ISSN: 2329-8863

Research Article OMICS International

Production Potential of Tef (*Eragrostis tef* (Zucc.) Trotter) Genotypes in Relation to Integrated Nutrient Management on Vertisols of Mid High lands of Oromia Region of Ethiopia, East Africa

Yonas Mebratu, Cherukuri V Raghavaiah* and Habtamu Ashagre

Department of Plant Science, College of Agriculture and Veterinary Sciences, Ambo University, Ambo, Ethiopia

Abstract

Tef is a highly valued nutritious cereal crop which plays an important role in the diet of Ethiopians. Soil fertility depletion pose a serious threat to tef production in high lands of Ethiopia which are characterised by high rainfall, soil acidity, soil erosion, leaching and the attendant non availability of plant nutrients to the crop. In view of this a feld experiment was carried out during 2014/15 cropping season on a feld belonging to Hommicho Ammunition Engineering Industry with the objective to evaluate the response of Tef genotypes to integrated nutrient management in terms of productivity and yield components in Guder, Toke kuttai district. The treatments consisted of six levels of integrated nutrient management practices: 1) 0-0-0 (check) 2) 40-60-0 NPK (RDF) 3) 50%RDF+50% N (FYM) 4) 75%RDF+25% N (FYM) 5) 100% RDF+5 t FYM/ha and 6)RDF through new complex fertilizer (19-38-7 NPS) tested on fve genotypes (Magna, Simoda, Quncho, Dz-Cr-409, Local variety). The experiment was laid out in a randomized complete block design with factorial arrangement with three replications. The results revealed that there was signifcant interaction between genotypes and integrated nutrient management practices where in application of 75% RDF+25% FYM and 100% RDF+5 t/ha FYM to genotypes DZ-CR-387 and DZ-01-196 delayed days to fowering and days to maturity, but in other genotypes these were not altered due to fertilizer application. In plant height, variety DZ-CR-385 and DZ-CR-409 responded better to 100%RDF+5 t/ha FYM combination, while DZ-01-196 and local variety was signifcantly affected over all fertilizer treatments. Signifcantly higher initial tiller capacity and fertile tiller production were obtained with application of 75% RDF+25% FYM and 100% RDF+5 t/ha FYM. Local variety had signifcantly higher number of leaves with 100% RDF+5 t/ha FYM followed closely by DZ-CR-409 with 75% RDF+25% FYM, and DZ-CR-385 and DZ-CR-387 with 75% RDF+25%FYM. Length of panicle and panicle weight were signifcantly affected where integrated nutrient management in new varieties DZ-CR-409 and DZ-CR-387 gave higher seed weight with 50%RDF+50% FYM and 75% RDF+25%FYM. There was signifcant interaction between varieties and integrated nutrient management on grain and straw yield, where DZ-01-196 recorded maximum grain and straw yield with application of 100% RDF+5 t/ha FYM which was comparable with 75%RDF+25% FYM. Therefore application of 50% RDF+50%FYM, 75%RDF+25%FYM and 100% RDF+5 tha-1 to DZ-01-196, DZ-CR-409 and Local varieties of Tef, respectively exhibited best production performance on vertisols of mid high lands of Ethiopia.

[illegible]

Tef [*Eragrostis tef* (Zucc.) Trotter] is one among the major cereals of Ethiopia and occupies about 2.7 million hectares (27% of the grain crop area) of land which is more than any other major cereals such as maize (22.7%), sorghum (19%) and wheat (16%) (5,36). It is an indigenous cereal crop to Ethiopia and it has been recognized that Ethiopia is the centre of origin and diversity of tef. It is a C4 self pollinated chasmogamous annual cereal which belongs to the family poacea, sub family Eragrostidae and genus *Eragrostis*. Of the 82% gross grain production (about 1.7 million tonnes) contri[illegible] accounts for 19.9% during the main season of 201[illegible]

Ethiopian farmers grow tef due to a number [illegible] mainly attributed to the socio-economic, cultu[illegible] benefits [6]. Tef has more food value than the [illegible] wheat, barley and maize. Tef grain contains 14-1[illegible] mg iron, 100-150 mg calcium, and rich in potassiu[illegible] nutrients [6]. Tef has got many prospects outside [illegible] its gluten free nature, tolerance to biotic and abi[illegible] feed value and soil erosion control quality [7]. Sma[illegible] production of tef has begun in areas of the whea[illegible] Canada and Australia (34). Tef has been introdu[illegible]

***Corresponding author:** Cherukuri V Raghavaiah, Department of Plant Science, College of Agriculture and Veterinary Sciences, Ambo University, Ambo, Post Box No 19, Ethiopia, Tel: 0933907158; E-mail: cheruraghav@yahoo.in

Received December 07, 2016; **Accepted** December 16, 2016; **Published** December 23, 2016

Citation: Mebratu Y, Raghavaiah CV, Ashagre H (2016) Production Potential of Tef (Eragrostis tef (Zucc.) Trotter) Genotypes in Relation to Integrated Nutrient Management on Vertisols of Mid High lands of Oromia Region of Ethiopia [illegible]

and cultivated as a forage crop, and in recent years cultivated as a cereal crop in Northern Kenya [7].

Tef production has been increasing from year to year and so does the demand for it as staple grain in both rural and urban areas of Ethiopia [8]. Although tef is found in almost all cereal growing areas of Ethiopia, the major areas of production are Shewa, Gojam, Gonder, Wellega and Wello with central highlands of the country [9]. In those areas where it is consumed as a staple food, tef contributes about two-thirds of the dietary protein intake [7].

Tef is adapted to diverse agro-ecological zones which are marginal to most other crops [10]. Tef su ers less from diseases and gives better preparation with two times ploughing, harrowing and levelling were done to obtain a fine tilth. The field was then marked out into 90 plots of 3.2 m × 2.0 m^2. After preparing the land the layout of the experiment was done as per the treatments randomly in factorial randomized block design with 3 replications. Farm yard manure was applied to the plots as per the treatments 20 days before application of inorganic fertilizer. Before seeding, inorganic fertilizer as per treatments was applied. Urea was top dressed 2 times, once before sowing as basal dose and the other 7 days after emergence.

Treatments and design

There were six nutrient management treatments and five varieties of tef. The experiment was laid out in 5 × 6 factorial randomized Complete Block Design with three replications.

Varieties of Tef:

Days to maturity: The number of days taken for the crop to attain physiological maturity too exhibited distinct variation with nutrient management. It was observed that the crop matured earlier when supplied with only inorganic fertilizer and no fertilizer (97-98.8 days). Integrated nutrient supply through inorganic fertilizer with farmyard manure delayed the crop maturity due to prolonged vegetative growth and balanced nutrition (99-102 days) in comparison with unfertilized control. Delay in crop maturity due to INM has also been reported by Brady and Weil [21]. Early flowering varieties (DZ-CR-385, DZ-CR-409) have taken 96 days to mature, while the late maturing varieties (DZ-01-196, DZ-CR-387) matured in 110 days, whereas the local variety matured in 106 days, indicating differing maturing groups which is a genetic character and not much altered by growing environment.

Significant interaction between varieties and fertilizer revealed that DZ-CR-387 and DZ-01-196 when fertilized with 75% RDF+25% FYM and 100%RDF+5 t/ha FYM (Table 3) delayed maturity (114 days) in comparison with control and only inorganic fertilizer (110 days). But in DZ-CR-385, DZ-CR-409 and local Varity the days to maturity was not altered much due to fertilizer management practices (Table 3).

Lodging percentage: Tef being a weak stalked plant, often is prone for lodging, especially at reproductive stage due to weight of developing spikes. It was found that the crop exhibited less lodging without fertilizer (1.1%), whereas the lodging percent increased with the application of either inorganic fertilizer alone or in integration with organic manure (1.3-1.5%) (Table 2). The role of P in providing strength of straw and thus preventing lodging has been reported [21,22]. This calls for a need for balanced/optimum fertilization of tef to obtain less lodging so as to avoid pre and postharvest loss of grain. Different varieties did not exhibit discernible variation in lodging percent; however local variety tended to lodge more (1.87%) than improved tef varieties (1.2%). Traditional varieties are tall in stature and prone to lodging in comparison with the improved genotypes, which are medium in stature and have stiff straw and consequently are less prone to lodging.

Plant height (cm): Application of nutrient either in the form of (1.87%

(18.9) or no fertilizer check (10.0). This result corroborates with the findings of Hafsom et al., Al Abdul Salam and Warraich et al. [23-25]. The different genotypes did not show discernible variation in the initial tiller counts, though the traditional cultivar tended to produce less tillers than the improved test varieties.

Significant interaction between varieties and nutrient management practices (Table 5) showed that all the improved varieties produced significantly greater number of tillers than local variety with the application of 75% RDF+25% FYM and 100% RDF+5 t/ha FYM when compared with RDF, 50% RDF+50% FYM and control. Application of FYM improved tillering capacity.

Effective/productive tillers: Effective tillers are those bearing panicles that contribute to the grain yield. There was a decrease in the number of tillers at reproductive stage in comparison with those observed at vegetative stage owing mainly to mortality and variable source to sink relationships. The effective tillers followed a trend akin to the vegetative tillers in relation to the nutrient management practices; in that integrated nutrient management had an edge (21-23.4 tillers)over exclusive application of inorganic fertilizer(16.4 tillers) or no fertilizer control (7.8 tillers) in manifestation of tillering capacity. Enhancement in productive tillers due to application of nitrogen has also been reported by Al-Abdul Salam and Warraich et al. [25]. Tef varieties showed distinct variation in panicle bearing tillers where variety DZ-CR-387(20 tillers) remaining comparable with DZ-CR-385(19 tillers), DZ-01-196 and DZ-CR-409 produced greater number of tillers than local cultivar (17 tillers). Variation in productive tillers has also been reported by Belay and Baker [26].

Significant interaction between varieties and nutrient management revealed that all the improved varieties exhibited significant improvement in effective tillers over local variety with the application of 75% RDF+25% FYM (Table 6). Application of 100% RDF+5 t/ha FYM for all varieties produced higher number of effective tillers. The fertile tillers were significantly lower with RDF through inorganic fertilizer, which in turn was superior to unfertilized control.

Leaf number plant^{-1}: Application of fertilizer showed substantial improvement in the number of leaves/plant (42.9-56.2) over unfertilized check (25.3). Integrated application of inorganic fertilizer with farmyard manure produced significantly higher number of leaves/plant (49 to 56) than with the application of inorganic fertilizer (42.9) improved varieties DZ-CR-409(56) which in turn had higher leaf number in comparison with the rest of the genotypes which had almost similar leaf number/plant^{-1} (37-39).

Interaction of varieties and nutrient management practices signi cantly a ected mean number of leaf plant (Table 7) where Local variety produced large number of leaves/plant with 100% RDF+5 t/ha FYM, followed by DZ-CR-409 with 75%RDF+25% FYM.

Leaf a ea (c): Application of N at stem elongation stage has been reported to greatly stimulate leaf area growth resulting in signi cantly greater assimilation capacity, both before and a er antithesis. Application of new complex fertilizer (NPS 23-10-5) resulted in substantially higher leaf area (8.2 cm) than the rest of the fertilizer treatments. However, 75% RDF+25% FYM was found superior to the other treatments in leaf area; whereas inorganic fertilizer alone (5.78 cm) showed least leaf area.

Leaf area, which is an indicator of assimilatory surface, varied with varieties; where the variety DZ-CR-387(7.9 cm) remaining at a par with local cultivar (7.7 cm) possessed grater leaf area than DZ-01-196(6.87 cm), DZ-CR-385(5.60 cm) and DZ-CR-409(5.1 cm).

e varieties DZ-CR-385 and DZ-CR-387 showed signi cant enhancement in leaf area (8.54 cm) when fertilized with 75% RDF+25% FYM as revealed by varieties and fertilizer interaction.

Yield c

Pa icle le g h (c): Application of fertilizer either in organic or inorganic form (29.5 cm) and their integrated application (35.0 cm) brought about discernible variation in the length of panicle in comparison with unfertilized control (23.7 cm). Higher number of tillS/2g (alone)0.6 (e)32th u2/T11 1 Tf10 0 0 nd DZ-CR-409s1ea, which is of

Citation: Mebratu Y, Raghavaiah CV, Ashagre H (2016) Production Potential of Tef (*Eragrostis* tef (Zucc.) Trotter) Genotypes in Relation to Integrated Nutrient Management on Vertisols of Mid High lands of Oromia Region of Ethiopia, East Africa. Adv Crop Sci Tech 4: 249. doi: 10.4172/2329-8863.1000249

nutrient management and application of new complex fertilizer over RDF and unfertilized control. Application of RDF through inorganic source was superior to no fertilizer control in all varieties.

Panicle weight (g): The panicle weight has been significantly higher with integrated use of inorganic fertilizer with organic manure (1.9 g) as compared with sole application of inorganic nutrient (1.5 g) or no fertilizer (1.1 g). This is in agreement with the finding of Tekalign et al. [13]. The panicle weight tended to be in accordance with the length of the panicle. Among the varieties, DZ-CR-387 possessed panicles of greater weight (1.72 g), closely followed by local cultivar (1.68 g) and DZ-CR-409(1.66 g); while the lower panicle weight was obtained from DZ-CR-385(1.59 g) and DZ-01-196(1.54 g). These findings are in agreement with the report of Blum and Belay; Baker [26,27].

The panicle weight of all the varieties improved substantially with integrated nutrient management in comparison with application of RDF through inorganic source and no fertilizer check. The least panicle length was recorded in all the varieties with no fertilizer.

Thousand seed weight (g): Application of fertilizer significantly improved thousand seed weight (0.318 g) over no fertilization check (0.248 g). Further, integration of inorganic fertilizer with farm yard manure in different proportions had a synergistic effect on thousand seed weight (0.337 g-0.368 g) in comparison with sole inorganic fertilizer or no fertilizer application. Improvement in thousand seed weight due to fertilizer application has also been reported by AL-Abdul Salam [24]. The tef varieties differed significantly in their thousand seed weight where DZ-CR-387 had superior thousand seed weight (0.33 g) followed by DZ-CR-409(0.331 g) and local cultivar (0.331 g) which in turn were comparable. The variety DZ-CR-385(0.316 g) was found superior to DZ-01-196 (0.309 g) which gav Tw T[(superiorc1e)Td weight (0.33 g06

RDF through inorganic fertilizer+25% N through farmyard manure

Interaction of varieties of Tef with nutrient management practice on harvest index was signi cant (Table 14) where Tef variety DZ-01-196 with integrated nutrient management practice produced signi cantly greater harvest index (34.09), which was comparable with DZ-CR-385 with 75% RDF+25% FYM (33.19) and DZ-CR-409 with 100% RDF+5 t/ha FYM (31.20). ere was distinct improvement of harvest index of local variety with fertilizer use (31.33) over no fertilizer (21.88).

C cl i

From the foregoing account it can be inferred that in rain fed Tef crop raised on Vertisols, Integrated use of FYM in conjunction with inorganic fertilizer is more e cient than use of RDF through inorganic source and unfertilized crop employing selected improved Tef genotype can considerably improve grain yields. In this study, application of 50% RDF+50% FYM, 75% RDF+25% FYM and 100% RDF+5 t/ha FYM using DZ-01-196, DZ-CR-409 and Local variety, respectively exhibited best yield performance in the mid high lands of West Shoa zone in Oromia region of Ethiopia.

References

1. Mulat D (1999) Agricultural Technology, Economic Viability and Poverty Alleviation in Ethiopia, Paper presented to the Agricultural Transformation Policy Workshop, Kenya.
2. UNDP (2002) UNDP assistance in the ffth country program to the agricultural sector.
3. Yihenew G (2002) Selected chemical and physical characteristics of soils of Adet Research Centre and its testing sites in north western Ethiopia. Ethiopian Journal of Natural Resources 4: 199-215.
4. Tekalign M (1998) Effect of source, rate and timing of nitrogen applied to wheat on soil N level in a vertisol in central highland of Ethiopia. In: Crop Management Options to sustain Food Security, pp: 85-100.
5. Central Statistic Authority (2008) Agricultural Sample Survey. Report on area and production for major crops (private peasant holdings Meher season) Statistical Bulletin 417, Addis Ababa.
6. Seyfu K (1993) Tef [Eragrostis tef (Zucc.)Trotter]. Breeding, Genetic Resources, Agronomy, Utilization and Role in Ethiopian Agriculture. Institute of Agricultural Research, Addis Ababa, Ethiopia.
7. Seyfu K (1997) Tef [Eragrostis tef (Zucc.) Trotter]. Promoting the conservation and use of underutilized and neglected crops. Biodiversity institute, Addis Ababa, Ethiopia.
8. Mitiku H, Fassil K (1996) Soil and moisture conservation in Semi-arid areas of Ethiopia. In: Proceedings of the Third Conference of Ethiopian Soil Science Society (ESSS). Addis Ababa, Ethiopia.
9. Piccinin D (2010) More About Ethiopian Food: Teff. Ethno Med: Ethiopian food. Online. Internet available.
10. Hailu T, Seyfu K (1990) Variability and genetic advance in tef (Eragrostis tef) cultivars. Tropical Agriculture 67: 317-320.
11. Fufa H, Tesfa B, Hailu T, Kebebew A, Tiruneh K, et al. (2001) Agronomy Research in tef. In: Hailu Tefera, Getachew Belay and M. Sorrels (ed.), Narrowing the Rift: Tef Research and Development, Proceedings of the International Workshop on Tef Genetics and Improvement, Addis Ababa, Ethiopia, pp: 167-176.
12. Yu JK, Graznak E, Breseghello F, Hailu T, Sorrells ME (2007) QTL mapping of agronomic traits in tef [Eragrostistef (Zucc) Trotter]. BMC Plant Biol 7: 13.
13. Tekalign M, Teklu E, Balesh T (2001) Soil Fertility and Plant Nutrition Research on Tef in Ethiopia. In: Hailu T, Getachew B, Mark S (eds.), Narrowing the Rift. Tef Research and Development, Proceedings of the International Workshop on Tef Genetics and Improvement, Addis Ababa, Ethiopia, pp: 167-176.
14. Tareke B (2008) Increasing Productivity of Tef, Eragrostis tef (Zucc.) Trotter: New Approaches with Dramatic results (Unpublished Report), Addis Ababa, Ethiopia.
15. Van Reeuwijk LP (1992) Procedures for soil analysis. 6th edn. International soil reference and information center, Wageningen (ISRIC).
16. Day PR (1965) Hydrometer method of particle size analysis. In: Back CA (ed.), Method of Soil Analysis. Amer. Soc. Agron. Madison, Wisconsm Agron, p: 562.
17. 17.