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SHORT COMMUNICATION

Assessment of genetic variability and heritability of recently released *Tef* [*Eragrostis tef* (Zucc.) Trotter] varieties in Awi zone, western Ethiopia

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ABSTRACT

The present study was conducted in Awi zone in Jawi District, Western Ethiopia to evaluate and identify well-adapted promising varieties and estimate heritability associated with genetic variability. The experiment comprised 13 varieties, including a local check using RCBD with three replications. The analysis of variance revealed significant differences among the varieties for most traits except days to seedling emergency and total biomass. Based on the result, the highest grain yield was recorded for DZ-Cr-438 (1056.7 kg ha^{-1}), followed by Areka-1 (945.0 kg ha^{-1}). The highest phenotypic coefficient of disparity (PCV) was recorded for days to 50% seedling emergence, plant height, and grain yield. The genotypic coefficient of variation (GCV) estimates was higher for panicle length and grain yield. High expected genetic advance values were observed for plant height and grain yield. This study found genetic variability for some important traits and suggested direct selection to improve grain yield.

Keywords: genetic advance, genotypic, phenotypic, *Tef*, yield

INTRODUCTION

Tef [*Eragrostis Tef* (Zucc.) Trotter, 2n=4x=40] is annually grown belongs under the Poaceae family and the genus of Eragrostis which is an imperative crop with its origin and center of diversity in Ethiopia (Turrill, 1929). It is the second most important among cereal crops in terms of production volume next to maize and the leading for production area coverage in Ethiopia (Dereje et al., 2018). Genetically, *Tef* is adaptable to a wide range of environmental conditions; however, its production and productivity varied with the altitude range (Kebebew et al., 2013). Different scientists revealed that the performance of one genotype drastically varied from environment to environment (Haldane, 1946; Bakala et al., 2018). *Tef* is a C_4 plant that has high chlorophyll a/b ratios and exploits CO_2 proficiently for the period of photosynthesis (Kebede et al., 1989); this makes it adaptable in wide range of altitude from 1100 to 2950m.a.s.l in Ethiopia (Hailu and Seyfu, 2000). Genetic variability is very essential for attaining appropriate crosses with enviable characters. *Tef* has a very traditional value for injera making and has the highest privilege engaging gusts in most parts of Ethiopia. It is also used for the preparation of local food porridge and alcoholic drink in most rural communities of the country (Wondimu and Mekbib, 2001). *Tef* is not only honored crop, but also the main dietary food for healthy existence and food security in some areas of Ethiopia (Girma, 2019). The dietary value of *Tef* grain is like to the conventional cereals and believed to have an excellent amino acid composition, lysine levels privileged than wheat and barley, while somewhat less than rice and oats. It is gluten free or contains very minute gluten and superior in several minerals mainly iron, now a days this makes popular in the health food markets of developed countries (Zhu, 2018).

In Awi zone *Tef* is prominently valued by farmers and consumers for human food consumptions mainly injera making in addition to barley, peas, and potatoes along with its straw is very indispensable for animal feed (Wondim, 2018). As the CSA (2017) report revealed that *Tef* is the 4th mostly produced among cereal crops next to maize, finger millet and wheat with an average grain yield of 1.6 t ha^{-1}. However, the production and productivity of this crop varied from place to place at this zone mainly in Jawe District, it is not well known and ignored crop due to several reasons. Among those absence of well adapted improved *Tef* variety in the environment and poor technology adoption techniques are the major production gaps. Concentrating only on cash oil crops mainly soybean and sesame production in addition other insect pests mostly shoot flies are also another production constraints for *Tef* at this District. But now the production and productivity of sesame be come at risk due to production reduction in the case of various biotic factors and farmers enforced to find alternative cash crops. Since now days *Tef* becomes a cash crop, they are interested to grow it. Genetic inconsistency is valuable for evaluating and takes accurate selection of adapted varieties and /or parents for identifying advanced heterosis to attain constructive recombinants. It is also vital for the enhancement of wider adaptation across environments. Therefore, the objectives of this study were evaluating and identifying well adapted promising variety/ies and estimate heritability associated with genetic variability.

MATERIALS AND METHODS

Description of the study site

This experiment was conducted at Jawi District in Worqi Meda Kebele at farmers' training center (FTC) in the 2020 main cropping season. Jawi is one of the Districts in the Amhara Region of Ethiopia. It is a part of the Awi Zone; Jawi is enclosed on the West by the Benishangul-Gumuz Region, on the North-by-North Gondar Zone, on the East by West Gojjam Zone, and on the Southeast by Dangila. Worqi Meda is geographically located latitude 11º21′30"N and longitude 36º39′3″E with an altitude of 1308masl. This area has unimodal with high rainfall pattern and the duration of main season starts in May and ends at the end of October. The soil type in the study area is Nitosol. The most commonly cultivated crops nearby the location are oil crops, and then maize (*Zea mays* L.), sorghum and finger millet are the next predominant and staple food crops followed by oil crops.

Materials and Experimental Design

Twelve recently released improved *Tef* varieties were taken from Debre Zeit Agricultural Research Center. One local check was included in the experiment with a total of thirteen varieties (**Table 1**). These varieties were planted 20cm inter row spacing using randomized complete block design (RCBD) in three replications and each variety was assigned at 4m^2 plot size along with the plot length and width of 2m each.

Data collection and analysis

Days to 50% of seed emergency: the number of days take the seed to be emerged and cover 50% of the plot area, days to heading: the number of days from 50% of the plots showing seedling emergence up to 50% of the plants in the plot flower, days to maturity: the number of days from 50% of the plots showing seedling emergence till to 50% of the plants in the plot success phenological maturity time evidenced via eye-ball decision of the plant take as the color is changed from green to color of white straw, plant height (cm): measured the length from the base of the stem of the main tiller to the tip of the panicle at the maturity stage, panicle length (cm): this was also measured from the node where the first panicle starts to branch till to the apex of the main panicle at maturity phase, total biomass (g): the weight of all the harvestable plot area including tillers harvested at the level of the ground then converted to kg ha^{-1}

and grain yield (g): this was also weighed the grain yield for all the harvested plot area of each plot after threshed and converted in to kg ha^{-1} during the analysis. The collected data were summarized and subjected to the analysis of variance (ANOVA) via using SAS Software (Version 9.4). The mean separation was done using least Significant Difference (LSD) at 5 % level of significance.

RESULTS AND DISCUSSION

The analysis of variance showed a significant variation among *Tef* genotypes at ($p<0.05$), for days to heading and grain yield, and highly significant difference ($p<0.01$) for days to maturity, plant height and panicle length at the main cropping seasons (Table 1). Fentie et al. (2012) , Yasin and Agedew (2017) and Bakala et al. (2018) also reported considerable variation in the days to maturity, plant height, panicle length and grain yield of different *Tef* varieties at the planted season.

Table 1. The analysis Result of Mean Performance *Tef* Varieties at Jawe (Worqi Meda) in the 2020 main season

Pedigree Name	Days to Seed emergency	Days to heading	Days to Maturity	Plant height (cm)	Panicle length (cm)	Total bio mass (kg ha^{-1})	Grain Yield (kg ha^{-1})
DZ-Cr-438 (RIL91A) (Dagiem)	7.0	50.7	89.3	121.5	46.6	7333.0	1056.7
DZ-Cr-429 (Neguse)	5.0	46.3	89.3	103.9	42.1	6167.0	878.8
DZ-Cr-457(Tesfa)	5.0	49.3	89.7	104.1	38.5	5167.0	657.9
DZ-Cr-442 (Felagot)	7.0	47.0	89.0	104.0	35.8	6167.0	585.0
DZ-Cr-419 (Hiberande)	5.3	50.3	90.3	120.7	49.4	7000.0	705.0
DZ-Cr-438 (RIL7) (Abola)	6.0	52.7	89.0	114.1	49.9	5167.0	558.8
Areka-1	6.0	48.0	90.0	102.9	41.4	5833.0	945.0
DZ-Cr-458 (RIL-18) (Ebba)	7.0	48.3	89.0	108.4	43.2	5000.0	700.0
DZ-Cr-453(RIL-120B) (Bora)	5.3	51.7	90.7	126.2	55.9	7000.0	590.0
DZ-Cr-429 (RIl29) (Washara)	6.0	50.0	90.7	118.8	52.1	6167.0	842.1
DZ-01-256-(Jitu)	7.0	49.7	91.7	132.3	52.4	6667.0	594.2
DZ-Cr-428(Mena)	7.3	49.0	90.3	116.5	44.7	7000.0	776.3
Local check	5.3	48.7	92.0	103.5	41.1	5833.0	467.1
Mean	6.1	49.4	90.1	113.6	45.6	6192.3	719.7
CV (%)	22.1	4.0	1.1	8.5	7.9	23.5	27.2
LSD (5%)	2.3	3.3*	1.7***	16.3***	6.1***	2449.1	330.5*

Days to heading showed significant difference among varieties evaluated in the main cropping season. Days to maturity is highly significant difference among varieties was observed in the main cropping season. Plant height is a vital character to be considered during advancing lodging tolerant *Tef* varieties. It is the cumulative of Culm Length (CL) and Panicle Length (PL). The analysis of variance explained highly significant difference among varieties in the study of 2012 main cropping season. The longest variety was DZ-01-256-(Jitu) (132.3cm) followed by DZ-Cr-438 (RIL91A) (Dagiem) (121.5cm) whereas the shortest was the local check (103.5cm). This investigation stated that the longest variety is liable to lodging leading to low grain yield. This result agreed with previously reported by Plaza et al (2013) which revealed that culm length and panicle length has a substantial role for developing lodging tolerant *Tef* variety. My investigation also revealed that DZ-01-256-(Jitu) was the highest plant height, but susceptible to lodging and provide low mean grain yield (594.2 kg ha^{-1}) however the second variety DZ-Cr-438 (RIL91A) (Dagiem) was the highest in plant height, but tolerant to lodging and gave the highest mean grain yield (1056.7 kg ha^{-1}).

On the contrary the shortest variety (local check) granted the lowest mean grain yield (467.1 kg ha^{-1}) due to the cumulative effect of genetic constituents of inheritable traits, shoofly and lodging problem. Previously similar research results were reported which agreed with my investigation in some characters such as Aliyi et al. (2016); Yasin and Agedew (2017) and Bakala et al. (2018) reported the presence of significant variation in plant height among *Tef* varieties.

Panicle length analysis result also revealed the existence of highly significant differences among varieties. The highest panicle length was recorded for DZ-Cr-453(RIL-120B) (Bora) (55.9cm) while the shortest panicle length was recorded for DZ-Cr-442 (Felagot) (35.8cm) (**Table 1**). Aliyi et al (2016); Yasin and Agedew (2017) and Bakala et al. (2018) stated the presence of significant difference in panicle length between various *Tef* varieties. Grain yield was also significant difference among the evaluated *Tef* varieties under the main season.

The highest grain yield was recorded for DZ-Cr-438 (RIL91A) (Dagiem) (1056.7 kg ha^{-1}) followed by Areka-1 (945.0 kg ha^{-1}) in 2020 main cropping season. The lowest grain yield was recorded for local check (467.1 kg ha^{-1}). Fentie et al. (2012); Aliyi et al. (2016); Yasin and Agedew (2017) and Bakala et al. (2018) also reported the existence of significant variation in grain yield among different *Tef* varieties

Estimations of the phenotypic and genotypic variances

The estimation of genotypic and phenotypic variance, genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), heritability (h^2), genetic advance (GA) and genetic advance as the percentage of mean (GAM) are presented in (Table 1). The lowest and highest estimated phenotypic variances were observed 1.6 for days to maturity to 55027.8 for grain yield. Similarly, the lowest and highest genotypic variances were recorded 0.1 for days to seed emergence to 16566.8 for grain yield. Conversely, GCV values of better than 10% were observed for panicle length and grain yield (12.4% and 17.9%) respectively. Similarly, days to 50% seedling emergency, plant height, panicle length and grain yield were observed greater than 10% of the PCV values (23.0%, 11.14%, 14.7% and 32.6%) respectively while the left behind characters were below 10%. (**Table 2**).

The higher GCV and PCV values noticed for some of the characters might be an indication for the reality of wide range of variation to advance those characters. The lower for GCV phenological traits and plant height implies the complexity of utilizing these characters through selection. Generally, in this research the PCV values were higher than the GCV values for all studied characters explain the environmental influence were higher for the expression of the characters under exploration. This result is in agreement with previously reported by Asefa et al. (1999); Kefyalwe et al. (2000) and Solomon et al. (2009).

Table 2. PCV, GCV, GA and h^2 of mean grain yield and other related traits in 2020 main season at Jawi District

Traits	Means	Range max	Range mini	Msg	σ^2P	σ^2g	σ^2e	PCV (%)	GCV (%)	h^2 (%)	GA	GAM (%)
Days to 50% seedling emergence	6.1	7.0	5.0	2.2	2.0	0.1	1.8	23	6.2	7.19	0.2	3.4
Days to heading	49.4	52.7	46.3	9.4	5.8	1.8	3.9	4.9	2.7	31.8	1.6	3.2
Days to Maturity	90.1	92	89	3.0	1.6	0.7	1.0	1.4	0.9	40.7	1.1	1.2
Plant height(cm)	113.6	132.3	102.9	293.7	160.2	66.7	93.5	11.14	7.2	41.6	10.9	9.6
Panicle length(cm)	45.6	55.9	35.8	108.2	44.8	31.7	13.1	14.7	12.4	70.7	9.8	21.4
Grain yield (kg ha^{-1})	719.7	1056.7	467.1	88161.3	55027.8	16566.8	38461	32.6	17.9	30.1	145.7	20.2

Msg= mean square of genotypes, Max= maximum mean values of the trait, Mini= minimum values of the trait, PCV=phenotypic coefficient of variation, GCV= genotypic coefficient of variation, GA=genetic advance, h^2=heritability, GAM = genetic advance as the percentage of the mean.

The estimate of probable genetic advance evaluates the expected pace of genetic gain in selection, was inconsistent among characters, signifying the lack of additive genetic variance. However, high expected genetic advance estimates were obtained for plant height and grain yield.

Heritability (h^2) was calculated as the ratio of genotypic variance over phenotypic variance. Both estimation of high heritability coupled with the genetic advance as the percentage of mean values was recorded for panicle length (70.74% and 11.7) respectively. High genetic advance as the percentage of mean values were also observed for panicle length and grain yield, but the heritability values for both plant height and grain yield were below 40% (**Table 2**). The low heritability and genetic advance estimates for phenological characters suggested that breeding for these characters improvement in *Tef* would be a serious job. Hence days to 50% seedling emergence, days to 50% heading and days to maturity were highly influenced by the environment. Therefore, considering the production environment associated with variety selection will be the principal concern enhancing the production and productivity of *Tef.* Similarly, plant breeders should consider during the advancement and designing of *Tef* improvement through important trait selection including panicle length and grain yield.

CONCLUSION

These research findings indicated the presence of substantial variations among the 13 varieties for most evaluated characters which provides opportunity to breeders for the advancement. On the other hand, the phenotypic coefficients of variation (PCV) values of all studied characters were observed higher than the genotypic coefficient of variation values. This implies the environment is the main factor for *Tef* production at different areas. Therefore, selecting and promoting well adapted *Tef* variety is the best solution to increase the adoption, production and productivity. Hence this research was conducted for a single location and one year, it is better to be evaluated across locations and years to strength this recommendation.

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COMPETING INTERESTS

The authors declare that they have no competing interests

DATA AVAILABILITY STATEMENT

The raw data used to support the findings of this study are available from the corresponding author upon request.

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