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Participatory variety selection of improved tef varities for low moisture stress areas of Guji zone, Southern Oromia

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ABSTRACT: *Tef is a highly valued indigenous cereal crop produced in Ethiopia. As a result, the crop is adapted to diverse agro-ecological regions of Ethiopia and grows well under stress environments better than other cereals including low moisture stressed areas of Guji Zone, Southern Oromia. However, an access of improved tef variety is highly limited to such marginalized area. Due to this and other preceding factors, the potential of the area to tef production is not exploited. So, there is a need to develop and promote technologies that suit for the area. As a result, the current experiment was conducted at two low moisture stressed districts of Guji zone (Adola and Wadera) to select and recommend high yielding, early maturing, low moisture stress and diseases tolerant improved tef varieties through participatory variety selection. Seven low moisture stress tolerant improved tef varieties with one local check were used as testing materials. The treatments were arranged in randomized completed block design with three replications for mother trial and farmers were used as replication for baby trials. Both agronomic and farmers data were collected based on the recommended standards. Data collected from mother trail were subjected to analysis of variance where as matrix ranking was used for data's collected from baby trial. The analysis of variance indicated presence of significant differences at (P≤0.01, P≤0.05) among the evaluated tef varieties for all of the characters considered except number of fertile tillers per plant (NFTPP).Significant variability was observed among the tested tef varieties for grain yield qt/ha, which was ranged from 6.03 to 16.67 qt/ha with the mean value of 9.57 qt/ha and coefficient of variation 23.43%. The highest grain yield (16.67 qt/ha) was recorded for Dagim. But, low yield of 6.03 qt/ha was obtained from Guduru variety. In other cases, farmers were allowed to evaluate the varieties using their own criteria. Accordingly, variety Dagim was selected by farmers due to their best performance. Thereby, improved tef varieties Dagim and tesfa are selected based on their agronomic performance and farmer's choice for production to the study area and similar agro-ecologies.*

KEY WORDS*:* Tef, participatory variety selection, improved variety

INTRODUCTION

Tef (*Eragrostis tef* (Zucc.) is a highly valued indigenous cereal crop produced in Ethiopia. A farmer in different parts of the county usually grows tef as a guaranteeing crop to address their socio-economic and cultural needs. Because it is considered as low risky crop (Hailu, 2002). According to Ketema, (1993) there are five main reasons for the popularity of tef as compared

to other cereal crops. Its importance is based firstly on its high demand by the consumers. As a result, the crop is majorly grown for its grain that is used for preparing injera, which is a staple and very popular food in the national diet of Ethiopians. Tef contains 11% protein, 80% complex carbohydrates and 3% fat (Piccinin, 2002). In addition, its high price in the market, reduction of post harvest management cost, fewer disease and pest problems and sustained demand from consumer, are some of the specific merits that makes tef important and preferred by farmers (Ketema, 1993).Secondly, its agronomic versatility and reliability, even under adverse condition, which suit it well to a country of contrasting and unpredictable environment, where drought, water logging, pests and disease cause recurrent famine (Ketema, 1993). It can be grown in altitudes ranging from near sea level to 3000ms, but the best performance occurs between 1100 and 2950m.s.l (Tesfaye and Ketema, 2000). Thirdly, besides its value for human grain, tef straw is equally important for livestock forage. Fourthly, tef straw reinforces mud in the construction of local buildings. Fifthly, tef can be produced in a relatively short growing season and will produce both grain for human and fodder for cattle.

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As a result, its national production area leads the other cereal crops with acreage of 3.02 Million hectares (23.85%). From the total annual cereal grain production, tef ranks 2nd with a total production of 52.83 million quintals (17.26%) (CSA, 2016).Out of the total national production, about 48.86% production was obtained from Oromia regional states followed by Amhara (38.6%), Southern Nations Nationalities and Peoples (SNNP) (7%), Tigray (4.88%), and Benishangul-Gumuz (0.6%). In Oromia regional state, tef is majorly produced in South West shewa Zone with an average yield of 18qt/ha followed by ***West Shewa Zone*** 3.808 Million qt with the average yield of 18.53qt/ha. In Guji Zone, *tef* is grown on more than 17,005 ha of land with a production of more than 230,016 qt. However, the productivity of the crop remains low to the Zone (13.53 qt ha-1) as compared to the national and regional average yield of the crop which is 17.48qt ha-^{1} and 17.88 qt ha-^{1} respectively (CSA, 2016). This might be, due to lack of improved varieties, poor management practices, biotic factors (weeds, diseases and insect pests etc.) and a biotic factors (frost), rain fall variability (intensity as well as duration) (Obsa *et al*.,2017). To overcome such problems, introducing improved technologies by involving users through participatory variety selection is very imperative. Because, it enables faster adoption of new cultivars than the formal crop improvement and also the spread of varieties from farmer-to-farmer through the local seed system can be very fast, thus guaranteeing a further good adoption(Assefa *et al*.,2014). It also enables the farmers to evaluate the materials based on important traits of their interest, help to increase on farm varietal diversity, faster varietal replacement and rapid scaling up (Asaye *et al*., 2013). In view of this, the current study was conducted to address the following objectives;

- ❖ To evaluate the performance of the different released tef varieties through PVS
- ❖ To assess farmers‟ selection criteria for improved tef varieties and
- ❖ To identify the most important farmers criteria for future crop improvement work in the area.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at two districts on three sites (Adola on station, on farm and Wadera on farmers' field) during short season of 2017/18 cropping season to select and

recommend high yielding, early maturing, low moisture stress and diseases tolerant improved tef varieties through PVS. Adola and Wadera districts are located at about 470 KM and 530 KM to the south from Addis Ababa. Both districts are characterized by three agro-climatic zones, namely Dega (high land), Weina dega(mid land) and Kola(low land) with different coverage. The mean annual rain fall and temperature of the districts are about 900mm and 12-34 ^{0}c respectively. Based on this condition two time cropping season was commonly practiced i.e Arfasa (main cropping season) which start from March to April especially for maize, haricot bean, wheat and barley. The second cropping season is called Gana (short cropping season) which was practiced as double cropping using small size cereal crops like tef, wheat and barley after harvesting the main cropping season crops. This study was also conducted during short cropping season at selected low moisture stress area.

Description of planting materials and Experimental Design employed

Seven low moisture stress tolerant improved tef varieties (Felagote, Teseta, Kena, Dagim, Guduru, Nigusie, Boset) were used as testing materials with one local check. The treatments were arranged in randomized completed block design with three replications for mother trial (MT) (planted on station) and farmers were used as replication for baby trials (BT). For this purpose, one farmer field was used as replication for baby trials in which selected farmer's plant materials in one replication and the other host farmers were planted the two non-replicated trials. At both trial sites, the materials were planted on a plot size of, 3mX4m having 15 rows with 20 cm between rows. In puts (seeds, fertilizers) and management practices were applied as recommended for tef production. Data was collected in two ways: agronomic data & farmer's data. For agronomic data phenological, Growth, yield and its component were collected following their own principles.

Data Collection: Data was collected from centeral rows and selected plants of the plot for agronomic and diseases data. Collected agronomic data includes; Days to heading (DTH), Days to 90% maturity (DTM), Grain filling period (GFP), Plant height (cm), Peduncle length (cm), Total number of tillers/plant (NTP), Number of fertile tillers per plant (NFTPP) and Grain yield/ha (kg/ha).

Data analysis: Data collected from mother trials was subjected to ‘’SAS’ ’software (version 9.0) to evaluate the variability of the tested varieties. This was done through computing analysis of variance for all characters studied according to the method given by Gomez and Gomez (1984). For data’s collected from baby trials, matrix ranking suggested by De Boef *et al*., (2007) was employed.

RESULT & DISCUSSION

The analysis of variance (ANOVA) for grain yield and other agronomic characters of 8 tef varieties sown at research station as mother trail is presented in table 1. The analysis of variance (ANOVA) indicated presence of significant differences at ($P \leq 0.05$ and $P \leq 0.01$) respectively among the evaluated tef varieties for all the characters considered except Number of fertile tillers per plant (NFTPP). Similar result of significant difference among tef varieties was also reported by Molla *et al*., 2012, Daniel *et al*., 2016, Abebe and Wondowsen, 2017, Chondie and Bekele, 2017 and Natol *et al*., 2018.

Table 1. Analysis of Variance for different agronomic parameters of different tef Varieties from mother trial

Source of variation	Mean square							
	DH	GFP	DTM	PH(cm)	PL(cm)	NTP	NPTPP	Gy(kg/ha
Genotype(7)	0.8*	15.42**	16.81*	341.52**	82.86**	2.7*	1.2ns	33.72**
Rep(2)	4.50**	124.03**	81.28**	295.91*	78.97**	7.9*	1.7ns	35.62*
Error(14)	0.21	2.17	2.07	26.15	2.16	0.82	0.52	5.02

*** = highly significant at P ≤ 0.001; *= significant at P ≤ 0.05; ns = not significant at P= 0.05; a Numbers in brackets are degrees of freedom associated with the corresponding source of variation; DH: Days to heading, GFP: grain filling period, DTM: Days to maturity, , PH: plant height in centimetre, PL: Peduncle length in centimetre, Total number of tillers/plant (NTP), Number of fertile tillers per plant (NFTPP) Gy: grain yield/ha in quintals.*

Mean performance of the varieties

Phenological parameters

Range and mean values for the 8 characters are shown in Table 2. The variation with respect to days to heading and days to maturity was ranged from 57.5 to 59 and 98 to 104 days respectively, showing a wide range of variation among the varieties for maturity. Based on the study result, the longest day to heading was revealed by Guduru and Nigusie (59 days). However, early heading was recorded for variety Dagim (57 days) followed by Tesfa and Boset (58 days). With the similar instance, variety Dagim was early maturing variety (98 days) followed by Nigusie (99 days). Among the tested varieties, Guduru variety was late maturing with 104 days followed by Kena (103 days). Early maturity is an important selection criteria in areas of moisture deficient to produce significant crop yield through sustaining effective crop growth stages. According to Din *et al*. (2010), higher temperature reduced the growth and development of plant and the early maturity due to high temperature was one factor of reduced yield. Short growing period of crops is an important criterion in area of having moisture deficient.

Growth parameters: Among the considered growth parameters, significant variation was observed among the tested tef varieties for plant height with the mean value of 83.1cm and coefficient of variation 6.16 %(Table 2). The longest plant height was exhibited by Kena Variety (96.87cm) followed by variety Guduru (95.12cm).However, the shortest plant height was revealed by Boset variety (69.32cm). Significant variation among tef variety for plant height was also reported by many authors including Daniel *et al*., 2016, Abebe *and* Wondowsen, 2017, Chondie and Bekele, 2017 and Natol *et al*., 2018. In contrast, non-significant variation among tef varieties was reported by Molla *et al*., 2012.

Yield and related parameters

As indicated in table (2), significant variability was observed among the tested tef varities for number of tillers per plant with the range of 3.45 to 6 and mean value of 4.83. The highest number of tillers per plant was depicted by Nigusie variety followed tesfa. In contrast, local

variety exhibited the lowest number of tillers per plant. The result is in agreement with the finding of Daniel *et al*, 2016 who was reported non- significant difference among tef varieties for number of tillers per plant.

As the study result indicates, significant variability was observed among the tested tef varieties for grain yield qt/ha, which was ranged from 6.03 to 16.67 qt/ha with the mean value of 9.57 qt/ha and coefficient of variation 23.4%. The highest grain yield (16.67 qt/ha) was recorded for Dagim followed by Tesfa (10.6 qt/ha). But, low yield of 6.03 qt/ha was obtained from Guduru variety. Many authors including Daniel *et al*., 2016, Abebe *and* Wondowsen, 2017, Chondie and Bekele, 2017 and Natol *et al*., 2018 were also reported significant variability of tef varities for grain yield.

Table 2. Mean values of different tef varieties for grain yield and other agronomic characters from MT

Genotypes	DH	GFP	DTM	PH	PL	NTP	NFTP	GY
Local	58.5^{ab}	43.5^{bc}	102^{bcd}	83.47^{bc}	33.57^{cd}	3.45^{c}	2.97^{c}	8.4^{bcd}
Felagote	58.5^{ab}	42^{cd}	100.5^{cde}	71.27^{d}	30.53^{ef}	4.18bc	3.88^{abc}	7.83^{bcd}
Tesfa	58^{bc}	42.5^{bcd}	100.5^{cde}	80.67^{c}	33.87^{cd}	5.95^{a}	4.67^{a}	10.6^{b}
Boset	58^{bc}	47^{a}	101.5^{bcd}	69.32^{d}	28.25^{f}	4.87^{abc}	4^{abc}	10.01^{bc}
Kena	58.5^{ab}	44.5^{abc}	103^{abc}	96.87^{a}	39.15^{b}	4.97^{abc}	4.3^{ab}	10.36^{bc}
Dagim	57.5^{c}	40.5^{d}	98^{e}	91.9^{ab}	35.38^{c}	5.4^{ab}	4.47^{a}	16.67^{a}
Guduru	59^{a}	45^{ab}	104^{a}	95.12^{a}	45.1^{a}	3.82^{bc}	3.13^{bc}	6.03^{d}
Nigusie	59^{a}	40.5^{d}	99.4^{de}	76.07^{cd}	32.68^{de}	6^{a}	4.67^{a}	6.5^{cd}
Over all mean	58.38	43.19	101.56	83.1	34.82	4.83	3.98	9.57
CV(%)	0.79	3.41	1.42	6.16	4.22	18.76	18.12	23.43
LSD(0.05)	0.81	2.58	2.52	8.97	2.57	1.59	1.26	3.92

DH: Days to heading, GFP: grain filling period, DTM: Days to maturity, , PH: plant height in centimetre, PL: Peduncle length in centimetre, Total number of tillers/plant (NTP), Number of fertile tillers per plant (NFTPP) Gy: grain yield/ha in quintals.

Farmer's variety selection criteria's

In this case, farmers were allowed to evaluate the varieties using their own criteria. Because, have a broad knowledge base on their environments, crops and cropping systems built up over many years and do experiments by their own and generate innovations, even though they lack control treatment for comparison and statistical tools to test the hypothesis (Bänziger *et al*.,2000). Based on this concept, farmers were informed to set criteria for selecting best tef variety according to their area before undertaking varietal selection. This was done by making group discussion among the farmers which comprises elders, women and men. After setting the criteria they were informed to prioritize the criteria according to their interest. By doing this, farmers were allowed to select varieties by giving their own value. Accordingly, high yield, early maturity, plant height, Tillering capacity, lodging resistant, marketability, diseases resistant, Paletablity were among the *criteria's outlined by the farmers.* Based on set criteria, the evaluated varieties were revealed various values by the evaluators (farmers). With this regard, variety Tesfa and Dagim were showed better performance in tolerance to various diseases, high grain yield, early maturity, lodging tolerant, tillering capacity and plant height.

Better performance of these varieties to the set criteria may reflect the importance of the varieties to the study area. For instance, early maturity of the varieties to the area may enable the varieties to produce significant yield with the offered moisture during the crop growth. Asefa *et al*., 2014 also justified early maturing variety in moisture deficit area enables the variety to produce high yield. Seed colour is also another selection criteria considered by the farmers. For tef, white seed colour is highly preferred for market value. Among the evaluated varieties, Tesfa,dagim and Niguise were selected by farmers due to their colour . Belay *et al.*, 2006 also reported Ethiopia farmers selected the very white seed variety for market purpose, and brown-seeded tef for home consumption.

Table 3. Farmers' preference scores and ranking for baby trial

Variety name	Farmers selection criteria										
	1	2	3	4	5	6	7	8	Total	Average	Rank
Local	3.3	3.7	4.0	4.3	4.3	4.3	5.0	5.0	34.0	4.2	5
Felagote	1.3	3.7	3.7	4.3	4.0	1.0	2.7	4.7	25.3	3.2	7
Tesfa	5.0	4.7	5.0	5.0	5.0	5.0	5.0	5.0	39.7	5.0	1
Boset	4.3	4.0	4.0	4.3	4.0	4.7	4.7	5.0	35.0	4.4	3
Kena	4.0	3.0	4.0	4.3	4.3	4.3	4.7	5.0	33.7	4.2	5
Dagim	4.3	4.3	4.7	4.7	4.7	5.0	5.0	5.0	37.7	4.7	2
Guduru	3.7	3.3	4.7	4.7	4.3	4.3	4.7	5.0	34.6	4.3	4
Nugusie	1.7	4.0	3.0	4.0	4.0	5.0	5.0	5.0	31.7	4.0	6

1=High yield, 2= Early maturity, 3=plant height,4=Tillering capacity, 5=lodging resistant, 6=Marketability, 7=Diseases tolerant, 8=Paletablity

CONCLUSION

In areas where improved technologies are not widely addressed like Guji Zone of Southern Oromia, it's paramount to take immediate action towards setting appropriate research methods. In such case, Participatory variety selection is an effective tool in facilitating the adoption and extension of the improved technologies. Because, the users are allowed to participate in selecting appropriate technologies by employing their own indigenous knowledge. As the result, the current study was also verified that farmers were able to participate in selecting improved tef varieties through employing their own selection criteria. Thereby, based on the agronomic performance and farmers preference criteria two improved tef varieties Dagim and tesfa are selected and recommended for production to the study area and similar agro-ecologies.

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