

Effect of the Rate of N-fertilizer Application on Growth and Yield of Wheat (Triticum aestivum L.) at Gamo-gofa Zone, Southern Ethiopia

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Abstract
There is little knowledge among farmers on the rate of N-fertilizer application at Gamo-gofa. Therefore, there is a need to determine rate of N-fertilizer application on growth and yield of wheat. Accordingly, an experiment were conducted to evaluate the effect of the rate of N-fertilizer application on yield and yield components of wheat on two locations at Gamo-gofa, Southern Ethiopia in 2014 and 2015 cropping season. A factorial combination of the rate (0, 23, 46, 69 and 92 k.gha^{-1}) of N-fertilizer application was arranged in split plot. Rate of N-fertilizer had significantly affected days to heading, plant height, number of tiller, panicle, grain, straw and total biomass yields. Also year and location had significantly affected maturity and spike length. Fertilizer applied 92 kg ha^{-1} minimize the date of heading by eight days compared with control. Wheat planted in 2014 was delayed the date of maturity by twenty days compared with planted in 2015. Fertilizer applied 23 kg ha^{-1} had contributed for 10.5 cm increments in height than control and N applied 46 kg ha^{-1}. Fertilizer applied with the rate of 92 kg ha^{-1} was contributed 5.0 cm increment in spike length than control. Fertilizer applied 92 kg ha^{-1} had 28.6 % more tillers than control, but 58.8 % less tillers than fertilizer applied 69 kg ha^{-1}. Fertilizer applied 69 kg ha^{-1} contributed to 33.6 % increment in biomass than fertilizer applied 23 kg ha^{-1}. Fertilizer applied 23 kg ha^{-1} had 37.3 % less straw than fertilizer applied at the rate of 69 kg ha^{-1}. Fertilized applied at fifteen days after planting with rate of 23 kg ha^{-1}had 25.5 % more grain yield than control. Wheat planted in 2015 had 35.7 % less harvest index than which, planted in 2015. Thus, N fertilizer applied at the rate of 69 kg ha^{-1} is economically beneficial compared to the other treatments.
Keywords: Rate of fertilizer, Fertilizer, Nitrogen

1. INTRODUCTION

Ethiopia is one of the largest producers of wheat in sub-Saharan Africa (Tanner and Mwangi, 1992). Wheat grows mostly in the highlands area of Ethiopian, at altitudes ranging from 1500 to 3000 m (Bekele *et al*., 1994).

Though Ethiopian agro-climatic condition is suitable for white production, productivity is low (1.3 t ha^{-1}). This is because of depleted soil fertility (Asnakew *et al*., 1991; Tanner *et al*., 1993), low levels of chemical fertilizer usage, limited knowledge on time and rate of fertilizer application (Asnakew *et al*., 1991; Amsal *et al*., 1997), and the unavailability of other modern crop management inputs (Asnakew *et al*., 1991). Therefore managing of soil fertility is crucial for improving wheat productivity.

Using of fertilizers which, containing N and P are affects wheat yield and quality (Fischer, 1989; Bacon 1995).Especially using of N fertilizer is considered to be a primary means of increasing wheat grain yield in Ethiopia (Tanner *et al*., 1993; Amsal *et al*.,2000).

Though appropriate time and rate of N fertilizer application have a number of merits, there is little knowledge in Ethiopia (Asnakew *et al*., 1991). Particularly farmers of Chencha and Bonke woreda have no idea on appropriate rate of N fertilizer application. These resulted for reeducation in both yield and quality of wheat (Tilahun *et al*., 1996b). Therefore, this study was initiated with the following objectives:

- To evaluate the effect of the rate of N-fertilizer application on growth and yield of wheat.
- To identify optimum rate of N-fertilizer application on growth and yield of wheat.

2. MATERIALS AND METHODS

2.1 Site Description

These studies were conducted at Chencha and Bonke woredas, in Southern Ethiopia. The Chencha and Bonke woredas are situated at 9^0 5'N and 39^0.45'E and 50 9'N and $37^0$24'E respectively. Meantime Chencha and Bonke woredas are situated an elevation range of 1700- 3100 masl and 501-3500 masl respectively; which are ideal for the production of wheat. The mean annual rain fall varies from 900-1400 mm in Chencha woreda and 900-1400 mm in Bonke woreda. The dominant crops growing around the experimental area are enset (*Ensete ventricosum*), wheat (*Triticum aestivum* L.) and Potato (*Solanum tuberosum*) (GGZRDO, 2016).

2.2. Experimental Treatments and design

The experiment consisted single factor, which is the rate of N-fertilizer application; was arranged in split plot design and replicated four times. Rat of N-fertilizer consists of application (0, 23, 46, 69 and 92k.gha^{-1}).

2.3. Experimental Procedure
Degelo wheat variety was used at 150kg ha^{-1} as a test crop; and the experimental field was prepared by using oxen plow and plowed four times, before planting. 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 0 , 23, 46, 69 and 92 k.g ha^{-1} 30 days after planting.

2.4. Soil Sampling and Analysis
Sixteen random soil samples (0-30 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% 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).
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 wheat was obtained by assessing the market at harvest (2014 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 of Chencha and Bonke woredas were textured loam and

clay loam respectively. Meantime both woredas having organic carbon content (OC) of 0.95 and 0.78% respectively (Table 1). Accordance with Sahlemedhin (1999), the soil in both locations had high OC, who rated OC between 1.74-2.90% as high. The CEC of the soil were 22.4 cmol kg^{-1} and 24.6 cmol kg^{-1} at Chencha and Bonke woredas respectively which, could be considered as medium. Because if CEC value ranges between 25 and 40 cmol kg-1 satisfactory response for applied fertilizer (Sahlemedhin, 1999). 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 experimental sites, available P content were medium in both locations. The pH of the soil were 5.23 and 5.88 on Chencha and Bonke woredas respectively, which is within the range of 4 to 8 suitable for wheat production (FAO, 2000).Total N of the soil on both locations (0.098 % and 0.070%), are low; as rated by Havlin et al., (1999) who rated total N less than 0.15 % as low.

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

Location	Depth (cm)	pH (H_2o)	CEC (cmol kg^{-1})	OC (%)	Total N (%)	Av.P (mg kg^{-1})	Particle size distribution (%)			Textural
							sand	clay	silt	Class
Chencha	0-30	5.23	22.4	0.78	0.070	7.8	26	26	48	Loam Clay loam
Bonke	0-30	5.88	24.6	0.95	0.098	8.4	36	28	36	

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

3.2. Crop Phenology
3.2.1. Days to heading

The rate of N-fertilizer application had a significant (P≤0.001) effect on date of heading; whereas year and location had no significant.

Fertilizer applied 92 kg ha^{-1} minimize the date of heading by eight days compared with control (Table 2). The result in line with the finding of Cock and Ellis (1992) indicated that sufficient nitrogen at right time results in rapid growth and heading.

Table2:- Effect of the rate of N-fertilizer application on phenology of wheat

Treatments	**50% Heading**	**90 % Maturity**
Rate of N-fertilizer		
0 kg ha	56.50a	158.75
23 kg ha	47.62c	152.00
46 kg ha	52.87ab	157.00
69 kg ha	49.87bc	155.37
92 kg ha	48.75c	151.37
LSD (5%)	4.07	15.81
CV (%)	5.51	7.07
Year		
2014	51.10	164.70a
2015	51.15	145.10b
LSD (5%)	7.05	7.05
CV (%)	5.51	7.07
Location		
Chencha	51.80	164.30a
Bonke	50.45	145.50b
LSD (5%)	4.07	7.05
CV (%)	5.51	7.07

FR= Fertilizer Rate, the same letter in a column of each factor shows a non-significant difference at 5% probability level.

3.2.2. Days to maturity

The rate of N fertilizer application had no significant effect on days to 90% maturity; whereas year and location had significant (P≤0.001); effect on days to 90% maturity.

Wheat planted in 2014 was delayed the date of maturity by twenty days compared with planted in 2015 (Table 2). This is due to limited amount of rain in 2015 retarded the growth rate and facilitates the day for maturity. Because the growth and maturity of wheat directly influenced by availability of essential nutrients (Hailu Geberemariam, 2003).

Planting of wheat at Bonke woreda hasten the day for maturity by nineteen days compared with planting at Chencha woreda (Table-3). This is due to relatively high elevation in Chencha woreda, results for maximum freezing effect. Because temperature has great influence on crop metabolism which, is directly affect growth and maturity of the crop (Amanuel *et al*., 2002).

3.3. Growth data

3.3.1. Plant height

The rate of fertilizer application and year had significant effect at ($P \leq 0.001$), ($P \leq 0.05$) respectively on plant height. But location had non-significant effect on plant height.

Fertilizer applied 23 kg ha^{-1} had contributed for 10.5 cm increments in height than control and N applied 46 kg ha^{-1} (Table 3). This result is major indicator for the height of wheat mainly affected by the rate of fertilizer application (Lemma *et al*.'1992).

Wheat which, planted in 20014 had 4.4 cm more plant height than planted in 2015 (Table 3). This is because of adequate rain in 2014 contributed for increment in plant height. The result is in line with the finding of (Kumara *et al*., 2006), the amount of water supplied for plants has direct effect on growth of height of plant. Meantime growth rate and height of wheat varies based on the season which planted (FAO, 2003).

Table 3:- Effect of the rate of N-fertilizer application on growth and yield of wheat

Treatments	PH (CM)	SL (CM)
Rate of N-fertilizer		
Control (0 kg ha^{-1})	77.52c	5.07c
23 kg ha^{-1}	89.32a	6.77c
46 kg ha^{-1}	80.12c	5.42c
69 kg ha^{-1}	88.75ab	13.74a
92 kg ha^{-1}	80.75bc	10.10b
LSD (5%)	8.13	2.52
CV (%)	6.76	21.22
Year		
2014	85.50a	7.45b
2015	81.09b	8.99a
LSD (5%)	3.63	1.12
CV (%)	6.76	21.22
Location		
Chencha	84.58	8.79a
Bonke	82.01	7.65b
LSD (5%)	3.63	1.12
CV (%)	6.76	21.22

PH=Plant Height, SL= Spike Length, FR= Fertilizer Rate, the same letter in a column of each factor shows a non-significant difference at 5% probability level.

3.3.2. Spike length

The rate of N-fertilizer application, year and location had significant at ($P \leq 0.001$), ($P \leq 0.01$) and ($P \leq 0.05$) respectively.

Fertilizer applied with the rate of 92 kg ha^{-1} was contributed 5.0 cm increment in spike length than control, but minimize spike length by 3.6 cm than fertilizer applied 69 kg ha^{-1} (Table 3). These findings are strongly justifies, large amount of N fertilizer application by itself do not have significant effect on panicle length of wheat. But the optimum amount of fertilizer has significant effect on growth of spike length. Similar results have also been reported by (Alcoz *et al*., 1993), higher spike length of wheat achieved by fertilizer applied 69 kg ha^{-1}. Meanwhile excessive application of N fertilizer has toxic effect on wheat growth and results for stunted growth and reduced spike length (Smith and Hamel (1999).

Wheat which planted in 2014 had maximized spike length by 1.5 cm compared with planted in 2015 (Table 3). Inadequate and less uniform rain in 2015 resulted for reduction in spike length. Because spike length of wheat, directly affected by amount of available nutrients and water (Genene, 2003).

Wheat planted at Chencha woreda had 1.14 cm more height than which planted at Bonke woreda; because spike length of wheat is affected by place which it planted (Amanuel *et al*., 2002).

3.4. Yield and yield components

3.4. 1. Tillers

Fertilizer rate was significantly ($P<0.001$) affected the number of tillers. But the year of planting and location were not significantly affected the number of tillers.

Fertilizer applied 92 kg ha^{-1} had 28.6 % more tillers than control, but 58.8 % less tillers than fertilizer applied 69 kg ha^{-1} (Table 4).These variations on tiller number due to, optimum amount of fertilizer application had significant effect on the number of tiller of wheat (Haftom *et al*, 2009).

The above result indicated that enhancement in tiller number when N fertilizer applied at optimum amount. Meanwhile the result is agreement with that of Genene (2003) who reported higher tillering and maximum survival percentage of tillers with optimum rate of N fertilizer application in bread wheat. Agree with the results of this study, Botella *et al*. (1993) reported that stimulation of tillering with optimal application of nitrogen might be due to its positive effect on cytokinin synthesis. Generally maximum number of tiller achieved through 23 kg ha^{-1} of N fertilizer application.

Table 4:- Effect of the rate of N-fertilizer application on growth and yield of wheat

Treatments	NT	TBM (kg ha^{-1})	SY (kg ha^{-1})	TSW (g)	GY (Qha^{-1})	HI
Rate of N-fertilizer						
0 kg ha	2.02c	11188.8bc	7826.3ab	46.62	22.22bc	0.24
23 kg ha	2.32c	9280.9c	6130.6b	55.50	19.76c	0.23
46 kg ha	3.11b	12307.9ab	8893.2a	49.00	28.78b	0.21
69 kg ha	6.80a	13969.0a	9768.2a	46.62	36.62a	0.25
92 kg ha	2.81b	11414.6abc	7864.6ab	47.62	22.52bc	0.22
LSD (5%)	0.40	4080	4067.5	11.25	6.00	0.07
CV (%)	8.15	15.46	21.50	15.86	19.52	21.18
Year						
2007	3.34	11067.0	8412.0	51.85a	26.54	0.28a
2008	3.49	12197.4	7781.1	46.30b	25.42	0.18b
LSD (5%)	0.18	1158.5	1121.5	5.01	3.27	0.03
CV (%)	8.15	15.46	21.50	15.86	19.52	21.18
Location						
Chencha	3.41	11547.6	8052.3	50.72	26.66	0.24
Bonke	3.42	11716.8	8140.9	47.42	25.30	0.22
LSD (5%)	0.18	1158.5	1121.5	5.01	3.27	0.03
CV (%)	8.15	15.46	21.50	15.86	19.52	21.18

FR= Fertilizer Rate, DAP=Days After Planting, NT= Number of Tillers**,** TBM = Total Bio Mass, SY = Straw Yield, GY = Grain Yield, the same letter in a column of each factor shows a non-significant difference at 5% probability level.

3.4.2. Total biomass

The rate of N fertilizer application of planting was significantly affected biomass yield of wheat, whereas year and location were not significantly ($p \leq 0.001$) affected biomass yield of wheat.

Fertilizer applied 69 kg ha^{-1} contributed to 33.6 % increment in biomass than fertilizer applied 23 kg ha^{-1} (Table 4). N fertilizer application at optimum amount significantly enhanced biomass yield of wheat (Amanuel *et al*.; 1991). Application of highest level of N by its self not resulted in maximum biomass yield. 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 (Albert *et al.;*2005).

3.4.3. Straw yield

The rate of N fertilizer application was significantly ($p \leq 0.001$) affected biomass yield of wheat, whereas year and location were not significantly affected biomass yield of wheat.

Fertilizer applied 23 kg ha^{-1} had 37.3 % less straw than fertilizer applied at the rate of 69 kg ha^{-1}, but no significant variation in straw yield compared with all other treatments (Table 4). These might be due to optimum rate of N fertilizer application on treatment of 69 kg ha-1, resulted for maximum vegetative growth (Alcoz *et al*.;1993). But excessive N fertilizer application had toxic effect on crop and resulted for less vegetative growth and straw than control. Similarly, Abdo (2009) reported highest straw yield of durum wheat in response to applying nitrogen at the rate of 69 kg ha^{-1}.

3.4.4. Thousand Seed weight

Thousand seed weight is an important yield determining component and reported to be a genetic character that is influenced least by environmental factors (Ashraf *et al*, 1999). The analysis of variance showed that, the rate of N fertilizer application and location had no significant effect on thousand seed weight. But the year of planting had significantly effect at ($p \leq 0.05$).

Wheat planted in 2014 had 10.7 % more thousand seed weight than which planted in 2015 (Table 4). This is due to sufficient amount of rain in2014 contributed for increment in thousand seed weight, since of thousand seed weight strongly influenced by nutrient availability and environmental like rainfall (Ashraf *et al*, 1999).

3.4.5. Grain yield

Grain yield of wheat was significantly (P≤0.001) influenced by the rate of N fertilizer application. But year and location were not significantly affected grain yield of wheat.

Fertilized applied at the rate of 0 kg ha^{-1} had 11.1 % more grain yield than 23 kg ha^{-}l; but 46 % less grain yield than fertilizer applied at the rate of 69 kg ha^{-1} (Table 4). In line with the result of this study, Temesgen (2001) reported that application of different levels of N significantly affected grain yield of tef on farmer's field. This is because of well-balanced supply of N fertilizer, results in higher net assimilation rate and increased grain yield (Sage and Pearcy, 1987). According to this study to maximizing the grain yield wheat, applying of 69 kg ha^{-1} N is appropriate, because proper rate of application are critical for meeting crop needs. Also it has considerable opportunities for improving grain yields (Blankenau *et al*.; 2002). Consistent with this study, also Ashraf and Azam (1998) reported that growth stage of plants at which fertilizer is applied determines the final yield of the crop. In agreement with the results of this study, Michael *et al*. (2000) and Anthony *et al*. (2003) indicated that split N application 69 kg ha^{-1} is effective in attaining higher grain yield of wheat.

3.4.6. Harvest index

The year of planting had significant (P≤0.001) effect on harvest index of wheat. But the rate of N fertilizer application had no significant effect on harvest index of wheat.

Harvest index is describes plant capacity to allocate biomass (assimilates) into the formed reproductive parts (Mazid et al., 2013). Since the year of planting affects harvest index of the most cereals (Wnuk, 2013). So wheat planted in 2014 had 35.7 % less harvest index than which, planted in 2015 (Table 4). The result is in line with finding of Reynolds et al (2013), the year of planting has direct effect on harvest index of wheat.

3.5. Correlation of grain yield with yield and yield components

Grain yield considered as dependant, whereas date of heading and maturity, plant height, growth rate, tillers, spike 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 < 0.01) associated with thousand seed weight, r= 0.59; but non-significant associated with other parameters. Similar correlations were reported in barley by Mekonnen (2005) and Alam *et al.* (2005).

Table-5:- Correlation between yield and yield components of wheat

X	DH	DM	PH	TN	SL	TBM	SY	GY	TSW	HI
DH	1.0	0.19^{ns}	0.03^{ns}	-0.07^{ns}	-0.24^{ns}	0.008^{ns}	0.08^{ns}	0.35^{ns}	0.07^{ns}	-0.13^{ns}
DM		1.0	0.41*	0.42*	0.01^{ns}	0.10^{ns}	0.23^{ns}	0.33^{ns}	0.12^{ns}	0.55*
PH			1.0	0.78***	0.54**	0.46*	0.77***	-0.35^{ns}	-0.14^{ns}	0.41*
TN				1.0	0.33^{ns}	0.19^{ns}	0.47*	-0.24^{ns}	0.06^{ns}	0.67***
SL					1.0	0.86***	0.53**	-0.25^{ns}	-0.30^{ns}	-0.06^{ns}
TBM						1.0	0.53 **	-0.24^{ns}	-0.60***	-0.15^{ns}
SY							1.0	-0.42^{ns}	-0.31^{ns}	0.08^{ns}
GY								1.0	0.59 **	0.02^{ns}
TSW									1.0	0.35^{ns}
HI										1.0

ns = not significant, * ** &*** significant at 0.05, 0.01and 0.001 respectively, DHD= Date of Heading, DM= Date of Maturity, TN= Tillers Number, SL = Spike Length TBM = Total biomass, GY = Grain Yield, SY = straw yield, TSW = Thousand Seed Weight and HI= Harvest Index.

3.6. Partial Budget Analysis

The net benefit obtained in response to N fertilizer applied 0, 23, 46, 69 and 92 kg ha^{-1} were 26,000, 21,614, 31,420, 39,900 and 21,851 birr respectively. The higher marginal rate of return with least cost was obtained from N fertilizer applied 69 kg ha^{-1}. Because the marginal rate of return was above the minimum level (100%). According to CIMMYT (1988) the recommendation is not necessarily based on the treatment with the highest marginal rate of return compared to that of neither next lowest cost, the treatment with the highest net benefit, and nor the treatment with the highest yield. The identification of a recommendation is based on a change from one treatment to another if the marginal rate of return of that change is greater than the minimum rate of return. Thus, 69 kg ha^{-1} N fertilizer applied is economically beneficial compared to the other treatments.

Table-6:- Partial budget analysis of wheat as influenced by the rate of N-fertilizer application

Treatment	Av.Y (q ha^{-1})	ADTY (q ha^{-1})	GFB (birr ha^{-1})	Total variable cost (Birr ha-1)	Net benefit (Birr ha-1)	MRR (%)
0	22.22	20	26,000	0	26,000	
23	19.76	17.78	23,114	1,500	21,614	-
46	28.78	25.9	33,670	2,250	31,420	1307.5
69	36.62	33	42,900	3,000	39,900	1130.7
92	22.52	20.27	26,351	4,500	21,851	-

Av.Y= Average Yield, ADTY=adjusted yield, GFB= Gross Field Benefit and MRR=Marginal Rate of Return.

3.7. Conclusion

In this study it was found that, the rate of N-fertilizer application had significant effect on growth and yield of wheat. Especially N applied 69 kg ha^{-1}, gave both maximum biological yield and economically benefit compared to the other treatments. Meantime fertilizer applied 69 kg ha^{-1} had acceptable MRR (1130.7%); and net benefit 39,900 birr ha^{-1} from grain yield. Thus, it is possible to recommend that; N application 69 kg ha^{-1} is effective in attaining higher grain yield and economic benefit of wheat in the trail area. However, it is advisable to undertake further research across soil type, years and locations to draw sound recommendation on a wider scale.

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