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Effect of Tef Variety and Rates of Nitrogen Fertilizer Application on Growth and Yield Components Under Jimma Condition

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Abstract
Tef is a highly valued crop in the national diet of Ethiopians. However, its productivity is constrained by low plant-available soil nitrogen due to depleting soil organic matter content and minimum usage of improved variety in the producer. This problem is compounded by low rates of N fertilizer applications and cultivating of Tef varieties that is not improved in the country. Therefore, a field experiment was carried out with the objectives of studying the effects of rates of nitrogen fertilizer and varieties on growth and yield components of Tef and determining the most optimum Nitrogen fertilizer application rate for Tef production, determine the response of Tef varieties to different nitrogen fertilizer application rates and identify high yielding Tef variety .The treatments consisted of four levels of nitrogen (0, 46, 69 and 92 kg N ha-1) and two varieties (Jimma local and Quoncho variety). The experiment was laid out as RCBD in factorial treatment with three replications. Among the parameters evaluated, five were affected by the main effect of N fertilizer rate (days of panicle emergence, days to maturity, plant height, number of effective tillers and fresh biomass yield). Three parameters (days to panicle emergence and days to maturity are high significantly ($p<0.01$) affected and fresh biomass yield was significantly ($p<0.05$) affected by varieties). However, plant height, panicle length and numbers of effective tillers were non-significantly affected by varieties. The only parameters that were significantly affected by the interaction effects of both nitrogen and varieties were Fresh biomass yield.
Keywords: Tef Variety; Nitrogen Fertilizer Rate; Growth; Yield Components: Jimma

1. INTRODUCTION

Tef (Eragrostis tef), a cereal crop that belongs to the grass family Poaceae, is endemic to Ethiopia and has been widely cultivated in the country for centuries (Teklu and Tefera 2005). Tef is adaptable to a wide range of ecological conditions in altitudes ranging from near sea level to 3000 msl and even it can be grown in an environment unfavourable for most cereal, while the best performance occurs between 1100 and 2950 masl in Ethiopia (Hailu and Seyfu, 2000). Teff is grown mainly in Amhara and Oromiya, which together accounted for 84 and 86% of the total cultivated area and production in 2011. East and West Gojam of Amhara and East and West Shoa of Oromiya are particularly known teff producing areas in the country (Demeke and Marcantonio, 2013). Tef is resistant to extreme water conditions, as it is able to grow under both drought and waterlogged conditions (Teklu and Tefera 2005; Minten et al. 2013). Combined with its low vulnerability to pest and diseases, it is considered a low risk crop (Fufa et al. 2011; Minten et al. 2013).

Tef is the country's most important staple crop in terms of both production and consumption, at least in value terms. During the 2012/13 meher rains, more than 6 million farmers allocated 22 percent of the national grain area to teff. On these teff lands, a total output of almost 4 million metric tons was obtained, accounting for 16 percent of all grain output. In 2013, the average teff yield reached 1.4 tons per hectare—an increase of eight percent from 2012 (CSA 2013). Although the recent increase was mainly due to an increase in production area, previous increases in Tef production are attributed both to yield improvements and to expansion of the production area (Taffesse et al. 2011). Minten et al. (2013) evaluated national Tef production for 2012 and estimated that Tef is the most important food crop in the country. The value of its commercial surplus is second only to coffee. In addition to its importance as a staple food, teff straw is important for fodder and use in house construction (Teklu and Tefera 2005). Tef is used in Ethiopia to produce the nation's staple dish enjera. Grinding teff grain into flour and mixing with water results in a spongy type of pancake. Teff is also used to brew local beer. It has high protein, fiber and complex carbohydrates content, relatively low-calorie content, and is gluten free (Berhane et al. 2011; ATA 2013c). It accounts for between 11 and 15 percent of all calories consumed in Ethiopia (Berhane et al. 2011, ATA 2013c) and provides about 66 percent of daily protein intake (Fufa et al. 2011). Almost two thirds of the Ethiopian population use teff as their daily staple food. It is estimated that per capita consumption grew by 4 percent over the last 5 years (ATA, 2013c). Teff is considered an economically superior good, relatively more consumed by urban and richer consumers (Berhane et al. 2011; Minten et al. 2013). In urban areas, the share of per capita teff consumption in total food expenditure is 23 percent, while in rural area this is only 6 percent. In rural areas, teff is seen as a luxurious grain consumed only by elders or during special occasions. Growth in average incomes and faster urbanization in Ethiopia are likely to increase the demand for teff over time (Berhane et al. 2011).

Even though, Ethiopia is a center of origin and diversity of tef and has the above-mentioned importance and coverage of large area, its productivity is very low to feed the demand of its people and market. These is due to low soil fertility and suboptimal use of mineral fertilizers in addition to weeds, lack of high yielding cultivars, erratic rainfall distribution in lower altitudes, lodging, water-logging, low moisture, and low soil fertility conditions (Fufa, 1998). On the other hand, under conditions where most growth requirements are available and in organic matter rich soils, application of fertilizers without knowing its fertility status causes yield and fertilizer losses (Tekalign et al., 2001).

There are different blanket fertilizer recommendations for various soil types of Ethiopia for tef cultivation. This is due to its cultivation in different agro-ecological zones and soil types, having different fertility status and nutrient content. Accordingly, N/P recommendation rates by the Ministry of Agriculture were set at 55/30, 30/40, and 40/35 N/P kg ha-1 for tef crop on Vertisols, Nitosols, and Cambisols, respectively across the country (Seyfu, 1993). However, 100 kg DAP ha-1 and 100 kg urea ha-1 were set by the Ministry of Agriculture and Rural Development later (Kenea et al., 2001). Those blanket recommendations brought generally, an increase in yield of improved cultivars ranging from 1700 to 2200 kg/ha (Seyfu, 1997). Accordingly, the average national yield in the year 2010 reached 1200 kg/ha (CSA, 2010). However, the recommendations do not work for all production aspects of various soil types of different regions. It is in fact possible to increase the yield potential of tef via optimizing nutrient supply to the soil. Determination of optimum fertilizer rates for specific soil types is vital for overcoming the problem that arose from the use of blanket fertilizer recommendations. Systematic studies should, thus, be conducted under varying conditions and in various regions to determine the fertilizer requirements of tef for optimizing yield. The most important shortcoming in tef production is its inherent low productivity. The local tef cultivar that is most often cultivated in the study area is known as '*Jimma Local*'. It has low yield potential compared to improved tef cultivar; however, recently genetic improvement of tef crop has resulted in the development of varieties that could yield as high as 3 tons ha^{-1}. This high yielding cultivar, 'Quncho' was released by Debre-Zeit Agricultural Research Centre and is being aggressively disseminated in different parts of Ethiopia. Moreover, to realize optimum yields of the crop, appropriate fertilizer rates have to be used since this could vary according to soil type and weather conditions of the area. The response of tef cultivars to fertilizer applications depends on the types of fertilizers, rates applied, time and method of application. Higher yield responses to recommended rates of fertilizers are obtained from released cultivars than from the local ones. However, all growth parameters of both released and local cultivars are highly influenced by fertilizer application (Melesse, 2007). The author also reported that, it was possible to increase yield by more than two-fold using improved cultivars and their respective recommended fertilizer rates. Tef responds to fertilizers especially to N highly in all its yield components. N is essential for carbohydrate use within plants and stimulates root growth and development as well as uptake of other nutrients (Tisdale *et al*., 1993; Brady and Weil, 2002). This study was therefore, initiated with the objective of determining the response of tef cultivars to nitrogen fertilizer rate under Jimma condition.

1.1 Statement of the Problem

Even though Tef is the staple food of most Ethiopian people, the present production system cannot satisfy the consumers' demand; since most of Ethiopian farmers use local variety than improved variety in most areas and this could lead to less productivity across Tef production areas. Plants with adequate amount of nitrogen fertilizer stimulates rapid growth, root growth, tiller production which leads to high grain yield and leaf area; there by increases photosynthetic activity and growth (Evans, 1997). But, blended nitrogen fertilizer application, which is not supported by modern technology, can have adverse impacts on Tef production and productivity. This is because local farmers use local Tef variety with a low or maximum nitrogen fertilizer application rather than using improved variety with optimum rate of nitrogen fertilizer application. Thus, evaluating the response of Tef varieties and N fertilizer application rates is necessary to limit gap in Tef productivity.

1.2 Significance of the study

Generally the purpose of this study is to observe and review the effect of different rates of nitrogen fertilizer on yield and yield components of Tef varieties. Since maximum or minimum rates of nitrogen fertilizer, which responsible for vegetative growth having a positive correlation with its yield and yield components causes; susceptibility for diseases and pests, drought, and yield reduction, optimum nitrogen rate (69kg/ha) help to obtain the desired yield and yield components.

Not only nitrogen rate but also variety has a significant influence on growth and yield components of Tef. Because of Jimma local variety has high germination rate under Jimma condition than Quncho variety. But, it is more susceptibility to disease and pests, water logging and drought as compared to Quncho Tef variety. Generally, this research helps to identify variety of Tef that withstanding constraints of Tef production and having high nitrogen up take and usage capacity and giving high yield and yield components.

1.3 Objectives
1.3.1 General Objective
The study is generally aimed to evaluate the response of Tef varietal growth and yield components to different N fertilizer application rates under Jimma condition, Eastern Ethiopia.

1.3.2. Specific objectives
- To determine the response of Tef varieties to different nitrogen fertilizer application rates
- To identify optimum N fertilizer application rate for Tef production

3. Materials and methods
3.1. Description of the Study Area
The experiment was conducted in Oromia region south west part of the country at the Jimma University College of Agricultures and Veterinary Medicine (JUCAVM) research site in 2015. JUCAVM is geographically located at about 7o, 33oN Latitude and 36oS, 57o E longitude at altitude of 1710 meters above sea level (m.a.s.l). The mean maximum and minimum temperature of the area is 26.8oC and 11.4oC, respectively and the mean maximum and minimum humidity is 91.4% and 31.2% respectively. The annual rain fall of the area is estimated to be 1500mm. The soil of the area is characteristically radish brown well drained clay to silty clay with PH ranges from 5.07 to 6.0 (Gezahegn, 2003).

3.2. Materials Used for the Experiment
3.2.1. Planting material
The tef variety Quncho [(974 × 196)-HT′-387(RIL355)] was developed by Debre Zeit Agricultural Research Center (DZARC) Quncho was developed from an intra-specific hybridization between two improved pure line selection varieties (DZ-01-974 and DZ-01-196). The ovule parent DZ-01-974 (Dukem) is a high-yielding variety developed through pureline selection and released in 1995 (Tefera et al., 1995, 2001); however, because of the seed colour (pale white), its preference by farmers was very limited. On the other hand, the pollen parent DZ-01-196 (Magna) is an old improved variety developed by pureline selection and released in 1970 (Tefera et al., 1995, 2001). DZ-01-196 has been popular for its very white seed colour, but its productivity has been relatively low (1.6–1.8t ha21). Hence, a targeted cross was made between the two varieties, with the objective of selecting recombinants combining the high yield of DZ-01-974 and the seed quality trait of DZ-01-196. Quncho was then developed as a single-seed descent-derived recombinant inbred line and, after series of multi-environment yield tests in various major tef-growing regions of the country, was officially released in 2006 (MoARD, 2008),and Jimma local variety was used for the experiment.

3.2.2. Fertilizer material
Urea [46% N) was used as a source of nitrogen nutrient elements.

3.3. Treatments and Experimental Design
The treatments consisted of four levels of nitrogen (0, 46, 69 and 92 kg N ha-1) and two varieties (Jimma local variety and Quncho variety). The experiment was laid out as a randomized complete block design in a factorial arrangement and replicated three times. A plot size of 0.6 m by 1 m was used and adjacent plots and blocks were spaced 0.5and 0.5 respectively.

3.4. Experimental procedures
The experimental field was selected and all unwanted materials like stones, straw, weed and other will be removed. The land was prepared very well by ploughing four times using draft animals and human labor. The seed of each variety obtained from Horticulture department were sown on upper surface of the soil. Watering was carried out two times per day i.e. early in the morning and in the afternoon. On the other hand other cultural practices like weeding, cultivating, etc were carried out as per the recommendation for Jimma area. Nitrogen fertilizer was applied on the same day of planting for each plot according to the treatment levels provided above during sowing.

3.5. Data collected and Methods of Data Collection
All the necessary data were collected randomly and from the six central plots of each plot by using materials and was organized. Sample was measured starting from half life of growth stage to the final growth stage or the yield of the plant. At all parameter of data collection, randomly five plants per plot were taken excluding the border rows to avoid border effects. Thus, the following data were collected.

3.5.1. Phenological data
Days to panicle emergence: This parameter was determined by counting the number of days from sowing to the time when 50% of the plants started to emerge the tip of panicles through visual observation.

Days to maturity: Days to maturity were determined as the number of days from sowing to the time when the plants reached maturity based on visual observation. It was also be indicated by Senescence of the leaves as well as free threshing of grain from the glumes when pressed between the forefinger and thumb.

3.5.2. Growth and yield component

Plant height: Plant height was measured at physiological maturity from the ground level to the tip of panicle from five randomly selected plants in each plot.

Panicle length: It is the length of the panicle from the node where the first panicle branches emerge to the tip of the panicle which was determined from an average of five selected plants per plot.

Number of effective tillers: Number of effective tiller mean that, number of tillers that can emerge panicle performed as the first plant. It was determined by counting the tillers from an area of 0.25 m x 0.25 m plants by throwing a quadrant into the middle portion of each plot.

Fresh Biomass yield: At maturity, the whole plant parts, including leaves and stems, and seeds from the whole plot were harvested and immediately, the biomass was measured. It was measured by harvesting the whole above ground plant parts including, leaves, stems and seeds.

3.6. Data Analysis

The data were subjected to analysis of variance (ANOVA) following the appropriate procedures of RCBD as stated by Gomez and Gomez (1984) for a factorial experiment. ANOVA was computed with the help of SAS computer software programme. Means of significant treatment effects were separated using the Least Significant Difference (LSD) test at 5% level of significance (SAS Institute, 2004).

4. RESULTS AND DISCUSSION

4.1. Effects on Crop Phenology

4.1.1. Days to panicle emergence

Days to panicle emergence were highly significantly ($P < 0.01$) affected by the variety (Quncho and Jimma local Variety) and nitrogen fertilizer rate, but the interaction of the two factors (nitrogen rate * variety) had a non-significant effect on panicle emergence (Appendix1).

In treatment of tef to 92 kg ha^{-1}, days to panicle emergence were prolonged about **48** days after sowing and followed by 44.7 days treated under 69kgha^{-1} in mean. In the other hand tef that was, treat as control had shortest days to panicle emergence, which is about 44.5 days in mean of days of emergence of tef.

Two varieties of tef, grown at the rate of 46 kg N ha^{-1} had significantly hastened days to panicle emergence than those grown at the other two higher rates of nitrogen. The maximum number of days to panicle emergence was observed in Quncho variety (about 48.9 days in mean) as compared to Jimma local variety(about 41.6 days in mean) of which they were treat with the same level of nitrogen rates of fertilizer. This result is in line with the finding of Getachew (2004) and Mekonen (2005) who reported that the heading was significantly delayed at the highest N fertilizer rate compared to the lowest rate on wheat and barley crops, respectively. In contrast, to the results of the present study, Sewnet (2005) reported early flowering with an increase in the rate of N application in rice.

Table1. Main effects of Nitrogen fertilizer rates and Variety on the phenology of tef

Nitrogen (kg/ha)	days to panicle emergence (days)	days to maturity (days)
0kg\ha	44.5^{b}	66.5^{b}
46kg\ha	43.8^{b}	66.0^{b}
69kg\ha	44.7^{b}	66.2^{b}
92kg\ha	48.0^{a}	70.0^{a}
LSD (p<0.05)	1.6	1.7
Variety	**days to panicle emergence (days)**	**days to maturity (days)**
Jimma local	41.6^{b}	63.6^{b}
Quncho	48.9^{a}	70.8^{a}
LSD (p<0.05)	1.1	1.2
CV (%)	2.8	2.1

LSD=Least significance difference
CV=coefficient of variance
*Means sharing the same superscript letter do not differ significantly at P = 0.05 and highly significantly at P=0.01 according to the LSD test.

4.2.2. Days to maturity

Days to maturity of tef plant was highly significantly ($P < 0.01$) affected by the main effect of variety and nitrogen fertilizer rate and the interaction effect of the two (Nitrogen * Variety) factors did not affect this parameter (Appendix 2).

In general, the maturity of tef plants hastened under lower N rates (about 66.5days by mean at controlled and 66 days at 46kgha-1 fertilizer rate than under the higher N (about 70daystreated with 92kgha-1 followed by 66.2 days by mean at 69 kgha-1nitogen fertilizer rates. Thus, increasing the rate of nitrogen from 46kgha-1 to 69 kg N ha-1 prolonged days to maturity by about relative shorten days as compared to that of 92kgha- 1 nitrogen rate, which was very prolonged maturation, date and hasten the vegetative phase of tef in our research. However, in case of varieties Quncho variety also had long maturation time (about 70.8 days in mean) as compared to Jimma local variety, which has shorter maturation day about 63.6 days in mean. This result is in line with the report of Marschener (1995), Tanaka *et al*. (1995), Brady, and Weil (2002) that N applied in excess than required delayed plant maturity. According to Mitiku (2008) days to physiological maturity of tef found to be positively correlated with fertilizer application.

4.4. Growth Parameters

4.4.1. Plant height

The analysis of variance showed that plant height was affected highly significantly ($P < 0.01$) by N fertilizer rates and non- significantly by variety and the interaction of the two factors (Appendix 3).

Plant height generally increased with the increase in the rate of N application (Table 2).Thus, tef plants treated with higher rates of nitrogen (92kgha-1) were taller (about 112.6cm in mean height followed by 107.7cmat 69kgha-1) than the rest rates of nitrogen fertilizer. However, plants supplied with lower rates of nitrogen nutrient (control and 46kgha-1 was give 97.3cm and 99.3cm by mean respectively). In the other hand, varieties (both Quncho and Jimma local variety) had not significant effect on plant height of tef.

Many studies revealed significant influence of N on plant height as it plays vital role in Vegetative growth of plants. A similar result was reported by Haftom *et al.* (2009) showing that tef plants with higher plant height (92 cm) and panicle length (38 cm) were found by applying a high amount of N fertilizer (92 kg N ha-1). This may be attributed to the fact that N usually favors vegetative growth of tef, resulting in higher stature of the plants with greater panicle length. Legesse (2004) also reported that high N application resulted in tef plants with significantly taller plants due to direct effect of N on vegetative growth of crop plants. In line with this finding Mekonn (1999) reported that plant height measured at physiological maturity increased significantly with increasing levels of N in wheat and sorghum respectively. Similarly, Tenaw (2000) and Zeidan *et al.* (2006) reported a significant effect of increased N fertilizer on the stature of maize plants. The plant height obtained from the all treated plots was significantly higher than the unfertilized plot. This is because nitrogen fertilizer has a great role in plant growth.

4.4.2. Panicle length

Panicle length neither influenced by the main effect of the rate of nitrogen fertilizer and variety nor by the interaction of the two factors significantly (0.05) and highly significantly (0.01) (Appendix 4).

These finding was contrary to the previous study of Channabasavanna and Setty (1994) and Rathore *et al.* (1991), they revealed that increased yield of cereal crops due to increased yield attributes such as panicle length as a result of successive increases in N application. Those findings was also in line with the findings of Hailu (1988); Hailu *et al.* (1996); Mulugeta (2000); Legesse (2004); Mitiku (2008) and Haftamu *et al.* (2009) that panicle length exhibited positive and highly significant correlation with culm length, plant height, number of internodes, and grain yield. In all findings including the aforementioned ones, increased application of N caused increased panicle length and hence crops with higher panicle length produced significantly higher total biomass yield, grain yield and straw yield than those with shorter panicles.

4.4.3. Number of effective tillers

Number of effective tillers counted at 0.0625 m^2 was not significantly ($P < 0.05$) influenced by the main effect of cultivars as well as by interaction effects.. However, this parameter was significantly influenced by the main effect of N fertilizer application (Appendix 5).

The number of effective tillers was significantly increased in response to increasing rate of nitrogen fertilizer to both varieties. The maximum number of effective tillers was recorded in response to nitrogen applied at the rate of 92 kg N ha-1 with 3.5 effective tillers, but from plots treated with 46 kg N ha-1nitrogen the lowest number of effective tillers(about 1.5 by mean) was obtained . Consistent with these results, Seyfu (1993); Tekalign *et al*. (2000); Legesse (2004); Haftamu *et al*. (2009) reported significantly higher number of tillers in response to the application of high N rate in tef. Corroborating the results of this study, Botella *et al*. (1993) reported that stimulation of tillering with high application of nitrogen rate might be due to its positive effect on cytokinin synthesis.

Table 2. Main effects of Nitrogen fertilizer rates and Variety on the growth parameter of tef

Nitrogen (kg/ha)	plant height (cm)	panicle length (cm)	number of effective tiller (no)
0kg\ha	97.3^{b}	62.1	1.5^{c}
46kg\ha	99.3^{b}	58.4	2.5^{b}
69kg\ha	107.7^{a}	60.9	2.9^{ab}
92kg\ha	112.6^{a}	62.3	3.5^{a}
LSD (p<0.05)	5.4	NS	0.6
Variety	**plant height (cm)**	**panicle length (cm)**	**number of effective tiller (no)**
Jimma local	103.2	61.3	2.5
Quncho	105.2	60.6	2.7
LSD (p<0.05)	NS	NS	NS
CV (%)	4.2	8.4	19.0

LSD=Least significance difference
CV=coefficient of variance
*Means sharing the same superscript letter do not differ significantly at P = 0.05 and highly significantly at P=0.01 according to the LSD test.

4.5. Yield Response to Cultivars and Applied N Fertilizer Rates
4.5.1. Fresh Biomass Yield
The biomass yield was highly significantly (P < 0.01) influenced by the main effect of Nitrogen fertilizer rate and interaction effect of the two factors, and significantly (P < 0.05) by variety (Appendix 6). The highest biomass yield (1056.6g and 890.3 per plot) was obtained under plants supplied with 69 kg N ha-1 applied in Quncho and Jimma local varieties of tef respectively. Whereas the lowest biomass (701.5g followed by492.9g per plot) yield was obtained from plants treated at 46 kg N ha-1 rate and applied in Jimma local and Quncho tef varieties respectively. This nitrogen application significantly enhanced biomass yield agrees with the result of Amanuel *et al*. (1991) who reported a significant increase in biomass yield of wheat because of increased rate of N application. The application of highest level of N resulted in less biomass yield (614.8g per plot) compared to 69 kg N ha-1 rate applied in Quncho variety. This might be due to the effect of lodging resulted from too high amount of N fertilizer that encourage vegetative growth and height leading to lodging before the translocation of dry matter to economic yield since biomass includes the economic yield. This result is, however, in contrast to that of Haftom *et al*. (2009) who found the highest biomass yield of tef in response to the application of 92 kg N ha-1. This may be attributed to possible differences in the inherent fertility of the two soils, whereby the soil on which these authors conducted their experiment may have been lower in organic matter than the soil used for this experiment. This may have rendered the latter soil to have lower ability to supply N from mineralization, thus requiring the application of more external nitrogen (92 kg N ha-1) for increased biomass production of tef than the soil used for this experiment. Studies by Legesse (2004); Mitiku (2008) and Haftamu *et al.* (2009) similarly revealed that, further increases in N application resulted in higher total biomass yield. The increase in total biomass yield with increased N application was ascribed by the authors to highly increased tiller numbers and panicle length that are usually highly enhanced due to high N application.

Table 3. Mean days of fresh biomass yield of tef as affected by interaction effect of rates of nitrogen fertilizer Application and variety

Nitrogen rate kgha-1	variety	
	Jmma local	**Quncho**
0	701.5^{cd}	492.9^{e}
46	832.6^{bc}	663.6^{d}
69	890.3^{b}	1056.6^{a}
92	715.8^{cd}	668.5^{d}
LSD (p<0.05)	144.0	
CV (%)	11.0	

LSD=Least significance difference
CV=coefficient of variance
*Means sharing the same superscript letter do not differ significantly at P = 0.05 and highly significantly at P=0.01 according to the LSD test.

CONCLUSION AND RECOMMNDATION
The experiment was conduct in oromia region southwest part of the country at Jimma university college of Agricultures and veterinary medicine (JUCAVM) research site in 2015, to determine optimum N fertilizer rates on tef cultivars. During the off season, march to may 2015 a tef varieties 'Quncho' (Dz-cr-387) and a local tef

cultivar called 'Jimma local' were used as test crops to determine their response to increased N (0, 46,69 and 92 kg ha-1) fertilizer rates. The 2×4×3 factorial experiment was carried out using randomized complete block design with three replications at Jimma university college of Agricultures and veterinary medicine (JUCAVM) research site. Urea's (46% N) were also used as a source of N fertilizers.

Tef cultivars 'Quncho' and 'Jimma local' significantly differed in phenologic parameters such as days to panicle emergence and days to maturity. 'Jimma local' variety took a reduced day lengths than 'Quncho' for panicle emergence. The maximum number of days to panicle emergence was observed in Quncho variety (about 48.9 days in mean) as compared to Jimma local variety(about 41.6 days in mean) of which they were treat with the same level of nitrogen rates of fertilizer. However, increasing the N fertilizer rate prolonged the phenological parameters. Quncho variety also had long maturation time (about 70.8 days in mean) as compared to Jimma local variety, which has shorter maturation day about 63.6 days in mean. In treatment of tef to 92 kg ha^{-1}, days to panicle emergence were prolonged about **48** days after sowing and followed by 44.7 days treated under 69$kgha^{-1}$ in mean. In the other hand tef that was, treat as control had shortest days to panicle emergence, which is about 44.5 days in mean of days of emergence of tef.

All growth parameters (Plant height panicle length and number of effective tillers) were non-significantly affected due to the main effects of cultivars and the interaction effect of (Variety*Nitrogen fertilizer rate) .But, plant height and number of effective tillers were high significantly (<0.01) affected by nitrogen fertilizer rate and panicle length was in the other hand affected non-significantly by nitrogen fertilizer rate. The increase in N application from 0 to 92 kg ha-1 resulted in significantly increased plant height and tiller number. In general high N application to tef crop promoted significantly high vegetative growth that led to high production. Thus, tef plants treated with higher rates of nitrogen (92kgha-1) were taller (about 112.6cm in mean height followed by 107.7cmat 69kgha-1) than the rest rates of nitrogen fertilizer. However, plants supplied with lower rates of nitrogen nutrient (control and 46kgha-1 was give 97.3cm and 99.3cm by mean respectively). The maximum number of effective tillers was also recorded in response to nitrogen applied at the rate of 92 kg N ha-1 with 3.5 effective tillers, but from plots treated with 46 kg N ha-1nitrogen the lowest number of effective tillers(about 1.5 by mean) was obtained .

Yield components of the tef cultivar, I have used also affected high significantly by the main effects of N fertilizer rate and the interaction effect (Cultivar*N fertilizer rate) and significantly by the main effects of two verities. Biomass yield generally increased significantly with the increase in the rate of nitrogen across the two varieties. The highest biomass yield (1056.6g and 890.3 per plot) was obtained under plants supplied with 69 kg N ha-1 applied in Quoncho and Jimma local varieties of Tef respectively. Whereas the lowest biomass (**832.6** g followed by **663.6** g per plot) yield was obtained from plants treated at 46 kg N ha-1 rate and applied in Jimma local and Quoncho Tef varieties respectively. The application of highest level of N resulted in less biomass yield (**668.5** g per plot) compared to 69 kg N ha-1 rate applied in Quncho variety. This might be due to the effect of lodging resulted from too high amount of N fertilizer that encourage vegetative growth and height leading to lodging before the translocation of dry matter to economic yield since biomass includes the economic yield.

In general, Tef plant that were treat with 69kgha-1 gives highest biomass, shortest days to panicle emergence and days to maturity as compared to the highest level of nitrogen fertilizer (92kgha-1).in the other hand, Quoncho variety was required higher nitrogen fertilizer rate as compared to Jimma local variety in terms of responses to days of panicle emergence, days to maturity, panicle length and plant height e.t.c but gives higher fresh biomass yield. Hence, we are going to recommend using the optimum rate of nitrogen fertilizer rate (69kgha-1) and Quoncho variety for obtain best growth; yield and yield components of Tef to full fill the demand of the local consumers and foreign market.

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APPENDIX

Appendix table (1) the analysis of variance for panicle days of emergence (days), using adjusted SS for tests

Sources of variation	DF	SST	MS	FV	Pr>f
Replication	**2**	**18.25**	**9.13**	**5.70**	**0.0155**
Nitrogen	**3**	**62.83**	**20.94**	**13.08**	**0.0002**
Variety	**1**	**322.67**	**322.67**	**201.52**	**<.0001**
Nitrogen * Variety	**3**	**10.33**	**3.44**	**2.15**	**0.139**
Error	**14**	**22.42**	**1.60**		
Corrected Total	**23**	**436.50**			

Appendix table (2) the analysis of variance for days of maturity (days) ,using adjusted SS for tests

Sources of variation	DF	SST	MS	FV	Pr>f
Replication	2	18.08	9.04	4.53	0.0303
Nitrogen	3	65.00	21.67	10.87	0.0006
Variety	1	308.17	308.17	154.54	<.0001
Nitrogen * Variety	3	8.17	2.72	1.37	0.2940
Error	14	27.97	1.99		
Corrected Total	23	427.33			

Appendix table (3) the analysis of variance for plant height, using adjusted SS for tests

Sources of variation	DF	SST	MS	FV	Pr>f
Replication	2	71.62	35.81	1.87	0.1899
Nitrogen	3	928.54	309.51	16.20	<.0001
Variety	1	24.81	24.81	1.30	0.2736
Nitrogen * Variety	3	172.737	57.58	3.01	0.0656
Error	14	267.42	19.10		
Corrected Total	23	1465.112			

Appendix table (4) the analysis of variance for panicle length, using adjusted SS for tests

Sources of variation	DF	SST	MS	FV	Pr>f
Replication	2	9.64	4.8200	0.19	0.8330
Nitrogen	3	56.33	18.78	0.72	0.5559
Variety	1	3.08	3.088	0.12	0.7360
Nitrogen *Variety	3	17.09	5.70	0.22	0.8817
Error	14	364.63	26.04		
Corrected Total	23	450.78			

Appendix table (5) the analysis of variance for number of effective tillers, using adjusted SS for tests

Sources of variation	DF	SST	MS	FV	Pr>f
Replication	2	10.02	5.01	20.54	<.0001
Nitrogen	3	12.94	4.31	17.67	<.0001
Variety	1	0.48	0.48	1.97	0.1819
Nitrogen *Variety	3	0.78	0.26	1.06	0.3961
Error	14	3.42	0.26		
Corrected Total	23	27.64			

Appendix table (6) the analysis of variance for fresh biomass yield, using adjusted SS for tests

Sources of variation	DF	SST	MS	FV	Pr>f
Replication	2	15711.46	7855.73	1.19	0.3319
Nitrogen	3	459690.77	153230.26	23.30	<.0001
Variety	1	30281.51	30281.51	4.60	0.0499
Nitrogen *Variety	3	136680.14	45560.05	6.93	0.0043
Error	14	92066.15	6576.15		
Corrected Total	23	734430.04			