Journal of Biology, Agriculture and Healthcare www.iiste.org
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.7, No.24, 2017

Grain Yield Stability and Agronomic Performance of Tef Genotypes in Western Oromia

Girma Chemeda[1*] Chemeda Birhanu[1] Dagnachew Lule[2]
1.Bako Agricultural Research Center, P.O. Box 3, Bako, Ethiopia
2.Oromia Agricultural Research Institute, Addis Ababa,Ethiopia

Abstract
Tef, Eragrostis tef (Zucc.) Trotter, is the major Ethiopian cereal grown on about 3 million hectares annually. Because of its gluten-free proteins and slow release carbohydrate constituents, tef is recently being advocated and promoted as health crop at the global level. Because of this importance and lack of enough improved varieties of tef, this activity was conducted in three locations to identify and further evaluate stable tef varieties .For this purpose, several genotypes were evaluated under different breeding stage so as to screen and reach to the stable once. Accordingly, the year 2014/15 25 genotypes were tested in preliminary variety trial out of which nine genotypes were advanced to regional variety trial and tested in 2016 in multi-locations. Finally the combined analysis of variance across the three locations revealed highly significant (p<0.01) difference among genotypes for plant height, panicle length, shoot biomass, lodging % and grain yield. Two test genotypes, viz.236952and 55253 found to be stable, high yielder and lodging tolerant across the tasted locations with grain yield advantage of 26%, 19.29% and 11.13% over the standard check respectively. Therefore based on their high yield and stable performance, genotypes 236952 and 55253 were promoted to Variety Verification Trial (VVT) evaluation and for possible release.
Keywords: Eragrostis tef, stability,

Introduction

Eragrostis tef (Zucc.) Trotter, is a self pollinated warm season annual grass with the advantage of C_4 photosynthetic pathway (Miller,2010). Tef is among the major Ethiopian cereal crops grown on about 3 million hectares annually (CSA, 2015), and serving as staple food grain for over 70 million people. Tef grain is primarily used for human consumption after baking the grain flour into popular cottage bread called "injera". Tef has an attractive nutritional profile, being high in dietary fiber, iron, calcium and carbohydrate and also has high level of phosphorus copper, aluminum, barium, thiamine and excellent composition of amino acids essential for humans (Hager et al., 2012; Abebe et al.,2007). The straw (*chid*) is an important source of feed for animals. Generally, the area devoted to tef cultivation is increased because both the grain and straw fetch high domestic market prices. Tef is also a resilient crop adapted to diverse agro-ecologies with reasonable tolerance to both low (especially terminal drought) and high (water logging) moisture stresses. Tef, therefore, is useful as a low-risk crop to farmers due to its high potential of adaptation to climate change and fluctuating environmental conditions(Balsamo *et al.,* 2005). Nevertheless, until recently, tef was considered as “orphan” crop: one receiving no international attention regarding research on breeding, agronomic practices or other technologies applicable to smallholder farmers.

The continued cultivation of tef in Ethiopia is accentuated by the following relative merits: 1) as the predominant crop, tef is grown in a wide array of agro-ecologies, cropping systems, soil types and moisture regimes; 2) with harvests of 4.75 million tons of grain per year from about 3 million ha. Tef constitutes about 30% of the total acreage and 20% of the gross yearly grain production of cereals in Ethiopia followed by maize which accounts for about 21% of the acreage and 31% of the overall cereal grain production (CSA, 2015); 3) the values of the grain and straw contribute about four billion Birr to the national GDP; 4) it has a good export market, although domestic grain price hikes led to food grain export ban; 5) tef grain has got relatively good nutritive value especially since it contains relatively high amounts of iron, calcium and copper compared to other cereals. Because of its gluten-free proteins and slow release carbohydrate constituents, tef is recently being advocated and promoted as health crop at the global level (e.g. Spaenij-Dekking et al., 2005).

Agricultural Development Led Industrialization (ADLI) policy requires an increase in productivity of tef such that, apart from satisfying the household consumption, it feeds into the emerging grain processing industries that are cropping up due to the change in life-style as well as the recently burgeoning global tef market. Secondly, barring the temporary export ban in the past few years, the export-led research policy requires increased tef productivity particularly in view of exploiting the recent globalization and consequently burgeoning global tef market.

Tef research at Bako was started before two decayed. Since then, commendable achievements have been made through basic and applied research endeavors. Of these, the major once include the release of two improved varieties at regional level and recommendation of appropriate cultural practices (seed rate, planting time, harvesting stage, fertilizer rate) for major tef growing mandate areas. In addition the socioeconomics and the research extension wings have played pivotal role to generate a number of need felt basic information, and disseminate tef production technologies through the years.

The most important bottlenecks constraining the productivity and production of tef in Ethiopia are: i) low yield potential of farmers' varieties under widespread cultivation; ii) susceptibility to lodging particularly under growth and yield promoting conducive growing conditions; iii) biotic stresses such as diseases, weeds and insect pests; iv) abiotic stresses such as drought, soil acidity, and low and high temperatures; v) the culture and labor-intensive nature of the tef husbandry; vi) inadequate research investment to the improvement of the crop as it lacks global attention due to localized importance of the crop coupled with limited national attention; and vii) weak seed and extension system (kebebew Asefa *et.; al* 2013). Therefore the objective of this activity was to develop and release high yielding, lodging and diseases tolerant tef varieties for tef growing areas of western parts of the country.

Objective:
To develop and release high yielding and pest tolerant tef varieties for Western parts of tef growing areas of Ethiopia.

Material and Methods
Thirty two genotypes developed through recombinant line were tested under preliminary variety trial will be used to be evaluated in multi-location sites so as to see their adaptability, stability, yield, and resistance/tolerance to major tef diseases in the main season during 2018-2020 cropping season. The experiment will be conducted at Shambu, Gedo and Arjo sub site using Randomized Complete Block design with three replications on a plot size (experimental unit) of 2m x2m (4m^2) each with 0.2m of row spacing. The distance between block was 1.5m and between plots will be 1.0m. Fertilizer rate of 100/50 kg DAP/UREA at planting and 10 kg/ha of seed rate will used. Other agronomic practices were applied uniformly as required.

Data on days to emergence, days to heading, days to maturity, panicle length, plant height, panicle length, shoot biomass, lodging %, effective tiller, Stand %, grain yield per plot and disease score (1-9 scale) will collected and subjected to statistical analysis using SAS statistical software.

Result and Discussion
The combined analysis of variance across the three locations revealed highly significant ($p<0.01$) difference among genotypes for plant height, panicle length, shoot biomass, lodging % and grain yield qt/ha (Table 1). Accession 236952 gave the highest grain yield (22.98qt/ha) followed by accession 55253 (21.76 qt/ha) and DZ-01-102 (20.27qt/ha). The standard check variety Kena gave 18.24 qt/ha. The three candidate genotypes had yield advantage of 26%, 19.29%, 11.13% over the standard check respectively (Table 1). In agreement with this finding; previous studies of Genotype x environment on 22 tef genotypes at four locations in Southern regions of Ethiopia have indicated significant variations in grain yield for the tested genotypes (Ashamo M, Belay G 2012). Similar study on phenotypic diversity in tef germplasm in a pot experiment using 124 single panicle sample collection showed substantial variability for traits such as plant height, panicle length, maturity, seed color, seed yield, lodging and panicle type (Malak-Hail et al.; 1965).

The combined analysis of variance for biomass depicted significant ($P<0.01$) difference among the tested genotypes. Accession 236952 gave the highest shoot biomass (10.6t/ha) followed by accession DZ-01-102 (10.10 t/ha) and accession 55253 (10.6 t/ha).The standard check kena gave a shoot biomass of 7.1ton/ha..

The analysis of variance for lodging percent revealed that low percent for genotype 55253 (7.11%) followed by genotype DZ-01-102 (11%) and genotype 236952 (15%) respectively.

The stability study indicat that genotypes 236952, 55253 and DZ-01-102 found to be stable and high yielders across the tasted locations with grain yield advantage of 26%, 19.29% and 11.13% respectively over the check.

The GGE biplot analysis revealed that three candidate genotypes showed stable adaptability across the three locations (Fig 1).They were also high yielders than the best check and fall relatively close to the concentric circle near to average environment axis, suggesting their potential for wider adaptability with better grain yield performance

Table 1. Mean grain yield (qt/ha) of tef genotypes per locations across years

Accession	Shambu		Gedo		Arjo		Mean	% yield advantage	Rank
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17			
Acc.236952	25.07	21.2	22.56	23.3	21.34	23.63	22.85	26.00	1
Acc.55253	21.87	23.02	21.95	21.81	20.12	21.81	21.76	19.29	2
DZ-01-1001	19.16	20.61	17.03	18.58	16.75	18.87	18.50		9
DZ-01-1004B	19.31	20.42	16.53	16.77	16.72	16.52	17.71		10
DZ-01-102	21.80	20.30	19.00	20.10	20.74	19.69	20.27	11.13	3
DZ-01-385	20.44	18.82	18.71	21.02	14.77	20.81	19.10		5
DZ-01-739	19.22	19.97	19.43	18.48	17.55	18.41	18.84		7
DZ-01-778	20.65	19.02	20.02	18.00	18.53	18.83	19.18		4
DZ-01-821	20.18	18.94	19.38	18.51	18.31	19.14	19.08		6
Kena	20.09	20.43	18.30	16.37	17.83	16.44	18.24		8
Local	16.91	17.98	17.48	18.06	17.06	17.77	17.54		11
Mean	20.25	20.43	19.18	19.27	18.16	19.27			
CV	8.9	6.3	6.6	6.1	11.3	4.3			
F-Value	<0.005	<0.002	<0.001	<0.001	<0.028	<0.001			
LSD 0.05	2.46	4.22	2.38	4.30	2.03	4.12			

Table 4. Mean grain yield (qt/ha) per location across years

Accession	Shambu		Gedo		Arjo		Mean	% yield advantage	Rank
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17			
Acc.236952	25.07	21.2	22.56	23.3	21.34	23.63	22.85	25.27	1
Acc.55253	21.87	23.02	21.95	21.81	20.12	21.81	21.76	19.27	2
DZ-01-1001	19.16	20.61	17.03	18.58	16.75	18.87	18.5		9
DZ-01-1004B	19.31	20.42	16.53	16.77	16.72	16.52	17.71		10
DZ-01-102	21.80	20.3	19	20.1	20.74	19.69	20.27	11.13	3
DZ-01-385	20.44	18.82	18.71	21.02	14.77	20.81	19.1		5
DZ-01-739	19.22	19.97	19.43	18.48	17.55	18.41	18.84		7
DZ-01-778	20.65	19.02	20.02	18	18.53	18.83	19.18		4
DZ-01-821	20.18	18.94	19.38	18.51	18.31	19.14	19.08		6
Kena	20.09	20.43	18.3	16.37	17.83	16.44	18.24		8
Local	16.91	17.98	17.48	18.06	17.06	17.77	17.54		11
Mean	20.25	20.43	19.18	19.27	18.16	19.27			
CV	8.9	6.3	6.6	6.1	11.3	4.3			
F-Value	<0.005	<0.002	<0.001	<0.001	<0.028	<0.001			

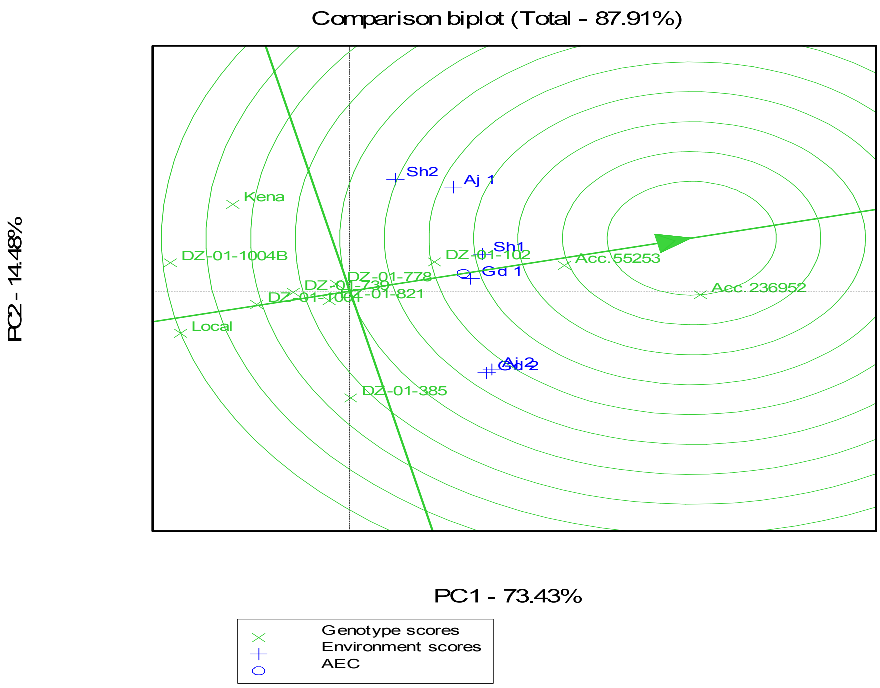

Fig-1. Genotype and Environment that fall in the central circle are considered ideal environments and stable genotypes, respectively

Conclusion and Recommendation

Combined analysis of variance for the genotypes portrayed highly significant differences for plant height, panicle length, shoot biomass, lodging % and grain yield qt/ha. Genotype 236952and 55253 were found stable, high yielders and lodging tolerant across the tasted locations with grain yield advantage of 26%, 19.29% and 11.13% over the standard check respectively. As a result of these all merits, these three genotypes *viz*. 236952and 55253 were identified as candidate varieties to be verified at three of the sites in the coming cropping season.

Acknowledgment

The author acknowledge Oromia Agricultural Research Institute, Bako Agricultural Research Center and Agricultural Growth Program (AGP II) for their financial and technical support during the implementation of this activity.

References

Abebe Y, Bogale A, Hamgidge, KM, Stoecker BJ, Bailey K, Gibson RS, (2007) Phytate, zinc, iron, and calcium content of selected raw and prepared foods consumed in rural Sudama, Southern Ethiopia and implication of bioavailability. J food Compo Anal.20:161-168.

Ashamo M, Belay G (2012) Genotype x Environment Interaction Analysis of Tef Grown in Southern Ethiopia Using Additive Main Effects and Multiplicative Interaction Model. Journal of Biology Agriculture and Healthcare 2: 66-72.

Balsamo R A, Willigen C V,Boyko W, Farrent L (2005) Retention of mobile water during dehydration in the desiccation-tolerant grass Eragrostis nindeensis' . Physiol Planetarium.134:336-342.

Central Statistical Agency (CSA).2014/15. The federal Democratic Republic of Ethiopia. Central Statistical Agency Agricultural Sample Survey 2014/15: Report on Area and Production of Major Crops (Private peasant Holdings, Maher Season), Volume III. Addis Ababa,Ethiopia.

Hanger AS, Wolter A, JacobF, Zannini E, Arendt EK (2012).National properties and ultera-structure of commercial gluten free flours from different botanical sources compared to wheat flours. J Cereal Sci. 56:239-247.

Kebebew Assefa, Solomon Chanyalew and Gizaw Metaferia 2013.Conventional and Molecular Tef Breeding, Proceedings of the Second International Workshop,November 7-9, 2011, Debre Zeit, Ethiopia.

Melak-Hail Mengesha, Picket R. C., Davis R. L. (1965). Genetic variability and interrelationship of characters in teff, Eragrsotis tef (Zucc.) Trotter, Crop Sci. 5: 155-157.

Miller, D (2010) Teff guide 3rd edition, viewed on 24 September 2012, http://www.calwestseeds.com.product/teff

Spaenij-Dekking L, Kooy-Winkelaar Y and Koning F. (2005). The Ethiopian cereal tef in celiac disease. N. Engl. J. Med. 353: 16.