P-ISSN: 2305-6622; E-ISSN: 2306-3599

International Journal of Agriculture and Biosciences

www.ijagbio.com; editor@ijagbio.com

Research Article

Screening of Tef [*Eragrostis tef* (Zucc.) Trotter] Genotypes under Irrigation at Raya Valley, Northern, Ethiopia

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Article History: Received: November 23, 2018 Revised: January 22, 2019 Accepted: February 04, 2019

ABSTRACT

Tef is an indigenous and major staple cereal crop in Ethiopia. It adapts to a wide range of agro-ecological conditions. Therefore, this experiment was conducted to select high yielding genotype for future improvement program under irrigation condition. A total of forty- nine tef genotypes including two released varieties as standard check were evaluated in simple lattice design with two replications on research station of Mehoni Agricultural Research Center, Southern Tigray under irrigation condition of 2016 and 2017. From the combined analysis of the two consecutive years, genotypes by year interaction showed highly significant difference for days to heading, plant height and grain yield as well as highly significant differences were observed among tef genotypes for panicle length and grain yield and significant difference for days to heading, days to maturity and shoot biomass. The highest shoot biomass were recorded at the two genotypes DZ-Cr-387XGA-10-3(RIL-217) (14.25 t ha^{-1}), and GA-10-3XKaymurri (RIL-186) (14.250 t ha^{-1}). The highest grain yield was obtained at genotype Kaymurrix3774-13(RIL-72) (3.40 t ha^{-1}), GA-10-3XKaymurri (RIL-248) (3.34 t ha^{-1}), and GA-10 3XKaymurri (RIL-186) (3.32 t ha^{-1}). Therefore, it can be recommended to use Kaymurrix3774-13(RIL-72), GA-10-3XKaymurri (RIL-248) and GA-10 3XKaymurri (RIL-186) genotypes for tef improvement by breeders in the study area under irrigation.

Key words: Eragrostis tef, Genotype, Screening, Year

INTRODUCTION

Tef [*Eragrostis tef* (Zucc.) Trotter] is an indigenous staple cereal crop of Ethiopia, occupying about 2.6 million hectares (23% of the grain crop area) of land which is more than any other major cereals such as maize (16%), sorghum (14%) and wheat (13%) (CSA, 2008). Ethiopians are the first domesticator of this unique cereal in the world. The geographic center of origin of tef is Ethiopia (Vavilov, 1951). Records of tef cultivation dates back to between 1000 and 400 B.C in the pre-Semitic peoples of Ethiopia (Porters, 1976). According to Costanza *et al*. (1979) tef was distributed to several countries in the 19th century, and now it is cultivated as a forage grass in Australia, India, Kenya and South Africa. According to Seyfu (1997), the Royal Botanical Gardens, Kew, imported kernel from Ethiopian in 1866 and distributed to India, Australia, the USA and South Africa He also added that Burt Davy in 1916 introduced tef to California, Malawi, Zaire, India, Sri Lanka, Australia, New Zealand and Argentina.

Tef has a wide range of ecological adaptation in Ethiopia and grows well under stress environments better than other cereals known worldwide (Hailu and Peat, 1996). Because of this, it is said to be a “low-risk" crop for farmers. According to Seyfu (1997) it can be grown from sea level up to 2800 m.a.s.l, under various rainfalls, temperature and soil regimes. However, He emphasized that for better performance, it requires an altitude of 1800-2100 m.a.s.l., annual rain fall of 750-850 mm, and a temperature range of 10°C-27°C. It is predominantly cultivated on sandy loam to black clay soils. In addition, its high price in the market, reduction of post-harvest management cost, fewer disease and pest problems, sustained demand from consumer, are some of the specific merits that makes tef important and preferred by farmers (Seyfu, 1997).

Nutritionally, tef has as much, or even more food value than the major grains: wheat, barley and maize. This is probably because tef is eaten in the whole grain. Tef grain contains high levels of several minerals such as iron, magnesium, calcium, phosphorus, and thiamine (National

Cite This Article as: Degife G, E Demis and G Haftu, 2019. Screening of tef [*Eragrostis tef* (Zucc.) trotter] genotypes under irrigation at Raya Valley, Northern, Ethiopia. Inter J Agri Biosci, 8(1): 50-55. www.ijagbio.com

Research Council, 1996; Mengesha, 1965). It is an excellent source of essential amino acids, especially lysine, the amino acid that is most often deficient in common grain foods including wheat and millet (Lovis, 2003; Spaenij-Dekking *et al.,* 2005). Unlike common cereals (wheat, corn, and barley), tef has balanced nutrition but is low in gluten, which makes a good diet source for gluten intolerant people (Stallknecht *et al*., 1993). The seeds of the tef plant are among the smallest of cereals (Belay *et al*., 2009). According to (Wrigley *et al*., 2016), the mass of one tef grain is only 0.6-0.8% of the total mass of a wheat grain. Because of this, tef grain is milled into whole-grain flour. This results in a much higher content of fiber and other nutrients such as minerals, vitamins and bioactive phenolic compounds than most other cereals (Gebremariam *et al*., 2014). The color of tef seed varies from white to dark brown. Tef in Ethiopia, is mainly used to make a traditional fermented-circular soft bread called *injera* or flat bread (Tatham *et al*., 1995). Other than Ethiopia, there was no interest in tef in the rest of the world for centuries. Now-a-days, there is a worldwide interest in cultivating this cereal. The Netherlands was for a long time, the only country cultivating tef in Europe (Wrigley *et al*., 2016). The high global demand of tef is a result of its high levels of essential amino acids, gluten-free nature and high mineral contents (Zhang *et al*., 2016).

Among the cultivated food crops grown in Ethiopia, Tef ranks first, with an estimated production area of 2,730,272.95 ha and a mean productivity of 1.38 t ha^{-1} (CSA, 2013). Tef has the genetic potential to yield up to 6 t ha^{-1} (Ketema, 1993). The low productivity of Tef in Ethiopia is mainly attributed to its susceptibility to lodging, its small seed size, poor pre- and post-harvest agronomic management practices, and moisture stresses (Ketema, 1997). Drought is one of the main challenges facing world agriculture, but its effects may vary from region to region. Ethiopia is one of the sub-Saharan African countries facing recurrent droughts leading to low crop productivity or crop failure and food insufficiency (Deressa and Hassan, 2009). Declining levels and high variability of rainfall is among the main causes for low crop productivity in different parts of Ethiopia (Tilahun, 2006). Yield losses of tef due to low moisture are estimated to reach up to 40% during severe stress (Ayele, 1993). Furthermore, yield reduction of up to 77% has been reported to have occurred as a result of drought at the anthesis stage of tef (Takele, 2001). Haileslassie *et al*., (2011) studied tef production constraints in Tigray Region of northern Ethiopia, and found that in the highlands, poor soil fertility, and in the lowlands, low moisture stress, were the major constraints affecting tef production. It is among the most dominant staple major cereal crops in Raya Valley Southern Tigray. In south Tigray, it was covered an estimated total land area of 44,036.04 ha (22.4% of cereal crops coverage). Its average productivity was 1.397 t ha^{-1} which is less than the national average productivity of 1.664 t ha^{-1} in 2016/ 2017 cropping season (CSA, 2017). The low productivity of tef in Raya Valley is due to lack of improved varieties and moisture stresses, to alleviate this problem releasing of a high yielding and adapted varieties under irrigation at Raya Valley of Southern Tigray and similar areas. Therefore, the objectives of the study:

- To select high yielding genotype for future improvement program under irrigation condition.

MATERIALS AND METHODS

Description of the Experimental Area

The experiment was carried out at Mehoni Agricultural Research center (MARC), Ethiopia in 2016 and 2017 cropping season under irrigation conditions. Mehoni agricultural research center is suited about 678 km from the capital city of Addis Ababa and about 120 km to south from Mekelle, the capital city of Tigray regional state, Northern Ethiopia. Geographically, the experimental site is located at 12° 41'50" North latitude and 39° 42'08" East longitude with an altitude of 1578 m.a.s.l. The site receives a mean annual rainfall of 750 mm with an average minimum and maximum temperature of 22°C and 32°C, respectively. The soil textural class of the experimental area is clay loam with pH of 7.9-8.1 (Haileslassie *et al.*, 2015).

Experimental Materials and Design

A total of Forty nine tef genotypes used in the experiment which were obtained from Debre Zeit Agricultural Research Center, the national tef research coordinating center (Table 1). The experiment was arranged in Simple lattice design with two replicates. Each experimental plot had 5 rows at a spacing of 20 cm, having plot length of 2 m and width of 1 m. Spacing between plots was 1 m and the distances between replications were 1.5 m.

Experimental Procedures

The experimental plots were prepared by using tractor ploughing and harrowing. Rows were made by hand pulled row-marker. Fertilizer was applied at the rate of 60 kg DAP ha^{-1} and 60 kg urea ha^{-1}. Sowing was done by hand drilling at the seed rate of 15 kg ha^{-1}. All appropriate agronomic practices such as weeding, watering and others were conducted uniformly at the experimental field.

Data Collection

Data on days to heading, days to maturity, shoot biomass (t ha^{-1}) and grain yield (t ha^{-1}) were assessed on plot basis. On the other hand, plant height (cm) and panicle length (cm) were recorded on previously selected and tagged five random samples of plants from the central parts of each plot. The three central rows were used for data collection on plot basis, whereas mean values of the five random samples of plants per plot were then used for the analyses of data collected on individual plant basis.

Data Analysis

All the collected agronomic and growth components data were subjected to analysis of variance (ANOVA) using SAS statistical software (9.2) version. Combined analysis of variance over years were carried out and Duncan's Multiple Range Test (DMRT) test was used to compare the mean separations at $P<0.05$.

Table 1: List and pedigree of the forty nine tef genotypes including two released varieties

Genotype No.	Pedigree	Genotype No.	Pedigree
G1	Boset (standard check)	G26	Kaymurrix3774-13(RIL-133)
G2	Kaymurrix3774-13(RIL-144)	G27	GA-10-3XKaymurri(RIL-9)
G3	Kaymurrix3774-13(RIL-87)	G28	Kaymurrix3774-13(RIL-10)
G4	GA-10-3XKaymurri(RIL-241)	G29	DZ-Cr-387XGA-10-3(RIL-181)
G5	Kaymurrix3774-13(RIL-215)	G30	Kaymurrix3774-13(RIL-147)
G6	Kaymurrix3774-13(RIL-105)	G31	Kaymurrix3774-13(RIL-136)
G7	DZ-Cr-387XGA-10-3(RIL-156)	G32	GA-10-3XKaymurri(RIL-186)
G8	GA-10-3XKaymurri(RIL-273)	G33	Kaymurrix3774-13(RIL-68)
G9	GA-10-3XKaymurri(RIL-263)	G34	Quncho (standard check)
G10	GA-10-3XKaymurri(RIL-261)	G35	Kaymurrix3774-13(RIL-80)
G11	Kaymurrix3774-13(RIL-71)	G36	GA-10-3XKaymurri(RIL-275)
G12	Kaymurrix3774-13(RIL-55)	G37	Kaymurrix3774-13(RIL-173)
G13	GA-10-3XKaymurii(RIL-143)	G38	GA-10-3XKaymurri(RIL NO.146)
G14	Kaymurrix3774-13(RIL-66)	G39	Kaymurrix3774-13(RIL NO.60)
G15	Kaymurrix3774-13(RIL-202)	G40	Kaymurrix3774-13(RIL-110)
G16	DZ-Cr-387XGA-10-3(RIL-154)	G41	Kaymurrix3774-13(RIL-45)
G17	DZ-Cr-387XGA-10-3(RIL NO.72)	G42	GA-10-3XKaymurri(RIL-196)
G18	GA-10-3XKaymurri(RIL-192)	G43	Kaymurrix3774-13(RIL-7)
G19	Kaymurrix3774-13(RIL NO.58)	G44	Kaymurrix3774-13(RIL-218)
G20	DZ-Cr-387XGA-10-3(RIL-193)	G45	GA-10-3XKaymurri(RIL-257)
G21	GA-10-3XKaymurri(RIL-171)	G46	DZ-Cr-387XGA-10-3(RIL-168)
G22	DZ-Cr-387XGA-10-3(RIL-217)	G47	GA-10-3XKaymurri(RIL NO.52)
G23	GA-10-3XKaymurri(RIL-12)	G48	Kaymurrix3774-13(RIL-72)
G24	GA-10-3XKaymurri(RIL-248)	G49	DZ-Cr-387XGA-10-3(RIL-212)
G25	Kaymurrix3774-13(RIL-220)		

Source: from Debre Zeit Agricultural Research Center.

RESULTS AND DISCUSSION

Analysis of variance

The analyses of variance results showed genotypes by year interaction showed highly significant (*P<0.01*) difference for days to heading, plant height and grain yield. However the interaction exhibited also non-significant for traits days to maturity, panicle length and shoot biomass while highly significant differences (*P<0.01*) were observed among genotypes for panicle length and grain yield and significant (P<0.05) difference were observed for days to heading, days to maturity and shoot biomass but non-significant difference for plant height (Table 2). Such considerable of variations would provide a good opportunity for yield improvement. Bakala *et al*. (2018) also conducted performance evaluation and adaptation trial of tef genotypes for moisture stress areas of Borena, Southern Oromia. They reported considerable variation in the days to flowering, plant height and grain yield of different Tef varieties when planted over years. However, this result is dis agreement based on interaction significant difference for days to maturity and spike length were observed by Fentie *et al*. (2012).

Mean performance of genotypes phenological characters

Days to heading

The variation among genotypes for days to heading ranged from 52.5 to 64.5. About 24.50% genotypes had mean performances lower than the earliest standard check (Boset) for character days to heading, indicating those genotypes were early heading as compared to the others while only one new entry genotypes showed late heading over late heading check (Quncho) for days to heading (Table 3). This implied that the higher chance of selecting early genotypes which can escape the terminal moisture stress which is one of the tef production problems in the study area. The longest days to heading (64.5) was recorded at DZ-Cr-387XGA-10-3(RIL-212) genotype whereas the lowest value was recorded at genotype GA-10-3XKaymurri (RIL-192) (52.5 days) and GA-10-3XKaymurri (RIL-273) (52.7 days).

Days to maturity

As the study result indicates, significant difference was observed among the tested genotypes for days to maturity but it was non-significant difference for the interaction over year. The genotypes variation for days to maturity ranged from 89.7 to 96 days. The genotype GA-10-3XKaymurri (RIL-171) (89.7) had short period for maturity while DZ-Cr-387XGA-10-3(RIL NO.72) (96.0) and DZ-Cr-387XGA-10-3(RIL-212) had long period for maturity. As compared to the overall genotypes mean of days to maturity, among 49 genotypes, 44.90 % exhibited lower days to maturity while as compared to the early maturing check variety (Boset), 53.06% of the genotypes were early maturing than the check. This suggested that the higher chance of selecting early genotypes (Table 3). These results are in harmony with working on germplasm evaluation; Kebebew *et al*. (1999) reported that days to maturity ranged from about 87 to 113.

Plant height

Plant height is an important features that positively contribute to yield. The genotypes variation for plant height ranged from 79.2 to 94.4 cm. Genotype Kaymurrix3774-13(RIL-202) (94.4 cm) and DZ-Cr-387XGA-10-3(RIL NO.72) (94.2) cm were recorded the highest plant height while the lowest plant height was recorded at genotype GA-10-3XKaymurri (RIL NO.146) (79.2 cm) (Table 3). Among 49 genotypes 18 genotypes

Table 2: Mean square of combined analysis the screening tef genotypes from the 2016-2017 years

SOV	DF	DH	DM	PH(cm)	PL(cm)	SBM (t ha^{-1})	GY(t ha^{-1})
Rep	1	33.14	8.91	0.05	1.25	1.91	0.41
B	6	7.73	2.29	49.94	26.58	39.51	0.71
Yr	1	8690.59**	894.12**	1.13^{ns}	702.15**	6457.16**	1296.49**
G	48	12.67*	8.14*	35.96^{ns}	40.28**	78.96*	6.17**
BXG	33	3.96^{ns}	8.69*	33.45^{ns}	20.03**	38.99^{ns}	0.94^{ns}
G xYr	48	12.68**	7.02^{ns}	72.32**	0.05^{ns}	77.78^{ns}	7.55**
G xYr x B	39	9.75^{ns}	6.13^{ns}	47.45*	0.04^{ns}	48.64^{ns}	1.07^{ns}
Error	13	4.67	3.1	18.85	0.58	33.09	0.99
CV (%)	-	3.80	1.90	4.92	2.28	1.62	1.25

ns= non-significant, *=significant, **= highly significant, at P<0.05; SOV= Source of variance, DF=Degree of freedom, CV=Coefficient of variance, G= Genotype, B=block, Yr= year, G= genotype, BxG= block by genotype interaction, GxYr=genotype by year interaction, G xYr x B= genotype by year by block, DF= degree freedom, DH= days to heading, DM= days to maturity, PH= plant height, PL= panicle length, SBM= shoot biomass tone per hectare and GY= grain yield tone per hectare.

Table 3: Combined mean of Screening tef Genotypes from 2016 and 2017 cropping seasons

Genotypes	DH	DM	PH	PL(cm)	SBM (tha^{-1})	GY (tha^{-1})
Kaymurrix3774-13(RIL-173)	58.7^{b-g}	94.2^{a-d}	84.8^{f-k}	32.0^{m-o}	10.50^{d-k}	2.23^{l-t}
Kaymurrix3774-13(RIL-202)	55.0^{h-n}	92.5^{b-k}	94.4^{a}	37.8^{b-d}	11.50^{a-j}	2.89^{a-h}
GA-10-3XKaymurri(RIL-275)	55.7^{f-n}	91.0^{h-k}	91.2^{a-g}	32.6^{k-n}	8.00^{k}	1.99^{q-v}
GA-10-3XKaymurri(RIL-192)	52.5^{n}	92.7^{b-k}	85.1^{f-k}	30.2^{qr}	10.37^{e-k}	2.26^{k-t}
GA-10-3XKaymurri(RIL-171)	53.7^{j-n}	89.7^{k}	86.4^{c-k}	32.3^{k-o}	11.37^{a-j}	2.88^{a-h}
GA-10-3XKaymurri(RIL-261)	56.5^{c-m}	93.0^{a-j}	90.8^{a-h}	33.2^{j-m}	12.37^{a-g}	2.64^{e-o}
GA-10-3XKaymurri(RIL-273)	52.7^{mn}	94.2^{a-e}	85.9^{d-k}	26.5^{t}	10.75^{c-k}	2.79^{b-k}
Kaymurrix3774-13(RIL-147)	58.0^{b-h}	93.5^{a-i}	89.7^{a-i}	36.2^{ef}	12.87^{a-e}	3.10^{a-e}
GA-10-3XKaymurri(RIL-248)	53.7^{j-n}	93.2^{a-j}	93.2^{a-d}	34.7^{gh}	13.87^{a-c}	3.34^{ab}
Kaymurrix3774-13(RIL-71)	56.7^{c-k}	93.2^{a-j}	84.8^{f-k}	32.3^{k-o}	10.12^{e-k}	2.31^{i-t}
Kaymurrix3774-13(RIL-45)	59.7^{bcd}	95.0^{abc}	85.8^{d-k}	33.6^{h-k}	10.62^{d-k}	2.11^{o-v}
Kaymurrix3774-13(RIL-72)	58.7^{b-g}	95.0^{abc}	92.9^{a-d}	35.1^{fg}	14.12^{ab}	3.40^{a}
Kaymurrix3774-13(RIL-87)	58.7^{b-g}	92.0^{c-k}	93.4^{a-c}	36.1^{ef}	13.62^{a-d}	2.88^{a-h}
Kaymurrix3774-13(RIL-133)	56.0^{e-n}	93.0^{a-j}	88.1^{a-i}	32.3^{k-o}	9.15^{i-k}	2.15^{n-v}
Kaymurrix3774-13(RIL-66)	57.0^{c-j}	93.7^{a-h}	93.0^{a-d}	36.7^{de}	13.25^{a-e}	3.30^{a-c}
Kaymurrix3774-13(RIL-10)	55.2^{g-n}	90.7^{i-k}	86.8^{b-j}	34.0^{g-j}	11.62^{a-j}	2.17^{mv}
Kaymurrix3774-13(RIL-80)	59.5^{b-e}	93.5^{a-i}	87.4^{a-j}	32.1^{l-o}	10.87^{c-k}	2.48^{g-r}
Kaymurrix3774-13(RIL-55)	55.7^{f-n}	95.2^{ab}	90.8^{a-h}	34.7^{gh}	12.12^{a-i}	3.24^{a-d}
Kaymurrix3774-13(RIL-68)	60.0^{bc}	92.0^{c-k}	85.2^{e-k}	33.2^{j-m}	118.75^{a-j}	3.05^{a-f}
Kaymurrix3774-13(RIL-105)	56.5^{c-m}	91.0^{h-k}	84.0^{g-k}	32.3^{k-o}	87.50^{jk}	1.65^{v}
GA-10-3XKaymurri(RIL-241)	56.7^{c-l}	90.7^{i-k}	92.5^{a-e}	37.3^{c-e}	92.50^{g-k}	1.79^{tuv}
Kaymurrix3774-13(RIL-144)	57.2^{c-j}	91.2^{d-k}	93.4^{a-c}	36.2^{ef}	11.87^{a-j}	2.70^{dm}
DZ-Cr-387XGA-10-3(RIL-168)	57.5^{c-h}	94.0^{a-g}	80.5^{jk}	22.7^{u}	10.12^{e-k}	1.95^{r-v}
GA-10-3XKaymurri(RIL-196)	57.0^{c-j}	94.2^{a-f}	88.6^{a-i}	34.6^{g-i}	8.85^{jk}	2.22^{mu}
DZ-Cr-387XGA-10-3(RIL-217)	57.2^{c-j}	93.2^{a-j}	90.6^{a-i}	38.5^{a-c}	14.25^{a}	2.29^{j-t}
Kaymurrix3774-13(RIL-7)	56.2^{d-n}	90.2^{jk}	90.0^{a-i}	33.4^{i-l}	9.62^{f-k}	1.67^{uv}
GA-10-3XKaymurri(RIL-257)	58.7^{b-g}	93.7^{a-h}	84.9^{f-k}	33.3^{j-m}	10.25^{e-k}	2.23^{m-t}
DZ-Cr-387XGA-10-3(RIL-181)	53.0^{l-n}	93.5^{a-i}	87.1^{a-j}	30.2^{qr}	11.37^{a-j}	2.69^{d-n}
GA-10-3XKaymurri(RIL-186)	53.2^{k-n}	92.5^{b-k}	91.8^{a-e}	35.2^{fg}	14.25^{a}	3.31^{a-c}
DZ-Cr-387XGA-10-3(RIL-193)	53.7^{j-n}	91.7^{d-k}	89.3^{a-i}	33.0^{j-m}	10.50^{d-k}	2.08^{p-v}
GA-10-3XKaymurri(RIL-263)	58.2^{b-h}	93.2^{a-j}	86.0^{c-k}	37.1^{de}	11.00^{b-k}	2.40^{h-r}
GA-10-3XKaymurii(RIL-143)	55.7^{f-n}	92.0^{c-k}	93.9^{ab}	39.5^{a}	13.00^{a-e}	3.26^{a-c}
Kaymurrix3774-13(RIL-215)	54.7^{h-n}	92.2^{b-k}	86.9^{b-j}	32.1^{m-o}	9.25^{g-k}	1.83^{s-v}
DZ-Cr-387XGA-10-3(RIL-156)	59.0^{b-f}	93.7^{a-h}	88.1^{a-i}	32.1^{l-o}	10.87^{c-k}	2.51^{f-q}
DZ-Cr-387XGA-10-3(RIL-154)	56.7^{c-l}	91.7^{d-k}	83.5^{h-k}	34.9^{fg}	13.00^{a-e}	2.60^{e-p}
DZ-Cr-387XGA-10-3(RIL-212)	64.5^{a}	96.0^{a}	83.3^{i-k}	27.8^{s}	9.60^{f-k}	2.00^{q-v}
Kaymurrix3774-13(RIL-220)	55.7^{f-n}	91.0^{h-k}	89.2^{a-i}	32.9^{j-n}	12.62^{a-f}	2.89^{a-h}
Kaymurrix3774-13(RIL-110)	56.7^{c-l}	91.2^{e-k}	91.0^{a-g}	33.5^{h-k}	13.62^{a-d}	2.85^{b-i}
Kaymurrix3774-13(RIL-218)	58.2^{b-h}	92.7^{b-k}	86.1^{c-k}	32.4^{k-o}	10.25^{e-k}	2.38^{h-s}
GA-10-3XKaymurri(RIL-9)	53.7^{j-n}	91.2^{g-k}	91.6^{a-f}	33.4^{i-k}	12.12^{a-i}	2.83^{b-j}

showed superiority over highest performing check (Quncho) for plant height while 25 genotypes had mean number of plant height greater than the highest performing check variety (Boset). This results in line with, Abel, (2005) reported that plant height varied from 41 cm to 95cm.

Panicle Length

Genotype GA-10-3XKaymurii (RIL-143) (39.5 cm) shows maximum panicle length followed by genotype DZ-Cr-387XGA-10-3(RIL-217) (38.5 cm) whereas genotype DZ-Cr-387XGA-10-3(RIL-168) (22.7 cm) shows minimum panicle length (Table 3). Eleven genotypes with longer panicle length than the check (Quncho), the longest panicle length between check varieties. This results in line with, Abel, (2005) reported that panicle length varied from 17cm to 42cm. similar result was also reported by Aliyi *et al.* (2016) who observed that among the tested tef varieties for panicle length across the study locations which was ranged from 29.56 to 41.18.

Table 4: Combined mean of Screening tef Genotypes from 2016 and 2017 cropping seasons) (continued)

GA-10-3XKaymurri(RIL-12)	57.2^{c-j}	91.2^{f-k}	85.0^{f-k}	31.2^{o-q}	10.75^{c-k}	2.49^{g-q}
Kaymurrix3774-13(RIL-136)	58.2^{b-h}	90.2^{jk}	89.7^{a-i}	30.4^{p-r}	11.12^{a-k}	2.70^{dm}
GA-10-3XKaymurri(RIL NO.146)	60.0^{bc}	92.2^{b-k}	79.2^{k}	29.6^{r}	9.12^{i-k}	1.94^{r-v}
Kaymurrix3774-13(RIL NO.60)	57.0^{c-j}	92.7^{b-k}	86.3^{c-k}	31.6^{n-p}	12.37^{a-h}	2.52^{f-q}
GA-10-3XKaymurri(RIL NO.52)	59.0^{b-f}	91.0^{h-k}	84.1^{g-k}	36.8^{de}	9.24^{h-k}	2.24^{l-t}
Kaymurrix3774-13(RIL NO.58)	59.7^{b-d}	92.7^{b-k}	87.8^{a-j}	35.3^{fg}	9.62^{f-k}	2.24^{l-t}
DZ-Cr-387XGA-10-3(RIL NO.72)	54.0^{i-n}	96.0^{a}	94.2^{ab}	38.7^{ab}	14.12^{ab}	2.45^{g-r}
Quncho	61.7^{ab}	93.5^{a-i}	89.6^{a-i}	35.3^{fg}	12.62^{a-f}	2.99^{a-g}
Boset	55.2^{g-n}	93.0^{b-j}	87.5^{a-j}	27.2^{st}	11.25^{a-j}	2.78^{c-l}
Over all means	56.85	92.66	88.27	33.35	11.30	2.52
Range Max.	64.5	96	94.4	39.5	14.25	3.4
Min.	52.5	89.7	79.2	22.7	8.00	1.65
CV (%)	3.80	1.9	4.92	2.28	16.22	12.46

Means followed by the same letter in the same column are not significant difference at P<0.05; where DH= days to heading, DM= days to maturity, PH= plant height, PL= panicle length, SBM (t ha^{-1}) = shoot biomass tone per hectare, GY (t ha^{-1}) = grain yield tone per hectare, LSD= least significant difference and CV= coefficient of variance.

Yield and yield component

Shoot biomass

The highest shoot biomass tone per hectare were recorded at genotypes GA-10-3XKaymurri (RIL-248) (13.87 t ha^{-1}), Kaymurrix3774-13(RIL-72) (14.12 t ha^{-1}), DZ-Cr-387XGA-10-3(RIL-217) (14.25 t ha^{-1}), GA-10-3XKaymurri (RIL-186) (14.25 t ha^{-1}) and DZ-Cr-387XGA-10-3(RIL NO.72) (14.12t ha $^{-1}$) (Table 3) while the lowest shoot biomass was recorded at genotype GA-10-3XKaymurri (RIL-275) (8.00 t ha^{-1}). Among 49 genotypes, 16.33% of the genotypes were greater than the highest biomass yielder check Quncho (12.62 t ha^{-1}).

Grain yield

Variation in grain yield tone per hectare among genotypes, extrapolated from yield per plot, is presented in Table 3. Accordingly, highly significant variability was observed among genotypes for grain yield, which ranged from 1.65 to 3.40 t ha^{-1} with the mean value of 2.52 t ha^{-1} and coefficient of variation of 12.46%. Based on the mean performances, genotypes such as Kaymurrix3774-13(RIL-72)(3.40 t ha^{-1}), GA-10-3XKaymurri(RIL-248) (3.33 t ha^{-1}), GA-10-3XKaymurri(RIL- 186) (3.31 t ha^{-1}) Kaymurrix3774-13(RIL-66)(3.30 t ha^{-1}), Kaymurrix3774-13(RIL-55) (3.24 t ha^{-1}), Kaymurrix3774-13(RIL-68)(3.05 t ha^{-1}), Kaymurrix3774-13(RIL-147)(3.10 t ha^{-1}), and GA-10-3XKaymurii(RIL-143) (3.26 t ha^{-1}) had mean performances higher than the highest performing check variety (Quncho=2.89 t ha^{-1}) for grain yield. While lower yielder were obtained from genotypes Kaymurrix3774-13(RIL-105) (1.65 t ha^{-1}) and Kaymurrix3774-13(RIL-7) (1.67 t ha^{-1}). These high yielding genotypes could be exploited in further breeding. According to Aliyi *et al*. (2016) observed that among the tested varieties across the testing locations for grain yield t/ha, which was ranged from 1.04 to 1.58 t ha^{-1} with the mean value of 1.32 t ha^{-1} under rain feed condition.

Conclusion

From this study, it was observed that each of the tested genotypes shows different performance for different characters. Grain yield is an important trait to be emphasized for genotype selection to address the objective of the conducted activity. Generally, from this study Kaymurrix3774-13(RIL-72), GA-10-3XKaymurri (RIL-248), GA-10-3XKaymurri(RIL-186), Kaymurrix 3774-13 (RIL-66) (33.00), Kaymurrix 3774-13 (RIL-55), Kaymurrix 3774-13(RIL-68), Kaymurrix 3774-13(RIL-147), and GA-10-3XKaymurii(RIL-143) showed up to 8.36 to 13.75% yield increment than the highest performing check variety as well as the best adapted and high yielding genotypes that could be used for further improvement under irrigation conditions. Therefore, these genotypes were selected and recommended for the study area.

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