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Effect of Time of Fertilizer Application on Yield and Yield Components of Tef ((Eragrostic tef) Trotter) at Shebedino, Southern Ethiopia

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Abstract
Time of DAP application vary from farmer to farmer. Therefore, there is a need to determine time of DAP for recommending to tef (Eragrostis tef (Zucc) Trotter). Accordingly, an experiment was conducted to evaluate the effect of the time of DAP application on yield and yield components of tef at Shebedino, Southern Ethiopia in 2012 cropping season.DZ-37 tef variety was used as a test crop. The times of DAP fertilize application consisted application at planting, two, four, six and eight days before planting; was laid out in Randomized Complete Block design (RCBD) with four replications. DAP applied two days before planting had significantly affected days to heading and maturity, plant height , first growth rate, number of tiller and panicle, thousand seed weight, grain, straw and total biomass yields and harvest index. Days to emergence and panicle length were significantly affected by fertilizer applied two days before planting. Also DAP applied two days before planting hasten days to heading and maturity by 4 and 5 days, respectively, than DAP applied eight days before planting. Meanwhile DAP applied two days before sowing increased panicles, grain and biomass yields by 41.7, 62.1and 59.6% respectively, than DAP applied eight days before sowing. DAP applied at the time of sowing, had 54.7 and 1.07% more 1000 seed weight and harvest index respectively, than DAP applied at the time of sowing. Therefore, DAP application two days before planting could be recommended as an economically feasible choice for the study area.
Keywords: time of fertilizer/DAP application before planting

1. INTRODUCTION

Tef (Eragrostis tef (Zucc) Trotter) is a small - seeded cereal indigenous to Ethiopia and originated in Ethiopia between 4000 and 1000 BC. Currently, tef is grown in almost all regions of Ethiopia; because it is the preferred grain crop for home consumption, market and fetches the highest grain price compared with the other cereals (Zeleke, 2009).

Tef is among the major cereal crops in Ethiopia and occupies about 22.6% of the total cereals' land (about 2,731,111.67 hectares), which is more than any other major cereals such as maize (17%), sorghum (15.92%) and wheat (11.89%) (CSA, 2012). Of the total 30 million grain production,14 million tons is contributed by cereals; tef constituted about 16% (34,976,894.64 quintals), next to maize 27.77% (60,694,130.14 quintals) during the main cropping season of 20011/12.

In Ethiopia, tef performs well in 'Weina dega' agro-ecological zones or medium altitude (1700-2400 masl). According to Haftamu et al. (2009), mean temperature and optimum rainfall for tef during growing season range from 10 to 27 ^oC and 450 to 550mm, respectively. Tef withstands low moisture conditions and has the ability to tolerate and grow on Vertisols having a drainage problem, which make it a preferred cereal by farmers.

The length of growing period (LGP) considering rainfall of 450 to 550 mm and evapo-transpiration of 2-6 mm day^{-1}, ranges from 60 to 180 days. Depending on variety and altitude, tef requires 90 to 130 days for growth (Haftamu et al., 2009).

Ethiopian farmers grow tef for a number of merits; which are mainly attributed to the socioeconomic, cultural and agronomic benefits (Hailu and Seyfu, 2001); although it ranks the lowest in terms of yield from of all cereals grown in Ethiopia.

The lower productivity of tef might be due to its confinement to Ethiopia in terms of origin and diversification, which limits the chance of improvement like other cereals of international importance (Kebebew et al., 2001). Other factors contributing to its low in productivity are lodging, method of planting and fertilizer application; the combined effect of those factors result up to 22% reduction in grain and straw yield (Hailu and Seyfu, 2001).

Therefore, further improvement of product and productivity of tef is highly needed; as even improved varieties of tef are reported to yield only up to 2.2 t ha^{-1} on farmers' field (Hailu and Seyfu, 2001) and the national average yield is 1.17 t ha^{-1} (CSA 2012).

High rate of nutrient depletion in Ethiopia; due to lack of adequate synthetic fertilizer input, limited return of organic residues and manure, high biomass removal, erosion, and leaching (Balesh.et al., 2007). The solution for these would be selecting combinations of nutrient source, appropriate rate and timing of fertilizer application; that would optimize fertilizer use efficiency and increases economic return (Grant et al., 2002). Especially, **application of nutrients before peak crop nutrient demand is critical; and adequate nutrients early in the growing season are necessary to maximize yield. Mainly, N and P are ensuring good grain or seed fill (Clain Jones, 2011). According to Clain (2011)**, **there are many advantages from early application, like** increased nutrient use efficiency and reduced adverse environmental effects.

Though there is much advantage from early application, time of fertilizer application before planting is not known; due to limited research work on early application.

Therefore, there are controversies regarding appropriate time of DAP fertilizer application before planting. Some farmers prefer to apply DAP four days before planting, while others prefer to apply three days before planting, the remaining prefers to apply two and one day before planting; which might result on loss of fertilizer and reduction in yield.

Therefore to improve production and productivity of tef optimum time of fertilizer application should be considered (ATA, 2012). Hence, this study was initiated with the following objectives:

- To evaluate the effect of time of Di-Ammonium Phosphate (DAP) fertilizer application on growth and yield of tef.
- To see the interactive effect of time of DAP fertilizer application on growth and yield of tef.
- To identify the optimum time DAP fertilizer application in tef production

2. MATERIALS AND METHODS

2.1 Site Description

This study was conducted at Taremessa Kebele of Shebedino Woreda, in Sidama Zone. The site is located 27 km south of Hawassa and situated at 7^0 4'N and 44^0E with an elevation of 1900-2600 masl. The mean annual rain fall varies from 900-1500 mm, with two rainy seasons (bimodal); the belg (short rain from Feb-April) and meher (main season from June- October).

The dominant crops growing around the experimental area are enset (Enset ventricosum), maize (Zea mays L.), tef, different vegetables and Chat (Catha edulis). Specifically the study site has an altitude of 1980 masl with clay loam textural soil and considered as representative of the Woreda's cool sub humid (Weyna Dega) agro climatic zone (SWRDO, 2013, unpublished).

Based on ten years (2003 to 2012) meteorological data, the average annual rainfall of the study area was 798 mm; with a range of 704.3 mm to 1197.9 mm per year. The total rainfall of the growing year was 922.8 mm with a range of 0.2 to 193.6 mm per month. The total rainfall of the growing season was 590.4 mm with a range of 5.5 to 155.2 mm per month; which are ideal for the production of tef (Appendix Table1).

The average annual minimum and maximum temperatures are 13.3 ^oC and 27.5 ^oC, respectively. The mean minimum and maximum temperatures of the growing year were 13.5 ^oC and 27.8 ^oC, respectively. The mean minimum and maximum temperatures of the growing season were 14.5 ^oC and 26.3 ^oC, respectively. Generally the Woreda consist of two agro climatic zone, namely cool sub humid (Weyna Dega (90%)) and cool and humid (Dega (10%)) (SWRDO, 2013) (unpublished)

2.2. Experimental Treatments and design

The experiment was done on time of fertilizer application and arranged in randomized complete block design (RCBD). Times of fertilizer (DAP) application consist of (0, 2, 4, 6 and 8 days before planting), were arranged as factorial with four replication.

2.3. Experimental Procedure

Tef variety, DZ-Cr-37 (Tsedeay) released in 1984 was used as a test crop; which is most widely grown variety in the relatively low altitude and moisture prone areas (Truneh et al., 2000).

The experimental field was prepared by using oxen plow and plowed four times, before planting. Plowing started at the end of June and the fourth plowing was done in the middle of August 2012. The experimental plot size was 2 m x 2.5 m (5 m^2) and the space between plots was 0.5 m; which had 0.2m intra row space. Meanwhile DAP fertilizer was used at the rate of 100 kg ha^{-1} as source of N and P; and Urea was applied at the rate of 50 kg ha^{-1}; in which 1/3 at planting and 2/3 at stem elongation

2.4. Soil Sampling and Analysis

Sixteen random soil samples (0-20 cm depth) from the experimental field were thoroughly mixed to make a composite. The sample was air dried and ground to pass 2 mm sieve and necessary parameters such as soil texture, available P, pH and CEC were determined. For the determination of OC and N 1mm sieve was used. Soil texture was analyzed by Bouyoucos hydrometer method (Day, 1965). Available P was extracted with a sodium bicarbonate solution at pH 8.5 following the procedure described by Olsen et al. (1954).The pH of the soil was measured potentiometrically in the 1:2.5 soil: water mixture by using a pH meter and organic carbon was determined following Walkely and Black wet oxidation method (Walkely and Black, 1934).Cation Exchange Capacity (CEC) was determined by Ammonium Acetate method (Jackson, 1973).

2.5. Data Collection

2.5.1. Phenological data

Days to 50% emergence: number of days from sowing up to the date when 50% of the plants emerged in a plot.
Days to 50% heading: number of days from sowing up to the date when the tips of the panicles first emerged from the main shoot, on 50% of the plant in a plot
Days to 90% maturity: number of days from the date of sowing up to the date when 90% of the crop stands in a plot changed to light yellow color.

2.5.2. Growth data

Plant height (cm): - It was taken at an interval of 20 days; by taking six randomly selected plants and measured from the base of the main stem to the tip of the panicle.
Growth Rate: - It was the ratio of the differences between two consecutive plant heights measured at difference time [GR= $\Delta H \div \Delta T$] (Watson, 1952).

Growth rates (GR_1, GR_2 and GR_3) were calculated according to Watson (1952), as following:-

$GR_1 = [H_2 - H_1] \div [T_2 - T_1]$ $GR_2 = [H_3 - H_2] \div [T_3 - T_2]$ $GR3 = [H_4 - H_3] \div [T_4 - T_3]$

Where,

GR_1 = First growth rate	T_1 = 20 days after emergence
GR_2 = Second growth rate	T_2 = 40 days after emergence
GR_3 = Third growth rate	T_3 = 60 days after emergence
H_1 = Height of plant at time t_1	T_4 = 80 days after emergence
H_2 = Height of plant at time t_2	
H_3 = Height of plant at time t_3	
H_4 = Height of plant at time t_4	

Tillers number (m^{-2})**: -** to determine the capacity of tillering per $1m^2$, 10 cm X 20 cm area was demarcated and the number of plants existed in that area was counted. Then recounting was done after at flowering on demarked area; because maximum tillers produced during vegetative phase and senescence occurs at maturity (Lafarge et al., 2004). Finally the difference between the first and second count was converted into $1m^2$.
Panicles per plant: - six plants were randomly taken and the average number of panicles per plant was considered.
Panicle length (cm): - length of the panicle was measured by selecting six plants randomly and measuring from the node (the first panicle branch started) to the tip of the panicle.

2.5.3 Yield and yield components

Total above ground biomass (kg):- was measured after sun-drying for two days.
Straw yield (kg): - was measured by subtracting grain yield per plot from the total above ground biomass.
Grain yield (kg ha^{-1}):- yield from every plot
Thousand seed weight (g): - the seeds were taken from each plot and 1000 seeds counted by hand and then weighted.
Harvest index: - the ratio of grain yield to the above ground (shoot) biomass. [HI= Grain yield/Total biomass].

2.6. Economic Analysis

For economic analysis, a simple partial budget analysis was employed using CIMMYT approach (CIMMT, 1988). For partial budget analysis, the factors with significant effect were considered. The yield was adjusted by subtracting 10 % from average gain yield. Than after, gross yield benefit was obtained by multiplying the adjusted yield by the price of grain (13 birr kg^{-1}). Net benefit was calculated, by subtracting labor cost from gross yield. Finally marginal rate of return (MRR) was obtained, by dividing marginal net benefit to the marginal cost and expressed as percentage (CIMMT, 1988). The mean market price of tef was obtained by assessing the market at harvest (2012 cropping season).

2.7. Data Analysis

The various agronomic data were analyzed using the general linear model (GLM) procedures of the SAS statistical software (SAS Institute, 2000) to evaluate the effect of sowing method and time of fertilizer application and their interaction. Least Significant Difference (LSD) test at $P \leq 0.05$ was used to separate means whenever there were significant differences.

3. RESULTS AND DISCUSSION

3.1. Physicochemical Properties of the Experimental Soil.

The analytic results indicated that the experimental soil was clay loam textured; having organic carbon content (OC) of 2.54 % (Table 1). The soil had high OC in accordance with Sahlemedhin (1999), who rated OC between 1.74-2.90% as high. The CEC of the soil was 23.87 cmol kg^{-1}, which could be considered as medium (Landon, 1991). According to Olsen et al. (1954) P rating (mg kg^{-1}), P content of < 3 is very low, 4 to 7 is low, 8 to 11 is medium, and > 11 is high. Thus, the experimental site of available P content is high. The pH of the soil was 4.98, which is within the range of 4 to 8 suitable for tef production (FAO, 2000).Total N of the soil (0.16 %), is medium; as rated by Havlin et al., (1999) who rated total N between 0.15 to 0.25% as medium.

Table 1: - Physio-chemical properties of the experimental soil.

Depth (cm)	pH (H_2o)	CEC (cmol kg^{-1})	OC (%)	Total N (%)	Av.P (mg kg^{-1})	Particle size distribution (%)			Textural Class
						sand	clay	silt	
0-20	4.98	23.87	2.54	0.16	27.4	32	30	38	Clay loam

CEC= Cation Exchange Capacity, OC= Organic Carbon, Av.P= Available phosphorous.

3.2. Crop Phenology

3.2.1. Days to emergence

Days to 50% crop emergence was significantly affected by the time of fertilizer application ($P \leq 0.001$) (Appendix Table 4).

Fertilizer applied eight days before sowing delayed emergency by 2-days than that applied two days before sowing (Table 2). This might be attributed to the high loss of DAP fertilizers from the earlier application before it is used by the plant; especially N, which is highly soluble and may be lost from the soil-plant system by leaching, de-nitrification, volatilization and erosion (Vaughan et al., 1990).

Table2:- Effect of method of sowing and time of DAP application on the days to emergence, heading and maturity of tef.

DBP=Days Before Planting, column which has the different letters shows significant difference

Treatments	50% Emergence	50% Heading	90 % Maturity
Time of fertilizer application			
At planting	8c	45cd	66cd
2-DBP	8c	44d	65d
4-DBP	9b	46bc	67bc
6-DBP	9b	47b	68ab
8-DBP	10a	48a	70a
LSD (5%)	**0.54**	**1.25**	**1.80**
CV (%)	**4.32**	**1.87**	**1.84**

3.2.2. Days to heading

The time of fertilizer application had a significant ($P \leq 0.001$) on days to heading (Appendix Table 4). Days to heading was enhanced by 4 days on DAP applied two days before sowing, compared to that of DAP applied eight days before sowing (Table 2).Thus days to heading for application of DAP two days before sowing is smaller; due to minimum loss fertilizer contributes for growth of crop (Brady and Weil, 2002).

3.2.3. Days to maturity

Days to 90% maturity were significantly ($P \leq 0.001$) affected by time of fertilizer application (Appendix Table 4). Meanwhile application of fertilizer at planting resulted in 1-day delay and 4-days earlier mature compared to those applied two and eight days before sowing, respectively (Table 2). Thus, applying fertilizer two days before sowing enhanced maturity and this was because of time of application is one of the factor influencing crops phonology and growth (Mugwe et al., 2007).

3.3. Growth Parameters

3.3.1. Plant height

The time of fertilizer application had very high significant ($P \leq 0.001$) effect on plant heights, except the effect of planting method on plant height (ph1) which was highly significant on probability level ($p \leq 0.01$) (Appendix Table 5).

Application of fertilizer two days before sowing had 25% more plant height than DAP applied at sowing on the first measurement. Whereas application of fertilizer two days before sowing had 42, 25.6 and 8.7% higher plant height than that of applied eight days before sowing on PH_2, $PH_3$and PH_4 respectively (Table-3). The results are in line with the report of Taylor and Francis (2005) and Vaughan et al. (1990), who indicated maximum use of N and P with minimum loss resulting in maximum growth in height on lentil and wheat, respectively.

Table3:- Effect of time of DAP application and sowing method on growth of tef

Time of fertilizer application		PH_2	GR_1	PH_3	GR_2	PH_4	GR_3	PL	PN	TN
PH_1										
At planting	11.48b	38.16ab	1.32	77.95ab	2.00	97.77ab	2.69	23.75a	11b	5a
2-DBP	15.40a	43.00a	1.38	84.00a	2.05	100.15a	1.34	20.61b	12a	6a
4-DBP	14.60a	35.80ab	1.05	71.50bc	1.78	95.45bc	1.20	18.94bc	10c	3b
6-DBP	11.37b	30.58bc	0.96	66.90cd	1.82	93.75cd	0.82	17.63c	8d	2c
8-DBP	9.89b	24.97c	0.90	62.50d	1.87	91.40d	1.01	17.33c	7e	1c
LSD (5%)	**2.58**	**7.63**	**0.51**	**8.24**	**0.48**	**3.56**	**2.33**	**1.68**	**0.77**	0.87
CV (%)	**14.00**	**15.13**	**31.30**	**7.78**	**17.54**	**2.54**	**11.3**	**5.86**	**5.54**	17.09

DBP= Days Before Planting, PH = Plant Height (PH_1- was measured 20 days after emergence; PH_2-measured 40 days after emergence; PH_3-measured 60 days after emergence and PH_4- was measured 80 days after emergence),GR= Growth Rate (GR_1-calculated from PH_1& PH_2, GR_2-calculated from PH_2& PH_3, GR_3-calculated from PH_3& PH_4), PL= Panicle Length, PN= Panicle Number and TN= Number of Tiller. The same letter in a column of each factor shows a non-significant difference at 5% probability level

3.3.2. Growth rate

Time of fertilizer application, had no significant effect on all growth rates; except method of sowing had significant ($P \leq 0.05$) on the first growth rate (Appendix Table-5).

The non significant effect on others growth rate were due to efficient utilization of applied DAP fertilizer at earlier growth stage. Especially N is a constituent of chlorophyll, proteins and nucleic acids, which are essential for plant growth (Rashid et al, 2007).

3.3.3. Panicle length

The time of fertilizer application significantly ($P \leq 0.001$) affected panicle length (Appendix Table 5).

Fertilizer applied two days before sowing had 16% more and 13% less panicle length than fertilizer applied eight days earlier sowing and at time of sowing, respectively. This might be due to maximum utilization of nutrients on fertilizer applied two days before sowing and at the time of sowing; because time and rate of fertilizer application has significant effect on both growth and yield (Lloveras et al., 2001).

3.3.4. Panicle number

Time of fertilizer application had significantly ($p \leq 0.001$) affected number of panicles per plant (Appendix Table 5).

Application of DAP eight days before sowing and at time of sowing had 42 and 8% less panicle number, respectively, than applied two days before sowing (Table 3). This result is in line with the finding of Genene (2003) who reported time of fertilizer application, particularly those containing N and P affects panicle number of wheat.

3.3.5. Tillers

Time of fertilizer application had significantly ($P<0.001$) affected the number of tillers (Appendix Table 5).
The DAP applied two days before sowing had 16.7% more tillers than DAP applied at the time of sowing. Whereas the DAP applied eight days before sowing had reduce the number of tiller by 80% compared with fertilizer applied at sowing (Table 3).These might be due to maximum loss of N when DAP was applied eight days earlier to sowing, which could result to less tillering (Lloveras et al., 2001). Because N stimulates tillering due to its' effect on cytokinin synthesis (Mengel and Kirkby, 1996)

3.4. Yield and yield components

3.4.1. Total biomass

Sowing method had significantly ($p \leq 0.001$) affected biomass yield (Appendix Table 6). Application of DAP at the time of sowing resulted in 52.5 % more biomass than the treatment with DAP applied eight days prior to sowing. Whereas applying of DAP at the time of sowing 15 % less biomass than DAP applied two days before sowing (Table 5), this might be due to maximum use of applied fertilizer on fertilizer applied two days prior sowing; because efficient utilization of applied fertilizer increased vegetative growth, which resulted for higher biomass production (Wakene 2010).

Table: - 4 Effects of time of DAP application and sowing method on yield and yield components of tef

Time of fertilizer	TBM (k.g)	SY(k.g)	GY(Q^{-ha})	TSW(g)	HI (g)
At planting	1525.0ab	110.0ab	21.45ab	1.60a	0.93a
2-DBP	1793.8a	117.5a	25.11a	1.08b	0.93a
4-DBP	1331.3b	101.3ab	18.45b	0.64c	0.92a
6-DBP	937.5c	95.0ab	12.7c	0.31d	0.89a
8-DBP	725.0c	90.1b	9.53c	0.29d	0..84b
LSD (5%)	359.9	26.1	5.18	0.12	0.06
CV (%)	19.5	17.4	5.18	10.53	4.3

DBP= Days before Planting, CV= Coefficient of Variations, TBM = Total Bio Mass, SY = Straw Yield, GY = Grain Yield, TSW= Thousand Seed Weight and HI= Harvest Index.

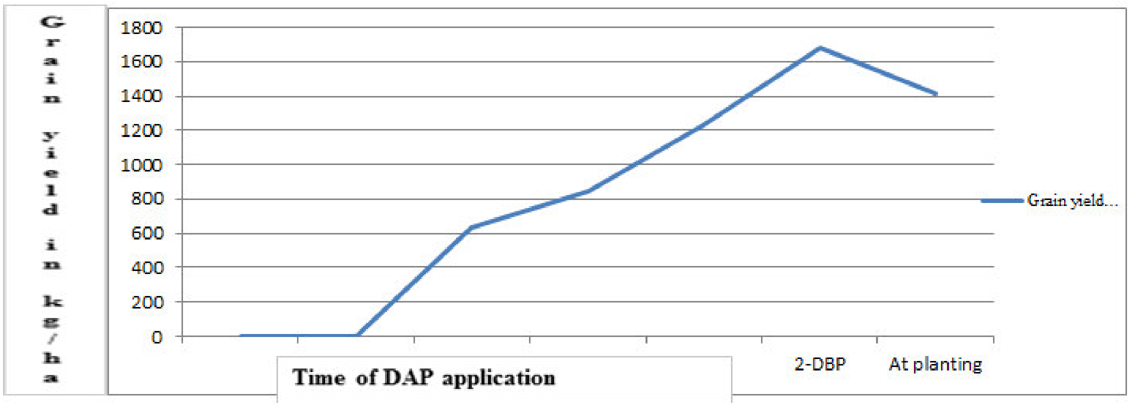
3.4.2. Straw yield

Time of fertilizer application significantly ($p \leqq 0.5$) affected biomass yield (Appendix Table 6).

Application of DAP at the time of sowing and two days before sowing resulted in 18 and 23.3% more straw yield, respectively than the treatment with DAP applied eight days prior to sowing (Table 4). This might be due to maximum use of applied fertilizer, with little loss on applied at the time of sowing and two days prior to sowing; because efficient utilization of applied fertilizer increased vegetative growth, which contribute to higher straw yield (Alam et al., 2005).

3.4.3. Grain yield

The time of fertilizer application ($P<0.001$) had significant effect on grain yield (Appendix Table 6). Application of DAP two days before sowing increased grain yield by14.6% over DAP applied at the time of sowing, whereas DAP applied eight days before sowing decreased grain by 55.6% compared to application at sowing (Table 4).These could attributed by minimum loss through leaching and volatilization on DAP applied two days before sowing and which resulted in better growth (Erkossa & Teklewold, 2009)



3.4.4. Thousand Seed weight

The time of fertilizer application and their interaction had significant ($p \leqq 0.001$) effect on thousand seed weight (Appendix Table 6). Meanwhile DAP applied two days before sowing had 32.5% more thousand seed weight than DAP applied at sowing. Whereas as DAP applied eight days prior sowing was weighted 81.9% less compared with DAP applied at sowing (Table 4). These might be because of let application enhances efficiently utilization of applied fertilizer (Minale et al., 1999) and appropriate rate of N fertilizer at correct time, which optimizes grain yield and quality (Abdo, 2009).

3.4.5. Harvest index

The time of fertilizer application had significant effect on harvest index (Appendix Table 6).
Meanwhile fertilizer application two days before sowing had 9.7% more harvest index than fertilizer application eight days prior to sowing (Table 4). These might be due to, efficient utilization of Urea results for increment vegetative growth due to compassion of N, which in turn increase grain yield by improving cumulative solar radiation intercepted by the crop (Osman et al., 2001).

3.5. Association of Grain Yield with Yield and Yield Components

Stepwise multiple linear regressions analyses were carried out using treatment means to determine the effects of the time of fertilizer on the grain yield formation. Grain yield considered as dependant, whereas plant height, growth rate, tillers, panicles, panicle length, thousand seed weight, straw yield, total biomass and harvest index were taken as explanatory variables (Table 5).
Grain yield was positively and significant ($P < 0.001$) associated with plant heights taken at four different times,

first growth rate, number of tillers and panicle, panicle length and thousand seed weight, r=0.60, 0.69, 0.72, 0.70, 0.51, 0.8,0.6 and 0.81, respectively. Similar correlations were reported in barley by Mekonnen (2005) and Alam et al. (2005). On the other hand, grain yield was associated negatively with thrid growth rate ($r=^{-}0.69^{***}$) and panicle length ($^{-}0.75^{***}$); which was in line with the report of Getachew (2004) on bread wheat. Table 5:- Correlation between yield and yield components of tef.

	PH1	PH2	PH3	PH4	GR1	GR2	GR3	PN	PL	GY	SY	TBM
PH1	1.0	0.56***	0.80***	0.82***	0.81 ns	-0.09ns	-0.75***	0.64***	-0.49**	0.60***	0.14***	0.56***
PH2		1.0	0.80***	0.82***	0.82ns	-0.09 ns	-0.75***	0.76***	-0.71***	0.69***	0.30*	0.62***
PH3			1.0	0.94***	0.59***	0.51***	-0.98***	0.83***	-0.69**	0.72***	0.37 *	0.66***
PH4				1.0	0.59***	0.39*	-0.84***	0.81***	-0.68***	0.70***	0.34*	0.22***
GR1					1.0	-0.19 ns	-0.56***	0.49**	-0.49**	0.51***	0.29 ns	0.53***
GR2						1.0	-0.55***	0.29 ns	0.38**	0.21 ns	0.18 ns	0.63 ns
GR3							1.0	-0.79***	0.66***	-0.69***	-0.37*	-0.64***
TN								0.86***	-0.77***	0.80***	0.31*	0.75***
PN								1.0	-0.49	0.60***	0.14ns	0.56***
PL									1.0	-0.75***	-0.22 ns	-0.69***
TSW										0.81***	0.42 ns	0.76***
GY										1.0	0.43 ns	0.97 ns
SY											1.0	0.46 *
TBM											1.0	0.46 *
HI												

ns = not significant, * ** &*** significant at 0.05, 0.01and 0.001 respectively, $PH_{1,}$ $PH_{2,}$ PH_3 &PH_4= first, second, thread & fourth Plant Height respectively, $GR_{1,}$ GR_2 & $GR_{3=}$ first, second & third growth rates, respectively, TN= Tillers in Number, PL= Panicle Length TBM = Total biomass, GY = Grain Yield, SY = straw yield, TSW = Thousand Seed Weight and HI= Harvest Index.

4. CONCLUSION

Fertilizer applied two days prior to sowing had 8, 15.6 and 15% more panicles numbers, grain and biomass yield than DAP applied at a time of sowing. Meanwhile DAP applied two days before sowing resulted in 82.2 and 17.2 % more thousand seed weight and harvest index, than DAP applied eight days before sowing.

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