodging index, thousand seed weight, biomass yield, straw yield and harvest index. Fertile tillers per plant showed positive and highly significantly correlated (r=0.885) with above ground biomass. Thousand seed weight showed positive and highly correlated (r=0.987) with harvest index. Lodging index showed negative and non-significant relationship with all traits.Habte *et al.,* (2015) reported substantial negative correlation of grain yield with lodging index. Generally, the existence of a strong correlation is the indication that those traits are conditioned by the same set of gene, be it in the positive or negative direction (Falconer, 1989). Consequently, selection for one trait can indirectly introduce changes in the other trait in positive or negative direction due to either genetic linkage or presence of pleiotropic gene effect or both (Falconer, 1989).

Table 2: Pearson's correlation coefficients among yield and yield attributing traits

	GY	DH	DM	GFP	PH	PL	CL	FT	LI	TSW	BY	SY	HI
GY													
DH	-0.75858												
DM	-0.20701	0.78843											
GFP	0.26123	0.42014	0.88921*										
PH	0.39145	-0.31477	-0.02264	0.17899									
PL	-0.04669	-0.31914	-0.43593	-0.42929	0.7634								
CL	0.54136	-0.26099	0.1827	0.4465	0.94837**	0.51917							
FT	0.81595*	-0.25204	0.37585	0.74548	0.29802	-0.34147	0.56085						
LI	-0.466	0.42662	0.09859	-0.15854	-0.44598	-0.32344	-0.43048	-0.32863					
TSW	-0.29561	-0.12365	-0.35706	-0.45034	0.24739	0.6364	0.01654	-0.57724	-0.53814				
BY	0.93587**	-0.58157	-0.04114	0.38091	0.17749	-0.32269	0.3932	0.88512*	-0.19886	-0.60582			
SY	0.94757**	-0.67925	-0.15337	0.28583	0.30517	-0.15932	0.48427	0.77032	-0.29835	-0.33521	0.9136*		
HI	-0.30904	-0.11152	-0.36134	-0.46224	0.13619	0.53286	-0.0791	-0.59943	-0.49161	0.9878**	-0.60309	-0.31015	

Where, GY=grain yield, DH=days to heading, DM=days to maturity, GFP=grain filling period, PH=plant height, PL=panicle length, CL=culm length, FT=number of fertile tillers, LI=lodging index, TSW=thousand seed weight, BY=above ground biomass, SY=straw yield, HI=harvest index

Conclusion

According to Pearson's correlation analysis, grain yield is positive and significantly correlated with fertile tillers per plant, above ground biomass yield and straw yield. Positive relation suggests a common genetic/physiological basis among these traits and the possibility of simultaneous improvement of the traits. However, plant height, culm length, panicle length, thousand seed weight were not highly correlated with the grain yield. Plant height, panicle length and culm length can be considered as good criteria for selection of tef varieties suitable for breeding programs.

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Conflict

The authors have not declared any conflict of interest

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