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ORIGINAL ARTICLE

Yield evaluation of recently released Tef [*Eragrostis tef (Zucc) Trotter*] varieties for high potential areas in Southern Ethiopia

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Tef is extremely nutritional and is a crucial a part of Ethiopia's cultural heritage and national identity. The experiment was conducted to identify, choose and advocate adaptable, high yielding variety. Twenty tef genotypes were evaluated in RCBD with 3 replications at 2 locations Meskan and Wulbareg districts throughout main cropping season of 2021/22. The combined Analysis of variance discovered that there have been vital variations among tested tef varieties. Supported the obtained results of the combined two locations highest grain yield obtained from improved tef varieties Boset (1746 kg/ha) followed by Dagim (1552 kg/ha). On the opposite hand, lowest grain yield was recorded by Werekiyu and Jitu (957 kg/ha). Boset, and Dagim were counseled for the study space and similar ecologies of Siltie zone and Guraghe zone, because the result the research worker recommends that these selected varieties ought to go any through pre-extension and demonstration for further wider multiplication and addressing farmers within the study area.

Keywords: Adaptability, Improved, Tef varieties.

Introduction

Tef *[Eragrostis tef (Zucc) Trotter]* is an allotetraploid with 40 chromosomes (2n=4x=40), belongs to the family Poaceae, subfamily Eragrostoideae, tribe Eragrosteae and genus Eragrostis.. It's an ancient and also the most vital cereal crop in Ethiopia and the country is considered to be both the centre of origin and diversity for this cereal (N.I. Vavilov, 1951). There are about 350 Eragrostis species of that E.tef is that the solely species cultivated for human consumption.

Tef is adaptable to a large vary of ecological conditions in altitudes starting from close to water level to 3000 masl and even it can be mature in an surroundings unfavourable for many cereal, whereas the most effective performance happens between 1100 and 2950 masl (K. Assefa, et al., 2000). It's the main food crop in Ethiopia wherever it is annually cultivated on about 3 million hectares of land by 6.3 million small-scale farmers on more than 30% of the total area allocated to cereal crops (CSA, 2016).

The importance of tef in Ethiopia is principally because of its preference by each farmers and consumers. Farmers, on top of all, grow tef due to its tolerance to many biotic and a biotic stress particularly to the poorly drained Vertisols, a dominant soil sort within the central highlands wherever different cereals will hardly survive. Over 50 million individuals in Ethiopia consume tef as staple food because of the higher quality bread known as "injera" made of it compared thereto from other cereals. The absence of gluten protein in its grain makes tef a healthy food such people allergic to gluten can safely consume tef products (T. Fikre, et al., 2018; K. Assefa et al., 2015).

The yields of Tef are low in Ethiopia yet as in southern region because of different production issues including: lack of improved varieties, non-adoption of improved technologies, unwellness and pests are a number of the foremost serious production constraints in Tef production in region. Some varieties of Tef were released by the various regional and federal research centres in Ethiopia; however, most of them weren't evaluated around areas of southern Ethiopia and farmers were not participated in varietal improvement and testing method (F. Fufa, et al., 2010). Two way feedbacks between farmers and researchers is so very important element of extremely client-oriented breeding programs in regionally important and traditionally cultivated crop (H. Tefera, et al., 2008). Therefore, this study conducted primarily for the aim of evaluating and choosing adapted, high yielding improved tef varieties for the study area, Southern Ethiopia.

Materials and Methods

Description of the study area

The experiment was conducted at 2 locations Meskan/Butajira and Wulbareg/Worabe at Farmer Training centre (FTC) of 2021/2022 main cropping season. Wulbareg (Worabe) is found 173 173 km south of Addis Ababa and located at 9°4′N altitude 38°30′ E, latitude and longitude at an altitude of 2070 masl. The soil of studyarea is characterised by well-drained sandy loam (46% sand, 36% silt and 18% clay), with a pH vary of 5.2-7.6. Day-time temperatures are usually between 12.5-25.5°C, with night-time temperatures falling on the point of state change at higher altitudes. The foremost usually cultivated crops in its surrounding spaces are tef, maize and wheat within the Wulbareg district.

Meskan/Butajira area is found 130 km south of Addis Ababa and 50 km to the west of Zway town in the Rift Valley, 8.2^{o} North latitude and 38.5° East longitudes. Climate varies from arid dry lowland areas at altitudes around 1,500 m (tropical climate) to chill mountainous areas up to 3,500 m on top of mean water level (temperate climate). The wet season happens between June and October; with the remaining months preponderantly dry. Day-time temperatures are typically between 20-30°C, with night-time temperatures falling close to freezing at higher altitude. The lowland areas are drought prone and are affected throughout the most droughts in Ethiopia.

Experimental materials

The experimental material of the study comprised of 20 tef varieties kindly provided from the Debre Zeit Agricultural Research Center Table 1.

Table 1. List of tef (*Eragrostis tef*) varieties used for experiments.

S No.	Code	Local Name	Year of release	Released by	Seed color	On-farm grain yield(tha^{-1})
1	DZ-Cr-409 RIL 50d	Boset	2012	DebreZeit	Very white	1.8-2.2
2	DZ-Cr-442 RIL77C	Felagot	2017	DebreZeit	Brown	1.9-2.4
3	DZ-Cr-285 RIL295	Simada	2009	DebreZeit	White	1.6-2.4
4	DZ-Cr-457 RIL-181	Tesfa	2017	DebreZeit	White	2.1-2.4
5	Dz-Cr-429 RIL 29	Washera	2019	Adet	Very white	2.0-2.5
6	Dz-Cr-458 RIL 18	Ebba	2019	DebreZeit	Very white	2.0-2.6
7	Dz-Cr-37	Tsedey	1984	DebreZeit	White	1.4-1.9
8	ACC225931	Abay	2018	Adet	White	1.8-2.2
9	DZ-Cr-387 RIL355	Quncho	2006	DebreZeit	Very white	2.0-2.2
10	Acc. 214746A	Werekiyu	2014	Sirinka	White	1.8-2.2.
11	Dz-Cr-453RIL120B	Bora	2019	DebreZeit	Very white	1.8-2.4
12	Dz-Cr-429RIL125	Negus	2017	DebreZeit	Very white	2.1-2.6
13	Dz-Cr-419	Hiber	2017	Adet	White	1.7-2.2
14	Dz-01-974	Dukem	1995	DebreZeit	White	2.0-2.5
15	Dz-01-196	Magna	1978	DebreZeit	Very white	1.4-1.6
16	Dz-01-256	Jitu	2019	Bako	White	1.9-2.4

17	Dz-Cr-438RIL7	Abola	2016	Adet	Very white	1.8-2.3
18	-	Farmer variety	-	-	-	-
19	Dz-Cr-438RIL133B	Kora	2014	DebreZeit	Very white	2.0-2.3
20	Dz-Cr-438RIL91A	Dagim	2016	DebreZeit	Very white	2.0-2.5

Experimental design and trial management

Twenty (19) improved varieties and one (1) farmer variety of tef had been tested for adaptability, and performance (yielding ability) in the study areas. The trial was carried out in Randomized Complete Block Design (RCBD) in three replications. The varieties were grown under uniform rain fed conditions. The plot size was 2 m length and 2 m width (4 m^2) with 0.2 m of row spacing. The spaces between plots and replications were 1 m and 1.5 m, respectively. Sowing was done by manual drilling along the rows at seed rate of 15 kg/ha. Sowing was done within the last week of July to 1st week of August for two years of main cropping seasons 2020/21 to 2021/22. The sources of P_2O_5 and nitrogen fertilizer were NPS and UREA respectively. Both applied at the rate of 100 kg ha^{-1}. All of the NPS was applied at planting and UREA was applied in two splits, half at the time of planting and the remaining half at tillering stage. All other pre and post-planting management practices were done in accordance with the research recommendations for tef production in the area. Twice hand weeding and ploughing and other management practices were done as required. All other recommended agronomic practices were kept normal and uniform to ensure normal plant growth and development. Seed yield of each plot was recorded and then converted into kg/ha.

Agronomic data collected

Data were collected either on plant or plot bases on yield and yield related traits.

Days to 50% heading (DH): the number of days from sowing up to the date of emergence of the tips of the panicles from the flag leaf sheath.

Days to maturity (DM): The number of days from sowing up to the physiological maturity stage as evidenced by eye-ball judgment of the change of the vegetative parts of the plants from green to light yellow or straw color.

Grain filling period (GFP): Obtained as the difference between the days to heading and to maturity.

Lodging index (LI): It is the value recorded following the method of caldicott and Nuttall (1979) who defined LI as the sum of product of each scale or degree of lodging (0-5) and their respective percentage divided by five.

Shoot Biomass per plot (BM): It was recorded by weighing the total above ground yield harvested from the central rows of each experimental plot at the time of harvest when moisture content adjusted to 8%-10%.

Grain yield per plot (Y): The grain yield per plot was measured in grams using sensitive balance after moisture of the seed is adjusted to 12.5%. Total dry weight of grains harvested from the middle rows.

Plant height (cm): The distance between the ground level to the tip of the terminal spikelet in cm of the mother ten plants.

Panicle length (cm): Panicle lengths as the average length from the base of the panicle to the tip of ten pre-tagged plants were recorded in cent meter from central rows of each plot.

Statistical analysis and variance components

The data was subjected to analysis of variance using SAS software v 9.1.3 (SAS Software). The Significant difference among genotypes was tested by 'F' test at 1% and 5% levels of Probability. The structure of analysis of variance (ANOVA) Table 2 is presented below.

Table 2. The structure of analysis of variance (ANOVA) (K.A. Gomez, et al., 1984).

Source	Df	(SS)	(MS)	F
Block	r-1	SSB	SSB/r-1	MSR/MSE
Treatment	t-1	SST	SST/t-1	MST/MSE
Error	(t-1)(r-1)	ESS=(SST-SSB)	ESS/(t-1)(r-1)	

Total	(bt-1)	TSS

Where: r=Number of replications; t=Number of treatments/genotypes; SS=Sum of Square; MS=Mean of square; S.Em=± E.M.SS/r

Coefficient of variation (CV %)= $\sqrt{\frac{\text{erro MS}}{\text{grand MS}}} \times 100$

Results and Discussion

Analysis of variance (two years combined data by locat ion)

The two location of combined analysis of the experiment sites showed large variation among the tested tef genotypes for all the traits studied (K. Assefa, et al., 2003) (Table 3).

The analysis of variance of the combined two locations results showed that the presence of adequate variations among the tef varieties for many of the traits suggesting that the higher chance of choosing varieties for trait of interest. The results of analysis of variance permits concluding more genetic analyses for all traits, similar results were reported by A. Demelash (2017). Likewise, H. Tefera, et al., (2003) reported important variations for similar traits with current study and conjointly. In agreement with this study M. Fentie, et al., 2012 and Y.G. Chondie., et al., (2017) also reported considerable variation within the days to maturity, plant height and spike length and grain yield of various tef varieties once planted over years. Days to maturity: Tseday/ Dz-Cr-37 Dz-Cr-37 (95 days) was matured before all alternative varieties and Boset (109 days) followed by Dukem (108 days) and farmer variety (100 days) were late matured than all other varieties (Table 3).

Grain yield: compared to standard check (Negus 1464 kg/ha) and farmer variety (833 kg/ha) best performed genotypes were Boset (1746 kg/ha), and Dagim (1552 kg/ha) in contrast, poor performed varieties were Werekiyu/ Acc. 214746A (957 kg/ha) and Jitu (957 kg/ha) (Table 3).

Table 3. Mean performance of 20 tef test varieties for 8 traits tested (Average over two locations).

Traits	DTH	DTM	GFP	PH(cm)	PL(cm)	LI	BM(kgha^{-1})	Y(kgha^{-1})
Boset	43.8^{a}	109.3^{a}	65.5^{ba}	98.9^{a}	39.1^{ab}	56.8^{de}	8313^{a}	1746.1^{a}
Felagot	43.5^{a}	98.8^{ba}	55.3^{ba}	80.3^{fg}	31.2^{e}	72.5^{a-d}	6125^{b-d}	969.2^{c-e}
Simada	43.3^{ba}	102.8^{ba}	59.5^{ba}	92.3^{a-e}	31.2^{e}	66^{b-e}	6125^{b-d}	1159.8^{b-e}
Tesfa	42.8^{ba}	97^{ba}	55.3^{ba}	90.1^{a-f}	34.8^{c-e}	72.5^{a-d}	6125^{b-d}	1159.8^{b-e}
Washera	42.5^{ba}	103.3^{ba}	60.8^{ba}	83.7^{e-g}	34.8^{c-e}	50.5^{e}	6125^{b-d}	1294.9^{a-e}
Ebba	42.3^{ba}	99.5^{ba}	57.25^{ba}	78.3 ^{g}	34.9^{b-e}	79.5^{a-c}	5313^{cd}	1464.6^{a-d}
Tsedey	42.3^{ba}	95.8^{ba}	53.5^{ba}	92.2^{a-e}	34.9^{b-e}	79.5^{a-c}	6375^{a-d}	1506.5^{a-c}
Abay	41.8^{ba}	97.3^{ba}	55.5^{ba}	83.7^{e-g}	34.8^{c-e}	79.5^{a-c}	6375^{a-d}	1294.9^{a-e}
Quncho	41.8^{ba}	109.8^{a}	68^{a}	85.3^{c-g}	34.8^{c-e}	63.5^{c-e}	6125^{b-d}	1294.9^{a-e}
Were Kiyu	41.5^{ba}	95^{ba}	53.5^{ba}	83.95^{e-g}	33.8^{de}	72.5^{a-d}	6125^{b-d}	957de
Bora	41.5^{ba}	100^{ba}	58.5^{ba}	85.7^{c-g}	31.2^{e}	79.5^{a-c}	6875^{a-c}	1506.5^{a-c}
Nigus	41^{ba}	99.8^{ba}	58.8^{ba}	97.4^{ba}	39.4^{a}	79.5^{a-c}	6875^{a-c}	1464.6^{a-d}
Hiber	41^{ba}	104^{ba}	63^{ba}	94.9^{bdac}	37^{a-d}	79.5^{a-c}	5313^{cd}	1159.8^{b-e}
Dukem	41^{ba}	108^{a}	67^{a}	86.8 $^{b-g}$	37^{a-d}	72.5^{a-d}	4250^{d}	957.5^{de}
Magna	40.8^{ba}	105.3^{ba}	64.5^{ba}	89.5^{a-f}	33.8^{de}	66^{b-e}	6125^{b-d}	1464.6^{a-d}
Jitu	40.5^{ba}	99.8^{ba}	59.5^{ba}	94.9^{bdac}	39.4^{a}	81.3^{ba}	6125^{b-d}	957.5^{de}
Abola	40.3^{ba}	99.5^{ba}	59.5^{ba}	84.7^{d-g}	37^{a-d}	72.5^{a-d}	6875^{a-c}	1464.6^{a-d}
Local	40 ^{ba}	100.8^{ba}	50.8^{b}	99.5^{a}	40.5^{a}	83^{a}	6375^{a-d}	833.9^{e}
Kora	40^{ba}	90.8^{b}	60.8^{ba}	89.5^{a-f}	34.8^{c-e}	79.5^{a-c}	6125^{b-d}	1464.6^{a-d}
Dagim	38.8^{b}	102.^{ba}	64^{ba}	96 ^{bac}	38^{abc}	72.5^{a-d}	7500^{ab}	1552.7^{ab}
lsd (α=5%)	5	17.2	15.7	11.2	4.1	17	2127.2	544.7
cv%	8.2	12.3	19.4	9.2	9.1	17.3	23.6	31.4

Where, PL=Panicle Length, PH=Plant Height, DTH=Days to Heading, DM=Days to Maturity, GFP=Grain Filling Period, Y=Grain Yield, BM=Biomass yieLd, LI=Lodging Index, lsd=least significant difference and cv=coefficient of variation. Mean within a column followed by the same letter(s) within a column are not significantly different from each other at 5%.by DMRT.

Conclusion and Recommendation

The objective of the study was to evaluate and choose improved tef varieties that are adaptable, high yielding tef varieties, in which recently released by national and regional recent centers in Ethiopia. Analysis of variance means that performance of quantitative traits during this study showed that there have been important variations among tef varieties for all recorded traits like grain yield and yield related traits. For each locations highest grain yield obtained from improved tef varieties Boset (1746 weight unit/ha) followed by Dagim (1552 kg/ha). On the opposite hand, lowest grain yield was recorded by Werekiyu and Jitu (957 kg/ha) wherever standard check and farmer variety yields 1465 and 8334 kg ha-1 respectively. Grain yield was a vital character to be thought-about for selection choice to handle the target of this activity. For this reason improved varieties i.e. Boset and Dagim varieties were recommended for the study area and similar ecologies of Siltie zone and Guraghe zone, because the result the investigator recommends that the chosen varieties ought to go more through pre-extension and demonstration for further broader scaled multiplication and addressing farmers within the study area. And additionally it's extremely recommended that participatory analysis and selection activities for the study area to realize best improved varieties in line with farmer's preference criteria.

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