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Research Article

# Effect of Nitrogen Fertilizer and Seed rates on Yield and Yield Components of Bread Wheat in the Irrigated Condition of South West Shewa, Central Highland of Ethiopia

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## Abstract

Inappropriate seed density and fertilizer management can lead to unstable crop yields. Excessive fertilizer application can potentially cause yield loss and nitrogen (N) leaching that leads to environmental pollution. The aim of this study was to explore the optimal N application rate and seed rate on bread wheat with different nitrogen responding under irrigation condition at two experimental sites in the South West Shewa, Ethiopia. A year field experiment was conducted to explore the effects of five N application rates (N0, N23, N46, N69, and N92) and three seed rates on bread wheat yield components like; - aboveground biomass, harvest index, number of tillers per plant, spike length, number of kernels per plant, grain yield and net return. The results showed that N application rate and seed rate were significantly interaction ($P< 0.05$) effect on aboveground biomass, harvest index, number of tillers per plant, spike length, number of kernels per plant and grain yield. Generally, spike length, number of tillers per plant and number of kernels per spike of wheat were increased with increased at some level in nitrogen fertilizer rate for the three seed rate at both locations. Highest number of kernels per spike (42.00, 44.00) and the highest mean above ground biomass yield (13.70 t $ha^{-1}$, 7.5 t $ha^{-1}$) were obtained for 150 kg $ha^{-1}$ seed rate with 69 N kg $ha^{-1}$ application at Ameya and Woliso sites respectively. The highest net benefit of 171531.88 EB $ha^{-1}$ with marginal rate of return of 351.14% was obtained from 175 kg $ha^{-1}$ seed rate with application of 69 kg N $ha^{-1}$. Therefore, 175 kg $ha^{-1}$ seed rate with application of 69 kg N $ha^{-1}$ is economical feasible for bread wheat production at Ameya area and also the highest net benefit of 51675 EB $ha^{-1}$ with marginal rate of return of 115.22% was obtained from 150 kg $ha^{-1}$ seed rate with application of 69 kg N $ha^{-1}$ at Woliso area.

## Keywords

Bread Wheat, Nitrogen Level, Seed Density, Productivity, Ameya, Woliso

## 1. Introduction

Wheat (Triticum aestivum L.) is the livelihood of the overwhelming mainstream of Ethiopians; consequently, the third in world and the second major crop in Ethiopia. It is the source of food and cash for those who are engaged in the sector and others [2] Consequently, Wheat (Triticum aestivum L.) is one of the leading cereal grains where more than one-third of the population uses it as a staple food. As the world population is increasing to reach nine billion by 2050,

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there should be an urgent need to increase crop productivity like wheat to meet the increasing demand for food [14].

The number of regions in Ethiopia and volumes of land covered with irrigation wheat farming showing an increase over the past few years. Globally; wheat production trend is grown smoothly year after year and; ten top maize producers in the world are China, India, USA, France, Russia, Canada, Germany, Pakistan, Australia and Turkey. Whereas, 2.19 million hectare and 7.6 metric tons quantities of wheat yield harvested in the world. Also, the major share of wheat in the world by region is Asia (43.7%), Europe (32.8%), America (16.9%), Africa (3.3%) and Oceania (3.3%). When we go to African content the usual wheat-producing countries in Sub-Sahara Africa are Ethiopia, South Africa, Sudan, Kenya, Tanzania, Nigeria, Zimbabwe, and Zambia hold the highest benefactions, respectively. Consequently, in African continent account; 9.97-million-hectare area was cultivated and 2.5 million metric ton yield of wheat harvested [3] However, on the African continent, it is the most important food crop and pillar of rural diets in the eastern and southern regions.

Wheat production in Ethiopia is accounted 56 million metric ton from this 56 percent is utilized for household consumption, 16 percent revolved for seed and 24 percent is sales for market. Oromia (56.88 %), Amhara (31.41 %), Southern (7.47 %) and Tigray (3.87 %) regions are Ethiopia's major wheat growing regions, and 56 percent of cultivated Ethiopian wheat is primarily for house hold conception Season Post Harvest [2]. As of Ethiopia has been relying on foreign food aid and purchasing wheat from abroad spending hundreds of millions of hard currencies. Now the government of Ethiopia aims to make wheat import and foreign food aid history in the coming few years by expanding irrigation farming across the nation. However, its production and productivity are low compared with the world average. Consequently, there is no bread wheat released variety for irrigated areas of mid to highland areas of Ethiopia.

Nitrogen is the most limiting nutrient for wheat production that affects the rapid plant growth and improves grain yield. Many researches showed that Nitrogen application increased grain yield of wheat. [7] concluded that number of fertile tillers per unit area, number of grains per spike, and harvest index were significantly increased by increasing N fertilization levels. [6] reported that increasing the N level from 50 to 200 kg ha$^{-1}$ significantly increased the plant height, total number of plants m$^{-2}$, number of spikes, spike weight, and grain weight compared to 0 kg N ha$^{-1}$. [8] reported that increasing N up to 180 kg ha$^{-1}$ increased grain yield and its components, spike length, weight of grain per spike and thousand grain weight. Therefore, the objective of this work was designed to identify the optimum nitrogen level and seed rate applied for irrigated wheat for better yield and yield components of bread wheat.

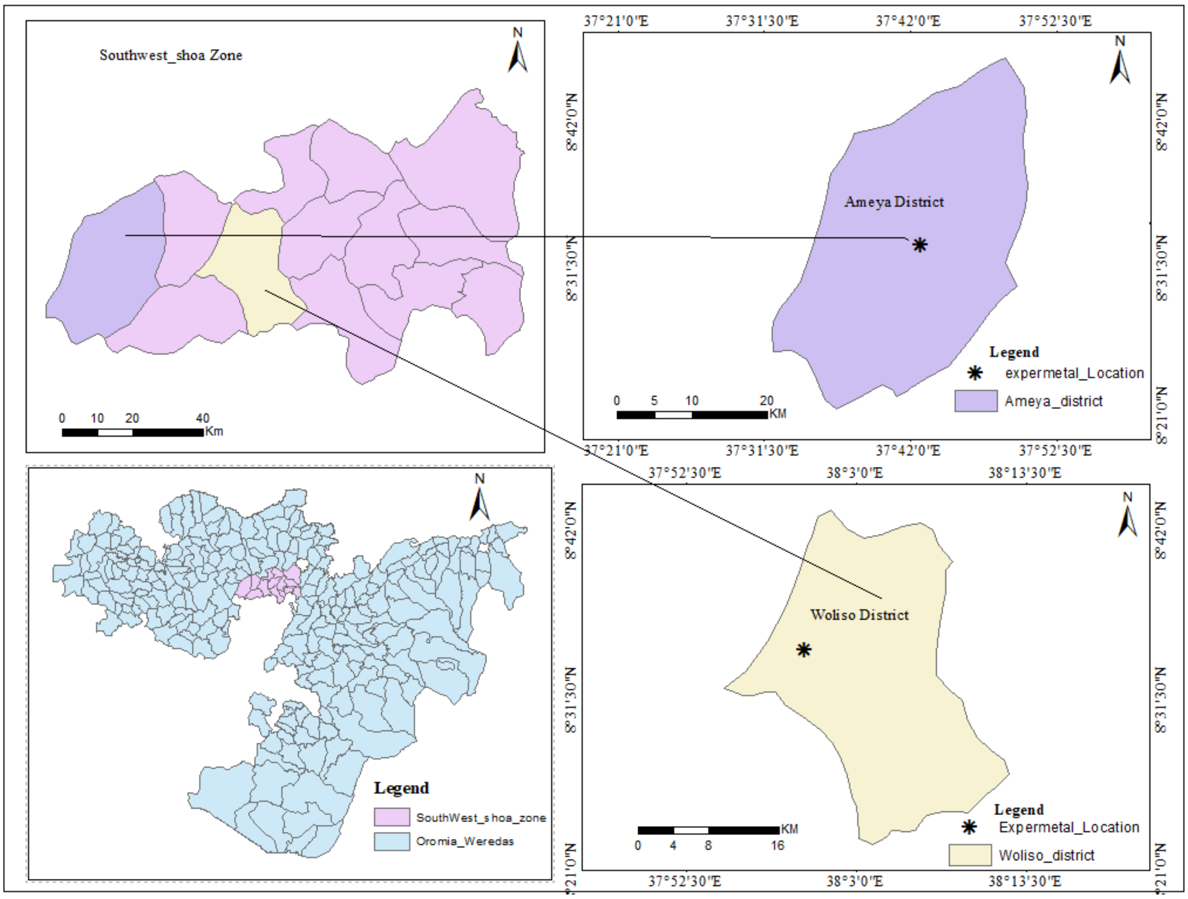


*Figure 1. Study location map.*

## 2. Material and Methods

### 2.1. Characterization of Study Area Location

The study was conduct in south Southwest Shewa zone of Oromia National Regional State. From the zone two districts were selected the first one is Woliso district which is located about 114 km away from Addis Ababa. The specific experiment location geographically located 8° 34’35’’ N and 37° 59’48’’ E. The second district is Ameya which is located about 160 from Addis Ababa and the specific study site geographically located 8°33'4" N and 37°42'10" E (figure 1).

***Table 1.*** *Climate data of experimental sites.*

| | **Ameya** | | | | | | | **Weliso** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Months** | **Prec [mm]** | **PET [mm]** | **T [°C]** | **Sun fraction [%]** | **Sun hrs. [h]** | **Vapor [hPa]** | **Wind [km/h]** | **Prec [mm]** | **PET [mm]** | **vapor [hPa]** | **Wind [km/h]** | **T_mean [°C]** | **Sun [%]** | **Sun hrs. [h]** |
| Jan | 23 | 114.7 | 18.2 | 70 | 8:09 | 10 | 4.32 | 5 | 114.7 | 10.1 | 4.32 | 18.5 | 70 | 8:09 |
| Feb | 56 | 113.6 | 19 | 64 | 7:34 | 9.6 | 4.68 | 39 | 113.6 | 9.8 | 4.68 | 19.2 | 64 | 7:34 |
| Mar | 32 | 131.1 | 19.2 | 61 | 7:21 | 10 | 4.68 | 63 | 131.1 | 10.6 | 4.68 | 19.3 | 61 | 7:21 |
| April | 108 | 120.2 | 19.2 | 53 | 6:31 | 11.8 | 4.32 | 79 | 120.2 | 12.2 | 4.32 | 19.6 | 53 | 6:31 |
| May | 135 | 122.2 | 19 | 54 | 6:44 | 12.6 | 4.68 | 99 | 122.2 | 12.8 | 4.68 | 19.2 | 54 | 6:44 |
| June | 206 | 93.6 | 17.3 | 41 | 5:09 | 14.3 | 2.88 | 256 | 93.6 | 14.8 | 2.88 | 17.6 | 41 | 5:09 |
| July | 212 | 79 | 16.3 | 26 | 3:15 | 15.8 | 2.88 | 277 | 79 | 16.3 | 2.88 | 16.6 | 26 | 3:15 |
| August | 300 | 82 | 16.1 | 30 | 3:42 | 15.4 | 2.88 | 239 | 82 | 16.8 | 2.88 | 16.2 | 30 | 3:42 |
| September | 152 | 91.2 | 16.6 | 42 | 5:06 | 14.5 | 3.6 | 109 | 91.2 | 15 | 3.6 | 16.7 | 42 | 5:06 |
| October | 28 | 120.3 | 17.2 | 63 | 7:30 | 10.6 | 5.76 | 20 | 120.3 | 10.8 | 5.76 | 17.5 | 63 | 7:30 |
| November | 4 | 116.5 | 17.1 | 73 | 8:33 | 8.5 | 5.4 | 16 | 116.5 | 8.7 | 5.4 | 17.2 | 73 | 8:33 |
| December | 8 | 114.5 | 17.7 | 74 | 8:35 | 10 | 5.4 | 6 | 114.5 | 10 | 5.4 | 18 | 74 | 8:35 |

Prec = precipitation, PET= potential of evapotranspiration, T. mean = temperature mean,
Source FAO, 2006

### 2.2. Experimental Design and Treatment Setup

The experiment had 15 treatments in factorial combination of three seed rates (125, 150 and 175) and five rates of N fertilizers (0, 50, 100, 150, and 200 kg $ha^{-1}$ Urea) or (0, 23, 46, 69, 92 kg $ha^{-1}$ N) with consideration of 19% NPS content of N (0, 23+19, 46+19, 69+19, 92+19). The spacing between ridge rows, plots and blocks will be 0.5, 1 and 2 m, respectively. The experiment was laid out in RCBD with three replications with the gross area of 39 mx 31m and net area of 37m x29m in a plot size of (3m×5m = 15 $m^2$) with ridge-to-ridge distance of 50 cm having six ridges rows. Bread wheat variety “Kakaba” was used as test crop. At sowing 100 NPS kg $ha^{-1}$ uniformly supplemented for experimental plot except for without fertilizer (zero rates plot). Other necessary Agronomic practices were applied to all plots uniformly as needed.

### 2.3. Data Collection

Data were collected on phonological traits (days to flowering and days to maturity) and important agronomic traits (plant height (cm), Spike length, Spikelet per spike and thousand seed weight (g) based on the standard procedures. Moreover, all the yield and yield related parameters were taken from five central rows of 1.8$m^2$ areas.

### 2.4. Soil Sampling and Analysis

Physical and chemical properties of soil in the experimental site.

One representative composite soil sample was taken at a depth of 0-30 cm from five randomly selected spots diagonally across the experimental field using auger. The sample was analyzed for selected physicochemical properties. Soil paste extract of ECe and pH was measured potentiometrically using a digital electrical conductivity and pH-meter [12]. Determination of soil organic carbon was carried out as described by [13]. Available phosphorus was determined calorimetrically using spectrophotometer following the Olsen extraction method as described by [9]. Total N was analyzed using the Kjeldahl digestion, distillation and titration method. Cation exchange capacity (CEC) of the soil was determined by 1M ammonium acetate (NH4OAc) saturated samples at pH 7 [10].

***Table 2.*** *Soil physio chemical character of the experimental site.*

| Testing Location | PH-$H_2O$ | Av p/ mg/kg soil | % O.C | % O.M | CEC Meq/100g soil | Texture (%) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | sand | clay | silt | Class |
| Woliso (Obi kebele) | 6.5 | 8.12 | 2.07 | 3.57 | 21.83 | 31 | 40 | 29 | Clay |
| Ameya (Marisekela kebele) | 6.4 | 5.58 | 1.77 | 3.05 | 21.3 | 45 | 20 | 35 | Loam |

### 2.5. Data Analysis

Statistical analysis of variance (ANOVA) was carried out using R software Version 1.4.1106. Significant difference between and among treatment means were assessed using the least significant difference (LSD) at 0.05 level of probability (Gomez and Gomez, H., 1984).

### 2.6. Economic Analysis

Mean grain yield of the selected treatment was used in partial budget analysis [1] Economic analysis was performed to investigate the economic feasibility of the treatments (fertilizer rates). A partial budget and marginal analysis were used. The average open market price (Birr kg-1) for Urea and the official prices of blended, Urea and NPS fertilizers were used for economic analysis.

## 3. Results and Discussion

### 3.1. Interaction Effect of Seed Rate and Nitrogen Level on Bread Wheat at Ameya and Woliso

#### 3.1.1. Plant Height

The plant height of bread wheat was significantly ($P<0.05$) affected by the interaction effects of seed rate and nitrogen level (Table 3). Significantly taller plant height (79 cm) was obtained on 150 kg ha$^{-1}$ with the application of 46 N ha$^{-1}$, while the shorter plant (67.1) was recorded on 175 kg ha$^{-1}$ with 46 Nitrogen application at Ameya (Table 3) while the combination of 150 kg ha $^{-1}$ with 69 kg ha $^{-1}$ nitrogen level gave tallest plant height and combination of 175 kg ha$^{-1}$ of seed rate with non-nitrogen fertilized plot gave shortest plant height 72.4 cm, 53 cm respectively at Woliso (Table 4). Similarly [15] At the highest seeding density, the increased intra-plant competition may have also contributed to the reduction in plant height.

#### 3.1.2. Spike Length

The Spike length of bread wheat was significantly ($P<0.01$) affected by the interaction effects of seed rate and nitrogen level (Table 3). Significantly taller spike length (7.6 cm) was obtained on 150 kg ha$^{-1}$ with the application of 92 N ha$^{-1}$, while the shorter spike length ($\leq$ 6.7cm) was recorded on three seed rates without Nitrogen application at Ameya (Table 3). Increasing level of nitrogen curtail and its positive effects on spike length, number of grains per spike, 1000-grain weight and yield. this result agreed with [11] who indicated a decrease in the length of the spike when the seed rate was increased with limited nitrogen in barley crop.

### 3.2. Number of Tillers Per Plant

Numbers of fertile tillers per plant of wheat crop were statistically affected by seeding rate and nitrogen levels (Table 3). More intensity of tillers per plant when seed rate increasing nitrogen level also increasing high number of tillers were observed for three seeding rate the highest nitrogen level, while a smaller number of fertile tillers (at both locations) were recorded at all seeding rate with low level of nitrogen application (Tables 3 & 4). According to [5] report number of tillers were significantly affected by application of nitrogen level.

## 3.3. Number of Kernels Per Spike

Data recorded on number of kernels per spike indicated that number of kernels per spike of bread wheat was significantly (P<0.05) influenced by the seeding rate and nitrogen level (tables 3 and 4). The highest number of kernels per spike were observed at highest nitrogen level (92 N kg $ha^{-1}$ and also increasing with seed rate at Ameya, While the highest number of kernels per spike were recorded from 150 kg $ha^{-1}$ seed rate with 69 kg $ha^{-1}$ nitrogen level at Woliso.

## 3.4. Aboveground Biomass Yield

The aboveground biomass of bread wheat was significantly (P<0.01) affected by the interaction effects of seed rate and nitrogen level (Tables 3 & 4). Significantly highest above-ground biomass (13.5 t $ha^{-1}$) was obtained on 150 kg $ha^{-1}$ with the application of 92 N $ha^{-1}$, while the lowest aboveground biomass (6.3 t $ha^{-1}$) was recorded on 125 kg $ha^{-1}$ without Nitrogen application at Ameya (Table 3). While highest aboveground biomass was observed from (7.6 t $ha^{-1}$) 175 kg $ha^{-1}$ seed rate with 69 kg $ha^{-1}$ nitrogen application and the lowest aboveground biomass was recorded (4 t $ha^{-1}$) from 175 kg $ha^{-1}$ seed rate with 0 N kg $ha^{-1}$ at Woliso. highest seeding density, increased intra-plant competition may have also contributed to the reduction in aboveground biomass. the reason for this can be attributed to the role of nitrogen in increasing vegetative growth, cell division, expansion and elongation, which was reflected in the increase in leaf area and consequently an increase in its weight and the amount of dry matter. This result agreed with [5] who indicated the Increased in biomass production might be attributed to the increased plant population due to higher seeding rate with better nitrogen application.

## 3.5. Harvest Index

The harvest index was significantly (P<0.01) affected by the interaction effects of seed rate and nitrogen level (Tables 3 & 4). As for the interaction between seed rate and nitrogen fertilization levels, the two combinations (125 kg $ha^{-1}$ seed rate × 69 kg $ha^{-1}$ nitrogen) and (125 kg $ha^{-1}$ seed × 46 kg $h^{-1}$ nitrogen) gave the two highest averages for this trait, reaching 0.43 and 0.40 at Ameya respectively (table 3), while the combination of 150 kg $ha^{-1}$ with 69 kg $ha^{-1}$ nitrogen gave highest harvest index(0.38%) and 175 kg $ha^{-1}$ seed rate with non- nitrogen gave lowest harvest index at Weliso( table 4) this result agreed with[16] who indicated that Nitrogen application rate significantly affected leaf area index, above-ground biomass, grain yield, and harvest index.

## 3.6. Grain Yield

The grain yield was highly significantly (P< 0.01) affected by the interaction effects of seed rate and nitrogen level (Tables 3 & 4). Significantly highest grain yield was obtained on 150 kg $ha^{-1}$ (5034 kg $ha^{-1}$) from seed density with the application of 69 N $ha^{-1}$, while the lowest grain yield all of the three seed rates without Nitrogen application at Ameya (Table 3). While highest grain yield was observed from (2574 kg $ha^{-1}$) 150 kg $ha^{-1}$ seed rate with 69 kg $ha^{-1}$ nitrogen application and the lowest grain yield was recorded (1398 kg $ha^{-1}$) from 175 kg $ha^{-1}$ seed rate with 0 N kg $ha^{-1}$ at Woliso (Table 4.) Similarly [4] also reported that increasing rate of nitrogen fertilization increased grain yield of wheat crop.

***Table 3.*** *Interaction effect of seed rate and nitrogen level on bread wheat at Ameya.*

| Seed Rate (kg $ha^{-1}$) | Nitrogen Level | PH (cm) | SL (cm) | NTPP | NKPP | ABM t $ha^{-1}$ | HI (%) | GY (kg $ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|
| 125 | 0 | 75.1$^{abcd}$ | 6.7$^{cd}$ | 4$^{b}$ | 30$^{d}$ | 6.3$^{h}$ | 0.35$^{d}$ | 2834$^{d}$ |
| | 23 | 78.8$^{a}$ | 6.8$^{cd}$ | 4$^{b}$ | 34$^{cd}$ | 10.0$^{def}$ | 0.37$^{bc}$ | 3760$^{c}$ |
| | 46 | 77.7$^{ab}$ | 7.2$^{abcd}$ | 5$^{a}$ | 35$^{c}$ | 11.1$^{abcde}$ | 0.40$^{a}$ | 4258$^{bc}$ |
| | 69 | 69.9$^{bcd}$ | 7.3$^{abc}$ | 5$^{a}$ | 40$^{ab}$ | 12.8$^{abc}$ | 0.43$^{a}$ | 4132bc |
| | 92 | 75.1$^{abcd}$ | 7.6$^{ab}$ | 5$^{a}$ | 40$^{ab}$ | 10.2$^{def}$ | 0.38$^{ab}$ | 2847$^{d}$ |
| 150 | 0 | 77.5$^{ab}$ | 6.7$^{cd}$ | 3$^{c}$ | 35$^{c}$ | 7.1$^{gh}$ | 0.37$^{bc}$ | 2705$^{d}$ |
| | 23 | 78.7$^{a}$ | 6.8$^{bcd}$ | 4$^{b}$ | 35$^{c}$ | 10.7$^{cdef}$ | 0.36$^{cd}$ | 4045$^{bc}$ |
| | 46 | 79.1$^{a}$ | 7.2$^{abc}$ | 5$^{a}$ | 40$^{ab}$ | 12.1$^{abcd}$ | 0.38$^{ab}$ | 4663$^{ab}$ |
| | 69 | 68.3$^{cd}$ | 7.4$^{abc}$ | 4$^{b}$ | 42$^{a}$ | 13.7$^{a}$ | 0.38$^{ab}$ | 5034$^{a}$ |
| | 92 | 74.0$^{abcd}$ | 7.6$^{a}$ | 5$^{a}$ | 43$^{a}$ | 13.5$^{a}$ | 0.38$^{ab}$ | 4942$^{ab}$ |
| 175 | 0 | 76.2$^{abc}$ | 6.4$^{d}$ | 3$^{c}$ | 35$^{c}$ | 8.4$^{fgh}$ | 0.31$^{de}$ | 2914$^{d}$ |

| Seed Rate (kg $ha^{-1}$) | Nitrogen Level | PH (cm) | SL (cm) | NTPP | NKPP | ABM t $ha^{-1}$ | HI (%) | GY (kg $ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|
| | 23 | 78.7$^{a}$ | 6.8$^{cd}$ | 4$^{b}$ | 35$^{cd}$ | 11.0$^{abcde}$ | 0.34$^{d}$ | 4083$^{bc}$ |
| | 46 | 67.1$^{d}$ | 7.1$^{abcd}$ | 5a | 36$^{bc}$ | 13.4$^{ab}$ | 0.38$^{ab}$ | 4155$^{bc}$ |
| | 69 | 67.3$^{d}$ | 6.9$^{abcd}$ | 5$^{a}$ | 37$^{bc}$ | 13.1$^{abc}$ | 0.38$^{ab}$ | 5037$^{a}$ |
| | 92 | 73.3$^{abcd}$ | 7.2$^{abc}$ | 5$^{a}$ | 40$^{ab}$ | 9.4$^{efg}$ | 0.38$^{ab}$ | 3897$^{c}$ |
| CV (%) | | 7.21 | 5.10 | 10.86 | 6.36 | 12.17 | 6.02 | 8.2 |
| LSD (5%) | | 8.72 | 0.78 | 0.87 | 4 | 2.46 | 0.04 | 634 |

PH (cm) = plant height in centimeter, SL = spike length in centimeter, NTPP = number of tillers per plant, NKPP = number of kernels per plant, ABM = aboveground biomass, HI = harvest index, GY = grain yield

***Table 4**. Interaction effect of seed rate and N level on bread wheat at Woliso.*

| Seed Rate (kg $ha^{-1}$) | Nitrogen Level | PH (cm) | SL (cm) | NTPP | NKPP | ABM t $ha^{-1}$ | HI (%) | GY (kg $ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|
| 125 | 0 | 66.5$^{bcd}$ | 7.73$^{bcd}$ | 5$^{de}$ | 33$^{c}$ | 4.4$^{bcd}$ | 0.33$^{b}$ | 1704$^{efg}$ |
| | 23 | 66.9$^{bcd}$ | 8.07$^{abc}$ | 5$^{cd}$ | 40$^{b}$ | 5.5$^{abcd}$ | 0.32$^{b}$ | 1739$^{efg}$ |
| | 46 | 72.5$^{ab}$ | 7.87$^{abcd}$ | 6$^{a}$ | 39$^{b}$ | 7.0$^{ab}$ | 0.36$^{ab}$ | 2492$^{ab}$ |
| | 69 | 68.3$^{abcd}$ | 8.53$^{ab}$ | 5$^{cd}$ | 41$^{b}$ | 6.4$^{abc}$ | 0.37$^{a}$ | 2431$^{ab}$ |
| | 92 | 70.5$^{abc}$ | 8.53$^{ab}$ | 5$^{cd}$ | 42$^{ab}$ | 5.5$^{abcd}$ | 0.34$^{ab}$ | 1893$^{cdef}$ |
| 150 | 0 | 63.3$^{d}$ | 7.73$^{bcd}$ | 4$^{f}$ | 40$^{b}$ | 5.2$^{bcd}$ | 0.30$^{cd}$ | 1563$^{fg}$ |
| | 23 | 67.5$^{bcd}$ | 7.53$^{cd}$ | 4$^{ef}$ | 39$^{b}$ | 5.5$^{abcd}$ | 0.35$^{bc}$ | 1949$^{cde}$ |
| | 46 | 69.3$^{abcd}$ | 7.83$^{bcd}$ | 6$^{a}$ | 41$^{ab}$ | 6.8$^{ab}$ | 0.32$^{bc}$ | 2210$^{bc}$ |
| | 69 | 74.2$^{a}$ | 8.73$^{a}$ | 6$^{a}$ | 44$^{a}$ | 7.5$^{a}$ | 0.38$^{a}$ | 2574$^{a}$ |
| | 92 | 69.3$^{abcd}$ | 8.33$^{abc}$ | 5$^{de}$ | 41$^{b}$ | 6.7$^{ab}$ | 0.32$^{b}$ | 2155$^{bc}$ |
| 175 | 0 | 53.0$^{e}$ | 7.10$^{d}$ | 4$^{ef}$ | 32$^{c}$ | 4.0$^{d}$ | 0.26$^{cd}$ | 1398$^{g}$ |
| | 23 | 66.1$^{bcd}$ | 7.10$^{d}$ | 5$^{cd}$ | 32$^{c}$ | 5.1$^{bcd}$ | 0.35$^{ab}$ | 1799$^{def}$ |
| | 46 | 64.4$^{bcd}$ | 8.03$^{abc}$ | 5$^{cd}$ | 42$^{ab}$ | 7.5$^{a}$ | 0.35$^{ab}$ | 1970$^{cde}$ |
| | 69 | 69.5$^{abcd}$ | 7.93$^{abcd}$ | 5$^{cd}$ | 35$^{c}$ | 7.6$^{a}$ | 0.29$^{bc}$ | 2183$^{bc}$ |
| | 92 | 69.5$^{abcd}$ | 7.93$^{abcd}$ | 6$^{a}$ | 41$^{b}$ | 6.5$^{abc}$ | 0.33$^{ab}$ | 2150$^{bcd}$ |
| CV (%) | | 4.4 | 5.10 | 6.03 | 4.87 | 17.60 | 8.78 | 10.12 |
| LSD (5%) | | 6.49 | 0.89 | 0.72 | 3.00 | 0.05 | 355 | 2.20 |

PH (cm) = plant height in centimeter, SL = spike length in centimeter, NTPP = number of tillers per plant, NKPP = number of kernels per plant, ABM = aboveground biomass, HI = harvest index, GY = grain yield

For economic analysis, a simple partial budget analysis was employed using [1] approach. For the analysis, factors that have significant effect were considered. Relevant data was collected to assess economic yield level. These include mainly the costs of inputs (labor, seed and fertilizer) and the current mean market prices of bread wheat yield was obtained by assessing the market at the time of harvest of crop of 2021 season. It was Analyzed separately by calculating gross benefit (GB), total costs (TCV), net benefit (NB), and the marginal rate of return (MRR) for each treatment. Seed cost of improved bread wheat kakaba variety was 25.00 Eth. birr per 1kg. Costs of fertilizer (Urea and NPSB) were 16.50 and 17.00Eth. birr per 1kg respectively and numbers of labor and their expenses were considered based on each activity of crop husbandry. Wheat yields were adjusted downwards by 10% to more closely approximate yields. The cost benefit analysis was calculated as TCV=the sum of cost input (labor, seed, NPS fertilizer and N fertilizer), AdY = grain yield x 10/100; GB = adjusted grain yield x variable cost of grain yield (price of yield), NB = gross benefit-total variable cost, MRR (%) = change of net benefit divided to change of total variable cost x 100.

The highest net benefit of 171531.88 EB ha$^{-1}$ with marginal rate of return of 351.14% was obtained from 175 kg ha$^{-1}$ seed rate with application of 69 kg N ha$^{-1}$ and the lower net benefit was 40534.38 EB ha$^{-1}$ with marginal rate return 83.71 % through application of 92 kg N ha$^{-1}$ (Table 5). Therefore, 175 kg ha$^{-1}$ seed rate with application of 69 kg N ha$^{-1}$ is economical feasible for bread wheat production in Ameya area.

The highest net benefit of 51675 EB ha$^{-1}$ with marginal rate of return of 115.22% was obtained from 150 kg ha$^{-1}$ seed rate with application of 69 kg N ha$^{-1}$ followed by net benefit of EB 46656.25 ha$^{-1}$ and marginal rate return of 95.51% from 175 kg ha$^{-1}$ seed rate with application of 69 kg N ha$^{-1}$ and the lower net benefit was 8125 EB ha$^{-1}$ with marginal rate return 18.01 % through application of 0 kg N ha$^{-1}$ at Woliso (Table 6). Therefore, 150 kg ha$^{-1}$ seed rate with application of 69 kg N ha$^{-1}$ is economical feasible for bread wheat production in Woliso area.

***Table 5****. Partial budget analysis at Ameya.*

| Seed Rate (kgha-1) | Nitrogen Level | Grain Yield (Kg ha$^{-1}$) | Gross Benefit (birr) | Cost of Urea (ETB ha$^{-1}$ | Labor cost | TVC | Net Benefit (ETB ha$^{-1}$) | MRR (%) |
|---|---|---|---|---|---|---|---|---|
| 125 | 0 | 2834.00 | 88562.50 | 0.00 | 42000.00 | 45125.00 | 43437.50 | 0 |
| | 23 | 3759.70 | 117490.63 | 825.00 | 42000.00 | 45950.00 | 71540.63 | 155.69 |
| | 46 | 4257.70 | 133053.13 | 1650.00 | 42000.00 | 46775.00 | 86278.13 | 184.45 |
| | 69 | 5132.00 | 160375.00 | 2475.00 | 42000.00 | 47600.00 | 112775.00 | 236.92 |
| | 92 | 2846.70 | 88959.38 | 3300.00 | 42000.00 | 48425.00 | 40534.38 | 83.71 |
| 150 | 0 | 2704.70 | 101426.25 | 0.00 | 42000.00 | 45750.00 | 55676.25 | 121.70 |
| | 23 | 4045.30 | 151698.75 | 825.00 | 42000.00 | 46575.00 | 105123.75 | 225.71 |
| | 46 | 4663.30 | 174873.75 | 1650.00 | 42000.00 | 47400.00 | 127473.75 | 268.93 |
| | 69 | 4941.70 | 185313.75 | 2475.00 | 42000.00 | 48225.00 | 137088.75 | 284.27 |
| | 92 | 5034.00 | 188775.00 | 3300.00 | 42000.00 | 49050.00 | 139725.00 | 284.86 |
| 175 | 0 | 2914.00 | 127487.50 | 0.00 | 42000.00 | 46375.00 | 81112.50 | 174.91 |
| | 23 | 4082.70 | 178618.13 | 825.00 | 42000.00 | 47200.00 | 131418.13 | 278.43 |
| | 46 | 4155.00 | 181781.25 | 1650.00 | 42000.00 | 48025.00 | 133756.25 | 278.51 |
| | 69 | 5037.30 | 220381.88 | 2475.00 | 42000.00 | 48850.00 | 171531.88 | 351.14 |
| | 92 | 3897.00 | 170493.75 | 3300.00 | 42000.00 | 49675.00 | 120818.75 | 243.22 |

TVC = total value cost, MRR (%) = marginal rate of return in percentage

***Table 6****. Partial budget analysis at Woliso.*

| Seed Rate (kgha$^{-1}$) | Nitrogen Level | Grain Yield (Kg ha$^{-1}$) | Gross Benefit (birr) | Cost of Urea (ETB ha$^{-1}$ | Labor cost | TVC | Net Benefit (ETB ha$^{-1}$) | MRR (%) |
|---|---|---|---|---|---|---|---|---|
| 125 | 0 | 1704.00 | 53250.00 | 0.00 | 42000.00 | 45125.00 | 8125.00 | 0 |
| | 23 | 1739.00 | 54343.75 | 825.00 | 42000.00 | 45950.00 | 8393.75 | 18.27 |
| | 46 | 2492.00 | 77875.00 | 1650.00 | 42000.00 | 46775.00 | 31100.00 | 66.49 |
| | 69 | 2431.00 | 75968.75 | 2475.00 | 42000.00 | 47600.00 | 28368.75 | 59.60 |
| | 92 | 1893.00 | 59156.25 | 3300.00 | 42000.00 | 48425.00 | 10731.25 | 22.16 |

| Seed Rate ($kgha^{-1}$) | Nitrogen Level | Grain Yield ($Kg\ ha^{-1}$) | Gross Benefit (birr) | Cost of Urea ($ETB\ ha^{-1}$ | Labor cost | TVC | Net Benefit ($ETB\ ha^{-1}$) | MRR (%) |
|---|---|---|---|---|---|---|---|---|
| 150 | 0 | 1563.00 | 58612.50 | 0.00 | 42000.00 | 42375.00 | 16237.50 | 38.32 |
| | 23 | 1949.00 | 73087.50 | 825.00 | 42000.00 | 43200.00 | 29887.50 | 69.18 |
| | 46 | 2210.00 | 82875.00 | 1650.00 | 42000.00 | 44025.00 | 38850.00 | 88.25 |
| | 69 | 2574.00 | 96525.00 | 2475.00 | 42000.00 | 44850.00 | 51675.00 | 115.22 |
| | 92 | 2155.00 | 80812.50 | 3300.00 | 42000.00 | 45675.00 | 35137.50 | 76.93 |
| 175 | 0 | 1398.00 | 61162.50 | 0.00 | 42000.00 | 46375.00 | 14787.50 | 31.89 |
| | 23 | 1799.00 | 78706.25 | 825.00 | 42000.00 | 47200.00 | 31506.25 | 66.75 |
| | 46 | 1970.00 | 86187.50 | 1650.00 | 42000.00 | 48025.00 | 38162.50 | 79.46 |
| | 69 | 2183.00 | 95506.25 | 2475.00 | 42000.00 | 48850.00 | 46656.25 | 95.51 |
| | 92 | 2150.00 | 94062.50 | 3300.00 | 42000.00 | 49675.00 | 44387.50 | 89.36 |

TVC = total value cost, MRR (%) = marginal rate of return in percentage

## 4. Conclusion and Recommendation

Significant differences have been observed among the bread wheat seed rate which could be due to their differences in nitrogen level. Similarly, application of different rates of nitrogen/Urea had significant effect on some agronomic traits of wheat. Moreover, the seed rate with nitrogen fertilizer rate interaction had significant effect on some agronomic traits. The seed rate and nitrogen level showed significant variation in some of the yield and yield parameters. Generally, spike length, number of tillers per plant and number of kernels per spike of wheat were increased with increased at some level in nitrogen fertilizer rate for the three seed rate at both locations. Highest number of kernels per spike (42.00, 44.00) and the highest mean above ground biomass yield (13.70 t $ha^{-1}$, 7.5 t $ha^{-1}$) were obtained for 150 kg $ha^{-1}$ seed rate with 69 N kg $ha^{-1}$ application at Ameya and Woliso sites respectively. The most important characters in evaluating the performance of the irrigated bread wheat as these characters are highly determinant in economical view of crop production. Thus, the seed rate and nitrogen level of bread wheat, as noticed from their performance on various growths and phenological characters treatments including its response to seed rate and nitrogen application, might be used alternatively under Amaya and Woliso agroecology's.

Ultimately the highest net benefit of 171531.88 EB $ha^{-1}$ with marginal rate of return of 351.14% was obtained from 175 kg $ha^{-1}$ seed rate with application of 69 kg N $ha^{-1}$ and the lower net benefit was 40534.38 EB $ha^{-1}$ with marginal rate return 83.71 % through application of 92 kg N $ha^{-1}$. Therefore, 175 kg $ha^{-1}$ seed rate with application of 69 kg N $ha^{-1}$ is economical feasible for bread wheat production in Ameya area and also the highest net benefit of 51675 EB $ha^{-1}$ with marginal rate of return of 115.22% was obtained from 150 kg $ha^{-1}$ seed rate with application of 69 kg N $ha^{-1}$ at Woliso area.

## Abbreviations

| | |
|---|---|
| EB | Ethiopian Birr |
| TVC | Total Value Cost |
| MRR | Marginal Rate of Return |

## Author Contributions

**Takele Zike:** Conceptualization, Data curation, Formal Analysis, Methodology, Software, Supervision, Visualization, Writing - original draft, Writing - review & editing

**Bethel Nekir:** Conceptualization, Funding acquisition, Methodology, Project administration, Writing - review & editing

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## Conflicts of Interest

The authors declare no conflicts of interest.

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