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Assessment of Enhanced Tef Varieties in the Basketo Zone, Southern Ethiopia

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Abstract

Tef is one of the most vital staple crops in Ethiopia, providing significant food security and economic value to the country. In this study, six distinct Tef varieties, including a local farmer cultivar, were evaluated under field conditions using a randomized complete block design (RCBD) in the Basketo Zone of Southern Ethiopia. The objective was to assess the performance of these varieties in terms of adaptation and grain yield potential, identifying those that exhibit superior performance in the region's specific agroecological conditions.A combined analysis of variance revealed notable differences in grain yield across the varieties, with the highest average yield of 1545 kg ha^{-1} observed in the variety 'Dagim.' This finding suggests that 'Dagim' is highly adaptable and well-suited to the growing conditions of the Basketo Zone. Additionally, other varieties demonstrated variable performance, indicating that genotype-by-environment interactions play a significant role in Tef productivity. Agronomic traits such as plant height, days to maturity, and lodging resistance were also considered in the evaluation to determine the overall suitability of each variety. Therefore, it is recommended that 'Dagim' be prioritized for further demonstration trials and pre-scaling activities in the Basketo Zone as well as in other regions with similar environmental conditions. The results of this evaluation could serve as a valuable guideline for improving Tef production, contributing to both food security and the livelihoods of farmers in the area. Furthermore, continued research and participatory selection with farmers could enhance the adoption and sustainability of high-yielding Tef varieties, ensuring long-term agricultural development in Ethiopia.

Keywords: Tef, Grain yield, Varieties, *genotype, agroecological*

INTRODUCTION

Tef (Eragrostis tef (Zucc.) Trotter) is a C4, self-pollinating, chasmogamous annual cereal that belongs to the Poaceae family and the Eragrostis genus, which includes approximately 350 species (Watson and Dallawitz, 1992). Tef is an allotetraploid plant with a chromosome count of 2n = 4x = 40, and the basic chromosome number for the genus Eragrostis is x =10 (Tavassoli, 1986). According to Stallknecht (1997), tef originated in Ethiopia between 4000-1000 B.C. and was likely cultivated before the introduction of wheat and barley in the region (Tadesse, 1975). Tef has been grown in East Africa for millennia as a staple food crop (D'Andrea, 2008) and is a warm-season annual grass that benefits from the C4 photosynthetic pathway (Miller, 2010).

In Ethiopia, tef is the leading cereal, cultivated annually on approximately 3.02 million hectares (CSA, 2019/20). The primary production regions include Amhara and Oromia, with smaller quantities grown in Tigray and the Southern Nations, Nationalities, and Peoples' Region (SNNPR) (Abebe, 2019). Tef accounts for 23.85% of the total cereal cultivation area and contributes 17.26% of the total cereal output (CSA, 2019/20). It

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is widely grown across Ethiopia, serving as a staple food crop and a critical component of food security (Valvow, 1951). Tef flour is primarily used to make enjera, a traditional Ethiopian dish. Additionally, the straw is a valuable livestock feed, especially for lactating cows and working oxen, and is priced higher than other cereal straws (Seyfu, 1997) [1-5].

Tef's popularity has expanded globally due to its gluten-free nature, making it suitable for individuals with celiac disease and diabetes. It is a promising substitute for gluten-containing grains such as wheat, barley, and rye in various food products, including pasta, bread, beer, cookies, and pancakes (Spaenij-Dekking et al., 2005).

The high iron content in tef makes it particularly beneficial in preventing pregnancy-related anemia (Alaunyte et al., 2012). The crop demonstrates resilience across different agro-ecological zones, tolerating both drought and waterlogging conditions. It is also relatively resistant to pests, particularly storage pests, making it a low-risk crop for farmers facing environmental uncertainties and climate change. Due to increasing market demand, nutritional value, and adaptability, tef production has expanded significantly (Ketema, 1997). However, productivity remains low in Ethiopia and the southern region due to challenges such as the lack of improved varieties, limited adoption of modern technologies, and pest and disease issues. Various tef varieties have been developed and released by Ethiopian agricultural research institutions to address these challenges. Evaluating their performance in southern Ethiopia is essential.

MATERIALS AND METHODS

The experiment was conducted in two locations within the Basketo Zone, South Ethiopia, during the 2023 cropping season. Six improved tef varieties—Kora, Quncho, Dagim, Tesfa, Flagote, and Nigussie—were sourced from the Debre Zeit Agricultural Research Center, alongside one local farmer's variety from the study area. The field trial employed a randomized complete block design with three replications. Each plot measured 3 meters in length and 4 meters in width, with spacing of 0.5 meters between plots and 1.5 meters between blocks. Seeds were manually sown at a rate of 10 kg/ha, with a row spacing of 20 cm. Agronomic practices were applied according to recommendations, including the application of 100 kg/ha of NPS and 50 kg/ha of urea. Weeds were controlled manually through hand weeding [6].

Data Collection

Five plants from the central rows of each plot were randomly selected for data collection, which included plant height, panicle length, and tiller number per plant. Yield evaluation was conducted by harvesting all plants from the central rows.

Data Analysis

Variance analysis was performed using Genestat software. Mean differences among varieties were assessed using the Least Significant Difference (LSD) test at a 5% probability level. A combined analysis of variance across the two locations was conducted to assess the varietal response to different environmental conditions.

RESULTS AND DISCUSSION

The combined analysis of variance revealed significant ($p<0.05$) differences among the tef varieties for panicle length, tiller number, and grain yield. However, plant height differences were not statistically significant. These findings align with earlier studies by Chondie and Bekele (2017) and Bakala et al. (2018), [7]which reported substantial variation in panicle length and grain yield among different tef varieties.

MATERIALS AND METHODS

The experiment was carried out at two locations in the Basketo Zone, South Ethiopia, during the 2023 cropping season. Seven tef varieties were evaluated, including six improved varieties—Kora, Quncho, Dagim, Tesfa, Flagote, and Nigussie—sourced from the Debre Zeit Agricultural Research Center, along with one local farmer cultivar from the study area. The field experiment followed a randomized complete block design (RCBD) with three replications. Each plot measured 3 meters in length and 4 meters in width, with spacing of 0.5 meters between plots and 1.5 meters between adjacent blocks. [8] The seeds were manually drilled at a rate of 10 kg/ha, maintaining a row spacing of 20 cm. All recommended agronomic practices were applied, including fertilization with 100 kg/ha of NPS and 50 kg/ha of urea. Weed control was managed manually through hand weeding.

Data Collection Five plants were randomly selected and tagged from the central rows of each plot for data collection on traits such as plant height, panicle length, and the number of tillers per plant. Additionally, all plants from the central rows were harvested to assess yield performance.

Data Analysis Analysis of variance (ANOVA) was conducted using Genestat software. Mean separation among the varieties was performed using the Least Significant Difference (LSD) test at a 5% probability level. A combined analysis of variance was carried out across the locations to determine the performance of the varieties based on the selected traits.

Results and Discussion The combined analysis of variance indicated significant differences ($p<0.05$) among the varieties in terms of panicle length, tiller number, and grain yield. However, plant height differences were found to be non-significant. Table 1 These findings align with previous studies by Chondie and Bekele (2017) and Bakala et al. (2018), which reported substantial variations in panicle length and grain yield among different tef varieties[9].

Table 1. Combined analysis of variance for yield and other agronomic traits of tef genotypes at Basketo Zone during the 2023 cropping season.

Source of variation	DF	GY	PH	TN	PL
Replication	2	1985.	18.5	0.245	32.13
Locations	1	456ns	3658.7**	0.095ns	65.88ns
Varieties	6	103529**	203.4ns	6.905*	72.09*
Location x varieties	6	2113.ns	328.6ns	5.962ns	65.85
Residual	24	5331.	189.2	2.029	25.33

GY = grain yield, PH =plant height, PN=panicle length, TN=tiller number, and DF=degree freedom.

MEAN PERFORMANCE OF GENOTYPES FOR PHENOLOGICAL CHARACTERS

Plant Height

Analysis of variances showed significant differences for plant height at Motikessa. Among the tested varieties, Quncho (129.9cm) and Dagim (121cm) recorded the longest plant height whereas the shortest plant height was recorded by farmer cultivar (106.3). Moreover, these results are in line with Abel (2005) who reported that plant height varied from 41 to 95 cm. However, at Zaba location, varieties performed similarly without significant differences for all studied traits except grain yield. Similarly, the result of the averaged data of both locations (Table 2) revealed statistically similar performance of varieties over locations. This finding is in line with Molla *et al*. (2012), who reported non-significant differences in plant height among tef varieties over years. This indicated the varieties had responded consistently across tested environments for the studied traits and this implied less variation among the tested locations.

Panicle Length [10]

At Motikessa location, variety Quncho (48.27 cm) followed by variety Kora (42.73) shows the longest panicle length without significant difference between the two whereas farmers' cultivar (30.33 cm) showed the shortest panicle length (Table 2). Another researcher like Aliyi *et al* (2016) who observed different tef varieties for panicle length across the various locations, ranging from 29.56cm to 41.18cm, also reported a similar result. However, at Zaba location, varieties performed without significant difference for all traits except grain yield. The average mean value for panicle length ranged from 43.57 cm for Quncho to 31.77c for farmer cultivar with a mean value of 37.82cm. This result is in line with the findings of yazachew *et,.al* (2021) who reported varied responses of genotypes for panicle length from 34cm to 42cm.

Table 2. Mean grain yield and yield components of tef varieties at Motikessa kebele (Basketo Zone) during the 2023 cropping season.

Treatments	PH (cm)	PL(cm)	TN	GY (kg/ha)
Dagim	121.0ab	41.13b	5.067b	1574a
Quncho	129.9a	48.27a	5.733b	1207cd
Kora	118.3bc	42.73ab	11.200a	1339b
Filagote	104.5d	32.93cd	8.133ab	1234c
Tesfa	111.3cd	38.33bc	6.533b	1144d
Nigussie	113.2bcd	39.80b	6.467b	1317b
Local	106.3d	30.33d	7.000b	1234c
Mean	114.9	39.08	7.16	1292.7
CV	4.6	8.8	25.7	11.4
LSD	9.32	6.12	3.27	77.84

GY = grain yield, PH =plant height, PN=panicle length, TN=tiller number

Table 3. Mean grain yield and yield components of tef varieties at Zaba (Basketo Zone during 2023 cropping season [11].

Treatments	Traits			
	PH(cm)	***PL(cm)***	***TN(cm)***	***GY(kg/ha)***
Dagim	98.13	39.00	7.800	1503a
Quncho	100.13	37.80	7.560	1221bcd
Kora	94.67	34.20	6.840	1383ab
Filagote	100.87	38.53	7.707	1204cd
Tesfa	94.80	36.40	7.280	1149d
Nigussie	92.00	35.00	6.600	1329bc
Local	93.27	35.07	7.013	1214cd
Mean	96.3	36.6	7.26	1286.14
CV	20.8	18.8	12.2	12.1
LSD	Ns	NS	NS	167.61

GY = grain yield, PH =plant height, PN=panicle length, TN=tiller number

Number of Tillers Per Plant

Analysis of variance showed significant differences among varieties for productive tillers at the Motikessa location. A maximum number of tillers per plant was recorded for variety Kora (11.2) followed by filagote (8.133) while the other tested genotypes perform a minimum number of tillers per plant without significant difference between them (Table 3). A similar result was reported by Aliyi *et al.* (2016). At the Zaba location, varieties performed in a similar way statistically for all parameters measured except grain yield. The mean value for average data showed the highest number of tillers per plant was recorded from varieties, Kora and Filagote without statistical variation.

Grain Yield

The mean performance of the varieties for grain yield for each location is presented in Tables 2 and 3. The varieties had over locations mean grain yield of 1289.6kg/ha (Table 4). A significant ($P < 0.05$) variation was observed among the experimental varieties in grain yield over locations (Table 2). The highest over location grain yield was obtained from variety Dagim (1545kg ha^{-1}) with a yield advantage of 16.8% over the tef productivities in the area whereas varieties Tesfa (1125c kg ha^{-1}), Kuncho (1214c), Filagote (1269c), and farmers' cultivar (1285c) gave the lowest grain yield without significant variation. This study was in line with fantie *et al* 2012, Ashamo and Belay 2012 and Bakala *et al,* 2018 who reported a significant difference in grain yield in tef varieties [12-14].

Table 4. Combined mean values of yield and yield-related traits for 2023 cropping season.

Treatments	PH (cm)	PL(cm)	TN	GY (kg/ha)
Dagim	103.4	37.27 bc	5.873c	1539a
Quncho	115.6	43.57a	6.587bc	1214c
Kora	105.6	39.20ab	9.133a	1361b
Filagote	109.2	37.43bc	8.093ab	1219c
Tesfa	106.6	37.93ab	6.853bc	1147c
Nigussie	101.4	37.60abc	6.940bc	1323b
Local	97.4	31.77c	6.987bc	1224c
Mean	105.6	37.82	7.21	1289.6
CV	13.0	13.3	19.8	5.7
LSD	NS	8.446	2.391	122.54

GY = grain yield, PH =plant height, PN=panicle length, TN=tiller number

CONCLUSION AND RECOMMENDATION

Tef is an important field crop in terms of area coverage, production, and utilization in the study area. The studied varieties were performed significantly for most studied traits. From the tested varieties, the highest grain yield (1539 kg/ha) was recorded for Dagim with a yield advantage of 16.8% over the farmer cultivar in the study area. Thus, a variety, Dagim could be demonstrated before large-scale production in the study areas and areas with similar agro-ecologies.

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